Attachment K

South Florida Coastal Water Quality Monitoring Network

Network Optimization Questionnaire -- Partial Draft Only

Example for February 11, 2003 TOC Meeting

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Background

The Environmental Monitoring and Assessment Department must periodically review the design of the South Florida Water Management District's (District's) monitoring networks to ensure that the agency's information needs are being fulfilled in a technically defensible and cost-effective manner. To accomplish this overall goal, water quality monitoring programs are examined from several different perspectives:

- **District Mission** – Are the data necessary to meet the District's mission? Is the monitoring effort specifically mandated or does it support projects that are mandated or mission driven? Is the monitoring information nice to have or essential to have for environmental management of South Florida?
- **Environmental Design** – Does the network design make sense from a general environmental-science perspective?
- **Statistical Importance** – How does each site contribute information on ecosystem water quality status and trends? Are there redundancies in the sampling regime such that if a site was removed, little information would be lost?
- **Financial costs, benefits and partnerships** – The District alone pays to collect, analyze and report on the data discussed below. How do the costs and benefits for collecting and analyzing the data balance out? Are there other sources of funding or financial partnerships that can help to support the data network?

This network optimization concerns the long-term South Florida Coastal Water Quality Monitoring Network. This unified network consists of 177 marine stations at which samples are collected and analyzed for a variety of physical, chemical and biological parameters to quantify water quality. Florida International University has conducted both field sampling and analytical work since monitoring began in 1990. The network includes monthly sampling at 128 stations in Florida Bay, Whitewater Bay, Rookery Bay, Estero Bay, Shark Slough estuaries, Biscayne Bay and Ten Thousand Islands. It also includes quarterly sampling in the Gulf of Mexico at 49 stations in the southwest Florida shelf. Data from all these stations are integrated into quarterly progress reports and annual interpretive data summaries submitted to the District. Information from this network serves to measure status and trends in water quality andtoevaluate progress towards protecting and restoring marine resources of South Florida coastal waters.

This questionnaire on the South Florida Coastal Water Quality Monitoring Network seeks to gain your perspective on the utility of the existing water quality network and its linkage to the District's responsibilities. We would appreciate your review and input on our analysis and proposed changes. Some of the routine water quality monitoring in the sub-regions considered below is clearly needed for District water resources management. Some stations may primarily benefit other agencies, such as Everglades and Biscayne National Parks and Big Cypress National Preserve. Some stations may have been needed at one time but are no longer as critical as they once were. Please note that the District is not questioning the overall need for routine water quality monitoring in South Florida coastal waters. . Instead, we are interested in value to the District and its partners in meeting the network's objectives. Obviously, cost sharing and expanded partnerships would be welcome to continue the existing network in its entirety.

Approach to Network Optimization

The proposed actions to optimize the South Florida Coastal Water Quality Monitoring Network were derived from environmental and statistical evaluations. First, stations were examined for their fundamental ability to provide useful information for regional environmental management. District staff looked at the locations of the stations, both geographically and in relation to neighboring stations, to answer several questions: Are the data from a station or group of stations necessary to meet the District's mission? Is the monitoring information merely nice to have, or is it essential for environmental management of South Florida? Are the sampling locations dispersed in a manner that will capture important environmental variation and gradients? Is an area either over-represented or under-represented by the network? Are all significant areas of the regional ecosystem being sampled? For example, four stations on a small mangrove river in a remote area may be viewed as an over-representation if there is not some mandate for monitoring or a compelling reason to quantify gradients. . On the other hand, sampling one station in this environment for status and trends may be wholly justifiable from the perspective of long-term, regional management.

The District then undertook a statistical evaluation of the network to askhow much information each site contributes to ecosystem water quality status and trendsand whether redundancies are apparent in the sampling regime such that if a redundant site was

removed, little information would be lost. The objective of the statistical analysis was to compare the concentrations of water quality parameters between stations within small geographical groupings. Details of the statistical methods are presented in Attachment 1, followed by statistical summary tables in Attachment 2. Based on input from staff experts, analysis of salinity similarity, and geographic location, stations were grouped into small sets for statistical evaluation. The geographic locations of these groups of stations are provided on the maps in Attachment 3 for each segment of the coastal network.

The analysis of covariance (ANACOVA) (Garth: I think the ECR uses "ANCOVA" for analysis of covariance) for time series data was used to determine whether the observed differences in concentrations were statistically significant for stations within a geographic grouping (Attachment 1). This analysis was applied to salinity, chlorophyll-a, total phosphorus and total nitrogen in a hierarchical manner. An initial comparison between monitoring stations in a geographical grouping was performed for salinity. Stations exhibiting significant differences (where probability (p) < 0.05) were deemed statistically necessary for the monitoring network. Those stations not exhibiting a significant difference (where $p \geq 0.05$) within their geographic group were then compared for differences using the next parameter in the hierarchy. This approach was performed on each geographical grouping of stations and for all subsequent parameters (chlorophylla, total phosphorus and total nitrogen, respectively). Stations not exhibiting statistically significant differences for all four parameters of interest were considered redundant. Matrices summarizing station- by-station comparisons can be found in Attachment 2 for the geographic groupings provided in Attachment 3.

The monitoring of costs, mandates and partnerships is another dimension to the optimization analysis. However, for this particular network the District alone pays to collect, analyze and report on the data, and no part of the network is mandated in permits, legislation or agreements. Therefore, in this instance the financial evaluation boils down to costs and benefits for collecting and analyzing the data relative to the strengths demonstrated for a station or grouping of stations for District environmental management. Are there other sources of funding or financial partnerships that can help to support the data network? As mentioned previously, it is hoped that as readers examine the District's proposed optimization recommendations, new sources of funding and partnerships will be forthcoming to continue this important water quality network.

Proposed Revisions to the South Florida Coastal Water Quality Monitoring Network

The South Florida Coastal Water Quality Monitoring Network is divided into seven large geographic areas spanning the southern coast of South Florida from Biscayne Bay to Pine Island Sound. Information on each area is summarized below and can be found on the website managed by Florida International University's Southeast Environmental Research Center at http://serc.fiu.edu/wqmnetwork/. In the following paragraphs, each of these geographic areas and its monitoring network will be briefly described, followed by the Network Optimization Team's recommendations on stations proposed for deletion. Each section of this report will end with requests for information specific to each geographic area in the network. Please note that the District seeks specific information on who, what, when and where, not blanket statements about various segments of the

network. The District has already received dozens of letters of general support for the existing network from various individuals and groups. While the District welcomes these endorsements, they do not provide a defensible basis for deciding if a particular station or group of stations is truly needed for environmental management.

-- Example Sections of Results --

Whitewater Bay and Mangrove Rivers, Stations 29 - 50

Description of the Area and Network

These 22 stations span the coastal embayments and mangrove rivers (Attachment 3, Figure A.2) from First Bay (Lostman's River) in the north (29-32) through Broad River (33-35), Harney River (36-38), Whitewater Bay (39-49) and ending in the south with Coot Bay (50). Whitewater Bay and neighboring areas to the north receive freshwater as overland flow from Everglades National Park through Shark River Slough. These areas should experience subtle, long-term changes in hydrology and loading, as water management activities, including the Comprehensive Everglades Restoration Plan (CERP) and the Combined Structural Operating Plan, gradually alter the water movement to and through Shark River Slough and adjacent wetlands. Therefore, water quality monitoring in this region is needed to support management interests of the District and Everglades National Park. However, as detailed below, some of the stations in this network do not appear to contribute substantial information for purposes of regional environmental management.

Recommendations

In reviewing the potential for information gain from the four groups of stations in this area of the network, primary consideration was given to station location and number relative to detecting possible water management influences .

Whitewater Bay. For Whitewater Bay, water quality monitoring should track overall status and trends for the bay as a whole and should not attempt to distinguish differences within small subsections. The number of stations monitored in this area (Attachment 3, Figure A.2) is far more than what is needed to assess general water quality. In addition, statistical analysis reveals several stations that appear to be statistically redundant. The following six stations are proposed for deletion from Whitewater Bay monitoring:

Station Number	Reasons for Proposed Deletion from Whitewater Bay Network
41	Redundant with #40; area water quality characterized by #40 on marine side and bay stations moving inland; area not independently influenced by water management
42, 47	Not located to be representative of overall bay water quality
44, 45	Not located to be representative of overall bay water quality; stations are statistically redundant

49	Not located to be representative of overall bay water quality; station is redundant with #48; #46 and 48 characterize water quality in this area
50 (Coot Bay)	Isolated location with no known reason for water quality monitoring

Mangrove Rivers. For the mangrove rivers to the north of Whitewater Bay, long-term monitoring for characterization of water quality entering the Gulf of Mexico and detection of any long-term changes in quality are reasonable objectives for District monitoring. These objectives can be met with a single station monitored for the long-term on the main mangrove rivers. Predictably, statistical analysis did not reveal any redundancies for these rivers; riverine-marine gradients consistently generate station differences in water quality. Therefore, the network optimization issue at this location boils down to the need for multiple stations on each river. Information for use in environmental management can be met using downstream stations #29, 35 and 36; other stations on these rivers can be deleted as follows:

Station Number	**Reasons for the Proposed Deletion from the Mangrove Rivers Network**
30, 31,and 32, Lostman's River (Group 9)	Need for upstream, downstream stations has not been established
33 and 34, Broad River (Group 8)	Need for upstream, downstream stations has not been established
37, 38, 39, Harney River (Group 7)	Need for upstream, downstream stations has not been established

Requested Information:

1. What are the specific objectives for monitoring Whitewater Bay for Everglades National Park? As mentioned above, the District seeks to monitor the overall status and trends of water quality, and this objective can be met with four central-bay stations. The high density of stations in the current network seems to reflect interest in examining input gradients and geographic sub-regions within the bay environment. The need for such detail has not been established or linked to the overall objectives of this coastal monitoring program. If Everglades National Park has monitoring objectives beyond those of general water management for either Whitewater Bay or the mangrove rivers, then the District would welcome a funding partnership to support the existing upstream stations proposed for deletion.
2. There may be other assessments possible for the mangrove mangrove rivers (salinity gradient analyses), and there may also be needs for additional data from other stations to be used for modeling or for CERP project-specific monitoring. Examples and supporting documentation for any such applications are needed from either the District or the Park and/or the U.S.A.C.E., along with information on cost sharing.

Ten Thousand Islands, Stations 51 - 74

Description of the Area and Network

The 24 stations comprising this portion of the network (#51-74) are dispersed into three general habitat types: mangrove fringe, Gulf mangrove islands and nearshore Gulf waters. This suite of stations is located south of the Blackwater River and north of the mangrove rivers/Whitewater Bay segment of the network. The stations are divided into four similar groups for statistical analysis, shown in Attachment 3, Figure A.3.

Water entering this area comes primarily from Everglades National Park through relatively small drainage basins, some bordering Big Cypress Preserve. CERP may directly influence the region in the northern segments associated with exports from Southern Golden Gates Estates into the Faka Union Bay area and through flow increases associated with modifications to Tamiami Trail. Some influence from Gulf waters transporting materials from northern sources, such as the Caloosahatchee River and Tampa Bay, is possible, though any such influence is expected to decrease as CERP redirects freshwater discharges. Local water management and land-use activities at the northern end of the region will be reflected in water quality at a few sites.

Recommendations

Like the Whitewater Bay area, the objectives the network is attempting to assess are key considerations in this segment of the Coastal Monitoring Network . Stations associated with freshwater discharges at the coast are obviously most relevant to evaluating upstream, inland changes in water quality and Gulf Coast loading from such changes. The purpose of dispersing stations throughout mangrove islands and nearshore areas of the Gulf are less clear from the perspective of regional water management. These stations are not likely to detect any signal from freshwater sources due to the confounding marine influence. Conversely, their use in detecting the dynamics of Gulf water quality is likewise confounded by local coastal inputs.

These considerations and the statistical evaluations in Attachment 2, Table A.5 underlie the following proposed deletions from the Ten Thousand Islands network:

Station Number	**Reasons for the Proposed Deletion from the Ten Thousand Islands Network**
71, 73 (Group 1)	Statistically redundant with other stations; not located to be representative of freshwater influences; need to measure nearshore-offshore differences has not been established
65, 66, 67, 68 (Group 2)	All statistically redundant with #69; not located to be representative of freshwater influences; need to measure nearshore-offshore differences has not been established
52, 53, 55 (Group 3)	Need to measure nearshore-offshore differences has not been established; Need for upstream, downstream stations has not been established
56, 61, 62, 63 (Group 4)	Water quality from inland areas should be reflected in data from #60 and 58; need to measure water quality in these isolated mangrove transition areas has not been established.
59 (Group 4)	Not located to be representative of freshwater influences; need to measure nearshore-offshore differences has not been established

Requested Information

1. When the nearshore Gulf stations of the TTI region (#52, 59, 66, 67, 68, 71 and 73) are combined with inshore coastal stations, such as #74, 72, 70, 69 and 64, it may be possible to evaluate east-west, inshore-offshore gradients through the mangrove islands. Setting aside the fact that variability will limit any quantification of the quality of waters moving either toward or away from the undeveloped mangrove islands, the utility of gradient analysis for resource management by the Park, Big Cypress Preserve or the District has not been established. Estuarine experts suggest gradient analysis might be useful in some contexts, but there is currently no information from the Park, Big Cypress Preserve or other organizations that indicates the need either for gradient analysis or plans for any such evaluations. This information is requested, and if a need is determined, then the District would welcome funding partnerships to continue the existing Ten Thousand Islands network.

2. Sites #51, 54, 58, 60, 64, 69, 72 and 74 should provide information on water quality from upstream sources and are adequate for regional water management. The District will continue to fund monitoring at these sites. If additional sites are needed for the Tamiami Trail Flow Enhancement Critical Restoration Project and other projects in the northern Ten Thousand Islands area, then they should probably be included in project-specific monitoring and should be funded by the responsible agency. If additional sites are needed for RECOVER regional monitoring, then they should be included in the Monitoring and Assessment Plan and supported by RECOVER funding. The District requests information on these topics from Everglades National Park, RECOVER and Big Cypress Preserve.

Table A.3. Overall scores for pair-wise comparisons of Whitewater Bay stations (Project FLAB) in geographical groups 6 through 9

Group 6

Station Pairs	40	41	42	43	44	45	46	47	48	49	50
39	1	0	1	1	2	1	0	1	0	0	0
40		*4*	2	1	2	2	1	1	1	0	0
41			2	1	2	2	1	1	1	1	0
42				2	3	2	2	1	1	0	1
43					3	2	3	2	1	0	1
44						*4*	2	1	2	1	1
45							3	2	2	1	1
46								3	*4*	1	1
47									2	0	0
48										*4*	1
49											2

Group 7

Station Pairs	37	38
36	0	0
37		1

Group 8

Station Pairs	34	35
33	2	0
34		0

Group 9

Station Pairs	30	31	32
29	1	0	0
30		1	2
31			2

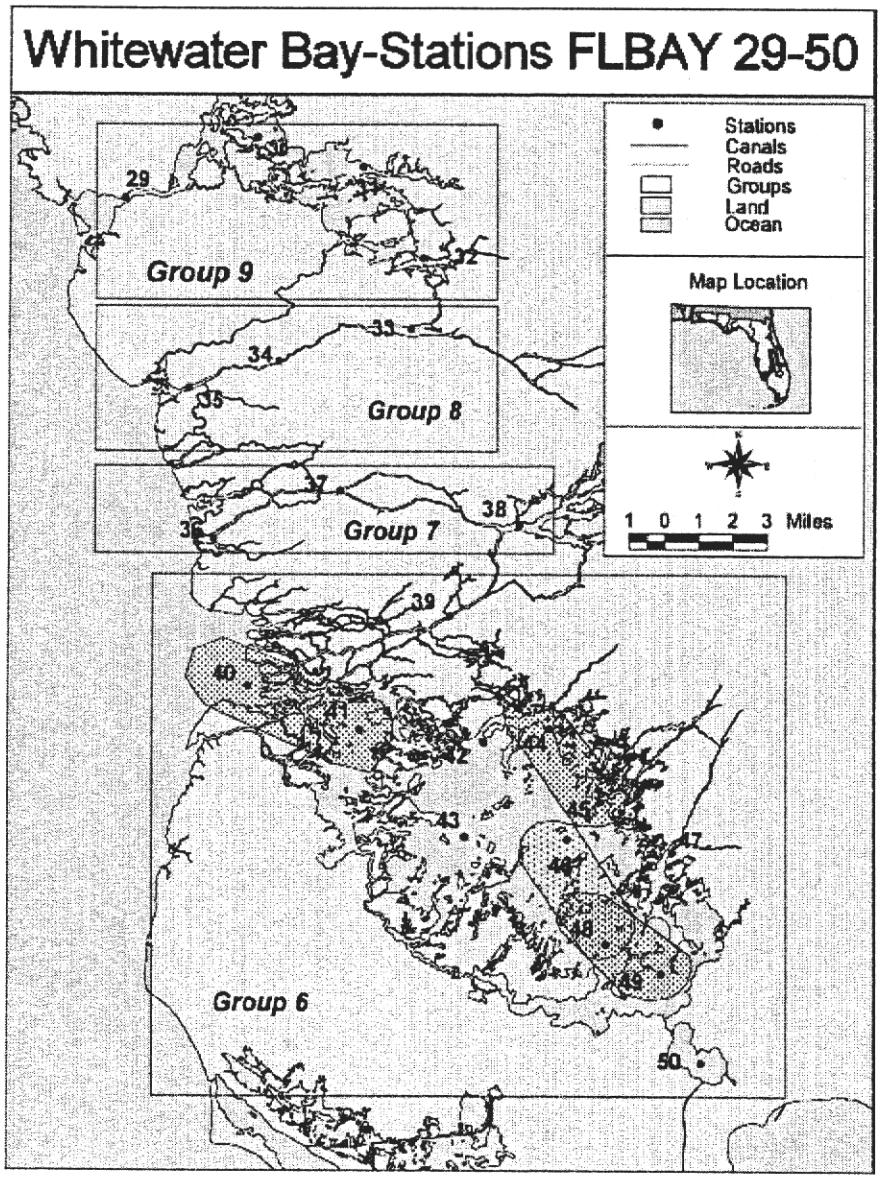

Figure 4. Location of monitoring stations in Whitewater Bay. Stations are divided into four geographical groups with stations in shaded regions exhibiting no statistical differences with respect to the four parameters of interest

Table A.4. Overall scores for pair-wise comparisons of Ten Thousand Islands stations (Project TTI) in geographical groups 1 through 4

Group 1

Station Pairs	72	73	74	75
71	*4*	2	2	2
72		2	2	2
73			*4*	1
74				1

Group 2

Station Pairs	66	67	68	69	70
65	*4*	3	3	*4*	3
66		*4*	*4*	*4*	3
67			*4*	*4*	2
68				*4*	2
69					2

Group 3

Station Pairs	52	53	54	55	64
51	2	3	3	0	3
52		2	2	2	1
53			3	1	2
54				3	3
55					1

Group 4

Station Pairs	57	58	59	60	61	62	63
56	3	3	2	2	3	0	0
57		*4*	1	2	3	0	1
58			1	2	1	0	0
59				1	2	0	0
60					3	1	1
61						1	1
62							1

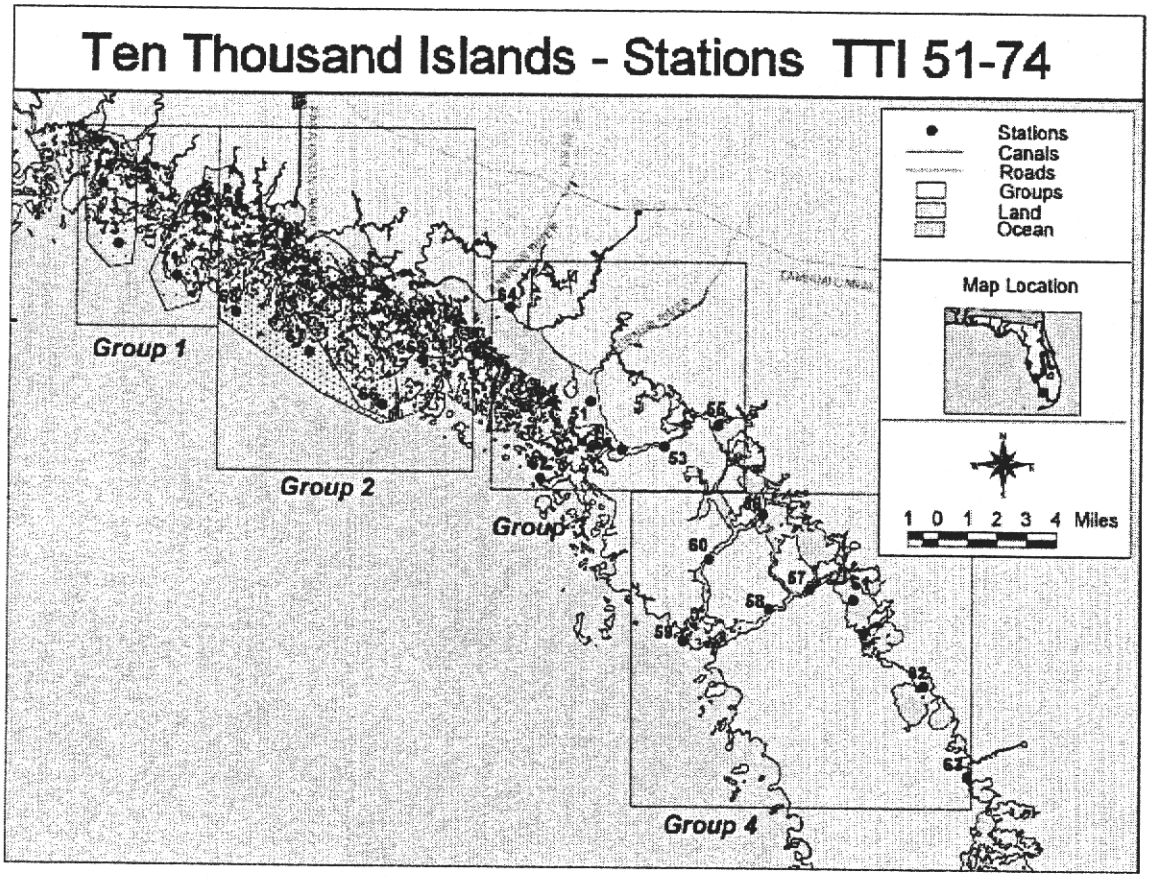

Figure 5. Location of monitoring stations for Ten Thousand Islands. Stations are divided into four geographical groups with stations in shaded regions exhibiting no statistical differences with respect to the four parameters of interest