The Financial Implications of Implementing Six Sigma in a Government Enterprise

Hugh Van Seaton
Jacksonville University
Jacksonville, Florida, USA
vseaton@ju.edu

ABSTRACT

This study explored Six Sigma, a performance management system which has recently experienced widespread adoption in industry in the United States, internationally, and in some government organizations. In this study, Six Sigma and its effects and organizational cultural impacts on one organization were examined. Successful organizations continually seek ways to improve productivity, reduce and control costs, and increase efficiency. Governmental entities also are driven by the need for increased efficiency and accountability in public service for their constituents. There is a continuing need for better tools and a number of government entities have turned to performance management systems due to their promise of improvement in various areas of productivity and accountability.

The study used the organization's published financial information from 1997 through 2006 to determine whether there was a tangible financial benefit of implementing Six Sigma. The analysis indicated that the financial implications were statistically significant and quantified them as material and relevant to the organization's two major business units

INTRODUCTION

Government entities in public service also are being increasingly driven by the need for increased efficiency and accountability to their constituents. A number of government entities have turned to performance management systems due to their promise of improvement in various areas of productivity and accountability. JEA, the subject location of this study, in 2000 began the process of implementing Six Sigma across the organization. This study reviews the Proforma financial implications of the implementation on the operating expenses over the following five year period.

For most of the last two centuries, business has used non-financial and financial information to guide management's decision making in planning the extent of activities

and financing of the organization and controlling the production units and workers. Before the technological evolution of the computer in the 1960s, accounting information was primarily used to plan, forecast, and develop what-if scenarios, while non-accounting metrics and information were geared toward managing activities through tracking the flows and costs through the organization. Now, however, accounting has begun to be replaced by newer forms of performance management incorporating ideas such as Deming's (1982, 1986) continuous process improvement philosophy and its resultant tools.

One example of managers' efforts to develop new and better ways of managing performance is the Six Sigma system. The recent emergence of Six Sigma as a performance management system is of primary interest to the present study. Though a growing number of companies are adopting Six Sigma, such as Motorola, GE, and DuPont (Eckes, 2001a); JEA, the Jacksonville, Florida, municipally owned electric, water, and sewer authority, the site of this study, is one of the few government entities to have used this system.

SIGNIFICANCE

JEA employs in excess of 2,300 people. JEA, an independent agency of the City of Jacksonville, Florida, is the eighth largest municipally-owned electric utility in the United States in terms of number of customers, and a regional water and system utility company operating in Duval, St. Johns, and Nassau Counties. On June 1, 1997, the water and sewer systems operated by the city since 1880 also became part of JEA's utility service offerings. It was fitting that this merger took place, as the Main Street Light Plant was built at the city's Waterworks Park at First and Main Streets" (JEA, 2009).

Employees in today's organizations are well educated, highly trained, and prepared to excel in achieving corporate goals. The Six Sigma system addresses the importance of the managerial and professional workforce and requires rigorous training of personnel at these levels so that proficiency can be realized. Yet, assessments of the impact of Six Sigma implementation are dominated by traditional metrics. Assessments typically do not include the measurement of organizational culture changes. Further, analysis of the systemic impact of Six Sigma in an organization has not been measured at the operating cost level. Table 1 provides an example of the traditional metrics used by Six Sigma, as recently described at JEA, illustrating financial performance since the TargetSmart implementation.

Based on these preliminary data, the indicated payback (Table 1) appears to be excellent, at some 12 times the $12,990,000 in costs. According to an internal rate of return analysis, and assuming all the costs in the initial year with the results achieved

evenly over the following 5 years, the program results show an estimated internal rate of return on the costs of the efforts of 188%.

There is a need to analyze and investigate these implied program results by comparing the operating expenditures calculated in relation to units of production separately for the electric system and the water and sewer system over the period of fiscal years 2000-2006, using a baseline average of fiscal years 1997-1999.

JEA - TargetSmart Initiative Costs	Unit Cost	Quantity	Total Cost
Initial exploration team costs	$ 400,000	1	$400,000
1 wave Black Belts (BB) and 3 waves of Green Belt (GB) training costs - Qualtec Contract	1,200,000	1	1,200,000
BB personnel costs for entire program	7,000,000	1	7,000,000
GB personnel costs for entire program	5,000	400	2,000,000
Typical BB project costs (team participation)	5,000	128	640,000
Typical GB project costs (team participation)	3,000	260	780,000
MSI first contract	970,000	1	970,000

JEA - TargetSmart Initiative Results	Expected Benefit	Actual Savings
Typical BB cost: 43 over $100,000 projects	$56,453,715	$56,453,715
Typical GB cost: 53 over $100,000 projects	31,499,555	29,176,084
Impact of projects with < $100,000 savings	N/A	$62,018,273
Totals	$87,953,270	$147,648,072
Return on investment	677%	1137%
Annual rate of return	123%	207%
Internal rate of return, assuming = savings in each period over 6 years	110%	188%

Table 1: TargetSmart Program Results

SIX SIGMA DEFINED

Six Sigma is a rigorous application of principles-based continuous process improvement methods, tools, and statistic-based analyses of processes. Goals include

improved customer service and quality, reduced error rates, and increased productivity. To achieve Six Sigma, a process must not produce more than 3.4 defects per million opportunities [number of defects observed for a given process]. The fundamental objective of the Six Sigma methodology is the implementation of a measurement-based strategy focus on process improvement and variation reduction through the application of specialized statistical tools on process improvement projects.

INTRODUCTION OF SIX SIGMA PERFORMANCE SYSTEM AT JEA

JEA's present comprehensive organizational culture began with the CEO who assumed the leadership of JEA in 1994. Previous management had guided JEA to being very well run through the 1990s, when JEA began to focus on customer satisfaction; a focus that current management has expanded upon. [4] Senge (1990) described the successful organization of the future as an organism with the developed capacity to continually enhance its capabilities and shape its own future. The learning organization, at its core, would be a complex organization, perhaps a company, association, church, school, or government agency, which is a complex organic system, and which understands itself. The organization would have a conscious vision and purpose and would be aware of its feedback systems and alignment mechanisms, as well as organized in the use of them. The disciplines of building shared vision and team learning differ from the other three in that they are inherently collective in nature. The practices are activities engaged in by groups. [4] (Senge, p. 375)

METHODOLOGY

The study examined the implementation of Six Sigma in a large government enterprise by investigating the financial impacts of the implementation. The study focused on financial in the context of the broader implications of performance management systems.

METHODOLOGY OF THE QUANTITATIVE PHASES

The quantitative methodology used in this study was a financial analysis, which was conducted using traditional financial metrics and JEA's publicly disclosed financial statements and schedules. JEA's actual operating and maintenance expenses were analyzed for each of its two major systems: the electric system and the water and sewer system, over the base period from 1997 through 1999 and used those years as the base for comparing the subsequent years (2000 – 2006) operating performance (Appendices I - III).

The methodology for the financial analysis was a Proforma analysis. "Proforma financial statements may project … years into the future. The advantage to the Proforma approach to forecasting is that a much greater degree of flexibility is possible" (Eakins, 2005, p. 422). This method used in this study used the JEA historically determined (base period) relationship of operating expenses as a percentage of the units of production, and then applied the percentages against the actual units of production over the periods following the base period (fiscal years 2000 through 2006) to project the results, assuming no change in the relationship. This method differs from the more normal Proforma methods which usually are for the forward planning and budgeting related activities. "A simple model to construct pro forma financial statements is one in which every item increases at the same rate as sales" (Jordan & Miller, 2007). The Proforma financial statements "describe a statement that is not based on actual data but rather depicts a firm's financials under a given set of hypothetical assumptions" [7] (Berk & DeMarzo, 2007, p. G-13). "These financial statement columns yield Proforma financial statements because they show the statements *as if* the proposed transactions occurred" (Wild, 2005, p. 122).

DATA ANALYSIS

Question: What is the cost/benefit to JEA of implementing Six Sigma? This research question used the published financial information for JEA from 1997 through 2006. An analysis was conducted to determine whether there was a tangible financial benefit discernible from the historical data. The metrics for this phase of the study examined the operating results for those years just before the introduction of Six Sigma and compared those operating data over subsequent years through the recently published results for fiscal year 2006. This study analyzed the audited financial statements of JEA, using the baseline years, 1997, 1998, and 1999, compared the actual operating and maintenance expenses separately for the electric system and the water and sewer system, as a percentage of the actual units of sale for each of the two operating systems being examined. Based on this analysis, the aggregate savings for the period under investigation were projected to be $84,928,000, allocated between the electric system at $10,275,000 and the water and sewer system at $74,653,000.

The results were then tested with Minitab: For the Electric System, the aggregate Proforma Operating and Maintenance (O&M) Expenses (1200898) divided by the MWhs Sold (a) during the period of FY2000-FY2006 versus Electric System Actual O&M Expenses (1190623) divided by the MWhs Sold FY2000-FY2006 were compared and are presented in Table 2.

Sample	X	N	Sample p
1	1200898	X	90275817 (a) = 0.013303 Proforma O&M Expenses / Total MWh Sold
2	1190623	X	90275817 (a) = 0.013189 Actual O&M Expenses / Total MWh Sold

Difference = p (1) – p (2) Estimate for difference: 0.000113818
95% CI for difference: (0.0000804661, 0.000147170)
Test for difference = 0 (vs. not = 0): Z = 6.69, P-Value = 0.000
There is a statistically significant savings

Table 2: Minitab Test and CI for Two Proportions – Electric System

Based on the analysis, the data showed a statistically significant difference between the Proforma savings and the actual operating and maintenance expenses for the electric system in Figure 1.

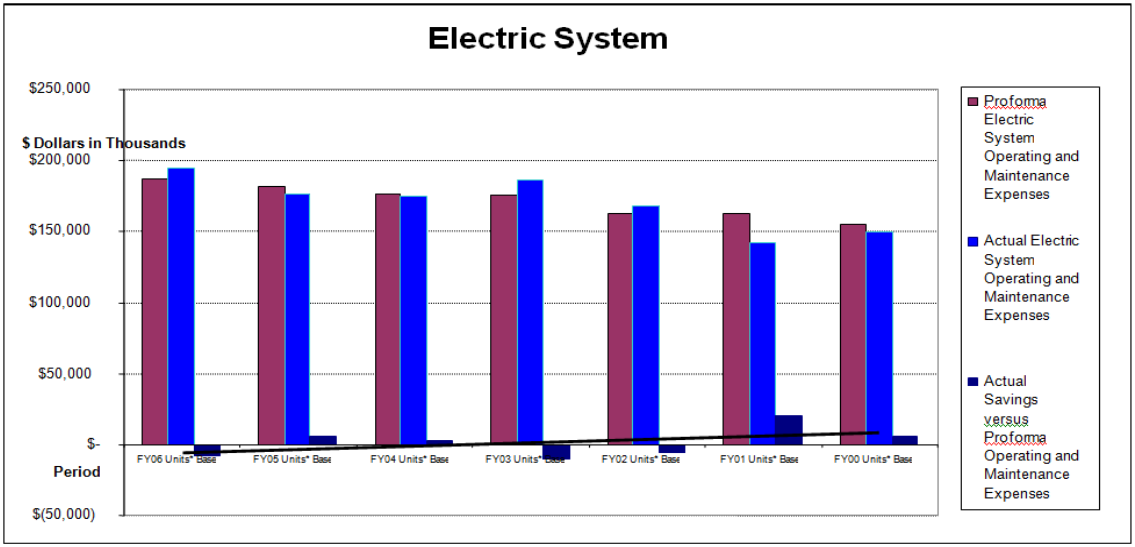

Figure 1: The electric system analysis of Proforma savings.

For the Water & Sewer System the aggregate Proforma Operating and Maintenance (O&M) Expenses (596805) divided by the CCFs Sold (b) during the period of FY2001-FY2006 (O&M/CCF) versus Water & Sewer System Actual O&M divided by the CCFs Sold during the period of FY2001-FY2006 were compared and are presented in Table 3. The Minitab Test of Two Proportions used in this analysis, was taken from the software system used for the GreenBelt (GB) and BlackBelt (BB) projects.

Sample X N Sample p
1 (b) 596805 X 531121649 (b) = 0.001124 Proforma O&M Expenses / Total CCFs Sold
2 (b) 522152 X 531121649 (b) = 0.000983 Actual O&M Expenses / Total CCFs Sold
Difference = p (1) – p (2) Estimate for difference: 0.000140557
95% CI for difference: (0.000136656, 0.000144459)
Test for difference = 0 (vs. not = 0): Z = 70.61, P-Value = 0.000
There is a statistically significant savings

Table 3: Minitab Test and CI for Two Proportions – Water and Sewer System

The null hypothesis for this test is the H*0*: p1 = p2, that there is no statistical significance. The alternative hypothesis reflects, in this case, H*a*: p1< p2, or H*a*: p1 > p2, there is a statistically significant difference, illustrated by the Z = 70.71 or (p< .001). The *Z-scores* are a means of answering the question of how many standard deviations the observation is from the mean. By empirical rule, if data follow a bell-shaped curve, then approximately 95% of the data should have the *Z-score* between -2 and 2, so with a Z-score of greater than 70, the statistically significant conclusion is supported at the 0.05 level of confidence. Figure 2, which follows, illustrates the Proforma and Actual operating and maintenance expenses, and the detailed data examination and analysis are reviewed and illustrated in Table 4. For further information on JEA's financial history, please refer to the Appendices A, B, and C attached.

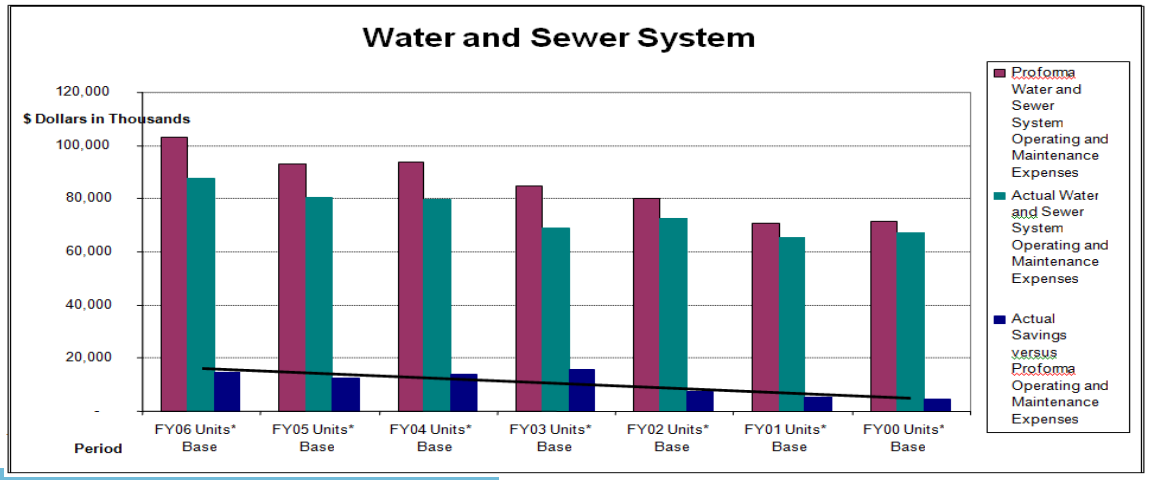

Figure 2: The water and sewer system analysis of Proforma savings.

Analysis of Potential Savings Fiscal Years 2000-2006: ($ Millions)								
Proforma Operating Expenses, Based on the % for FY 1997-1999 as the Base for Calculations:	FY06 Units* Base	FY05 Units* Base	FY04 Units* Base	FY03 Units* Base	FY02 Units* Base	FY01 Units* Base	FY00 Units* Base	FY99-96 Average
Electric System Megawatt Hours Sold (000)	16,684	16,238	15,953	16,117	15,212	15,222	14,576	
Electric System Megawatt Hours Sold (000) (a) *	14,035	13,660	13,296	13,205	12,228	12,216	11,636	
Proforma Electric System Operating and Maintenance Expenses (a)	186.7	181.7	176.9	175.7	162.7	162.5	154.8	
Actual Electric System Operating and Maintenance Expenses (a)	194.5	176.6	174.5	186.0	168.6	141.5	149.0	1.330%
Actual Savings Versus Proforma Operating and Maintenance Expenses	(7.658)	5.098	2.403	(10.347)	(5.919)	20.972	5.727	
Water & Sewer System Water CCFs (000)	55,732	49,711	50,256	45,113	43,440	38,130	39,239	
Water & Sewer System Sewer CCFs (000)	35,762	33,346	33,038	30,381	27,912	24,640	24,422	
Total Water & Sewer System Sewer CCFs (000) (b)	91,494	83,057	83,295	75,494	71,352	62,769	63,661	
Proforma Water and Sewer System Operating and Maintenance Expenses 1 (b)	102.8	93.3	93.6	84.8	80.2	70.5	71.5	
Actual Water and Sewer System Operating and Maintenance Expenses 2 (b)	87.9	80.7	79.5	69.0	72.6	65.3	67.1	0.112%
Actual Savings Versus Proforma Operating and Maintenance Expenses	14.883	12.668	14.090	15.784	7.560	5.203	4.465	
Actual Savings versus Proforma – Annual	7.225	17.766	16.492	5.437	1.641	26.175	10.192	
Aggregate Actual Savings Versus Proforma	$84.928							

* Excludes FPL saleback. [9 - 18] JEA (1997 – 2006) *Annual Report*

Table 4: Analysis of Operating and Maintenance Expenses

DISCUSSION OF FINDINGS

The study considered the financial implications of Six Sigma's implementation at JEA. Empirical analyses supported that there was economic value added through implementation of the program. The analysis indicated that the aggregate savings for the period under investigation (fiscal years 2000 through fiscal year 2006) [12 - 18] (JEA, 2000-2006] were projected to be $84,928,000, and that the savings were achieved by both

the electric system at $10,275,000 and the water and sewer system at $74,653,000. There was a statistically significant difference.

CONCLUSIONS

The financial implications of the implementation of Six Sigma in a governmental enterprise are several. First, the research supported that the performance management system being investigated, Six Sigma, has had financial success at the organization. The data indicated that the financial implications were statistically significant, and the financial analysis that was performed quantified it as material and relevant to both of JEA's major business units.

Training is a critical element in the commencement of any statistically based continuous process improvement structure, and it was concluded that without an effective long term training program, no organization can successfully implement Six Sigma. The inferential analysis from this study seeks to provide important information useful in evaluating performance management initiatives in a government enterprise.

RECOMMENDATIONS FOR FUTURE RESEARCH

This study supports the need for more comprehensive studies of the performance management systems being used by government entities. Because this was an exploratory study, the sample was delimited to one government enterprise. Future researchers may be interested in exploring this topic further to determine whether other government enterprises can benefit from Six Sigma or other performance management systems. Finally, an important reason for a government organization to improve performance measurement is the indirect improvement in citizens' (JEA's rate payers) perceptions of government performance.

REFERENCES

Berk, J., & DeMarzo, P. (2007). *Corporate finance*. Boston: Pearson.

Deming, W. E. (1982, 1986). *Out of the crisis.* Cambridge, MA: Massachusetts Institute of Technology. Center for Advanced Engineering Study.

Eakins, S. G. (2005). *Finance: Investments, institutions, management.* Boston: Pearson Addison Wesley.

Eckes, G. (2001a). *Making six sigma last: Managing the balance between cultural and technical change.* New York: John Wiley & Sons (2009).

JEA history - JEA's background. Retrieved May 3, 2009, from JEA History - JEA's Background Web site: http://www.jea.com/about/history/index.asp

JEA. (1997). *Annual Report* [Brochure]. Jacksonville, FL

JEA. (1998). *Annual Report* [Brochure]. Jacksonville, FL
JEA. (1999). *Annual Report* [Brochure]. Jacksonville, FL
JEA. (2000). *Annual Report* [Brochure]. Jacksonville, FL
JEA. (2001). *Annual Report* [Brochure]. Jacksonville, FL
JEA. (2002). *Annual Report* [Brochure]. Jacksonville, FL
JEA. (2003). *Annual Report* [Brochure]. Jacksonville, FL
JEA. (2004). *Annual Report* [Brochure]. Jacksonville, FL
JEA. (2005). *Annual Report* [Brochure]. Jacksonville, FL
JEA. (2006). *Annual Report* [Brochure]. Jacksonville, FL

Jordan, B. D. & Miller, T. W. (2007). *Fundamentals of Investments Valuation and Management, 4 ed.* New York: McGraw-Hill/Irwin.

Senge, P. M. (1990). *The fifth discipline: The art & practice of the learning organization.* New York: Currency Doubleday.

Wild, J. J. (2005). *Financial accounting: Information for decisions.* New York: McGraw-Hill/Irwin.

APPENDICES

Appendix A: JEA Historical Operating Statistics

Fiscal Years	2005-06	2005-04	2004-03	2003-02	2002-01
Operating Revenues:					
Electric	1,160,463	$973,326	$840,210	$830,519	$793,685
Water and sewer	214,906	182,961	173,579	161,053	151,515
District Energy System	3,054	1,297	-	-	-
Other, net	49,454	42,299	54,803	44,147	38,485
Total operating revenues	1,427,877	1,199,883	1,068,592	1,035,719	983,685
Operating Expenses:					
Fuel and purchased power	599,426	494,721	409,690	371,074	345,843
Water & Sewer Operating & maintenance	87,926	80,660	79,506	69,046	72,616
Electric Operating & maintenance	194,355	176,617	174,469	186,006	168,584
Operations and maintenance	282,281	251,099	248,269	249,945	237,046
Operations and maintenance, per Annual Report	282,281	257,277	253,975	255,052	241,200
Electric Operations & Maintenance Expenses/MWh	1.385%	1.293%	1.312%	1.409%	1.429%
Water & Sewer Operations & Maintenance Expenses per Water CCF	0.158%	0.162%	0.158%	0.153%	0.167%

Water & Sewer Operations & Maintenance Expenses per Sewer CCF	0.246%	0.242%	0.241%	0.227%	0.260%
Operating Expenses % of Electric, Water & Sewer & District Energy Revenues	20.48%	22.23%	24.49%	25.21%	25.08%
Operating Expenses % of Total Revenues	19.77%	21.44%	23.23%	24.13%	24.10%
Fuel & Purchased Power % of Electric Revenues	51.65%	50.83%	48.76%	44.68%	43.57%
Depreciation	297,614	278,531	251,493	252,778	188,725
State utility and franchise taxes	26,807	21,791	18,941	19,323	18,120
Recognition of deferred costs/revenues	40,428	44,141	44,184	29,110	52,417
Total operating expenses	1,236,658	1,090,283	972,577	922,230	842,151
Operating Income	191,219	109,600	96,015	113,489	141,534

Fiscal Years	**2001-00**	**2000-99**	**1999-98**	**1998-97**	**1997-96 ***
Operating Revenues ($000 omitted)					
Electric	$800,445	$766,482	$754,478	$754,799	$711,252
Water and sewer	132,758	131,112	127,448	115,700	38,013
District Energy System	-	-	-	-	-
Other, net	43,828	30,378	29,543	24,857	37,612
Total operating revenues	977,031	927,972	911,469	895,356	786,877
Operating Expenses:					
Fuel and purchased power	404,487	368,171	299,400	302,956	290,731
Water & Sewer Operating & maintenance	65,329	67,069	64,378	63,487	65,604
Electric Operating & maintenance	141,529	149,063	147,322	148,952	144,473
Operations and maintenance	206,858	210,550	208,830	209,310	163,215
Operations and maintenance, per Annual Report	206,858	216,132	211,700	212,439	210,077
Electric Operations & Maintenance Expenses/MWh	1.159%	1.281%	1.259%	1.458%	1.394%
Water & Sewer Operations & Maintenance Expenses per Water CCF	0.171%	0.171%	0.168%	0.184%	0.203%
Water & Sewer Operations & Maintenance Expenses per Sewer CCF	0.265%	0.275%	0.269%	0.289%	0.310%
Operating Expenses % of Electric, Water & Sewer & District Energy Revenues	***22.17%***	***23.46%***	***23.68%***	***24.04%***	***21.78%***
Operating Expenses % of Total Revenues	***21.17%***	***22.69%***	***22.91%***	***23.38%***	***20.74%***
Fuel & Purchased Power % of Electric Revenues	***50.53%***	***48.03%***	***39.68%***	***40.14%***	***40.88%***
Depreciation	157,715	137,657	126,553	101,378	86,918

State utility and franchise taxes	17,654	16,671	16,561	16,488	15,497
Recognition of deferred costs/revenues	35,758	28,960	93,085	59,491	25,550
Total operating expenses	822,472	762,009	744,429	689,623	581,911
Operating Income	154,559	165,963	167,040	205,733	204,966

Appendix B: JEA Historical Operating Statistics

JEA - Analysis of Potential Savings Fiscal Years 2000 – 2006 ($ Millions):

Proforma Operating Expenses, based on the % for FY 1997-1999 as the base for calculations ($ Millions):	***FY06 Units* Base***	***FY05 Units* Base***	***FY04 Units* Base***	***FY03 Units* Base***	***FY02 Units* Base***	***FY01 Units* Base***	***FY00 Units* Base***	***FY99-96 Average O & M***
Electric System								
Megawatt Hours sold (MWh)	16,684	16,238	15,953	16,117	15,212	15,222	14,576	
Electric System Megawatt Hours Sold (000)*	14,035	13,660	13,296	13,205	12,228	12,216	11,636	
Proforma Electric System Operating and Maintenance Expenses	186.7	181.7	176.9	175.7	162.7	162.5	154.8	
Actual Electric System Operating and Maintenance Expenses	194.5	176.6	174.5	186.0	168.6	141.5	149.0	1.330%
Actual Savings Versus Proforma Operating and Maintenance Expenses	(7.658)	5.098	2.403	(10.347)	(5.919)	20.972	5.727	
Water & Sewer System								
Water CCFs (000 omitted)	55,732	49,711	50,256	45,113	43,440	38,130	39,239	
Water & Sewer System Sewer CCFs	35,762	33,346	33,038	30,381	27,912	24,640	24,422	
Total Water & Sewer System Sewer CCFs	91,494	83,057	83,295	75,494	71,352	62,769	63,661	
Proforma Water and Sewer System Operating and Maintenance Expenses	102.8	93.3	93.6	84.8	80.2	70.5	71.5	
Actual Water and Sewer System Operating and Maintenance Expenses	87.9	80.7	79.5	69.0	72.6	65.3	67.1	0.112%
Actual Savings versus Proforma Operating and Maintenance Expenses	14.883	12.668	14.090	15.784	7.560	5.203	4.465	
Actual Savings versus Proforma Annual Total	7.225	17.766	16.492	5.437	1.641	26.175	10.192	
Aggregate Actual Savings versus Proforma	**$84.928**							

* Excludes FPL saleback

Appendix C: JEA Historical Operating Statistics Summary

JEA Analysis of Potential Savings Fiscal Years 2000 - 2006:
($000 omitted)

Electric System Analysis:	
Fiscal Year 2000-2006 Aggregate MWh	90,275,817
Proforma Electric System Operating and Maintenance Expenses	$1,200,898
Actual Electric System Operating and Maintenance Expenses	1,190,623
Electric System - Aggregate Savings Proforma versus Actual	10,275
Water and Sewer System Analysis:	
Fiscal Year 2000-2006 Total Water & Sewer System Sewer CCFs	531,121,649
Proforma Water and Sewer System Operating and Maintenance Expenses	$596,805
Actual Water and Sewer System Operating and Maintenance Expenses	522,152
Water and Sewer System - Aggregate Savings Proforma versus Actual	$74,653
Aggregate Actual Savings versus Proforma	**$84,928**