City of Lawrence

Measurement & Verification Report

Year 1 Savings

March 2018 through February 2019
ENERGY PERFORMANCE CONTRACT 1-YEAR SUMMARY: THE CITY OF LAWRENCE

In 2018, the City of Lawrence completed an Energy Performance Contract with Willdan Group Inc. (Willdan). The City of Lawrence was able to complete over $12 million in capital upgrades, funded by Green Bonds. By leveraging energy savings, this project funded deferred maintenance needs in a cash-neutral manner.

As a part of the energy savings contract, Willdan is responsible for measuring and verifying the project’s energy savings over the next several years. Recently, the City of Lawrence was given the Year 1 Measurement and Verification (M&V) Report for the energy project.

As the report demonstrated, significant energy and maintenance cost savings were achieved throughout the City of Lawrence facilities in Year 1 of the M&V period. In Year 1, the City of Lawrence exceeded the savings guarantee, saving over $550,000 annually. The total of all savings during the Year 1 reporting period was $551,864 which was comprised of $424,159 in electric and fuel savings and $127,704 in maintenance savings.

The savings in Year 1 included almost 4,000 MWh (Mega-Watt Hours) of electrical consumption, and over 50,000 therms of natural gas. The electric and fuel savings in Year 1 from the City of Lawrence’s project are equivalent to:

- 7,462,103 miles driven by an average passenger vehicle
- 3,336,526 pounds of coal burned
- 3,592 acres of U.S. forests in one year
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Project Summary

Willdan Performance Engineering is pleased to provide you with this report demonstrating the level of savings achieved during the Measurement and Verification Phase from March 2018 through February 2019 as a result of the energy conservation upgrades project. As this report demonstrates, significant energy and maintenance cost savings were achieved throughout your facilities. The total of all savings during the reporting period was $551,864 which was comprised of $205,577 in Option C Electric Savings, $40,508 in Option C Fuel Savings, $166,406 in Option A Electric Savings, $11,668 in Stipulated Electric/Fuel Savings, and $127,704 in Stipulated Maintenance Savings; the total was $3,845 more than the guarantee savings of $548,019. 'Facility Improvements' are provided in the margins for each building; noting that 'Bonus Improvements' were implemented at Willdan’s expense (i.e. no cost to the City).

Sincerely,

Kevin Player
Measurement & Verification Professional

Project Savings Performance Summary

The chart below tracks project savings over time. The blue line represents the guaranteed contract savings while the yellow line represents the actual savings achieved.

Overall Project Cumulative Cost Savings

Utility Cost

Utility Cost Savings

Savings
Cost
$246,086 23%
$813,961 77%
Savings Details

Overall Electrical Performance

The following graphs illustrate the electrical performance for all facilities during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in electrical usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated electric savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.
Overall Fuel Performance

The following graphs illustrate the fuel performance for all facilities during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in fuel usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated fuel savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.
Community Health Building Electrical Performance

The following graphs illustrate the electrical performance for the Community Health Building during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in electrical usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated electric savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
- New Air-cooled chiller,
- New Air handler filtration,
- New DDC controls with updated sequences,
- New roof,
- New LED lighting
The following graphs illustrate the fuel performance for the Community Health Building during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in fuel usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated fuel savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
- New heating water boilers,
- New Air handler filtration,
- New DDC controls with updated sequences,
- New roof
Indoor Aquatic Center Electrical Performance

The following graphs illustrate the electrical performance for the Indoor Aquatic Center during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in electrical usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated electric savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
- 2 New dehumidification units,
- New low-capture exhaust systems,
- New pool pump variable frequency drives,
- New VAV air handler condensing unit,
- New supplemental electric heat,
- Updated sequences,
- LED lighting
Indoor Aquatic Center Fuel Performance

The following graphs illustrate the fuel performance for the Indoor Aquatic Center during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in fuel usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated fuel savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
* 2 New dehumidification units,
* New pool heating boilers,
* New pool pump variable frequency drives,
* Updated sequences
Library Electrical Performance

The following graphs illustrate the electrical performance for the Library during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in electrical usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated electric savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
* New CO2 sensors & updated sequences for demand controlled ventilation,
* LED lighting
Airport Terminal Electrical Performance

The following graphs illustrate the electrical performance for the Airport Terminal during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in electrical usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated electric savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
* New AC split systems,
* New internet-based thermostats,
* LED lighting
Airport Terminal Fuel Performance

The following graphs illustrate the fuel performance for the Airport Terminal during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in fuel usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated fuel savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
* New gas furnaces,
* New internet-based thermostats
Fire/Med #5 Electrical Performance

The following graphs illustrate the electrical performance for the Fire/Med #5 during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in electrical usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated electric savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
* New 100 kW solar PV array,
* New DDC control system with updated sequences,
* LED lighting

Bonus Improvements:
* Rebalance register airflows to improve comfort
Fire/Med #5 Fuel Performance

The following graphs illustrate the fuel performance for the Fire/Med #5 during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in fuel usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated fuel savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
* New DDC control system with updated sequences

Bonus Improvements:
* Rebalance airflows to improve comfort
The following graphs illustrate the electrical performance for the Fire/Med #4 during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in electrical usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated electric savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
* New DDC control system with updated sequences,
* LED lighting

Bonus Improvements:
* Rebalance airflows to improve comfort
Fire/Med #4 Fuel Performance

The following graphs illustrate the fuel performance for the Fire/Med #4 during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in fuel usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated fuel savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

**Facility Improvements:**
- New DDC control system with updated sequences

**Bonus Improvements:**
- Rebalance airflows to improve comfort
Fire/Med #3 Electrical Performance

The following graphs illustrate the electrical performance for the Fire/Med #3 during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in electrical usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated electric savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
* New packaged heating & cooling roof-top units,
* New DDC control system with updated sequences,
* New roof,
* LED lighting

Bonus Improvements:
* Rebalance airflows to improve comfort
Fire/Med #3 Fuel Performance

The following graphs illustrate the fuel performance for the Fire/Med #3 during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in fuel usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated fuel savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

**Facility Improvements:**
- New packaged heating & cooling roof-top units,
- New DDC control system with updated sequences,
- New roof

**Bonus Improvements:**
- Rebalance airflows to improve comfort
Fire/Med #2 Electrical Performance

The following graphs illustrate the electrical performance for the Fire/Med #2 during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in electrical usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated electric savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
* New packaged heating & cooling roof-top units,
* New internet-based thermostats,
* LED lighting

Bonus Improvements:
* Rebalance airflows to improve comfort
Fire/Med #2 Fuel Performance

The following graphs illustrate the fuel performance for the Fire/Med #2 during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in fuel usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated fuel savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
* New packaged heating & cooling roof-top units,
* New internet-based thermostats

Bonus Improvements:
* Rebalance airflows to improve comfort
Fire and Rescue Training Electrical Performance

The following graphs illustrate the electrical performance for the Fire and Rescue Training during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in electrical usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated electric savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
* New internet-based thermostats
* LED lighting
Fire and Rescue Training Fuel Performance

The following graphs illustrate the fuel performance for the Fire and Rescue Training during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in fuel usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated fuel savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
* New internet-based thermostats
Parking/Animal Control/Transit Electrical Performance

The following graphs illustrate the electrical performance for the Parking/Animal Control/Transit during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in electrical usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated electric savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
- New packaged heating & cooling units (replaced electric heat with gas heat),
- New internet-based thermostats,
- LED lighting
Parking/Animal Control/Transit Fuel Performance

The following graphs illustrate the fuel performance for the Parking/Animal Control/Transit during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in fuel usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated fuel savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
- New packaged heating & cooling units (replaced electric heat with gas heat),
- New internet-based thermostats
Lawrence Arts Center Electrical Performance

The following graphs illustrate the electrical performance for the Lawrence Arts Center during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in electrical usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated electric savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
* New air-cooled chiller,
* New DDC control system with updated sequences,
* LED lighting (except theatre performance lights)
Lawrence Arts Center Fuel Performance

The following graphs illustrate the fuel performance for the Lawrence Arts Center during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in fuel usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated fuel savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
* New DDC controls with updated sequences
City Hall Electrical Performance

The following graphs illustrate the electrical performance for the City Hall during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in electrical usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated electric savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
* New supplemental electric heating in entries,
* Updated control sequences,
* New windows,
* LED lighting
City Hall Fuel Performance

The following graphs illustrate the fuel performance for the City Hall during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in fuel usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated fuel savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
* New supplemental electric heating in entries,
* Updated control sequences,
* New windows
East Lawrence Rec Center Electrical Performance

The following graphs illustrate the electrical performance for the East Lawrence Rec Center during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in electrical usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated electric savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
* New packaged heating & cooling rooftop units (except W. side)
* Updated control sequences
* LED lighting

[Graphs showing electric consumption and cost savings with data points and labels]
East Lawrence Rec Center Fuel Performance

The following graphs illustrate the fuel performance for the East Lawrence Rec Center during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in fuel usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated fuel savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
* New packaged heating & cooling rooftop units (except W. side)
* Updated control sequences
Prairie Park Nature Center Electrical Performance

The following graphs illustrate the electrical performance for the Prairie Park Nature Center during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in electrical usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated electric savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
- New AC split systems,
- New ventilation system,
- New DDC control system with updated sequences,
- LED lighting

Bonus Improvements:
- New bipolar ionization cleaner on 3 split systems.
Prairie Park Nature Center Fuel Performance

The following graphs illustrate the fuel performance for the Prairie Park Nature Center during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in fuel usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated fuel savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
* New gas furnaces,
* New ventilation system,
* New DDC control system with updated sequences

Bonus Improvements:
* New bipolar ionization cleaner on 3 furnaces.
Vehicle Maintenance Garage Electrical Performance

The following graphs illustrate the electrical performance for the Vehicle Maintenance Garage during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in electrical usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated electric savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
- New AC ductless mini-split for Server Room,
- Internet-based thermostats,
- LED lighting
Vehicle Maintenance Garage Fuel Performance

The following graphs illustrate the fuel performance for the Vehicle Maintenance Garage during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in fuel usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated fuel savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
* Internet-based thermostats
Community Building Electrical Performance

The following graphs illustrate the electrical performance for the Community Building during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in electrical usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated electric savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
* New packaged heating & cooling rooftop units (except RTU-11),
* Updated control sequences,
* New roof
* LED lighting
Community Building Fuel Performance

The following graphs illustrate the fuel performance for the Community Building during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in fuel usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated fuel savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
* New packaged heating & cooling rooftop units (except RTU-11),
* Updated control sequences
* New roof
Holcom Park Rec Center Electrical Performance

The following graphs illustrate the electrical performance for the Holcom Park Rec Center during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in electrical usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated electric savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

Facility Improvements:
* New packaged heating & cooling rooftop units for Gym,
* New gas duct heaters for air handlers (remove hydronic heating),
* Updated control sequences,
* LED lighting

Bonus Improvements:
* Rebalance airflows to improve comfort
The following graphs illustrate the fuel performance for the Holcom Park Rec Center during the measurement and verification period. The first graph below illustrates the weather adjustments and savings that occurred in fuel usage. The blue bar represents the baseline, the green bar represents the adjustments made to the baseline based on actual weather, and the yellow bar is the current usage. The difference between the blue and green bars is the savings (or loss) due to weather effects, and the difference between the green and yellow bars is the calculated fuel savings.

The graph below illustrates the monthly cost savings achieved through the project. The white bar represents savings, and the blue bar represents the new monthly costs.

**Facility Improvements:**
* New packaged heating & cooling rooftop units for Gym,
* New gas duct heaters for air handlers (remove hydronics),
* Updated control sequences

**Bonus Improvements:**
* Retro-commission to improve comfort
Appendix
Overall Project Performance Summary

The cumulative energy savings performance across the Lawrence city-wide energy conservation project met the project savings guarantee, exceeding net expected savings by $3,845 in the first year of Measurement and Verification. While this is a successful overall project result, some individual buildings performed better than individual facility model estimates, and some buildings performed worse than initial model estimates. Ultimately, more City of Lawrence buildings exceeded energy savings expectations, which offset poorer performing buildings.

Willdan recognizes that despite the overall project success, individual building performance issues can create a utility budgeting challenge, specifically for the poorer performing Indoor Aquatic Center (IAC). Willdan is committed to working with the City of Lawrence to help the City understand why this building did not perform as expected, as well as identify areas for improved function and reporting related to energy savings.

Indoor Aquatic Center – Building Performance

The Indoor Aquatic Center has not performed as well as expected during the Measurement and Verification period. As shown in previous sections of this report, both gas and electric savings are lower than predicted. Several issues contributed to this outcome, including project components that were not fully executed. A brief description of each issue and its impact is shown below.

Unoccupied Pool Turndown – Not Executed

This measure has had the most impact on the expected savings. During construction, Willdan installed variable-speed drives for the pool circulation pumps. The intent was to reduce the amount of water pumped at night when the pools are closed. Building codes require a minimum amount of pumped water to travel through the filtration system. These same codes allow for a reduction in pumped water when the pool is unoccupied. The planned pumping reduction saves both electricity and heat.

The pool pumps are in an underground vault below the mechanical room. The chemical treatment system is on the first level, in the mechanical room. To activate the chemical system, a portion of the circulated pool water is diverted to the chemical treatment system. Because the diverted water must move vertically upward to reach the chemical treatment system, extra pressure, known as “head”, is required. The existing piping system uses a manual reducing valve to provide necessary head in the diversion loop. When the pool water circulation pumps are slowed down, a manual adjustment of the reducing valve would be required to maintain enough head for the chemical treatment loop.

The manual reducing valve for artificial flow resistance is contrary to recommended design. A better design would be the addition of a circulation pump that maintains required head without introducing artificial restrictions. If an additional circulation pump is installed for the chemical treatment system, the large pool circulation pumps can be turned down at night to achieve the expected energy savings.

Leisure Pool Dehumidification Unit (DHU) – Consumes More than Expected

The Leisure Pool DHU was replaced as a separate project just prior to the Willdan construction project. The new DHU uses considerably more gas and electricity than the original unit that it replaced. The increase in electrical consumption can be seen in the summer months of 2017 in the graph below. This
increase was not considered in the baseline calculations (2014-2015) used to determine cost savings. The extra utility costs incurred from the new Leisure Pool DHU continue to contribute to the overall utility costs of the Indoor Aquatic Center.

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**Pool Flow Meters – Not Accurate During IGA**

During the Preliminary Analysis, Willdan engineers examined the existing flow meters for the pool circulation loops. They discovered that the pool circulation flows were higher than the design flow, resulting in wasted electrical energy. During the construction phase of the project, Willdan discovered that the circulation flow meters gave inaccurate readings. The actual pool circulation flows were at or lower than design flows. The circulation flow could not be lowered further, eliminating the potential savings.

**Summary**

The unexpected variations to the Willdan design and energy calculations have changed the expected utility costs of the Indoor Aquatic Center. Willdan continues to monitor the IAC building performance and can make further recommendations for energy reduction if the City of Lawrence would like to explore potential opportunities. While net project savings city-wide offset the poorer than expected performance at the IAC, Willdan recognizes individual building performance still creates challenges, and we are committed to helping the City with continued documentation of building performance and savings to assist in utility budget allocations, etc.
Utility Rate Adjustment

The utility rates were adjusted for the current year’s CPI according to Schedule C, Section 7 of the contract.

The current year’s CPI was determined using the CPI Table for the Mid-Atlantic region on the U.S. Bureau of Labor Statistics’ website:

https://www.bls.gov/regions/mid-atlantic/data/consumerpriceindexhistorical_us_table.htm

The CPI for March 2017 was used for the Baseline (year zero) CPI since the Contract Start Date was 2/28/2017. The average CPI was used for the Year 1 Performance Period (future year) CPI of March 2018 to February 2019 as follows:

CPI for 3/2017 = 243.801
Avg. CPI for 3/2018 to 2/2019 = 251.543

Rate adjustment = (251.543 – 243.801) / 243.801 = 0.0318

New Rates

<table>
<thead>
<tr>
<th>Utility Rate</th>
<th>Program Year</th>
<th>Electric Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Westar MGS</td>
<td>0</td>
<td>$0.0485 / kWh (Jun – Sept)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$0.0402 / kWh (all other months)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$22.926 / kW (all months)</td>
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<tr>
<td>Westar SGS</td>
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<td>$0.0850 / kWh (all months)</td>
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<td>Natural Gas (High Rate)</td>
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<td>$1.00 / Therm</td>
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<tr>
<td>All Rates</td>
<td>Future Years</td>
<td>Year zero rate adjusted for current year’s CPI or future year’s actual rate, whichever is greater.</td>
</tr>
</tbody>
</table>

Westar MGS

$0.0485 / kWh (June – Sept)
$0.0402 / kWh (all other months)
$22.926 / kW (all months)

Westar SGS

$0.0877 / kWh (all months)
$8.739 / kW (June – Sept)
$5.551 / kW (all other months)

Natural Gas (Low Rate)

$0.722 / Therm

Natural Gas (Medium Rate)

$0.877 / Therm

Natural Gas (High Rate)

$1.032 / Therm
Baseline Energy Adjustments - Not included in Savings

The following conditions were identified which according to the contract could be analyzed to determine adjustments to the Baseline Consumption. However, the adjustment associated with each item was not analyzed since Year 1 Savings produced enough savings to meet the guarantee. The items have been included in the Appendix for informational purposes to illustrate that additional savings beyond those reported could have been achieved.

East Lawrence Recreation Center

1) Unoccupied setpoints were found to be higher than the contract Unoccupied heating setpoint of 55F. All setpoints were higher than 60F, with some areas being overridden to 70-72F for Unoccupied heating setpoint.
   a. Lobby/Weight Rm, & Gymnastics Rm had Unocc. Heat Setpoint set to 68F.
   b. RTU-1, & Party/Conference Rm had Unocc. Heat Setpoint set to 70F.

Holcom Park Recreation Center

1) Unoccupied setpoints were found to be higher than the contract Unoccupied heating setpoint of 55F.
   a. North Gym RTU, & South Gym RTU both had Unocc. Heat Setpoint overridden to 71F.
2) Improved comfort by adjusting Baseline Zone Differential setpoint from 3F to 1F, meaning previously a zone had to get 3F off setpoint before enabling heat or cool for that zone. Now, a zone will enable heat or cool when 1F off setpoint. This has provided vastly improved comfort in all areas of building, but will use more energy to achieve these comfort levels.

City Setpoint Policy Changes updated January 1, 2018

Due to numerous comfort complaints at various buildings in both heating & cooling season, the city elected to update the setpoint policy on January 1, 2018 (Policy #121). Sections of the policy document have been included below:

All interior office workspaces within the City must have the following setpoints. During normal operating hours, thermostats shall have a setpoint between 68°F and 72°F during the heating season and between 72°F and 76°F during the cooling season.

The following spaces are exempt from the aforementioned standards:
   a) Pool spaces shall be kept at 2°F above pool water temperature setpoints;
   b) Gyms, community gathering areas, locker rooms and other changing areas shall be set for occupant comfort; and
   c) Residential sleeping quarters for first responders may have a setpoint between 70°F and 76°F during the cooling season.

The setpoints in red above conflict with the contractual setpoints in Schedule I, Section 1 of the contract (see below) and would result in increased energy consumption.

1) HVAC systems: ESCO will install systems capable of maintaining the following standards of comfort:
   a) Occupied heating setpoints: 70°F
   b) Occupied cooling setpoints: 74°F
Option A Measurement & Verification of Electrical Energy Savings

The table below demonstrates the amount of savings achieved throughout all facilities in which Option A Savings was calculated. The table breaks down the essential measured parameters (kWh, kW) which were used to determine the achieved savings. Based on the analysis performed, the facilities saw a combined savings of $166,406, this was $27,651 more than the guaranteed savings of $138,755. The graphs shown below the table are to illustrate the impact the energy saving measures have had on your facilities.

City-Wide Building Lighting

<table>
<thead>
<tr>
<th>Building Name</th>
<th>Pre-Project Consumption (kWh)</th>
<th>Pre-Project Demand (kW)</th>
<th>Pre-Project Cost ($)</th>
<th>Post-Project Consumption (kWh)</th>
<th>Post-Project Demand (kW)</th>
<th>Post-Project Cost ($)</th>
<th>Consumption Savings (kWh)</th>
<th>Annual Demand Savings (kW)</th>
<th>Annual Savings ($)</th>
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<td>Post-Project Cost ($)</td>
<td>Consumption Savings (kWh)</td>
<td>Annual Demand Savings (kWh)</td>
<td>Annual Savings ($)</td>
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<td><strong>226,692</strong></td>
<td><strong>755,189</strong></td>
<td><strong>1,980.6</strong></td>
<td><strong>1,555,102</strong></td>
<td><strong>3,967.1</strong></td>
<td><strong>148,361</strong></td>
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**Utility Cost Savings**

- **$78,331 (35%)**
- **$148,361 (65%)**

**Annual Consumption**

- Pre-Project Consumption: 2,310,291 kWh
- Post-Project Consumption: 755,189 kWh

**Annual Demand**

- Pre-Project Demand: 2,310,291 kW
- Post-Project Demand: 1,980.6 kW
## Sports Field Lighting

<table>
<thead>
<tr>
<th>Building Name</th>
<th>Pre-Project Consumption (kWh)</th>
<th>Pre-Project Demand (kW)</th>
<th>Pre-Project Cost ($)</th>
<th>Post-Project Consumption (kWh)</th>
<th>Post-Project Demand (kW)</th>
<th>Post-Project Cost ($)</th>
<th>Annual Consumption Savings (kWh)</th>
<th>Annual Demand Savings (kW)</th>
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<td>Chief Jim McSwain Park</td>
<td>2,887</td>
<td>54.9</td>
<td>$575</td>
<td>1,768</td>
<td>33.8</td>
<td>$408</td>
<td>1,099</td>
<td>21.0</td>
<td>$167</td>
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<tr>
<td>Deerfield Park</td>
<td>4,300</td>
<td>82.3</td>
<td>$792</td>
<td>2,652</td>
<td>50.8</td>
<td>$542</td>
<td>1,648</td>
<td>31.5</td>
<td>$250</td>
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<tr>
<td>Holcomb Park</td>
<td>11,468</td>
<td>219.5</td>
<td>$1,881</td>
<td>7,073</td>
<td>135.4</td>
<td>$1,213</td>
<td>4,295</td>
<td>84.1</td>
<td>$667</td>
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<tr>
<td>Lyons Park</td>
<td>57,552</td>
<td>1,101.5</td>
<td>$8,878</td>
<td>46,656</td>
<td>892.9</td>
<td>$7,224</td>
<td>10,896</td>
<td>208.5</td>
<td>$1,655</td>
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<tr>
<td>Veterans Park</td>
<td>8,601</td>
<td>164.6</td>
<td>$1,445</td>
<td>5,304</td>
<td>101.5</td>
<td>$945</td>
<td>3,296</td>
<td>63.1</td>
<td>$501</td>
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<tr>
<td>Youth Sports Complex</td>
<td>383,249</td>
<td>6,851.0</td>
<td>$81,812</td>
<td>325,570</td>
<td>5,945.7</td>
<td>$70,718</td>
<td>57,679</td>
<td>905.3</td>
<td>$11,094</td>
</tr>
<tr>
<td>Holcom</td>
<td>-</td>
<td>-</td>
<td>$139</td>
<td>3,484</td>
<td>9.5</td>
<td>$476</td>
<td>(3,484)</td>
<td>(9.5)</td>
<td>(337)</td>
</tr>
<tr>
<td>Clinton Softball Complex</td>
<td>2,405</td>
<td>6.6</td>
<td>$305</td>
<td>5,229</td>
<td>14.3</td>
<td>$500</td>
<td>(2,824)</td>
<td>(7.7)</td>
<td>(195)</td>
</tr>
<tr>
<td>19th and Moodie</td>
<td>14,374</td>
<td>80.0</td>
<td>$1,665</td>
<td>5,932</td>
<td>41.0</td>
<td>$796</td>
<td>8,442</td>
<td>39.0</td>
<td>$869</td>
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<tr>
<td>Horticulture</td>
<td>9,836</td>
<td>46.7</td>
<td>$1,157</td>
<td>5,192</td>
<td>24.8</td>
<td>$677</td>
<td>4,644</td>
<td>21.9</td>
<td>$480</td>
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<tr>
<td>Oak Hill Cemetery</td>
<td>3,718</td>
<td>27.0</td>
<td>$555</td>
<td>935</td>
<td>5.6</td>
<td>$240</td>
<td>2,783</td>
<td>21.4</td>
<td>$315</td>
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<tr>
<td>15th Street Cemetery</td>
<td>6,572</td>
<td>38.0</td>
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<td>3,059</td>
<td>16.3</td>
<td>$462</td>
<td>3,513</td>
<td>21.7</td>
<td>$380</td>
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<tr>
<td><strong>Totals</strong></td>
<td>541,072</td>
<td>9,363.6</td>
<td>$105,812</td>
<td>434,506</td>
<td>7,686.1</td>
<td>$87,766</td>
<td>106,566</td>
<td>1,677.5</td>
<td>$18,045</td>
</tr>
</tbody>
</table>

### Utility Cost Savings

- **Savings**: $87,766 (83%)
- **Cost**: $18,045 (17%)

### Annual Consumption

- **Pre-Project Consumption**: 541,072 kWh
- **Post-Project Consumption**: 434,506 kWh

### Annual Demand

- **Pre-Project Demand**: 9,363.6 kW
- **Post-Project Demand**: 7,686.1 kW
Option A Measurement & Calculated Savings Methodology

The following section explains how measurements were taken to determine the savings achieved.

A. Savings calculated for Option A were determined by following the guidelines laid out in the International Performance Measurement & Verification Protocol Volume I. As prescribed by the instructions for Option A: Partially Measured Retrofit Isolation, the equipment affected by the energy conservation measures (ECM) was isolated and measured prior to the retrofit, and again post retrofit, to determine the impact of the ECM on the energy usage of the equipment.

B. Sampling was conducted to obtain a 90% confidence and 20% precision according to Appendix B of the Federal Energy Management Program (FEMP) M&V Guidelines v4.0. The purpose of sampling is to monitor a representative sample of points rather than the entire population. The end result is to obtain reliable estimates within a specified precision and statistical confidence. The basic equation used in sample group sizing for 90% confidence and 20% precision is:

\[ n = \frac{z^2 \cdot (C_v)^2}{(P)^2} = \frac{(1.645)^2 \cdot (0.5)^2}{(0.2)^2} = 16.91 \]

Where, \( z \) = Z-statistic, 1.645 for 90% confidence; \( C_v \) = Coefficient of Variance, 0.5; \( P \) = Precision, 20%

For populations less than 500, the sample size should be modified using the finite population correction equation:

\[ n^* = \frac{N n}{n + N} \]

Where, \( n^* \) = sample size corrected for population size; \( n \) = sample size for infinite population; \( N \) = population size.

Furthermore, the sample size includes a 10% oversampling factor in case of data collection device failure or unexpectedly high data scatter.

\[ n^* = \frac{N n}{n + N} = \frac{(92)(16.91)}{16.91 + 92} = 14.28 \times 10\% = 15.7 = 16 \]

C. Pre-retrofit & post-retrofit measurements were taken at the various fixtures themselves, and then the average difference between the measurements was applied to all the fixtures in the sample set. The resulting savings was evaluated using the average occupancy, operations, and annual use to determine the total building energy savings.

D. Pre-retrofit & post-retrofit annual usage was estimated for each fixture to calculate an annual consumption for each building.

E. Pre-retrofit & post-retrofit annual consumption was then multiplied by the contractual energy rates to determine the annual energy costs.

F. The pre-retrofit energy cost was then compared to the post-retrofit energy cost to determine the annual energy savings solely from the energy conservation measure.
Solar PV Performance and Savings

The 100kW Solar PV array was installed on the roof of Fire/Medical #5 (1911 Stewart Ave.) in the summer of 2017. Since that time, this system has produced over 245,000 kWh of electrical power that would have been purchased from the electric utility.

Equivalent savings to 245,000 kWh includes the following:

**Greenhouse gas emissions from**

- Passenger vehicles driven for one year: 36.8
- Miles driven by an average passenger vehicle: 423,599

**CO₂ emissions from**

- Gallons of gasoline consumed: 19,495
- Pounds of coal burned: 189,404
- Homes’ electricity use for one year: 30.2

**Carbon sequestered by**

- Tree seedlings grown for 10 years: 2,865
- Acres of U.S. forests in one year: 204