SOUTH FLORIDA WATER MANAGEMENT DISTRICT

AUDIT OF THE PROPOSED UPGRADE/REPLACEMENT OF THE SCADA SYSTEM

Audit #02-13

Prepared by
Office of Inspector General

Allen Vann, Inspector General
Tim Beirnes, Lead Consulting Auditor
John Lynch, Lead Information Systems Auditor

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

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MGT 08-06F

August 14, 2002

Audit Committee Members:
Mr. Gerardo B. Fernandez, Chair
Mr. Lennart E. Lindahl, Vice-Chair
Ms. Pamela D. Brooks-Thomas, Member
Mr. Michael Collins, Member
Mr. Patrick J. Gleason, Member

RE: Final Report - Proposed Upgrade/Replacement of the SCADA System - Audit # 02-13

This audit was performed pursuant to the Inspector General's authority set forth in Chapter 20.055, F.S. The audit focused on assessing the appropriateness of the selected technology for the District's SCADA system and analyzing the reasonableness of the 10-year cost estimates for the SCADA capital outlay and operating costs. Field work was conducted between April 12, 2002 and July 24,2002. Mr. John T. Lynch, Lead Information Systems Auditor and Mr. Tim Beirnes, Lead Consulting Auditor, prepared this report.

Sincerely,

Allen Vann
Inspector General

AV/
Enclosure

c: Henry Dean
John Fumero

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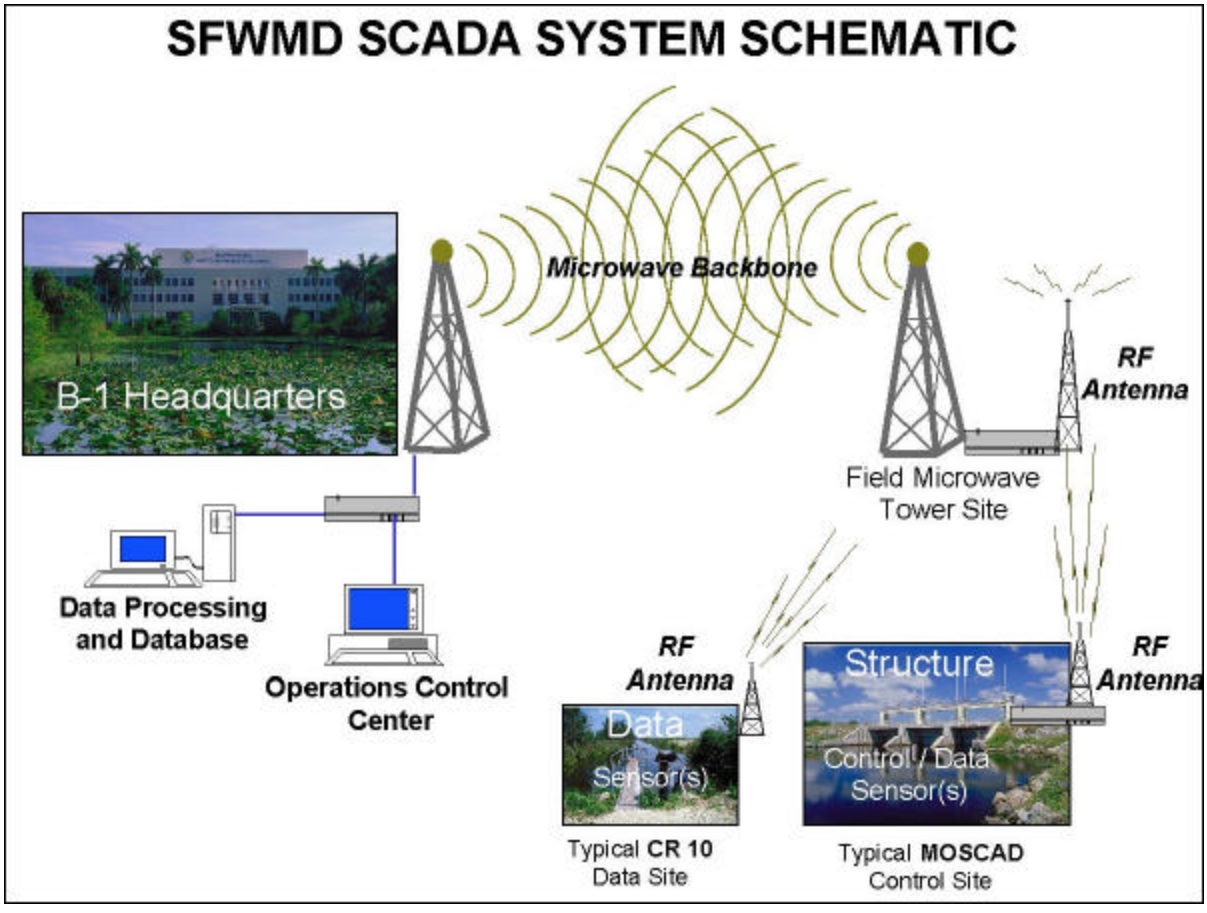
INTRODUCTION

During the April 10, 2002 Governing Board Workshop the Information Technology Staff made a presentation on the "Cost Model and 10-Year Projects" for the District's Water Management System (WMS). This presentation covered the 10-year cost projections for the upgrade/replacement of the District's supervisory control and data acquisition (SCADA) system software, hardware, data collection and communications equipment. Staff estimated the cost for this planned project, including ongoing support, would be $402,481,801 spread over the 10-year plan period.

During the Regular Governing Board meeting on April 11, 2002, the Board requested that the Inspector General's Office audit the SCADA plan as presented by staff and report the findings to the Board.



BACKGROUND

In the 1970's the District contracted with General Dynamics Corporation for the development of a Telemetry and Control System. The system was designed to support the flood control mission by monitoring stage levels, gate activity, and issuing commands for remote facility operations from District headquarters over a backbone of microwave towers. These operations were controlled by the analog microwave communications links to Master Concentrator Units (MCU's) located in the field that were in turn fed by Radio Frequency (RF) communications from the field control units referred to as Remote Access and Control Units (RACU's).

Information from the system is monitored 24 hours a day 7 days a week. SCADA operators using a computer system located in a control room at District Headquarters issue commands. This proprietary system was developed specifically for the District. (See Appendix B.)

The District also maintains a network of Campbell Scientific, Inc. CR10 Dataloggers. These dataloggers collect data such as rainfall, groundwater, and lake stages, which is communicated back to the District by dial-up telephone links, RF communications, or must be downloaded at the collection sites to disk for processing at a District facility.

In 1998 a project to modernize the proprietary SCADA system was initiated. This comprehensive project includes:

- Replacing of the central computer operations software, database, and supporting computer hardware.

- Upgrading the microwave communications to a non-proprietary digital communications protocol.

- Replacing the MCU/RACU custom technology with off-the-shelf Remote Terminal Units (RTU's) for data collection and command/control.

- The various data collection technologies (CR10's) and others into the SCADA system.

- Expanding the microwave backbone, data/control sites, and sensors to meet the needs of CERP and other major District initiatives.

OBJECTIVES, SCOPE, AND METHODOLOGY

The objectives of the audit are to:

- Review the technical case for selecting the proposed systems.

- Review the system development business case and major cost assumptions for projected maintenance, upgrades, and operational expense of the system.

- Compare current costs to projected costs and determine whether projections are based on supported assumptions.

- Determine if proposed new data monitoring sites and sensor devices are supported by legitimate District need and are not duplicative of existing sites and/or could be accomplished through alternative means.

We focused on the proposal presented to the Governing Board as the “District Water Management (WMS), Cost Model and 10-Year Projections.”

Our methodology included:

1. Review the current status of the SCADA system and the “10-year plan” projections for the replacement/upgrades of various system components.
2. Evaluate the supporting cost projections:
    - Non-recurring,
    - Recurring, and
    - Reimbursable Costs.
3. Interview project managers, implementation/maintenance support staff, and data collection/processing staff.
4. Review the criteria and selection process for the MOSCAD RTU’s.

This audit was conducted in accordance with "generally accepted government auditing standards" as promulgated by the Comptroller General of the United States. In addition, we were guided by the "Standards for Information Systems Auditing" as developed by The Information Systems Audit and Control Foundation Standards Board.

EXECUTIVE SUMMARY

Staff's Technical Case Supported

Staff followed extensive outside studies in developing their proposed SCADA plans. KEMA Consulting conducted three studies, including a "Needs Analysis Report", "Communication Infrastructure Study", and "Corporate information Management Study." An additional review of the "Enterprise SCADA Technology" was conducted by PB Water. Their report supports the staff's SCADA plan.

Cost Estimates Overstated

The original ten-year SCADA cost projection presented to the Governing Board on April 10, 2002 estimated to cost approximately $402 million. Our audit of this analysis indicates the cost to be approximately $292 million - $110 million less.

The number of new sites used in the analysis is based on a site survey performed among the user community. Therefore, site survey results are users represented needs and have not been analyzed or independently verified to determine whether all these sites are necessary or whether duplications exist. Therefore, the SCADA system site cost may be different than the pre-audit estimates

New Spending Only 19%

Of the $292 million for the eleven-year period from FY2002 through 2012 (inclusive), only $55 million (19%) is due to new capital and maintenance spending. Approximately $43 million, or 15%, is due to inflation.

58% Charge-able to Special Revenue Funds

Three District programs, representing 58% of new site installation costs, are funded through special revenue funds. The Big Cypress Basin will account for $10 million in estimated cost. The ECP already has dedicated funding sources for its $5 million in estimated new field site costs. The $29 million estimated cost for CERP project sites should be counted as in-kind credit towards the District's 50% cost share.

FINDINGS AND RECOMMENDATIONS

Staff's Technical Case Supported

In January of 2000 the District contracted with KEMA Consulting to develop a "Needs Analysis Report" for a modern (state of the art) fully integrated Water Management System. [1] The report presented the following:

Conditions Reported

- Outdated Proprietary SCADA system not capable of meeting growth needs,
- Saturation of the Communications System,
- Multiple platforms and data collection methods,
- Difficulty in timely access for Operations to information,
- Large amounts of manually collected data and inconsistent validity checks,
- Manpower requirements and time requirements for data validation are high,
- Duplication of archived data,
- Water Quality and Hydrologic data in multiple databases and do not share a common data structure, and
- Limited provision for real-time data.

KEMA Recommendations

- Replacing the proprietary SCADA system with a modern "Open System" with the following characteristics;

    - Flexible platform that supports a relational database.
    - Existing Remote Access and Control Units (RACU) to modern open Remote Terminal Unit (RTU) architecture such as the existing MOSCAD and CR10 units.
    - Upgrade the existing Modcomp Computers to interface RACU's with new system.
    - New system should interface with existing MOSCAD gateways.
    - Interface new system with LoggerNet system used by the CR10 RTU's.

[1] KEMA Consulting. South Florida Water Management District, Water Management, Needs Analysis. May 2000; 1.1 – 1.5.

- Database should be capable of supporting data from non-telemetry sources.
- Provide a consistent integrity checks on all data.
- Maintain hardware and software contracts to keep system "current".

- Conducting an extensive communications study that focuses on RTU communications paths, and

- Conducting a comprehensive data storage and access needs requirements study.

KEMA Consulting delivered a Communication Infrastructure Study in January of 2001 and a Corporate information Management Study in January of 2002. We found that the staff utilized the KEMA studies in developing their proposed SCADA 10-year plan for the system upgrade/replacement.

An additional review of the "Enterprise SCADA Technology" was conducted by PB Water (A Division of Parsons Brinkerhoff Quade & Douglas, Inc.) in February of 2002. PB Water reviewed the three KEMA reports, as well as cost, user information, and technical specifications provided by District staff. Their report supported the staff's planned direction with the SCADA Technology, which includes the use of both the Motorola MOSCAD and Campbell Scientific CR10 remote terminal units.

Cost Estimates Overstated by $110 Million

The original ten-year SCADA cost projection presented to the Governing Board on April 10, 2002 estimated cost at approximately $402 million[2]. Our audit of this analysis indicates the cost is approximately $292 million - $110 million less. A detailed schedule of adjustments and explanations for those adjustments are shown in Appendix A. Following are discussions of the most significant adjustments.

- The original estimate included indirect cost of $81.8 million, which includes $20.3 million for fringe benefits and $61.5 million in central services overhead. In our opinion, fringe benefits should be included; however, the SCADA initiatives will not materially impact the current level of central service overhead costs and thus is irrelevant for the purposes of this

[2] The backup material presented to the Governing Board also contained an estimate of $320 million that excludes fringe benefits and indirect cost.

analysis. Hence, indirect costs were decreased by $81.8 million and salary costs were increased by $20.3 million, for a net decrease of $61.5 million.

- Escalation of field site installation costs for inflation was inadvertently omitted from the original estimate. Including inflation adds $10 million to the cost estimate.

- Field site maintenance cost was estimated at $3,600 per site per year. Our analysis indicates current annual site maintenance cost is about $2,520 per site. Our analysis was based on a review of current outsourced contracts for site maintenance and historical repair frequency. This reduced the site maintenance cost estimate by $12.9 million.

- The original estimate assumed that the increased data management workload generated from new sensor installations would be outsourced at an annual cost of $1,628 per sensor. This assumes data management cost increases linearly in relationship to the number of new sensor installations. However, the District's investment in SCADA technology should provide significant gains in data management efficiencies because the system will automate some of the current manual process. Consequently, existing staff should be able to absorb most of the increased workload thereby eliminating about $42 million of the $48 million in estimated outsourcing cost[3].

- Various other adjustments were made that reduced estimated cost by a net of $3.8 million. Detailed explanations of these adjustments are included in Appendix A.

The number of new field site installations is a significant driver of SCADA expenditures because each additional site further increases annual operating cost to maintain the equipment and manage the data the site generates. The estimated number of new sites in the analysis is based on a site survey performed among the user community. Therefore, site survey results represent users represented needs and have not been analyzed or independently verified to determine whether these sites are necessary or whether duplications exist.

[3] Management's Response and Comments at Appendix C, Note 2 (Page 16), states that the "draft report inadvertently applies productivity increase to all included EMA salaries rather than to data QA/AC alone". Using this methodology, however, also decreases the estimated cost per sensor. Additional analysis by the Office of Inspector General considering staff's methodology indicates that the cost estimate would be about the same. We additionally concluded that the Customer Support and Legally Mandated units workloads do not increase proportionately with the number of new sensors.

Furthermore, the Budget Office did not have any input into this analysis and the input from the Finance Department was very minimal.

Recommendations:

(1) We recommend that department managers request more extensive assistance from the Finance and Administration Department when preparing major financial analyses.

Management Response:

Management agrees with the recommendation. Changes initiated with the most recent reorganization call for stronger ties between Finance and Administration and Resource Area business staff. Communications will be enhanced and standardization of business functions will include review of financial data prepared by Resource Areas.

Responsible Department/Division: Finance and Administration Department

Estimated Completion Date: N/A

(2) The site survey should be validated to ensure that surveyed sites are necessary and do not duplicate existing or projected new sites.

Management Response: Management agrees with the recommendation. We further suggest that this effort be undertaken by an independent third party.

Responsible Department/Division: TBD

Estimated Completion Date: TBD

New Spending Represents Only 19% Of The Total Estimated Cost

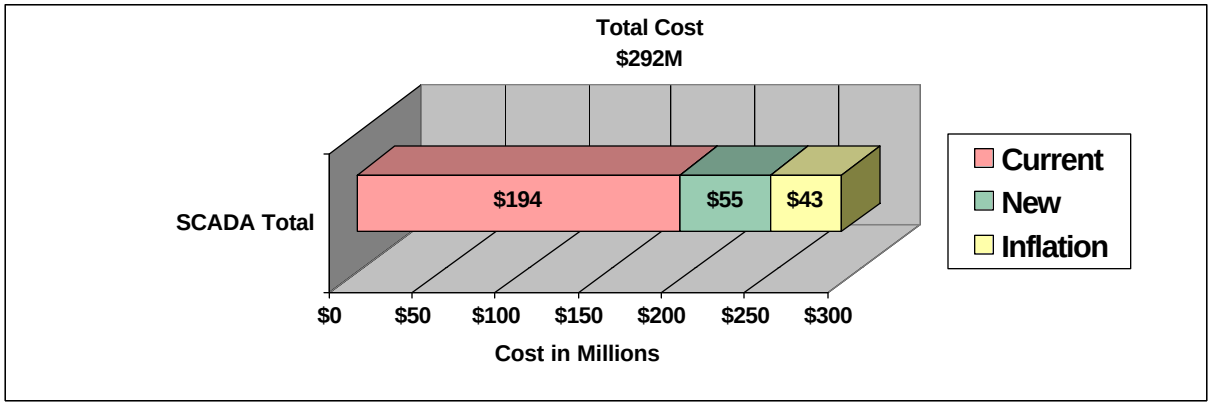
Our analysis indicates the estimated cost to develop and operate the SCADA system is about $292 million for the eleven-year period from FY2002 through

2012 (inclusive). We analyzed this cost to determine how much is due to current spending levels, new spending, and inflation. Following is the results of this analysis:

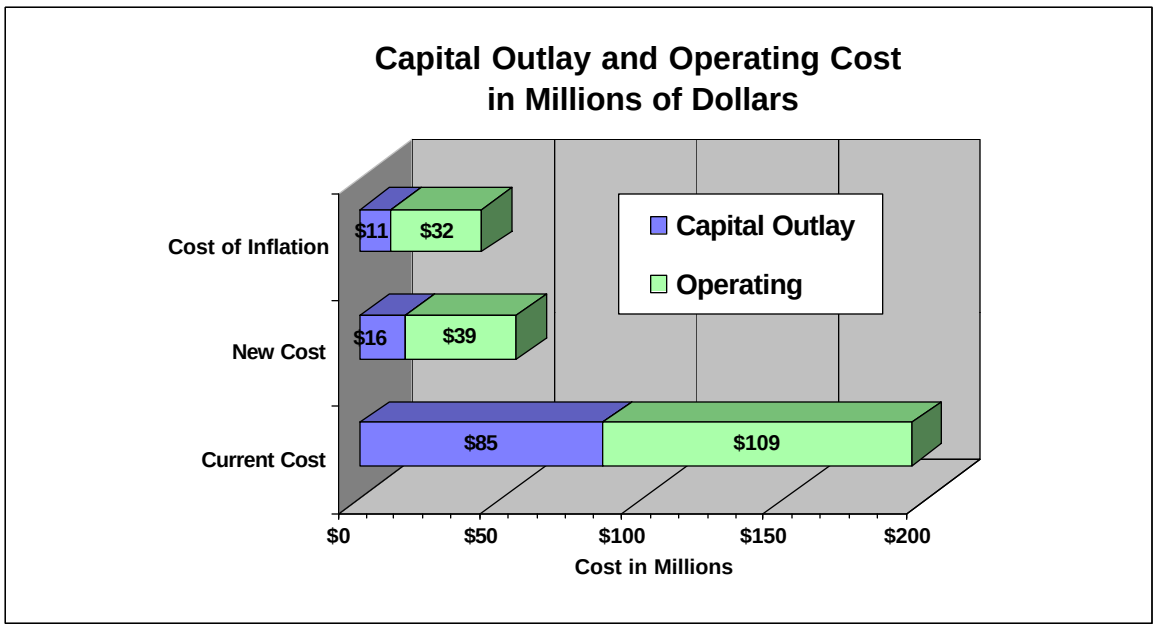
- The District budgeted $17.6 million for SCADA initiatives in fiscal year 2002. Thus, the District would expend $194 million over the 11-year period if expenditures continued at the current level and if prices did not increase.

- Only $55 million (19%) is due to proposed new spending beyond the current level of expenditures at current price levels.

- About $43 million (15%) is due to escalating current and new spending for inflation.



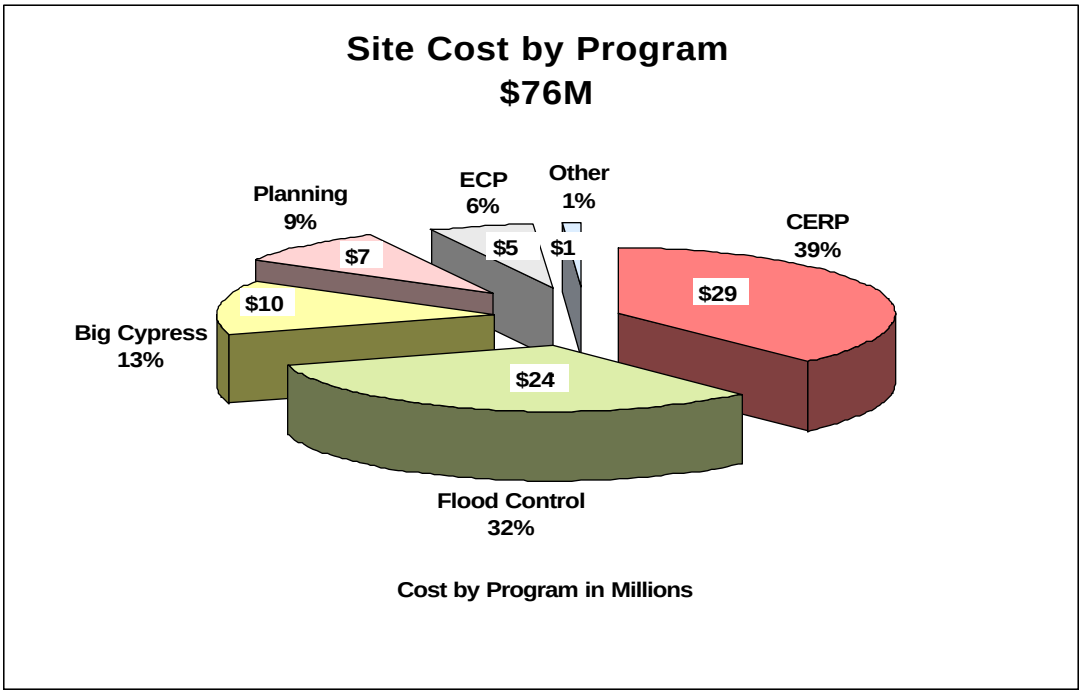
The following graph shows a breakdown of cost between capital outlay and operating cost by the above categories:



In summary, current SCADA spending levels and inflation account for approximately 81% of total estimated expenditures over the 11-year period.

Approximately 58% Of The New Field Sites Chargeable To Special Revenue Funds

Five District programs account for 99% of all new field site installation costs as shown in the following graph:



Three District programs, representing 58% of new site installation costs, are funded through special revenue funds. These expenditures are specifically identifiable with these programs; accordingly, the cost for these new sites should be charged directly to the following programs.

- The $29 million estimated cost for CERP project sites should be eligible for in-kind credit towards the District's 50% cost share. Also, the U. S. Army Corps of Engineers (USCOE) will likely pay directly for some of these costs since approximately 40% of site installation cost is for items that are generally part of the structural construction contract (such as wiring, equipment housing, and building accesses to the equipment).

- ECP already has dedicated funding sources for its $5 million estimated new field site costs.

- Big Cypress Basins' Governing Board is responsible for appropriating the $10 million estimated cost for their own sites.

CERP operating expenditures will also be cost shared 50/50 with the USCOE. Maintenance costs for CERP project sites are readily identifiable and separately accounted for. Therefore, maintenance expenditures should be creditable to the District's share of CERP operating cost. We estimate this cost to be approximately $12 million over the eleven-year period.

Recommendation:

(3) Management should ensure that SCADA expenditures are charged directly to programs where costs and benefits can be identified with specific programs and linked to specific revenue streams.

Management Response: Management agrees with the recommendation. This is the current policy for all new field installations, which are budgeted and justified by the initiating end user, and coded to the appropriate Fund and Activity. For maintenance and data processing, costs are allocated similarly.

Responsible Department/Division: Electronic Support and Data Acquisition Division, Infrastructure Services Division, Environmental Monitoring and Assessment Department

Estimated Completion Date: N/A

Appendix A

Summary Schedule of 10-Year SCADA Cost Projections

	Staff Estimates	Adjustments	Note	IG Estimates
Non-Recurring Costs				
New Installations - Outsource	**$ 65,964,984**	**$ 10,021,767**	***a***	**$ 75,986,751**
Field Infrastructure				
Site Upgrades - Outsource	$ 5,901,377	$ -		$ 5,901,377
Site Upgrades - Other Direct	1,266,743	-		1,266,743
Total Field Infrastructure	**$ 7,168,120**	**$ -**		**$ 7,168,120**
Communications Infrastructure				
System Expansion - Outsource	$ 7,662,342	$ (355,239)		$ 7,307,103
System Expansion - Other Direct	12,847,706	-		12,847,706
Total Communications Infrastructure	**$ 20,510,047**	**$ (355,239)**	***b***	**$ 20,154,809**
SCADA Central				
Water Management SCADA System - Outsource	$ 2,821,747	$ (1,771,851)		$ 1,049,896
Water Management SCADA System - Other Direct	525,000	1,101,487		1,626,487
Total SCADA Central	**$ 3,346,747**	**$ (670,364)**	***c***	**$ 2,676,383**
Information Management				
Water Management Information System - Outsource	$ 6,570,000	$ (2,125,000)	***d***	$ 4,445,000
Water Management Information System - Other Direct	500,000	-		500,000
Other EMA Direct	1,518,400	(650,000)	***e***	868,400
Total Information Management	**$ 8,588,400**	**$ (2,775,000)**		**$ 5,813,400**
Total Non-Recurring Costs	**$ 105,578,298**	**$ 6,221,165**		**$ 111,799,463**
Recurring Costs				
Field Infrastructure				
Operations and Maintenance - Outsource	$ 47,705,935	$ (12,890,115)	***h***	$ 34,815,820
Operations and Maintenance - Other Direct	33,036,794	-		33,036,794
Operations and Maintenance - Salaries	23,056,091	7,377,949	***f***	30,434,040
Indirect	28,234,489	(28,234,489)	***g***	-
Total Field Infrastructure	**$ 132,033,309**	**$ (33,746,655)**		**$ 98,286,654**
Communications Infrastructure				
Operations and Maintenance - Outsource	$ 2,002,471	$ -		$ 2,002,471
Operations and Maintenance - Other Direct	7,358,465	-		7,358,465
Operations and Maintenance - Salaries	5,768,151	1,845,808	***f***	7,613,960
Indirect	6,301,705	(6,301,705)	***g***	-
Total Communications Infrastructure	**$ 21,430,794**	**$ (4,455,897)**		**$ 16,974,897**
SCADA Central				
Operations and Maintenance - Outsource	$ 5,266,335	$ -		$ 5,266,335
Operations and Maintenance - Other Direct	128,078	-		128,078
Operations and Maintenance - Salaries	5,242,210	1,266,604	***f***	6,508,815
Indirect	5,727,115	(5,727,115)	***g***	-
Total SCADA Central	**$ 16,363,738**	**$ (4,460,510)**		**$ 11,903,228**
Information Management				
Operations and Maintenance - Outsource	$ 48,304,200	$ (42,270,373)	***i***	$ 6,033,827
Operations and Maintenance - Other Direct	6,562,850	-		6,562,850
Operations and Maintenance - Salaries	30,641,013	9,805,124	***f***	40,446,137
Indirect	41,567,598	(41,567,598)	***g***	-
Total Information Management	**$ 127,075,662**	**$ (74,032,847)**		**$ 53,042,814**
Total Recurring Costs	**$ 296,903,502**	**$ (116,695,910)**		**$ 180,207,593**
Total Costs	**$ 402,481,801**	**$ (110,474,745)**		**$ 292,007,056**

Appendix A (continued)
Note Key

(a) *Adjustment increases new field site installation costs to include the effect of 3% annual inflation. This was inadvertently omitted from the original estimate.*

(b) *Equipment lease payments were inadvertently escalated for inflation where the payments are fixed amounts over the lease term. Adjustment reflects removal of the inflation from the lease payments.*

(c) *During the course of the audit, the Governing Board approved a contract for the Central SCADA system in the amount of $1,328,368. This system was originally estimated to cost $2,000,000. Thus, estimate was reduced to reflect actual contract cost.*

(d) *Costs for software and implementation of the new Water Management Information System (WMIS) and database upgrades were based on preliminary numbers in a draft report KEMA Consulting prepared. Costs were adjusted to reflect the estimate in KEMA Consulting's final report, which were significantly less then the draft report estimates.*

(e) *Adjustment represents cost relating to the new WMIS that were double counted.*

(f) *Staff estimate added indirect cost, which includes fringe benefits as well as central services overhead. In our opinion, only the fringe benefits portion of indirect cost should be included in the analysis. All indirect costs were removed (see Note g) and fringe benefit costs were added to base salaries (at the rate of 32%).*

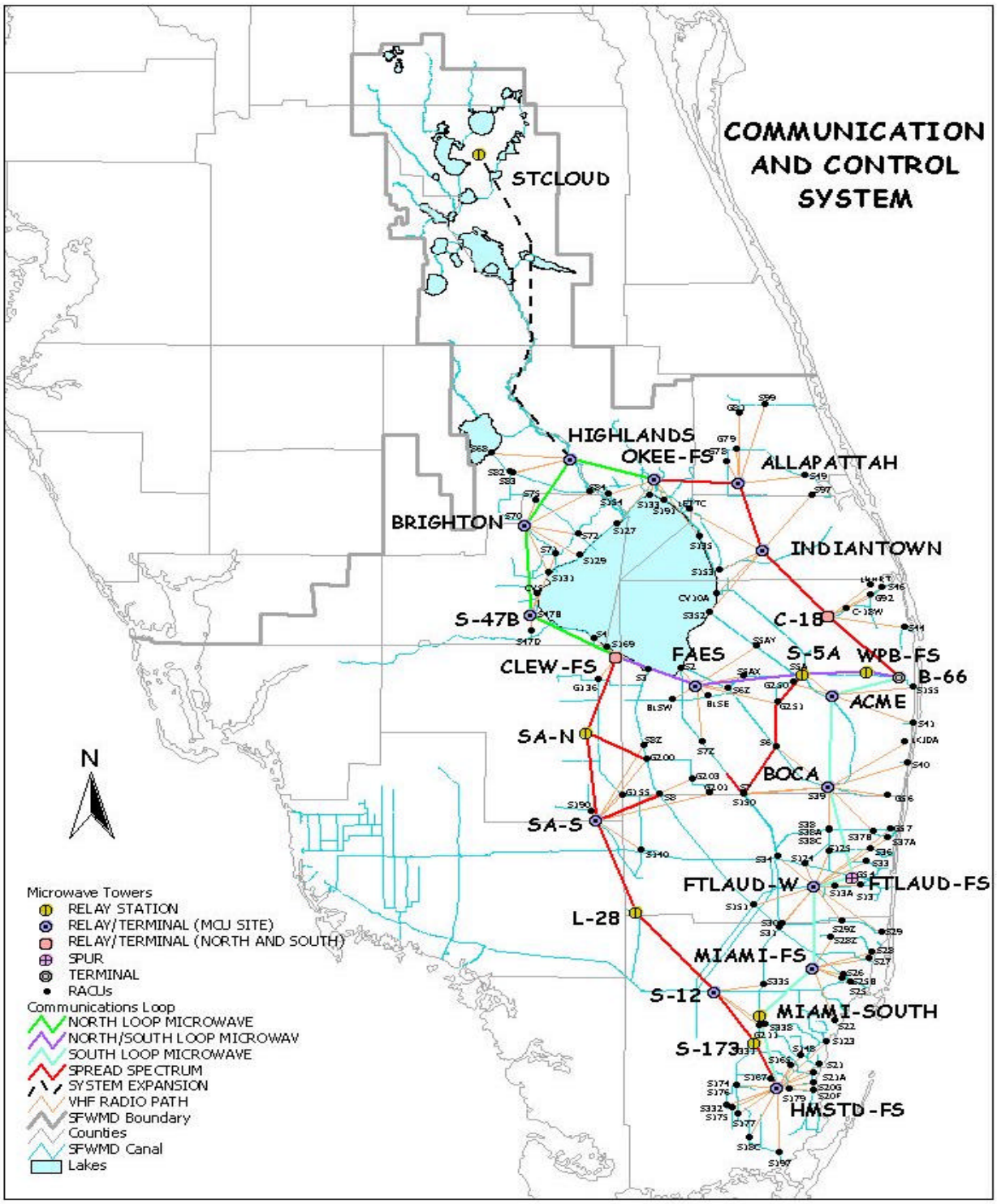
(g) *Indirect costs include central services overhead and salary fringe benefits. The level of SCADA system activity will not materially impact central services overhead; however, fringe benefits are variable expenditures. Hence, all indirect costs were removed and fringe benefit costs were added to the base salaries (see Note f). The effect of removing central services overhead reduces the ten-year cost estimate by $61,535,422.*

(h) *Original estimate was based on an annual cost of $3,600 for preventative maintenance and emergency repairs for each field site. We performed an analysis of field site maintenance expenditures, which showed cost to be approximately $2,520 per site annually. Cost estimates were adjusted accordingly.*

(i) *Investments in the SCADA system and the Environmental Data and Analysis System should provide significant efficiency gains by standardizing the data collection process and incorporating program logic to validate data that is currently examined manually. The new system will only necessitate staff manually reviewing exceptions the system generates. The staff estimate assumes that data quality assurance cost will increase linearly with new sensor installations - plus 3% inflation. The staff estimate also assumes that external contractors will be engaged to handle the increased workload the new sensors generate. Our analysis indicates that the new system will approximately double internal staff's efficiency, thereby eliminating most of the outsourcing needs.*

Note: The Inspector General estimates are based on the number of new sites per the "site survey", which is subject to revision based on staff review. Any significant changes to the number of estimated sites would materially change cost estimates.

Appendix B


COMMUNICATION AND CONTROL SYSTEM
STCLOUD
HIGHLANDS
OKEE-FS
ALLAPATTAH
BRIGHTON
INDIANTOWN
S-47B
C-18
CLEW-FS
FAES
S-5A
WPB-FS
B-66
ACME
SA-N
BOCA
SA-S
FTLAUD-W
FTLAUD-FS
L-28
MIAMI-FS
S-12
MIAMI-SOUTH
S-173
HMSTD-FS
N
Microwave Towers
RELAY STATION
RELAY/TERMINAL (MCU SITE)
RELAY/TERMINAL (NORTH AND SOUTH)
SPUR
TERMINAL
RACUs
Communications Loop
NORTH LOOP MICROWAVE
NORTH/SOUTH LOOP MICROWAV
SOUTH LOOP MICROWAVE
SPREAD SPECTRUM
SYSTEM EXPANSION
VHF RADIO PATH
SFWMD Boundary
Counties
SFWMD Canal
Lakes

Appendix C

Click here to view Appendix C
(MS Word document)

GLOSSARY of TERMS

These definitions were developed by District staff or were drawn from the "Free On-line Dictionary of Computing," by Dennis Howe @ Web Site: http://www.foldoc.org.

application program (Or "application")

A complete, self-contained program that performs a specific function directly for the user. This is in contrast to systems software such as an operating system (OS), which exists to support application programs.

audit trail (computer)

A record showing who has accessed a computer system and what operations he or she has performed during a given period of time. Audit trails are useful both for maintaining security and for recovering lost transactions.

backup

A spare copy of a file or system of files, usually kept on magnetic tape or other removable medium such as compact disc, for use in the event of failure or loss of the original files or system.

CR 10

Campbell Scientific, Inc. remote terminal unit (RTU) data logger.

hardware

The physical, touchable, material parts of a computer or other system. The term is used to distinguish these fixed parts of a system from the more changeable software or data components.

information systems security

Control techniques and measures applied to an Information Technology Process that satisfies the business requirement to safeguard information against unauthorized use, disclosure or modification, damage or loss and is enabled by physical, logical and administrative controls which ensure access to systems, data and programs is restricted to authorized users. (Brian A. Coleman, CISA)

local area network (LAN)

Networks that cover a smaller area such as a complex of buildings are called a Local Area Network, LAN. Multiple Local Area Networks can be interconnected through a Wide Area Network. (i.e. B-50 to B-1 computer communications link.)

MOSCAD

Motorola SCADA remote terminal units (RTU's). MOSCAD RTU's are programmable units with multiple communication paths that have the capable of controlling gates, pumps, and monitoring data sites.

on-line

Accessible directly via a computer (or terminal), rather than on paper or other removable medium such as magnetic tape or CD.

operating system (OS)

The low-level software, which scheduled tasks, allocates storage, handles the interface to peripheral hardware and presents a default interface to the user when no application program is running.

password

An arbitrary string of characters chosen by a user or system administrator and used to authenticate the user when he attempts to log on in order to prevent unauthorized access to his account.

platform

*Specific computer **hardware**. It may also refer to a specific combination of hardware and operating system.*

real-time

An application which requires a program to respond to stimuli within some small upper limit of response time (typically milli- or microseconds). Process control at a chemical plant is the classic example. Such applications often require special operating systems (because everything else must take a back seat to response time) and speed-tuned hardware.

recovery

The process of restoring computer data file with a backup copy usually after a crash or accidental deletion of a file.

relational data base

A relational database allows the definition of data structures, storage and retrieval operations and integrity constraints. In such a database the data and relations between them are organized in tables. A table is a collection of records and each record in a table contains the same fields. Certain fields may be designated as keys, which means that searches for specific values of that field will use indexing to speed them up.

supervisory control and data acquisition (SCADA)

Systems are used in industry to monitor and control plant status and provide logging facilities. SCADA systems are highly configurable, and usually interface to the plant via PLCs (Programmable Logic Controller, a device used to automate monitoring and control)

software

Computer programs, as opposed to the computers on which they run (the "hardware").

telemetry

Transmission and collection of data obtained by sensing conditions in a real-time environment.

user(s)

The people who either use computers directly, or use the information they provide; also called computer users or end users.

wide area network *(WAN)*

A computer communications network used to access information with a link over distances of more than one kilometer. Multiple Local Area Networks (LAN's) can be interconnected through a Wide Area Network. (District-wide computer communications network.)