Overview of the Florida Department of Environmental Protection's Integrated Water Resource Monitoring Efforts and the Design Plan of the Status Network

Florida Department of Environmental Protection
Division of Water Facilities

Watershed Management Program
Ambient Monitoring Section

May 1999

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Chapter I

An Overview of Florida's Integrated Water Resources Monitoring Efforts

(Rick Copeland, May 1999)

Why Monitor Our Water Resources?

Most Floridians are aware that the state has experienced tremendous population growth over the past several decades. The growth is expected to continue. The increased population threatens the quality and quantity of both surface and ground water. Recognizing the value of our water resources, the state has acted to protect them. For example, Florida Statutes, Chapters 373, 376 and 403 define the authority for managing Florida's water resources.

One important aspect of managing our water is water resource monitoring. Both the federal government and the state of Florida recognize that we can not manage our resources without monitoring them. At the federal level, the "Clean Water Act" (Federal Water Pollution Control Act, 33 U.S.C. 1251-1375, as amended) [305(b)] directs each state to: (1) prepare and submit a report every two years which includes a description of water quality of all of its navigable surface waters to the U.S. Environmental Protection Agency (EPA) and (2) to protect balanced indigenous populations. At the state level, "the Water Quality Assurance Act" (Florida Statutes, Section 403.063 (1997)) directs the Florida Department of Environmental Protection (DEP) to establish and maintain a ground water quality monitoring network designed to detect or predict contamination of the state's ground water resources. The Department's Office of Ecosystem Management Recommendation F-7 states that the Department, at the ecosystem management area level, should create and coordinate an aggressive statewide monitoring program to determine the ecological health, status and trends for all pertinent ecosystem components statewide. This should be coupled with an inventory of biologic, hydrologic, geologic, air and anthropogenic resources. Finally, monitoring is required through a series of rules that govern the Department's permitting activities (Florida Statutes, Chapter 376 (1997)). The Department has been assigned the responsibility of coordinating monitoring activities within the state. Florida Administrative Code R. 62-40.540 of Florida's Water Policy states that the Department shall coordinate district, state agency and local government water quality monitoring activities in order to improve data quality and reduce costs.

In 1996, DEP initiated an effort to re-design its water resource monitoring efforts. The purpose was to create an efficient, multi-resource, comprehensive monitoring network. The revised network is called the Integrated Water Resource Monitoring (IWRM) Network. It is designed to fulfill many of the department's monitoring needs. These needs include the 305(b) reporting requirement, total maximum daily load (TMDL) establishment, ecosystem management needs, permitting, and the development and testing of biocriteria. The design of the integrated approach has resulted in the adoption of a three-tiered, compliance monitoring framework that has an integrated sampling design and provides information for many of the department's issues.

The purpose of this document is to provide an overview of the three-tiered, IWRM approach to monitoring and to provide the design plan of the Status Network, which emphasizes the major elements of Tier I. The other portion of Tier I will be referred to as the Temporal Variability (TV) Network. The TV Network will be discussed briefly in this document. However, a separate, written plan for the TV Network is scheduled for completion by October 1999.

It should be pointed out that additional, written plans for Tiers II and III will be prepared before the end of the calendar year 1999. It should also be understood that the design plans for each of the various subnetworks of the IWRM Network will be living documents. As updates to portions of the plans are made, they will replace older versions.

Mission Statement, Goal and Objectives of the IWRM Network

Mission Statement

The mission of the Integrated Water Resource Monitoring Network is to establish and maintain an integrated network in order to monitor Florida's surface water, ground water, aquatic biology, sediments and other pertinent aquatic media in an efficient, systematic and scientifically defensible manner. The purpose of the monitoring is to assist the Division of Water Facilities, along with the Division of Waste Management, other Departmental programs, plus other agencies and the public, in describing the water quality, detecting pollution, and predicting contamination of the State's water resources.

Goal

The goal of the IWRM Network is to provide scientifically defensible, statewide data and information on the important chemical, physical and pertinent biological characteristics of water, including sediments, from the major surface water bodies, the major aquifer systems, and the coastal waters of the state. The information generated by the integrated network is to be the basis for reporting and advising relevant Departmental and other governmental agencies on the status and trends of Florida's water quality.

Objectives

1) Identify, document and predict the conditions of Florida's water resources. Assist in determining the status of an ecosystem's "environmental health".
2) Establish the water quality of relatively "pristine" aquatic reference sites for comparison with affected surface and ground waters and ecosystems.
3) Document potential problem areas.
4) Identify water quality changes over time in pertinent water bodies.
5) Provide information to managers, legislators, agencies and the public.
6) Determine the proportion of the state's water bodies that meet water quality criteria.

Redesign of the Department's Ambient Monitoring Networks

As a partial response to the issues mentioned above and the desire to increase the efficiency of monitoring, the Department's Division of Water Facilities restructured its monitoring programs in July of 1996. As a consequence, the Division's surface water and ground water ambient monitoring networks were merged and are currently operated by the Ambient Monitoring Section (AMS). The AMS was also assigned the task of increasing the efficiency of monitoring and coordinating an effort to integrate its monitoring efforts. As a result, when fully operational the redesigned IWRM Network will generate data from surface water, ground water, biological systems and sediments. In addition, it will eventually include regulatory and non-regulatory data and data from both inside and outside the Department.

In the late 1996, it was decided that an IWRM Committee should be formed. The committee includes members from the various organizational units of the Department, including its District offices, plus the water management districts (WMDs), counties, EPA, the U.S. Geological Survey (USGS) and private consultants.

Integrated and Tiered Approach to Monitoring

By mid-1997 the IWRM Committee decided that the most efficient form of monitoring Florida's water resources is obtained by using a three tiered monitoring approach. The Department's revised, statewide Status and TV Networks represent Tier I. Tier II includes basin assessments, the monitoring required for TMDLs, and other types of monitoring that is not included in either Tier I or III. Tier III includes all monitoring tied to regulatory permits issued by DEP and the monitoring associated with evaluating the effectiveness of best management practices and TMDLs. In general, Tier I will address statewide and regional (within Florida) questions. Tier II will address basin-specific to stream-segment-specific questions, while Tier III will generally answer site-specific questions.

Figure I-1 is a schematic of the relationships among monitoring activities within the umbrella IWRM Network. When the IWRM Network is fully implemented, the regulated community will monitor for permit-specific analytes and for indicators that are compatible with those of both Tiers I and II and the indicators of each of the water resources are compatible with each other. Data and information will flow from Tier I to Tier II and from Tier II to Tier III. These data and information flowing among the tiers will keep monitoring efforts of the various tiers from being isolated from one another and should ensure that the concepts of integrated monitoring are met.

The Division of Water Facilities will conduct the monitoring of Florida's fresh waters. The monitoring of the state's estuaries will be conducted by DEP's Florida Marine Resource Research Institute (FMRI). It should also be noted that wetlands are currently not included in the list of water resources to be monitored in the IWRM Network. There are two reasons for this: (1) lack of established biological criteria and (2) lack of adequate funding. However, DEP is in the process of developing biological criteria for wetlands. When these are established, and additional funds become available, Florida will add the monitoring of wetland resources to IWRM.

Currently, FMRI is working closely with the Division of Water Facilities and is also developing a tiered monitoring approach for Florida's estuaries. At the current time (December 1998) the FMRI is developing a monitoring plan for estuary monitoring.

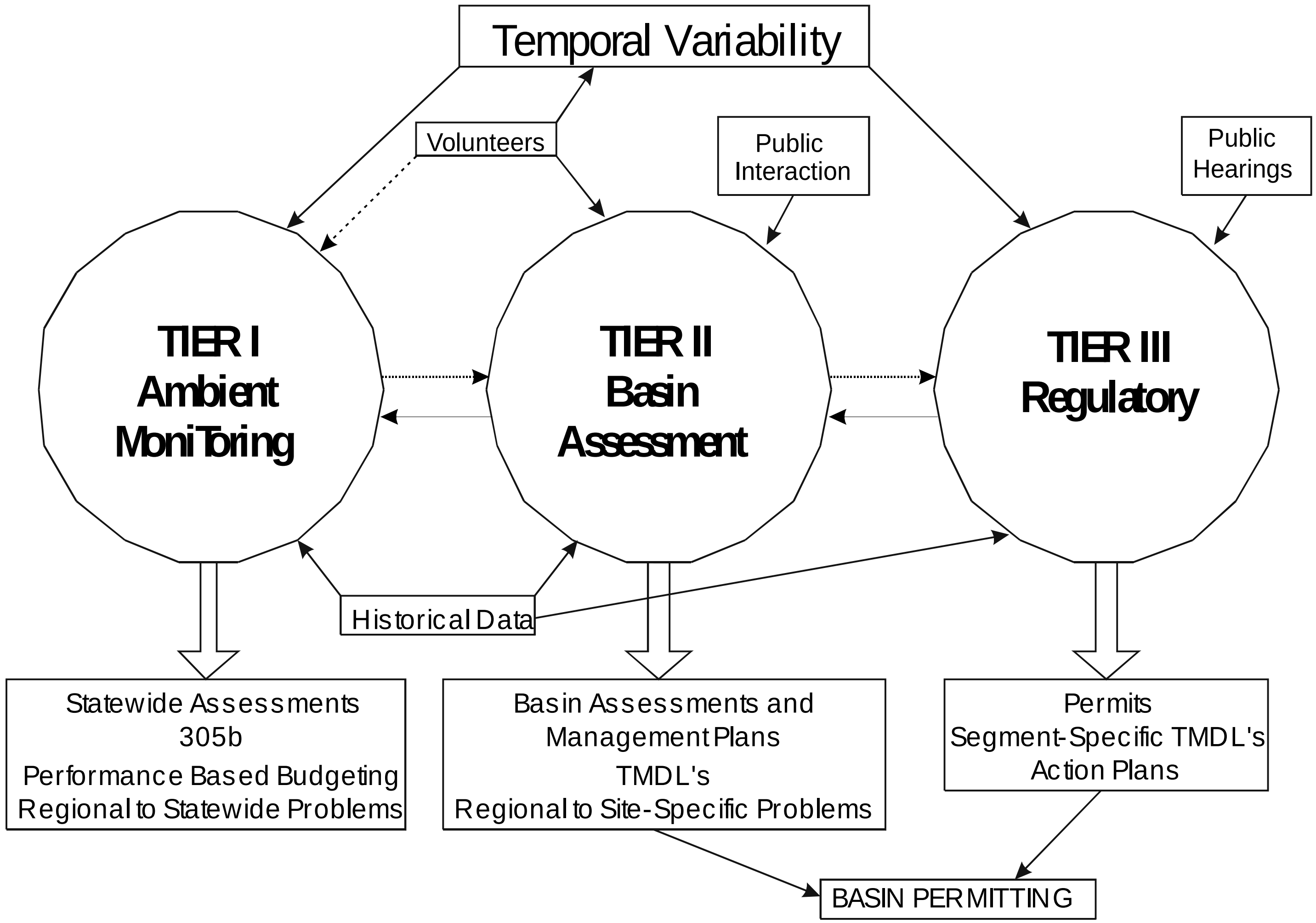

Figure I-1 Schematic of Florida's Integrated Water Resource Monitoring Network

Chapter II

The Monitoring Process of the Status Network

(Rick Copeland, May 1999)

Introduction

The purpose of the Status Network is to characterize the environmental conditions of Florida's water resources and to determine if those conditions are changing over time. The following addresses the probabilistic nature of the Tier I Status Network. The design is significantly influenced by EPA's Environmental Mapping and Assessment Program (EMAP). The probabilistic nature of the design of the Status Network allows us to answer broad-based, statewide to basin-wide questions. The design also enables us to track the overall progress toward sound environmental management. As will be demonstrated, it does not address issues related to individual water bodies, unless the probabilistic program is designed at that spatial scale. Those issues will be addressed in Tiers II and III and will be discussed later.

Description of the Monitoring Process

Administratively, Florida is divided into five WMDs (Figure II-1) and six regional DEP Districts (Figure II-2). The WMDs are statutorily responsible for water quantity issues, while DEP is statutorily responsible for water quality issues. Since the two responsibilities often overlap, the WMDs and DEP have developed a strong working relationship over the years. It is hoped that the five WMDs will continue to work closely with the Department regarding monitoring and to assist, under contract, DEP in sample collection with regard to Florida's status monitoring efforts. In addition, DEP's central laboratory is committed to conducting the analyses of the samples.

For the Status Network, it was decided to divide the state into five primary spatial strata that coincide with the five WMDs. Secondary spatial strata were determined (reporting units (RUs) as one or more of the hydrologic units comprising the WMDs (Figure II-3). Each WMD was divided into four RUs. The four RUs within each WMD (Figure II-4) are the basis of a five-year rotating monitoring philosophy. During the five-year cycle, all RUs from each WMD will be sampled, in a random sequence and one RU will randomly be selected to be sampled twice.

In order to monitor short-term issues related to its water resources, temporal variability monitoring will be conducted. To assist temporal variability issues at the RU scale, DEP will take a two pronged approach. First, one of the four RUs of each WMD will be randomly selected and sampled a second time during the five-year cycle. For example, in northwest Florida RU C (Figure II-5) will be sampled during year three and again in year five. To the extent possible, the same sites sampled in year three will be sampled again in year five. Second, for surface water DEP will sample approximately 80 temporal variability, or trend, stations monthly. Most of 52 drainage basins (hydrologic units) will have at least one temporal variability station located at its lower end. Several stations will be located on major streams near the state line. The remainder of the stations will be strategically located throughout Florida. Stream discharge measurements will be collected at most of the fixed stations, as well as chemical and, possibly, biological data. A separate monitoring design plan is currently being produced for the temporal variability stations. The network will be referred to as the Temporal Variability (TV) Network. As previously mentioned, included in the document will be a discussion of a Ground Water TV Network, yet to be established.

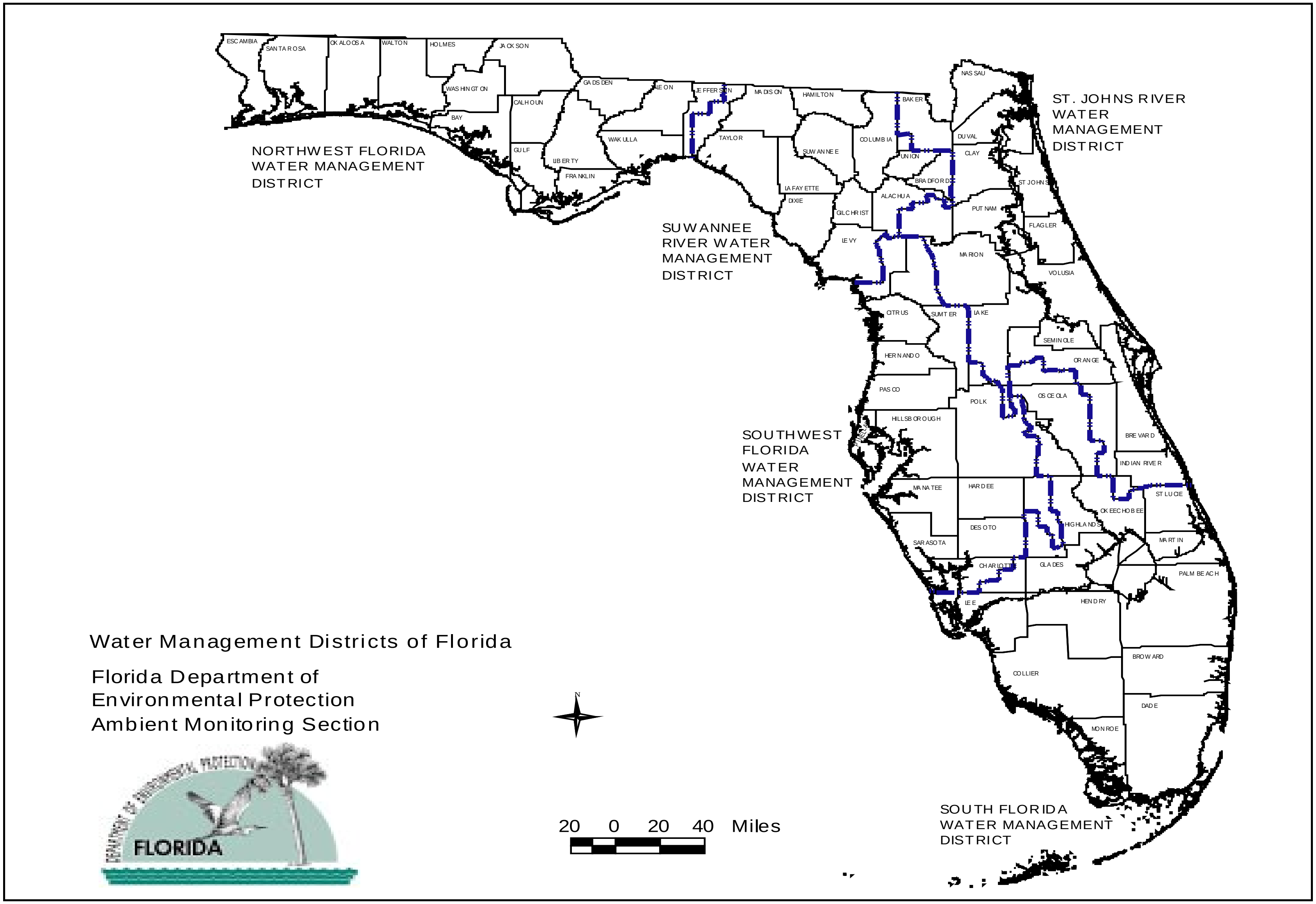
ESCAMBIA
SANTA ROSA
OKALOOSA
WALTON
HOLMES
JACKSON
WASHINGTON
BAY
CALHOUN
GULF
LIBERTY
FRANKLIN
GADSDEN
LEON
WAKULLA
JEFFERSON
MADISON
TAYLOR
HAMILTON
SUWANNEE
LAFAYETTE
DIXIE
COLUMBIA
BAKER
UNION
BRADFORD
NASSAU
DUVAL
CLAY
ST JOHNS
ALACHUA
GILCHRIST
LEVY
PUTNAM
FLAGLER
MARION
VOLUSIA
CITRUS
SUMTER
LAKE
SEMINOLE
HERNANDO
ORANGE
PASCO
POLK
OSCEOLA
HILLSBOROUGH
BREVARD
INDIAN RIVER
MANATEE
HARDEE
ST LUCIE
OKEECHOBEE
HIGHLANDS
DESOTO
SARASOTA
MARTIN
CHARLOTTE
GLADES
PALM BEACH
LEE
HENDRY
BROWARD
COLLIER
DADE
MONROE
NORTHWEST FLORIDA WATER MANAGEMENT DISTRICT
SUWANNEE RIVER WATER MANAGEMENT DISTRICT
ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
SOUTH FLORIDA WATER MANAGEMENT DISTRICT
Water Management Districts of Florida
Florida Department of
Environmental Protection
Ambient Monitoring Section
FLORIDA
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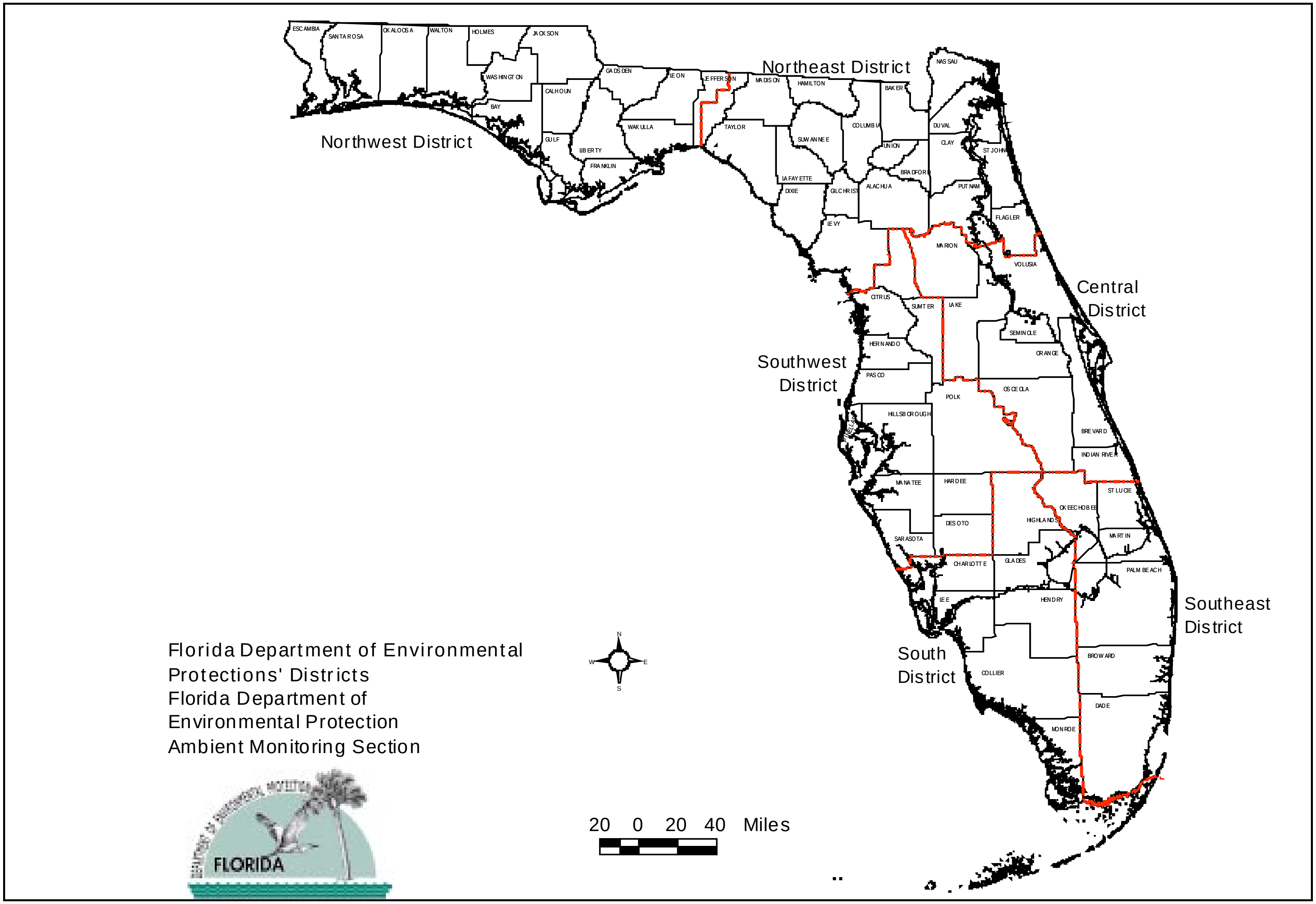
Figure II-1



Northwest District
Northeast District
Central District
Southwest District
South District
Southeast District
Florida Department of Environmental Protections' Districts
Florida Department of Environmental Protection
Ambient Monitoring Section
FLORIDA
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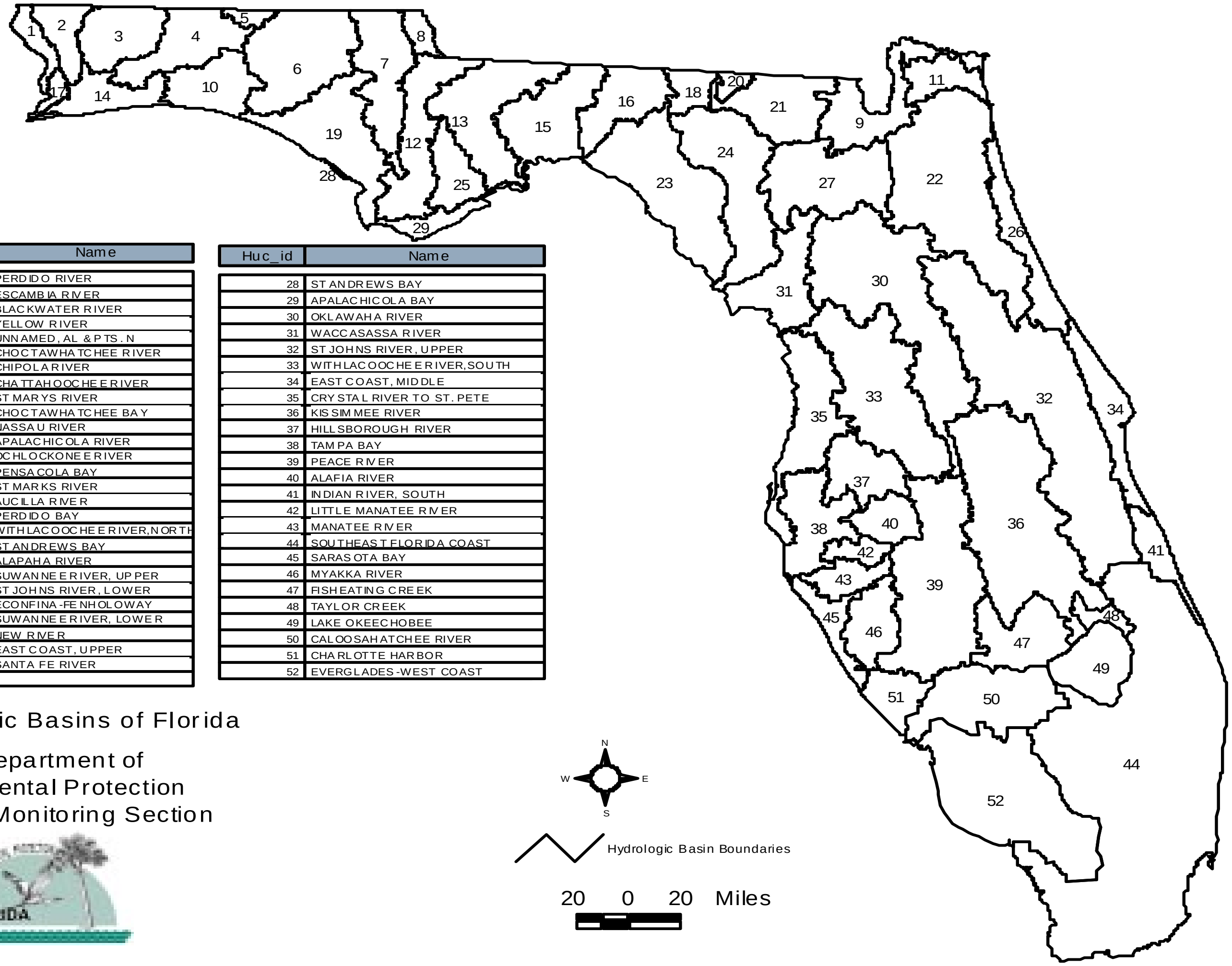
Figure II-2



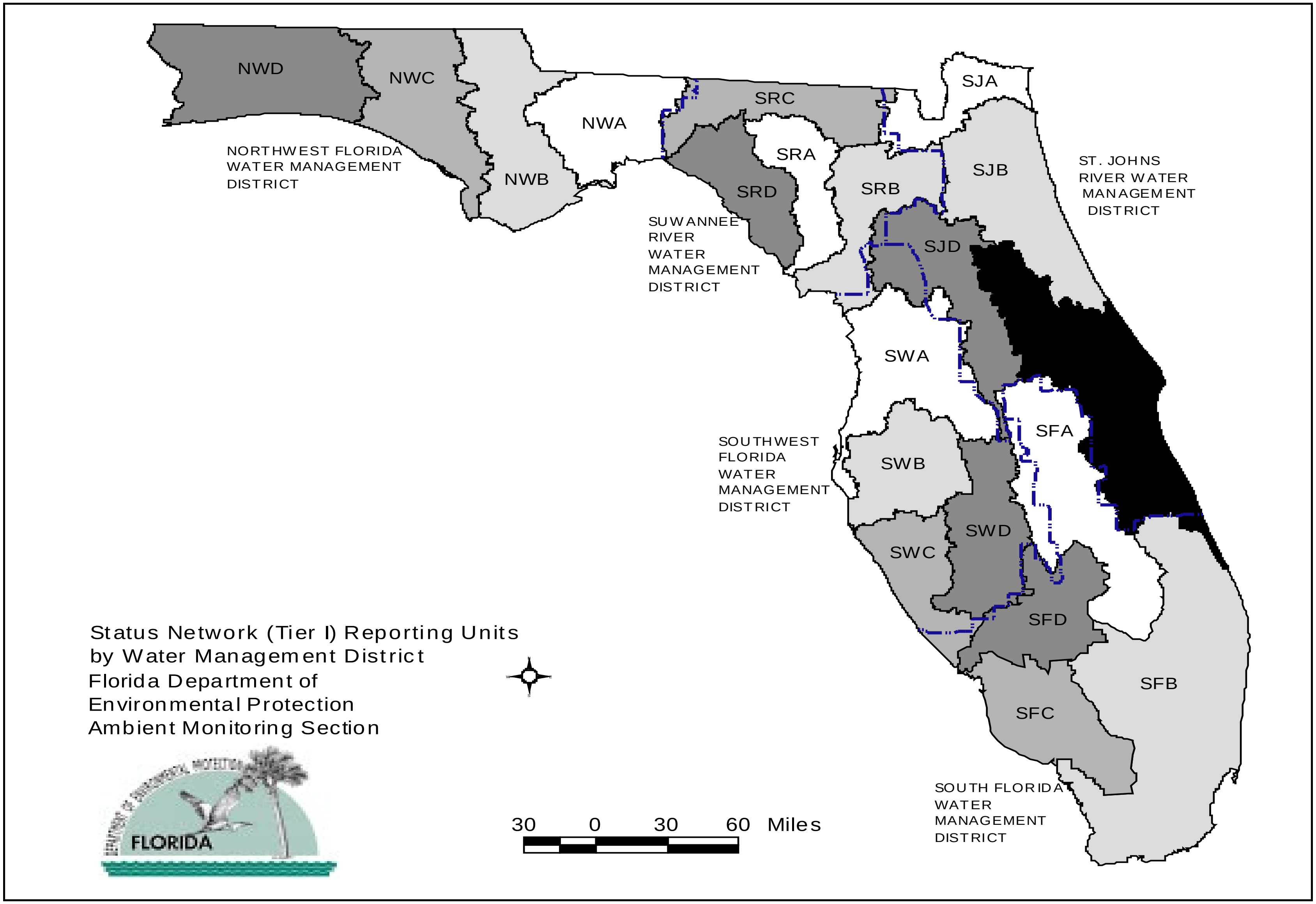
Huc_id	Name
1	PERDIDO RIVER
2	ESCAMBIA RIVER
3	BLACKWATER RIVER
4	YELLOW RIVER
5	UNNAMED, AL & PTS. N
6	CHOCTAWHATCHEE RIVER
7	CHIPOLA RIVER
8	CHATTAHOOCHEE RIVER
9	ST MARYS RIVER
10	CHOCTAWHATCHEE BAY
11	NASSAU RIVER
12	APALACHICOLA RIVER
13	OCHLOCKONEE RIVER
14	PENSACOLA BAY
15	ST MARKS RIVER
16	AUCILLA RIVER
17	PERDIDO BAY
18	WITHLACOOCHEE RIVER, NORTH
19	ST ANDREWS BAY
20	ALAPAHA RIVER
21	SUWANNEE RIVER, UPPER
22	ST JOHNS RIVER, LOWER
23	ECONFINA-FENHOLOWAY
24	SUWANNEE RIVER, LOWER
25	NEW RIVER
26	EAST COAST, UPPER
	SANTA FE RIVER

Huc_id	Name
28	ST ANDREWS BAY
29	APALACHICOLA BAY
30	OKLAWAHA RIVER
31	WACCASASSA RIVER
32	ST JOHNS RIVER, UPPER
33	WITHLACOOCHEE RIVER, SOUTH
34	EAST COAST, MIDDLE
35	CRYSTAL RIVER TO ST. PETE
36	KISSIMMEE RIVER
37	HILLSBOROUGH RIVER
38	TAMPA BAY
39	PEACE RIVER
40	ALAFIA RIVER
41	INDIAN RIVER, SOUTH
42	LITTLE MANATEE RIVER
43	MANATEE RIVER
44	SOUTHEAST FLORIDA COAST
45	SARASOTA BAY
46	MYAKKA RIVER
47	FISHEATING CREEK
48	TAYLOR CREEK
49	LAKE OKEECHOBEE
50	CALOOSAHATCHEE RIVER
51	CHARLOTTE HARBOR
52	EVERGLADES-WEST COAST

Hydrologic Basins of Florida

Florida Department of
Environmental Protection
Ambient Monitoring Section

Figure II-3


NWD
NWC
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SRC
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SJA
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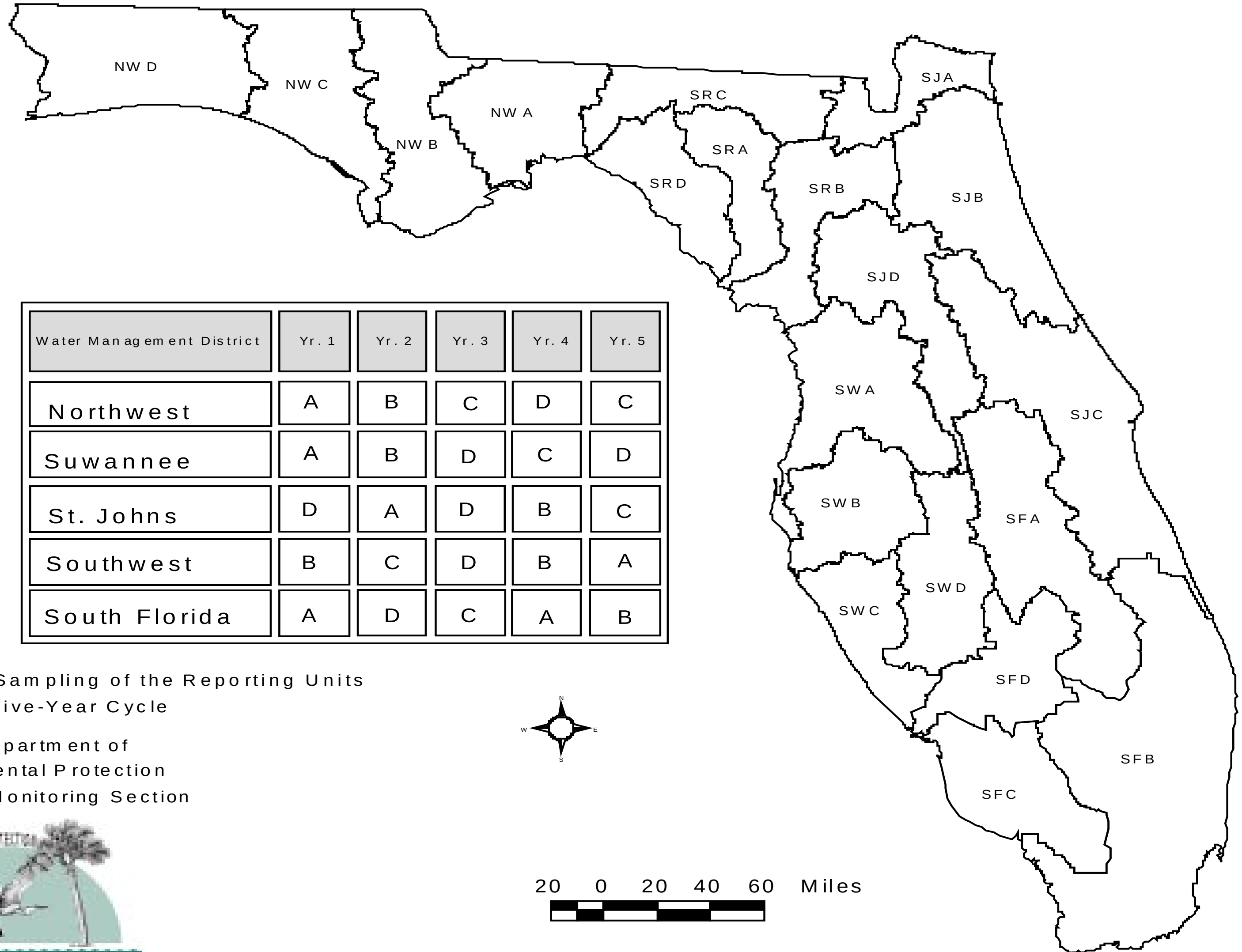
SFC
SFD
NORTHWEST FLORIDA WATER MANAGEMENT DISTRICT
SUWANNEE RIVER WATER MANAGEMENT DISTRICT
ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
SOUTH FLORIDA WATER MANAGEMENT DISTRICT
Status Network (Tier I) Reporting Units
by Water Management District
Florida Department of
Environmental Protection
Ambient Monitoring Section
FLORIDA
30 0 30 60 Miles

Figure II-4



Water Management District	Yr. 1	Yr. 2	Yr. 3	Yr. 4	Yr. 5
Northwest	A	B	C	D	C
Suwannee	A	B	D	C	D
St. Johns	D	A	D	B	C
Southwest	B	C	D	B	A
South Florida	A	D	C	A	B

Order of Sampling of the Reporting Units
for First Five-Year Cycle

Florida Department of
Environmental Protection
Ambient Monitoring Section

Figure II-5

Turning attention back to the reporting units, each year 30 random samples will be collected from each of six water resources for five RUs. The resources are: (1) low order streams (stream order 1- 4), (2) high order streams (stream order > 4) plus canals, (3) small lakes (1-10 hectares), (4) large lakes (>10 hectares), (5) confined aquifers and (6) unconfined aquifers plus springs. Thus, including quality assurance samples, for any given year (e.g. year one) over 900 samples will be collected. The indicator list will consist of both chemical and biological data. The indicator list is found in Table II-1.

The same sampling and analytical methodologies will be used for all of the RUs of the state. This will enable DEP to compare the conditions of RU A to RU B, compare RU A to RU A over time and to assess issues of statewide concern in a consistent manner. For example, DEP will be able to answer questions of statewide concern such as: (1) "What are the concentrations of nitrate in Florida's ground waters?" and (2) "Are the nitrate concentrations decreasing over time?"

Relationship with Tiers II and III Monitoring

The main purpose of basin assessment monitoring to occur in Tier II will be to determine the extent and severity of the problem water bodies, to develop management plans to "fix" the problems, and to monitor special water bodies of Florida. For example, Florida has a classification of surface water bodies known as Outstanding Florida Waters. Because of their ecological value or exceptional water quality, these water bodies have special interest to the state but are not necessarily in danger of becoming impaired. Tier II monitoring will also be used to set TMDLs for water bodies that have been designated as needing them.

Regarding Tier II, Florida will also address basin monitoring with a rotating basin approach using a five-year cycle. However, this monitoring may differ from the Tier I cycle. Previously, it was mentioned that DEP is divided into six districts. Each DEP District will be also divided into four RUs and the DEP Districts will take the lead role in monitoring those units (Figure II-6). The Tier II RU areas (referred to as groups) are based on the number of permitted facilities located within them and the number of water bodies that need TMDL assessments. The motivation for this design is the distribution of the workload required at the DEP District offices. As an example, suppose that the Southwest DEP District is subdivided into the four areas as depicted in Figure II-7. Groups 1 and 2 represent the Tampa Bay region. This area has, by far, the most permitted facilities located within the Southwest DEP District. Under the targeted monitoring plan, selected water bodies within Groups 1 and 2 will be monitored and assessed during year one and two. During year three, Group 3 will be monitored. Then, during year four Group 5 will be sampled and Group 4 will be monitored in year five.

One should note that the Tier II monitoring cycle begins one year after the beginning of the Tier I cycle. This will ensure that data and information generated from the Status Network can be used by those conducting assessment monitoring.

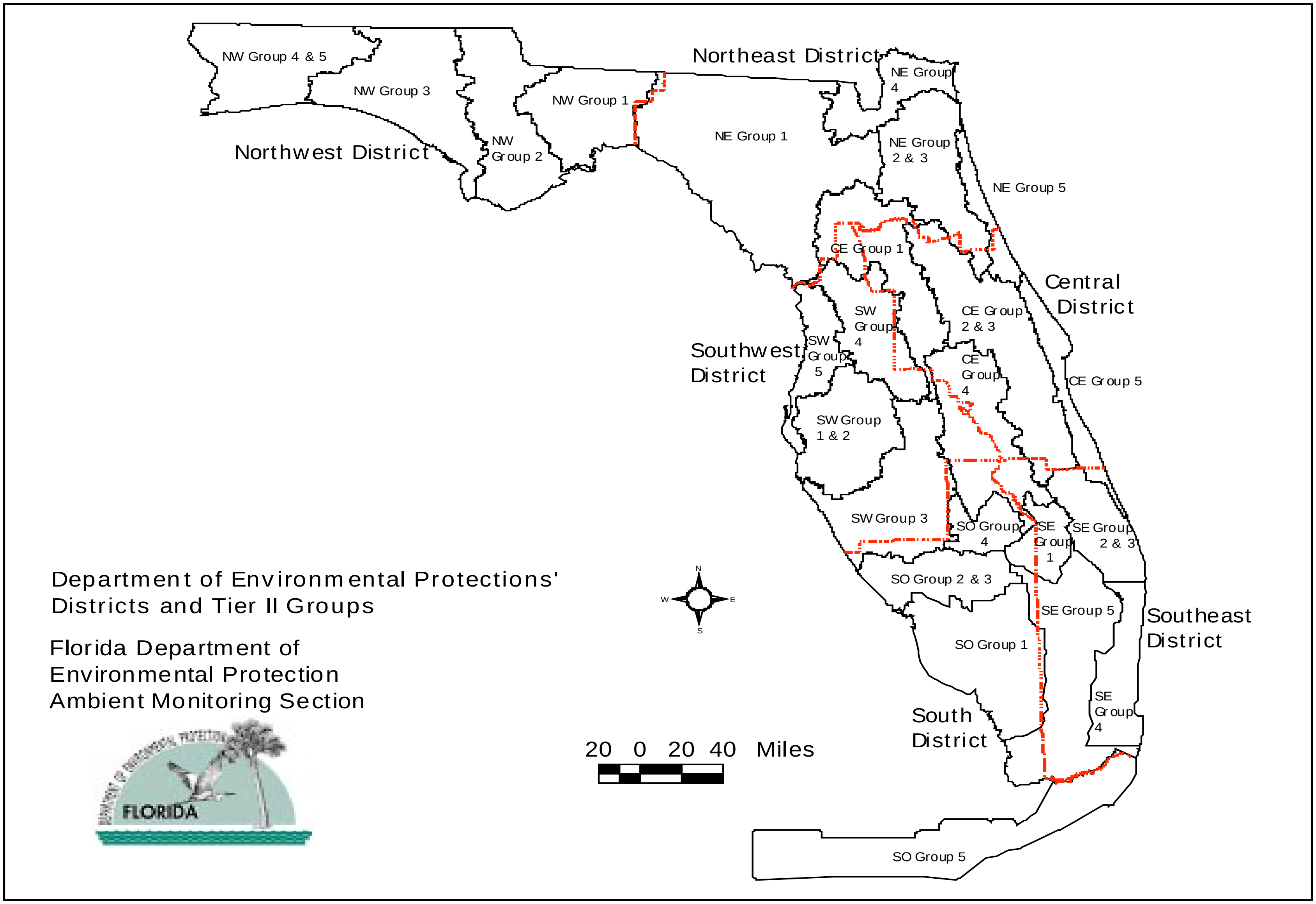
Tier II monitoring efforts will address the same six water resources as those of Tier I. However, it will monitor resources only if warranted. If applicable, monitoring will include one or more indicators/analytes listed in Table II-1, plus others as needed.

The monitoring efforts of Tier II will not be restricted to participation by DEP and its contractors. Before monitoring commences, an evaluation of existing data and information, including those generated in Tier I will be evaluated. Also, non-DEP stakeholders will be brought into the process. The stakeholders will include the general public, federal and state agencies, WMDs and local governments. Stakeholder input will be paramount in establishing the proper monitoring strategies for selected water bodies. The use of volunteers and interagency cooperators to assist in monitoring will be imperative. Stake holder involvement will enable the participants to pool their resources and assure that the best interest of the public is served.

It should be noted that basin management plans and best management plans (BMPs) will be developed during the Tier II cycle. It is hoped that regulatory permits will be issued at the end of each Tier II monitoring cycle. This will enable information from Tier II to be "fed" into Tier III (and vice versa) and will influence the Department's permit activities.

As mentioned previously, Tier III includes the monitoring of individual regulatory permits and the effectiveness of best management practices. DEP determines how monitoring is to be conducted and the actual monitoring efforts of Tier III are the responsibility of the permittees and/or their contractors.

By invoking Best Management Practices in Tier II and refining its Tier III monitoring activities as needed, the quality of Florida's water resources should improve. Every five years the monitoring activities of Tier I will enable the state to objectively determine the status of its water resources. Thus, the results of Status Network monitoring will serve as Florida's "score card" for managing water quality.


Department of Environmental Protections'
Districts and Tier II Groups
Florida Department of
Environmental Protection
Ambient Monitoring Section
Northwest District
Northeast District
Central
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Southwest
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Southeast
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South
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NW Group 4 & 5
NW Group 3
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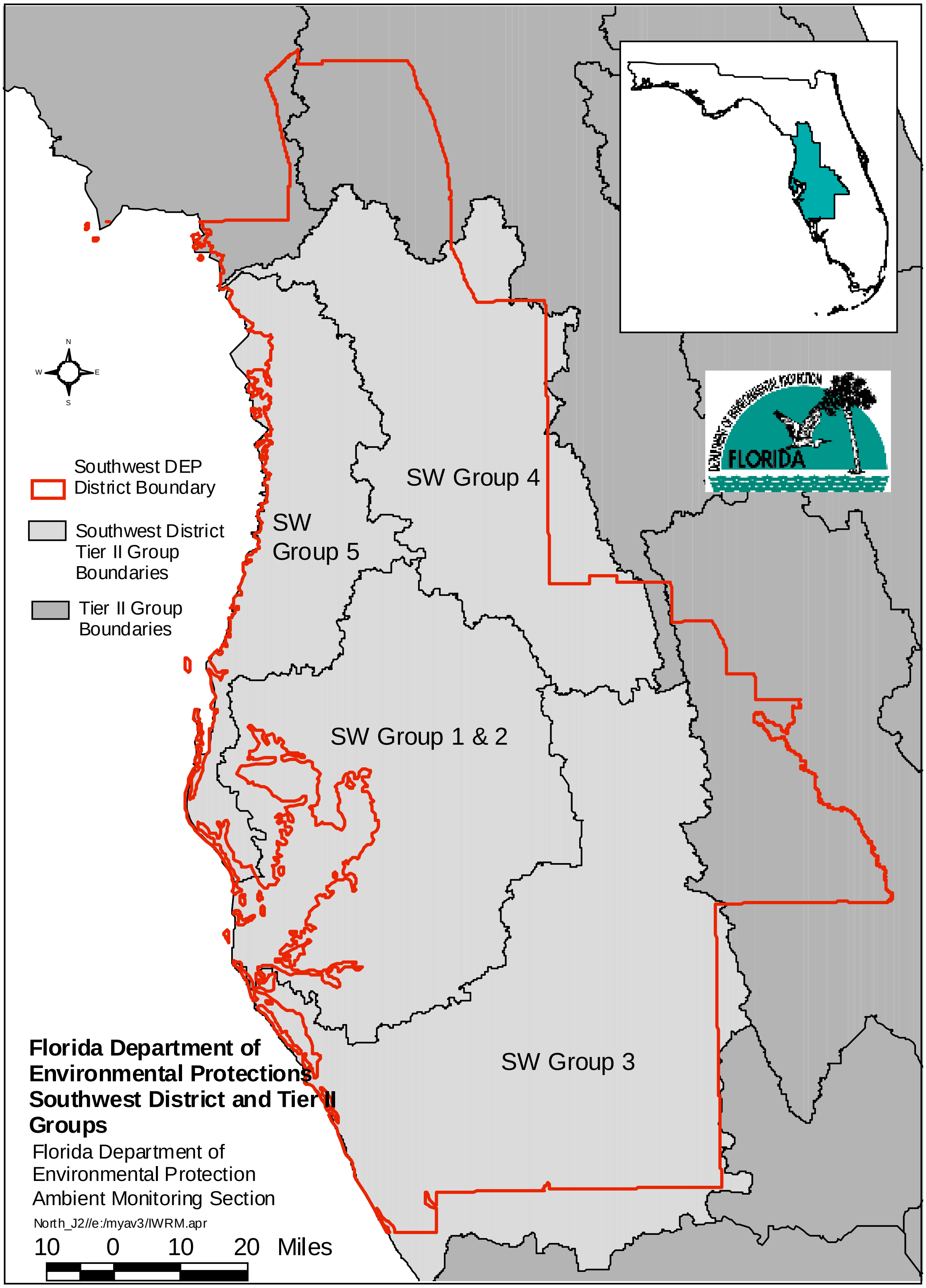
Figure II-6


SW Group 4
SW Group 5
SW Group 1 & 2
SW Group 3
Southwest DEP District Boundary
Southwest District Tier II Group Boundaries
Tier II Group Boundaries
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Florida Department of Environmental Protections Southwest District and Tier II Groups
Florida Department of Environmental Protection
Ambient Monitoring Section
North_J2//e:/myav3/IWRM.apr
10 0 10 20 Miles

Figure II-7

Table II-1 Status Monitoring Indicator List

INDICATOR	Lakes (lg)	Lakes (sm)	Streams (ho)	Streams (lo)	Aquifers
Calcium	T	T	T	T	D
Magnesium	T	T	T	T	D
Sodium	T	T	T	T	D
Potassium	T	T	T	T	D
Chloride	T	T	T	T	D
Sulfate	T	T	T	T	D
Fluoride	T	T	T	T	D
Alkalinity	T	T	T	T	D
Nitrate + Nitrite	T	T	T	T	D
Ammonia	T	T	T	T	D
Kjeldahl Nitrogen	T	T	T	T	D
Phosphorous	T	T	T	T	D
ortho-Phosphate	D	D	D	D	D
Organic Carbon	T	T	T	T	T
Dissolved Solids	T	T	T	T	D
Suspended Solids	T	T	T	T	T
Turbidity	T	T	T	T	T
Color	T	T	T	T	T
Chlorophyll-A	T	T	T	T	
Total Coliform	T	T	T	T	T
Fecal Coliform	T	T	T	T	T
Water Temperature	X	X	X	X	X
pH	X	X	X	X	X
Specific Conductance/Salinity	X	X	X	X	X
Dissolved Oxygen	X	X	X	X	X
Secchi Depth	X	X	X	X	
Total Depth	X	X	X	X	
Sample Depth	X	X	X	X	
Habitat Assessment	X	X	X	X	
Bio-Recon	Z	Z	Z	Z	
Depth to Water (from LSE)					X
Land Surface Elevation (LSE)					X
Microlanduse					X
	T = Total Sample				
	D = Filtered Sample				
	X = other sample or measurement				
	Z = currently undefined				

Chapter III

Resource Assessments

(Sam Upchurch and Mary Paulic, May 1999)

Overview

The probabilistic design of the Status Network will, for the first time, permit the Department to answer many water-resource-related questions with an unbiased, rigorous data set. DEP will be able to place statistically sound confidence limits on the answers to these questions. This design, in part, is dictated by the questions it must address.

Formulation of the questions to be addressed by the Status Network was initiated at a meeting of over 50 representatives from throughout the Department in November 1996. A list of over 200 issues and desired outcomes of a comprehensive, statewide monitoring plan was formulated by this group. These ranged from site- or issue-specific questions to broad questions related to the water quality of the state as a whole.

The Status Network monitoring design is structured to address questions at three different scales: (1) the state as a whole, (2) regions of the state and (3) large drainage basins, or drainage basin complexes, within of the state (i.e. 20 reporting units depicted in Figure I-4. The questions that the Status Network is designed to address, therefore, relate to the status of water quality on a regional basis. This network is not designed to address smaller drainage basins, counties, or localities. These smaller areas are addressed by other monitoring networks within the IWRM Program (e.g. Tier II or Tier III).

Addressing questions is a three-step process. First, the monitoring must be accomplished following standardized protocols for data acquisition. Second, the larger, "parent" population from which the sample data were collected must be characterized in order to statistically describe the magnitude and variability of the distributions of indicators used to evaluate the water resource. This step is termed *Population Characterization*. Finally, the distributions are used to draw inferences about the overall status of the resource (the parent population) in question. This last step is termed *Statistical Inference* in statistics. Step 1 in this process is described in Chapters IV and V of this document. The following subsection describes the questions addressed in steps 2 and 3. The process of completing steps 2 and 3 are discussed in Chapters VIII, X, and XI.

Questions To Be Addressed

One way to think of the questions that can be answered by the Status Network is whether or not the designated use of the water is met. With this in mind, some sample questions are as follows.

1. What percentage or number of river miles (lake area) statewide (or region, within an RU) have less than optimal habitat (defined as X, Y or Z)?
2. What percentage of river miles or area of lakes (or aquifers) statewide (or region, within an RU) exceed standards for fecal coliforms?
3. What percentage of aquifer area exceeds 10 mg/L nitrate statewide (or region, within an RU)?
4. What percentage of lakes (rivers, aquifers) exceed a nitrate concentration of 1.0 mg/L statewide (or region, within an RU)?
5. Has statewide water quality significantly improved or worsened for the measured indicators since the last reporting period?
6. Do significantly fewer or greater percentages of river miles exceed a nitrate concentration of 1.0 mg/L since the last reporting period?

Population Characterization - Many of the questions that the Status Network is designed to answer are not true questions — they are, instead, measures of the quality of the resource. These questions are included in the population characterization step.

In order to compare indicators and indicator population descriptors over time and from reporting unit to reporting unit, measurements of each indicator and resource must be taken at the sample time period within the year's climatic cycles in order to minimize time-dependent variability. The period within the year when each resource will be evaluated is termed the *index period*. Index periods are discussed in Chapter V. The index period for each resource period has been selected to ensure that the samples will be collected when the resource and its biota are most sensitive to human activities. For example, streams will be sampled when the aquatic biota are active and productivity is high.

Examples of these questions, or measures, of the resource are discussed below.

How and Why We Answer the Measure or Question

Measure - Characterize the overall distribution of the data for an indicator

<u>Sample Specific Question.</u>

1. For the purposes of conducting a statistical analysis, suppose we need to know the distribution of nitrates in low order streams in Florida. What is it?

A *cumulative distribution function* (CDF)(Figure III-1) is created to describe the overall variability of the indicator. The CDF (Mendenhall et al., 1981) shows the values of the indicator on the horizontal axis and the percentage of the samples (and by inference the overall population) less than or equal to each value on the vertical axis. The CDF is a fundamental tool for characterization of the population of an indicator.

Measure - Determine the population descriptors for the indicator

<u>Sample Specific Questions.</u>

1. What is the percentage of small lakes in Florida that contain detectable fecal coliform?
2. What is the probable range of salinities in ground water in the St. Johns River Water Management District?
3. What is the median nitrate concentration in the Floridan aquifer in the Lower Suwannee River reporting unit based on a 95% level of confidence?

Population descriptors are the measures we most often use to describe a population. For example, the median of a population is a measurement of the magnitude of the center of a distribution. Since many environmental indicator distributions are not symmetrical about the average, other population descriptors, which are not sensitive to the symmetry of the distribution will be used. These include the following descriptors.

Median - the 50th percentile of the CDF (Figure III-1). Half of the values of the indicator fall below this value.
Percentiles - the 10th, 25th, 75th, 90th, and other percentile can be used to describe what proportion of the resource has an indicator less than the percentile.
Range - the total range of values for an indicator is a measure of its variability.
Measure - Determine if the indicator has changed since the last sampling event.

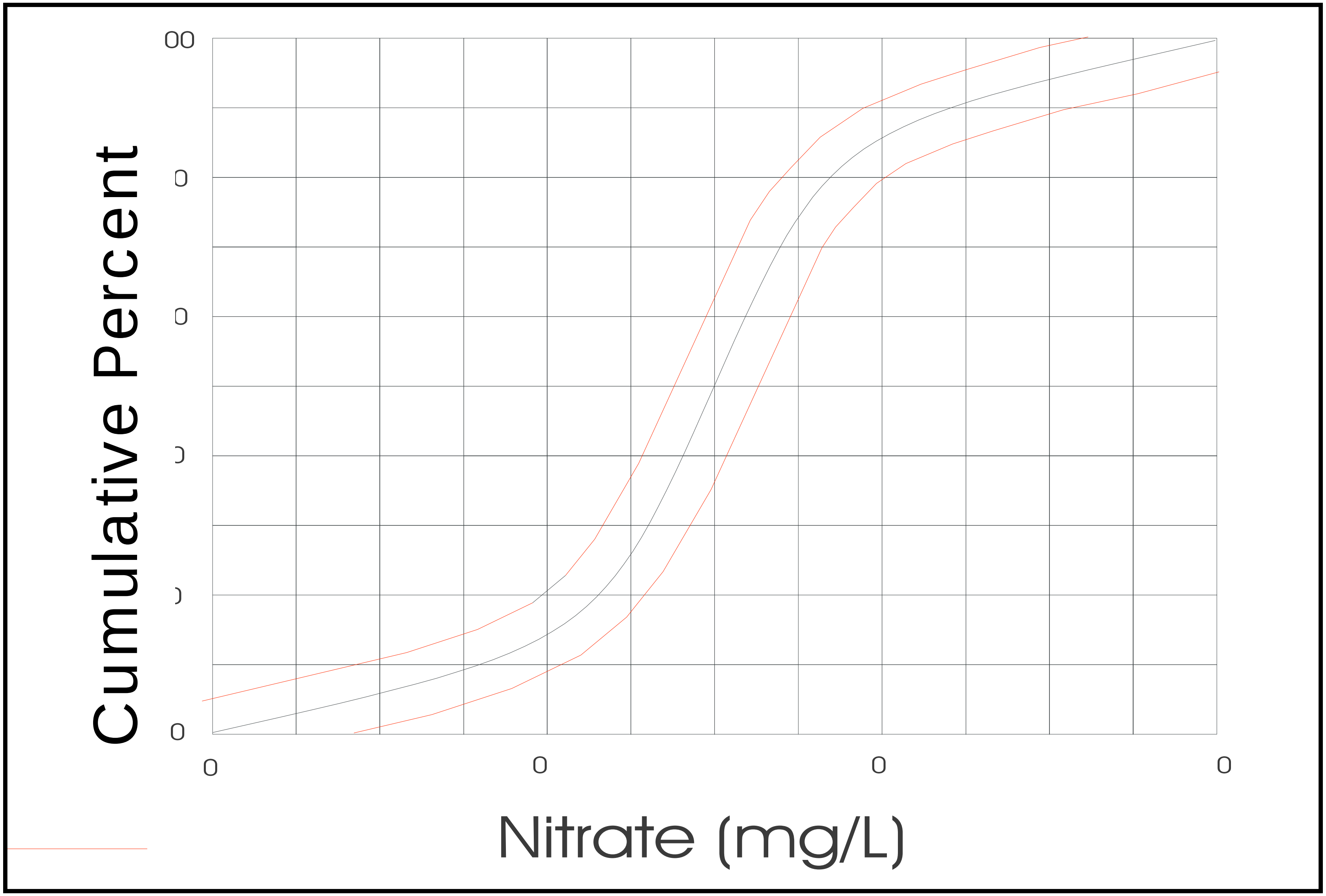

Figure III-1 Example of a Cumulative Frequency Diagram

Sample Specific Questions.

1. Has the proportion of low order streams with detectable nitrate declined since the last sampling in the reporting unit?
2. Have dissolved oxygen concentrations increased in high order streams within the reporting unit as a result of higher rainfall over the last five years?
3. Has implementation of a TMDL for nitrate resulted in a statistically significant decline in nitrate concentrations in rivers and streams in the reporting unit? If so, by how much?

Nonparametric statistical tests will be used to compare the median and CDFs over time to determine is statistically significant changes have occurred. Nonparametric tests make no assumptions about the symmetry of indicator distributions and are the most appropriate tests for comparison of population descriptors and CDFs over time or between sampling units. Some of the tests that will be used are the chi-square test and the Mann-Whitney two sample test. All statistical tests will be considered significant at a 95% probability.

Measure - Determine the resource index?

Sample Specific Questions.

1. What proportion of ground water in Florida has an overall quality rated as poor?
2. What proportion of low order streams in west-central Florida has a biological integrity rated as good?

A summary index which also uses the tripartite, “good”, “fair”, and “poor” terminology has been developed to allow an overall summary of the quality of the resource within a sampling unit. The summary index is based on the number of sample sites that have “good”, “fair”, and “poor” sample indices, so it can be used to communicate the overall quality of a resource.

Measure - Determine if the resource index is changing over time?

Sample Specific Questions.

1. Has the proportion of low order and non-high order streams in the Lower Suwannee River reporting unit has improved water quality since TMDL implementation?
2. Does the biorecon index indicate that fifth-year permitting is improving management of discharges in the reporting unit?

The number of “good”, “fair”, and “poor” sample index assignments will be compared over time using a chi-square contingency table. This will serve to statistically quantify change (improvement or deterioration of the resource) of the resource index.

Statistical Inference - The questions listed above are designed to simply *describe* the condition of the resource. In order to *evaluate* the quality of a resource within the state or a reporting unit, it is necessary to transition from samples to the parent population. The need to make this transition is the primary reason that a random sample design for the Status Network was chosen. By randomly sampling each resource, we can assume that all segments of the resource have equal probability of being sampled and, therefore, the sample set is an adequate measure to the resource in the reporting unit. The third step in evaluating the resource is to utilize the populations of indicators and indices to draw conclusions about the entire reporting unit and resource.

Many of the statewide environmental issues can be directly addressed by the inference of data collected in the Status Network. Indicators that directly address statewide issues include: biological integrity and productivity, stream and lake acidity, thermal pollution, dissolved oxygen in streams and lakes, nitrates, phosphates, salt-water intrusion, and coliform bacteria. There are many important indicators that cannot be assessed within the Status Network because of lack of financial resources. These latter indicators will be addressed within the Basin Assessments and the Regulatory /Compliance networks
(Tiers II and III).

The following questions will be addressed as part of the Status Network. These questions can be addressed at the scale of reporting units or any larger area, including the state. Since RUs within a WMD will be sampled on a five-year rotation (with one reporting unit being resampled within the five-year cycle), comparison of the results between RUs assumes that any change is slow relative to the rotation schedule. The resampling of one RU in each WMD during each rotation cycle is to allow evaluation of this assumption. In addition, the TV Network will be used to monitor time dependent change on a high frequency, monthly time scale.

Question - What proportion of the resource is minimally impacted
within the state and/or reporting unit?

<u>Sample Specific Questions.</u>

1. What percent of Florida lakes have nitrate concentrations below the detection limits?
2. What proportion of Florida lakes have no detectable dissolved orthophosphate?

Knowledge as to whether the amount of minimally impacted water within a resource is increasing or decreasing is a critical management tool. Surface and ground water data collected prior to implementation of the IWRM Network vary in their ability to be applied to this comparison. 1991-1997 data from the [ground water] Background Network (a subnetwork of DEP's old Ground Water Quality Monitoring Network) will be used for the preliminary comparison with respect to ground water. The existing reference sites will be used for surface water, where applicable. In the absence of appropriate existing, pre-IWRM Network data, the initial Status Network sampling round will be used to identify minimally impacted areas by study of the CDFs for each indicator and comparison with existing data. The proportion (area or stream length) of the resource identified as minimally impacted in the first, five-year Status Network sampling effort will be used as a baseline for future sampling.

Question - What proportion of the resource is potentially impacted?

<u>Sample Specific Questions.</u>

1. What proportion of low order stream miles in Florida is rated "fair" or "poor" by the biorecon index?
2. What percent of the Biscayne aquifer in southeast Florida has a ground water index of "poor"?

Use of the sample and resource indices will allow inference as to the amount of the resource impacted by human activities. Since the samples are random and the Status Network is not designed to assess specific sites, it will be necessary to conduct basin or site-specific assessments to identify and confirm specific impacted areas.

Question - What proportion of a resource has water that contains a
potentially hazardous constituent or violates a water quality standard?

Sample Specific Questions.

1. What percentage of non-high order stream miles exceed the fecal coliform standard in Florida?
2. What percentage of the Floridan aquifer contains sulfate concentrations greater than the drinking water standard in the Peace River reporting unit?

Many indicators to be determined as part of the Status Network have water quality standards or are not considered to occur naturally in Florida's water resources. For example, there is a standard for fecal coliform and a healthy system should not contain significant numbers of these organisms. By analysis of the CDF for fecal coliform, the Status Network will be able to address the proportion of the resource that contains coliform counts that are higher than the standards and/or the proportion with fecal coliforms reported. It is important to note that lack of resources dictates that many anthropogenic constituents present in Florida waters will not be sampled in the Status Network. The indicator list (Table II-1) was selected to detect stress to the resource, but not necessarily identify the cause of this stress.

Question - What proportion of the state's water resources have less than optimal habitat?

Specific Question.

1. What proportion of a resource within a reporting unit or the State has less than optimal biological habitat?

The percentage and/or number of kilometers/hectares of a resource that do not support the natural ecosystem will be addressed by examination of the indices assigned to the resource. CDFs of indicators and indices can be used to identify the probable causes of this failure to adequately support the biota. Note that this question will not be applied to ground water until we gain a better understanding of the biota in Florida's ground water.

Question - Has statewide water quality improved or worsened since the last Status Network sampling event?

Specific Questions.

1. Has the ground water quality index for the Floridan aquifer improved statewide over the last five years?
2. Has the median nitrate concentration in lakes declined significantly since the last evaluation?

Statistical comparisons of previous and current Status Network indicator and index CDFs will allow this question to be answered. In addition trend analyses of medians and percentiles can be used to identify long-term changes in overall water quality. The answer to this question is an important resource management outcome evaluation tool.

The sample questions presented above are indicative of the many types of questions that can be addressed by the Status Network. The advantage of random sampling is that unbiased answers to questions can be presented with known statistical confidence.

Chapter IV

Resource Selections and Subdivisions

(Sam Upchurch, May 1999)

Definition of a Resource

The Status Network is designed to ultimately monitor and report on all waters of the state of Florida. In order to systematically sample the many different occurrences of water, they have been subdivided into "resources". Each resource constitutes a readily identifiable occurrence of water of interest for the purposes of management.

The resources that will be monitored as part of the Status Network include:

Ground water and springs,
Lakes,
Rivers, streams and canals,
Estuaries, near-shore, marine waters, and
Wetlands.

The scale of a water body has an effect on sampling strategy and, in many cases, management of these resources. As a result, some of the resources have been subdivided to facilitate sampling and resource evaluation. The resources and their subdivisions are discussed in the following subdivisions.

Resources Monitored by the Status Network

Ground Water - Ground water, as a resource, includes those portions of Florida's aquifers that have the potential for supplying potable water or affecting the quality of currently (1998) potable water. Florida has three aquifer systems (Florida Geological Survey, 1988), all of which will be sampled. These include the surficial aquifer system (SAS), the intermediate aquifer system (IAS), and the Floridan aquifer system (FAS).

The ground water resource is subdivided into two target populations for the purposes of sampling and resource characterization. These subdivisions are: (1) *unconfined aquifers and springs* and (2) *confined aquifers*. Typically, the SAS, which is unconfined and near the land surface, can be readily affected by human activities. Because of this vulnerability to contamination, the SAS will be randomly sampled where present. In areas where the SAS is not present and either the IAS or the FAS is unconfined, these aquifers will be sampled as part of the unconfined aquifer target population.

The confined aquifer target population includes confined portions of either the IAS and the FAS, depending on which is the most heavily utilized as a source of public-water supply. The rationale for sampling a confined-aquifer target population is that pumpage for municipal supply typically involves high volumes of water, which may induce lateral or upward movement of saline water. Since the effects of salt-water intrusion take many years to reverse and the resulting degradation of water quality may result in significant and costly changes in water-supply systems, DEP feels that the confined IAS and FAS should be monitored as part of the Status Network.

Financial resources do not exist for installation of monitoring wells each time a new sample site is randomly selected for inclusion into the Status Network. Consequently, samples will be randomly selected from existing monitoring well networks on the basis of a hexagonal grid. The grid design is described in Chapter V. Wells to be used include those from the former Ground Water Quality Monitoring's Background Network or Very Intense Study Area (VISA) Network (Maddox et al., 1991 and Maddox et al., 1992), including those from a Department of Health private well survey that was cosponsored by DEP, those from the WMD's and county salt water intrusion networks, as well as background wells located at facilities that have been permitted by DEP. The Background Network was created to monitor background ground water quality throughout the state, so wells were not placed in areas known, or strongly suspected, to have contaminated ground water, including coastal areas where salt-water intrusion was suspected and many heavily industrialized areas. On the other hand, VISA wells were located in selected areas of the state suspected of being contaminated. Agricultural, residential, and local, isolated industrialized areas were not avoided in the VISA Network.

The following step was taken to eliminate this bias against coastal and industrial areas. Florida's five water management districts and many of its counties maintain coastal monitoring well networks. These will be accessed if a coastal grid cell is randomly chosen.

It was reasoned that most wells available for sampling in urbanized areas are associated with facilities permitted by DEP. Each permitted facility has several wells purposefully placed to detect and evaluate a known or suspected contaminant plume. In addition, each facility is required by DEP to place a "background" well upgradient of the facility. While the compliance wells are heavily biased towards contaminated ground water, the background well is located outside of the facility's plume and is more likely to detect regional degradation of water quality.

<u>Lakes</u> **-** Lakes have also been subdivided into two groups: (1) *small lakes***,** which are from one to 10 hectares in size, and (2) *large lakes*, which are over 10 hectares in area. This differentiation on the basis of area is intended to accommodate differing sampling strategies and methods. Small lakes will be randomly sampled from a list frame, while large lakes will be randomly selected for sampling from a grid. The details of this sampling are given in Section V.

<u>Rivers, Streams, and Canals</u> - Only perennial rivers, streams, and canals will be sampled. These have been subdivided into two categories based on stream order. *Low order streams* are perennial streams of orders 1-4. *High order streams and canals* include higher order streams (order >4) that are expected to require different sampling strategies than the smaller streams. Canals predominate in many areas of the state where former streams and rivers have been modified to enhance drainage. Because they require similar sampling strategies and represent master drainage systems, they are included in the high order stream category.

In order to randomly sample streams and canals, each category of stream was broken into one meter stream lengths (see Chapter V). The stream segments in each category are placed on list frames and randomly selected.

<u>Estuaries and Nearshore Waters</u> - Florida's estuaries and nearshore marine environments will be sampled as part of the IWRM Network. However, as previously mentioned, estuaries will be monitored by DEP's Florida Marine Research Institute. The monitoring plan to monitor this category is now only in the development stage. The estimated completion date is Spring 1999.

<u>Wetlands</u> - There is a great need in Florida to include wetlands in the IWRM Network. The "health" of wetlands, including areas, hydrologic regimes, water quality, and biological integrity are changing from year to year. While physical and chemical criteria for wetlands exist, DEP has not adopted methods for biological assessment of wetlands. However, the criteria is being developed. Since these criteria are not fully developed and resources currently do not exist to monitor Florida's wetlands, it is premature to include the monitoring of wetlands in the Status Network at this time. Recognizing the need for this type of monitoring, however, the IWRM Network has included wetlands as a resource to be monitored.

Chapter V

Design of the Status Monitoring Network

(Kevin Summers and Gary Maddox, May 1999)

Design Objectives

Most of the assessment questions mentioned previously can be assessed at three different scales: (1) site specific, (2) basin wide, and (3) statewide. The site-specific approach requires a delineation of the hypotheses to be tested by the monitoring activity (e.g., a comparison of selected areas receiving anthropogenic impacts to reference or unaffected sites). The basin and state approaches, if applicable to all waters, require a probabilistic design. These approaches require that the boundaries of the monitored population (e.g., waters of the state, waters of a WMD, waters of a reporting area) be determined, acceptable uncertainty criteria ascertained, and the appropriate design and reporting strata be determined.

The spatial and temporal aspects of a monitoring design are derived from the assessment questions and the variation associated with the selected analyte/indicators. The state-level assessment questions (and some basin-level questions) tend to call for monitoring results that apply to “all” Florida waters. A probabilistic design is required to meet this need. Site specific questions call for monitoring results that will differentiate among selected sites or will test working hypotheses. As a result, a set of judgmental sites are required to address each hypothesis. Because both forms of questions are posed, then a multi-tier design should be incorporated to include aspects of these approaches.

Data Quality Objectives - Uncertainty Levels

Uncertainty criteria must be defined and agreed upon in order to select a monitoring design that has the appropriate power to address the assessment questions. As an example, one assessment criteria might be that all status or “health” assessments have 95% confidence intervals of 10% such that an assessment of lake chemistry with contaminant concentrations greater than criteria A would be X% ± 10% (e.g., 35 ± 10% of all Florida’s fresh waters). This type of uncertainty pertains to probabilistic statements. Site-specific assessments also will require uncertainty criteria at primarily the level of discrimination often referred to as a p-level. For example, the uncertainty level for discrimination between affected and reference sites might be a 95% chance of discerning a difference if a difference exists between the sites.

Strata

Appropriate design strata can include many approaches. As a rule of thumb, if you wish to answer an assessment question with regard to a stratum with the desired level of certainty then that stratum should be designed into the overall monitoring plan. However, if the stratum simply represents a geographic unit from which one wants information (e.g., by habitat unit, use type, etc.) but one does not care whether the design certainty level is met, then the stratum should not be incorporated into the monitoring design.

In general, the use of strata within a sampling design enhances the power to detect differences because it optimizes the design based on the natural variability characteristics of what is being measured. However, in broad scale monitoring designs where many indicators are being utilized, what is optimal for one indicator is often not optimal for another. In addition, to design a monitoring plan based on strata that represents the entire resource (i.e., “all” of Florida’s lakes) requires that the physical distribution of the selected strata be known and the variability of the indicators in question be known. Often this is not the case. While much information is known concerning potential strata in Florida lakes, rarely can a known distribution be determined for all strata variables without preliminary sampling.

Several options exist with regard to stratification for both statewide and WMD-wide monitoring. Final strata include:

Base geography (i.e., the state of Florida),
WMD boundaries,
Four reporting areas within each WMD comprised of single or multiple hydrologic units (HUCs).

These strata represent reasonable approaches to developing a spatial sampling design. The key to selecting the appropriate strata is a determination of the monitoring needs, the availability of data on the distribution of the strata, the availability of data on the spatial variability of indicators of interest within the strata, and the ramifications of multiple strata on sampling size (i.e., reduce sampling size for site-specific monitoring and increase sampling size for ecosystem-wide sampling). Because the selected strata represent a graduated subdivision of the base stratum (state of Florida), the design needs only to be determined for the RUs of the WMDs (Figure II-4).

The actual placement of sites and the total number of sites is also based on the assessment questions. Since many of the Tier I questions require assessments for "all" of Florida's fresh waters, then an element of the sampling design must be extractable and, thus, probabilistic in nature. This does not necessarily mean that the sites are randomly placed,
although that type of placement is one possibility. Probabilistic simply infers that the sites are representative and not biased. If the sites can be placed judgmentally (i.e., based on experience and knowledge) so that they are representative of selected strata (e.g., habitats, use zones), then the requirement for a probabilistic nature for the design will be met. The specific protocol for the selection of sample sites for each resource type (e.g., small lakes, low order streams, etc.) can be somewhat different. Specific protocols by resource type are discussed below under Recommended Options.

Designing the temporal aspects of the sampling plan also relate directly to the initial set of assessment questions. The SW TV Network was created from a subset of the former
Surface Water Ambient Monitoring trend stations (to be discussed later). The issue with the choice of a temporal framework is not that the values of the indicators change all the time, but rather, what is the time scale of interest.

Many of the proposed indicators exhibit large intra-annual variability (i.e., they are seasonal)(Oviatt and Nixon, 1973; Jefferies and Terceiro, 1985; Grassle et al., 1985, Holland et al. 1987). Generally, monitoring programs do not have the monetary resources to characterize this variability or to assess ambient conditions in all seasons for "all" resources (i.e., all of Florida's fresh waters). Therefore, sampling has often been limited to a confined portion of the year (i.e., an index period) when indicators are expected to show the greatest response to anthropogenic and climatic stress. The annual sampling sites for the Status Monitoring Network utilize an index period for 4-12 weeks for sampling for each resource type. For example, in most coastal ecosystems of the Northern hemisphere, mid-summer (July-August) is the period when ecological responses to pollution exposure are likely to be most severe. During this period, dissolved oxygen concentrations are most likely to approach stressful, low values (U.S. EPA, 1984; Officer et al., 1984; Oviatt, 1981). Moreover, the cycling and adverse effects of sediment- contaminant exposure are generally greatest at the low dilution flows and high temperatures that occur in mid-summer (Connell and Miller, 1984; Sprague, 1985; Mayer et al., 1989). The index periods for each resource type are shown in Table V-1.

Table V-1

Sampling Index Periods

Numbers Indicate Probable Number of Samles to be Processed

N = North Florida[1], P = Peninsular Florida[2]

Month	Confined Aquifer		Unconfined Aquifer		Low Order Streams		High Order Streams		Small Lakes		Large Lakes		Total # of Samples[3]
	N	P	N	P	N	P	N	P	N	P	N	P	
January	20	30											50
February	20	30											50
March	20	30											50
April				45					30				75
May				45	30			45	30				150
June			30		30			45					105
July			30							45	30		105
August						45	30			45	30		150
September						45	30					45	120
October												45	45
November	**Retool, prepare for next year**												
December	**Retool, prepare for next year**												

1 North Florida - NWFWMD & Srwmd

2 Peninsular Florida - DJRWMD, SWFWMD & SFWMD

3 Does not include QA samples.

Recommended Options

The majority of questions raised by the IWRM Committee members suggest a generalized probabilistic design for the Status Network (Tier I) with nested designs supplementing the remaining tiers (Tiers II and III). The overall design must include both ecosystem-wide annual elements based on reporting strata and collected over a five-year period and site specific monthly elements to characterize inter-annual or seasonal trends. In addition, the design must permit an estimate of the condition of Florida's resources each year with an enhanced estimate every five years. The designs for the six fresh water resource types are described below.

Ground Water (Confined Aquifers and Unconfined Aquifers plus Springs).

The protocol for site selection of the two ground water strata — confined aquifers and unconfined aquifers plus springs — is based on available information relating to established wells. The protocol is listed below.

(1) A hexagonal grid is overlaid on each RU with a random location identified in each grid. If the number of hexagons overlaid on the RU is less than 29 or greater than 31, the process is repeated with varying distances between triangular grid centers until 29-31 random location for each RU are determined.

(2) DEP staff will then review permit and other files existing within the Department for wells that can be sampled (well meets program requirements) that lie within the hexagonal cell. If the cell is located near the coast, DEP staff will review files of the WMDs or local governments that have salt-water intrusion networks in order to see if latter network wells lie within the cell. For unconfined ground water, DEP staff will overlay the locations of the: (a) upgradient wells at permitted facilities, (b) salt water intrusion wells, plus (c) Background Network wells, (d) Very Intense Study Area (VISA) wells, both from the old Ground Water Quality Monitoring Network, (e) Department of Health, Private Well Survey wells that were part of a survey that began in the late 1980's and (f) springs. For confined ground water, DEP staff will overlay the locations of wells from (b) - (e).

    The potential wells to be sampled from upgradient wells at permitted facilities include the following types of facilities: (a) Domestic Waste including waste water facilities (and spray irrigation sites), (b) Industrial Waste including chemical processing plants as well as phosphate mining processing, dairies, and electroplating plants, (c) Solid Waste including solid waste disposal sites, and possibly underground storage tanks. Note that phosphate mining processing only takes place in the Southwest and Northeast DEP Districts.

(3) From each random location (a randomized latitude/longitude), DEP staff locates the nearest qualified well to be sampled located within the RU for both the confined aquifers and the unconfined aquifers plus springs resources. A qualified well is a well that there exists certain known information. The information includes: (a) well owner, (b) total depth, (c) depth of casing, (d) casing material, (e) open hole (or screen) interval, (f) latitude/longitude of the well, and (h) sampling data for the previous 12 months (if practical). DEP staff use a Geographical Information System (GIS) application to generate the 10 nearest wells to the randomly selected point. The lists will include distance to the randomly selected point. DEP staff will then select the closest well and determine if it is sampleable. If it is not sampleable, the next closest well will be selected and the process repeated until a sampleable well is determined.

(4) Staff from the WMDs and selected counties will work with DEP staff in obtaining permission to sample the upgradient wells from the facility owners.

Streams (Low Order and High Order).

The protocol for site selection for low order (orders 1-4) and high order streams (orders >4) is based on available Digital Line Graphs (DLGs) for streams provided by the USGS and from the RiverReach3 File provided by EPA.

(1) All streams are identified for the state of Florida and segments are identified with regard to stream order. All ephemeral streams have been deleted from the base population.

(2) All stream segments are subdivided into one meter-long segments with associated latitude-longitude coordinates for the segment.

(3) The one-meter segments associated with each reporting unit within the WMDs are determined and a list frame for each of the two strata within each RU is developed.

(4) Thirty random samples for each stratum are selected and the appropriate segments are located on RU maps.

Twenty additional random samples were selected for each stratum to be used for potentially unsampleable segments (as replacements).

Lakes (Small and Large)

The protocol for site selection for *small lakes* (1-10 hectares in surface area) is based on available DLGs for surface waters provided by USGS and from the RiverReach3 File provided by EPA.

(1) All lakes 1–10 hectares in surface area are identified for the state of Florida.

(2) All small lakes are associated latitude-longitude coordinates for the epicenter of the lake.

(3) Small lakes associated with each reporting unit within the WMDs are determined and a list frame for each reporting unit is developed.

(4) Thirty random samples (30 lakes) are selected for each RU and the appropriate small lakes are located on RU maps.

Twenty additional random samples (small lakes) are selected for each RU to be used for potentially unsampleable lakes (as replacements).

The protocol for site selection for *large lakes* (> 10 hectares in surface area) is based on available DLGs for surface waters provided by USGS and from the RiverReach3 File provided by EPA.

(1) All lakes > 10 hectares in surface area are identified for the state of Florida.

(2) Large lakes associated with each reporting unit within the WMD determined and a triangular grid resulting in hexagonal spatial units is overlaid on the reporting area such that approximately 30 hexagon contained large lakes or portions of large lakes.

(3) A random location is identified in each hexagon based upon an angular momentum program. The number of "hits" (intersections of random points and lake surface area) is determined. If this intersection resulted in 30 locations for a RU, then these 30 sites become the sampling sites for that RU. If the intersection is greater than or less than 29-31 sites, the process in repeated with varying distances between the triangular grid centers until 29-31 sampling sites for each RU are determined.

(4) The "thirty" random samples (29-31 latitude-longitude coordinates in large lakes) for each RU are located on RU maps.

An additional random sample was selected for hexagonal space and coupled to the original sampling site for each RU to be used for potentially unsampleable locations (as replacements). As this design is spatially dependent, only the coupled alternative site can be used in the event of a unsampleable location.

Five-Year, Rotating Cycle of the Design

The overall state design provides for the sampling of all 20 of the RUs of Florida within a five-year period (2000-2004, 2005-2009, etc.). Each of the five WMDs is broken down into four RUs (Figure I-4). Each year, for each WMD, one of the four units will be sampled on a rotating basis. One unit from each WMD is selected randomly to be sampled twice in the five-year period. To the extent practical, the same sites will be sampled during the second sampling period as in the first period. Thus, for each WMD in the five-year cycle, three units will be sampled once and one will be sampled twice. The only constraints on the random selection is that the same RU cannot be sampled two years in a row and that, in a five-year cycle, each unit must be sampled at least once. The distribution of RUs throughout the first five-year cycle in shown in Table V-2. The total number of samples by resource type of each WMD over the five year cycle is shown in Table V-3.

Table V-2
Sampling Distribution for the First Five-Year Sampling Cycle of the Status Network (Letters Refer to Reporting Units; See Figure II-4)

	Water Year				
Water Management District	1999	2000	2001	2002	2003
Northwest Florida	A	B	C	D	C
Suwannee River	A	B	D	C	D
St. Johns River	D	A	D	B	C
Southwest Florida	B	C	D	B	A
South Florida	A	D	C	A	B

Table V-3
Number of Samples* by Resource Type and Water Management District Over Five-Year Cycle (* Number Does not include QA Samples)

Water Management District	**Resource Type**					
	Lakes		**Streams**		**Ground Water**	
	Small	Large	Low Order	High Order	Confined	Uncofined
Northwest Florida	150	150	150	150	150	150
Suwannee River	150	150	150	150	150	150
St. Johns River	150	150	150	150	150	150
Southwest Florida	150	150	150	150	150	150
South Florida	150	150	150	150	150	150
Totals	750	750	750	750	750	750

Inclusion Probabilities

The inclusion probability for each sample site has been determined and is equal within each resource type by reporting unit combination. For example, for low order stream segments, the inclusion probability for each segment is determined as the product of 1/30 x 30/# segments in RU. Thus, the integrity of the inclusion probabilities throughout the sampling in order to combine condition estimates: (1) for each RU to create an estimate for each WMD, and (2) for each WMD to create an estimate for the state.

Temporal Variability Network (TV Network)

The ecosystem-wide (RU) surveys are supplemented by intensive surveys conducted monthly at 80 locations throughout the state of Florida. The following criteria were used to set priorities with regard to station selection, roughly in order of importance:

(1) Primarily monitor one surface water resource. This was high order rivers plus canals which were mostly non-tidal. A smaller number of additional Surface Water TV sites have been allotted for small and large lakes, and low order streams,

(2) One sampling site at or near the bottom of each Hydrologic Unit (HUC), but above the saline interface,

(3) Preference given to sites located at or near existing gaging stations,

(4) Preference given to sites with long term monitoring record,

(5) Preference given to sites with access assured, and

(6) Preference given to sites located at or near Florida state line on major rivers entering Florida form Alabama or Georgia.

The purpose of the 80 station TV Network is to:

(1) Correlate Tiers I, II and III sampling results with seasonal climatic changes (i.e. sampling occurring during the wet or the dry hydrographic periods,

(2) Estimate general basin-wide loading at HUC level, for sampled indicators, and

(3) Make the best temporal estimates of population parameters for sampled indicators (e.g. means, variances etc.).

As mentioned previously, the TV Network is a complement to the Status Network. It is scheduled to have its own design document (in press). The completion date is March, 1999.

Chapter VI

Indicators

(Paul Hansard and Tony Janicki, May 1999)

Candidate Indicators by Resource Type

The candidate lists of indicators to be measured as part of the IWRM Status Network were presented in Table II-1 by water resource. The lists were derived from multiple discussions with the participating agencies and consist of core measurements used to evaluate water quality. It is important to note this list is not exhaustive. For example, it would be cost-prohibitive to fully analyze the ground water resource, Florida's chief source of drinking water, for every potential contaminant. Instead, key indicator contaminants (e.g. chloride, nitrate, and bacteria) will serve to assess the general suitability of this resource for drinking water purposes. Likewise, the indicator lists for surface water resources were designed to detect the major threats to surface water quality, such as eutrophication and habitat loss.

It should be recognized that meeting the published holding times for some key indicators (e.g. orthophosphate, total coliform, and fecal coliform) has routinely been a problem in past monitoring efforts and that such problems will likely continue. However, a number of reviewers of the lists have supported including these indicators: they are likely to be of semi-qualitative utility, despite the shortcoming of not meeting the holding times.

Readers will note that aquifers are generally being monitored for dissolved constituents, while surface water resources are monitored for total constituents. We do not consider the "dissolved versus total" debate to be resolved: ground water samples are being field-filtered to mitigate well construction factors which contribute to excessive sample turbidity.

The habitat assessments to be conducted will be based on those protocols accepted as part of the DEP bioreconnaissance procedures. Eventually, funds allowing, biorecons will be added to the list of stream indicators. For lakes, a benthic grab sample will be taken in lieu of a lake bioassessment, a protocol that is still under development.

Procedure to Add/Delete Indicators

The long-term stability of the indicator list is paramount to the goal of discerning long-term changes in water quality. In the past, long-term variability in water quality has been difficult to assess, due to changing indicators, analytical and sampling methods, sampling frequencies, site selection, and program goals. The success of IWRM Tier I (Status and TV Networks) will depend upon the ability of its managers to minimize these changes. Funds allowing, analytes may be added when it becomes desirable to make statistical inferences regarding their regional distribution, possibly to assist Tier II monitoring activities. However, logistical constraints (e.g. holding times and collection procedures) must also be considered when adding indicators.

Table II-1 Status Monitoring Indicator List

INDICATOR	Lakes (lg)	Lakes (sm)	Streams (ho)	Streams (lo)	Aquifers
Calcium	T	T	T	T	D
Magnesium	T	T	T	T	D
Sodium	T	T	T	T	D
Potassium	T	T	T	T	D
Chloride	T	T	T	T	D
Sulfate	T	T	T	T	D
Fluoride	T	T	T	T	D
Alkalinity	T	T	T	T	D
Nitrate + Nitrite	T	T	T	T	D
Ammonia	T	T	T	T	D
Kjeldahl Nitrogen	T	T	T	T	D
Phosphorous	T	T	T	T	D
ortho-Phosphate	D	D	D	D	D
Organic Carbon	T	T	T	T	T
Dissolved Solids	T	T	T	T	D
Suspended Solids	T	T	T	T	T
Turbidity	T	T	T	T	T
Color	T	T	T	T	T
Chlorophyll-A	T	T	T	T	
Total Coliform	T	T	T	T	T
Fecal Coliform	T	T	T	T	T
Water Temperature	X	X	X	X	X
pH	X	X	X	X	X
Specific Conductance/Salinity	X	X	X	X	X
Dissolved Oxygen	X	X	X	X	X
Secchi Depth	X	X	X	X	
Total Depth	X	X	X	X	
Sample Depth	X	X	X	X	
Habitat Assessment	X	X	X	X	
Bio-Recon	Z	Z	Z	Z	
Depth to Water (from LSE)					X
Land Surface Elevation (LSE)					X
Microlanduse					X
	T = Total Sample				
	D = Filtered Sample				
	X = other sample or measurement				
	Z = currently undefined				

Chapter VII

Sampling and Laboratory Quality Assurance (QA)

(Paul Hansard, May 1999)

In a multi-agency statewide program, it is essential to have a centralized QA program to ensure that data are properly and consistently collected. The QA Program for the Tier I, ambient monitoring (the Status and TV Networks), will be coordinated by DEP staff, with the cooperation of project QA officers at the sampling agencies and analytical laboratories. The QA program will consist of three related efforts.

First, a QA Plan will be cooperatively developed for the Status and TV Monitoring Networks, to be adopted by all participating agencies. The QA Plan will prescribe standardized protocols for sampling, analysis, and data reporting. The QA Plan development process will consist of identifying existing protocols, improving protocols through consensus where necessary, and encouraging adoption of the protocols throughout the participating agencies.

Second, communication of these protocols to the relevant parties will be accomplished through project management meetings and sampler training classes. In the past, the Ambient Monitoring Program has contracted with the USGS to provide basic sampler training classes. In addition, DEP staff has offered a separate class focusing on program-specific sampling requirements. This training effort is being expanded to include both surface water and ground water sampling, in addition to aquatic habitat assessment.

Third, data quality assessment tools will be developed to evaluate the effectiveness of the QA Plan and the training classes. These tools will include systems and performance audits of sampling agencies and analytical laboratories. Adherence to standard field protocols will be verified by internal and external field audits performed on a quarterly basis. Assessment of field measurement accuracy will be accomplished through internal (DEP) and external (USGS) field reference sample programs. Systems evaluations of analytical laboratories will be conducted through contract with the DEP Bureau of Laboratories (Quality Assurance Section). The laboratory performance audit program will be expanded to include all participating laboratories. Finally, formalized procedures for computerized and manual data review will be developed.

The QA Plan will serve as the essential document describing all aspects of the Program's quality assurance efforts. This plan will be available for review April 1, 1999.

Chapter VIII

Data Management

(Paul Hansard, May 1999)

This section is incomplete as of December, 1998. It will include a discussion: (1) communication and sample tracking and (2) data management and storage for Tier I.

A smooth and timely flow of water quality data from sample collectors and analytical agencies to data analysts is a high priority. The data flow path (Figure VIII-1) begins with the AMS, the lead IWRM organization. Assisted by the cooperating federal, state, and county agencies, sample locations will be selected, monitoring parameters and frequencies will be determined, and sample collection and analysis coordinated. This information will be communicated electronically to the sampling agencies, in advance of sampling operations.

Data collected in the field will be computerized at the sampling agency, using a DEP-written field data-entry program. This customized software will ensure a common data exchange format, facilitating the flow of data from the field. The data-entry software will be based on existing software currently in use, and will be expanded to include data entry verification, and additional data entry capability.

Water quality samples will be tracked from the field to the lab via ***A**utomated **DA**ta **M**anagement* (ADAM) software. Files containing analytical data will be transferred to DEP staff via Internet FTP, where they will be processed and merged with corresponding field data, and linked to the corresponding site data. Computerized accuracy and completeness checks will be automatically run, in addition to a variety of other QA checks, water quality checks, extreme value checks, etc. Each data file will then be manually checked by DEP staff, using results from the computerized reviews to identify any obvious random or systematic errors. A schematic is depicted in Figure VIII-1.

After preliminary data review for a project is completed, a copy of the project file will be transferred to the sampling agency for their review. Also, notifications required by the Division of Water Facilities will be generated automatically and sent to Department of Health, specific DEP/WMD programs, property owners, etc. After data review for a project has been completed, the data will be considered “release quality” and made available to the public at-large in a variety of ways. All data collected will be uploaded to STORET within one year of release. Data are also made available through CD-ROM, along with GWIS3, a data retrieval and report program. Periodically, data will be uploaded to an in-house Oracle database version of GWIS that will be available to DEP personnel). Finally, data will be accessible via Internet through the Division of Water Facilities’ web page.

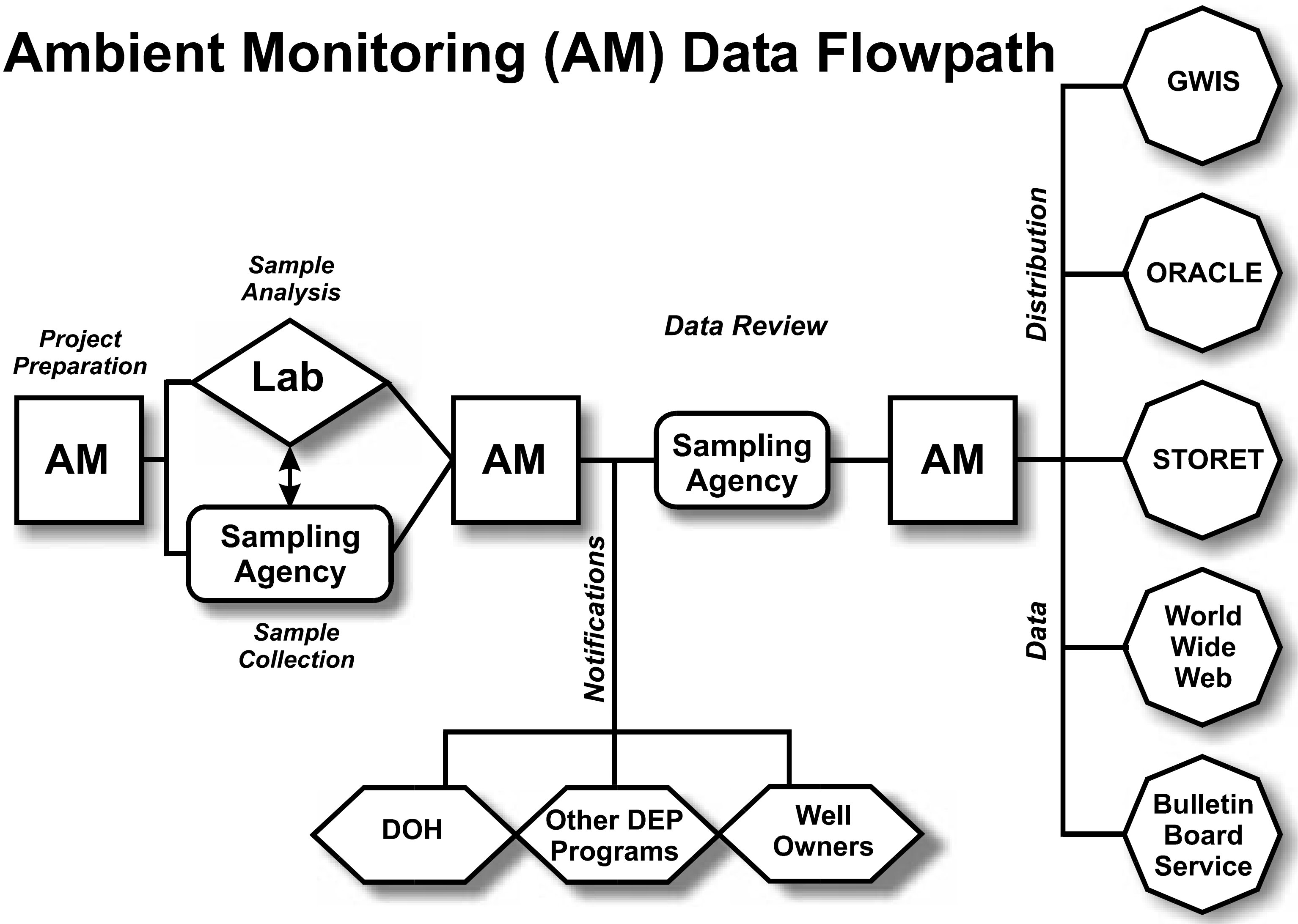

Figure VIII-1 Ambient Monitoring (AM) Data Flowpath

Chapter IX

Data Analysis

(Sam Upchurch and Rick Copeland, May 1999)

Introduction

For the purposes of the Status Network, the Department is most concerned with reporting units and larger areas, including the WMDs and the state as a whole. With this goal in mind, the following discussion will deal with who will collect and analyze the data and which statistical treatments are most likely to be utilized for reporting of the status of Florida's water resources.

The design of the Status Network uses the RUs as the basic "building block". As long as the number of samples in each RU is about 30, for statistical inference the uncertainty is approximately 10 percent for each RU. Because of the consistency of the design of the Status Network, results from RUs can be combined to draw conclusions about larger geographic units, including the state, and multiple resources, such as all streams. The data can also be post stratified, or subdivided, according to smaller sample sets to correspond with smaller geographic units, land uses, or resource subdivisions. However, if the number of samples is significantly below 30, the uncertainty is greater than 10 percent.

It is anticipated that others in the Department and WMDs will utilize the data and information generated by the Status Network. Methods of data reporting and statistical analysis will be standardized as much as possible in order to ensure that the results of the use of the Status Network are comparable from year to year and from area to area. Standardization will involve the following measures.

Responsible Parties

The AMS staff will work with other groups to develop a standard list of questions to be answered at a minimum for submission to EPA for 305(b) reporting, basin assessment, TMDL development, and other routine activities of the Department. A methods manual will be developed to provide protocols for data analysis with regard to these questions.

Reporting of the results of these questions will be automated as part of the routine reporting process to the extent possible. This will ensure standardization of reporting from year to year and area to area.

To further standardize the use of the data for routine reporting, the AMS will train appropriate DEP and WMD staff in the use of the data base and statistical analysis of the data generated by the Status Network. Finally, to the extent practical, AMS staff are available as a service to the Department and WMDs for assistance in data analysis and interpretation.

Population Descriptors

The following characterizes the general properties of the sampled populations and will be routinely used to characterize and compare the Status Network data and indices:

1. Median (50th percentile),
2. Range of values,
3. Quartiles (25th and 75th percentile),
4. Mode (most commonly reported condition), and
5. Percentages of each category.

The cumulative distribution function will be used to describe indicator distributions as discussed in Chapter III. Percentiles and proportions will also be used. For example, percent of rivers that exceed a water-quality standard will be reported. CDFs generated for different sampling events will be compared in order to detect changes over time. Procedures such as the chi square test, the Kolmagorov-Smirnov, and the Mann-Whitney two sample test will used to test whether or not the shapes of the CDFs, and consequently, the conditions have changed between sampling events.

Statistical Procedures

The data generated by the Status Network represents a mixed collection of number systems that restrict the techniques that can be used for reporting and analysis of the status of the resources. For example, Status Network indicator data have the following properties that constrain the statistical methods that can be used for interpretation.

1. Concentration data have detection limits that censors the data at the low concentration end.

2. The data include a mixture of parametric and nonparametric numbers that require statistical methods that can be applied to both.

3. Many of the parametric indicators, especially concentration data, are usually skewed. That is, most of the data reflect low concentrations, but one or more samples have high concentrations.

4. Data distributions are rarely normally distributed, a requirement for most parametric statistical methods.

These constraints require that nonparametric statistical methods be used. It should be pointed that nonparametric methods are applicable to parametric data, while parametric statistics cannot be applied to nonparametric data.

Chapter X

Reporting

(Mary Paulic and Rick Copeland, May 1999)

Role of Tier I in 305(b) Assessment and Reporting

Goals and Objective of 305(b) Assessment

An important long-term goal for future 305(b) reports is to comprehensively characterize the quality of all surface and ground waters. Historically, the state has only been able to assess a percentage of its total surface waters based on availability of data. EPA has not previously asked for analysis of regional or statewide aquifer quality. The dilemma is that not every water body or foot of the aquifer can be individually sampled and assessed under the current targeted monitoring strategy.

Other goals of the 305(b) assessment process are to: (1) determine the condition of the state's water resources and whether those resources support state water quality standards or classification for designated use, (2) define changes in quality, (3) identify impaired waters, and (4) identify causes and sources of pollution. EPA defines several broad goals of use support for different waterbody types. These include protect and enhance ecosystems, protect and enhance public health, and social and economic benefit.

Florida incorporates EPA's broad goals into five classes of surface waters designated by most beneficial use: Class I-Potable water supply; Class II- Shellfish propagation and harvesting; Class III- Recreation and well-balanced population of fish and wildlife; Class IV- Agricultural water supply; and Class V- Navigation, utility, and industrial use. Class III waters include recreational activities such as fishing, fish consumption, swimming, and boating and protection of aquatic life. Within Class III, Florida does not distinguish between secondary (i.e. boating) and primary (i.e. swimming) recreational contact.

Goals and objectives of the 305(b) report can be accomplished through a comprehensive monitoring and assessment plan. The best approach for Florida to attain comprehensive coverage is a combined probability based and targeted sampling design. Justification for this dual approach to monitoring and assessment is that each approach addresses different assessment needs. A probability type approach addresses broader questions of resource condition as percent area or total miles or, for example, a watershed, river basin, region, or the state. It provides for comparison of change over time in a resource. On the other hand, a targeted monitoring plan can answer waterbody specific questions such as whether existing water quality meets standards and criteria, effects of a specific discharger, changes in water quality over time at that geographic location and, in some cases, causes and sources of pollution.

What part of a 305(b) assessment can a probability based sampling approach address?

Florida must provide through the 305(b) report total miles or areas of support or non-support for designated use. There are separate tables for rivers, lakes, estuaries, and optionally wetlands. Probability type monitoring can make use support statements by larger geographic area nested into each other rather than the current limitation of a waterbody. In one sense, Florida defines a waterbody as an approximate five square mile area or watershed. Currently total miles of support are made by summing of individual five square mile waterbodies across the state. Data are displayed by HUC, but it is an assessment of individual waterbody quality and not of the HUC. Individual waterbodies are not representative of any other waterbody, thus results can not be extrapolated between them. Probability type monitoring can provide unbiased estimates by HUC, Reporting Unit, Region and the entire State. Probability monitoring can be used to provide 100% coverage of Florida's water resources, thus meeting the long-term 305(B) goal for comprehensive characterization. EPA and the 305(b) Consistency Work Group are working on guidance for data integration. The efforts of the Status Network to integrate its surface and ground water monitoring efforts fits into the guidance of the Work Group.

Probability based sampling is most appropriate for evaluation of Class III fresh waters and Class II and III marine waters, specifically for aquatic life support and recreational use support assessments. These are by far the greatest number of miles of waters within the State and the least likely to be sampled adequately in a targeted program.

As mentioned previously, changes in water quality of each resource type can be made from a probability based design. Statewide or regional regulatory changes, basically large scale initiatives, to improve water quality should be detectable at the RU or coarser scale.

Unfortunately, a probability based design cannot answer questions about changes in individual waterbodies or regulatory changes that effect only a localized area, nor can it address whether an individual waterbody is impaired and should be listed on a 303(d) list. However, it can provide reference water quality for an area or region of the State. Assessment of targeted sampling can be used to identify specific waterbodies and causes for nonsupport. Targeted sampling is needed to address these issues.

Class I and Class IV waters are best covered under a targeted approach that addresses their usability as drinking water supply and agricultural water supply . Justifications are that there are a relatively small number of Class I and Class IV surface waters and their objectives are more narrowly defined.

Schedule of Reporting

At the end of each year, reports from the evaluation of the Status Network will be delivered to the basin Planning and Management (BPM) Section of the Watershed Management Program. The BPM Section will incorporate the annual Status Network report into its 305(b) assessment reports. At the end of every five years, a statewide Status Network report will be given to the BPM Section for incorporation into a statewide assessment of Florida’s water resources.

Input into Basin Planning and Management

(This section is incomplete as of December, 1998).

Other Types of Reporting

Periodically, as data are generated form the Status Network, assessments of a variety of types (independent of 305(b) assessments) will be generated. As these miscellaneous reports are generated, they will be distributed to programs within DEP, to the WMDs, to local governments, and to the public as needed. For example, the status of the water resources lying within the St. Johns River Water Management District (SJRWMD) will be generated periodically. As the reports are generated, they will be sent to the SJRWMD for review. Once approved, the final report will sent to the SJRWMD headquarters and distributed to local governments in northeast Florida, as well as to the general public.

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