12-YEAR PUMP STATION COST COMPARISON

MAINTENANCE AND REPAIR COSTS — WET WELL MOUNTED PUMP STATIONS VS. SUBMERSIBLE PUMP STATIONS

EXECUTIVE SUMMARY:

The Unified Government of Wyandotte County and Kansas City, Kan. keeps detailed records on all repair and maintenance work orders and costs for its 53 duplex submersible and Wet Well Mounted Pump Stations.

A comprehensive 12-year study of this data reveals a nearly 56% difference in total maintenance costs between the two types of systems, factoring labor, parts and outside contractor expenses.

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Tracking Pump Station Ownership Costs Generate Data for Optimum Asset Management

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ABSTRACT

Asset management is critical in maintaining and evaluating equipment crucial to the successful operation of a utility. A key aspect is the collection of complete, meaningful data for each piece of equipment and the ability to easily evaluate the data. In 2002, the Unified Government of Wyandotte County/Kansas City, Kan. implemented a system to collect data from their wastewater pump stations. For each station, they logged labor hours, material costs, and outside contractor costs. From this data, they can establish a predictive maintenance schedule, budget for station repair and/or replacement based on return on investment, establish a benchmark for the cost of maintaining a typical station, compare the cost to operate and maintain different types of stations, etc. The utility has saved money by choosing equipment that results in lower life cycle costs, replacing equipment where costs exceed the benchmark and determine the financial impact of maintaining its pump stations.

KEYWORDS: Asset management, data collection, pump station, operational cost, life-cycle cost, total cost of ownership, pump repair, collection system

INTRODUCTION

Asset management continues to trend across the North American water industry. Infrastructure funding issues are driving utilities to become even wiser stewards of the dwindling funds available for capital equipment like pump stations. Instituting an asset management mindset with respect to these pump stations should begin with compiling and analyzing life-cycle cost data. Adopting this practice in turn provides a framework to make improved capital and rehabilitation decisions in the future, which can result in a significant decrease in expenditure.

When looking at life-cycle costs, one should consider the cost of time and materials to operate, maintain and repair the equipment, energy efficiency, expected equipment life, downtime costs, and outside contracted service expenses, in addition to the capital and installation costs. The cost of preventative maintenance programs should also be determined.

If this data was available in sufficient amounts, a utility could statistically project maintenance and repair costs 20 to 30 years into the future. This information could be utilized along with capital costs, installation costs, energy costs, etc. to project total life cycle costs. This becomes an invaluable tool to determine the most cost-effective type of pump station for the purpose of determining the best long-term value for the utility. Many utilities are forced to base their decisions on gut feel, rules of thumb, past practices and sometimes, flying by the seat of their pants because of a lack of good data required to make informed decisions. Decisions that should reflect the best long-term value for their constituents and support good asset management concepts to sustain our nation's water and wastewater infrastructure.

The Unified Government of Wyandotte County/Kansas City, Kan. (Unified Government) is known for operating one of the most progressive local governments in America. Formed when voters decided to combine the Wyandotte County Government and the Kansas City, Kan. Government, the Unified Government represents nearly 160,000 citizens. Wyandotte County includes the cities of Kansas City, Bonner Springs and Edwardsville.

In 2002, the Unified Government initiated new asset management practices for their collection system pump stations. The results of their data compilation yielded new-found information about the individual "assets" within their collection system, namely their pump stations. The data allowed them to understand how the cost of maintaining their assets differed based on station type, as well as serve as a basis for predictive labor time and parts.

METHODOLOGY

In 2002, the Unified Government's Water Pollution Control Division began to track all expenditures on labor and materials for its collection system operating. To track their assets, they installed detailed asset management software, produced and data collection infrastructure in order to track all pump station related costs. The software systems include MaintStar Sewer Management, MaintStar Inc., Irvine, Calif., and Lucity Project Management, Lucity, Overland Park, Kan.

This software provides a structured system to identify and record each pump station along with providing inventory control of the parts used at each station. The work order based system was to be utilized each time any service was done at the pump station site. It records any issues, along with what was done to correct the problem. Labor hours are captured along with parts and materials used for each work order. Labor hours can be coded to several different labor rates based on regular, overtime, holiday rate, etc. The software can be used to schedule preventative maintenance. Work orders are filled out by the maintenance personnel each time they visit a station and then are returned to their supervisor, who has these entered into the system. The Unified Government also established a Preventative Maintenance schedule on all pump stations, based upon manufacturer recommendations.

This study examines all of the data recorded by the Unified Government between January 2002 and January 2014, or 12 years. It specifically compares the 53 common duplex pump station systems, all of which handle a maximum total flow of 189 m^3/d (50,000 gpd) and a maximum flow per pump of 63 L/s (1,000 gpm). Of these 53 pump stations operated by the Unified Government, 21 are submersible type pump stations while 32 are above-ground, vacuum primed type. The submersible stations are made up of the following brands: Flygt, Meyers, Zoeller, Hydromatic, Fairbanks Morse, KSB, Gorman Rupp and ABS. The above-ground vacuum primed stations are Smith & Loveless brand. It should also be noted that two of the submersible stations and three of the vacuum primed stations were replaced with like kind within the study period. Additionally two of the submersible stations were replaced with vacuum primed stations within the study period.

In order to more completely analyze the total cost of pump station ownership with regard to preventative maintenance and repairs, the study includes all costs at the pump station site. For example, these include: electrical issues, pump repairs, outside contractor costs, service center costs, parts costs, material costs, etc. The following definitions should be applied when analyzing the data:

Months in study - number of months in which a particular pump station has data included in the study.

PS # - unique pump station designation utilized by the Unified Government.

Labor hours - includes all Unified Government personnel time at the pump station site.

Labor cost - hourly rates multiplied by labor hours (rates vary by technician grade and by regular or overtime hours).

Contractor cost - money paid to contractors or service shops for repairs, upgrades, maintenance, and emergency calls either on site or at an outside contractor's facilities.

Material cost - parts cost to repair or upgrade pump stations.

Total cost - equals Labor cost, Outside Contractor Cost, and Material Cost.

Average cost per year - equals the Total Cost divided by the number of Months in Study times 12 months per year.

Average per station per year - equals the Total Cost divided by the number of Months in Study times 12 months per year divided by the number of stations.

RESULTS

Table 1 summarizes the data from the 53 pump stations. This data was compiled from each of the individual work orders from the 12-year study. The maximum time that data was available was 144 months.

The following pump stations cover less than the maximum of 144 months because they were commissioned after the study began or were taken out of service before the study ended. Submersible pump station 20A was replaced in 2003 with vacuum primed station 20B in 2003. Submersible station 47A was replaced in 2007 with submersible station 47B. Vacuum primed pump station 17A was replaced in 2005 with vacuum primed pump station 17B. Submersible pump station 56A was replaced in 2002 with vacuum primed pump station 56B. Vacuum primed pump station 11A was replaced in 2005 with vacuum primed pump station 11B. Submersible pump station 70A was replaced in 2009 with submersible pump station 70B. Vacuum primed pump station 42A was replaced in 2008 with 42B.

Stations did not receive a letter suffix unless all of the equipment at the site was replaced. When a complete station was replaced, the installation and capital costs were not included in the study. If a pump, valve, electrical component, etc. was replaced, all associated costs were included.

Table 1. Total maintenance and repair costs from 2002 to 2014

MONTHS IN STUDY	PS #	ADDRESS	FLOW (GPM)	TDH (FEET)	POWER (HP)	PUMPS REPLACED	LABOR HOURS	LABOR COST	CONTRACTOR COST	PARTS COST	TOTAL COST
144	36	2847 N. 99th Street	500	115	34	3	1,104.88	$32,933.80	$92,146.45	$31,978.40	$157,058.65
144	13	74th & Washington Avenue	150	15	1.6	0	1,524.60	$48,897.27	$18,434.79	$25,266.86	$92,598.92
144	53	3198 Woodview Ridge Drive	90	64	7.5	6	1,177.58	$33,035.94	$10,068.82	$39,990.73	$83,095.49
144	29	3034 N. 48th Terrace	100	38	5	7	747.25	$21,583.59	$21,239.85	$34,982.59	$77,806.03
144	10	3120 N. 83rd Street	125	114	10	5	1,083.30	$31,911.84	$14,910.93	$30,160.58	$76,983.35
144	63	123rd Leavenworth Road	150	66	10	2	799.60	$24,155.90	$9,388.58	$21,054.03	$54,598.51
116	34A	3225 N. 46th Street	100	61	7.5	0	861.75	$26,619.47	$16,984.98	$10,496.69	$54,101.14
117	67	3306 N. 128th Street	353	88	15	2	559.05	$15,967.45	$19,277.09	$15,018.61	$50,263.15
144	61	3903 N.123rd Street	695	32	10	2	864.22	$25,440.25	$3,316.42	$18,126.19	$46,882.86
144	15	10614 Rowland Avenue	125	55	5	2	982.75	$27,898.79	$2,763.34	$13,864.75	$44,526.88
61	47A	403 Orville Avenue	250	30	5	4	451.08	$13,566.36	$6,915.61	$21,718.19	$42,200.16
144	26	3231 N. 38th Street	103	49	7.5	2	651.83	$17,664.86	$4,063.69	$15,317.16	$37,045.71
144	27	2998 N. 42nd Street	200	116	20	0	719.33	$22,451.68	$6,339.69	$5,418.15	$34,209.52
101	17B	9402 State Avenue	150	85	10	0	655.30	$21,731.21	$10,198.97	$2,221.47	$34,151.65
144	62	1599 S. 45th Street	200	43	5	3	557.47	$15,537.98	$2,077.47	$15,987.89	$33,603.34
144	54	8054 Leavenworth Road	300	95	20	0	521.43	$16,103.68	$8,952.94	$6,942.76	$31,999.38
144	57	5098 Douglas Avenue	350	46	7.5	1	655.08	$18,852.33	$2,684.21	$9,758.19	$31,294.73
144	55	3500 N. 27th Street	150	35	10	0	605.92	$17,641.77	$4,315.10	$8,933.07	$30,889.94
144	48	7324 Oliver Street	190	57	10	1	536.65	$14,966.21	$10,555.35	$4,849.26	$30,370.82
121	32	1865 Saint Paul Street	100	45	5	0	523.25	$16,373.81	$11,838.90	$1,991.93	$30,204.64
109	25	3356 N. 34th Street	120	78	10	0	1022.22	$19,348.47	$7,526.43	$3,176.77	$30,051.67
144	23	6020 Kansas Avenue	100	14	3	0	649.50	$18,609.34	$2,519.42	$8,907.50	$30,036.26
82	42A	4801 Steele Road	197	57	7.5	0	592.92	$17,749.09	$2,007.95	$8,592.42	$28,349.46
144	60	2938 N. 103rd Terrace	200	40	5	0	645.43	$18,454.80	$5,023.40	$4,606.85	$28,085.05
111	66	10910 Hollingsworth Road	110	131	20	0	722.15	$20,432.70	$1,845.75	$3,237.40	$25,515.85
125	20B	1006 S. 49th. Drive	200	50	7.5	0	495.50	$14,542.89	$5,112.55	$2,404.54	$22,059.98
20	20A	1006 S. 49th. Drive	200	50	7.5	2	199.75	$4,961.03	$8,239.93	$8,029.00	$21,229.96
144	33	2480 S. 88TH Street	200	107	20	0	416.37	$10,873.78	$6,438.73	$3,904.40	$21,216.91
98	11B	9191 Minnesota Avenue	80	37	3	0	340.67	$10,882.70	$6,347.60	$2,774.04	$20,004.34
134	56B	1399 S. 55th Street	165	45	5	0	526.58	$15,104.67	$2,566.17	$1,176.33	$18,847.17
64	70B	5425 N. 99th Street	600	46	18	0	428.55	$14,654.29	$3,589.15	$39.52	$18,282.96
144	43	8009 Kansas Avenue	100	61	8	0	333.75	$9,738.60	$3,479.09	$3,823.79	$17,041.48
144	39	1830 S. 13th Street	75	41	7.5	0	349.85	$9,978.42	$863.93	$5,985.68	$16,828.03
144	30	3240 N. 84th Place	100	48	5	0	447.52	$12,311.83	$1,799.28	$1,606.39	$15,717.50
144	49	2059 S. 50th Street	100	90	10	0	282.53	$7,420.27	$5,280.93	$1,505.72	$14,206.92
83	47B	403 Orville Avenue	250	30	7.5	0	381.15	$11,671.59	$1,536.53	$909.60	$14,117.72
78	74	1910 N. 92nd Terrace	80	46	5	0	231.00	$6,777.67	$6,598.20	$307.40	$13,683.27
43	17A	9402 State Avenue	150	85	10	0	203.00	$5,621.41	$4,516.67	$3,469.62	$13,607.70
81	72	10651 Augusta Drive	195	53	7.5	0	194.00	$7,054.41	$2,806.56	$1,567.05	$11,428.02
47	11A	9191 Minnesota Avenue	80	37	3	0	192.33	$5,169.89	$4,500.38	$725.47	$10,395.74
144	9	800 N. 41st Terrace	100	18	1.5	0	211.00	$5,610.54	$917.54	$3,825.30	$10,353.38
78	83	10635 Kaw Drive	142	37	5	0	244.00	$9,718.92	$68.84	$540.67	$10,328.43
101	69	12133 Pine Valley Drive	200	74	7.5	0	297.83	$8,521.78	$902.49	$867.20	$10,291.47
103	68	11430 Cleveland Avenue	114	60	7.5	0	257.33	$7,786.42	$289.60	$1,606.27	$9,682.29
71	84	10901 Kaw Drive	80	25	2	0	238.42	$7,703.82	$32.99	$371.92	$8,108.73
62	42B	4801 Steele Road	210	60	10	0	196.33	$6,135.05	$1,511.87	$169.00	$7,815.92
25	70A	5251 N. 101st Terrace	125	NA	NA	0	202.17	$6,011.74	$783.16	$48.77	$6,843.67
66	80	5837 Walker Avenue	100	62	10	0	135.42	$4,521.36	$1,761.20	$31.61	$6,314.17
81	73	10500 Augusta Drive	155	37	5	0	119.05	$3,544.56	$249.37	$525.36	$4,319.29
10	56A	1399 S. 55th Street	165	45	NA	0	69.00	$1,909.67	$0.00	$1,805.88	$3,715.55
70	78	12708 Hubbard Drive	200	135	25	0	92.75	$3,013.79	$12.00	$115.26	$3,141.05
13	46	831 South 78th Street	160	116	20	0	66.75	$2,074.37	$235.88	$0.00	$2,310.25
28	34B	3225 N. 46th Street	100	61	7.5	0	79.17	$2,172.53	$25.78	$83.65	$2,281.96

From this compilation of data, the Unified Government has been able to realize the total financial impact of maintaining all of its pump stations during the period, totaling $1,550,097.02 or at an average annual cost per station of $3,315 (based on total months). Furthermore, it identifies for the department which individual pump stations cost the most to repair and maintain. Because the average cost per station per year is $3,315, it is evident that 32 of the stations exceed the average (18 of the total 21 submersible and 14 of the total 30 vacuum primed). These were the first pump stations to be investigated to determine the reasons for higher maintenance and repair costs. In fact, five have been replaced resulting in lower costs. Following are examples of the savings.

Station 56A was a submersible type station and was replaced with a vacuum prime station in 2002. The average cost per year before replacement was $4459; after replacement, the cost dropped to $1688. If the average cost would have remained constant and the station not replaced, it would have cost the Unified Government an additional $30,941 during the study period.

Station 20A was replaced in 2003. The submersible station was replaced with a vacuum prime station. This has resulted in lowering the average cost per year from $12,738 to $2,118. If the average cost would have remained constant and the station had not have been replaced, it would have cost the Unified Government an additional $109,566 during the study period.

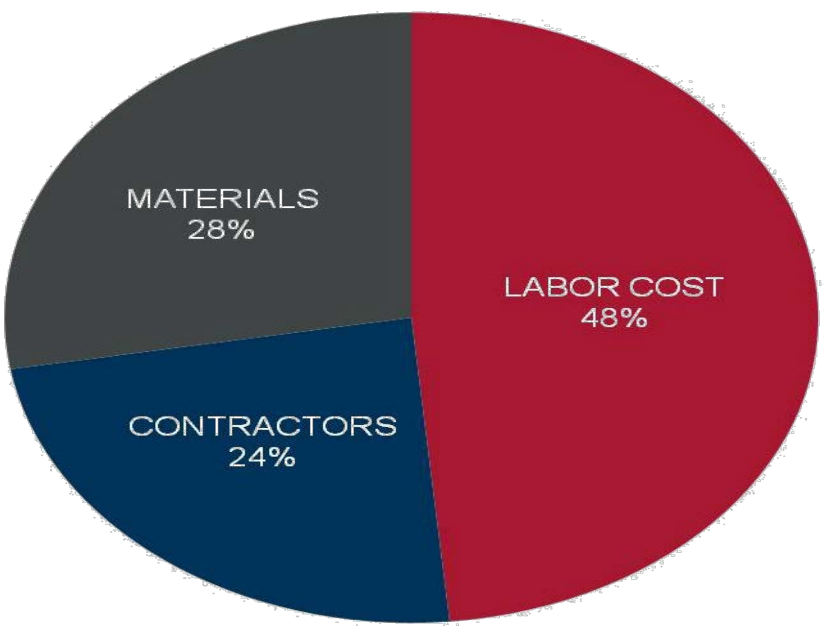

Figure 1. Total repair and maintenance cost segmented by component

As seen in Figure 1, labor is the largest component of the total cost for the 53 pump stations and in fact, is more than the total of the other two components combined. This is good data to evaluate in the future to see if there are ways to reduce each category. Table 2 and Table 3 separate the data by pump station type to better facilitate additional analysis.

Table 2. Submersible pump station total maintenance and repair costs 2002-2014

MONTHS IN STUDY	PS #	ADDRESS	FLOW (GPM)	TDH (FEET)	POWER (HP)	PUMPS REPLACED	LABOR HOURS	LABOR COST	CONTRACTOR COST	PARTS COST	TOTAL COST
144	36	2847 N. 99th Street	500	115	34	3	1,104.88	$32,933.80	$92,146.45	$31,978.40	$157,058.65
144	13	74th & Washington Avenue	150	15	1.6	0	1,524.60	$48,897.27	$18,434.79	$25,266.86	$92,598.92
144	53	3198 Woodview Ridge Drive	90	64	7.5	6	1,177.58	$33,035.94	$10,068.82	$39,990.73	$83,095.49
144	29	3034 N. 48th Terrace	100	38	5	7	747.25	$21,583.59	$21,239.85	$34,982.59	$77,806.03
144	10	3120 N. 83rd Street	125	114	10	5	1,083.30	$31,911.84	$14,910.93	$30,160.58	$76,983.35
144	63	123rd Leavenworth Road	150	66	10	2	799.60	$24,155.90	$9,388.58	$21,054.03	$54,598.51
117	67	3306 N. 128th Street	353	88	15	2	559.05	$15,967.45	$19,277.09	$15,018.61	$50,263.15
144	61	3903 N.123rd Street	695	32	10	2	864.22	$25,440.25	$3,316.42	$18,126.19	$46,882.86
144	15	10614 Rowland Avenue	125	55	5	2	982.75	$27,898.79	$2,763.34	$13,864.75	$44,526.88
61	47A	403 Orville Avenue	250	30	5	4	451.08	$13,566.36	$6,915.61	$21,718.19	$42,200.16
144	26	3231 N. 38th Street	103	49	7.5	2	651.83	$17,664.86	$4,063.69	$15,317.16	$37,045.71
144	62	1599 S. 45th Street	200	43	5	3	557.47	$15,537.98	$2,077.47	$15,987.89	$33,603.34
144	57	5098 Douglas Avenue	350	46	7.5	1	655.08	$18,852.33	$2,684.21	$9,758.19	$31,294.73
144	48	7324 Oliver Street	190	57	10	1	536.65	$14,966.21	$10,555.35	$4,849.26	$30,370.82
144	23	6020 Kansas Avenue	100	14	3	0	649.50	$18,609.34	$2,519.42	$8,907.50	$30,036.26
20	20A	1006 S. 49th. Drive	200	50	7.5	2	199.75	$4,961.03	$8,239.93	$8,029.00	$21,229.96
144	33	2480 S. 88TH Street	200	107	20	0	416.37	$10,873.78	$6,438.73	$3,904.40	$21,216.91
64	70B	5425 N. 99th Street	600	46	18	0	428.55	$14,654.29	$3,589.15	$39.52	$18,282.96
83	47B	403 Orville Avenue	250	30	7.5	0	381.15	$11,671.59	$1,536.53	$909.60	$14,117.72
25	70A	5251 N. 101st Terrace	125	NA	NA	0	202.17	$6,011.74	$783.16	$48.77	$6,843.67
10	56A	1399 S. 55th Street	165	45	NA	0	69.00	$1,909.67	$0.00	$1,805.88	$3,715.55
					Total For All Stations For 12 Years	42	14,041.83	$411,104.01	$240,949.52	$321,718.10	$973,771.63
					Average/Station/Year Based On Months In Study		70.33	$2,058.95	$1,206.76	$1,611.28	$4,876.99

Table 3. Vacuum primed pump station total maintenance and repair costs 2002-2014

MONTHS IN STUDY	PS #	ADDRESS	FLOW (GPM)	TDH (FEET)	POWER (HP)	PUMPS REPLACED	LABOR HOURS	LABOR COST	CONTRACTOR COST	PARTS COST	TOTAL COST
116	34A	3225 N. 46th Street	100	61	7.5	0	861.75	$26,619.47	$16,984.98	$10,496.69	$54,101.14
144	27	2998 N. 42nd Street	200	116	20	0	719.33	$22,451.68	$6,339.69	$5,418.15	$34,209.52
101	17B	9402 State Avenue	150	85	10	0	655.30	$21,731.21	$10,198.97	$2,221.47	$34,151.65
144	54	8054 Leavenworth Road	300	95	20	0	521.43	$16,103.68	$8,952.94	$6,942.76	$31,999.38
144	55	3500 N. 27th Street	150	35	10	0	605.92	$17,641.77	$4,315.10	$8,933.07	$30,889.94
121	32	1865 Saint Paul Street	100	45	5	0	523.25	$16,373.81	$11,838.90	$1,991.93	$30,204.64
109	25	3356 N. 34th Street	120	78	10	0	1022.22	$19,348.47	$7,526.43	$3,176.77	$30,051.67
82	42A	4801 Steele Road	197	57	7.5	0	592.92	$17,749.09	$2,007.95	$8,592.42	$28,349.46
144	60	2938 N. 103rd Terrace	200	40	5	0	645.43	$18,454.80	$5,023.40	$4,606.85	$28,085.05
111	66	10910 Hollingsworth Road	110	131	20	0	722.15	$20,432.70	$1,845.75	$3,237.40	$25,515.85
125	20B	1006 S. 49th. Drive	200	50	7.5	0	495.50	$14,542.89	$5,112.55	$2,404.54	$22,059.98
98	11B	9191 Minnesota Avenue	80	37	3	0	340.67	$10,882.70	$6,347.60	$2,774.04	$20,004.34
134	56B	1399 S. 55th Street	165	45	5	0	526.58	$15,104.67	$2,566.17	$1,176.33	$18,847.17
144	43	8009 Kansas Avenue	100	61	8	0	333.75	$9,738.60	$3,479.09	$3,823.79	$17,041.48
144	39	1830 S. 13th Street	75	41	7.5	0	349.85	$9,978.42	$863.93	$5,985.68	$16,828.03
144	30	3240 N. 84th Place	100	48	5	0	447.52	$12,311.83	$1,799.28	$1,606.39	$15,717.50
144	49	2059 S. 50th Street	100	90	10	0	282.53	$7,420.27	$5,280.93	$1,505.72	$14,206.92
78	74	1910 N. 92nd Terrace	80	46	5	0	231.00	$6,777.67	$6,598.20	$307.40	$13,683.27
43	17A	9402 State Avenue	150	85	10	0	203.00	$5,621.41	$4,516.67	$3,469.62	$13,607.70
81	72	10651 Augusta Drive	195	53	7.5	0	194.00	$7,054.41	$2,806.56	$1,567.05	$11,428.02
47	11A	9191 Minnesota Avenue	80	37	3	0	192.33	$5,169.89	$4,500.38	$725.47	$10,395.74
144	9	800 N. 41st Terrace	100	18	1.5	0	211.00	$5,610.54	$917.54	$3,825.30	$10,353.38
78	83	10635 Kaw Drive	142	37	5	0	244.00	$9,718.92	$68.84	$540.67	$10,328.43
101	69	12133 Pine Valley Drive	200	74	7.5	0	297.83	$8,521.78	$902.49	$867.20	$10,291.47
103	68	11430 Cleveland Avenue	114	60	7.5	0	257.33	$7,786.42	$289.60	$1,606.27	$9,682.29
71	84	10901 Kaw Drive	80	25	2	0	238.42	$7,703.82	$32.99	$371.92	$8,108.73
62	42B	4801 Steele Road	210	60	10	0	196.33	$6,135.05	$1,511.87	$169.00	$7,815.92
66	80	5837 Walker Avenue	100	62	10	0	135.42	$4,521.36	$1,761.20	$31.61	$6,314.17
81	73	10500 Augusta Drive	155	37	5	0	119.05	$3,544.56	$249.37	$525.36	$4,319.29
70	78	12708 Hubbard Drive	200	135	25	0	92.75	$3,013.79	$12.00	$115.26	$3,141.05
13	46	831 South 78th Street	160	116	20	0	66.75	$2,074.37	$235.88	$0.00	$2,310.25
28	34B	3225 N. 46th Street	100	61	7.5	0	79.17	$2,172.53	$25.78	$83.65	$2,281.96
					Total For All Stations For 12 Years	0	12,404.48	$362,312.58	$124,913.03	$89,099.78	$576,325.39
					Average/Station/Year Based On Months In Study		46.30	$1,352.33	$466.24	$332.57	$2,151.14

Because there is a representative sample of the two different types of pump stations, it is also possible to compare their associated costs. As was stated before, they are similar in size as well as in amount of wastewater pumped. It was surprising to see a significant difference in each category: labor, material and outside contractor. Figure 2 graphically portrays the differences in each category.

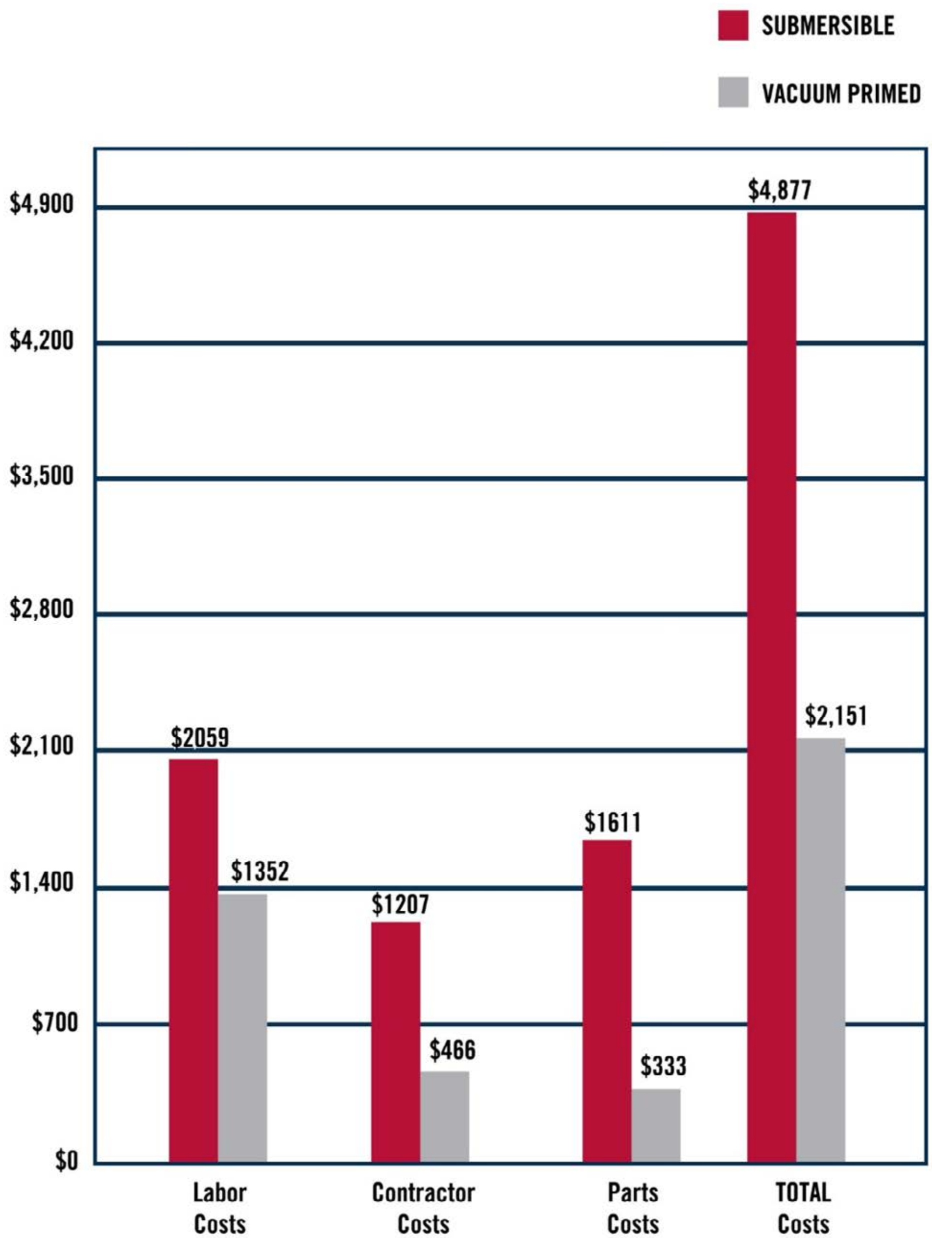

Figure 2. Comparison of submersible and vacuum primed pump stations based on average annual cost per station.

Figure 2 shows that each category is greater for the submersible pump stations based on the average yearly cost per station per year. The labor hours are 51.9% more, the labor cost is 52.3% more, the outside contractor cost is 159% more, the material or parts cost is 383.8% more and the overall cost is 126.7% more for the submersibles.

Comparing the total cost in Tables 2 and 3 over the 144-month study period, one will find that the submersibles cost $397,446 more to maintain and repair, bearing in mind there are 21 submersibles compared to 32 vacuum primed. Material or parts cost make up the largest portion of the difference. If you drill down into the data, you will find that much of this can be attributed to replacement pumps. The vacuum primed stations had few occurrences of high cost items.

When one begins to examine the potential reasons for the increased Material costs with the submersible stations, the results become telling. Examining all individual work orders in excess of $4,000 yields a total of 64 for the 53 stations in the study, with a total cost of more than $428,000, or an average of $35,667 per year. The 30 vacuum primed stations had 10 work orders in excess of $4,000, with a total cost just over $71,000. Less than half of the work orders related directly to the pump station equipment. These work orders were for wet well cleaning, a broken force main, new electrical service at the site, generator rental, all because of power failure and a new auto-dialer system being installed. It should be noted that of the 32 vacuum primed stations, not a single pump (of the 64 total duplex pumps) has required replacement during the 12 year period.

The 21 submersible stations had 54 work orders in excess of $4,000, with a total cost slightly above $357,000. A very small percentage of the orders (seven) were not directly related to the pump station equipment; examples include a broken force main and new electrical service being installed at two separate stations. The strong majority of the submersible pump station work orders related directly to the system equipment. This amount included <u>replacement of more than 42 individual pumps</u> over the 144 months totaling more than $282,000. These 42 pump replacements constitute an average of more than $23,000 per year alone on the submersible stations (not taking into account individual pumps that have a cost lower than $4,000).

Certainly identification of equipment that is beyond its useful life and ready for replacement is an important benefit of data analysis as described. There are a number of other important areas where savings and extending equipment life results from constant monitoring and evaluation of cost categories.

Negative trends have been identified utilizing the system and corrective action has been taken. The database is used to determine when a part was previously replaced to see if it is achieving its expected life. If not, the cause is investigated. It may be determined that installation methods are being incorrectly carried out due to lack of training. A retraining program is initiated, solving a recurring problem thus reducing both labor and material costs.

Identification and action have been taken to improve methods in the predictive maintenance program. Increased cost trends over a period of time reflect a need to improve maintenance procedures. An example would be periodic retrieval and cleaning of accumulated grease and contaminates from the submersible pumps in accordance with the manufacturer’s instructions. This prolongs life of the equipment and reduces the possibilities of catastrophic failures.

Other costly maintenance and repair events can be uncovered and treated through the use of new technologies or products that reduce or eliminate a specific problem. The majority of the pumps in this study are 100 mm (4-inch) pumps that are more prone to clogging. There are impellers that have been newly developed that will reduce or eliminate clogging, thereby reducing the intensive amount of labor required to remove a blockage.

CONCLUSIONS

After more than 12 years of generating quality data to analyze, it's abundantly clear that this is a powerful tool that allows the Unified Government to put good asset management principles into operation. Without good data, it is impossible to maximize the potential of each pump station and operate the system in the most efficient manner. Tracking pump station ownership costs facilitates more accurate long range planning. It is imperative for performing life cycle costing. With this system in place, capital equipment repair/replace decisions can be based on a cost benefit analysis.

The results of the study also overwhelmingly demonstrate a strong life-cycle cost for above-ground, vacuum primed pumps stations compared to submersible types within the system, including across all sectors of labor time, cost, outside contractor cost, parts and maintenance. The study revealed that in the 12-year period, the savings for the vacuum primed type station was nearly 56% (or more than $2,725 per station).

The historical data has made trend analysis possible. This has resulted in replacement of problematic controls, pumps, valves, etc. and provides the needed information to justify decisions to upper management. An additional benefit is more accurate budgeting for projected future expenses. Future research should include energy efficiency and expected pump life based on historical data. Good asset management practices have proven to reduce expenses and greatly improve decision making.

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