ENERGY SAVINGS PERFORMANCE CONTRACT

This Energy Savings Performance Contract (the "Contract") is made and entered into as of this ________ day of _____________, 2017, in the County of Clay, State of Missouri, by and between NAVITAS, LLC ("ESCO"), having its principal offices at 25501 WEST VALLEY PARKWAY, SUITE 200, OLATHE, KS 66061, and City of Gladstone ("Customer") having principal offices at 7010 N Holmes Street Gladstone, Missouri 64118, for the purpose of installing certain energy and water cost saving equipment, described in **Schedule J (Equipment to Be Installed by ESCO)**, and providing other services designed to save energy for the Customer's property and buildings in **Schedule I (Description of Premises)** (the "Premises").

RECITALS

WHEREAS, Customer owns and operates the Premises, and is in need of energy and water cost saving equipment and services designed to save energy and associated energy costs at said Project Sites; and

WHEREAS, Customer has funds available or been authorized to enter into a third party financing agreement for all professional services, equipment and construction for the purchase and installation of energy and water cost savings measures, collectively referred to as the "Work" (as herein after defined); and

WHEREAS, ESCO has developed or become knowledgeable about certain procedures for controlling energy and water consumption through services provided and equipment installed and maintained at project sites similar in scope and scale of Customer; and

WHEREAS, ESCO was selected after a determination that its proposal was the most advantageous to Customer pursuant to a Request for Proposal; and

WHEREAS, ESCO has made an assessment of the utility consumption characteristics of the Premises and existing equipment described in **Schedule I (Description of Premises)**, which was delivered to Customer as an Investment Grade Audit which Customer has approved and is attached as **Appendix A (Investment Grade Audit)**; and

WHEREAS, Customer desires to retain ESCO to purchase, install and service certain energy and water cost savings equipment and to provide other services and strategies described in the attached Schedules, for the purpose of achieving energy and water cost reductions within Premises, as more fully described herein; and

WHEREAS, Customer is authorized under the Constitution and the laws of the State of Missouri to enter into this Contract for the purposes set forth herein.

NOW, THEREFORE, in consideration of the mutual promises and covenants contained herein, and intending to be legally bound hereby, Customer and ESCO hereto covenant and agree that the following Schedules, Exhibits and Appendices are attached hereto (or will be, as provided in this Contract) and are made a part of this Contract by reference.

ARTICLE 1. DEFINITIONS, SCHEDULES, EXHIBITS AND APPENDICES

Section 1.1. Definitions.

Certificate of Acceptance: The certificate substantially in the forms provided in **Exhibit III**.

Contract: This Energy Savings Performance Contract and all Schedules and Exhibits attached hereto.

Contract Sum: The sum of all materials, labor, auditing, design, engineering, project construction management fees, overhead, profit, contingency, subcontracted services related to the project.

Energy and Water Cost Savings: The savings as provided in **Schedule A (Energy Savings Guarantee)**.

Energy and Cost Savings Guarantee: The guarantee that is achieved as a result of the installation and operation of the Equipment and provision of services provided for in this Contract as specified in **Schedule G (Compensation to ESCO for Annual Service)** and in accordance with the Savings Calculation Formula as set forth in **Schedule C (Savings Measurement and Verification Plan)**.

Equipment: The goods enumerated on **Schedule J (Equipment to be Installed by ESCO)** that is now or hereafter from time to time become attached hereto and incorporated herein by reference, together and with any and all additions, modifications, attachments, replacements and parts thereof.

Event of Default: Those events described in **Section 20 (Events of Default)** hereof.

Interim Period: The period from Contract Execution until the Commencement Date.

Commencement Date: The date described in **Section 2.2 (Commencement Date)**.

Premises: The facilities of the Customer in need of energy and water saving equipment and services designed to reduce consumption and associated costs at said Premises.

Work: Collectively, the Equipment, professional services, and project construction related to the project.

Section 1.2. <u>Design Drawings and Project Development.</u>

The complete design for of the Premises is set forth in **Schedule J Equipment to be Installed by ESCO** and has been approved and accepted by Customer as set forth in **Exhibit III(i) (Certificate of Acceptance—Investment Grade Audit)**. The design documents include all measures agreed upon by the parties.

Section 1.3. <u>Schedules, Exhibits and Appendices.</u>

ESCO has prepared and Customer has approved and accepted the following Schedules, copies of which are attached hereto (or will be as provided for in the Contract), set forth in their entirety and made a part of this Contract by reference.

<u>Schedules</u>

Savings Guarantee

Schedule A	Energy Savings Guarantee
Schedule B	Baseline Energy Consumption
Schedule C	Savings Measurement and Verification Plan
Schedule D	Utility Monitoring and Energy Management Agreement

Payments and Schedule

Schedule E	Final Project Cost & Project Cash Flow Analysis
Schedule F	Financing Agreement and Payment Schedule
Schedule G	Compensation to ESCO for Annual Services
Schedule H	Rebates, Incentives, and Grants

Design and Construction Phase

Schedule I	Description of Premises
Schedule J	Equipment to be Installed by ESCO
Schedule K	Construction and Installation Schedule
Schedule L	Systems Start-Up and Commissioning
Schedule M	Detailed Savings Calculations
Schedule N	Standards of Comfort
Schedule O	ESCO's Training Responsibilities

Post-Construction

Schedule P	ESCO's Maintenance Responsibilities
Schedule Q	Customer's Maintenance Responsibilities
Schedule R	Facility Maintenance Checklist

Administration

Schedule S	Assumptions
Schedule T	Detailed Pollution Credit Calculations
Schedule U	Dispute Resolution

Exhibits

Exhibit I	Performance Bond
Exhibit II	Labor and Material Payment Bond
Exhibit III(i)	Certificate of Acceptance – Investment Grade Audit
Exhibit III(ii)	Certificate of Acceptance – Installed Equipment
Exhibit III(iii)	Certificate of Project Completion
Exhibit IV	Equipment Warranties

Section 1.4. Other Documents.

This Contract incorporates herein and makes a part hereof the **Investment Grade Audit**. Acceptance by the Customer of the **Investment Grade Audit** is reflected in **Exhibit III(i) (Certificate of Acceptance – Investment Grade Audit)**. Notwithstanding, the provisions of this Contract and the attached Schedules shall govern in the event of any inconsistencies between the Investment Grade Audit and the provisions of this Contract.

ARTICLE 2. PURCHASE AND SALE; COMMENCEMENT DATE AND TERMS; INTERIM PERIOD

Section 2.1. Purchase and Sale.

Customer agrees to fund or lease equipment through a third party financier, as provided for in a separate lease document, **Schedule F (Financing Agreement and Payment Schedule)**. ESCO agrees to provide the Equipment, together with installation, maintenance and other services as provided herein, as in **Schedule J, (Equipment to be Installed by ESCO)** based upon the terms and conditions set forth in **Schedule I (Financing Agreement and Payment Schedule)**.

The agreed to Contract Sum for the Work is a Guaranteed Maximum Price of $4,055,287 as set forth in **Schedule E (Final Project Cost & Project Cash Flow Analysis)**. Payment terms are described in **Schedule F (Financing Agreement and Payment Schedule).**

ESCO will provide the Work and all related services identified in **Schedule J (Equipment to be Installed by ESCO)** and the services detailed in **Schedule P (ESCO's Maintenance Responsibilities)** and **Schedule G (Compensation to ESCO for Annual Services)**. ESCO shall supervise and direct the Work and shall be responsible for all construction means, methods, techniques, sequences, and procedures and for coordinating all portions of the Work under this Contract. ESCO shall be responsible to pay for all labor, materials, equipment, tools, construction equipment and machinery, transportation and other facilities and services necessary for the proper execution and completion of the Work.

Customer shall pay ESCO the Contract Sum in accordance with **Schedule F (Financing Agreement and Payment Schedule).** Payments will be made on a progress basis in accordance with **Schedule F (Financing Agreement and Payment Schedule)**, for Work completed and authorized by Customer during the Interim Period. Retainage of five percent (5%) will be withheld from each payment until the construction installation is completed as set forth in **Section 2.2 (Commencement Date)**.

Section 2.2. Commencement Date.

The Commencement Date shall be the first day of the month after the month in which all schedules are in final form and accepted by Customer and ESCO shall have delivered a Notice to Customer that it has installed and commenced operating all of the Equipment specified in **Schedule J (Equipment to be Installed by ESCO)** and in accordance with the provisions of **Article 8 (Construction Schedule and Equipment Installation; Approval)**, **Schedule K (Construction and Installation Schedule),** and **Schedule L (Systems Start-Up and Commissioning)**; and Customer has inspected and accepted said installation and operation as evidenced by the Certificate of Project Completion as set forth in **Exhibit III(iii) (Certificate of Project Completion)**.

Notwithstanding anything to the contrary in this **Article 2 (Purchase and Sale; Commencement Date and Terms; Interim Period)** and **Article 3 (Savings Guarantee; Annual Reconciliation; Payments to ESCO)**, the Commencement Date shall not occur and the Customer shall not be required to accept the work under this Contract unless and until all equipment installation for the Premises is completed by ESCO in accordance with the terms and conditions of this Contract. Customer shall have thirty (30) days after notification by the ESCO to inspect and accept the Equipment. Customer reserves the right to reject the Equipment if installation fails to meet reasonable standards of workmanship, does not comply with applicable building codes, or is otherwise not in compliance with this Contract. ESCO shall not be paid in full, including retainage, until after the punch list is completed and ESCO has satisfied any and all claims for labor and materials and the Certificate of Acceptance has been signed. The Certificate of Acceptance will not be unreasonably withheld by the Customer.

Compensation payments due to ESCO for on-going services and maintenance under this Contract as set forth in **Schedule G (Compensation to ESCO for Annual Services)** shall begin no earlier than thirty (30) days from the Commencement Date as defined herein.

Section 2.3. Term of Contract; Interim Period.

Subject to the following sentence, the term of this Contract shall be fifteen (15) years beginning with the Commencement Date. Nonetheless, the Contract shall be effective and binding upon the parties immediately upon its execution, and the period from Contract Execution until the Commencement Date shall be known as the "Interim Period." All energy savings achieved during the interim period will be fully credited to Customer.

ARTICLE 3. SAVINGS GUARANTEE; ANNUAL RECONCILIATION; PAYMENTS TO ESCO

Section 3.1. <u>Energy and Cost Savings Guarantee.</u>

ESCO has formulated and, subject to the adjustments provided for in **Article 15 (Material Changes)**, has guaranteed the annual level of energy and water cost savings to be achieved as a result of the installation and operation of the Equipment and provision of services provided for in this Contract in accordance with the methods of savings measurement and verification as set forth in **Schedule C (Savings Measurement and Verification Plan).** Customer accepts the estimate and corresponding guarantee of savings calculated by the ESCO. The Energy and Cost Savings Guarantee is set forth in annual increments for the term of the Contract as specified in **Schedule A (Energy Savings Guarantee)** and has been structured by the ESCO to be sufficient to cover any and all annual payments required to be made by the Customer as set forth in **Schedule G (Compensation to ESCO for Annual Services)** and **Schedule F (Financing Agreement and Payment Schedule)**.

Section 3.2. <u>Annual Review and Reimbursement/Reconciliation.</u>

Energy-related cost savings shall be measured and/or calculated as specified in **Schedule C (Savings Measurement and Verification Plan)** and **Schedule B (Baseline Energy Consumption)** and a report provided within <u>ninety (90) days</u> of the end of the year for the previous year for each anniversary of the Commencement Date for the duration of the period set forth by the Contract.

In the event the Energy and Cost Savings achieved during such guarantee year are less than the Guaranteed Energy and Cost Savings as defined in **Schedule A (Energy Savings Guarantee)**, ESCO shall pay the Customer an amount equal to the deficiency.

The ESCO shall remit such payments to the Customer within <u>ninety (90) days</u> of written notice by the Customer of such monies due.

Section 3.3. <u>ESCO Compensation and Fees.</u>

ESCO has structured the Energy and Cost Savings Guarantee referred to in **Section 3.1 (Energy and Cost Savings Guarantee)** above, to be sufficient to include any and all annual payments required to be made by the Customer in connection with financing/purchasing the Equipment to be installed by ESCO under this Contract as set forth in **Schedule F (Financing Agreement and Payment Schedule)**. Actual energy and operations savings achieved by ESCO through the operation of equipment and performance of services by ESCO shall be sufficient to cover any and all annual fees to be paid by Customer to ESCO for the provision of services as set forth and in accordance with the provisions of **Schedules E (Compensation to ESCO)** and **Schedule P (ESCO's Maintenance Responsibilities)**.

Section 3.4. <u>Interim Period Progress Payments.</u>

During the period beginning the date of execution of this Agreement and continuing through the date of **Exhibit III (iii) (Certificate of Project Completion)**, Customer or third party financier will make monthly progress payments to ESCO based on the percentage of the scope of work completed at the end of each month. ESCO will provide Customer with an itemized Application for Payment for the preceding calendar month. Customer will pay ESCO the amount of the Application for Payment, less retainage, within <u>thirty (30) days</u> of the date from which ESCO provides such Application for Payment to Customer. Customer will not unreasonably withhold any such payment. If Customer disputes any portion of the payment, Customer will remit the undisputed portion on schedule.

Section 3.5. Late Payments.

Amounts not in dispute and not paid to ESCO when due will accrue interest at nine percent (9%) per annum, following the due date until such time as the amount due has been paid in full.

Section 3.6. Lien Waivers.

Upon receipt of each progress payment from Customer, ESCO will furnish partial lien waivers, for the amount of payment received, certifying that ESCO has paid its subcontractors and vendors through the period of the progress payment.

ARTICLE 4. FISCAL FUNDING

Section 4.1. Non-appropriation of Funds.

In the event no Customer or other funds or insufficient Customer or other funds are appropriated and budgeted, and funds are otherwise unavailable by any means whatsoever in any fiscal period for which payments are due ESCO under this Contract, then the Customer will, not less than sixty (60) days prior to end to such applicable fiscal period, in writing, notify the ESCO of such occurrence and this Contract shall terminate on the last day of the fiscal period for which appropriations were made without penalty or expense to the Customer of any kind whatsoever, except as to the portions of payments herein agreed upon for which Customer and/or other funds shall have been appropriated and budgeted or are otherwise available.

ARTICLE 5. ENERGY USAGE RECORDS AND DATA

Customer has furnished and shall continue to furnish (or authorize its energy suppliers to furnish) during the Term of this Contract to ESCO or its designee, upon its request, all of its records and complete data concerning energy and water usage and related maintenance for the Premises.

ARTICLE 6. LOCATION AND ACCESS

ESCO acknowledges that there exists sufficient space on the Premises for the installation and operation of the Equipment. Customer shall take reasonable steps to protect such equipment from harm, theft, and misuse during the term of this Contract. Customer shall provide access to the Premises for ESCO to perform any function related to this Contract during regular business hours, or such other reasonable hours as may be requested by ESCO and acceptable to the Customer. ESCO shall be granted immediate access to make emergency repairs or corrections as it may, in its discretion, determine are needed. The ESCO's access to Premises to make emergency repairs or corrections as it may determine are needed shall not be unreasonably restricted by the Customer. ESCO shall immediately notify the Customer when emergency action is taken and follow up with written notice with three (3) business days specifying the action taken, the reasons therefore, and the impact upon the Premises, if any.

ARTICLE 7. PERMITS, APPROVALS AND STATUTORY PROVISIONS

Section 7.1. Permits and Approvals.

It is ESCO's responsibility to obtain all necessary permits and approvals for installation of the Equipment. Customer shall use its best efforts to assist ESCO in obtaining said permits and approvals. In no event shall Customer, however, be responsible for payment of any permit fees. The equipment and the operation of the Equipment by ESCO shall at all times conform to all federal, state, and local code requirements. ESCO shall furnish copies of each permit or license, which is required to perform the work to the Customer before the ESCO commences the portion of the work requiring such permit or license.

Section 7.2. Coordination During Installation.

The Customer and ESCO shall coordinate the activities of ESCO's equipment installers with those of the Customer, its employees, and agents. ESCO shall not commit or permit any act, which will interfere with the performance of business activities conducted by the Customer or its employees without prior written approval of the Customer.

Section 7.3. Bonding.

ESCO will provide a Performance Bond and Payment Bond in the form of AIA Document A312, each in the sum of 100% of the Contract Sum. The Performance Bond shall strictly apply to the construction and performance of the Work. The Payment Bond shall strictly apply to those providing labor, materials, equipment, supplies and services in connection with the performance of the Work. The surety's liability under the Performance Bond and Payment Bond shall be fully exonerated as of the final completion date of the Work.

The guarantees extended pursuant to these bonds are limited to the construction obligations only, and for the first year of warranty against defective materials and workmanship. These bonds specifically exclude any guarantee of the performance or payment obligations of those sections of the Contract related to extended maintenance services, annual reviews and/or guaranteed energy savings.

Section 7.4. Prevailing Wage.

ESCO agrees to obtain and maintain all documentation necessary to demonstrate compliance by the Customer with all prevailing wage statutes applicable to the Customer. ESCO agrees to indemnify and hold harmless the Customer for any failure to comply with the prevailing wage statutes for work performed on this project.

Section 7.5. Construction Safety Training Act.

The ESCO and all subcontractors to the ESCO must require all on-site employees to complete the "OSHA 10 Training" construction safety training program required under Missouri Revised Statute §292.675 if they have not previously completed the program and have documentation of having done so. ESCO will forfeit a penalty to the contracting public body of two thousand, five hundred dollars ($2,500) plus an additional one hundred dollars ($100) for each employee employed by the ESCO or its subcontractor, for each calendar day, or portion thereof, such employee is employed without the required training.

Section 7.6. Employment Eligibility.

Pursuant to Missouri Revised Statute §285.530 as a condition of the award of any public works contract in excess of five thousand dollars ($5,000.00), ESCO's subcontractors shall, by sworn affidavit and provision of documentation, affirm its enrollment and participation in a federal work authorization program (E-Verify) with respect to the employees working in connection to the contracted services. Subcontractors shall also sign an affidavit affirming that it does not knowingly employ any person who is an unauthorized alien in connection to the contracted services.

Section 7.7. <u>Background Checks.</u>

ESCO, and any subcontractors, suppliers, or lower level trades performing work for the ESCO at the Project site, shall perform background checks on all employees, and provide the Customer with an affidavit verifying and proving that all of its employees working on the Project have passed all applicable criminal background checks required by the Customer before entering the District premises. Forms and affidavits, located in **Schedule S (Assumptions)**, must be completed and returned to Customer.

Section 7.8. <u>Compliance with Laws.</u>

Throughout the term of this Agreement, ESCO shall fully comply with all applicable laws and ordinances and the applicable orders, rules, regulations and requirements of all federal, state and municipal governments and appropriate administrative officers and agencies having jurisdiction, including but not limited to, Executive Order 11246, the Vocational Rehabilitation Act of 1973 (§503), the Americans with Disabilities Act, the Equal Employment Opportunities Act (42 U.S.C. § 2000e, et seq.) and the Vietnam Era Veterans Readjustment Assistance Act of 1974 (38 U.S.C. § 4212 [formerly 2012]).

Section 7.9. <u>ESCO Representations.</u>

ESCO represents and warrants that (i) the Work constitutes the acquisition or installation of "energy cost savings measures" as defined in Sections 8.231 et seq. of the Revised Statutes of Missouri, as amended (collectively herein the "Act"), (ii) this Energy Contract is a "guaranteed energy cost savings contract" as defined in the Act, (iii) the Work constitutes an "energy conservation measure" as referenced in Section 165.011.4 of the Revised Statutes of Missouri, and (iv) ESCO is a "qualified provider" of energy cost savings measures, as defined by the Act.

Section 7.10. <u>Subcontracts.</u>

At its exclusive option, ESCO may subcontract some or all of the Work. While ESCO retains the sole discretion to determine whether it will subcontract some or all of the Work, Customer shall retain final authority to accept or reject a particular subcontractor within reason. Further, Customer shall retain the right to review all bids submitted to ESCO by potential subcontractors. ESCO will notify Customer of its solicitation for bids with a description of the Work that will be subcontracted. ESCO has taken steps and involved Customer to ensure that local contractors were given the opportunity to bid on subcontracts where there are qualified local providers. ESCO will forward submitted bids to Customer upon receipt.

ARTICLE 8. CONSTRUCTION SCHEDULE AND EQUIPMENT INSTALLATION; APPROVAL

Section 8.1. <u>Construction Schedule; Equipment Installation.</u>

Construction and equipment installation shall proceed in accordance with the construction schedule approved by Customer and attached as **Schedule K (Construction and Equipment Installation Schedule)**.

Section 8.2. <u>Systems Startup and Equipment Commissioning.</u>

The ESCO shall conduct a thorough and systematic performance test of each element and total system of the installed equipment in accordance with the procedures specified in **Schedule L (Systems Start-Up and Commissioning)** and prior to acceptance of the project by the Customer as specified in **Exhibit III (ii) (Certificate of Acceptance – Installed Equipment).** Testing shall be designed to determine if the Equipment is functioning in accordance with both its published specifications and the Schedules to this

Contract, and to determine if modified building systems, subsystems or components are functioning properly within the new integrated environment. The ESCO shall provide notice to the Customer of the scheduled test(s) and the Customer and/or its designees shall have the right to be present at any or all such tests conducted by ESCO and/or manufacturers of the Equipment. The ESCO shall be responsible for correcting and/or adjusting all deficiencies in systems and equipment operations that may be observed during system commissioning procedures as specified in **Schedule L (Systems Start-Up and Commissioning)**. The ESCO shall be responsible for correcting and/or adjusting all deficiencies in equipment operation that may be observed during system testing procedures. Prior to Customer acceptance ESCO shall also provide Customer with reasonably satisfactory documentary evidence that the Equipment installed is the Equipment specified in **Schedule J (Equipment to be Installed by ESCO)**.

ARTICLE 9. EQUIPMENT WARRANTIES

ESCO warrants that all equipment sold and installed as part of this Contract is new, will be materially free from defects in materials or workmanship, will be installed properly in a good and workmanlike manner, and will function properly for a period of one (1) year from the date of the Substantial Completion for the particular energy conservation measure if operated and maintained in accordance with the procedures established per building. Substantial Completion shall be defined as the stage in the progress of the Work where the Work is sufficiently complete in accordance with the Contract Documents so that the Customer can utilize and take beneficial use of the Work for its intended use or purpose. Substantial Completion does not occur until the Equipment or system has been commissioned, accepted, and the **Exhibit III (ii) (Certificate of Acceptance - Installed Equipment)** form fully executed.

After the warranty period, ESCO shall have no responsibility for performing maintenance, repairs, or making manufacturer warranty claims relating to the Equipment, except as provided in **Schedule P (ESCO's Maintenance Responsibilities)**.

ESCO further agrees to assign to Customer all available manufacturer's warranties relating to the Equipment and to deliver such written warranties and which shall be attached and set forth as **Exhibit IV (Equipment Warranties)**; pursue rights and remedies against the manufacturers under the warranties in the event of equipment malfunction or improper or defective function, and defects in parts, workmanship and performance. ESCO shall, during the warranty period, notify the Customer whenever defects in equipment parts or performance occur which give rise to such rights and remedies and those rights and remedies are exercised by ESCO. During this period, the cost of any risk of damage or damage to the Equipment and its performance, including damage to property and equipment of the Customer or the Premises, due to ESCO's failure to exercise its warranty rights shall be borne solely by ESCO.

All warranties, to the extent transferable, shall be transferable and extend to the Customer. The warranties shall specify that only new, not reconditioned, parts may be used and installed when repair is necessitated by malfunction. All extended warranties shall be addressed as the property of the owner and appropriately documented and titled.

Notwithstanding the above, nothing in this Section shall be construed to alleviate/relieve the ESCO from complying with its obligations to perform under all terms and conditions of this Contract and as set forth in all attached Schedules.

ARTICLE 10. STANDARDS OF COMFORT

ESCO will maintain and operate the Equipment in a manner that will provide the standards of heating, cooling, ventilation, hot water supply, and lighting quality and levels as described in **Schedule N (Standards of Comfort)**. During the term of this Contract, ESCO and Customer will maintain, according to **Schedule P (ESCO's Maintenance Responsibilities)** and **Schedule Q (Customer's Maintenance Responsibilities)**, and operate the Equipment in a manner that will provide the standards of comfort and levels of operation as described in **Schedule N (Standards of Comfort)**.

ARTICLE 11. ENVIRONMENTAL REQUIREMENTS

Section 11.1. Excluded Material and Activities.

Customer recognizes that in connection with the installation and/or service or maintenance of equipment at Customer's Premises, ESCO may encounter, but is not responsible for, any work relating to (i) asbestos, materials containing asbestos, or the existence, use, detection, removal, containment or treatment thereof, (ii) fungus (any type of form of fungi, including mold or mildew, and myotoxins, spores, scents or by-products produced or released by fungi), (iii) polychlorinated biphenyl (PCB) ballasts and mercury lamps, (iv) incomplete or damaged work or systems or code violations that may be discovered during or prior to the work of this Contract, or (v) pollutants, hazardous wastes, hazardous materials, contaminants other than those described in this Section below (collectively "Hazardous Materials"), or the storage, handling, use, transportation, treatment, or the disposal, discharge, leakage, detection, removal, or containment thereof. The materials and activities listed in the foregoing sentence are referred to as "Excluded Materials and Activities." Customer agrees that if performance of work involves any Excluded Materials and Activities, Customer will perform or arrange for the performance of such work and shall bear the sole risk and responsibility therefore. In the event ESCO discovers Hazardous or Excluded Materials, ESCO shall immediately cease work, remove all ESCO personnel or subcontractors from the site, and notify the Customer. The Customer shall be responsible to handle such Materials at its expense. ESCO shall undertake no further work on the Premises except as authorized by the Customer in writing. Notwithstanding anything in this Contract to the contrary, any such event of discovery or remediation by the Customer shall not constitute a default by the Customer. In the event of such stoppage of work by ESCO, the Time for Completion of Work will be automatically extended by the amount of time of the work stoppage and the ESCO and Customer will discuss and determine any additional reasonable costs incurred by ESCO as a result and upon said determination and authorization by Customer, the parties will agree to and execute a written Change Order.

ARTICLE 12. TRAINING BY ESCO

The ESCO shall conduct the training program described in **Schedule O (ESCO's Training Responsibilities)** hereto. The training specified in **Schedule O (ESCO's Training Responsibilities)** must be completed prior to the signature of **Exhibit III (iii) (Certificate of Project Completion)**. The ESCO shall provide ongoing training whenever needed with respect to updated or altered equipment, including upgraded software. Costs of any additional training will be negotiated at the time of the training request.

ARTICLE 13. EQUIPMENT SERVICE

Section 13.1. Actions by ESCO.

ESCO shall provide all service, repairs, and adjustments to the Equipment installed under terms of this Contract pursuant to **Schedule P (ESCO's Maintenance Responsibilities)**. Customer shall incur no cost for equipment service, repairs, and adjustments, except as set forth in **Schedule G (Compensation to ESCO for Annual Services)**, provided, however, that when the need for maintenance or repairs principally arises due to the negligence or willful misconduct of the Customer or any employee or other agent of Customer, and ESCO can so demonstrate such causal connection, ESCO may charge Customer for the actual cost of the maintenance or repair insofar as such cost is not covered by any warranty or insurance proceeds.

Section 13.2. Malfunctions and Emergencies.

Customer shall use its best efforts to notify the ESCO or its designated subcontractors within twenty-four (24) hours after the Customer's actual knowledge and occurrence of: (i) any malfunction in the operation of the Equipment or any preexisting energy related equipment that might materially impact upon the guaranteed energy savings, (ii) any interruption or alteration to the energy supply to the Premises, or (iii) any alteration or modification in any energy-related equipment or its operation.

Where Customer exercises due diligence in attempting to assess the existence of a malfunction, interruption, or alteration it shall be deemed not at fault in failing to correctly identify such conditions as having a material impact upon the guaranteed energy savings. Customer shall notify ESCO within twenty-four (24) hours upon its having actual knowledge of any emergency condition affecting the Equipment. ESCO shall respond or cause its designee(s) shall respond within forty-eight (48) hours and shall promptly proceed with corrective measures. Any telephonic notice of such conditions by Customer shall be followed within three business days by written notice to ESCO from Customer. If Customer unreasonably delays in so notifying ESCO of a malfunction or emergency, and the malfunction or emergency is not otherwise corrected or remedied, such conditions will be treated as a Material Change, and the applicable provisions of **Section 16 (Material Changes)** shall be applied.

Section 13.3. Actions by Customer.

Customer shall not move, remove, modify, alter, or change in any way the Equipment or any part thereof without the prior written approval of ESCO except as set forth in **Schedule Q (Customer's Maintenance Responsibilities)**. Notwithstanding the foregoing, Customer may take reasonable steps to protect the Equipment if, due to an emergency, it is not possible or reasonable to notify ESCO before taking any such actions. In the event of such an emergency, Customer shall take reasonable steps to protect the Equipment from damage or injury and shall follow instructions for emergency action provided in advance by ESCO. Customer agrees to maintain the Premises in good repair and to protect and preserve all portions thereof, which may in any way affect the operation or maintenance of the Equipment.

ARTICLE 14. MODIFICATION, UPGRADE OR ALTERATION OF THE EQUIPMENT

Section 14.1. Modification of Equipment.

During the Term of this Contract, Customer will not, without the prior written consent of ESCO, affix or install any accessory equipment or device on any of the Equipment if such addition will change or impair the originally intended functions, value, or use of the Equipment without ESCO's prior written approval, which shall not be unreasonably withheld.

Section 14.2. Upgrade or Alteration of Equipment.

ESCO shall at all times have the right, subject to Customer's prior written approval, which approval shall not be unreasonably withheld, to change the Equipment, revise any procedures for the operation of the Equipment or implement other energy saving actions in the Premises, provided that:

(i) the ESCO complies with the standards of comfort and services set forth in Schedule N (Standards of Comfort) herein;

(ii) such modifications or additions to, or replacement of the Equipment, and any operational changes, or new procedures are necessary to enable the ESCO to achieve the guaranteed energy and cost savings at the Premises and;

(iii) any cost incurred relative to such modifications, additions or replacement of the Equipment, or operational changes or new procedures shall be the responsibility of the ESCO.

All modifications, additions or replacements of the Equipment or revisions to operating or other procedures shall be described in a supplemental Schedule(s) to be provided to the Customer for approval, which shall not be unreasonably withheld, provided that any replacement of the Equipment shall, unless otherwise agreed, be new and have equal or better potential to reduce energy consumption at the Premises than the Equipment being replaced. The ESCO shall have the right to update any and all software to be used in connection with the Equipment in accordance with the provisions of **Section 17.1 (Ownership of Certain Proprietary Rights)** and **Schedule P (ESCO's Maintenance Responsibilities)**. All replacements of and alterations or additions to the Equipment shall become part the Equipment described in **Schedule J (Equipment to be Installed by ESCO)** and shall be covered by the provisions and terms of **Article 8 (Construction Schedule and Equipment Installation; Approval)**.

ARTICLE 15. MATERIAL CHANGES

Section 15.1. <u>Material Change Defined.</u>

A Material Change shall include any change in or to the Premises, whether structural, operational or otherwise in nature which reasonably could be expected, in the judgment of the Customer, to increase or decrease annual energy consumption in accordance with the provisions and procedures set forth in **Schedule B (Baseline Energy Consumption)** and **Schedule C (Savings Measurement and Verification Plan)** by at least 1% after adjustments for climatic variations. Actions by the Customer that may result in a Material Change include but are not limited to the following:

(i) manner of use of the Premises by the Customer; or

(ii) hours of operation for the Premises or for any equipment or energy using systems operating at the Premises; or

(iii) Permanent changes in the comfort and service parameters set forth in **Schedule N (Standards of Comfort)**; or

(iv) occupancy of the Premises; or

(v) structure of the Premises; or

(vi) types and quantities of equipment used at the Premises or

(vii) modification, renovation or construction at the Premises; or

(viii) the Customer's failure to provide maintenance of and repairs to the Equipment in accordance with **Schedule Q (Customer's Maintenance Responsibilities)**; or

(ix) any other conditions other than climate affecting energy use at the Premises including but not limited to the replacement, addition or removal of energy and water consuming devices whether plug in or fixed assets,

(x) casualty or condemnation of the Premises or equipment, or

(xi) changes in utility provider or utility rate classification, or

(xii) any other conditions other than climate affecting energy or water use at the Premises.

(xiii) Modifications, alterations or overrides of the energy management system schedules or hours of operation, set back/start up or holiday schedules.

Section 15.2. Reported Material Changes; Notice by Customer.

The Customer shall use its best efforts to deliver to the ESCO a written notice describing all actual or proposed Material Changes in the Premises or in the operations of the Premises at least thirty (30) days before any actual or proposed Material Change is implemented or as soon as is practicable after an emergency or other unplanned event. Notice to the ESCO of Material Changes that result because of a bona fide emergency or other situation that precludes advance notification shall be deemed sufficient if given by the Customer within forty-eight (48) hours after having actual knowledge that the event constituting the Material Change occurred or was discovered by the Customer to have occurred.

Section 15.3. Other Adjustments.

As agreed in **Section 15.1 (Material Change Defined)** Customer will alert ESCO of materials changes as known. Both parties have a vested interest in meeting the guaranteed savings of the Contract. As such, the ESCO will work with Customer to investigate, identify, and correct any changes that prevent the guaranteed savings from being realized. As a result of such investigation, ESCO and Customer shall determine what, if any, adjustments to the baseline will be made in accordance with the provisions set forth in **Schedule C (Savings Measurement and Verification Plan)** and **Schedule B (Baseline Energy Consumption)**. Any disputes between the Customer and the ESCO concerning any such adjustment shall be resolved in accordance with the provisions of **Schedule U (Dispute Resolution)** hereto.

ARTICLE 16. PERFORMANCE BY ESCO

Section 16.1. Corrective Action; Accuracy of the Services.

ESCO shall perform all tasks/phases under the Contract, including construction, and install the Equipment in such a manner so as not to harm the structural integrity of the buildings or their operating systems and so as to conform to the standards set forth in **Schedule N (Standards of Comfort)** and the construction schedule specified in **Schedule K (Construction and Installation Schedule)**. ESCO shall repair and restore to its original condition any area of damage caused by ESCO's performance under this Contract. The Customer reserves the right to review the work performed by ESCO and to direct ESCO to take certain corrective action if, in the opinion of the Customer, the structural integrity of the Premises or its operating system is or will be harmed. All costs associated with such corrective action to damage caused by ESCO's performance of the work shall be borne by ESCO.

ARTICLE 17. OWNERSHIP OF CERTAIN PROPRIETARY RIGHTS; EXISTING EQUIPMENT

Section 17.1. Ownership of Certain Proprietary Property Rights.

Customer shall not, by virtue of this Contract, acquire any interest in any formulas, patterns, devices, secret inventions or processes, copyrights, patents, other intellectual or proprietary rights, or similar items of property which are or may be used in connection with the Equipment. The ESCO shall grant to the Customer a perpetual, irrevocable royalty-free license for any and all software or other intellectual property rights necessary for the Customer to continue to operate, maintain, and repair the Equipment in a manner that will yield guaranteed utility consumption reductions for the specified contract term. ESCO shall not be liable for providing new versions of software or other enhancements.

Section 17.2. <u>Ownership of Existing Equipment.</u>

Ownership of the Equipment and materials presently existing at the Premises at the time of execution of this Contract shall remain the property of the Customer even if it is replaced or its operation made unnecessary by work performed by ESCO pursuant to this Contract. If applicable, ESCO shall advise the Customer in writing of all equipment and materials to be replaced at the Premises and the Customer shall within thirty (30) days designate in writing to the ESCO which equipment and materials that should not be disposed of off-site by the ESCO. It is understood and agreed to by both Parties that the Customer shall be responsible for and designate the location and storage for any equipment and materials that should not be disposed of off-site. The ESCO shall be responsible for the disposal of all equipment and materials designated by the Customer as disposable off-site in accordance with all applicable laws and regulations regarding such disposal.

ARTICLE 18. PROPERTY/CASUALTY/INSURANCE; INDEMNIFICATION

Section 18.1. <u>Insurances.</u>

(i) ESCO shall purchase and maintain such levels of insurance, acceptable to Customer, at all times as will protect it from claims that may arise out of or result from ESCO's operations under this Agreement, including but not limited to Professional Liability Errors and Omissions Insurance, Workers Compensation Insurance, Comprehensive Automobile Insurance, Automobile Liability Insurance, and Commercial General Liability Insurance. ESCO shall provide Customer with evidence of said insurance prior to commencing the Work, and shall not cancel or otherwise terminate coverage for the duration of this Agreement. ESCO shall cause all of its subcontractors to purchase and maintain like insurance acceptable to Customer. Customer shall be named as an additional insured on all such insurance policies.

(ii) The Commercial General Liability Insurance shall include premises-operations (including explosion, collapse and underground coverage), elevators, independent contractors, completed operations, and blanket contractual liability on all written contracts, all including broad form property damage coverage.

(iii) ESCO’s Commercial General and Automobile Liability Insurance, as required by Subparagraphs 18.1.(i) and 18.1.(ii), shall be written for not less than limits of liability as follows:

(a) Commercial General Liability
Combined Single Limit
$1,000,000 Each Occurrence

$2,000,000 Product & Completed Operations
Aggregate

$2,000,000 General Aggregate
Other Than Products & Completed Operations

(b) Commercial Automobile Liability Combined Single Limit
$1,000,000 Each Occurrence

(iv) ESCO shall maintain at all times during the performance of the Work and Services hereunder, Workman’s Compensation Insurance in accordance with the laws of the State in which the Work is performed.

Section 18.2. Damages to Equipment or Property.

ESCO shall be responsible for (i) any damage to the Equipment or other property on the Premises and (ii) any personal injury where such damage or injury occurs as a result of ESCO's performance under this Contract.

Section 18.3. Indemnification.

ESCO shall save and hold harmless, indemnify, and defend Customer and its officers, agents and employees or any of them from any and all claims, demands, actions, or liability of any nature based upon or arising out of any services performed by ESCO, its agents or employees under this Contract.

Section 18.4. Liabilities.

Neither party shall be liable for any special, incidental, indirect, punitive, or consequential damages, arising out of or in connection with this Contract. Further, the liability of either party under this Contract shall not exceed the Contract Sum in the aggregate.

ARTICLE 19. CONDITIONS BEYOND CONTROL OF THE PARTIES

If a party ("performing party") shall be unable to reasonably perform any of its obligations under this Contract due to acts of Nature, insurrections or riots, or similar events, this Contract shall at the other party's option (i) remain in effect but said performing party's obligations shall be suspended until the said events shall have ended; or, (ii) be terminated upon ten (10) days notice to the performing party, in which event neither party shall have any further liability to the other.

ARTICLE 20. EVENTS OF DEFAULT

Section 20.1. Events of Default by Customer.

Each of the following events or conditions shall constitute an "Event of Default" by Customer:

(i) any failure by Customer to pay ESCO any earned and undisputed sum due for a service and maintenance period of more than thirty (30) days after written notification by ESCO that Customer is delinquent in making payment and provided that ESCO is not in default in its performance under the terms of this Contract; or

(ii) any other material failure by Customer to perform or comply with the terms and conditions of this Contract, including breach of any covenant contained herein, provided that such failure continues for thirty (30) days after notice to Customer demanding that such failures to perform be cured or if such cure cannot be effected in thirty (30) days, Customer shall be deemed to have cured default upon the commencement of a cure within thirty (30) days and diligent subsequent completion thereof;

(iii) any representation or warranty furnished by Customer in this Contract that was false or misleading in any material respect when made.

Section 20.2. <u>Events of Default by ESCO.</u>

Each of the following events or conditions shall constitute an "Event of Default" by ESCO:

(i) the standards of comfort and service set forth in **Schedule N (Standards of Comfort)** are not provided due to failure of ESCO to properly design, install, maintain, repair or adjust the Equipment except that such failure, if corrected or cured within thirty (30) days after written notice by Customer to ESCO demanding that such failure be cured, shall be deemed cured for purposed of this Contract.

(ii) any representation or warranty furnished by ESCO in this Contract is false or misleading in any material respect when made;

(iii) failure to furnish and install the Equipment and make it ready for use within the time specified by this Contract as set forth in **Schedule J (Equipment to be Installed by ESCO)**

(iv) any failure by ESCO to perform or comply with the terms and conditions of this Contract, including breach of any covenant contained herein except that such failure, if corrected or cured within thirty (30) days after written notice by the Customer to ESCO demanding that such failure to perform be cured, shall be deemed cured for purposes of this Contract;

(v) any lien or encumbrance upon the Equipment by any subcontractor, laborer or materialman of ESCO;

(vi) the filing of a bankruptcy petition whether by ESCO or its creditors against ESCO which proceeding shall not have been dismissed within thirty (30) days of its filing, or an involuntary assignment for the benefit of all creditors or the liquidation of ESCO.

(vii) failure by the ESCO to pay any amount due the Customer or perform any obligation under the terms of this Contract or the Energy and Cost Savings Guarantee as set forth in **Schedule A (Energy Savings Guarantee)**.

ARTICLE 21. REMEDIES UPON DEFAULT

Section 21.1. <u>Remedies Upon Default.</u>

In the Event of Default, parties shall have the following remedies in law or equity: exercise and any all remedies at law or equity, to the extend allowed by law, or institute other proceedings, including, without limitation, bringing an action or actions from time to time for specific performance, and/or for the recovery of amounts due and unpaid and/or for damages, which shall include all costs and expenses reasonably incurred, including attorney's fees. Refer to **Schedule U (Dispute Resolution)**.

ARTICLE 22. ASSIGNMENT

The ESCO acknowledges that the Customer is induced to enter into this Contract by, among other things, the professional qualifications of the ESCO. The ESCO agrees that neither this Contract nor any right or obligations hereunder may be assigned in whole or in part to another firm, without the prior written approval of the Customer, not to be unreasonably withheld, except to a successor through merger, acquisition, or corporate reorganization.

Section 22.1. Assignment by ESCO.

The ESCO may, with prior written notice and written approval of the Customer, which consent shall not be unreasonably withheld, delegate its duties and performance under this Contract, and/or utilize ESCOs, provided that any assignee(s), delegee(s), or ESCO(s) shall fully comply with the terms of this Contract. The Customer will have the right to issue an addendum or require the execution of a new contract with said assignee(s) or delegee(s). Notwithstanding the provisions of this paragraph, the ESCO shall remain jointly and severally liable with its assignees(s), or transferee(s) to the Customer for all of its obligations under this Contract.

Section 22.2. Assignment by Customer.

Customer may transfer or assign this Contract and its rights and obligations herein to a successor or purchaser of the Buildings or an interest therein. The Customer shall remain jointly and severally liable with its assignees or transferees to the ESCO for all of its obligations under this Contract.

ARTICLE 23. REPRESENTATIONS AND WARRANTIES

Each party warrants and represents to the other that:

(i) it has all requisite power, authority, licenses, permits, and franchises, corporate or otherwise, to execute and deliver this Contract and perform its obligations hereunder;

(ii) its execution, delivery, and performance of this Contract have been duly authorized by, or are in accordance with, its organic instruments, and this Contract has been duly executed and delivered for it by the signatories so authorized, and it constitutes its legal, valid, and binding obligation;

(iii) its execution, delivery, and performance of this Contract will not breach or violate, or constitute a default under any Contract, lease or instrument to which it is a party or by which it or its properties may be bound or affected; or

(iv) it has not received any notice, nor to the best of its knowledge is there pending or threatened any notice, of any violation of any applicable laws, ordinances, regulations, rules, decrees, awards, permits or orders which would materially and adversely affect its ability to perform hereunder.

ARTICLE 24. ADDITIONAL REPRESENTATIONS OF THE PARTIES

Customer hereby warrants, represents, and promises that:

(i) it has provided or shall provide timely to ESCO, all records relating to energy usage and energy-related maintenance of Premises requested by ESCO and the information set forth therein is, and all information in other records to be subsequently provided pursuant to this Contract will be true and accurate in all material respects; and

ESCO hereby warrants, represents, and promises that:

(i) before commencing performance of this Contract:

   (a) it shall have become licensed or otherwise permitted to do business in the State and local jurisdictions as required.

   (b) it shall have provided proof and documentation of required insurance and bonds pursuant to this Contract;

(ii) it shall make available, upon reasonable request, all documents relating to its performance under this Contract, including all contracts and subcontracts entered into;

(iii) it shall use qualified subcontractors who are qualified, licensed and bonded in this state to perform the work so subcontracted pursuant to the terms hereof;

ARTICLE 25. MISCELLANEOUS DOCUMENTATION PROVISIONS

Section 25.1. Waiver of Liens, Construction Performance and Payment Bonds, Labor and Material Payment Bonds.

Such executed bonds are incorporated herein by reference as **Exhibit I (Performance Bond)** and **Exhibit II (Labor and Material Payment Bond, if applicable)**.

Section 25.2. Further Documents.

The parties shall execute and deliver all documents and perform all further acts that may be reasonably necessary to effectuate the provisions of this Contract.

Section 25.3. Customer's Responsibilities.

The parties acknowledge and agree that said Energy and Cost Savings would not likely be obtained unless certain procedures and methods of operation designed for energy and water conservation shall be implemented, and followed by Customer on a regular and continuous basis.

Customer agrees that it shall adhere to, follow and implement the energy conservation procedures and methods of operation to be set forth on **Schedule Q (Customer's Maintenance Responsibilities)**, to be attached hereto and made a part hereof after Customer's approval, such approval not to be unreasonably withheld, conditioned or delayed.

Customer agrees that ESCO shall, to the best of its abilities, have the right once a month, with prior notice, to inspect Premises to determine if Customer is complying, and shall have complied with its obligations as set forth in this section. For the purpose of determining Customer's said compliance, the checklist to be set forth at **Schedule R (Facility Maintenance Checklist)** as completed and recorded by ESCO during its monthly inspections, shall be used to measure and record Customer's said compliance. Customer shall make the Premises available to ESCO for and during each monthly inspection, and shall have the right to witness each inspection and ESCO's recordation on the checklist. Customer may complete its own checklist at the same time. ESCO agrees to not interfere with the Customer operations during any monthly inspection.

Section 25.4. Waiver of Liens.

ESCO will obtain and furnish to Customer a Waiver of Liens and Claims from each vendor, material manufacturer and laborer in the supply, installation and servicing of each piece of equipment.

ARTICLE 26. CONFLICTS OF INTEREST

Section 26.1. Conflicts of Interest.

Conflicts of interest relating to this Contract are strictly prohibited. Except as otherwise expressly provided herein, neither party hereto nor any director, employee or agent of any party hereto shall give to or receive from any director, employee or agent of any other party hereto any gift, entertainment or other favor of significant value, or any commission, fee or rebate in connection with this Contract. Likewise, neither party hereto nor any director, employee or agent of either party hereto, shall without prior notification thereof to the other party enter into any business relationship with any director, employee or agent of the other party or of any affiliate of the other party, unless such person is acting for and on behalf of the other party or any such affiliate. A party shall promptly notify the other party of any violation of this section and any consideration received as a result of such violation shall be paid over or credited to the party against whom it was charged. Any representative of any party, authorized by that party, may audit the records of the other party related to this Contract, upon reasonable notice and during regular business hours including the expense records of the party's employees involved in this Contract, upon reasonable notice and during regular business hours, for the sole purpose of determining whether there has been compliance with this section.

ARTICLE 27. COMPLETE CONTRACT

This Contract, when executed, together with all Schedules attached hereto or to be attached hereto, as provided for by this Contract shall constitute the entire Contract between both parties and this Contract may not be amended, modified, or terminated except by a written Contract signed by the parties.

ARTICLE 28. APPLICABLE LAW, JURISDICTION, AND VENUE

This Contract and the construction and enforceability thereof shall be interpreted under the laws of the State of Missouri.

Customer and ESCO agree that any and all disputes, including any and all disputes arising from, out of, or related to this Contract or the services set forth therein, shall be resolved in the Circuit Court of Clay County, Missouri, and each party consents to the exclusive in personam jurisdiction and exclusive venue of that Court.

ARTICLE 29. INTERPRETATION OF CONTRACT

The Customer shall have the authority to determine questions of fact that arise in relation to the interpretation of this Contract and the ESCO'S performance hereunder. However, such determinations are subject to the Alternative Dispute Resolution procedures as described in **Schedule U (Dispute Resolution)**. Unless the Parties agree otherwise, or the Work cannot be continued without a resolution of the question of fact, such determinations and Alternative Dispute Resolution procedures shall not be cause for delay of the Work. The ESCO shall proceed diligently with the performance of this Contract and in accordance with the Customer's decision whether or not the ESCO or anyone else has an active claim pending. Continuation of the Work shall not be construed as a waiver of any rights accruing to the ESCO.

ARTICLE 30. NOTICE

Any notice required or permitted hereunder shall be deemed sufficient if given in writing and delivered personally or sent by registered or certified mail, return receipt requested, postage prepaid, or delivered to a nationally recognized express mail service, charges prepaid, receipt obtained, to the address shown below or to such other persons or addresses as are specified by similar notice.

TO ESCO: Navitas, LLC
Attention: Dan Morrison, Director of Operations
25501 West Valley Parkway, Suite 200
Olathe, KS 66061
Phone: 913-344-0044
E-mail: dmorrison@navitas.us.com

TO CUSTOMER: City of Gladstone
Attention: Justin Merkey, Director of Parks and Recreation
7010 N Holmes Street
Gladstone, MO 64118
Phone: 816-423-4090
E-mail: justinm@gladstone.mo.us

IN WITNESS WHEREOF, and intending to be legally bound, the parties hereto subscribe their names to this Contract by their duly authorized representatives on the date first above written.

NAVITAS, LLC
(ESCO)

Name	Title	Date

CUSTOMER NAME
(Customer)

Name	Title	Date

SCHEDULE A
ENERGY SAVINGS GUARANTEE

A. Energy Savings Guarantee

All energy conservation measures savings will be shown through calculation and/or direct measurement as defined by the IPMVP/FEMP method. IPMVP is the International Performance Measurement and Verification Protocol developed by the United States Department of Energy, and is widely used in the verification of federal government projects through the Federal Energy Management Program (FEMP). While IPMVP does not give specific methods for all savings methodologies and baselines, it does give a basic overview and framework to work within.

ESCO and Customer have reviewed the calculations, assumptions and information upon which financial justification was determined to be correct and fully accepted by execution of this Contract. The term of the energy guarantee is a 15-year term, as shown in the pro forma cash flow given in **Schedule E (Final Project Cost & Project Cash Flow Analysis)** of this Contract.

B. Energy Conservation Measure Table and Guarantees

The rates used in this Contract are shown in **Schedule B (Baseline Energy Consumption)** of this Contract. The energy conservation measures and guaranteed savings are shown in Table A.1 on the following page. The measurement and verification methodology for each energy conservation measure are detailed in **Schedule C (Savings Measurement and Verification Plan)** of this Contract.

ESCO has translated the guaranteed savings into a dollar value for the purposes of this Contract.

Table A.1 Energy Conservation and Facility Conservation Measures Annual Energy Savings

	Projected Annual Savings										Guaranteed Annual Savings								
ECM Description	Electrical kWh	Electrical kW	Natural Gas Therm	Natural Gas CCR-Only Therm	Electrical kWh Cost Savings	Electrical kW Cost Savings	Natural Gas Therm Cost Savings	Natural Gas CCR-Only Therm Cost Savings	Total Cost Savings ($)	% Guar	Electrical kWh	Electrical kW	Natural Gas Therm	Natural Gas CCR-Only Therm	Electrical kWh Cost Savings	Electrical kW Cost Savings	Natural Gas Therm Cost Savings	Natural Gas CCR-Only Therm Cost Savings	Total Cost Savings ($)
AJM-Exterior Lighting to LED	182	0.0	0	0	$13	$0	$0	$0	$13	90%	164	0.0	0	0	$11	$0	$0	$0	$11
AJM-Interior Lighting to LED	2,849	12.2	0	0	$199	$38	$0	$0	$237	90%	2,564	11.0	0	0	$180	$34	$0	$0	$214
AJM-New Building Automation System	26,848	0.0	0	0	$1,897	$0	$0	$0	$1,897	90%	24,163	0.0	0	0	$1,707	$0	$0	$0	$1,707
Atkins-Johnson Museum	**29,879**	**12.2**	**0**	**0**	**$2,109**	**$38**	**$0**	**$0**	**$2,147**	**90%**	**26,891**	**11.0**	**0**	**0**	**$1,898**	**$34**	**$0**	**$0**	**$1,932**
ASR-Exterior Lighting to LED	315	0.0	0	0	$22	$0	$0	$0	$22	90%	284	0.0	0	0	$20	$0	$0	$0	$20
ASR-Interior Lighting to LED	3,137	13.3	-1	0	$220	$41	-$1	$0	$260	90%	2,823	11.9	-1	0	$198	$37	-$1	$0	$234
ASR-New Building Automation System	6,391	0.0	1,804	0	$517	$0	$1,135	$0	$1,652	90%	5,752	0.0	1,624	0	$465	$0	$1,022	$0	$1,487
ASR-Replace HVAC Equipment	908	7.1	279	0	$73	$22	$176	$0	$271	90%	818	6.4	251	0	$66	$20	$158	$0	$244
ASR-Weatherization	862	0.0	75	0	$60	$0	$47	$0	$107	90%	776	0.0	67	0	$54	$0	$42	$0	$96
Animal Shelter	**11,613**	**20.4**	**2,157**	**0**	**$892**	**$63**	**$1,357**	**$0**	**$2,312**	**90%**	**10,453**	**18.3**	**1,941**	**0**	**$803**	**$57**	**$1,221**	**$0**	**$2,081**
CCR-Demand Limiting Sequence in BAS Controls	0	200.1	0	0	$0	$1,673	$0	$0	$1,673	90%	0	180.1	0	0	$0	$1,505	$0	$0	$1,505
CCR-Destratification Fans in Main Entry Hallway	-368	0.0	0	421	-$26	$0	$0	$284	$258	90%	-409	0.0	0	379	-$28	$0	$0	$256	$228
CCR-Exterior Lighting to LED	30,883	0.0	0	0	$2,032	$0	$0	$0	$2,032	90%	27,795	0.0	0	0	$1,829	$0	$0	$0	$1,829
CCR-Interior Lighting to LED	459,355	693.6	0	-46	$30,230	$5,616	$0	-$31	$35,815	90%	413,420	624.2	0	-51	$27,207	$5,054	$0	-$34	$32,227
CCR-Replace Electric Boiler with Gas-Fired Unit and HX Addition	533,605	704.7	0	-32,031	$34,572	$4,969	$0	-$21,618	$17,923	90%	480,244	634.2	0	-35,590	$31,115	$4,472	$0	-$24,020	$11,567
CCR-Replace Electric DHW Boilers w/ Gas Unit	314,396	1,440.0	0	-11,292	$20,690	$11,659	$0	-$7,621	$24,728	90%	282,956	1,296.0	0	-12,547	$18,621	$10,493	$0	-$8,468	$20,646
CCR-Replace Emergency Lighting Inverter	0	0.0	0	0	$0	$0	$0	$0	$0	90%	0	0.0	0	0	$0	$0	$0	$0	$0
CCR-Replace Rooftop Units	819,006	2,133.7	0	-28,968	$53,663	$15,960	$0	-$19,550	$50,073	90%	737,106	1,920.3	0	-32,187	$48,297	$14,364	$0	-$21,722	$40,939
CCR-Solar PV Power Generation	135,100	175.0	0	0	$8,891	$1,417	$0	$0	$10,308	90%	121,590	157.5	0	0	$8,002	$1,275	$0	$0	$9,277
CCR-Upgrade or Replace Building Automation System	66,437	0.0	0	1,186	$4,629	$0	$0	$800	$5,429	90%	59,793	0.0	0	1,067	$4,166	$0	$0	$720	$4,886
CCR-Weatherization	5,818	0.0	0	504	$405	$0	$0	$340	$745	90%	5,236	0.0	0	453	$365	$0	$0	$306	$671
Community Center	**2,364,232**	**5,347.1**	**0**	**-70,226**	**$155,086**	**$41,294**	**$0**	**-$47,396**	**$148,984**	**90%**	**2,127,731**	**4,812.3**	**0**	**-78,476**	**$139,574**	**$37,163**	**$0**	**-$52,962**	**$123,775**
CHPS-Exterior Lighting to LED	8,046	0.0	0	0	$734	$0	$0	$0	$734	90%	7,241	0.0	0	0	$660	$0	$0	$0	$660
CHPS-Interior Lighting to LED	141,095	171.4	-17	0	$12,864	$1,035	-$11	$0	$13,888	90%	126,986	154.2	-19	0	$11,577	$931	-$12	$0	$12,496
CHPS-Replace HVAC Equipment	80,097	478.9	-7,084	0	$7,501	$2,722	-$4,458	$0	$5,765	90%	72,088	431.0	-7,871	0	$6,751	$2,451	-$4,953	$0	$4,249
CHPS-Roof Replacement	0	0.0	799	0	$0	$0	$503	$0	$503	90%	0	0.0	719	0	$0	$0	$453	$0	$453
CHPS-Upgrade or Replace Building Automation System	35,569	0.0	996	0	$2,997	$0	$627	$0	$3,624	90%	32,012	0.0	896	0	$2,698	$0	$564	$0	$3,262
CHPS-Weatherization	1,863	0.0	161	0	$157	$0	$101	$0	$258	90%	1,676	0.0	145	0	$141	$0	$91	$0	$232
City Hall / Public Safety	**266,670**	**650.3**	**-5,145**	**0**	**$24,253**	**$3,757**	**-$3,238**	**$0**	**$24,772**		**240,003**	**585.2**	**-6,130**	**0**	**$21,827**	**$3,382**	**-$3,857**	**$0**	**$21,352**
CPK-Exterior Lighting to LED	35,738	0.0	0	0	$2,502	$0	$0	$0	$2,502	90%	32,164	0.0	0	0	$2,252	$0	$0	$0	$2,252
CPK-Interior Lighting to LED	1,986	1.4	0	0	$139	$4	$0	$0	$143	90%	1,787	1.3	0	0	$125	$4	$0	$0	$129
Central Park Pool/Park	**37,724**	**1.4**	**0**	**0**	**$2,641**	**$4**	**$0**	**$0**	**$2,645**	**90%**	**33,951**	**1.3**	**0**	**0**	**$2,377**	**$4**	**$0**	**$0**	**$2,381**
CWE-Energy Manager / Data Analytics	499,486	1,049.6	0	0	$31,423	$6,337	$0	$0	$37,760	90%	449,538	944.6	0	0	$28,280	$5,704	$0	$0	$33,984
CWE-Retrofit Decorative Street Lights to LED	81,364	0.0	0	0	$6,672	$0	$0	$0	$6,672	90%	73,228	0.0	0	0	$6,005	$0	$0	$0	$6,005
City Wide	**580,850**	**1,049.6**	**0**	**0**	**$38,095**	**$6,337**	**$0**	**$0**	**$44,432**	**90%**	**522,766**	**944.6**	**0**	**0**	**$34,285**	**$5,704**	**$0**	**$0**	**$39,989**
FS1-Exterior Lighting to LED	1,691	0.0	0	0	$106	$0	$0	$0	$106	90%	1,522	0.0	0	0	$96	$0	$0	$0	$96
FS1-Interior Lighting to LED	33,258	52.0	0	0	$2,092	$314	$0	$0	$2,406	90%	29,932	46.8	0	0	$1,883	$283	$0	$0	$2,166
FS1-Interlock Heaters with Roll-Up Doors in Truck Bays	0	0.0	105	0	$0	$0	$66	$0	$66	90%	0	0.0	94	0	$0	$0	$59	$0	$59
FS1-New Building Automation System	3,369	0.0	255	0	$253	$0	$160	$0	$413	90%	3,032	0.0	230	0	$228	$0	$144	$0	$372
FS1-Replace HVAC Equipment	5,516	13.1	762	0	$414	$97	$480	$0	$991	90%	4,964	11.8	686	0	$373	$87	$432	$0	$892
FS1-Weatherization	1,912	0.0	714	0	$144	$0	$449	$0	$593	90%	1,721	0.0	643	0	$129	$0	$404	$0	$533
Fire Station #1	**45,746**	**65.1**	**1,836**	**0**	**$3,009**	**$411**	**$1,155**	**$0**	**$4,575**	**90%**	**41,171**	**58.6**	**1,653**	**0**	**$2,709**	**$370**	**$1,039**	**$0**	**$4,118**
FS2-Exterior Lighting to LED	1,432	0.0	0	0	$90	$0	$0	$0	$90	90%	1,289	0.0	0	0	$81	$0	$0	$0	$81
FS2-Interior Lighting to LED	37,307	56.1	-10	0	$2,347	$339	-$6	$0	$2,680	90%	33,576	50.5	-11	0	$2,112	$305	-$7	$0	$2,410
FS2-New Building Automation System	2,771	0.0	180	0	$208	$0	$113	$0	$321	90%	2,494	0.0	162	0	$187	$0	$102	$0	$289
Fire Station #2	**41,510**	**56.1**	**170**	**0**	**$2,645**	**$339**	**$107**	**$0**	**$3,091**	**90%**	**37,359**	**50.5**	**151**	**0**	**$2,380**	**$305**	**$95**	**$0**	**$2,780**
HHP-Exterior Lighting to LED	2,365	0.0	0	0	$166	$0	$0	$0	$166	90%	2,129	0.0	0	0	$149	$0	$0	$0	$149
HRP-Weatherization	4,132	0.0	0	0	$625	$0	$0	$0	$625	90%	3,719	0.0	0	0	$563	$0	$0	$0	$563
Happy Rock Park	**6,497**	**0.0**	**0**	**0**	**$791**	**$0**	**$0**	**$0**	**$791**	**90%**	**5,848**	**0.0**	**0**	**0**	**$712**	**$0**	**$0**	**$0**	**$712**
LSO-Exterior Lighting to LED	2,575	0.0	0	0	$162	$0	$0	$0	$162	90%	2,318	0.0	0	0	$146	$0	$0	$0	$146
Linden Square Office	**2,575**	**0.0**	**0**	**0**	**$162**	**$0**	**$0**	**$0**	**$162**	**90%**	**2,318**	**0.0**	**0**	**0**	**$146**	**$0**	**$0**	**$0**	**$146**
OGP-Exterior Lighting to LED	4,673	0.0	0	0	$327	$0	$0	$0	$327	90%	4,206	0.0	0	0	$294	$0	$0	$0	$294
OGP-Interior Lighting to LED	2,122	12.2	0	0	$149	$38	$0	$0	$187	90%	1,910	11.0	0	0	$134	$34	$0	$0	$168
Oak Grove Park	**6,795**	**12.2**	**0**	**0**	**$476**	**$38**	**$0**	**$0**	**$514**	**90%**	**6,116**	**11.0**	**0**	**0**	**$428**	**$34**	**$0**	**$0**	**$462**
PWK-Add Insulation Under Roof of Maintenance Building	0	0.0	152	0	$0	$0	$103	$0	$103	90%	0	0.0	137	0	$0	$0	$93	$0	$93
PWK-Engine Block Heater Control	5,250	0.0	0	0	$250	$0	$0	$0	$250	90%	4,725	0.0	0	0	$225	$0	$0	$0	$225
PWK-Exterior Lighting to LED	4,536	0.0	0	0	$258	$0	$0	$0	$258	90%	4,082	0.0	0	0	$232	$0	$0	$0	$232
PWK-Interior Lighting to LED	22,470	71.4	-6	0	$1,276	$473	-$4	$0	$1,745	90%	20,223	64.3	-7	0	$1,149	$426	-$5	$0	$1,570
PWK-New Building Automation System	5,117	0.0	362	0	$384	$0	$244	$0	$628	90%	4,605	0.0	326	0	$346	$0	$220	$0	$566
PWK-Replace HVAC Equipment	3,241	8.5	209	0	$243	$63	$141	$0	$447	90%	2,917	7.7	188	0	$219	$57	$127	$0	$403
PWK-Used Motor Oil-Fired Heater	0	0.0	1,000	0	$0	$0	$675	$0	$675	90%	0	0.0	900	0	$0	$0	$607	$0	$607
PWK-Weatherization	0	0.0	2,159	0	$0	$0	$1,457	$0	$1,457	90%	0	0.0	1,943	0	$0	$0	$1,311	$0	$1,311
Public Works	**40,614**	**79.9**	**3,876**	**0**	**$2,411**	**$536**	**$2,616**	**$0**	**$5,563**	**90%**	**36,552**	**72.0**	**3,487**	**0**	**$2,171**	**$483**	**$2,353**	**$0**	**$5,007**
WTT-Exterior Lighting to LED	9,627	0.0	0	0	$606	$0	$0	$0	$606	90%	8,664	0.0	0	0	$545	$0	$0	$0	$545
WTT-Interior Lighting to LED	14,350	53.0	-3	0	$903	$320	-$2	$0	$1,221	90%	12,915	47.7	-3	0	$812	$288	-$2	$0	$1,098
WTT-New Building Automation System	2,968	0.0	549	0	$223	$0	$345	$0	$568	90%	2,671	0.0	494	0	$201	$0	$311	$0	$512
WTT-Reconfigure Metering on Well Pumps and Change from LGS to	0	0.0	0	0	$0	$0	$0	$0	$0	90%	0	0.0	0	0	$0	$0	$0	$0	$0
WTT-Replace HVAC Equipment	2,211	9.6	498	0	$166	$71	$313	$0	$550	90%	1,990	8.7	448	0	$149	$64	$282	$0	$495
WTT-Resolve Billing Errors with KCPL on Well Pump Account	0	0.0	0	0	$0	$0	$0	$0	$0	90%	0	0.0	0	0	$0	$0	$0	$0	$0
WTT-Solar PV Power Generation	103,800	105.0	0	0	$6,530	$634	$0	$0	$7,164	90%	93,420	94.5	0	0	$5,877	$571	$0	$0	$6,448
WTT-Weatherization	2,053	0.0	575	0	$154	$0	$362	$0	$516	90%	1,848	0.0	518	0	$139	$0	$326	$0	$465
Water Treatment	**135,009**	**167.6**	**1,619**	**0**	**$8,582**	**$1,025**	**$1,018**	**$0**	**$10,625**	**90%**	**121,508**	**150.9**	**1,457**	**0**	**$7,723**	**$923**	**$917**	**$0**	**$9,563**
Totals (Energy Units):	**3,569,714**	**7,461.9**	**4,513**	**-70,226**	**$241,152**	**$53,842**	**$3,015**	**-$47,396**	**$250,613**		**3,391,193**	**7,088.7**	**3,556**	**-74,138**	**$229,096**	**$51,148**	**$2,405**	**-$50,035**	**$232,614**

C. ESCO and Customer Energy Savings Evaluation

After review of the measurement and verification protocol options, Customer and ESCO have agreed that measurements noted in Schedule C (Savings Measurement and Verification Plan) of this Contract meet Customer's needs and ESCO has priced the project accordingly. If, in the future, other measurement and verification activity is desired by Customer, the fee will be negotiated as an additional service.

D. Measurement and Verification Reporting of Energy Savings into Dollars

To calculate dollars, ESCO will utilize the energy savings measures as described in Schedule C (Savings Measurement and Verification Plan) and assumptions in Schedule M (Detailed Savings Calculations) to determine energy unit savings. The energy unit savings is multiplied by the appropriate rates from Schedule B (Baseline Energy Consumption) to compute an annual dollar savings amount.

E. Savings Reconciliation

A measurement and verification report shall be prepared and provided to Customer as shown in Table A.2.

Table A.2 Measurement & Verification Reporting Schedule

	Measurements Taken	Report Delivered	Savings Represented
Report 1	Prior to completing construction	60 days following construction final completion	Year 1 savings

In the event that measurements taken for any portion of an energy conservation measure are at a lower performance than the goal, ESCO will use the measurements and apply the appropriate rates from **Schedule B (Baseline Energy Consumption)** to compute an annual dollar savings amount. This will determine if the guaranteed energy savings have been met for that overall energy conservation measure. If the measurement based calculation indicates the guaranteed energy savings have been met for that measure, then no further computations are necessary and ESCO will forward the measurements and calculation results to Customer for their records. In the event that the measurement based calculation is less than the guaranteed savings for that measure, then ESCO will calculate an aggregate savings of all energy conservation measures using the calculations in **Schedule M (Detailed Savings Calculations)** and the collected measured data. If the measurement-based calculated aggregate savings meets or exceeds the guaranteed savings, then ESCO will forward all measurements and calculation results to Customer for their records. In the event the measurement-based calculated aggregate savings is a savings shortfall, then ESCO will provide services and/or funds, at the choice and election of the Customer, in the amount of the savings shortfall on an annual basis on the anniversary of the guarantee start date, as long as the shortfall continues. Payment or services will be provided within sixty (60) days of the anniversary of the guarantee start date. If the shortage is anticipated for all future years of the guarantee period, ESCO and Customer, after reaching a mutual agreement, may allow for the ESCO to present the value of the short fall at a 10% discount rate, make one payment, and finalize all contract obligations or re-measure each year until the savings are achieved.

SCHEDULE B
BASELINE ENERGY CONSUMPTION

Utility billings and district financials were evaluated to determine baseline energy consumption and energy rates. Utility rates and baselines are established from this historical information.

A. Utility Rates

Actual utility costs per unit of energy are determined by reviewing current energy rates. The baseline energy costs for electricity and natural gas are calculated as the average amount paid per unit of energy over the baseline period. Historically utility costs have increased an average of six percent (6%) per year for the Customer. The ESCO may escalate rates at an average of one and one half percent (1.5%) annually or use the actual rates, whichever is greater. The rates used for this Contract are detailed in Table B.1 below.

Table B.1 Average Utility Rate by Building

Facility	Electric (kWh)	Electric (kW)	Gas (Therms)
Animal Shelter	$0.1391	N/A	$0.712
Atkins-Johnson Museum	$0.1456	N/A	N/A
Central Park Pool/Park	$0.0945	$11.15	N/A
City Hall/ Public Safety	$0.0822	$6.11	N/A
City Wide	$0.3891	N/A	N/A
Community Center	$0.0747	$8.66	N/A
Fire Station #1	$0.0956	$7.92	$0.686
Fire Station #2	$0.0907	$7.25	$0.749
Hamilton Heights Park	$0.2097	N/A	N/A
Happy Rock Park	$0.1605	$2.20	N/A
Linden Square Office	$0.1226	N/A	$1.078
Oak Grove Park	$0.1695	$3.72	N/A
Public Works	$0.0833	$7.40	$0.712
Water Treatment	$0.1007	$4.81	$0.706

B. Baseline Energy and Cost Consumption

Tables B. 2 through B.18 on the following pages summarize the baseline energy and cost consumption for the sites.

Table B.2 Annual Utility Usage Summary – 72nd Street Tennis Park

City of Gladstone	72nd Street Tennis Courts
	BASELINE DATA

Data Start Year	Utility Providers:	Utility Units:
Average of Three Years	Electric Company KCPL	Electricity kWh
April	Heating Fuel Company Missouri Gas Energy	Heating Fuel Therm
	Water Company City of Gladstone-Water, KC Water Services-Sewer	Water kGal

AVERAGE YEARLY SUMMARY ADJUSTED FOR BILLING PERIOD

Square feet	0	kWh/sf	#DIV/0!	Therm/sf	#DIV/0!	Water gal/sf	#DIV/0!	Total Btu/sf	#DIV/0!
Utility Cost/sf	#DIV/0!	Avg Watts/sf	#DIV/0!	Gas $/Therm	$0.00	Water+Sewer $/kGal	$0.00	Total Utility Costs/Year	$1,528.49
Hours Operated	741	Electric $/sf	#DIV/0!	Gas $/sf	#DIV/0!	Water+Sewer $/sf	#DIV/0!	Total Utility Cost-Water	$1,528.49

Month	ELECTRICITY									
	kWh	kWh Cost	Estimated KW	Billed kW	Demand (kW) Costs	Electric Cost	Avg Cost/kWh	Avg Cost/Estimated kW	% Load Factor	Min Hours (from peak demand)
April	984	$139.48	13	0	$0.00	$139.48	$ 0.1418	$ -	10%	75
May	392	$66.07	13	0	$0.00	$66.07	$ 0.1687	$ -	4%	31
June	441	$95.80	13	0	$0.00	$95.80	$ 0.2173	$ -	5%	33
July	806	$153.23	14	0	$0.00	$153.23	$ 0.1902	$ -	8%	56
August	732	$131.72	11	0	$0.00	$131.72	$ 0.1800	$ -	9%	65
September	687	$130.38	14	0	$0.00	$130.38	$ 0.1897	$ -	7%	50
October	1,137	$173.16	14	0	$0.00	$173.16	$ 0.1524	$ -	11%	84
November	1,219	$176.82	13	0	$0.00	$176.82	$ 0.1451	$ -	13%	94
December	991	$151.94	10	0	$0.00	$151.94	$ 0.1534	$ -	13%	99
January	375	$66.71	12	0	$0.00	$66.71	$ 0.1780	$ -	4%	32
February	256	$54.97	14	0	$0.00	$54.97	$ 0.2149	$ -	3%	19
March	1,297	$188.21	13	0	$0.00	$188.21	$ 0.1451	$ -	14%	103
TOTAL	9,315	$1,528.49	153	0	$0.00	$1,528.49	$ 0.164	$ -	8%	741

Month	HEATING FUEL			WATER					Total Utility Costs
	Therms	Avg Cost/Therm	Gas Cost	Gallons x 1000	Water Cost	Sewer Cost	Total Cost/kGal	Total Water Cost	
April	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$139.48
May	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$66.07
June	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$95.80
July	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$153.23
August	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$131.72
September	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$130.38
October	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$173.16
November	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$176.82
December	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$151.94
January	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$66.71
February	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$54.97
March	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$188.21
TOTAL	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$1,528.49

Table B.3 Annual Utility Usage Summary – Animal Shelter

City of Gladstone	Animal Shelter
	BASELINE DATA

Data Start Year	Utility Providers:	Utility Units:
Most Recent Year Data	Electric Company KCPL	Electricity kWh
October	Heating Fuel Company Missouri Gas Energy	Heating Fuel Therm
	Water Company City of Gladstone-Water, KC Water Services-Sewer	Water kGal

AVERAGE YEARLY SUMMARY ADJUSTED FOR BILLING PERIOD

Square feet	2,304	kWh/sf	13.96	Therm/sf	1.775	Water gal/sf	0.00	Total Btu/sf	225,184
Utility Cost/sf	$3.21	Avg Watts/sf	4.91	Gas $/Therm	$0.71	Water+Sewer $/kGal	$0.00	Total Utility Costs/Year	$7,386.95
Hours Operated	2,795	Electric $/sf	$1.94	Gas $/sf	$1.26	Water+Sewer $/sf	$0.00	Total Utility Cost-Water	$7,386.95

Month	ELECTRICITY									
	kWh	kWh Cost	Estimated KW	Billed kW	Demand (kW) Costs	Electric Cost	Avg Cost/kWh	Avg Cost/Estimated kW	% Load Factor	Min Hours (from peak demand)
October	2,946	$364.01	14	0	$0.00	$364.01	$ 0.1236	$ -	28%	211
November	1,944	$261.30	10	0	$0.00	$261.30	$ 0.1344	$ -	26%	190
December	1,817	$228.42	8	0	$0.00	$228.42	$ 0.1257	$ -	32%	238
January	1,831	$231.29	8	0	$0.00	$231.29	$ 0.1263	$ -	32%	235
February	1,669	$220.10	8	0	$0.00	$220.10	$ 0.1319	$ -	31%	213
March	1,734	$231.95	8	0	$0.00	$231.95	$ 0.1338	$ -	28%	208
April	1,941	$255.19	9	0	$0.00	$255.19	$ 0.1315	$ -	31%	221
May	2,835	$403.27	12	0	$0.00	$403.27	$ 0.1422	$ -	32%	238
June	3,681	$536.64	13	0	$0.00	$536.64	$ 0.1458	$ -	38%	273
July	4,394	$628.06	15	0	$0.00	$628.06	$ 0.1429	$ -	39%	290
August	4,055	$618.79	16	0	$0.00	$618.79	$ 0.1526	$ -	35%	257
September	3,319	$493.63	15	0	$0.00	$493.63	$ 0.1487	$ -	31%	223
TOTAL	32,166	$4,472.64	136	0	$0.00	$4,472.64	$ 0.139	$ -	32%	2,795

Month	HEATING FUEL			WATER					Total Utility Costs
	Therms	Avg Cost/Therm	Gas Cost	Gallons x 1000	Water Cost	Sewer Cost	Total Cost/kGal	Total Water Cost	
October	265	$ 0.784	$207.68	0	$0.00	$0.00	$ -	$0.00	$571.69
November	368	$ 0.730	$268.80	0	$0.00	$0.00	$ -	$0.00	$530.11
December	668	$ 0.686	$457.83	0	$0.00	$0.00	$ -	$0.00	$686.25
January	781	$ 0.681	$531.58	0	$0.00	$0.00	$ -	$0.00	$762.87
February	587	$ 0.693	$406.84	0	$0.00	$0.00	$ -	$0.00	$626.94
March	425	$ 0.692	$294.23	0	$0.00	$0.00	$ -	$0.00	$526.18
April	243	$ 0.706	$171.68	0	$0.00	$0.00	$ -	$0.00	$426.87
May	144	$ 0.775	$111.78	0	$0.00	$0.00	$ -	$0.00	$515.05
June	147	$ 0.764	$112.25	0	$0.00	$0.00	$ -	$0.00	$648.88
July	152	$ 0.776	$117.99	0	$0.00	$0.00	$ -	$0.00	$746.04
August	168	$ 0.739	$123.96	0	$0.00	$0.00	$ -	$0.00	$742.75
September	143	$ 0.769	$109.69	0	$0.00	$0.00	$ -	$0.00	$603.32
TOTAL	4,090	$ 0.71	$2,914.31	0	$0.00	$0.00	$ -	$0.00	$7,386.95

Table B.4 Annual Utility Usage Summary – Atkins-Johnson House

City of Gladstone

Atkins-Johnson House

BASELINE DATA

Data Start Year	Utility Providers:		Utility Units:	
Average of Three Years	Electric Company	KCPL	Electricity	kWh
April	Heating Fuel Company	Missouri Gas Energy	Heating Fuel	Therm
	Water Company	City of Gladstone-Water, KC Water Services-Sewer	Water	kGal

AVERAGE YEARLY SUMMARY ADJUSTED FOR BILLING PERIOD

Square feet	2,504	kWh/sf	26.71	Therm/sf	0.000	Water gal/sf	0.00	Total Btu/sf	91,145
Utility Cost/sf	$3.89	Avg Watts/sf	6.67	Gas $/Therm	$0.00	Water+Sewer $/kGal	$0.00	Total Utility Costs/Year	$9,733.87
Hours Operated	4,291	Electric $/sf	$3.89	Gas $/sf	$0.00	Water+Sewer $/sf	$0.00	Total Utility Cost-Water	$9,733.87

Month	ELECTRICITY									
	kWh	kWh Cost	Estimated KW	Billed kW	Demand (kW) Costs	Electric Cost	Avg Cost/kWh	Avg Cost/Estimated kW	% Load Factor	Min Hours (from peak demand)
April	4,479	$682.91	19	0	$0.00	$682.91	$ 0.1525	$ -	33%	238
May	2,815	$557.02	10	0	$0.00	$557.02	$ 0.1979	$ -	37%	272
June	2,749	$560.82	6	0	$0.00	$560.82	$ 0.2040	$ -	66%	474
July	3,174	$607.66	6	0	$0.00	$607.66	$ 0.1915	$ -	70%	521
August	3,222	$607.19	6	0	$0.00	$607.19	$ 0.1884	$ -	69%	513
September	3,036	$556.06	8	0	$0.00	$556.06	$ 0.1832	$ -	50%	359
October	3,739	$627.65	17	0	$0.00	$627.65	$ 0.1679	$ -	29%	219
November	6,553	$916.50	25	0	$0.00	$916.50	$ 0.1399	$ -	37%	264
December	10,667	$1,281.96	28	0	$0.00	$1,281.96	$ 0.1202	$ -	51%	383
January	11,581	$1,346.86	28	0	$0.00	$1,346.86	$ 0.1163	$ -	56%	420
February	8,503	$1,076.62	24	0	$0.00	$1,076.62	$ 0.1266	$ -	52%	352
March	6,353	$912.64	23	0	$0.00	$912.64	$ 0.1437	$ -	37%	276
TOTAL	66,870	$9,733.87	200	0	$0.00	$9,733.87	$ 0.146	$ -	46%	4,291

Month	HEATING FUEL			WATER					Total Utility Costs
	Therms	Avg Cost/Therm	Gas Cost	Gallons x 1000	Water Cost	Sewer Cost	Total Cost/kGal	Total Water Cost	
April	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$682.91
May	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$557.02
June	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$560.82
July	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$607.66
August	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$607.19
September	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$556.06
October	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$627.65
November	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$916.50
December	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$1,281.96
January	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$1,346.86
February	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$1,076.62
March	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$912.64
TOTAL	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$9,733.87

Table B.5 Annual Utility Usage Summary – Central Park

City of Gladstone

Central Park

BASELINE DATA

Data Start Year	Utility Providers:		Utility Units:	
Average of Three Years	Electric Company	KCPL	Electricity	kWh
April	Heating Fuel Company	Missouri Gas Energy	Heating Fuel	Therm
	Water Company	City of Gladstone-Water, KC Water Services-Sewer	Water	kGal

AVERAGE YEARLY SUMMARY ADJUSTED FOR BILLING PERIOD

Square feet	3,300	kWh/sf	21.56	Therm/sf	0.000	Water gal/sf	0.00	Total Btu/sf	73,582
Utility Cost/sf	$2.99	Avg Watts/sf	7.11	Gas $/Therm	$0.00	Water+Sewer $/kGal	$0.00	Total Utility Costs/Year	$9,861.82
Hours Operated	57	Electric $/sf	$2.99	Gas $/sf	$0.00	Water+Sewer $/sf	$0.00	Total Utility Cost-Water	$9,861.82

Month	ELECTRICITY									
	kWh	kWh Cost	Estimated KW	Billed kW	Demand (kW) Costs	Electric Cost	Avg Cost/kWh	Avg Cost/Estimated kW	% Load Factor	Min Hours (from peak demand)
April	622	$158.91	4	30	$238.39	$397.30	$ 0.2554	$ 60.692	22%	158
May	5,197	$532.46	47	47	$260.22	$792.68	$ 0.1024	$ 5.543	15%	111
June	24,086	$1,809.99	54	60	$412.28	$2,222.27	$ 0.0751	$ 7.612	62%	445
July	21,862	$1,672.19	50	55	$369.51	$2,041.70	$ 0.0765	$ 7.326	58%	433
August	17,850	$1,548.83	53	58	$399.86	$1,948.69	$ 0.0868	$ 7.581	45%	338
September	-5,554	-$195.31	2	16	$211.76	$16.45	$ 0.0352	$ 141.176	-514%	(3,703)
October	1,890	$267.15	35	23	$182.25	$449.40	$ 0.1413	$ 5.161	7%	54
November	1,251	$201.15	26	26	$221.98	$423.12	$ 0.1608	$ 8.576	7%	48
December	1,159	$171.40	1	23	$198.97	$370.37	$ 0.1478	$ 182.297	143%	1,062
January	1,236	$208.10	6	24	$208.77	$416.87	$ 0.1684	$ 36.956	29%	219
February	828	$182.41	3	25	$214.35	$396.77	$ 0.2203	$ 83.373	48%	322
March	719	$166.05	1	26	$220.16	$386.21	$ 0.2310	$ 174.473	77%	570
TOTAL	71,146	$6,723.32	281	412	$3,138.50	$9,861.82	$ 0.095	$ 11.15	35%	57

Month	HEATING FUEL			WATER					Total Utility Costs
	Therms	Avg Cost/Therm	Gas Cost	Gallons x 1000	Water Cost	Sewer Cost	Total Cost/kGal	Total Water Cost	
April	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$397.30
May	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$792.68
June	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$2,222.27
July	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$2,041.70
August	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$1,948.69
September	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$16.45
October	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$449.40
November	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$423.12
December	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$370.37
January	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$416.87
February	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$396.77
March	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$386.21
TOTAL	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$9,861.82

Table B.6 Annual Utility Usage Summary – City Hall

City of Gladstone	City Hall BASELINE DATA

Data Start Year	Utility Providers:		Utility Units:	
Average of Three Years	Electric Company	KCPL	Electricity	kWh
Apr-16	Heating Fuel Company	Missouri Gas Energy	Heating Fuel	Therm
	Water Company	City of Gladstone-Water, KC Water Services-Sewer	Water	kGal

AVERAGE YEARLY SUMMARY ADJUSTED FOR BILLING PERIOD

Square feet	37,850	kWh/sf	14.42	Therm/sf	0.000	Water gal/sf	0.00	Total kBtu/sf	49.23
Utility Cost/sf	$1.46	Avg Watts/sf	3.57	Gas $/Therm	$56.56	Water+Sewer $/kGal	$0.00	Total Utility Costs/Year	$55,118.50
Hours Operated	4,073	Electric $/sf	$1.45	Gas $/sf	$0.01	Water+Sewer $/sf	$0.00	Total Utility Cost-Water	$55,118.50

Month	ELECTRICITY									
	kWh	kWh Cost	Estimated KW	Billed kW	Demand (kW) Costs	Electric Cost	Avg Cost/kWh	Avg Cost/Estimated kW	% Load Factor	Min Hours (from peak demand)
Apr	38,734	$2,961.89	104	127	$524.17	$3,486.06	$ 0.0765	$ 5.03	52%	372
May	40,131	$3,475.76	114	138	$633.29	$4,109.05	$ 0.0866	$ 5.56	47%	352
Jun	42,884	$4,113.97	120	127	$671.69	$4,785.66	$ 0.0959	$ 5.58	49%	356
Jul	47,082	$4,492.73	127	131	$700.53	$5,193.26	$ 0.0954	$ 5.50	50%	370
Aug	46,851	$4,561.28	131	138	$721.43	$5,282.71	$ 0.0974	$ 5.52	48%	359
Sep	41,407	$3,656.69	117	163	$747.40	$4,404.08	$ 0.0883	$ 6.41	49%	355
Oct	39,097	$2,947.37	115	211	$890.45	$3,837.81	$ 0.0754	$ 7.72	46%	339
Nov	43,938	$3,371.65	142	208	$966.92	$4,338.57	$ 0.0767	$ 6.83	43%	310
Dec	56,566	$4,268.71	182	209	$1,086.93	$5,355.64	$ 0.0755	$ 5.97	42%	311
Jan	58,016	$4,253.62	179	202	$1,055.55	$5,309.17	$ 0.0733	$ 5.90	44%	324
Feb	48,000	$3,548.84	154	197	$969.58	$4,518.42	$ 0.0739	$ 6.28	46%	311
Mar	43,096	$3,224.60	137	207	$950.68	$4,175.28	$ 0.0748	$ 6.92	42%	314
TOTAL	**545,803**	**$44,877.11**	**1,622**	**2,058**	**$9,918.61**	**$54,795.72**	**$ 0.082**	**$ 6.11**	**46%**	**4,073**

Month	HEATING FUEL			WATER					Total Utility Costs
	Therms	Avg Cost/Therm	Gas Cost	Gallons x 1000	Water Cost	Sewer Cost	Total Cost/kGal	Total Water Cost	
Apr	1	$ 19.41	$25.57	0	$0.00	$0.00	$ -	$0.00	$3,511.63
May	0	$ 132.72	$25.69	0	$0.00	$0.00	$ -	$0.00	$4,134.74
Jun	0	$ 171.57	$24.78	0	$0.00	$0.00	$ -	$0.00	$4,810.44
Jul	0	$ 84.24	$26.56	0	$0.00	$0.00	$ -	$0.00	$5,219.82
Aug	0	$ 124.09	$25.67	0	$0.00	$0.00	$ -	$0.00	$5,308.39
Sep	0	$ -	$24.28	0	$0.00	$0.00	$ -	$0.00	$4,428.37
Oct	0	$ 194.79	$26.87	0	$0.00	$0.00	$ -	$0.00	$3,864.68
Nov	0	$ 133.28	$26.04	0	$0.00	$0.00	$ -	$0.00	$4,364.61
Dec	0	$ 61.25	$25.40	0	$0.00	$0.00	$ -	$0.00	$5,381.04
Jan	1	$ 30.38	$26.16	0	$0.00	$0.00	$ -	$0.00	$5,335.33
Feb	0	$ 65.11	$25.45	0	$0.00	$0.00	$ -	$0.00	$4,543.86
Mar	2	$ 26.35	$40.30	0	$0.00	$0.00	$ -	$0.00	$4,215.58
TOTAL	**6**	**$ 56.56**	**$322.78**	**0**	**$0.00**	**$0.00**	**$ -**	**$0.00**	**$55,118.50**

Table B.7 Annual Utility Usage Summary – Community Center

City of Gladstone	Community Center BASELINE DATA

Data Start Year	Utility Providers:		Utility Units:	
Average of Two Years	Electric Company	KCPL	Electricity	kWh
April	Heating Fuel Company	Missouri Gas Energy	Heating Fuel	Therm
	Water Company	City of Gladstone-Water, KC Water Services-Sewer	Water	kGal

AVERAGE YEARLY SUMMARY ADJUSTED FOR BILLING PERIOD

Square feet	77,350	kWh/sf	54.90	Therm/sf	0.000	Water gal/sf	0.00	Total Btu/sf	187,375
Utility Cost/sf	$5.19	Avg Watts/sf	10.49	Gas $/Therm	$0.00	Water+Sewer $/kGal	$0.00	Total Utility Costs/Year	$401,741.73
Hours Operated	5,236	Electric $/sf	$5.19	Gas $/sf	$0.00	Water+Sewer $/sf	$0.00	Total Utility Cost-Water	$401,741.73

Month	ELECTRICITY									
	kWh	kWh Cost	Estimated KW	Billed kW	Demand (kW) Costs	Electric Cost	Avg Cost/kWh	Avg Cost/Estimated kW	% Load Factor	Min Hours (from peak demand)
April	352,336	$22,778.20	707	1,141	$5,953.24	$28,731.44	$ 0.0646	$ 8.424	69%	499
May	314,650	$23,779.88	804	1,257	$7,627.78	$31,407.66	$ 0.0756	$ 9.485	53%	391
June	295,326	$23,718.54	737	1,147	$8,044.73	$31,763.27	$ 0.0803	$ 10.909	56%	400
July	303,834	$24,169.63	705	1,188	$7,983.27	$32,152.90	$ 0.0795	$ 11.326	58%	431
August	298,720	$24,618.84	719	1,241	$8,182.44	$32,801.28	$ 0.0824	$ 11.374	56%	415
September	315,268	$24,073.04	698	1,170	$7,026.09	$31,099.13	$ 0.0764	$ 10.063	63%	452
October	351,418	$25,473.09	759	1,203	$6,529.23	$32,002.32	$ 0.0725	$ 8.603	62%	463
November	379,591	$28,180.02	845	1,169	$6,797.98	$34,978.00	$ 0.0742	$ 8.041	62%	449
December	443,904	$33,154.28	948	1,168	$6,381.81	$39,536.09	$ 0.0747	$ 6.728	63%	468
January	445,753	$33,145.98	1,014	1,133	$6,545.95	$39,691.93	$ 0.0744	$ 6.457	59%	440
February	389,200	$28,388.72	952	1,063	$6,828.27	$35,216.99	$ 0.0729	$ 7.169	61%	409
March	356,550	$25,873.99	851	1,068	$6,486.73	$32,360.72	$ 0.0726	$ 7.623	56%	419
TOTAL	4,246,550	$317,354.22	9,741	13,948	$84,387.51	$401,741.73	$ 0.075	$ 8.66	60%	5,236

Month	HEATING FUEL			WATER					Total Utility Costs
	Therms	Avg Cost/Therm	Gas Cost	Gallons x 1000	Water Cost	Sewer Cost	Total Cost/kGal	Total Water Cost	
April	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$28,731.44
May	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$31,407.66
June	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$31,763.27
July	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$32,152.90
August	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$32,801.28
September	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$31,099.13
October	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$32,002.32
November	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$34,978.00
December	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$39,536.09
January	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$39,691.93
February	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$35,216.99
March	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$32,360.72
TOTAL	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$401,741.73

Table B.8 Annual Utility Usage Summary – Fins & Foliage

City of Gladstone	Fins and Foilage Building BASELINE DATA

Data Start Year	Utility Providers:		Utility Units:
Most Recent Year Data	Electric Company	KCPL	Electricity: kWh
April	Heating Fuel Company	Missouri Gas Energy	Heating Fuel: Therm
	Water Company	City of Gladstone-Water, KC Water Services-Sewer	Water: kGal

AVERAGE YEARLY SUMMARY ADJUSTED FOR BILLING PERIOD

Square feet	7,560	kWh/sf	2.43	Therm/sf	0.064	Water gal/sf	0.00	Total Btu/sf	14,690
Utility Cost/sf	$0.43	Avg Watts/sf	0.39	Gas $/Therm	$1.54	Water+Sewer $/kGal	$0.00	Total Utility Costs/Year	$3,280.28
Hours Operated	7,064	Electric $/sf	$0.34	Gas $/sf	$0.10	Water+Sewer $/sf	$0.00	Total Utility Cost-Water	$3,280.28

Month	ELECTRICITY									
	kWh	kWh Cost	Estimated KW	Billed kW	Demand (kW) Costs	Electric Cost	Avg Cost/kWh	Avg Cost/Estimated kW	% Load Factor	Min Hours (from peak demand)
April	1,183	$98.95	1	0	$0.00	$98.95	$ 0.0837	$ -	198%	1,424
May	272	$112.82	2	0	$0.00	$112.82	$ 0.4143	$ -	17%	123
June	493	$136.41	3	0	$0.00	$136.41	$ 0.2768	$ -	20%	145
July	3,219	$388.51	4	0	$0.00	$388.51	$ 0.1207	$ -	103%	766
August	2,073	$286.73	3	0	$0.00	$286.73	$ 0.1383	$ -	95%	703
September	2,225	$319.52	4	0	$0.00	$319.52	$ 0.1436	$ -	70%	504
October	2,535	$264.63	4	0	$0.00	$264.63	$ 0.1044	$ -	91%	675
November	2,288	$286.31	4	0	$0.00	$286.31	$ 0.1251	$ -	74%	531
December	997	$172.50	4	0	$0.00	$172.50	$ 0.1730	$ -	38%	283
January	1,274	$170.42	1	0	$0.00	$170.42	$ 0.1337	$ -	130%	966
February	704	$151.01	3	0	$0.00	$151.01	$ 0.2146	$ -	31%	209
March	1,092	$148.87	1	0	$0.00	$148.87	$ 0.1364	$ -	99%	734
TOTAL	18,356	$2,536.69	36	0	$0.00	$2,536.69	$ 0.138	$ -	70%	7,064

Month	HEATING FUEL			WATER					Total Utility Costs
	Therms	Avg Cost/Therm	Gas Cost	Gallons x 1000	Water Cost	Sewer Cost	Total Cost/kGal	Total Water Cost	
April	74	$ 0.978	$72.01	0	$0.00	$0.00	$ -	$0.00	$170.96
May	13	$ 3.711	$48.97	0	$0.00	$0.00	$ -	$0.00	$161.79
June	-7	$ (4.278)	$29.66	0	$0.00	$0.00	$ -	$0.00	$166.07
July	0	$ (279.224)	$41.46	0	$0.00	$0.00	$ -	$0.00	$429.97
August	1	$ 39.490	$42.71	0	$0.00	$0.00	$ -	$0.00	$329.45
September	0	$ (73.786)	$33.08	0	$0.00	$0.00	$ -	$0.00	$352.60
October	1	$ 31.137	$44.02	0	$0.00	$0.00	$ -	$0.00	$308.65
November	0	$ (96.905)	$40.10	0	$0.00	$0.00	$ -	$0.00	$326.41
December	0	$ -	$36.11	0	$0.00	$0.00	$ -	$0.00	$208.61
January	0	$ -	$39.44	0	$0.00	$0.00	$ -	$0.00	$209.86
February	204	$ 0.784	$159.95	0	$0.00	$0.00	$ -	$0.00	$310.96
March	199	$ 0.786	$156.08	0	$0.00	$0.00	$ -	$0.00	$304.95
TOTAL	484	$ 1.54	$743.60	0	$0.00	$0.00	$ -	$0.00	$3,280.28

Table B.9 Annual Utility Usage Summary – Fire Station #1

City of Gladstone	Fire Station #1 BASELINE DATA

Data Start Year	Utility Providers:		Utility Units:
Most Recent Year Data	Electric Company	KCPL	Electricity: kWh
April	Heating Fuel Company	Missouri Gas Energy	Heating Fuel: Therm
	Water Company	City of Gladstone-Water, KC Water Services-Sewer	Water: kGal

AVERAGE YEARLY SUMMARY ADJUSTED FOR BILLING PERIOD

Square feet	7,950	kWh/sf	11.03	Therm/sf	0.543	Water gal/sf	0.00	Total Btu/sf	91,989
Utility Cost/sf	$1.66	Avg Watts/sf	2.46	Gas $/Therm	$0.69	Water+Sewer $/kGal	$0.00	Total Utility Costs/Year	$13,212.70
Hours Operated	4,506	Electric $/sf	$1.29	Gas $/sf	$0.37	Water+Sewer $/sf	$0.00	Total Utility Cost-Water	$13,212.70

Month	ELECTRICITY									
	kWh	kWh Cost	Estimated KW	Billed kW	Demand (kW) Costs	Electric Cost	Avg Cost/kWh	Avg Cost/Estimated kW	% Load Factor	Min Hours (from peak demand)
April	4,933	$420.35	11	22	$113.23	$533.58	$ 0.0852	$ 9.990	60%	435
May	7,051	$643.74	21	28	$149.65	$793.39	$ 0.0913	$ 7.156	45%	337
June	9,508	$970.05	23	25	$195.73	$1,165.78	$ 0.1020	$ 8.342	56%	405
July	10,701	$1,062.50	29	28	$197.46	$1,259.96	$ 0.0993	$ 6.817	50%	369
August	10,779	$1,077.11	25	31	$203.39	$1,280.50	$ 0.0999	$ 8.108	58%	430
September	8,939	$920.34	22	28	$182.27	$1,102.61	$ 0.1030	$ 8.230	56%	404
October	8,542	$735.37	25	30	$127.36	$862.72	$ 0.0861	$ 5.040	45%	338
November	3,363	$374.70	15	26	$128.66	$503.36	$ 0.1114	$ 8.871	32%	232
December	6,852	$644.93	18	29	$144.86	$789.78	$ 0.0941	$ 8.010	51%	379
January	5,448	$528.26	16	28	$135.66	$663.92	$ 0.0970	$ 8.434	46%	339
February	4,635	$391.81	9	25	$124.67	$516.48	$ 0.0845	$ 13.128	73%	488
March	6,929	$616.99	20	32	$159.02	$776.01	$ 0.0890	$ 8.041	47%	350
TOTAL	87,680	$8,386.14	235	331	$1,861.96	$10,248.10	$ 0.096	$ 7.92	51%	4,506

Month	HEATING FUEL			WATER					Total Utility Costs
	Therms	Avg Cost/Therm	Gas Cost	Gallons x 1000	Water Cost	Sewer Cost	Total Cost/kGal	Total Water Cost	
April	213	$ 0.668	$142.28	0	$0.00	$0.00	$ -	$0.00	$675.86
May	58	$ 1.245	$72.31	0	$0.00	$0.00	$ -	$0.00	$865.71
June	59	$ 1.084	$64.36	0	$0.00	$0.00	$ -	$0.00	$1,230.15
July	57	$ 1.246	$71.61	0	$0.00	$0.00	$ -	$0.00	$1,331.57
August	61	$ 1.219	$73.84	0	$0.00	$0.00	$ -	$0.00	$1,354.34
September	70	$ 1.002	$69.69	0	$0.00	$0.00	$ -	$0.00	$1,172.30
October	115	$ 0.899	$103.45	0	$0.00	$0.00	$ -	$0.00	$966.18
November	144	$ 0.815	$117.24	0	$0.00	$0.00	$ -	$0.00	$620.60
December	1,289	$ 0.621	$800.78	0	$0.00	$0.00	$ -	$0.00	$1,590.56
January	1,453	$ 0.618	$897.38	0	$0.00	$0.00	$ -	$0.00	$1,561.30
February	379	$ 0.694	$263.22	0	$0.00	$0.00	$ -	$0.00	$779.70
March	423	$ 0.682	$288.43	0	$0.00	$0.00	$ -	$0.00	$1,064.44
TOTAL	4,321	$ 0.69	$2,964.60	0	$0.00	$0.00	$ -	$0.00	$13,212.70

Table B.10 Annual Utility Usage Summary – Fire Station #2

City of Gladstone	Fire Station #2 BASELINE DATA

Data Start Year	Utility Providers:		Utility Units:	
Average of Two Years	Electric Company	KCPL	Electricity	kWh
April	Heating Fuel Company	Missouri Gas Energy	Heating Fuel	Therm
	Water Company	City of Gladstone-Water, KC Water Services-Sewer	Water	kGal

AVERAGE YEARLY SUMMARY ADJUSTED FOR BILLING PERIOD

Square feet	7,700	kWh/sf	12.02	Therm/sf	0.337	Water gal/sf	0.00	Total Btu/sf	74,756
Utility Cost/sf	$1.59	Avg Watts/sf	2.82	Gas $/Therm	$0.75	Water+Sewer $/kGal	$0.00	Total Utility Costs/Year	$12,227.56
Hours Operated	4,238	Electric $/sf	$1.34	Gas $/sf	$0.25	Water+Sewer $/sf	$0.00	Total Utility Cost-Water	$12,227.56

Month	ELECTRICITY									
	kWh	kWh Cost	Estimated KW	Billed kW	Demand (kW) Costs	Electric Cost	Avg Cost/kWh	Avg Cost/Estimated kW	% Load Factor	Min Hours (from peak demand)
April	6,216	$516.10	19	29	$134.11	$650.21	$ 0.0830	$ 7.127	46%	330
May	7,840	$712.25	24	30	$165.25	$877.50	$ 0.0908	$ 6.811	43%	323
June	10,228	$943.52	27	29	$188.02	$1,131.53	$ 0.0923	$ 6.901	52%	375
July	12,169	$1,092.19	29	29	$197.10	$1,289.29	$ 0.0898	$ 6.807	56%	420
August	11,290	$1,051.32	29	30	$197.36	$1,248.67	$ 0.0931	$ 6.881	53%	394
September	8,814	$828.98	27	29	$165.70	$994.68	$ 0.0940	$ 6.081	45%	323
October	7,021	$642.79	23	29	$143.90	$786.69	$ 0.0916	$ 6.195	41%	302
November	5,833	$533.38	17	28	$137.71	$671.08	$ 0.0914	$ 8.164	48%	346
December	6,093	$539.38	16	29	$140.19	$679.57	$ 0.0885	$ 8.990	53%	391
January	6,011	$522.79	15	29	$139.62	$662.42	$ 0.0870	$ 9.181	53%	395
February	5,406	$485.20	16	28	$136.08	$621.29	$ 0.0898	$ 8.412	50%	334
March	5,634	$522.55	19	30	$147.45	$670.00	$ 0.0928	$ 7.941	41%	303
TOTAL	92,554	$8,390.45	261	349	$1,892.48	$10,282.94	$ 0.091	$ 7.25	49%	4,238

Month	HEATING FUEL			WATER					Total Utility Costs
	Therms	Avg Cost/Therm	Gas Cost	Gallons x 1000	Water Cost	Sewer Cost	Total Cost/kGal	Total Water Cost	
April	125	$ 0.870	$108.58	0	$0.00	$0.00	$ -	$0.00	$758.79
May	26	$ 2.069	$53.18	0	$0.00	$0.00	$ -	$0.00	$930.67
June	20	$ 2.411	$48.58	0	$0.00	$0.00	$ -	$0.00	$1,180.11
July	18	$ 2.780	$49.98	0	$0.00	$0.00	$ -	$0.00	$1,339.28
August	19	$ 2.643	$49.11	0	$0.00	$0.00	$ -	$0.00	$1,297.78
September	19	$ 2.497	$47.63	0	$0.00	$0.00	$ -	$0.00	$1,042.31
October	42	$ 1.540	$64.36	0	$0.00	$0.00	$ -	$0.00	$851.04
November	274	$ 0.718	$197.06	0	$0.00	$0.00	$ -	$0.00	$868.14
December	637	$ 0.634	$403.78	0	$0.00	$0.00	$ -	$0.00	$1,083.35
January	720	$ 0.624	$449.24	0	$0.00	$0.00	$ -	$0.00	$1,111.66
February	478	$ 0.647	$309.58	0	$0.00	$0.00	$ -	$0.00	$930.87
March	220	$ 0.743	$163.56	0	$0.00	$0.00	$ -	$0.00	$833.56
TOTAL	2,597	$ 0.75	$1,944.63	0	$0.00	$0.00	$ -	$0.00	$12,227.56

Table B.11 Annual Utility Usage Summary – Hamilton Heights Park

City of Gladstone	Hamilton Heights Park BASELINE DATA

Data Start Year	Utility Providers:		Utility Units:	
Most Recent Year Data	Electric Company	KCPL	Electricity	kWh
April	Heating Fuel Company	Missouri Gas Energy	Heating Fuel	Therm
	Water Company	City of Gladstone-Water, KC Water Services-Sewer	Water	kGal

AVERAGE YEARLY SUMMARY ADJUSTED FOR BILLING PERIOD

Square feet	900	kWh/sf	3.56	Therm/sf	0.000	Water gal/sf	0.00	Total Btu/sf	12,141
Utility Cost/sf	$0.75	Avg Watts/sf	1.94	Gas $/Therm	$0.00	Water+Sewer $/kGal	$0.00	Total Utility Costs/Year	$671.34
Hours Operated	3,008	Electric $/sf	$0.75	Gas $/sf	$0.00	Water+Sewer $/sf	$0.00	Total Utility Cost-Water	$671.34

Month	ELECTRICITY									
	kWh	kWh Cost	Estimated KW	Billed kW	Demand (kW) Costs	Electric Cost	Avg Cost/kWh	Avg Cost/Estimated kW	% Load Factor	Min Hours (from peak demand)
April	138	$34.55	1	0	$0.00	$34.55	$ 0.2505	$ -	14%	103
May	160	$42.53	3	0	$0.00	$42.53	$ 0.2660	$ -	8%	63
June	117	$40.08	1	0	$0.00	$40.08	$ 0.3438	$ -	30%	217
July	477	$98.53	5	0	$0.00	$98.53	$ 0.2065	$ -	13%	94
August	40	$27.70	-2	0	$0.00	$27.70	$ 0.6887	$ -	-4%	(27)
September	149	$44.04	1	0	$0.00	$44.04	$ 0.2948	$ -	14%	102
October	323	$60.04	4	0	$0.00	$60.04	$ 0.1860	$ -	12%	86
November	332	$54.96	0	0	$0.00	$54.96	$ 0.1654	$ -	175%	1,259
December	350	$52.88	1	0	$0.00	$52.88	$ 0.1510	$ -	53%	398
January	331	$55.75	1	0	$0.00	$55.75	$ 0.1683	$ -	44%	324
February	278	$49.39	1	0	$0.00	$49.39	$ 0.1779	$ -	42%	280
March	506	$110.88	5	0	$0.00	$110.88	$ 0.2190	$ -	15%	110
TOTAL	3,202	$671.34	21	0	$0.00	$671.34	$ 0.210	$ -	21%	3,008

Month	HEATING FUEL			WATER					Total Utility Costs
	Therms	Avg Cost/Therm	Gas Cost	Gallons x 1000	Water Cost	Sewer Cost	Total Cost/kGal	Total Water Cost	
April	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$34.55
May	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$42.53
June	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$40.08
July	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$98.53
August	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$27.70
September	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$44.04
October	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$60.04
November	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$54.96
December	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$52.88
January	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$55.75
February	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$49.39
March	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$110.88
TOTAL	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$671.34

Table B.12 Annual Utility Usage Summary – Happy Rock Park

City of Gladstone	Happy Rock Park BASELINE DATA

	Utility Providers:		Utility Units:	
Data Start Year	Electric Company	KCPL	Electricity	kWh
Most Recent Year Data	Heating Fuel Company	Missouri Gas Energy	Heating Fuel	Therm
Oct-15 to Sep-16	Water Company	City of Gladstone-Water, KC Water Services-Sewer	Water	kGal

AVERAGE YEARLY SUMMARY ADJUSTED FOR BILLING PERIOD

Square feet	0	kWh/sf	#DIV/0!	Therm/sf	#DIV/0!	Water gal/sf	#DIV/0!	Total kBtu/sf	#DIV/0!
Utility Cost/sf	#DIV/0!	Avg Watts/sf	#DIV/0!	Gas $/Therm	$0.00	Water+Sewer $/kGal	$0.00	Total Utility Costs/Year	$23,097.28
Hours Operated	783	Electric $/sf	#DIV/0!	Gas $/sf	#DIV/0!	Water+Sewer $/sf	#DIV/0!	Total Utility Cost-Water	$23,097.28

Month	ELECTRICITY									
	kWh	kWh Cost	Estimated KW	Billed kW	Demand (kW) Costs	Electric Cost	Avg Cost/kWh	Avg Cost/Estimated kW	% Load Factor	Min Hours (from peak demand)
Oct	11,513	$1,623.72	248	165	$403.88	$2,027.61	$ 0.1410	$ 1.63	6%	46
Nov	6,477	$945.86	133	155	$386.99	$1,332.85	$ 0.1460	$ 2.92	7%	49
Dec	3,536	$486.24	27	153	$381.69	$867.93	$ 0.1375	$ 14.30	18%	132
Jan	3,771	$494.65	26	156	$389.79	$884.43	$ 0.1312	$ 15.02	20%	145
Feb	4,531	$641.14	73	157	$391.21	$1,032.34	$ 0.1415	$ 5.37	9%	62
Mar	6,416	$953.07	192	166	$415.47	$1,368.54	$ 0.1485	$ 2.17	4%	33
Apr	9,083	$1,335.97	236	159	$397.25	$1,733.21	$ 0.1471	$ 1.68	5%	38
May	13,924	$2,267.44	252	168	$417.83	$2,685.27	$ 0.1628	$ 1.66	7%	55
Jun	13,267	$2,368.93	233	153	$382.07	$2,751.01	$ 0.1786	$ 1.64	8%	57
Jul	12,577	$2,258.91	251	161	$403.09	$2,662.01	$ 0.1796	$ 1.60	7%	50
Aug	12,834	$2,352.31	262	170	$426.35	$2,778.66	$ 0.1833	$ 1.63	7%	49
Sep	16,033	$2,568.05	248	162	$405.38	$2,973.43	$ 0.1602	$ 1.63	9%	65
TOTAL	**113,962**	**$18,296.29**	**2,181**	**1,926**	**$4,800.99**	**$23,097.28**	**$ 0.161**	**$ 2.20**	**7%**	**783**

Month	HEATING FUEL			WATER					Total Utility Costs
	Therms	Avg Cost/Therm	Gas Cost	Gallons x 1000	Water Cost	Sewer Cost	Total Cost/kGal	Total Water Cost	
Oct	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$2,027.61
Nov	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$1,332.85
Dec	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$867.93
Jan	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$884.43
Feb	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$1,032.34
Mar	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$1,368.54
Apr	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$1,733.21
May	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$2,685.27
Jun	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$2,751.01
Jul	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$2,662.01
Aug	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$2,778.66
Sep	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$2,973.43
TOTAL	**0**	**$ -**	**$0.00**	**0**	**$0.00**	**$0.00**	**$ -**	**$0.00**	**$23,097.28**

Table B.13 Annual Utility Usage Summary – Linden Office

City of Gladstone	Linden Office BASELINE DATA

	Utility Providers:		Utility Units:	
Data Start Year	Electric Company	KCPL	Electricity	kWh
Most Recent Year Data	Heating Fuel Company	Missouri Gas Energy	Heating Fuel	Therm
April	Water Company	City of Gladstone-Water, KC Water Services-Sewer	Water	kGal

AVERAGE YEARLY SUMMARY ADJUSTED FOR BILLING PERIOD

Square feet	6,400	kWh/sf	11.84	Therm/sf	0.285	Water gal/sf	0.00	Total Btu/sf	68,945
Utility Cost/sf	$1.76	Avg Watts/sf	3.40	Gas $/Therm	$1.08	Water+Sewer $/kGal	$0.00	Total Utility Costs/Year	$11,261.91
Hours Operated	4,282	Electric $/sf	$1.45	Gas $/sf	$0.31	Water+Sewer $/sf	$0.00	Total Utility Cost-Water	$11,261.91

Month	ELECTRICITY									
	kWh	kWh Cost	Estimated KW	Billed kW	Demand (kW) Costs	Electric Cost	Avg Cost/kWh	Avg Cost/Estimated kW	% Load Factor	Min Hours (from peak demand)
April	4,765	$417.65	6	0	$0.00	$417.65	$ 0.0877	$ -	105%	755
May	4,367	$549.41	19	0	$0.00	$549.41	$ 0.1258	$ -	31%	230
June	6,875	$921.99	23	0	$0.00	$921.99	$ 0.1341	$ -	42%	299
July	9,254	$1,018.77	21	0	$0.00	$1,018.77	$ 0.1101	$ -	59%	437
August	9,052	$1,124.62	27	0	$0.00	$1,124.62	$ 0.1242	$ -	45%	333
September	6,934	$857.05	21	0	$0.00	$857.05	$ 0.1236	$ -	46%	334
October	6,016	$811.43	36	0	$0.00	$811.43	$ 0.1349	$ -	23%	168
November	4,779	$605.35	17	0	$0.00	$605.35	$ 0.1267	$ -	40%	288
December	7,052	$1,078.16	49	0	$0.00	$1,078.16	$ 0.1529	$ -	19%	143
January	6,956	$828.14	21	0	$0.00	$828.14	$ 0.1191	$ -	44%	324
February	5,040	$531.16	9	0	$0.00	$531.16	$ 0.1054	$ -	80%	560
March	4,693	$549.99	11	0	$0.00	$549.99	$ 0.1172	$ -	55%	410
TOTAL	75,783	$9,293.72	261	0	$0.00	$9,293.72	$ 0.123	$ -	40%	4,282

Month	HEATING FUEL			WATER					Total Utility Costs
	Therms	Avg Cost/Therm	Gas Cost	Gallons x 1000	Water Cost	Sewer Cost	Total Cost/kGal	Total Water Cost	
April	-37	$ (1.288)	$47.15	0	$0.00	$0.00	$ -	$0.00	$464.81
May	-10	$ (6.977)	$68.30	0	$0.00	$0.00	$ -	$0.00	$617.71
June	-4	$ (19.245)	$77.33	0	$0.00	$0.00	$ -	$0.00	$999.32
July	0	$ (186.569)	$80.85	0	$0.00	$0.00	$ -	$0.00	$1,099.61
August	0	$ -	$77.26	0	$0.00	$0.00	$ -	$0.00	$1,201.88
September	0	$ -	$72.43	0	$0.00	$0.00	$ -	$0.00	$929.48
October	6	$ 14.943	$82.91	0	$0.00	$0.00	$ -	$0.00	$894.35
November	32	$ 3.224	$102.42	0	$0.00	$0.00	$ -	$0.00	$707.77
December	418	$ 0.787	$328.42	0	$0.00	$0.00	$ -	$0.00	$1,406.58
January	980	$ 0.645	$631.98	0	$0.00	$0.00	$ -	$0.00	$1,460.12
February	482	$ 0.716	$345.03	0	$0.00	$0.00	$ -	$0.00	$876.18
March	-41	$ (1.335)	$54.11	0	$0.00	$0.00	$ -	$0.00	$604.10
TOTAL	1,826	$ 1.08	$1,968.19	0	$0.00	$0.00	$ -	$0.00	$11,261.91

Table B.14 Annual Utility Usage Summary – Oak Grove Park

City of Gladstone	Oak Grove Park
	BASELINE DATA

Data Start Year	Utility Providers:		Utility Units:	
Average of Three Years	Electric Company	KCPL	Electricity	kWh
April	Heating Fuel Company	Missouri Gas Energy	Heating Fuel	Therm
	Water Company	City of Gladstone-Water, KC Water Services-Sewer	Water	kGal

AVERAGE YEARLY SUMMARY ADJUSTED FOR BILLING PERIOD

Square feet	2,463	kWh/sf	4.80	Therm/sf	0.000	Water gal/sf	0.00	Total Btu/sf	16,397
Utility Cost/sf	$0.96	Avg Watts/sf	3.34	Gas $/Therm	$0.00	Water+Sewer $/kGal	$0.00	Total Utility Costs/Year	$2,373.72
Hours Operated	-47,821	Electric $/sf	$0.96	Gas $/sf	$0.00	Water+Sewer $/sf	$0.00	Total Utility Cost-Water	$2,373.72

Month	ELECTRICITY									
	kWh	kWh Cost	Estimated KW	Billed kW	Demand (kW) Costs	Electric Cost	Avg Cost/kWh	Avg Cost/Estimated kW	% Load Factor	Min Hours (from peak demand)
April	773	$148.81	4	10	$31.00	$179.81	$ 0.1925	$ 7.968	28%	199
May	668	$117.07	2	10	$30.82	$147.89	$ 0.1754	$ 19.291	56%	418
June	1,779	$286.98	22	10	$28.13	$315.11	$ 0.1613	$ 1.296	11%	82
July	2,165	$339.39	36	10	$30.08	$369.47	$ 0.1568	$ 0.847	8%	61
August	1,474	$271.15	32	11	$33.35	$304.50	$ 0.1840	$ 1.052	6%	46
September	430	$112.83	-7	10	$30.20	$143.03	$ 0.2622	$ (4.410)	-9%	(63)
October	699	$118.09	3	10	$29.15	$147.24	$ 0.1689	$ 10.781	35%	259
November	1,002	$169.06	5	11	$32.16	$201.22	$ 0.1688	$ 6.699	29%	209
December	754	$99.32	0	10	$28.76	$128.08	$ 0.1317	$ (1,934.757)	-6817%	(50,721)
January	752	$115.22	1	10	$30.77	$145.99	$ 0.1533	$ 27.206	89%	665
February	665	$112.10	1	11	$31.41	$143.51	$ 0.1686	$ 26.431	83%	560
March	673	$115.92	1	11	$31.93	$147.85	$ 0.1723	$ 22.060	62%	465
TOTAL	11,833	$2,005.95	99	124	$367.77	$2,373.72	$ 0.170	$ 3.72	16%	(47,821)

Month	HEATING FUEL			WATER					Total Utility Costs
	Therms	Avg Cost/Therm	Gas Cost	Gallons x 1000	Water Cost	Sewer Cost	Total Cost/kGal	Total Water Cost	
April	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$179.81
May	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$147.89
June	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$315.11
July	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$369.47
August	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$304.50
September	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$143.03
October	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$147.24
November	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$201.22
December	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$128.08
January	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$145.99
February	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$143.51
March	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$147.85
TOTAL	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$2,373.72

Table B.15 Annual Utility Usage Summary – Old Post Office

City of Gladstone	Old Post Office/Gladstone 18
	BASELINE DATA

Data Start Year	Utility Providers:		Utility Units:	
Average of Two Years	Electric Company	KCPL	Electricity	kWh
October	Heating Fuel Company	Missouri Gas Energy	Heating Fuel	Therm
	Water Company	City of Gladstone-Water, KC Water Services-Sewer	Water	kGal

AVERAGE YEARLY SUMMARY ADJUSTED FOR BILLING PERIOD

Square feet	5,000	kWh/sf	0.73	Therm/sf	0.000	Water gal/sf	0.00	Total Btu/sf	2,486
Utility Cost/sf	$0.13	Avg Watts/sf	-0.01	Gas $/Therm	$0.00	Water+Sewer $/kGal	$0.00	Total Utility Costs/Year	$673.34
Hours Operated	-4,377	Electric $/sf	$0.13	Gas $/sf	$0.00	Water+Sewer $/sf	$0.00	Total Utility Cost-Water	$673.34

Month	ELECTRICITY									
	kWh	kWh Cost	Estimated KW	Billed kW	Demand (kW) Costs	Electric Cost	Avg Cost/kWh	Avg Cost/Estimated kW	% Load Factor	Min Hours (from peak demand)
October	2,001	$378.21	0	0	$0.00	$378.21	$ 0.1890	$ -	-588%	(4,377)
November	184	$29.36	0	0	$0.00	$29.36	$ 0.1597	$ -	#DIV/0!	-
December	164	$25.11	0	0	$0.00	$25.11	$ 0.1532	$ -	#DIV/0!	-
January	182	$28.60	0	0	$0.00	$28.60	$ 0.1574	$ -	#DIV/0!	-
February	138	$24.80	0	0	$0.00	$24.80	$ 0.1792	$ -	#DIV/0!	-
March	180	$31.13	0	0	$0.00	$31.13	$ 0.1727	$ -	#DIV/0!	-
April	148	$28.42	0	0	$0.00	$28.42	$ 0.1915	$ -	#DIV/0!	-
May	153	$30.24	0	0	$0.00	$30.24	$ 0.1979	$ -	#DIV/0!	-
June	118	$25.45	0	0	$0.00	$25.45	$ 0.2164	$ -	#DIV/0!	-
July	146	$29.61	0	0	$0.00	$29.61	$ 0.2027	$ -	#DIV/0!	-
August	159	$30.42	0	0	$0.00	$30.42	$ 0.1909	$ -	#DIV/0!	-
September	69	$11.97	0	0	$0.00	$11.97	$ 0.1741	$ -	#DIV/0!	-
TOTAL	3,642	$673.34	0	0	$0.00	$673.34	$ 0.185	$ -	-1088%	(4,377)

Month	HEATING FUEL			WATER					Total Utility Costs
	Therms	Avg Cost/Therm	Gas Cost	Gallons x 1000	Water Cost	Sewer Cost	Total Cost/kGal	Total Water Cost	
October	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$378.21
November	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$29.36
December	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$25.11
January	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$28.60
February	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$24.80
March	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$31.13
April	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$28.42
May	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$30.24
June	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$25.45
July	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$29.61
August	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$30.42
September	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$11.97
TOTAL	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$673.34

Table B.16 Annual Utility Usage Summary – Public Works

City of Gladstone	Public Works
	BASELINE DATA

	Utility Providers:		Utility Units:	
Data Start Year	Electric Company	KCPL	Electricity	kWh
Most Recent Year Data	Heating Fuel Company	Missouri Gas Energy	Heating Fuel	Therm
October	Water Company	City of Gladstone-Water, KC Water Services-Sewer	Water	kGal

AVERAGE YEARLY SUMMARY ADJUSTED FOR BILLING PERIOD

Square feet	9,918	kWh/sf	11.70	Therm/sf	1.237	Water gal/sf	0.00	Total Btu/sf	163,672
Utility Cost/sf	$2.11	Avg Watts/sf	2.81	Gas $/Therm	$0.71	Water+Sewer $/kGal	$0.00	Total Utility Costs/Year	$20,888.15
Hours Operated	4,144	Electric $/sf	$1.22	Gas $/sf	$0.88	Water+Sewer $/sf	$0.00	Total Utility Cost-Water	$20,888.15

Month	ELECTRICITY									
	kWh	kWh Cost	Estimated KW	Billed kW	Demand (kW) Costs	Electric Cost	Avg Cost/kWh	Avg Cost/Estimated kW	% Load Factor	Min Hours (from peak demand)
October	8,117	$612.97	27	43	$207.95	$820.92	$ 0.0755	$ 7.731	41%	302
November	8,968	$657.96	26	41	$200.47	$858.43	$ 0.0734	$ 7.823	49%	350
December	11,593	$791.51	27	38	$195.41	$986.92	$ 0.0683	$ 7.190	57%	427
January	13,232	$891.53	31	35	$196.83	$1,088.36	$ 0.0674	$ 6.412	58%	431
February	11,938	$832.94	31	34	$197.02	$1,029.96	$ 0.0698	$ 6.306	55%	382
March	8,830	$657.27	26	36	$191.94	$849.21	$ 0.0744	$ 7.387	46%	340
April	7,200	$568.86	23	35	$180.87	$749.73	$ 0.0790	$ 7.966	44%	317
May	8,000	$749.76	27	37	$210.64	$960.41	$ 0.0937	$ 7.763	40%	295
June	9,345	$953.52	28	34	$218.56	$1,172.08	$ 0.1020	$ 7.789	46%	333
July	10,702	$1,086.78	30	35	$232.04	$1,318.82	$ 0.1016	$ 7.652	47%	353
August	9,833	$1,046.73	31	37	$237.40	$1,284.13	$ 0.1064	$ 7.770	43%	322
September	8,320	$819.15	28	35	$207.11	$1,026.25	$ 0.0985	$ 7.292	41%	293
TOTAL	116,077	$9,668.97	335	440	$2,476.24	$12,145.21	$ 0.083	$ 7.40	47%	4,144

Month	HEATING FUEL			WATER					Total Utility Costs
	Therms	Avg Cost/Therm	Gas Cost	Gallons x 1000	Water Cost	Sewer Cost	Total Cost/kGal	Total Water Cost	
October	794	$ 0.784	$623.05	0	$0.00	$0.00	$ -	$0.00	$1,443.96
November	1,104	$ 0.730	$806.41	0	$0.00	$0.00	$ -	$0.00	$1,664.84
December	2,003	$ 0.686	$1,373.48	0	$0.00	$0.00	$ -	$0.00	$2,360.40
January	2,342	$ 0.681	$1,594.75	0	$0.00	$0.00	$ -	$0.00	$2,683.11
February	1,762	$ 0.693	$1,220.51	0	$0.00	$0.00	$ -	$0.00	$2,250.47
March	1,276	$ 0.692	$882.69	0	$0.00	$0.00	$ -	$0.00	$1,731.90
April	729	$ 0.706	$515.04	0	$0.00	$0.00	$ -	$0.00	$1,264.78
May	433	$ 0.775	$335.34	0	$0.00	$0.00	$ -	$0.00	$1,295.75
June	441	$ 0.764	$336.74	0	$0.00	$0.00	$ -	$0.00	$1,508.82
July	456	$ 0.776	$353.96	0	$0.00	$0.00	$ -	$0.00	$1,672.79
August	504	$ 0.739	$371.89	0	$0.00	$0.00	$ -	$0.00	$1,656.01
September	428	$ 0.769	$329.06	0	$0.00	$0.00	$ -	$0.00	$1,355.31
TOTAL	12,271	$ 0.71	$8,742.94	0	$0.00	$0.00	$ -	$0.00	$20,888.15

Table B.17 Annual Utility Usage Summary – Santa Fe Glass

City of Gladstone	Santa Fe Glass
	BASELINE DATA

	Utility Providers:		Utility Units:	
Data Start Year	Electric Company	KCPL	Electricity	kWh
Most Recent Year Data	Heating Fuel Company	Missouri Gas Energy	Heating Fuel	Therm
March	Water Company	City of Gladstone-Water, KC Water Services-Sewer	Water	kGal

AVERAGE YEARLY SUMMARY ADJUSTED FOR BILLING PERIOD

Square feet	1,566	kWh/sf	0.00	Therm/sf	0.000	Water gal/sf	0.00	Total Btu/sf	0
Utility Cost/sf	$0.00	Avg Watts/sf	0.00	Gas $/Therm	$0.00	Water+Sewer $/kGal	$0.00	Total Utility Costs/Year	$0.00
Hours Operated	0	Electric $/sf	$0.00	Gas $/sf	$0.00	Water+Sewer $/sf	$0.00	Total Utility Cost-Water	$0.00

Month	ELECTRICITY									
	kWh	kWh Cost	Estimated KW	Billed kW	Demand (kW) Costs	Electric Cost	Avg Cost/kWh	Avg Cost/Estimated kW	% Load Factor	Min Hours (from peak demand)
March	0	$0.00	0	0	$0.00	$0.00	$ -	$ -	#DIV/0!	-
April	0	$0.00	0	0	$0.00	$0.00	$ -	$ -	#DIV/0!	-
May	0	$0.00	0	0	$0.00	$0.00	$ -	$ -	#DIV/0!	-
June	0	$0.00	0	0	$0.00	$0.00	$ -	$ -	#DIV/0!	-
July	0	$0.00	0	0	$0.00	$0.00	$ -	$ -	#DIV/0!	-
August	0	$0.00	0	0	$0.00	$0.00	$ -	$ -	#DIV/0!	-
September	0	$0.00	0	0	$0.00	$0.00	$ -	$ -	#DIV/0!	-
October	0	$0.00	0	0	$0.00	$0.00	$ -	$ -	#DIV/0!	-
November	0	$0.00	0	0	$0.00	$0.00	$ -	$ -	#DIV/0!	-
December	0	$0.00	0	0	$0.00	$0.00	$ -	$ -	#DIV/0!	-
January	0	$0.00	0	0	$0.00	$0.00	$ -	$ -	#DIV/0!	-
February	0	$0.00	0	0	$0.00	$0.00	$ -	$ -	#DIV/0!	-
TOTAL	0	$0.00	0	0	$0.00	$0.00	$ -	$ -	#DIV/0!	-

Month	HEATING FUEL			WATER					Total Utility Costs
	Therms	Avg Cost/Therm	Gas Cost	Gallons x 1000	Water Cost	Sewer Cost	Total Cost/kGal	Total Water Cost	
March	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$0.00
April	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$0.00
May	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$0.00
June	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$0.00
July	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$0.00
August	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$0.00
September	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$0.00
October	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$0.00
November	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$0.00
December	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$0.00
January	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$0.00
February	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$0.00
TOTAL	0	$ -	$0.00	0	$0.00	$0.00	$ -	$0.00	$0.00

Table B.18 Annual Utility Usage Summary – Water Treatment

City of Gladstone	Water Treatment Plant BASELINE DATA

Data Start Year	Utility Providers:		Utility Units:		
Average of Two Years	Electric Company	KCPL	Electricity	kWh	
April	Heating Fuel Company	Missouri Gas Energy	Heating Fuel	Therm	
	Water Company	City of Gladstone-Water, KC Water Services-Sewer	Water	kGal	

AVERAGE YEARLY SUMMARY ADJUSTED FOR BILLING PERIOD

Square feet	21,200	kWh/sf	106.34	Therm/sf	0.198	Water gal/sf	0.00	Total Btu/sf	382,731
Utility Cost/sf	$12.58	Avg Watts/sf	30.12	Gas $/Therm	$0.71	Water+Sewer $/kGal	$0.00	Total Utility Costs/Year	$266,725.17
Hours Operated	3,521	Electric $/sf	$12.44	Gas $/sf	$0.14	Water+Sewer $/sf	$0.00	Total Utility Cost-Water	$266,725.17

Month	ELECTRICITY									
	kWh	kWh Cost	Estimated KW	Billed kW	Demand (kW) Costs	Electric Cost	Avg Cost/kWh	Avg Cost/Estimated kW	% Load Factor	Min Hours (from peak demand)
April	164,932	$16,091.98	623	340	$1,936.42	$18,028.40	$ 0.0976	$ 3.110	37%	265
May	182,117	$18,053.85	660	502	$3,708.38	$21,762.23	$ 0.0991	$ 5.621	37%	276
June	209,139	$21,157.48	681	533	$4,640.19	$25,797.68	$ 0.1012	$ 6.812	43%	307
July	245,888	$24,431.24	724	569	$4,913.54	$29,344.77	$ 0.0994	$ 6.791	46%	340
August	220,908	$23,251.16	697	479	$4,146.00	$27,397.16	$ 0.1053	$ 5.952	43%	317
September	184,683	$18,847.91	612	404	$2,842.74	$21,690.65	$ 0.1021	$ 4.642	42%	302
October	184,727	$18,366.89	615	436	$2,528.14	$20,895.03	$ 0.0994	$ 4.112	40%	300
November	165,656	$16,710.06	579	405	$2,384.47	$19,094.53	$ 0.1009	$ 4.120	40%	286
December	180,287	$18,093.77	613	398	$2,404.73	$20,498.50	$ 0.1004	$ 3.920	40%	294
January	181,319	$18,080.67	623	411	$2,461.02	$20,541.69	$ 0.0997	$ 3.947	39%	291
February	162,454	$16,178.78	581	392	$2,287.96	$18,466.74	$ 0.0996	$ 3.939	42%	280
March	172,289	$17,678.20	654	441	$2,566.03	$20,244.23	$ 0.1026	$ 3.922	35%	263
TOTAL	2,254,399	$226,941.99	7,662	5,309	$36,819.62	$263,761.61	$ 0.101	$ 4.81	40%	3,521

Month	HEATING FUEL			WATER					Total Utility Costs
	Therms	Avg Cost/Therm	Gas Cost	Gallons x 1000	Water Cost	Sewer Cost	Total Cost/kGal	Total Water Cost	
April	134	$ 0.868	$116.19	0	$0.00	$0.00	$ -	$0.00	$18,144.60
May	20	$ 2.629	$52.49	0	$0.00	$0.00	$ -	$0.00	$21,814.71
June	4	$ 10.728	$41.57	0	$0.00	$0.00	$ -	$0.00	$25,839.25
July	4	$ 11.624	$41.53	0	$0.00	$0.00	$ -	$0.00	$29,386.31
August	4	$ 10.746	$43.62	0	$0.00	$0.00	$ -	$0.00	$27,440.78
September	7	$ 6.332	$42.95	0	$0.00	$0.00	$ -	$0.00	$21,733.59
October	53	$ 1.403	$74.63	0	$0.00	$0.00	$ -	$0.00	$20,969.67
November	383	$ 0.700	$267.92	0	$0.00	$0.00	$ -	$0.00	$19,362.45
December	1,104	$ 0.629	$694.91	0	$0.00	$0.00	$ -	$0.00	$21,193.41
January	1,309	$ 0.620	$811.48	0	$0.00	$0.00	$ -	$0.00	$21,353.17
February	769	$ 0.644	$494.71	0	$0.00	$0.00	$ -	$0.00	$18,961.45
March	407	$ 0.692	$281.55	0	$0.00	$0.00	$ -	$0.00	$20,525.78
TOTAL	4,196	$ 0.71	$2,963.56	0	$0.00	$0.00	$ -	$0.00	$266,725.17

SCHEDULE C
SAVINGS MEASUREMENT & VERIFICATION PLAN

The ESCO will guarantee the parameters set forth in this plan. The actual operation of the facility is the responsibility of the Customer. This includes properly maintaining the equipment, the future hours of operation based on a change in mission, or capacity and variations in weather or unit energy costs.

A. Utility Rates

The utility rates used in the energy savings calculations are not the average baseline rate which can be found in **Schedule B (Baseline Energy Consumption)** of this Contract. A more conservative approach was taken to match the savings rates with the appropriate tier from the actual utility rate tariff. These are included in Figure A.

Figure A.0 Measurement and Verification Methodology for Energy Conservation Measures

Facility	Summer Electric (kWh)	Summer Electric (kW)	Winter Electric (kWh)	Winter Electric (kW)	Blended Electric (kWh)	Blended Electric (kW)	First Year Gas (Therms)	After First Year Gas (Therms)
Animal Shelter	$0.0808	$3.07	$0.0646	$3.07	$0.0700	$3.07	$0.629	N/A
Atkins-Johnson Museum	$0.0808	$3.07	$0.0646	$3.07	$0.0700	$3.07	$0.629	N/A
Central Park Pool/Park	N/A	N/A	N/A	N/A	$0.0700	$3.07	$0.629	N/A
City Hall/ Public Safety	$0.0843	$7.41	$0.0949	$5.35	$0.0912	$6.04	$0.629	N/A
City Wide	$0.0629	$6.04	N/A	N/A	$0.0820	$0.00	$0.629	N/A
Community Center	$0.0697	$10.19	$0.0648	$7.05	$0.0658	$8.10	$0.675	$0.569
Fire Station #1	$0.0751	$7.41	$0.0568	$5.35	$0.0629	$6.04	$0.629	N/A
Fire Station #2	$0.0751	$7.41	$0.0568	$5.35	$0.0629	$6.04	$0.629	N/A
Hamilton Heights Park	N/A	N/A	N/A	N/A	$0.0700	$3.07	$0.629	N/A
Happy Rock Park	N/A	N/A	N/A	N/A	$0.1513	$3.07	$0.629	N/A
Linden Square Office	$0.0751	$7.41	$0.0568	$5.35	$0.0629	$6.04	$0.629	N/A
Oak Grove Park	N/A	N/A	N/A	N/A	$0.0700	$3.07	$0.629	N/A
Public Works	$0.0751	$7.41	$0.0476	$6.24	$0.0568	$6.63	$0.675	N/A
Water Treatment	$0.0751	$7.41	$0.0568	$5.35	$0.0629	$6.04	$0.629	N/A

Application of these rates are further defined in **Schedule A (Energy Savings Guarantee)**.

B. Energy Savings

The projected annual energy unit savings, as well as the conversion to a dollar amount, are shown in **Schedule A (Energy Savings Guarantee)** of this Contract. A measurement and verification report shall be prepared and provided to the Customer as outlined in **Schedule A (Energy Savings Guarantee)** of this Contract.

C. Methodologies for Energy Conservation Measures

1. Methodology

An overview of the energy conservation measures and the appropriate International Performance Measurement and Verification Protocol (IPMVP) measurement and verification methodology are shown in Figure C.1. "Calculation" means the savings have been calculated in the audit and agreed to by the Customer and the ESCO. "IPMVP Option" describes the IPMVP Option that has been selected for the given energy conservation measure (ECM). This requires measurements to determine the actual retrofit performance. In the "IPMVP Option" cases, the measured parameters, time of measurement and quantity of equipment to be measured are identified. Figure C.2 overviews the various IPMVP Options and their respective applications. One-time measurements will be taken at the end of construction. Additional monitoring of the retrofit performance beyond the scope described herein can be provided for an additional fee.

Figure C.1 Measurement and Verification Methodology for Energy Conservation Measures

ECM Description	Verification Methodology	Measured Parameter	Measurement Interval
Add Insulation Under Roof and In Attic	Calculation	N/A	N/A
Building Automation System	IPMVP Option A	Set Point / Scheduled Parameters	One Time
Demand Limiting Sequence in BAS	Calculation	N/A	N/A
Demand Management Strategy on High Lift Pumps	IPMVP Option A	Utility Bill Review	1 Month
Destratification Fans in Gymnasium and Main Hallway	Calculation	N/A	N/A
Energy Manager/Data Analytics	IPMVP Option A	Utility Bill Review	1 Year
Engine Block Heater Controllers	IPMVP Option B	OA Temp / Fixture kW	2 Weeks
Interlock Heaters with Rollup Doors	Calculation	N/A	N/A
Lighting Retrofit	IPMVP Option A	Fixture Wattage	One Time
Replace Electric Boiler and DHW with Gas Fired Unit	IPMVP Option A	Boiler Efficiency	One Time
Replace HVAC Equipment at City Hall / Public Safety	IPMVP Option B	Unit kW / Unit Tonnage	2 Weeks
Replace Rooftop Units at Community Center	IPMVP Option B	Unit kW / Unit Tonnage	2 Weeks
Replace Roof at City Hall / Public Safety	Calculation	N/A	N/A
Resolve Billing Errors with KCPL	IPMVP Option A	Utility Bill Review	1 Month
Retrofit Decorative Street Lights to LED	Calculation	N/A	N/A
Solar PV Power Generation	Calculation	N/A	N/A
Used Motor Oil Fired Heater	Calculation	N/A	N/A
Weatherization	Calculation	N/A	N/A

Figure C.2 IPMVP 2012 Volume 1 - Options

A. Partially Measured Retrofit Isolation	B. Retrofit Isolation	C. Whole Facility	D. Calibrated Simulation
Overview Savings are determined by partial field measurement of the energy use of the system(s) to which an ECM was applied, separate from the energy use of the rest of the facility. Measurements may be either short-term or continuous. Partial measurement means that some but not all parameter(s) may be stipulated, if the total impact of possible stipulation error(s) is not significant to the resultant savings. Careful review of ECM design and installation will ensure that stipulated values fairly represent the probable actual value. Stipulations should be shown in the M&V Plan along with analysis of the significance the error they may introduce.	Savings are determined by field measurement of the energy use of the systems to which the ECM was applied, separate from the energy use of the rest of the facility. Short-term or continuous measurements are taken throughout the post-retrofit period..	Savings are determined by measuring energy use at the whole facility level. Short-term or continuous measurements are taken throughout the post-retrofit period..	Savings are determined through simulation of the energy use of components or the whole facility. Simulation routines must be demonstrated to adequately model actual energy performance measured in the facility. This option usually requires considerable skill in calibrated simulation.
How Savings Are Calculated Engineering calculations using short term or continuous post-retrofit measurements and stipulations.	Engineering calculations using short term or continuous measurements.	Analysis of whole facility utility meter or sub-meter data using techniques from simple comparison to regression analysis.	Energy use simulation, calibrated with hourly or monthly utility billing data and/or end-use metering.
Typical Applications Lighting retrofit where power draw is measured periodically. Operating hours of the lights are assumed to be based on occupancy.	Applications of controls to vary the load on a constant speed pump using a variable speed drive. Electricity use is measured by a kWh meter installed on the electrical supply to the pump motor. In the base year this meter is in place for a week to verify constant loading. The meter is in place throughout the post-retrofit period to track variations in energy use.	Multifaceted energy management program affecting many systems in a building. Energy use is measured by the gas and electric utility meters for a twelve-month base ear period and throughout the post-retrofit period.	Multifaceted energy management program affecting many systems in a building but where no base year data are available. Post-retrofit period energy use is measured by the gas and electric utility meters. Base year energy is determined by simulation using a model calibrated by the post-retrofit period utility data.
Weakness Assumptions that are not measured are estimated and may be different than actual results. Does not consider whole utility bill or help provide knowledge of how all energy is being consumed.	More accurate, but also more expensive than option A. Does not consider whole utility bill or help provide knowledge of how all energy is being consumed.	Reviews entire utility bill, but does not give clarity to the role of each measure in actually achieving savings. “Baseline adjustments” cloud the achievement of real savings results	Reviews entire utility bill, but engineering calculations and estimates for the role of each measure in actually achieving savings. “Baseline adjustments” cloud the achievement of real savings results.

2. Calculation Formulae

   a. Measured Savings ECMs

      Savings for energy conservation measures listed as “Measurement” will be determined after testing and evaluation of the equipment. Utility bill consumption shall not be used to verify guaranteed savings achievement. Refer to **Schedule M (Detailed Savings Calculations)** for detailed savings calculations.

   b. Calculated Savings ECMs

      i. For all ECMs with calculated savings, no measurements shall be taken. The savings for the ECM have been reviewed and are accepted as calculated.

      ii. This calculation approach applies to the following ECMs:

         (1) Add insulation under roof and in Attic

         (2) Demand Limiting Sequence in BAS

         (3) Interlock heaters with rollup doors

         (4) Replace natatorium dehumidification units

         (5) Replace single pane windows

         (6) Retrofit decorative street lights to LED

         (7) Used motor oil fired heater

         (8) Weatherization

      iii. Building Automation System

         (1) Measurement Boundary: The ECM savings will be determined within a measurement boundary that encompasses only the building automation system (BAS) set points and buildings schedules. The set points and building occupancy schedules will be recorded to verify that these have been set up as defined in **Schedule N (Standards of Comfort)**.

         (2) Interactive Effects: The measurement boundary excludes:

            (a) The ongoing ability by the building maintenance staff to change the occupied time periods or temperature set points.

            (b) Changes in operational schedule, if the buildings are utilized more or less than the contracted values.

         (3) Measurement Process: Upon the completion of the controls portion of the project, the system temperature set points and occupancy schedule will be recorded and compared against the values given in **Schedule N (Standards of Comfort)**.

(4) Baseline Energy: The pre-retrofit building set points and schedules are estimated based upon the current operating schedule of the building and the current set points according to building maintenance staff.

(5) Independent Variables: While building occupancy and weather directly affect the usage of the facilities HVAC systems, these changes will not be directly measured as a part of this ECM measurement and verification.

(6) Post-Retrofit Test: Post-retrofit measurements will be taken within one month of completion of the HVAC controls installation. The information will be documented by reviewing the temperature set points and scheduling shown on the graphics of the BAS system.

(7) Assumptions: There are large variances in occupancy patterns within a facility throughout the year, and occupancy/usage is outside of the control of the ESCO. Therefore, the baseline number of occupied hours and the associated set points for the savings guarantee were determined prior to construction and were used for all savings calculations. The basis of the savings measurements for this ECM are determined upon the reduction in building HVAC equipment operation hours and associated unoccupied temperature set points.

(8) Building Automation System upgrade savings are verified by comparing the pre- and post-retrofit schedule and temperature set points. The savings are being guaranteed through calculated savings, but the parameters of the savings will be measured post-construction. The set points and schedules to be measured are listed in Figures C.3 – C.11.

Figure C.3 Building Automation System Schedules

Building	Measure Description	Existing HVAC Run-hours per Unit (Hours)	Estimated HVAC AC Run-hours per Unit (Hours)	Reduction in Run-hours (Hours)
Animal Shelter	Run-hours	6,425	5,945	480
Atkins-Johnson Museum	Run-hours	8,760	208	8,552
Community Center	Run-hours	6,387	5,252	1,135
City Hall / Public Safety – 1st Floor	Run-hours	5,292	3,328	1,964
City Hall / Public Safety – Ground Floor	Run-hours	8,760	5,668	3,092
Fire Station #1	Run-hours	8,760	6,812	1,948
Fire Station #2	Run-hours	8,760	6,812	1,948
Public Works	Run-hours	5,110	3,120	1,990
Water Treatment	Run-hours	8,760	4,745	4,015

Notes: 1) Represents an average between areas that can be set back and areas that are required to be occupied 24/7.

Figure C.4 Building Automation System Set Points – Animal Shelter

Measure Description	Existing HVAC Set Point	Proposed BAS Set Point	Reduction in Set Point
BAS Occupied Cooling	74°F	74°F	0°F
BAS Unoccupied Cooling	74°F	80°F	-6°F
BAS Occupied Heating	70°F	70°F	0°F
BAS Unoccupied Heating	70°F	60°F	10°F

Figure C.5 Building Automation System Set Points – Atkins-Johnson Museum

Measure Description	Existing HVAC Set Point	Proposed BAS Set Point	Reduction in Set Point
BAS Occupied Cooling	74°F	74°F	0°F
BAS Unoccupied Cooling	74°F	85°F	-11°F
BAS Occupied Heating	70°F	70°F	0°F
BAS Unoccupied Heating	70°F	55°F	15°F

Figure C.6 Building Automation System Set Points – Community Center

Measure Description	Existing HVAC Set Point	Proposed BAS Set Point	Reduction in Set Point
BAS Occupied Cooling	70°F	75°F	-5°F
BAS Unoccupied Cooling	79°F	85°F	-11°F
BAS Occupied Heating	68°F	70°F	-2°F
BAS Unoccupied Heating	61°F	60°F	1°F

Figure C.7 Building Automation System Set Points – City Hall / Public Safety – 1st Floor

Measure Description	Existing HVAC Set Point	Proposed BAS Set Point	Reduction in Set Point
BAS Occupied Cooling	72°F	75°F	-3°F
BAS Unoccupied Cooling	76°F	85°F	-9°F
BAS Occupied Heating	67°F	70°F	-3°F
BAS Unoccupied Heating	66°F	60°F	6°F

Figure C.8 Building Automation System Set Points – City Hall / Public Safety – Ground Floor

Measure Description	Existing HVAC Set Point	Proposed BAS Set Point	Reduction in Set Point
BAS Occupied Cooling	73°F	75°F	-2°F
BAS Unoccupied Cooling	75°F	85°F	-10°F
BAS Occupied Heating	69°F	70°F	-1°F
BAS Unoccupied Heating	67°F	60°F	7°F

Figure C.9 Building Automation System Set Points – Fire Station #1, Fire Station #2

Measure Description	Existing HVAC Set Point	Proposed BAS Set Point	Reduction in Set Point
BAS Occupied Cooling	74°F	74°F	0°F
BAS Unoccupied Cooling	74°F	85°F	-11°F
BAS Occupied Heating	70°F	70°F	0°F
BAS Unoccupied Heating	70°F	60°F	10°F

Figure C.10 Building Automation System Set Points – Public Works

Measure Description	Existing HVAC Set Point	Proposed BAS Set Point	Reduction in Set Point
BAS Occupied Cooling	74°F	74°F	0°F
BAS Unoccupied Cooling	80°F	85°F	-5°F
BAS Occupied Heating	68°F	68°F	0°F
BAS Unoccupied Heating	62°F	55°F	7°F

Figure C.11 Building Automation System Set Points – Water Treatment

Measure Description	Existing HVAC Set Point	Proposed BAS Set Point	Reduction in Set Point
BAS Occupied Cooling	74°F	74°F	0°F
BAS Unoccupied Cooling	74°F	85°F	-11°F
BAS Occupied Heating	70°F	70°F	0°F
BAS Unoccupied Heating	70°F	55°F	15°F

(9) This upgrade included the following buildings:

- Animal Shelter
- Atkins-Johnson Museum
- Community Center
- City Hall / Public Safety

- Fire Station #1
- Fire Station #2
- Public Works
- Water Treatment

iv. Demand Management Strategy on High Lift Pumps

(1) Measurement Boundary: ECM savings will be determined within a measurement boundary that encompasses only the high lift pumps (3 accounts / 3 meters).

(2) Interactive Effects: No interactive effects are identified.

(3) Measurement Process: Monthly utility bills will be inspected to verify that only one pump per account was operated during each month for 1 year.

(4) Baseline Demand: The baseline was established from pre-retrofit utility bills which show the total demand billed for the year prior to the retrofit.

(5) Independent Variables: Operation of the pumps is decided by Water Treatment Plant personnel so total demand per account is dependent of these decisions.

(6) Post-Retrofit Test: No tests will be performed. Inspection of monthly utility bills will provide the required data.

(7) Assumptions: Availability of at least one of two pumps in each account is necessary to make the demand savings. Unscheduled outages of pumps because of repairs may affect the demand savings.

(8) Measurement Cost and Accuracy: Using data recorded by the new utility meter on the account for pumps 1 and 2 will provide measurement accuracy and will minimize costs of implementation. If no more than one pump per account is operated at the same time during the test year, the savings will have been achieved.

(9) This upgrade included the following buildings:

- Water Treatment Plant

v. Energy Manager/Data Analytics

(1) Upon completion of the BAS upgrade, a data analytics software package will be integrated with the control system. The data analytics platform with monitor all the relevant HVAC points and set points every fifteen minutes and record this information for analysis by ESCO.

The savings for this ECM are realized through a continuous commissioning style approach of catching operational issues real-time and ensuring that set points and equipment operation are correct on a daily and weekly basis. This trended information is also run through an analytics engine to identify poor operating conditions, incorrect set points, or failed equipment.

The output from the data analytics process are then tracked and shared with the Customer to improve the efficiency of the HVAC systems and occupant comfort continually. This service is provided to the customer for three (3) years post construction.

(2) This upgrade included the following buildings:

- City Wide

vi. Engine Block Heater Controllers

(1) Measurement Boundary: ECM savings will be determined within a measurement boundary that encompasses only the circuit downstream of the block heater controller. Measurements will be taken on the electrical power supplied to the fixture and the outdoor air temperature only.

(2) Interactive Effects: The measurement boundary excludes the actual kW usage of the individual block heaters. Since the installed controller is only cycling the power on and off, the actual power draw of the block heaters shall not be measured.

(3) Measurement Process: Current transducers will be placed on the circuit downstream of the block heater controller and temperature probes will be placed near where the block heaters are being used. The data loggers will measure the current and outdoor air temperature at regular intervals. This information will be used to determine the runtime at the various outdoor air temperatures and determine how often the block heaters are operated outside of the scheduled time.

(4) Baseline Energy: The pre-retrofit block heater runtimes shall be determined from analyzing the utility bills and recording the block heater operation through interviewing the facility staff.

(5) Post-Retrofit Test: Post-retrofit measurements will be taken during the first winter period after the block heater controllers are installed. The test procedure will be as outlined in the measurement process. The average block heater runtime across all circuits measured will be used to determine the final savings.

(6) Assumptions: The baseline usage of the block heaters will be assumed as outlined in the baseline energy. Therefore, the number of run hours for the savings guarantee were determined prior to construction and will be used for all savings calculations. The basis of the savings measurements for this ECM are determined upon the reduction in runtime based upon the difference between the baseline usage and the post retrofit usage.

(7) Measurement Cost and Accuracy: an adequate number of pre and post measurements will be taken to ensure a maximum sampling error of +/- 10% with an overall confidence in the average wattage of 80%. This will result in an overall accuracy of the savings of +/- 7.1%.

If the average reduction in run hours from the pre- to post-construction is greater than the reduction in hours recorded in Figure C.12, the savings are achieved as guaranteed.

Figure C.12 Block Heater Controller Runtime

Measure Description	Existing Block Heater Runtime (hours)	Post Construction Block Heater Runtime (Hours)	Guaranteed Block Heater Runtime (Hours)
Block Heater Controller	960	377	396

(8) This upgrade included the following buildings:

- Public Works

vii. Lighting Upgrades

(1) Measurement Boundary: ECM savings will be determined within a measurement boundary that encompasses only the new and retrofitted light fixtures installed as a part of this project. Measurements will be taken on the electrical power supplied to the fixture only.

(2) Interactive Effects: The measurement boundary excludes:

(a) The project's energy interactions with the building HVAC systems. From simple HVAC heating and cooling cost analysis for this type of building, it has been determined that the cost of the extra winter heating in the perimeter zones is approximately offset by the reduction in cooling cost in the summer. Therefore, the heating and cooling load cost impacts are ignored.

(b) There will not be changes to the task lighting within the facility, therefore none of the task lighting power consumption will be measured.

(3) Measurement Process: Lighting wattages will be measured using a true RMS style clamp-on voltage/amperage meter. The lights within the facility will be randomly selected and the voltage and amperage will be measured at the switch. The wattage is calculated by multiplying the measured amperage by the measured voltage. When multiple fixtures are located on a single circuit, the total wattage of the circuit will be divided by the number of fixtures present to obtain a per fixture wattage. Any lamps that are not functional or burnt out will be factored into the calculation and removed from the total wattage.

(4) Baseline Energy: The pre-retrofit measurements will be taken prior to the removal or retrofit of the existing fixtures. The average wattage for each fixture type identified in Figure C.13 at the end of this section will be determined, along with the sampling error achieved to determine the final savings.

(5) Independent Variables: The lighting measurements will be taken of existing and retrofitted fixtures within 1 month of the installation. There are no routinely varying factors that affect lighting power in this short of a timeframe; therefore, no independence variables will be measured.

(6) Post-Retrofit Test: Post-retrofit measurements will be taken within one month of installation. The test procedure will be the same as the baseline measurements. Due to a higher consistency in new fixtures a lower sample size can be used to achieve the same level of confidence in the measurements. The average lamp wattage for each fixture or lamp type will be recorded and used for the final savings verification. Any lamps that are discovered to be burnt out during the measurement and verification process will be replaced prior to the measurements being taken.

(7) Assumptions: There are large variances in occupancy patterns within a facility, and occupancy/usage is outside of the control of the ESCO. Therefore, the number of occupied hours for the savings guarantee were determined prior to construction and will be used for all savings calculations. The basis of the savings measurements for this ECM are determined upon the reduction in wattage.

(8) Measurement Cost and Accuracy: an adequate number of pre and post measurements will be taken to ensure a maximum sampling error of +/- 5% with an overall confidence in the average wattage of 95%. This will result in an overall accuracy of the savings of +/- 7.1%.

Lighting upgrade savings are verified by taking pre- and post-retrofit measurements to verify that the reduction in lighting wattages are equal to or greater than those shown in Figure C.13. If the average wattage reduction of a given fixture type exceeds the value shown, the savings are achieved as guaranteed. The fixture type, quantity installed, and quantities to be measured are listed in Figure C.13. These fixture types account for over 83% of the total lighting savings.

These fixtures will be measured in accordance with the measurement interval descriptions outlined in Figure C.1. Where multiple fixtures can be measured from a single switch or circuit, the total wattage measured at the switch or circuit will be divided by the total number of fixtures to determine the wattage per fixture.

Figure C.13 Fixture Types Included in the Lighting Measurements

Fixture Type	Total Quantity	Quantity Measured	Existing Wattage	New Wattage	Wattage Reduction	Guaranteed Wattage Reduction	% of Lighting Savings
CFL-CF13W-1	29	0	62	46	16	14	0%
CFL-CF13W-2	6	0	231	136	95	85	0%
CFL-CF15W-2	1	0	149	114	35	32	0%
CFL-CF26W-1	38	0	114	64	50	45	0%
CFL-CF26W-2	45	0	248	82	165	149	1%
CFL-CF27W-9	9	0	1,421	551	870	783	1%
CFL-CF32W-1	25	0	216	99	116	105	0%
CFL-CF36W-2	22	0	377	156	221	199	1%
CFL-CF42W-1	143	0	252	93	159	143	3%
CFL-CF42W-2	14	0	525	121	404	364	1%
CFL-CF42W-3	44	0	740	184	557	501	3%
EXIT-I15-1	54	0	144	8	136	122	1%
EXIT-Tritium0-1	5	0	149	149	0	0	0%
F-F14T5-2	37	0	147	158	-11	0	0%
F-F17T8-2	25	0	124	99	25	23	0%
F-F17T8-3	156	0	290	160	130	117	3%
F-F25T8-2	7	0	294	126	168	151	0%
F-F28T5-2	40	0	116	52	64	58	0%
F-F32T8-1	37	0	209	70	139	125	1%
F-F32T8-2	705	71	305	134	171	154	15%
F-F32T8-3	237	24	504	151	353	318	11%
F-F32T8-4	23	0	839	251	588	529	2%
F-F54T5HO-1	17	0	284	131	152	137	0%
F-F54T5HO-2	1	0	567	263	305	274	0%
F-F54T5HO-3	8	0	851	394	457	411	0%
F-F54T5HO-4	68	0	905	475	429	386	4%
F-F96T12-2	40	0	90	24	67	60	0%
F-F96T8-2	3	0	355	127	228	205	0%
HAL-H35/LV-1	32	0	141	22	119	108	0%
HAL-H35/LV-2	7	0	307	61	245	221	0%
HAL-H35-1	4	0	184	37	147	132	0%
HAL-H50-1	53	0	289	52	237	213	2%
HAL-H50-2	4	0	438	74	364	327	0%
HAL-H75-1	94	0	394	117	277	249	3%
INCAN-I40-1	2	0	32	4	28	25	0%
INCAN-I42-2	2	0	67	14	53	48	0%
INCAN-I42-3	1	0	101	22	79	71	0%
INCAN-I60-1	27	0	283	58	225	202	1%
INCAN-I60-2	4	0	696	104	592	532	0%
INCAN-I75-1	17	0	372	114	258	232	1%
LED-L10-1	10	0	50	40	10	9	0%
LED-L12-1	13	0	46	34	12	11	0%
LED-L16-1	4	0	33	33	0	0	0%
LED-L20-1	39	0	71	71	0	0	0%
LED-L40-1	1	0	175	175	0	0	0%
LED-L8-1	5	0	46	46	0	0	0%
MH-MH1000-1	9	0	1,517	364	1,153	1,038	1%
MH-MH100-1	8	0	526	125	401	361	0%
MH-MH150-1	1	0	832	123	710	639	0%
MH-MH175-1	57	6	864	168	697	627	5%
MH-MH175-2	48	5	1,533	350	1,183	1,064	7%
MH-MH250-1	14	0	1,292	240	1,052	947	2%
MH-MH250-2	8	0	1,095	473	622	560	1%
MH-MH35-1	40	0	184	123	61	55	0%
MH-MH400-1	35	4	2,667	559	2,109	1,898	9%
MH-MH400-2	33	3	4,778	1,237	3,541	3,187	15%
MH-MH400-4	1	0	7,008	2,102	4,906	4,415	1%
MH-MH70-1	34	0	408	111	297	267	1%
QUARTZ-Q150-1	9	0	788	788	0	0	0%
UFL-FU31T8/6-2	80	0	236	102	134	120	1%

(9) This upgrade included the following buildings:

- Animal Shelter
- Atkins-Johnson Museum
- Central Park Pool/Park
- City Hall/Public Safety
- Community Center
- Fire Station #1
- Fire Station #2
- Hamilton Heights Park
- Oak Grove Park
- Public Works
- Water Treatment

viii. Replace Electric Boiler and Domestic Hot Water with Gas-Fired Unit

(1) Measurement Boundary: ECM savings will be determined within a measurement boundary that encompasses only the new boiler and the boiler exhaust stack. Measurements will be taken within the exhaust of the new boiler only.

(2) Interactive Effects: The measurement boundary excludes the control and sequencing of the boilers. How boilers are controlled can affect the efficiency and runtimes of the boilers. The measurement of this ECM only accounts for the efficiency of the actual high fire rate of the boiler itself. Therefore, the sequencing and runtimes of the boiler plant are ignored.

(3) Measurement Process: A flue gas analyzer will be placed into the exhaust of the boilers. The flue gas analyzer will be inserted as close to the exit of the boiler as is practical to measure as accurately as possible the true efficiency of the boiler. A minimum of two measurements per boiler shall be taken to ensure accuracy.

(4) Baseline Energy: The pre-retrofit measurements will be taken prior to the removal or retrofit of the existing boilers. The average boiler efficiency will be taken and used to identify the baseline boiler efficiency and to determine the savings.

(5) Independent Variables: The boiler efficiency measurements will be taken of existing and retrofitted fixtures within 1 month of the installation. There are no routinely varying factors that affect boiler efficiency in this short of a timeframe; therefore, no independence variables will be measured.

(6) Post-Retrofit Test: Post-retrofit measurements will be taken within one month of installation or as soon as heating season is in effect to allow fully loading the boiler plant. The test procedure will be the same as the baseline measurements. The average boiler efficiency for all accurate measurements will be recorded and used for the final savings verification.

(7) Assumptions: There are large variances in occupancy patterns within a facility, and occupancy/usage is outside of the control of the ESCO. Therefore, the number of occupied hours for the savings guarantee were determined prior to construction and will be used for all savings calculations. The basis of the savings measurements for this ECM are determined upon the reduction in wattage.

(8) Measurement Cost and Accuracy: A minimum of two tests per boiler will be taken to determine savings. The sampling error and overall confidence will be recorded in the final measurement and verification report.

The efficiency rating of a heating boiler is determined by measuring combustion efficiency, which is a value of MBTUs of gas input less the stack loss, per MBTUs of gas input, or percent efficiency. This method does not account for the heat losses through the skin of the boiler to the surrounding boiler room, which is known as radiant and convective losses. These losses can be estimated from the boiler manufacturer's data. The overall efficiency of the boiler is defined as the fuel-to-water efficiency, which includes the stack loss as well as the radiant and convective losses. The savings calculations are developed by the calculating the dollar savings from converting fuel types from electricity to natural gas. The combustion efficiency will be measured by taking a sampling of flue gas to determine the oxygen concentration, CO2 concentration, as well as the temperature of the flue gas. These values will be utilized to calculate the operational combustion efficiency (percentage) of the boiler. The savings for this ECM will be achieved if the measured efficiency of the installed natural gas boiler and domestic water heater are above the values stated in the ECM calculation.

(9) This upgrade included the following buildings:

- Community Center

ix. Replace HVAC Equipment at City Hall / Public Safety

(1) Measurement Boundary: ECM savings will be determined within a measurement boundary that encompasses only the new HVAC equipment (rooftop units and split systems) installed as a part of this project. Measurements will be taken on the electrical power supplied, and supply, return and outside air enthalpy.

(2) Interactive Effects: The measurement boundary excludes the HVAC equipment hours of operation; only the efficiency of the unit during peak loading will be measured. Therefore, the frequency of use and associated cost impacts are ignored as a part of this ECM.

(3) Measurement Process: Rooftop unit efficiency will be measured using multiple meter readings on the power supplied to the equipment: CTs connected on the power supply to the unit, and temperature/humidity sensors placed in the supply air from the unit, the return air to the unit, and the outside air. The sensors and CTs will be connected to a data logger; this data logger will remain in place for at least two weeks to collect data on the unit operation.

(4) Baseline Energy: The pre-retrofit measurements will be taken prior to the removal of the existing units and when peak outdoor air temperature is anticipated to be above 80°F for at least five (5) days of the measurement period. The average kW/ton for the rooftop units will be determined, along with the sampling error achieved to determine the final savings.

(5) Post-Retrofit Test: Post-retrofit measurements will be taken when peak outdoor air temperature is anticipated to be above 80°F for at least five (5) days of the

measurement period. The test procedure and calculations will be the same as the baseline measurements.

(6) Assumptions: The process of calculating the kW/ton energy efficiency of HVAC equipment requires the data logging of a vast array of points. Inherent to the gathering of many data points is a certain level of inaccuracy. The calculations are compiled using ranges to filter the data. For example, the data is filtered to account for only the times that: the discharge air temperature is in a range that proves the unit is operating in cooling mode, the amperage of the unit proves that the compressors are running, and the total tonnage being produced is within 15%-20% of the nameplate tonnage. This ensures that we are gathering and using data that correlates to the unit being fully loaded. The rest of the data gathered is ignored, as it is not relevant to the calculation.

It is assumed that the outdoor air damper to the unit will be closed and not operated during the data logging of the unit. Not having outdoor air to the unit will decrease the number of variables and allow for a more accurate measurement.

(7) Measurement Cost and Accuracy: Two existing RTUs and two existing split systems, and two new RTUs and two new split systems will be measured. The associated sampling error, confidence, and final variance in the savings will be recorded in the final M&V form after the measurements are taken.

HVAC equipment replacement savings are verified by taking pre- and post-retrofit measurements to verify that the difference in unit kW/ton efficiency pre- to post-construction is greater than or equal to the kW/ton reduction numbers located in Figure C.14 and C.15. If the average reduction in kW/ton from the pre- to post-construction is greater than the reduction in kW/ton recorded in these tables, the savings are achieved as guaranteed.

Figure C.14 Rooftop Unit Efficiencies

Measure Description	Existing RTU Efficiency (kW/ton)	New RTU Efficiency (kW/ton)	Calculated Variance	Guaranteed kW/ton Reduction
RTU Replacement Unit 5	1.2	0.86	0.34	0.32
RTU Replacement Unit 7	1.2	1.0	0.2	0.19

Figure C.15 Split-System Unit Efficiencies

Measure Description	Existing RTU Efficiency (kW/ton)	New RTU Efficiency (kW/ton)	Calculated Variance	Guaranteed kW/ton Reduction
Split System Replacement	1.2	0.86	0.34	0.32

(8) This upgrade included the following buildings:

- City Hall/Public Safety

x. Replace Rooftop Units at Community Center

(1) Measurement Boundary: ECM savings will be determined within a measurement boundary that encompasses only the new rooftop units installed as a part of this project. Measurements will be taken on the electrical power supplied, and supply, return and outside air enthalpy.

(2) Interactive Effects: The measurement boundary excludes the rooftop unit hours of operation; only the efficiency of the unit during peak loading will be measured. Therefore, the frequency of use and associated cost impacts are ignored as a part of this ECM.

(3) Measurement Process: Rooftop unit efficiency will be measured using multiple meter readings on the power supplied to the unit: CTs connected on the power supply to the unit, and temperature/humidity sensors placed in the supply air from the unit, the return air to the unit, and the outside air. The sensors and CTs will be connected to a data logger; this data logger will remain in place for at least two weeks to collect data on the unit operation.

(4) Baseline Energy: The pre-retrofit measurements will be taken prior to the removal of the existing units and when peak outdoor air temperature is anticipated to be above 80°F for at least five (5) days of the measurement period. The average kW/ton for the rooftop units will be determined, along with the sampling error achieved to determine the final savings.

(5) Post-Retrofit Test: Post-retrofit measurements will be taken when peak outdoor air temperature is anticipated to be above 80°F for at least five (5) days of the measurement period. The test procedure and calculations will be the same as the baseline measurements.

(6) Assumptions: The process of calculating the kW/ton energy efficiency of an RTU requires the data logging of a vast array of points. Inherent to the gathering of many data points is a certain level of inaccuracy. The calculations are compiled using ranges to filter the data. For example, the data is filtered to account for only the times that: the discharge air temperature is in a range that proves the unit is operating in cooling mode, the amperage of the unit proves that the compressors are running, and the total tonnage being produced is within 15%-20% of the nameplate tonnage. This ensures that we are gathering and using data that correlates to the unit being fully loaded. The rest of the data gathered is ignored, as it is not relevant to the calculation.

It is assumed that the outdoor air damper to the unit will be closed and not operated during the data logging of the unit. Not having outdoor air to the unit will decrease the number of variables and allow for a more accurate measurement.

(7) Measurement Cost and Accuracy: Two existing units and two new units will be measured. The associated sampling error, confidence, and final variance in the savings will be recorded in the final M&V form after the measurements are taken.

Rooftop unit replacement savings are verified by taking pre- and post-retrofit measurements to verify that the difference in rooftop unit kW/ton efficiency pre- to post-construction is greater than or equal to the kW/ton reduction numbers located in Figure C.16. If the average reduction in kW/ton from the pre- to post-construction is greater than the reduction in kW/ton recorded in Figure C.9, the savings are achieved as guaranteed.

Figure C.16 Rooftop Unit Efficiencies

Measure Description	Existing RTU Efficiency (kW/ton)	New RTU Efficiency (kW/ton)	Calculated Variance	Guaranteed kW/ton Reduction
RTU Replacement Unit 1	1.58	1.19	0.39	0.37

(8) This upgrade included the following buildings:

- Community Center

xi. Resolve Billing Errors with KCPL

(1) The savings for this ECM are based upon working with KCPL to correct the demand charges that are present on the existing bills at the Water Treatment Facility. The bills shall be reviews after the errors have been resolved to ensure that the overcharges have been removed. The savings will be achieved if the over charges have been removed from the bills as shown in the ECM calculations.

(2) This upgrade included the following buildings:

- Water Treatment

xii. Solar PV Power Generation

(1) Installation of solar PV arrays will reduce the electric demand and kWh required to be provided from the electric company. The power generation and energy production are calculated based on industry standard information for the location of the solar PV arrays. No measurements will be taken.

(2) This upgrade included the following buildings:

- Community Center
- Water Treatment

B. Measurement Templates

The forms shown in Figures C.17 – C.22 will be used to measure and verify savings guaranteed by this Contract.

Although there is no guarantee associated with the temperature set points or scheduling setup in the energy management system, ESCO finds it beneficial to document these parameters, and make adjustments as necessary to meet or improve upon the existing established operating conditions.

Verification documentation for temperature set points and scheduling will include screenshots of the BAS graphic user interface screens showing this information.

Figure C.17 Boiler Replacement Measurement and Verification Form

Boiler Replacement Measurement and Verification Form					
	Boiler Tag	Flue Gas Temperature (°F)	Excess Oxygen (percent)	Combustion Efficiency (percent)	Efficiency Goal (percent)
1					
2					
3					
4					

Figure C.18 Building Automation System Set Points Measurement and Verification Form

Building Automation System Setpoint Measurement & Verification Form								
To insure the savings projected are realized, the following settings and set points should be maintained.								
Location	**Heating (April)**				**Cooling (April)**			
	Occupied Goal	**Occupied Actual**	**Unoccupied Goal**	**Unoccupied Actual**	**Occupied Goal**	**Occupied Actual**	**Unoccupied Goal**	**Unoccupied Actual**
Building #1	71	71	55	55	74	74	85	85
Building #2	71	71	55	55	74	74	85	85

Figure C.19 Building Automation System Schedules Measurement and Verification Form

Building Automation System Schedule Measurement & Verification Form			
To ensure the savings projected are realized, the following settings and set points should be maintained.			
Location	**Contract Schedule**	**Observed Schedule July**	**Observed Schedule April**
Building #1	Summer Break: Unoccupied	Summer Break: Unoccupied	Winter/Spring Break: Unoccupied
	School Year: Occupied 8:45 am - 3:40 pm MTWF, 8:45 am - 3:05 pm Thurs	Occupied: 8:15 am - 4:45 pm M-F	Occupied: 8:15 am - 4:45 pm M-F
	Holiday: Unoccupied	Unoccupied	Unoccupied
	Weekend: Unoccupied	Unoccupied	Unoccupied
Building #1	Summer Break: Unoccupied	Summer Break: Unoccupied	Winter/Spring Break: Unoccupied
	School Year: Occupied 9:15 am - 4:10 pm MTWF, 9:15 am - 3:35 pm Thurs	Occupied: 7:00 am - 4:00 pm M-F	Occupied: 7:00 am - 4:00 pm M-F
	Holiday: Unoccupied	Unoccupied	Unoccupied
	Weekend: Unoccupied	Unoccupied	Unoccupied

Figure C.20 Block Heater Controllers Measurement and Verification Form

Block Heater Measurement and Verification Form						
School District						
	Pre-Retrofit			Post-Retrofit		
OA Temp (F)	% of Time at OA Temp	% of Time Running	Run Hours	% of Time at OA Temp	% of Time Running	Run Hours
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						
	Total Hours				Total Hours	
	Runtime Per HDD				Runtime Per HDD	
Total Reduction in Runtime Per HDD						

Figure C.21 HVAC Equipment Replacement (Rooftop Units) Measurement and Verification Form

Rooftop Unit Measurement and Verification Form

Existing Unit	Unit Capacity (Tons)	Unit Voltage/Phase	RA Temp (°F)	RA Enthalpy (BTU/LB)	RA RH (%)	SA Volume (CFM)	SA RH (%)	Power Factor	OA Volume (CFM)	Time	OA Temp (°F)	SA Temp (°F)	Unit Amperage	OA RH (%)	OA Enthaply (BTU/LB)	MA Enthalpy (BTU/LB)	SA Enthalpy (BTU/LB)	Tons	Unit Power w/o Fan (kW)	kW/Ton (Total BTU/LB)
New Unit	Unit Capacity (Tons)	Unit Voltage/Phase	RA Temp (°F)	RA Enthalpy (BTU/LB)	RA RH (%)	SA Volume (CFM)	SA RH (%)	Power Factor	OA Volume (CFM)	Time	OA Temp (°F)	SA Temp (°F)	Unit Amperage	OA RH (%)	OA Enthaply (BTU/LB)	MA Enthalpy (BTU/LB)	SA Enthalpy (BTU/LB)	Tons	Unit Power w/o Fan (kW)	kW/Ton (Total BTU/LB)

Existing Roof-Top Unit Tag	Existing kW/Ton	New Roof-Top Unit Tag	New kW/Ton

Measure Description	Existing RTU kW/ton	New RTU kW/ton	Goal kW/ton Improvement	Guaranteed kW/ton Improvement	Actual kW/ton Improvement
From Contract	1.32	0.98	0.34	0.31	
Actual Measurements					

Figure C.22 Lighting Retrofit (Pre-Construction) Measurement and Verification Form

Lighting Upgrade Measurement and Verification Form							
The actual location of each circuit measured will be documented at the time the measurements are taken.							
	Location	Fixtures/Circuit	Goal Watts/Fixture	Goal Voltage	Measured Watts	Measured Voltage	Watts/Fixture
Fixture #1							
Building #1	Room #1						
Building #1	Room #2						
Building #1	Room #3						
Fixture #2							
Building #2	Room #1						
Building #2	Room #2						
Building #2	Room #3						
Fixture #3							
Building #3	Room #1						
Building #3	Room #2						
Building #3	Room #3						
NEW 160w LED Flood							

SCHEDULE D
UTILITY MONITORING AND ENERGY MANAGEMENT PROGRAM

A. Utility Bill Monitoring

ESCO will collect and monitor Customer's monthly electric, natural gas and water/sewer utility bills for a period of three (3) years from final ECM installation completion "Project Completion". Customer is responsible to authorize its utility providers to provide ESCO with any necessary utility bill information or online account information or Customer will send copies of all energy bills to ESCO within thirty (30) days of receipt for the utility monitoring period.

ESCO will periodically meet with Customer – at least semi-annually – to review utility use and cost information compared to the Energy Baseline. ESCO will provide an annual utility monitoring report within for an agreed upon 12-month period following Project Completion that may correspond to Customer's fiscal year.

1. Factors Impacting Utility Bills

   There are many unpredictable factors that can affect utility costs of Customer's facility that are outside the control of ESCO. Material changes to facility use or operation often occur as a result of:

   - Physical changes to facilities (renovations, extensions, additions, closures or other changes in load characteristics)
   - Changes in usage, occupancy, hours of operation or building activity
   - Changes in the amount of space being heated or air conditioned
   - Changes in energy subsystems and end use equipment/appliances
   - Changes in the amount or use of equipment
   - Changes in environmental conditions (lighting levels, set point temperatures, etc.)
   - Changes in maintenance practices
   - Changes in utility rates or billing period length
   - Changes or variations in weather causing additional heating or cooling.

   These factors may impact Customer's utility costs even though the efficiency of equipment implemented by ESCO continues to operate at proper efficiencies. ESCO will work with Customer to discuss these types of issues and assist Customer to best manage utility costs.

2. Energy Star Certification Application

   ESCO will enter Customer's utility data, for buildings included in this Agreement, into U.S. EPA's ENERGY STAR Portfolio Manager® online energy benchmarking program. ESCO will perform all other Energy Star program requirements necessary to submit eligible buildings within 120 days after Project Completion.

B. Data Analytics and Monitoring

ESCO will install additional monitoring and communication equipment and integrate with ESCO's data analytics software to automatically analyzes building energy usage (15-minute data) and HVAC equipment operation to identify issues, faults and opportunities for additional and ongoing performance optimization savings. Specifically, the following meters and HVAC building automation systems are included:

- City Hall electric meter and natural gas meter
- Community Center electric meter and natural gas meter
- HVAC Building Automation System ("BAS") for City Hall, Community Center, Fire Station #1, Fire Station #2 and Public Works Building.

If, a data communication failure occurs related to Customer's Ethernet or network, Customer will promptly repair internal communication equipment to restore access.

C. Energy Performance Management

Visible, clearly defined objectives require a well-conceived energy policy that defines expectations for building performance and district-wide operational standards. These standards will provide Customer administrators and staff with best practices to help implement and maintain energy efficiency in this multi-campus organization. Currently Customer does not have this type of policy or organizational approach in place. To promote adoption of energy efficiency policy, Customer will create an energy committee to discuss and evaluate how the organization can impact potential energy saving solutions and results. ESCO will provide services of an Energy Manager following Project Completion to support Customer in managing an Energy Performance Management Program.

ESCO's Energy Manager role is to provide leadership and support the following actions:

- Create, implement, manage, and report on Customer's energy management policy.
- Create, implement, manage, and report on Customer's energy conservation procedures and guidelines.
- Periodically audit buildings (to include nights and weekends) and record findings of energy efficiency practice adoption.
- Train facility managers and custodians in proper energy saving techniques and operating plans.
- Train facility managers and custodians on how to shut-down properly for unoccupied periods such as weekends and holidays
- Monitor utility usage through utility bills and data analytics to find patterns of energy use that can be improved.
- Verify accuracy of utility bills and rate schedules
- Report of savings to administrators and building managers
- Work closely with maintenance personnel in solving energy related problems
- Periodic training of maintenance and operation personnel in energy savings methods
- Report projected energy savings compared to actual energy savings to the Customer

D. Extension of Utility Monitoring and Energy Management Program

The Utility Monitoring and Energy Management Program defined in this Schedule D will be performed by ESCO for a period of three (3) years following Project Completion. These services will automatically renew and continue for a period of two (2) additional years upon approval of ESCO's proposal by Customer which will be submitted sixty (60) days prior to the last month of the three year continuing services period.

SCHEDULE E
FINAL PROJECT COST & PROJECT CASH FLOW ANALYSIS

A. ESCO Implementation Costs

Table E.1 identifies each energy conservation measure ("ECM") included and the total costs include the full turn-key development and implementation including the design, construction, project management, and other related energy services to complete the ECM scope of work. The pricing received for ECMs and ESCO's Contract Sum is valid until **October 31, 2017**. If this Contract is not executed in this timeframe, new pricing may be required and adjustments will be made.

Contract Sum for the Work is Four Million, Fifty-Five Thousand, Two Hundred and Eighty-Seven Dollars ($4,055,287)

B. Customer Annual Cash-Flow Analysis

The projected cash flow analysis for the costs and savings associated with implementing the measures identified in Table E.1 is shown in Table E.2. Included in the cash flow is a potential one-time reimbursement from KCP&L for overcharges on one of the deepwell pump electric accounts. This repayment negotiation with KCP&L has not been concluded and agreed upon by KCP&L so Customer is at risk that the Year One positive cash flow may not materialize. Two financial proformas are included in this Schedule – one with KCP&L reimbursement included and one without. Further description of the well pump account reimbursement is included in Schedule M.

Table E.1 Energy Conservation Measure Summary Table

ECM Description	Projected Energy Savings	Operation & Maintenance Savings	Total Projected Savings	Project Cost
AJM-Exterior Lighting to LED	$13.00	$50.00	$63.00	$185
AJM-Interior Lighting to LED	$237.00	$304.00	$541.00	$3,630
AJM-New Building Automation System	$1,897.00	$284.00	$2,181.00	$7,712
AJM Total	$2,147.00	$638.00	$2,785.00	$11,527
ASR-Exterior Lighting to LED	$22.00	$68.00	$90.00	$2,418
ASR-Interior Lighting to LED	$260.00	$180.00	$440.00	$8,541
ASR-New Building Automation System	$1,652.00	$180.00	$1,832.00	$16,261
ASR-Replace HVAC Equipment	$271.00	$464.00	$735.00	$32,718
ASR-Weatherization	$107.00	$0.00	$107.00	$1,295
ASR Total	$2,312.00	$892.00	$3,204.00	$61,233
CCR-Demand Limiting Sequence in BAS Controls	$1,673.00	$0.00	$1,673.00	$9,066
CCR-Destratification Fans in Main Entry Hallway	$258.00	$0.00	$258.00	$18,026
CCR-Exterior Lighting to LED	$2,032.00	$1,580.00	$3,612.00	$42,229
CCR-Interior Lighting to LED	$35,815.00	$10,338.00	$46,153.00	$331,146
CCR-Replace Electric Boiler with Gas-Fired Unit and HX Addition	$17,923.00	$276.00	$18,199.00	$88,849
CCR-Replace Electric DHW Boilers w/ Gas Unit	$24,728.00	$1,996.00	$26,724.00	$89,648
CCR-Replace Emergency Lighting Inverter	$0.00	$874.00	$874.00	$48,445
CCR-Replace Rooftop Units	$50,073.00	$14,610.00	$64,683.00	$648,998
CCR-Solar PV Power Generation	$10,308.00	$0.00	$10,308.00	$175,355
CCR-Upgrade or Replace Building Automation System	$5,429.00	$1,050.00	$6,479.00	$108,846
CCR-Weatherization	$745.00	$0.00	$745.00	$8,829
CCR Total	$148,984.00	$30,724.00	$179,708.00	$1,569,436
CHPS-Exterior Lighting to LED	$734.00	$490.00	$1,224.00	$6,833
CHPS-Interior Lighting to LED	$13,888.00	$2,752.00	$16,640.00	$118,668
CHPS-Replace HVAC Equipment	$5,765.00	$3,972.00	$9,737.00	$595,946
CHPS-Roof Replacement	$503.00	$2,304.00	$2,807.00	$393,745
CHPS-Upgrade or Replace Building Automation System	$3,624.00	$1,612.00	$5,236.00	$70,833
CHPS-Weatherization	$258.00	$0.00	$258.00	$3,336
CHP Total	$24,772.00	$11,130.00	$35,902.00	$1,189,361
CPK-Exterior Lighting to LED	$2,502.00	$622.00	$3,124.00	$20,867
CPK-Interior Lighting to LED	$143.00	$170.00	$313.00	$4,072
CPK Total	$2,645.00	$792.00	$3,437.00	$24,939
CWE-Energy Manager / Data Analytics	$37,760.00	$5,188.00	$42,948.00	$405,971
CWE-Retrofit Decorative Street Lights to LED	$6,672.00	$1,468.00	$8,140.00	$74,295
CWE Total	$44,432.00	$6,656.00	$51,088.00	$480,266
FS1-Exterior Lighting to LED	$106.00	$186.00	$292.00	$2,768
FS1-Interior Lighting to LED	$2,406.00	$816.00	$3,222.00	$32,089
FS1-Interlock Heaters with Roll-Up Doors in Truck Bays	$66.00	$0.00	$66.00	$0
FS1-New Building Automation System	$413.00	$312.00	$725.00	$14,863
FS1-Replace HVAC Equipment	$991.00	$484.00	$1,475.00	$30,935
FS1-Weatherization	$593.00	$0.00	$593.00	$8,044
FS1 Total	$4,575.00	$1,798.00	$6,373.00	$88,699
FS2-Exterior Lighting to LED	$90.00	$34.00	$124.00	$856
FS2-Interior Lighting to LED	$2,680.00	$1,032.00	$3,712.00	$42,088
FS2-New Building Automation System	$321.00	$312.00	$633.00	$26,485
FS2 Total	$3,091.00	$1,378.00	$4,469.00	$69,429
⊟ HHP				
HHP-Exterior Lighting to LED	$166.00	$34.00	$200.00	$2,554
HHP Total	$166.00	$34.00	$200.00	$2,554
HRP-Weatherization	$625.00	$0.00	$625.00	$1,413
HRP Total	$625.00	$0.00	$625.00	$1,413
LSO-Exterior Lighting to LED	$162.00	$236.00	$398.00	$1,388
LSO Total	$162.00	$236.00	$398.00	$1,388
OGP-Exterior Lighting to LED	$327.00	$152.00	$479.00	$3,207
OGP-Interior Lighting to LED	$187.00	$198.00	$385.00	$6,428
OGP Total	$514.00	$350.00	$864.00	$9,634
PWK-Add Insulation Under Roof of Maintenance Building	$103.00	$0.00	$103.00	$2,304
PWK-Engine Block Heater Control	$250.00	$0.00	$250.00	$3,910
PWK-Exterior Lighting to LED	$258.00	$168.00	$426.00	$2,942
PWK-Interior Lighting to LED	$1,745.00	$2,138.00	$3,883.00	$48,518
PWK-New Building Automation System	$628.00	$162.00	$790.00	$15,440
PWK-Replace HVAC Equipment	$447.00	$568.00	$1,015.00	$42,457
PWK-Used Motor Oil-Fired Heater	$675.00	$100.00	$775.00	$23,625
PWK-Weatherization	$1,457.00	$0.00	$1,457.00	$30,725
PWK Total	$5,563.00	$3,136.00	$8,699.00	$169,921
WTT-Exterior Lighting to LED	$606.00	$152.00	$758.00	$11,468
WTT-Interior Lighting to LED	$1,221.00	$770.00	$1,991.00	$21,398
WTT-New Building Automation System	$568.00	$554.00	$1,122.00	$16,832
WTT-Reconfigure Metering on Well Pumps and Change from LGS to MGS and Manage Demand	$0.00	$14,688.00	$14,688.00	$48,814
WTT-Replace HVAC Equipment	$550.00	$882.00	$1,432.00	$60,856
WTT-Resolve Billing Errors with KCPL on Well Pump Account	$0.00	$8,554.00	$8,554.00	$0
WTT-Solar PV Power Generation	$7,164.00	$0.00	$7,164.00	$135,542
WTT-Weatherization	$516.00	$0.00	$516.00	$8,868
WTT Total	$10,625.00	$25,600.00	$36,225.00	$303,778
Construction Cost	$250,613.00	$83,364.00	$333,977.00	$3,983,577
Performance Bond and Insurance				**$71,710**
Project Cost Total				**$4,055,287**

Table E.2 Project Cost and Savings (with KCP&L one time reimbursement)

City of Gladstone IGA

Pro Forma Cash Flow for 15 Year Project

Program Data	
Program Cost	$4,047,584
Comprehensive Energy Audit Fee	$7,703
Total Program Cost	$4,055,287
Less Up Front Cash Buydown	$0
Net Financed Costs	$4,055,287
Rebates/Incentives Contribution	$155,425

Loan Data	
Lease Amount	$4,055,287.18
Interest Rate (Estimated)	3.00%
Term (years)	15
Calculated Finance Payment	$339,698
Finance Payments Total	$5,095,463
All Payments Total	$5,095,463

Facility Operational Data		**$/Sqft**
Total Square Feet	192,568	
Total Annual Utilities [1]	$886,876	$4.61
Annual Electric [1]	$864,311	$4.49
Annual Gas	$22,565	$0.12
Utility Escalation Rate	1.50%	
O&M Escalation Rate	1.50%	

Projected Savings Data		**% Savings**
Total Utility Savings	$250,613	28.26%
Electric Savings	$294,994	34.13%
Gas Savings	-$44,381	-196.68%
Operational Savings	$38,242	
Maintenance Savings [2]	$15,000	
Utility Error Operating Savings	$23,242	
Capital Cost Avoidance Savings	$2,842,365	

[1] Does not include $439,871 in street lighting lease utility

[2] Maintenance savings is calculated higher, the City has selected to use a conservative value of $15,000 in the proforma.

Program Year	Savings & New Revenue					Payments	Resulting Cashflow				
	Projected Utility Cost Savings	Operational & Maintenance Cost Savings	Capital Cost Avoidance Savings	Grants & Rebates	Funds Available	Debt Service Payment	Yearly Cash Flow	Cumulative Cash Flow	Excludes Capital Cost Avoidance	Yearly Cash Flow (Without CCA)	Cumulative Cash Flow (Without CCA)
Construction	$62,653	$0	$2,842,365	$155,425	$3,060,443	$0	$3,060,443	$3,060,443		$218,078	$218,078
1	$254,372	$38,816			$293,188	$339,698	-$46,510	$3,013,934		-$46,510	$171,569
2	$267,088	$39,398			$306,486	$339,698	-$33,212	$2,980,722		-$33,212	$138,357
3	$271,095	$39,989			$311,084	$339,698	-$28,614	$2,952,109		-$28,614	$109,744
4	$275,162	$40,589			$315,751	$339,698	-$23,947	$2,928,162		-$23,947	$85,797
5	$279,289	$41,198			$320,487	$339,698	-$19,211	$2,908,952		-$19,211	$66,587
6	$283,479	$41,816			$325,295	$339,698	-$14,403	$2,894,549		-$14,403	$52,184
7	$287,730	$42,443			$330,173	$339,698	-$9,525	$2,885,024		-$9,525	$42,659
8	$292,046	$43,080			$335,126	$339,698	-$4,572	$2,880,453		-$4,572	$38,088
9	$296,427	$43,726			$340,153	$339,698	$455	$2,880,908		$455	$38,543
10	$300,873	$44,382			$345,255	$339,698	$5,557	$2,886,466		$5,557	$44,101
11	$305,385	$45,048			$350,433	$339,698	$10,735	$2,897,201		$10,735	$54,836
12	$309,965	$45,724			$355,689	$339,698	$15,991	$2,913,193		$15,991	$70,828
13	$314,615	$46,410			$361,025	$339,698	$21,327	$2,934,520		$21,327	$92,155
14	$319,334	$47,106			$366,440	$339,698	$26,742	$2,961,263		$26,742	$118,898
15	$324,125	$47,813			$371,938	$339,698	$32,240	$2,993,503		$32,240	$151,138
TOTALS	$4,443,638	$647,538	$2,842,365	$155,425	$8,088,966	$5,095,463	$2,993,503			$151,138	

Table E.3 Project Cost and Savings (excluding KCP&L one time reimbursement)

City of Gladstone IGA

Pro Forma Cash Flow for 15 Year Project

Program Data	
Program Cost	$4,047,584
Comprehensive Energy Audit Fee	$7,703
Total Program Cost	$4,055,287
Less Up Front Cash Buydown	$0
Net Financed Costs	$4,055,287
Rebates/Incentives Contribution	$104,101

Loan Data	
Lease Amount	$4,055,287.18
Interest Rate (Estimated)	3.00%
Term (years)	15
Calculated Finance Payment	$339,698
Finance Payments Total	$5,095,463
All Payments Total	$5,095,463

Facility Operational Data		$/Sqft
Total Square Feet	192,568	
Total Annual Utilities [1]	$886,876	$4.61
Annual Electric [1]	$864,311	$4.49
Annual Gas	$22,565	$0.12
Utility Escalation Rate	1.50%	
O&M Escalation Rate	1.50%	

Projected Savings Data		% Savings
Total Utility Savings	$250,613	28.26%
Electric Savings	$294,994	34.13%
Gas Savings	-$44,381	-196.68%
Operational Savings	$38,242	
Maintenance Savings [2]	$15,000	
Utility Error Operating Savings	$23,242	
Capital Cost Avoidance Savings	$2,842,365	

[1] Does not include $439,871 in street lighting lease utility

[2] Maintenance savings is calculated higher, the City has selected to use a conservative value of $15,000 in the proforma.

Program Year	Savings & New Revenue					Payments	Resulting Cashflow				
	Projected Utility Cost Savings	Operational & Maintenance Cost Savings	Capital Cost Avoidance Savings	Grants & Rebates	Funds Available	Debt Service Payment	Yearly Cash Flow	Cumulative Cash Flow	Excludes Capital Cost Avoidance	Yearly Cash Flow (Without CCA)	Cumulative Cash Flow (Without CCA)
Construction	$62,653	$0	$2,842,365	$104,101	$3,009,119	$0	$3,009,119	$3,009,119		$166,754	$166,754
1	$254,372	$38,816			$293,188	$339,698	-$46,510	$2,962,610		-$46,510	$120,245
2	$267,088	$39,398			$306,486	$339,698	-$33,212	$2,929,398		-$33,212	$87,033
3	$271,095	$39,989			$311,084	$339,698	-$28,614	$2,900,785		-$28,614	$58,420
4	$275,162	$40,589			$315,751	$339,698	-$23,947	$2,876,838		-$23,947	$34,473
5	$279,289	$41,198			$320,487	$339,698	-$19,211	$2,857,628		-$19,211	$15,263
6	$283,479	$41,816			$325,295	$339,698	-$14,403	$2,843,225		-$14,403	$860
7	$287,730	$42,443			$330,173	$339,698	-$9,525	$2,833,700		-$9,525	-$8,665
8	$292,046	$43,080			$335,126	$339,698	-$4,572	$2,829,129		-$4,572	-$13,236
9	$296,427	$43,726			$340,153	$339,698	$455	$2,829,584		$455	-$12,781
10	$300,873	$44,382			$345,255	$339,698	$5,557	$2,835,142		$5,557	-$7,223
11	$305,385	$45,048			$350,433	$339,698	$10,735	$2,845,877		$10,735	$3,512
12	$309,965	$45,724			$355,689	$339,698	$15,991	$2,861,869		$15,991	$19,504
13	$314,615	$46,410			$361,025	$339,698	$21,327	$2,883,196		$21,327	$40,831
14	$319,334	$47,106			$366,440	$339,698	$26,742	$2,909,939		$26,742	$67,574
15	$324,125	$47,813			$371,938	$339,698	$32,240	$2,942,179		$32,240	$99,814
TOTALS	$4,443,638	$647,538	$2,842,365	$104,101	$8,037,642	$5,095,463	$2,942,179			$99,814	

SCHEDULE F
FINANCING AGREEMENT AND PAYMENT SCHEDULE

A. Compensation

Subject to adjustments in accordance with the provisions of this Contract, Customer agrees to pay compensation to ESCO as provided in the amount set forth in **Schedule E (Final Project Cost & Project Cash Flow Analysis)** for the work identified in **Schedule J (Equipment to be Installed by ESCO)** of this Contract.

B. Finance Agreement

The Customer has investigated financing sources through Springsted and plans to utilize certificates of participation or a lease-purchase financing agreement, which will be executed by the Customer prior to commencing construction. This will allow the Customer to pay ESCO progress payments during the construction period.

C. Construction Period Progress Payments

During the period beginning the date of execution of this Contract and continuing through the date shown in **Exhibit III(iii) (Certificate of Project Completion)**, Customer or third party financier will make monthly progress payments to ESCO, less 5% retainage, based on the percentage of the scope of work completed at the end of each month. ESCO will provide Customer with an itemized application for payment for the preceding month's construction period. Customer will pay ESCO the earned amount of the application for payment of earned amounts within thirty (30) days of the date from which ESCO provides such application for payment to Customer, less retainage. Customer will not unreasonably withhold any such payment of amounts earned by ESCO.

SCHEDULE G
COMPENSATION TO ESCO FOR ANNUAL SERVICES

There are no annual service fees paid to the ESCO.

SCHEDULE H
REBATES, INCENTIVES, AND GRANTS

A. Kansas City Power & Light Rebates

ESCO will work with Kansas City Power & Light (KCPL) and Customer to apply for and coordinate eligible rebate opportunities through KCPL's "Commercial and Industrial Custom Rebate Program."

B. Missouri Gas & Electric Rebates

ESCO will work with Missouri Gas & Electric (MGE) and Customer to apply for and coordinate eligible rebate opportunities through MGE's "Commercial and Industrial (C&I) Rebate Program".

SCHEDULE I
DESCRIPTION OF PREMISES

A. Description of Premises

Facilities included in this Contract are located at:

72nd Street Tennis Park
2099 NE 72nd Street
Gladstone, Missouri 64118

Animal Shelter
3960 NE 76th Street
Gladstone, Missouri 64119

Atkins-Johnson Farm & Museum
6607 North Antioch Road
Gladstone, Missouri 64119

Central Park
7001 N Holmes Street
Gladstone, Missouri 64118

City Hall
7010 N Holmes Street
Gladstone, Missouri 64118

Community Center
6901 N Holmes Street
Gladstone, Missouri 64118

Fins and Foliage
7022 N Locust Street
Gladstone, Missouri 64118

Fire Station #1
6118 N Oak
Gladstone, Missouri 64118

Fire Station #2
6569 N Prospect Avenue
Gladstone, Missouri 64119

Gladstone 18 (Old Post Office)
504 NE 70th Street
Gladstone, Missouri 64118

Hamilton Heights Park
6600 N Main Street
Gladstone, Missouri 64118

Happy Rock Park
7601 NE Antioch Road
Gladstone, Missouri 64119

Linden Office
7001 N Cherry Street
Gladstone, Missouri 64118

Oak Grove Park
7600A N Troost
Gladstone, Missouri 64118

Public Works
4000 NE 76th Street
Gladstone, Missouri 64119

Santa Fe Glass
7302 N Oak Trafficway B
Gladstone, Missouri 64118

Water Treatment
913 NW 44th Terrace
Kansas City, Missouri 64116

SCHEDULE J
EQUIPMENT TO BE INSTALLED BY ESCO

A. **Lighting Efficiency Improvements** [Community Center, City Hall/Public Safety, Fire Station 1, Fire Station 2, Public Works, Animal Shelter, Water Treatment, Atkins-Johnson Museum, Central Park, Oak Grove Park, Hamilton Heights Park, Decorative Street Lights]

1. The scope of the lighting efficiency improvements is limited to the fixture types, occupancy sensor types, and quantities listed in the room-by-room lighting fixture upgrade construction plan included under the "**Lighting**" tab at the end of this **Schedule J**. This construction plan details the extent of the lighting upgrade equipment to be installed. ESCO will upgrade the following existing light fixture types as described below and detailed in the room-by-room audit:

    a. Interior fluorescent light fixtures with T8 and/or T5 lamps (recessed troffers) will be upgraded with LED door kits. Existing fixture housings will be used unless otherwise noted.

    b. Interior fluorescent light fixtures with T8 lamps (troffers) on the first floor of City Hall will be replaced one-for-one with new 2'x4' LED fixtures in the same locations. This work will be performed when these spaces are renovated under a separately contracted project.

    c. Incandescent and CFL can-type downlight fixtures will be retrofit with LED kits.

    d. High-bay metal-halide and fluorescent light fixtures will be removed and replaced with LED light fixtures on a one-for-one basis.

    e. Exterior metal halide wall pack exterior light fixtures will be removed and replaced with LED light fixtures.

    f. Incandescent exterior soffit lamps will be replaced with LED lamps.

    g. Decorative street post-top light fixtures will be retrofit with LED kits.

    h. Wall-mounted occupancy sensors will be installed at existing manual switch locations as indicated in the room-by-room lighting fixture upgrade construction plan included under the "**Lighting**" tab at the end of this **Schedule J.**

    i. Ceiling occupancy sensors will be installed and indicated in the room-by-room lighting fixture upgrade construction plan included under the "**Lighting**" tab at the end of this **Schedule J**.

2. Light levels, measured in lumens, will be maintained or increased.

3. All dual switching capability will be maintained.

4. ESCO will dispose of removed lamps and ballasts per EPA guidelines and will furnish a Certificate of Disposal to Customer.

5. The following items are <u>not included</u> with the lighting retrofit:

    a. Painting, caulking, and wall repair.

    b. Bringing existing non-compliant conditions up to code or correcting any deficiencies in the electrical system.

c. Modifications to existing dimming lighting systems, unless noted.

d. Desk lamps, furniture lighting and vending machine lighting.

B. Weatherization [Community Center, City Hall/Public Safety, Fire Station 1, Public Works, Animal Shelter, Water Treatment, Happy Rock Park]

1. All of the buildings were audited to determine locations where weatherization is recommended, and the scope of work for weatherization is shown on the respective building weatherization drawings included under the "**Weatherization**" tab at the end of this **Schedule J**.

2. Roof-wall interfaces shown on the weatherization drawings will be sealed with one-part foam where practical or with two-part foam when necessary because of gap width, configuration, or surface properties. One or two-part foam is used at the joints, depending on the type of joint being sealed and whether or not it is visibility to the public eye.

3. ESCO will install door-sealing materials consisting of a heavy metal aluminum carrier, and strip of Q-lon which is a formed and angled sponge wrapped in vinyl. It is applied to the doorframes, secured with screws, and caulked for added durability and air sealing through the carrier. The sweeps utilize a double fin film seal between a set of brushes, also embedded in a heavy aluminum carrier. The material is typically placed under the kick plate of the door, and secured in the same method as the rest of the door seal.

C. City Hall/Public Safety Mechanical HVAC Upgrades and Equipment Replacement

1. ESCO will replace HVAC mechanical equipment defined in the project drawings and specifications located under the "**HVAC**" tab at the end of this **Schedule J** enumerated as follows:

   - CS: Cover Sheet
   - ME100: Symbols and Abbreviation – Mechanical & Electrical
   - ME201: Schedules & Details – Mechanical & Electrical (Rev. 1, 7-18-17)
   - ME202: Schedules & Details – Mechanical & Electrical (Rev. 1, 7-18-17)
   - DM100: Roof Plan – Demolition – Mechanical (Rev. 1, 7-18-17)
   - DM101: Ground Floor Plan - Demolition – Mechanical
   - DM102: First Floor Plan - Demolition – Mechanical
   - M100: Roof Plan – Mechanical (Rev. 1, 7-18-17)
   - M101: Ground Floor Plan – Mechanical (Rev. 1, 7-18-17)
   - M102: First Floor Plan - Mechanical

   HVAC Replacement design specifications are listed below. These specifications have been included under the "**HVAC**" tab at the end of this **Schedule J**.

   - Specification Section 230000: General Mechanical Requirements
   - Specification Section 235416.13: Gas-Fired Furnaces
   - Specification Section 237416: Packaged, Rooftop Air Conditioning Units
   - Specification Section 260000: General Electrical Requirements

2. ESCO is responsible for the following in connection with the HVAC replacement:

   a. All electrical work necessary for the HVAC scope of work.

b. Roof penetration and repair work associated with the HVAC scope of work.

c. Functional checkout and start-up for each RTU by manufacturer service technician.

d. Installation of structural reinforcement and roof curbs for RTU-9 and RTU-10 at City Hall.

3. ESCO will furnish and install complete replacement HVAC equipment as listed in the equipment schedules and shown on drawings located under the "HVAC" tab at the end of this Schedule J. Rooftop unit (RTU) and split system replacement work shall include:

   a. Procure all RTUs and split HVAC equipment per the attached specifications and schedules. Field verify airflow configuration, existing RTU measurements for curb adapter sizing, location of existing electrical feed and voltages for all RTUs, furnaces and condensers prior to ordering. Procure curb adapters as required for existing RTUs being replaced. Provide curbs for the two new RTUs replacing two existing split systems.

   b. Disconnect existing low voltage control wiring from each thermostat to its respective RTU and split system. Disconnect electrical power services from each of the existing RTUs and split systems. Demolish existing refrigerant line sets for each split system.

   c. Remove and properly dispose of existing RTUs and split systems. Recover and recycle refrigerant.

   d. Provide weather protection for any open roof curbs between time existing RTU is removed and time new RTU is installed.

   e. Disconnect and reconnect ductwork as needed to install new RTU and furnace. Demolish existing ductwork as required to match up to new unit configuration and fabricate and install ductwork as required to match up to new unit configuration.

   f. Provide crane and rigging to remove old equipment on roof and install new RTUs and condensing units. All crane lift work will be done when building is unoccupied so that area under lift path is vacant and clear of all occupants.

   g. Install curb adapters and RTUs on existing roof curbs where RTUs are replacing RTUs. Install new curbs for RTUs replacing split systems. Provide roofing demolition, cutting openings in the concrete deck, roofing repair, and flashing.

   h. Provide supports for condensing units and provide anchorage against wind loading.

   i. Provide new gas piping to RTU and furnace connections. Provide new gas regulators as required. Each RTU and furnace connection shall include plug valve shutoff and dirt leg. Gas piping supports shall be adjustable roller supports. Dura-Block or approved equal.

   j. Provide new line sets for all split systems.

   k. Install new condensate drains for all RTU. Utilize UV resistant piping and route to nearest roof drain or connect to existing drain piping. Piping materials shall match existing. Connect condensate drain from evaporator drain pans in split AHUs to existing drainage system.

   l. Provide electrical power service from the existing circuits serving the existing RTUs and split systems. New RTUs, condensing units and air handlers shall be provided with disconnects. Replace circuit breakers at electrical panelboards as required to meet NEC.

m. Provide new electrical circuits to RTU-9 and RTU-10 from Panel AC in the electrical room on the Ground Floor. Provide new fused switches as required for all new equipment fed from existing panels.

n. For new RTUs with return air smoke detectors replacing RTUS where the existing smoke detector in the RTU is wired to the fire alarm system, ESCO will wire the existing fire alarm system to the smoke detectors on the RTUs. If the existing RTU smoke detector is not connected to the fire alarm system, or if the existing RTU smoke detector is in the ductwork, ESCO will hard wire the new smoke detector to shut down the supply fan but will not wire new smoke detector to the fire alarm system. Existing smoke detectors in ductwork wired to fire alarm system shall remain.

D. Community Center Mechanical HVAC Upgrades and Equipment Replacement

1. ESCO will replace HVAC mechanical equipment as set forth in this scope and defined in the project drawings and specifications located under the "**HVAC**" tab at the end of this **Schedule J** enumerated as follows:

   - CS: Cover Sheet
   - ME100: Symbols and Abbreviation – Mechanical & Electrical
   - ME200: Roof Plan – Mechanical & Electrical (Rev. 1, 7-18-17)
   - ME300: Schedules & Details – Mechanical & Electrical
   - M101: Lower Level Floor Plan – Mechanical (Rev. 1, 7-18-17)
   - M102: Upper Level Floor Plan – Mechanical (Rev. 1, 7-18-17)
   - M200: Control Schematic Diagrams – Mechanical
   - ME201: Details – Mechanical

   HVAC Replacement design specifications are listed below. These specifications have been included under the "**HVAC**" tab at the end of this **Schedule J**.

   - Specification Section 223400: Fuel-Fired, Domestic-Water Heaters
   - Specification Section 230000: General Mechanical Requirements
   - Specification Section 232123: Hydronic Pumps
   - Specification Section 235216: Condensing Boilers
   - Specification Section 237416: Packaged, Rooftop Air Conditioning Units
   - Specification Section 238126: Split-System Air-Conditioners
   - Specification Section 260000: General Electrical Requirements

Replacement of Community Center HVAC Pool Units (RTU-4 and RTU-7) is not included in this Contract. ESCO drawings will be revised and issued for construction and incorporated by reference.

2. ESCO is responsible for the following in connection with the HVAC replacement:

   - All electrical work necessary for the HVAC scope of work.
   - Roof penetration and repair work associated with the HVAC scope of work.
   - Functional checkout and start-up for each RTU by manufacturer service technician.
   - Installation of structural reinforcement and roof curbs for RTU-9 and RTU-10 at City Hall.

3. **Replace Rooftop HVAC Units: RTU-1, RTU-2, RTU-3 and RTU-5**

   ESCO will furnish and install complete replacement of RTUs to include:

   a. Disconnect existing low voltage control wiring from each thermostat to its respective RTU.

   b. Disconnect electrical power services from each of the existing RTUs.

   c. Remove and properly dispose of existing RTUs. Recover refrigerant and recycle.

   d. Provide weather protection for any open roof curbs between time existing RTU is removed and time new RTU is installed.

   e. Disconnect and reconnect ductwork necessary to install new RTU.

   f. Crane and rigging to remove old RTUs and install new RTUs. All crane lift work shall be performed when building is unoccupied so area under lift path is vacant and clear of all occupants.

   g. Install curb adapters, as necessary on existing roof curbs.

   h. Provide new gas piping to RTU connections. Provide new gas regulators as required. Each RTU connection shall include plug valve shutoff and dirt leg. Gas piping supports shall be adjustable roller supports using Dura-Block or approved equal.

   i. Install new condensate drains for all RTU utilizing UV resistant piping routed to nearest roof drain or connected to existing drain piping.

   j. Provide electrical power service from the existing circuits serving the existing RTUs. New RTUs will be provided with new electrical disconnects. Replace circuit breakers at electrical panelboards as necessary to meet NEC

4. **Water Heater Replacements**: **GWH-1 and GWH-2**

   ESCO will furnish and install new storage-type gas-fired high efficiency condensing water heaters to replace existing electric water heaters which shall include:

   a. Furnish water heaters per specifications and equipment schedule.

   b. Disconnect electrical power services and disconnect cold-water make-up, hot water supply and return piping from existing water heater. Remove and properly dispose of existing water heaters.

   c. Provide new gas piping to water heater connections. Provide new gas regulators. Each water heater connection shall include plug valve shutoff and dirt leg.

   d. Reconnect cold-water make up, hot water supply, and return piping to new water heaters.

   e. Provide electrical power service to each water heater.

   f. Provide new combustion air vent lines and exhaust flues through roof and repair roof and flash penetrations to maintain existing warranty by manufacturer on roof.

5. **Pool Heating Boiler Replacement: B-1**

ESCO will furnish and install new gas-fired condensing hot water boiler to replace the existing electric boiler which shall:

a. Furnish boiler per specifications and equipment schedules. Field verify clearances, installation path, piping configuration, location of existing electrical feed and voltages for boiler prior to ordering.

b. Disconnect electrical power services and disconnect heating water supply and return piping from boiler. Remove and properly dispose of existing boiler.

c. Provide new gas piping to boiler connections. Provide new gas regulators as required. Boiler connection shall include plug valve shutoff and dirt leg.

d. Reconnect heating water supply and return piping to boiler.

e. Provide electrical power service to boiler.

f. Provide new combustion air vent lines and exhaust flues through building wall located to prevent cutting reinforcement. Seal penetrations weather tight with Link Seal or equivalent and provide escutcheon plates on outdoor side of penetration and on any penetration exposed in finished spaces.

6. Ductless Split System for A-V Room: AC-1

ESCO will furnish and install new ductless split system for the A-V room which shall include:

a. Procure ductless split system per drawings.

b. Place concrete pad outside of building for condensing unit.

c. Mount fan-coil on wall of A-V Room.

d. Provide line sets between fan-coil and condensing unit and to prevent cutting reinforcement. Engage with location service to locate reinforcement. Seal penetrations weather tight with Link Seal or equivalent provide escutcheon plates on outdoor side of penetration and on any penetration exposed in finished spaces.

e. Provide electric power circuits from existing distribution panel and install new electrical circuit breakers at panel to feed new AC-1 HVAC equipment.

f. Route condensate drain from fan-coil to building sanitary sewer line.

7. **Add Heat Exchanger to Leisure Pool Heating System: HX-6**

ESCO will furnish and install a new heat exchanger and control valve for the Leisure Pool Heating System and shall include:

a. Procure heat exchanger and control valve per drawings.

b. Support new heat exchanger next to existing series of heat exchangers.

c. Connect boiler-side supply and return piping and pool water-side supply and return piping to heat exchanger.

d. Provide shutoff valves, pressure and temperature gauges on boiler side supply and return piping and pool water-side supply and return piping. Install piping vents and drains.

e. Install temperature control valve and connect to BAS.

f. Insulate all new piping.

8. **Replace HVAC Equipment at Public Works Facility, Fire Station #1, Water Treatment Plant, Animal Control Building**

ESCO will furnish and install complete replacement HVAC equipment for existing HVAC equipment listed in Figure J.1 below.

Figure J.1 HVAC Equipment to be Replaced

Building Name	Manufacturer	Type
Public Works	Carrier	RTU
Public Works	Carrier	RTU
Fire Station #1	Carrier	Split System
Fire Station #1	Carrier	Split System
Water Treatment Plant	Lennox	RTU
Water Treatment Plant	Bryant	Split System
Water Treatment Plant	Bryant	Split System
Animal Control	Trane	RTU
Animal Control	Trane	RTU

HVAC replacement work shall include:

a. Procure all RTUs and split HVAC equipment per specifications and equipment schedules. Field verify airflow configuration, existing RTU measurements for curb adapter sizing, location of existing electrical feed and voltages for all RTUs, furnaces and condensers. Procure curb adapters as required for existing RTUs being replaced.

b. Verify existing gas pressure available at RTUs and furnaces and properly size regulators.

c. Disconnect existing gas service piping to existing RTUs and furnaces. Disconnect existing low voltage control wiring from each thermostat to its respective RTU and split system. Disconnect electrical power services from each of the existing RTUs and split systems. Demolish existing refrigerant line sets for each split system.

d. Remove and properly dispose of existing RTUs and split systems and properly recover and recycle refrigerant.

e. Provide weather protection for any open roof curbs between time existing RTU is removed and time new RTU is installed.

f. Disconnect and reconnect ductwork as needed to install new RTU and furnace.

g. Provide crane and rigging to remove old equipment on roof and install new RTUs and condensing units. All crane lift work shall be done when building is unoccupied so that area under lift path is vacant and clear of all occupants.

h. Install curb adapters and RTUs on existing roof curbs.

i. Provide supports for condensing units with anchorage against wind loading.

j. For RTUs replacing existing RTUs with gas heat and for furnaces, ESCO will provide new gas piping from existing gas lines to RTU and furnace connections. Provide new gas regulators as required. Each RTU and furnace connection shall include plug valve shutoff and dirt leg. Install piping supports per detail shown.

k. Provide new line sets for all split systems.

l. Install new condensate drains for all RTU. Utilize UV resistant piping and route to nearest roof drain or connect to existing drain piping. Piping materials shall match existing. Connect condensate drain from evaporator drain pans in split air handling units (AHU) to existing drainage system.

m. Provide electrical power service from existing electrical circuits serving existing RTUs and split systems. New RTUs, condensing units and air handlers shall be provided with electrical disconnects. Electrical wiring, conduit, control wires, fire alarm wire or any other connections will be extended due to increase in height or width of new curb adapter or location of connections on new RTU. As necessary. replace circuit breakers at electrical panelboards as required to meet NEC.

n. For new RTUs with return air smoke detectors replacing RTUs where existing smoke detector in the RTU is wired to the fire alarm system, ESCO will wire the existing fire alarm system to the smoke detectors on the RTUs. If the existing RTU smoke detector is not connected to the fire alarm system, or if the existing RTU smoke detector is in the ductwork, ESCO will hard wire the new smoke detector to shut down the supply fan but will not wire new smoke detector to the fire alarm system. Existing smoke detectors in ductwork wired to fire alarm system shall remain.

9. **New Used Motor Oil-Fired Space Heater at Public Works Facility**

a. ESCO will furnish and install motor oil-fired space heater to supplement the Public Works Facility service bays heating system. System will include Omni OWH-250 space heater and T2 250-gallon tank / furnace stand.

b. Provide Class A flue pipe and route through roof with weather cap.

c. Provide roof penetration and weatherproof sealing and flashing.

d. Install heater supported by the tank / furnace stand.

e. Provide 20 Amp, 120V electrical circuit from electrical distribution panel.

f. Mount thermostat to wall and wire back to heater.

g. Provide 3/8-inch copper tubing oil suction line from tank to pump and 3/8-inch copper tubing oil feed line from pump to heater.

E. Building Automation System for Community Center, City Hall / Public Safety, Fire Station #1, Fire Station #2, Public Works, Animal Shelter, Water Treatment Plant, Atkins-Johnson Museum

1. ESCO will furnish and install a complete building automation system ("BAS") temperature control system networked to the enterprise BAS controller to facilitate global and zone scheduling, temperature set point adjustment, and monitoring of HVAC equipment operation. The BAS will be networked through a BAS server with Ethernet connection for remote and local graphic user interface access. Individual HVAC equipment or zones will be controlled through unit controllers with room sensors. The BAS equipment installed will include:

    a. BAS network controller and panel with Ethernet port access. Customer will arrange to connect through existing IT server network switch with an IP address for the BAS server device to allow web access. ESCO will provide software, programming, and hardware for local and remote viewing and control using standard web browser on Customer's existing computer server. This server shall be loaded with BAS supervisory software and licensed for fifteen (15) sites. Server software will incorporate graphics, alarms, trend data, fault detection, and analytics.

    b. Thermostats and graphical interface will provide temperature control of rooms or zones with the following functionality:

        i. Space temperature with adjustable set point and user override for after-hours schedule
        ii. Space humidity (where noted)
        iii. Space CO_2 sensor (where noted)
        iv. Discharge air temperature sensor
        v. Economizer control based on CO_2 for demand control ventilation (where noted)

    c. BAS controller panels for pool heating system as further described in this section.

    d. Graphics will include:

        - 3D Depictions of each piece of controlled equipment
        - 3D floorplans with temperature overlay.
        - Links to the associated control drawings and submittals
        - Interactive sequence which describes the system operation, highlights the active mode, and includes imbedded set points and live data.
        - The interface shall be accessed through a PC web-browser or a tablet mobile application. There shall be an option on a mobile device to view in "mobile" mode. This is a view specifically tailored for small screens and contains mostly text.

2. BAS installation scope of work includes:

    a. Furnish and install wiring, conduit, plenum rated cable, and control components for a completely functional and operational BAS. Wiring in exposed areas to be routed in conduit. Wiring to new thermostats will be routed within existing old thermostat or routed in Wiremold raceway where no hidden or concealed wiring path exists.

b. Provide twelve (12) hours of training in three (3) separate four-hour sessions, one of which will take place approximately 9 months following final completion and initial training.

3. Community Center

a. Replace existing Johnson Controls NAE controls with a building level supervisory controller. All temperature control programming logic in the NAE controller will be replicated in the new building level supervisory controller to retain applicable functionality. Replace all existing controls necessary for a seamless integration. All new and existing equipment described below will be connected to the new building level supervisory controller.

New Equipment:

- Five (5) roof top units with DX and gas heat
- One (1) boiler for pool heating
- Two (2) domestic hot water boilers

b. Existing equipment to remain (replace controls for the following):

- Two (2) Dectron pool dehumidification and outside air units
- Three (3) air handling units
- Twenty-five (25) VAV boxes
- Ten (10) exhaust fans
- One (1) pool heating system

c. Provide CO_2 based demand control ventilation to operate economizer dampers on RTU-1 and RTU-3.

4. City Hall

a. Replace existing Automated Logic Supervisory Controller with a building level supervisory controller. All temperature control programming logic in the existing ALC controller shall be replicated in the new building level supervisory controller to retain applicable functionality. Connect unit controllers to new central building management system. Provide and install BACnet-networked unit controllers for the following equipment.

b. New Equipment:

- Eight (8) RTUs with gas heat
- Ten (10) split systems with gas furnaces
- One (1) split system computer AC unit

c. Provide supply air temperature sensor on each heating and/or cooling unit and for monitoring.

d. Provide CO_2 based demand control ventilation to operate the economizer dampers on all new RTUs and to operate the motorized OA damper on each split system air handler.

e. Provide ability enable control of hot gas reheat in RTUs for humidity control.

5. Fire Station #1

a. Provide and install a building level supervisory controller with BACnet-networked unit controllers for the following equipment. Connect unit controllers to new central building management system. If existing equipment does not have BACnet communication capability, provide unit controllers with thermostat interface.

b. New Equipment:

- Two (2) split systems with gas heat

c. Existing Equipment:

- One (1) split system with gas heat
- Two (2) gas radiant heaters

d. Provide a supply air temperature sensor on each heating and/or cooling unit for monitoring.

e. Add garage door monitors to disable radiant heaters when doors are open. Connection to central building management system not required. Three (3) Garage Doors interlocked to two (2) banks of radiant heaters.

f. Provide CO_2 based demand control ventilation to operate motorized OA damper on each split system air handler.

6. Fire Station #2

a. Provide and install a building level supervisory controller with BACnet-networked unit controllers for the following equipment. Connect unit controllers to new central building management system. If existing equipment does not have BACnet communication capability, provide unit controllers with thermostat interface.

b. Existing Equipment:

- Three (3) split systems with gas heat
- Two (2) gas-fired unit heaters

c. Provide a supply air temperature sensor on each heating and/or cooling unit for monitoring.

d. Provide CO_2 based demand control ventilation to operate the motorized OA damper on each split system air handler.

e. Add garage door monitors to disable unit heaters when doors are open. Connection to central building management system not required. Three (3) garage doors interlocked to two (2) unit heaters)

7. Public Works

a. Provide and install building level supervisory controller and BACnet-networked unit controllers for the following new and existing equipment. If existing equipment does not have BACnet communication capability, provide unit controllers with thermostat interface.

b. Connect thermostats to new central building management system. If existing equipment does not have BACnet communication capability, provide unit controllers with thermostat interface.

c. New Equipment:

- Two (2) roof top units (serving maintenance building)

d. Existing Equipment to Remain (serving office building):

- One (1) split system AC units

e. Provide a supply air temperature sensor on each heating and/or cooling unit for monitoring.

f. Provide CO_2 based demand control ventilation to operate the economizer dampers on all new RTUs.

8. Animal Shelter

a. Provide and install building level supervisory controller and BACnet-networked unit controllers for the following new and existing equipment.

b. Connect unit controllers to new central building management system. If existing equipment does not have BACnet communication capability, provide unit controllers with thermostat interface.

c. Existing Equipment:

- Two (2) split system with gas heat

d. New Equipment:

- Two (2) roof top units (located on the ground)

e. Provide a supply air temperature sensor on each heating and/or cooling unit for monitoring.

9. Water Treatment

a. Provide and install building level supervisory controller and BACnet-networked unit controllers for the following new and existing equipment.

b. New Equipment

- Two (2) split system AC units
- Two (1) roof top units

c. Connect unit controllers to new central building management system.

d. Provide a supply air temperature sensor on each heating and/or cooling unit for monitoring.

e. Provide CO_2 based demand control ventilation to operate the economizer dampers on all new RTUs and to operate the motorized OA damper on each split system air handler.

10. Atkins-Johnson Museum

a. Provide and install building level supervisory controller and BACnet-networked unit controllers for the following existing equipment.

b. Connect unit controllers to new central building management system. If existing equipment does not have BACnet communication capability, provide unit controllers with thermostat interface.

c. Existing Equipment

- One (1) split system AC units

d. Provide a supply air temperature sensor on each heating and/or cooling unit for monitoring.

e. Provide CO2-based demand control ventilation to operate the motorized OA damper on the split system air handler.

F. Replace Emergency Lighting Inverter System at Community Center

1. ESCO will remove existing inverter located in the main electrical room and properly send batteries and other recyclable components to recycling center and dispose of remainder.

2. ESCO will furnish and install new 16 kW emergency power inverter (Crucial Power Products or approved equal) and provide start-up testing and training to Customer.

G. Install Destratification Fans at Community Center

1. ESCO will furnish and install two (2) axial destratification fans in the main entry atrium/hallway as specified in the information provided under the **"Fans"** tab at the end of this **Schedule J**.

2. Destratification fans will be variable speed with ECM motors and the fan controls will be wireless central panel controller which will have an internet-based interface to manage the speed, direction and run time of the fans.

H. Solar PV Power Generation at Community Center and Water Treatment Plant

1. ESCO will furnish and install 100 kW fixed collector photovoltaic solar system (Solar PV) on roof of the Community Center.

2. ESCO will furnish and install 75 kW fixed collector photovoltaic solar system (Solar PV) at the Water Treatment Facility.

3. Turnkey solar PV systems includes racking and mounting hardware, inverter, wiring and interconnection to building power panel.

4. ESCO will prepare layout and interconnection design drawings for review and approval by Customer prior and submittal to KCP&L prior to placing any Solar PV equipment or materials.

5. ESCO is responsible to obtain approval by KCP&L for interconnection.

I. HVAC System Commissioning at Community Center and the City Hall / Public Safety Building

ESCO will provide commissioning on all new HVAC equipment and controls at City Hall / Public Safety and at Community Center. Additionally, ESCO will commission the following existing equipment to remain in service at Community Center:

- Three (3) air handling units
- Twenty-five (25) VAV boxes

- Ten (10) exhaust fans
- One (1) pool heating system

J. Add Insulation at Public Works Building

ESCO will furnish and install nominal 12-inch (12”) thick fiberglass batt insulation under the roof of the maintenance bays in the Public Works main maintenance building, as specified in the information provided under the **“Insulation”** tab at the end of this **Schedule J**.

K. Engine Block Heater Control at Public Works Building

Provide and install nine (9) ELEproducts electronic engine block heater controllers at the Public Works facility. Block heater controls will be programmed and installed on the walls of the snowplow trucks parking facility. Electronic engine block heater controllers will be installed with wall mount kit. Cord length of twenty-two feet (22 ft) for connection from block heater controller to trucks will be provided for each controller.

L. Reconfigure Electric Metering for Well Pumps 1, 2, 3 and 6

1. Install new current transducers and electric meter so that Pump #1 and Pump #6 are on one meter and Pump #2 and Pump #3 remain on separate meter.

2. Assist owner in requesting utility rate switch from KCP&L’s Large General Service for Pump #2 and Pump #3 to Medium General Service.

3. Provide Customer with recommendations for operation and sequencing of pumps.

M. Replace Roof at City Hall / Public Safety Building

1. Project consists of replacing the designated existing roof system at City Hall. The included roof areas consist of approximately 14,400 total square of modified bitumen and EPDM roof systems and will be replaced with a modified bitumen or EPDM roof system. This scope of work includes replacing roof over the entire building except for that which is identified as Area “A” (overhang over North entrance). This <u>does</u> include Area B as shown on the drawings.

2. Drawings and project manual specifications are included under the “**Roof**” tab at the end of this **Schedule J.**

3. Remove and dispose of the existing roofing materials and insulation.

4. Remove and dispose of penetrations no longer necessary and install plate over openings before new roof is installed.

5. Install new tapered polyisocyanurate roof insulation, two-inch (2”) minimum thickness, one eighth inch (1/8”) per foot slope in drainage areas and one quarter inch (1/4”) per foot slope in crickets with an average R-value of 22.

6. Install one half inch (1/2”) coverboard.

7. Install a 2-ply SBS modified roof and flashing system in roof areas B, area D, and area E. Install EPDM membrane system in area C, area F, and area G.

8. Install new perimeter sheet metal flashing and trim. Color to be selected by Customer from the manufacturer’s standard colors and finishes.

9. Remove and reinstall existing equipment screening for RTU 8.
10. Paint the existing horizontal exhaust pipe from the generator.
11. Install (4) new anchor tie-off points.

-— END OF SCOPE OF WORK -—

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	Action	Proposed	Qty	Sensor Type and Quantity
Public Safety / Animal Control	Interior	Lobby/Halls	1825	8	F-F32T8-3	Troffer-2X4-Prismatic-Surface	Retrofit	Eiko 3L 12W T8 Ballast Bypass DLCP	8	
Public Safety / Animal Control	Interior	Lobby/Halls	1825	5	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	5	
Public Safety / Animal Control	Interior	Lobby/Halls	8760	2	EXIT-I15-1	Emergency w/BBU-White-Red-Surface	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	2	
Public Safety / Animal Control	Interior	Restrooms	1825	1	CFL-CF32W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	1	Lutron Wall Sensor Switch
Public Safety / Animal Control	Interior	Dog Kennels	1825	12	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	12	
Public Safety / Animal Control	Exterior	Wallpack	4380	4	CFL-CF26W-1	Wallpack-Plug-in 4 Pin-Clear-Wall	Retrofit	Deco D400 LED Wall Pack, D400-LED1050UNVBZ	4	

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	Action	Proposed	Qty	Sensor Type and Quantity
Atkin-Johnson House	House	Interior	800	17	HAL-H35/LV-1	4-in Can-MR16-Clear-Recessed	Retrofit	Eiko LED MR16, 7W, 3000K	17	
Atkin-Johnson House	House	Interior	800	2	CFL-CF13W-1	Decorative-Medium-Frosted-Surface	Retrofit	Eiko LED A19, 9W, 3000K	2	
Atkin-Johnson House	House	Interior	800	1	INCAN-I42-3	Chandelier-Medium-Clear-Pendant	Retrofit	(3) Eiko LED A19, 9W, 3000K	1	
Atkin-Johnson House	House	Interior	800	2	INCAN-I42-2	Decorative-Medium-Frosted-Wall	Retrofit	(2) Eiko LED A19, 9W, 3000K	2	
Atkin-Johnson House	House	Interior	800	1	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	1	
Atkin-Johnson House	House	Interior	800	4	CFL-CF13W-1	Decorative-Medium-Clear-Wall	Retrofit	Eiko LED A19, 9W, 3000K	4	
Atkin-Johnson House	House	Interior	800	2	EXIT-I15-1	Exit-White-Red-Wall	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	2	
Atkin-Johnson House	Bathrooms	Exterior	800	2	INCAN-I40-1	Decorative-Medium-Open - no lens-Wall	Retrofit	Eiko LED Filament ST19, 5W, 2200K	2	
Atkin-Johnson House	Bathrooms	Exterior	800	1	CFL-CF13W-1	Decorative-Medium-Frosted-Surface	Retrofit	Eiko 3000K LED LiteSpan A19 Omni-Directional 300 Degree Beam 9W - 800lm Dimmable E26	1	
Atkin-Johnson House	Bathrooms	Interior	800	6	UFL-FU31T8/6-2	2X2-Troffer-Prismatic-Surface	Retrofit	(2) Eiko LED 6" U-Bend, 18W, 4000K	6	(2) Lutron Wall Sensor Switch

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	Action	Proposed	Qty	Sensor Type and Quantity
Central Park Pool	Interior	Passes	1460	2	F-F32T8-2	Vapor Tight-4 foot-Clear-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	
Central Park Pool	Interior	Closet	1460	7	F-F32T8-2	Vapor Tight-4 foot-Clear-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	7	
Central Park Pool	Interior	Concessions	1460	5	F-F32T8-2	Vapor Tight-4 foot-Clear-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	5	
Central Park Pool	Interior	Lifeguard Area	1460	8	F-F32T8-2	Vapor Tight-4 foot-Clear-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	8	
Central Park Pool	Interior	Bathrooms	1460	12	F-F32T8-2	Vapor Tight-4 foot-Clear-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	12	
Central Park Pool	Exterior	Break Area	2920	2	MH-MH70-1	Wallpack-Medium-Clear-Wall	Retrofit	ATG 28W LED WallPack	2	
Central Park Pool	Exterior	Pool Lights	2920	13	MH-MH400-1	Shoe Box-Mogul-Clear-Pole	Retrofit	RemPhos LED Block Retro Kit, 150W, 5000K, 24000 Lumen	13	
Central Park Pool	Exterior	Canopy	2920	2	F-F32T8-2	Vapor Tight-4 foot-Clear-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	Action	Proposed	Qty	Sensor Type and Quantity
City Hall / Public Safety	Exterior	Front Entrance	4380	6	INCAN-I60-1	6-in Can-Medium-Frosted-Recessed	Retrofit	Eiko 4000K LED LiteSpan A19 Omni-Directional 300 Degree Beam 9W - 800lm Dimmable E26	6	
City Hall / Public Safety	Exterior	Flag Poles	4380	6	MH-MH70-1	Flood-Medium-Clear-Ground	Retrofit	ATG LED Flood, 30W, 5000K	6	
City Hall / Public Safety	Exterior	Spotlights	4380	2	MH-MH70-1	Flood-Medium-Clear-Ground	Retrofit	ATG LED Flood, 30W, 5000K	2	
City Hall / Public Safety	Exterior	Spotlights	4380	2	MH-MH175-1	Flood-Mogul-Clear-Ground	Retrofit	ATG LED Flood, 50W, 50K	2	
City Hall / Public Safety	Exterior	Walkway	4380	4	MH-MH35-1	Security-Medium-Frosted-Wall	Retrofit	Eiko 4000K LED LiteSpan A19 Omni-Directional 300 Degree Beam 9W - 800lm Dimmable E26	4	
City Hall / Public Safety	Exterior	Back Entrance	4380	2	MH-MH100-1	Flood-Medium-Clear-Wall	Retrofit	ATG LED Flood, 30W, 5000K	2	
City Hall / Public Safety	Exterior	Back Entrance	4380	5	MH-MH70-1	Wallpack-Medium-Clear-Wall	Retrofit	ATG Trapezoid Wall Pack, 28W, 5000K	5	
City Hall / Public Safety	Exterior	Employee Entrance	4380	2	MH-MH35-1	Flood-G12-Clear-Wall	Retrofit	ATG LED Flood 15W, 5000K	2	
City Hall / Public Safety	City Hall Interior	Lobby	4959	17	INCAN-I75-1	8-in Can-Medium-Open - no lens-Recessed	Retrofit	MaxLite 23W LED 8 COMMERCIAL DOWNLIGHT RETROFIT 4000K	17	
City Hall / Public Safety	City Hall Interior	Lobby	8760	1	EXIT-I15-1	Emergency w/BBU-White-Red-Surface	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	
City Hall / Public Safety	City Hall Interior	Lobby	4959	4	LED-L10-1	6-in Can-Medium-Eyeball-Recessed	Retrofit	Eiko LED BR30, 8W, 4000K	4	
City Hall / Public Safety	City Hall Interior	Lobby	4959	6	LED-L10-1	8-in Can-Medium-Open - no lens-Recessed	Retrofit	Eiko LED BR30, 8W, 4000K	6	
City Hall / Public Safety	City Hall Interior	Lobby	4959	6	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	6	
City Hall / Public Safety	City Hall Interior	Lobby	4959	2	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	2	
City Hall / Public Safety	City Hall Interior	Lobby	4959	4	INCAN-I60-1	Decorative-Medium-Frosted-Wall	Retrofit	Eiko 4000K LED LiteSpan A19 Omnidirectional 300 Degree Beam 6W - 470lm Dimmable E26	4	
City Hall / Public Safety	City Hall Interior	Lobby Bathroom	4959	2	F-F32T8-2	Strip-4 foot-Parabolic-Recessed	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	Lutron Wall Sensor Switch
City Hall / Public Safety	City Hall Interior	1st Floor Hall	4959	4	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	4	
City Hall / Public Safety	City Hall Interior	1st Floor Hall	4959	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	1	
City Hall / Public Safety	City Hall Interior	1st Floor Hall	8760	3	EXIT-I15-1	Emergency w/BBU-White-Red-Surface	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	3	
City Hall / Public Safety	City Hall Interior	Employee Entrance	4959	3	CFL-CF36W-2	Troffer-Plug-in 4 Pin-Parabolic-Recessed	Retrofit	ATG 2X2 LED DOOR KIT	3	
City Hall / Public Safety	City Hall Interior	Employee Entrance	4959	1	CFL-CF36W-2	Troffer-Plug-in 4 Pin-Parabolic-Recessed	Retrofit	ATG LED 2x2 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	1	
City Hall / Public Safety	City Hall Interior	Employee Entrance	4959	2	HAL-H50-1	8-in Can-Medium-PAR20-Recessed	Retrofit	MaxLite 15W LED 8 COMMERCIAL DOWNLIGHT RETROFIT 4000K RR81540W	2	
City Hall / Public Safety	City Hall Interior	Employee Entrance	8760	1	EXIT-Tritium0-1	Exit-Red-White-Wall	Do Nothing	Do Nothing	1	
City Hall / Public Safety	City Hall Interior	South Conference	4959	16	CFL-CF36W-2	Troffer-Plug-in 4 Pin-Parabolic-Recessed	Retrofit	ATG 2X2 LED DOOR KIT	16	Leviton Ceiling Occ. Sensor
City Hall / Public Safety	City Hall Interior	South Conference	4959	2	CFL-CF36W-2	Troffer-Plug-in 4 Pin-Parabolic-Recessed	Retrofit	ATG LED 2x2 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	2	Leviton Ceiling Occ. Sensor
City Hall / Public Safety	City Hall Interior	South Conference	4959	12	INCAN-I60-1	6-in Can-Medium-Open - no lens-Recessed	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	12	
City Hall / Public Safety	City Hall Interior	South Conference	8760	4	EXIT-I15-1	Emergency w/BBU-White-Red-Surface	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	4	
City Hall / Public Safety	City Hall Interior	Breakroom	4959	4	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	4	Leviton Ceiling Occ. Sensor
City Hall / Public Safety	City Hall Interior	Breakroom	4959	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	1	
City Hall / Public Safety	City Hall Interior	Breakroom	4959	1	UFL-FU31T8/6-2	2X2-Troffer-Prismatic-Recessed	Retrofit	ATG 2X2 LED DOOR KIT	1	
City Hall / Public Safety	City Hall Interior	City Council Chambers	4959	15	UFL-FU31T8/6-2	2X2-Troffer-Parabolic-Recessed	Retrofit	ATG 2X2 LED DOOR KIT	15	(2) Leviton Ceiling Occ. Sensor
City Hall / Public Safety	City Hall Interior	City Council Chambers	4959	6	UFL-FU31T8/6-2	2X2-Troffer-Parabolic-Recessed	Retrofit	ATG LED 2x2 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	6	
City Hall / Public Safety	City Hall Interior	City Council Chambers	4959	5	CFL-CF13W-1	6-in Can-Medium-Open - no lens-Recessed	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	5	
City Hall / Public Safety	City Hall Interior	City Council Chambers	4959	8	LED-L12-1	6-in Can-Medium-Open - no lens-Recessed	Retrofit	Eiko LED BR30, 8W, 4000K	8	
City Hall / Public Safety	City Hall Interior	City Council Chambers	4959	2	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	2	
City Hall / Public Safety	City Hall Interior	Back Offices	4959	84	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	84	(6) Leviton Ceiling Occ. Sensor
City Hall / Public Safety	City Hall Interior	Back Offices	4959	2	CFL-CF13W-1	6-in Can-Medium-Open - no lens-Recessed	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	2	
City Hall / Public Safety	City Hall Interior	Back Offices	4959	28	F-F32T8-3	Troffer-2X4-Parabolic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	28	
City Hall / Public Safety	City Hall Interior	Back Offices	8760	5	EXIT-I15-1	Emergency w/BBU-White-Red-Surface	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	5	
City Hall / Public Safety	City Hall Interior	Back office bathrooms	4959	4	F-F32T8-2	Wrap-4 foot-Prismatic-Wall	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	4	(2) Lutron Wall Sensor Switch
City Hall / Public Safety	Public Safety Interior	Dispatch Electric Closet	730	3	F-F32T8-2	Strip-4 foot-Wire Guard-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	3	
City Hall / Public Safety	Public Safety Interior	Main Dispatch	8760	3	F-F17T8-2	Troffer-2X2-Indirect-Recessed	Retrofit	ATG 2X2 LED DOOR KIT	3	
City Hall / Public Safety	Public Safety Interior	Main Dispatch	8760	1	F-F17T8-2	Troffer-2X2-Indirect-Recessed	Retrofit	ATG LED 2x2 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	1	
City Hall / Public Safety	Public Safety Interior	Dispatch Kitchen/Bath	8760	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	1	Leviton Ceiling Occ. Sensor
City Hall / Public Safety	Public Safety Interior	Dispatch Kitchen/Bath	8760	2	HAL-H50-1	4-in Can-Medium-PAR20-Recessed	Retrofit	MaxLite 15W LED 4 COMMERCIAL DOWNLIGHT RETROFIT 4000K	2	
City Hall / Public Safety	Public Safety Interior	Dispatch Kitchen/Bath	8760	1	CFL-CF32W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	Nicor LED 6" Can Retrofit, 18W, 4000K w/ Emergency Blst	1	(2) Lutron Wall Sensor Switch
City Hall / Public Safety	Public Safety Interior	Dispatch Kitchen/Bath	8760	2	F-F32T8-2	Strip-4 foot-Open - no lens-Recessed	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	
City Hall / Public Safety	Public Safety Interior	Admin Office Area #139	8760	12	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	12	
City Hall / Public Safety	Public Safety Interior	Admin Office Area #139	8760	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	1	
City Hall / Public Safety	Public Safety Interior	Main Hall Baths	8760	2	CFL-CF32W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	Nicor LED 6" Can Retrofit, 18W, 4000K w/ Emergency Blst	2	
City Hall / Public Safety	Public Safety Interior	Main Hall Baths	8760	4	F-F32T8-2	Strip-4 foot-Open - no lens-Recessed	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	4	(2) Leviton Ceiling Occ. Sensor
City Hall / Public Safety	Public Safety Interior	Restricted Records #138	8760	4	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	4	
City Hall / Public Safety	Public Safety Interior	Main Hall	8760	6	CFL-CF32W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	6	
City Hall / Public Safety	Public Safety Interior	Main Hall	8760	9	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	9	
City Hall / Public Safety	Public Safety Interior	Main Hall	8760	6	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	6	
City Hall / Public Safety	Public Safety Interior	Main Hall	8760	1	UFL-FU31T8/6-2	2X2-Troffer-Prismatic-Recessed	Retrofit	ATG 2X2 LED DOOR KIT	1	
City Hall / Public Safety	Public Safety Interior	Cell Area	8760	6	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	6	
City Hall / Public Safety	Public Safety Interior	Cell Area	8760	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	1	
City Hall / Public Safety	Public Safety Interior	Cell Area	8760	7	F-F32T8-2	Vapor Tight-4 foot-Clear-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	7	
City Hall / Public Safety	Public Safety Interior	Cell Area	8760	5	CFL-CF13W-2	Security-Medium-Frosted-Surface	Retrofit	(2) Eiko LED A19 9W, 4000K	5	
City Hall / Public Safety	Public Safety Interior	Cell Area	8760	2	CFL-CF13W-1	Open Socket-Medium-Open - no lens-Surface	Retrofit	Eiko 4000K LED LiteSpan A19 Omni-Directional 300 Degree Beam 9W - 800lm Dimmable E26	2	
City Hall / Public Safety	Public Safety Interior	Maint 2	730	4	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	4	
City Hall / Public Safety	Public Safety Interior	Armory	8760	2	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	2	Lutron Wall Sensor Switch
City Hall / Public Safety	Public Safety Interior	Maint 3	730	1	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	1	
City Hall / Public Safety	Public Safety Interior	Men's Locker	8760	5	F-F32T8-2	Troffer-1X4-Prismatic-Recessed	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	5	(2) Leviton Ceiling Occ. Sensor
City Hall / Public Safety	Public Safety Interior	Men's Locker	8760	1	F-F32T8-2	Troffer-1X4-Prismatic-Recessed	Retrofit	(2) Remphos 4' LED Totaltube, 4000K w/ Emergency Blst	1	
City Hall / Public Safety	Public Safety Interior	Men's Locker	8760	1	F-F32T8-4	Strip-4 foot-Direct/Indirect-Wall	Retrofit	Eiko 4L 12W T8 Ballast Bypass DLCP	1	
City Hall / Public Safety	Public Safety Interior	Women's Locker Room	8760	3	F-F32T8-2	Troffer-1X4-Prismatic-Recessed	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	3	(2) Leviton Ceiling Occ. Sensor
City Hall / Public Safety	Public Safety Interior	Women's Locker Room	8760	1	F-F32T8-2	Troffer-1X4-Prismatic-Recessed	Retrofit	(2) Remphos 4' LED Totaltube, 4000K w/ Emergency Blst	1	
City Hall / Public Safety	Public Safety Interior	Women's Locker Room	8760	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	1	
City Hall / Public Safety	Public Safety Interior	Women's Locker Room	8760	2	F-F32T8-2	Vanity-4 foot-Prismatic-Wall	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	
City Hall / Public Safety	Public Safety Interior	Hall CLoset	730	1	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	1	Lutron Wall Sensor Switch
City Hall / Public Safety	Public Safety Interior	Supervisors Office #152	8760	5	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	5	Leviton Ceiling Occ. Sensor
City Hall / Public Safety	Public Safety Interior	Supervisors Office #152	8760	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	1	
City Hall / Public Safety	Public Safety Interior	Hall 161	8760	5	F-F32T8-3	Troffer-2X4-Prismatic-Surface	Retrofit	Eiko 3L 12W T8 Ballast Bypass DLCP	5	
City Hall / Public Safety	Public Safety Interior	Room 134	8760	14	F-F32T8-2	Strip-4 foot-Reflector-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	14	
City Hall / Public Safety	Public Safety Interior	Room 132	8760	7	F-F32T8-2	Strip-4 foot-Reflector-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	7	
City Hall / Public Safety	Public Safety Interior	Briefing	8760	6	F-F32T8-3	Troffer-2X4-Parabolic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	6	
City Hall / Public Safety	Public Safety Interior	Briefing	8760	4	HAL-H50-1	4-in Can-Medium-PAR20-Recessed	Retrofit	MaxLite 15W LED 4 COMMERCIAL DOWNLIGHT RETROFIT 4000K	4	
City Hall / Public Safety	Public Safety Interior	Briefing	8760	2	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	2	

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	Action	Proposed	Qty	Sensor Type and Quantity
City Hall / Public Safety	Public Safety Interior	Briefing	8760	5	HAL-H50-1	Track-Medium-PAR30-Track	Retrofit	Eiko LED PAR30, 11W, 4000K	5	
City Hall / Public Safety	Public Safety Interior	Traffic	8760	2	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	2	
City Hall / Public Safety	Public Safety Interior	Criminal Interest	8760	10	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	10	
City Hall / Public Safety	Public Safety Interior	Criminal Interest	8760	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	1	
City Hall / Public Safety	Public Safety Interior	Criminal Interest	8760	4	F-F32T8-4	Wrap-4 foot-Prismatic-Surface	Retrofit	Eiko 4L 12W T8 Ballast Bypass DLCP	4	
City Hall / Public Safety	Public Safety Interior	Crime Prevention	8760	4	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	4	
City Hall / Public Safety	Public Safety Interior	Crime Prevention	8760	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	1	
City Hall / Public Safety	Public Safety Interior	Records Office	8760	5	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	5	Leviton Ceiling Occ. Sensor
City Hall / Public Safety	Public Safety Interior	Records Office	8760	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	1	
City Hall / Public Safety	Public Safety Interior	Records Office	8760	1	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	1	
City Hall / Public Safety	Public Safety Interior	Lobby	8760	6	CFL-CF32W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	6	
City Hall / Public Safety	Public Safety Interior	Lobby	8760	1	CFL-CF32W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	Nicor LED 6" Can Retrofit, 18W, 4000K w/ Emergency Blst	1	
City Hall / Public Safety	Public Safety Interior	Lobby	8760	2	F-F32T8-3	Wrap-4 foot-Prismatic-Surface	Retrofit	Eiko 3L 12W T8 Ballast Bypass DLCP	2	
City Hall / Public Safety	Public Safety Interior	Lobby	8760	2	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	Action	Proposed	Qty	Sensor Type and Quantity
GLADSTONE COMM	Exterior	Parking Lot	4380	12	MH-MH250-1	Cobra Head-Mogul-Frosted-Pole	Retrofit	Eiko LED Post Top, 54W, 5000K, Mog Base (1623)	12	
GLADSTONE COMM	Exterior	Parking Lot	4380	8	MH-MH250-2	Cobra Head-Mogul-Frosted-Pole	Retrofit	(2) Eiko LED Post Top, 54W, 5000K, Mog Base (1623)	8	
GLADSTONE COMM	Exterior	Entrance	4380	25	CFL-CF26W-2	Decorative-Plug-in 4 Pin-Frosted-Surface	Retrofit	(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal (1623)	25	
GLADSTONE COMM	Exterior	Pathway	4380	22	MH-MH35-1	6-in Ground-G8.5-Clear-Ground	Do Nothing	Do Nothing	22	
GLADSTONE COMM	Exterior	Wall Lights	4380	7	HAL-H35/LV-2	Decorative-MR16-Clear-Wall	Retrofit	(2) Eiko LED MR16, 7W, 4000K (1623)	7	
GLADSTONE COMM	Exterior	Wall Flood	4380	12	MH-MH70-1	12-in Ground-Medium-Clear-Ground	Retrofit	Eiko 70W HIF Equal, 19W, 4000K, Med Base (1623)	12	
GLADSTONE COMM	Exterior	Bollards	4380	4	MH-MH70-1	Bollard-Medium-Frosted-Ground	Retrofit	Wayne Tyler Concrete Bollard 32W, 4000K, 120/277V (1623)	4	
GLADSTONE COMM	Exterior	Flag Poles	4380	3	MH-MH70-1	Flood-Medium-Clear-Ground	Retrofit	ATG LED FLOOD, 30W, 50K (1623)	3	
GLADSTONE COMM	Exterior	South Patio	4380	12	MH-MH35-1	Bullet-G8.5-Clear-Wall	Retrofit	MaxLite Bullet Flood, 11W, 50K, 3 Beam Angles	12	
GLADSTONE COMM	Interior	Entrance	5250	16	CFL-CF26W-2	Decorative-Plug-in 4 Pin-Frosted-Surface	Retrofit	(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal (1623)	16	
GLADSTONE COMM	Interior	Main Lobby/Halls	5250	8	F-F54T5HO-3	Decorative-4 foot-Prismatic-Pendant	Retrofit	(3) Eiko LED 4FT T5, 25W, 4000K (1623)	8	
GLADSTONE COMM	Interior	Main Lobby/Halls	5250	44	CFL-CF42W-3	Decorative-Plug-in 4 Pin-Open - no lens-Surface	Retrofit	Sielo LED Retrofit Kit, (1623)	44	
GLADSTONE COMM	Interior	Main Lobby/Halls	5250	27	HAL-H50-1	Track-2 Pin-Clear-Track	Retrofit	Eiko 3000K LED GEN5 MR16 GU5.3, 25 deg beam, 7W - 520lm, Dimmable, 3000K	27	
GLADSTONE COMM	Interior	Main Lobby/Halls	5250	15	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	15	
GLADSTONE COMM	Interior	Main Lobby/Halls	5250	14	CFL-CF42W-2	8-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	MaxLite 23W LED 8 COMMERCIAL DOWNLIGHT RETROFIT 4000K	14	
GLADSTONE COMM	Interior	Main Lobby/Halls	5250	4	HAL-H35-1	Decorative-2 Pin-Frosted-Pendant	Retrofit	Eiko LED MR16, 40D, 7W, 12V, GU5.3 (1623)	4	
GLADSTONE COMM	Interior	Main Lobby/Halls	5250	20	F-F17T8-3	Troffer-2X2-Parabolic-Recessed	Retrofit	ATG 2X2 LED DOOR KIT	20	
GLADSTONE COMM	Interior	Gashland Room	5250	17	HAL-H75-1	6-in Can-Medium-PAR30-Recessed	Retrofit	MaxLite 23W 6 LED COMMERCIAL DOWNLIGHT RETROFIT - 4000K	17	
GLADSTONE COMM	Interior	Gashland Room	5250	3	QUARTZ-Q150-1	Decorative-Double End-Frosted-Pendant	Do Nothing	Do Nothing	3	
GLADSTONE COMM	Interior	Gashland Room	5250	10	F-F17T8-3	Troffer-2X2-Parabolic-Recessed	Retrofit	ATG 2x2 Troffer Door Kit, 30W, 4000K w/ EM Backup (1623)	10	
GLADSTONE COMM	Interior	Gladstone Room	5250	18	HAL-H75-1	6-in Can-Medium-PAR30-Recessed	Retrofit	MaxLite 23W 6 LED COMMERCIAL DOWNLIGHT RETROFIT - 4000K	18	
GLADSTONE COMM	Interior	Gladstone Room	5250	3	QUARTZ-Q150-1	Decorative-Double End-Frosted-Pendant	Do Nothing	Do Nothing	3	
GLADSTONE COMM	Interior	Gladstone Room	5250	10	F-F17T8-3	Troffer-2X2-Parabolic-Recessed	Retrofit	ATG 2x2 Troffer Door Kit, 30W, 4000K w/ EM Backup (1623)	10	
GLADSTONE COMM	Interior	Linden Room	5250	20	HAL-H75-1	6-in Can-Medium-PAR30-Recessed	Retrofit	MaxLite 23W 6 LED COMMERCIAL DOWNLIGHT RETROFIT - 4000K	20	
GLADSTONE COMM	Interior	Linden Room	5250	3	QUARTZ-Q150-1	Decorative-Double End-Frosted-Pendant	Do Nothing	Do Nothing	3	
GLADSTONE COMM	Interior	Linden Room	5250	10	F-F17T8-3	Troffer-2X2-Parabolic-Recessed	Retrofit	ATG 2x2 Troffer Door Kit, 30W, 4000K w/ EM Backup (1623)	10	
GLADSTONE COMM	Interior	Male/Female RR 1st Floor	5250	1	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	1	Lutron Wall Sensor Switch
GLADSTONE COMM	Interior	Male/Female RR 1st Floor	5250	2	F-F32T8-2	Strip-4 foot-Open - no lens-Recessed	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	Lutron Wall Sensor Switch
GLADSTONE COMM	Interior	Audio/visual	730	1	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	1	Lutron Wall Sensor Switch
GLADSTONE COMM	Interior	Bathrooms 1st Floor	5250	12	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	12	(2) Leviton Ceiling Occ. Sensor
GLADSTONE COMM	Interior	Bathrooms 1st Floor	5250	6	F-F32T8-2	Strip-4 foot-Open - no lens-Recessed	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	6	
GLADSTONE COMM	Interior	Bathrooms 1st Floor	5250	1	F-F25T8-2	Strip-3 foot-Open - no lens-Recessed	Retrofit	(2) EIKO LED 3' T8 TUBE, BALLAST BYPASS, 12W, 1450LM, 4000K (1623)	1	
GLADSTONE COMM	Interior	1114	5250	6	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	6	
GLADSTONE COMM	Interior	1114	8760	2	EXIT-I15-1	Exit-White-Green-Surface	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	2	
GLADSTONE COMM	Interior	1108 Kitchen	5250	7	F-F32T8-3	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	7	(2) Leviton Ceiling Occ. Sensor
GLADSTONE COMM	Interior	1113 Custodial A	730	1	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	1	Lutron Wall Sensor Switch
GLADSTONE COMM	Interior	1117 Marketing	5250	2	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	2	Lutron Wall Sensor Switch
GLADSTONE COMM	Interior	1116 Museum mgr	5250	2	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	2	Lutron Wall Sensor Switch
GLADSTONE COMM	Interior	1110 operations	5250	6	F-F32T8-2	Troffer-2X4-Indirect-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	6	Leviton Ceiling Occ. Sensor
GLADSTONE COMM	Interior	1119 Banquet	5250	2	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	2	Lutron Wall Sensor Switch
GLADSTONE COMM	Interior	1118 Asst Admin	5250	2	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	2	Lutron Wall Sensor Switch
GLADSTONE COMM	Interior	Natatorium Entryway	5250	37	F-F14T5-2	Troffer-2X2-Indirect-Recessed	Retrofit	ATG 2X2 LED DOOR KIT	37	
GLADSTONE COMM	Interior	Natatorium Entryway	5250	3	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	3	
GLADSTONE COMM	Interior	2204/2206 bathrooms	5250	15	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	15	
GLADSTONE COMM	Interior	2204/2206 bathrooms	5250	9	F-F32T8-2	Strip-4 foot-Open - no lens-Recessed	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	9	
GLADSTONE COMM	Interior	2204/2206 bathrooms	5250	1	F-F17T8-2	Strip-2 foot-Open - no lens-Recessed	Retrofit	(2) Eiko 2FT LED T8, 9W, 4000K (1623)	1	
GLADSTONE COMM	Interior	2204/2206 bathrooms	5250	1	F-F25T8-2	Strip-3 foot-Open - no lens-Recessed	Retrofit	(2) EIKO LED 3' T8 TUBE, BALLAST BYPASS, 12W, 1450LM, 4000K (1623)	1	
GLADSTONE COMM	Interior	1522 Water Service	5250	4	F-F32T8-2	Strip-4 foot-Wire Guard-Suspended	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	4	Leviton Ceiling Occ. Sensor
GLADSTONE COMM	Interior	1520 Electrical	5250	4	F-F32T8-2	Strip-4 foot-Wire Guard-Suspended	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	4	Leviton Ceiling Occ. Sensor
GLADSTONE COMM	Interior	1520 Electrical	5250	8	F-F32T8-2	Strip-4 foot-Wire Guard-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	8	Leviton Ceiling Occ. Sensor
GLADSTONE COMM	Interior	1608 Storage	5250	3	F-F32T8-3	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	3	
GLADSTONE COMM	Interior	1608 Storage	5250	5	F-F32T8-4	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	5	(2) Leviton Ceiling Occ. Sensor
GLADSTONE COMM	Interior	1608 Storage	5250	3	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	3	
GLADSTONE COMM	Interior	1506 Life Guard Offic	5250	6	UFL-FU31T8/6-2	2X2-Troffer-Prismatic-Recessed	Retrofit	ATG 2X2 LED DOOR KIT	6	
GLADSTONE COMM	Interior	1329 Storage	730	1	F-F32T8-3	Troffer-2X4-Prismatic-Suspended	Retrofit	Eiko 3L 12W T8 Ballast Bypass DLCP	1	
GLADSTONE COMM	Interior	Room 1313 Break Room	5250	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	1	Lutron Wall Sensor Switch
GLADSTONE COMM	Interior	Men's Locker Room	5250	19	F-F17T8-3	Troffer-2X2-Parabolic-Recessed	Retrofit	ATG 2X2 LED DOOR KIT	19	
GLADSTONE COMM	Interior	Men's Locker Room	5250	14	CFL-CF42W-1	8-in Can-Plug-in 4 Pin-Frosted-Recessed	Retrofit	NICOR CLR8 8" DOWNLIGHT KIT.	14	
GLADSTONE COMM	Interior	Men's Locker Room	5250	5	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	5	
GLADSTONE COMM	Interior	Men's Locker Room	5250	8	F-F54T5HO-1	Vanity-4 foot-Frost-Wall	Retrofit	Eiko LED 4FT T5, 25W, 4000K (1623)	8	
GLADSTONE COMM	Interior	Men's Locker Room	5250	4	F-F32T8-2	Strip-4 foot-Open - no lens-Recessed	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	4	
GLADSTONE COMM	Interior	Women's Locker Room	5250	20	F-F17T8-3	Troffer-2X2-Parabolic-Recessed	Retrofit	ATG 2X2 LED DOOR KIT	20	
GLADSTONE COMM	Interior	Women's Locker Room	5250	21	CFL-CF42W-1	8-in Can-Plug-in 4 Pin-Frosted-Recessed	Retrofit	NICOR CLR8 8" DOWNLIGHT KIT.	21	
GLADSTONE COMM	Interior	Women's Locker Room	5250	6	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	6	
GLADSTONE COMM	Interior	Women's Locker Room	5250	9	F-F54T5HO-1	Vanity-4 foot-Frost-Wall	Retrofit	Eiko LED 4FT T5, 25W, 4000K (1623)	9	
GLADSTONE COMM	Interior	Women's Locker Room	5250	4	F-F32T8-2	Strip-4 foot-Open - no lens-Recessed	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	4	
GLADSTONE COMM	Interior	1300 Family Changing Roo	5250	7	F-F32T8-3	Troffer-2X4-Parabolic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	7	
GLADSTONE COMM	Interior	1300 Family Changing Roo	5250	10	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	10	
GLADSTONE COMM	Interior	1300 Family Changing Roo	5250	5	CFL-CF42W-1	8-in Can-Plug-in 4 Pin-Frosted-Recessed	Retrofit	NICOR CLR8 8" DOWNLIGHT KIT.	5	
GLADSTONE COMM	Interior	1300 Family Changing Roo	5250	5	F-F32T8-2	Strip-4 foot-Open - no lens-Recessed	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	5	
GLADSTONE COMM	Interior	1300 Family Changing Roo	8760	1	EXIT-I15-1	Exit-White-Green-Surface	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	
GLADSTONE COMM	Interior	1300 Family Changing Roo	5250	5	F-F25T8-2	Strip-3 Foot-Open - no lens-Recessed	Retrofit	(2) EIKO LED 3' T8 TUBE, BALLAST BYPASS, 12W, 1450LM, 4000K (1623)	5	
GLADSTONE COMM	Interior	1303 Custodial B	730	2	F-F32T8-2	Strip-4 foot-Wire Guard-Suspended	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	
GLADSTONE COMM	Interior	1020 Party Room	5250	11	F-F17T8-3	Troffer-2X2-Parabolic-Recessed	Retrofit	ATG 2X2 LED DOOR KIT	11	(2) Leviton Ceiling Occ. Sensor
GLADSTONE COMM	Interior	1020 Party Room	8760	1	EXIT-I15-1	Exit-White-Green-Surface	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	
GLADSTONE COMM	Interior	1018 Meeting Room	5250	8	F-F17T8-3	Troffer-2X2-Parabolic-Recessed	Retrofit	ATG 2X2 LED DOOR KIT	8	Leviton Ceiling Occ. Sensor
GLADSTONE COMM	Interior	1022 Child Watch	5250	9	F-F32T8-2	Troffer-2X4-Indirect-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	9	Leviton Ceiling Occ. Sensor
GLADSTONE COMM	Interior	1200 Offices	5250	27	F-F32T8-3	Troffer-2X4-Parabolic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	27	
GLADSTONE COMM	Interior	1200 Offices	8760	1	EXIT-I15-1	Exit-White-Green-Surface	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	
GLADSTONE COMM	Interior	1200 Offices	5250	9	HAL-H75-1	6-in Can-Medium-PAR30-Recessed	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	9	

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	Action	Proposed	Qty	Sensor Type and Quantity
GLADSTONE COMM	Interior	1200 Offices	5250	1	F-F54T5HO-2	Strip-4 foot-Clear-Pendant	Retrofit	(2) Eiko LED 4FT T5, 25W, 4000K (1623)	1	
GLADSTONE COMM	Interior	Fitness Stairs	5250	6	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	6	
GLADSTONE COMM	Interior	Fitness Stairs	5250	2	F-F32T8-2	Indirect-4 foot-Prismatic-Wall	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	
GLADSTONE COMM	Interior	Fitness Room	5250	18	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	18	
GLADSTONE COMM	Interior	Fitness Room	5250	64	F-F32T8-3	Direct/Indirect-4 foot-Frost-Aircraft Cable	Retrofit	Eiko 3L 12W T8 Ballast Bypass DLCP	64	
GLADSTONE COMM	Interior	2004 Studio B	5250	12	F-F17T8-3	Troffer-2X2-Parabolic-Recessed	Retrofit	ATG 2X2 LED DOOR KIT	12	
GLADSTONE COMM	Interior	2004 Studio B	5250	10	HAL-H75-1	6-in Can-Medium-PAR30-Recessed	Retrofit	MaxLite 23W 6 LED COMMERCIAL DOWNLIGHT RETROFIT - 4000K	10	
GLADSTONE COMM	Interior	2008 Fitness Supervisor	5250	2	F-F32T8-3	Troffer-2X4-Parabolic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	2	
GLADSTONE COMM	Interior	2010 Restroom	5250	1	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	1	
GLADSTONE COMM	Interior	2010 Restroom	5250	2	F-F32T8-2	Strip-4 foot-Open - no lens-Recessed	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	Lutron Wall Sensor Switch
GLADSTONE COMM	Interior	2012/2016	5250	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	1	
GLADSTONE COMM	Interior	2012/2016	5250	2	F-F32T8-2	Strip-4 foot-Wire Guard-Suspended	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	Lutron Wall Sensor Switch
GLADSTONE COMM	Interior	2020 Studio A	5250	24	F-F17T8-3	Troffer-2X2-Parabolic-Recessed	Retrofit	ATG 2X2 LED DOOR KIT	24	
GLADSTONE COMM	Interior	2020 Studio A	5250	20	HAL-H75-1	6-in Can-Medium-PAR30-Recessed	Retrofit	MaxLite 23W 6 LED COMMERCIAL DOWNLIGHT RETROFIT - 4000K	20	
GLADSTONE COMM	Interior	2020 Studio A	5250	2	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	2	
GLADSTONE COMM	Interior	Track	5250	8	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	Retrofit	Cree LS4 4' LED Surface Ambient Luminaire 44W, 40K, 40lm	8	
GLADSTONE COMM	Interior	Gym	5250	16	F-F54T5HO-4	Highbay-2X4-Open - no lens-Aircraft Cable	Retrofit	Lithonia IBG LED Highbay, 114W, 18000lm, 50K	16	
GLADSTONE COMM	Interior	Gym	5250	32	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	Retrofit	Cree LS4 4' LED Surface Ambient Luminaire 44W, 40K, 40lm	32	
GLADSTONE COMM	Interior	Gym	8760	4	EXIT-I15-1	Exit-White-Green-Surface	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	4	
GLADSTONE COMM	Interior	Gym	5250	8	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	8	
GLADSTONE COMM	Interior	Natatorium	5250	23	MH-MH400-2	Flood-Mogul-Clear-Surface	Replace	Meteor Bolt Series Flood, 280W, 4000K, 32900 Lumen	23	
GLADSTONE COMM	Interior	Natatorium	5250	10	MH-MH400-2	Flood-Mogul-Clear-Surface	Remove	Remove Existing Fixtures	0	
GLADSTONE COMM	Interior	Natatorium	8760	3	EXIT-I15-1	Exit-White-Green-Surface	Retrofit	E-conolight Wet Location LED Exit Sign (1623)	3	
GLADSTONE COMM	Interior	Natatorium	5250	4	MH-MH400-1	Flood-Mogul-Clear-Wall	Remove	Remove Existing Fixtures	0	
GLADSTONE COMM	Interior	Natatorium	5250	6	MH-MH400-1	Wallpack-Mogul-Clear-Wall	Replace	Meteor Bolt Series Flood, 280W, 4000K, 32900 Lumen	6	
GLADSTONE COMM	Interior	Pool	5250	12	MH-MH400-1	Flood-Mogul-Clear-Wall	Replace	Meteor Bolt Series Flood, 280W, 4000K, 32900 Lumen	12	
GLADSTONE COMM	Interior	Pool	8760	2	EXIT-I15-1	Exit-White-Green-Surface	Retrofit	E-conolight Wet Location LED Exit Sign (1623)	2	
GLADSTONE COMM	Interior	Gym Storage	730	4	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	4	
GLADSTONE COMM	Interior	Natatorium BOH	5250	25	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	25	
GLADSTONE COMM	Interior	Natatorium BOH	5250	11	F-F32T8-4	Strip-8 foot-Open - no lens-Surface	Retrofit	Eiko 4L 12W T8 Ballast Bypass DLCP	11	

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	Action	Proposed	Qty	Sensor Type and Quantity
City Hall/Community Center Decorative Street Light	City Hall / Community Center Street Lights	Single Head	4380	45	MH-MH175-1	Acorn-Mogul-Prismatic-Pole	Retrofit	RemPhos LEDSSEXT 40W 4400LM 4000K	45	
City Hall/Community Center Decorative Street Light	City Hall / Community Center Street Lights	Double Head	4380	46	MH-MH175-2	Acorn-Mogul-Prismatic-Pole	Retrofit	(2) RemPhos LED Post Top Retro Kit, 40W, 4000K	46	

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	Action	Proposed	Qty	Sensor Type and Quantity
Hamilton Heights Picnic Shelter	Parking Lot	Pole Lights	4380	2	MH-MH175-2	Acorn-Mogul-Clear-Pole	Retrofit	(2) RemPhos LED Post Top, 40W, 4000K, 4400 Lumen	2	

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	Action	Proposed	Qty	Sensor Type and Quantity
Linden Office	Concessions	Exterior	4380	12	HAL-H50-1	Decorative-MR16-Clear-Surface	Retrofit	Eiko LED MR16, GU10, 7W, 4000K (1633)	12	
Linden Office	Concessions	Exterior	4380	2	CFL-CF26W-2	8-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	Nicor 8" Retrofit Can, 18W, 4000K w/ Emerg Blst (1633)	2	

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	Action	Proposed	Qty	Sensor Type and Quantity
Oak Grove Park	Amphitheater	Interior	1460	17	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	Retrofit	Eiko 4FT LED Strip, 23W, 4000K	17	
Oak Grove Park	Amphitheater	Interior	1460	2	MH-MH175-1	Flood-Mogul-Clear-Wall	Retrofit	Deco D211 40W Flood, Slipfitter, Bronze	2	
Oak Grove Park	Amphitheater	Interior	8760	3	EXIT-I15-1	Exit-White-Red-Wall	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	3	
Oak Grove Park	Amphitheater	Exterior	4380	1	MH-MH175-1	Wallpack-Mogul-Prismatic-Wall	Retrofit	ATG 28W LED WallPack	1	
Oak Grove Park	Amphitheater	Exterior	4380	2	MH-MH175-1	Acorn-Mogul-Clear-Wall	Retrofit	Eiko LED Litespan Post Top 36W 4000lm 4K Non-Dim E39 Universal Burn Position Mogule Base	2	
Oak Grove Park	Bathrooms	Men's/womens/closet	1460	3	F-F32T8-2	Vapor Tight-4 foot-Clear-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	3	(3) Lutron Wall Sensor Switch
Oak Grove Park	Garage/storage	Exterior	4380	6	MH-MH100-1	Wallpack-Medium-Prismatic-Wall	Retrofit	ATG 28W LED WallPack	6	

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	Action	Proposed	Qty	Sensor Type and Quantity
Public Fire #1	Interior	Entrance	5800	2	CFL-CF26W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	Nicor 6in Can LED Retrofit, 18W, 4000K	2	
Public Fire #1	Interior	Entrance	5800	2	CFL-CF26W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	Nicor 6" LED Can Light, 18W, 4000K w/ Emergency Blst	2	
Public Fire #1	Interior	Entrance	8760	1	EXIT-I15-1	Exit-White-Red-Surface	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	
Public Fire #1	Interior	Entrance	5800	1	F-F32T8-1	Direct/Indirect-4 foot-Reflector-Pendant	Retrofit	Eiko 1L 12W T8 Ballast Bypass DLCP	1	
Public Fire #1	Interior	Hallway	5800	1	HAL-H50-1	Decorative-GU10-None-Wall	Retrofit	Eiko LED MR16, GU10, 120V, 7W, 4000K	1	
Public Fire #1	Interior	Hallway	8760	1	EXIT-I15-1	Exit-White-Red-Wall	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	
Public Fire #1	Interior	Hallway	5800	19	F-F32T8-1	Direct/Indirect-4 foot-Reflector-Pendant	Retrofit	Eiko 1L 12W T8 Ballast Bypass DLCP	19	
Public Fire #1	Interior	Hallway	8760	1	EXIT-I15-1	Exit-White-Red-Surface	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	
Public Fire #1	Interior	103	5800	2	F-F32T8-1	Direct/Indirect-4 foot-Reflector-Pendant	Retrofit	Eiko 1L 12W T8 Ballast Bypass DLCP	2	
Public Fire #1	Interior	104	5800	3	F-F32T8-1	Direct/Indirect-4 foot-Reflector-Pendant	Retrofit	Eiko 1L 12W T8 Ballast Bypass DLCP	3	
Public Fire #1	Interior	105	730	1	F-F32T8-2	Strip-4 foot-Open - no lens-Wall	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	1	
Public Fire #1	Interior	Kitchen	5800	4	F-F32T8-1	Strip-4 foot-Prismatic-Surface	Retrofit	Eiko 1L 12W T8 Ballast Bypass DLCP	4	
Public Fire #1	Interior	Kitchen	5800	10	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	10	
Public Fire #1	Interior	Kitchen	5800	5	LED-L8-1	Pendant-Candelabra-Open - no lens-Pendant	Do Nothing	Do Nothing	5	
Public Fire #1	Interior	Lounge	5800	8	CFL-CF26W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	Nicor 6in Can LED Retrofit, 18W, 4000K	8	
Public Fire #1	Interior	Lounge	5800	1	CFL-CF26W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	Nicor 6" LED Can Light, 18W, 4000K w/ Emergency Blst	1	
Public Fire #1	Interior	Lounge	5800	4	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	4	
Public Fire #1	Interior	Back Hallway	5800	5	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	5	
Public Fire #1	Interior	Back Hallway	5800	4	CFL-CF26W-1	4-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	MaxLite 15W LED 4 COMMERCIAL DOWNLIGHT RETROFIT 4000K	4	
Public Fire #1	Interior	Back Hallway	8760	1	EXIT-I15-1	Exit-White-Red-Wall	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	
Public Fire #1	Interior	Back Hallway	8760	1	EXIT-I15-1	Exit-White-Red-Surface	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	
Public Fire #1	Interior	Sleeping Rooms	5800	7	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	7	
Public Fire #1	Interior	Bathrooms	5800	6	F-F32T8-2	Troffer-1X4-Prismatic-Recessed	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	6	(4) Leviton Ceiling Occ. Sensor
Public Fire #1	Interior	Bathrooms	5800	2	F-F32T8-2	Troffer-1X4-Prismatic-Recessed	Retrofit	(2) Remphos Total Tube 15W, 4000K w/ Emergency Blst	2	
Public Fire #1	Interior	Bathrooms	5800	3	CFL-CF13W-1	6-in Can-Medium-Frosted-Recessed	Retrofit	Eiko 4000K LED LiteSpan A19 Omni-Directional 300 Degree Beam 9W - 800lm Dimmable E26	3	
Public Fire #1	Interior	Bathrooms	5800	8	F-F32T8-1	Strip-4 foot-Eggcrate-Recessed	Retrofit	Eiko 1L 12W T8 Ballast Bypass DLCP	8	
Public Fire #1	Interior	Office	5800	6	HAL-H35/LV-1	Track-2 Pin-None-Surface	Retrofit	Eiko LED MR16, 7W, 4000K	6	
Public Fire #1	Interior	Office	5800	9	HAL-H35/LV-1	Track-MR16-None-Pendant	Retrofit	Eiko LED MR16, 7W, 4000K	9	Leviton Ceiling Occ. Sensor
Public Fire #1	Interior	Garage	5800	9	CFL-CF27W-9	Highbay-2G11-Prismatic-Pendant	Retrofit	Lithonia IBG HighBay, 95W, 5000K w/ EM Backup	9	
Public Fire #1	Interior	Garage	730	7	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	7	
Public Fire #1	Interior	Garage	5800	6	F-F32T8-2	Strip-4 foot-Prismatic-Wall	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	6	
Public Fire #1	Interior	Garage	5800	2	F-F32T8-2	Troffer-1X4-Prismatic-Recessed	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	
Public Fire #1	Interior	Garage	5800	1	CFL-CF26W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	Retrofit	Nicor 6in Can LED Retrofit, 18W, 4000K	1	
Public Fire #1	Interior	Garage	8760	1	EXIT-I15-1	Exit-White-Red-Surface	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	
Public Fire #1	Exterior	Canopy	4380	8	CFL-CF13W-1	6-in Can-Medium-Open - no lens-Recessed	Retrofit	Eiko 4000K LED LiteSpan A19 Omni-Directional 300 Degree Beam 9W - 800lm Dimmable E26	8	
Public Fire #1	Exterior	Security	4380	1	CFL-CF15W-2	Security-Medium-Open - no lens-Surface	Retrofit	Eiko 13W PAR38 Lamp Flood Beam, 40K 1050lm 2L	1	
Public Fire #1	Exterior	Parking	4380	2	MH-MH175-1	Shoe Box-Mogul-Clear-Pole	Retrofit	Deco D824 LED Glade Luminaire, D824-LED4050UNVT5PMBZ	2	

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	Action	Proposed	Qty	Sensor Type and Quantity
Public Fire #2	Interior	Hallway/Lounge	5800	20	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	20	
Public Fire #2	Interior	Hallway/Lounge	8760	4	EXIT-I15-1	Emergency w/BBU-White-Red-Surface	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	4	
Public Fire #2	Interior	Watch	5800	2	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	2	
Public Fire #2	Interior	103	5800	2	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	2	
Public Fire #2	Interior	Division Chief	5800	3	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	3	Lutron Wall Sensor Switch
Public Fire #2	Interior	105	5800	2	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	2	
Public Fire #2	Interior	Dormitories	5800	2	F-F32T8-2	Wrap-4 foot-Prismatic-Wall	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	
Public Fire #2	Interior	Dormitories	5800	4	INCAN-I60-2	Decorative-Medium-Clear-Surface	Retrofit	(2) Eiko LED A19, 9W, 4000K	4	
Public Fire #2	Interior	Dormitories	5800	4	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	4	
Public Fire #2	Interior	Dormitories	5800	8	F-F32T8-3	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	8	
Public Fire #2	Interior	Training Room	5800	10	F-F32T8-3	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	10	Leviton Ceiling Occ. Sensor
Public Fire #2	Interior	Training Room	8760	1	EXIT-I15-1	Emergency w/BBU-White-Red-Surface	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	
Public Fire #2	Interior	Apparatus Bay	5800	20	F-F54T5HO-4	Highbay-2X4-Open - no lens-Surface	Retrofit	Lithonia IBG LED Highbay, 114W, 18000lm, 50K	20	
Public Fire #2	Interior	Apparatus Bay	5800	4	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	4	
Public Fire #2	Exterior	Security	4380	1	LED-L40-1	Security-Led-Clear-Wall	Do Nothing	Do Nothing	1	
Public Fire #2	Exterior	Security	4380	1	MH-MH175-1	Security-Mogul-Clear-Wall	Retrofit	Eiko Litespan Dusk to Dawn LED 40W 3200LM Grey w/120-277V Twistlock Photocell	1	
Public Fire #2	Exterior	Security	4380	1	MH-MH150-1	Wallpack-Medium-Clear-Wall	Retrofit	ATG 28W LED WallPack	1	

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	Action	Proposed	Qty	Sensor Type and Quantity
Public Works	Public Works	Ext Wallpacks	4380	9	LED-L20-1	Wallpack-LED-Clear-Wall	Do Nothing	Do Nothing	9	
Public Works	Public Works	Upstairs Offices	2650	7	UFL-FU31T8/6-2	2X2-Troffer-Prismatic-Recessed	Retrofit	ATG 2X2 LED DOOR KIT	7	
Public Works	Public Works	Upstairs Offices	2650	22	F-F32T8-3	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	22	
Public Works	Public Works	Upstairs Offices	2650	4	F-F32T8-2	Strip-4 foot-Parabolic-Recessed	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	4	
Public Works	Public Works	Upstairs Offices	8760	3	EXIT-I15-1	Exit-Black-Red-Surface	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	3	
Public Works	Public Works	Shop	2650	15	F-F54T5HO-4	Highbay-2X4-Open - no lens-Aircraft Cable	Retrofit	Lithonia IBG LED Highbay, 114W, 18000lm, 50K	15	
Public Works	Public Works	Shop	2650	3	F-F96T8-2	Strip-8 foot-Open - no lens-Surface	Retrofit	LED Strip Retro Kit w/ (4) Eiko LED T8, 12W, 4000K	3	
Public Works	Public Works	1st Floor Offices	2650	13	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	13	
Public Works	Public Works	1st Floor Offices	2650	8	F-F32T8-3	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	8	
Public Works	Public Works	1st Floor Offices	8760	1	EXIT-I15-1	Emergency w/BBU-White-Red-Surface	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	
Public Works	Public Works	Restrooms	2650	4	F-F32T8-2	Strip-4 foot-Parabolic-Recessed	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	4	(2) Lutron Wall Sensor Switch
Public Works	Storage West	Exterior	4380	4	LED-L20-1	Wallpack-LED-Clear-Wall	Do Nothing	Do Nothing	4	
Public Works	Storage West	Exterior	2650	4	F-F54T5HO-4	Vapor Tight-2X4-Clear-Aircraft Cable	Retrofit	Eiko 4L LED T5HO Lamp, Direct Fit 25W, 3200lm, 40K	4	
Public Works	Storage West	Interior	2650	13	F-F54T5HO-4	Highbay-2X4-Open - no lens-Aircraft Cable	Retrofit	Lithonia IBG LED Highbay, 114W, 18000lm, 50K	13	
Public Works	Storage West	Interior	2650	2	F-F32T8-4	Wrap-2X4-Prismatic-Aircraft Cable	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	2	
Public Works	Storage West	Interior	2650	2	F-F32T8-2	Strip-4 foot-Open - no lens-Aircraft Cable	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	
Public Works	Salt Dome	Dusk to dawn	4380	1	MH-MH250-1	Security-Mogul-Open - no lens-Pole	Retrofit	Eiko Litespan Dusk to Dawn LED 60W 5249LM Grey w/120-277V Twistlock Photocell	1	
Public Works	Salt Dome	Inside	2650	2	MH-MH175-1	Wallpack-Mogul-Clear-Surface	Retrofit	ATG 28W LED WallPack	2	
Public Works	New Property Barn	Exterior	4380	10	LED-L20-1	Wallpack-LED-Clear-Wall	Do Nothing	Do Nothing	10	
Public Works	New Property Barn	Imside	2650	6	LED-L20-1	Wallpack-LED-Clear-Wall	Do Nothing	Do Nothing	6	
Public Works	Storage	Wallpacks	2650	3	LED-L20-1	Wallpack-LED-Clear-Wall	Do Nothing	Do Nothing	3	
Public Works	Storage East	Exterior	4380	4	HAL-H50-2	Security-Medium-PAR38-Wall	Retrofit	Eiko LED PAR38, Flood 40D, 17W, 1300lm, 40K	4	
Public Works	Storage East	Imterior	2650	32	F-F32T8-2	Strip-4 foot-Wire Guard-Suspended	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	32	
Public Works	Water Barn	Exterior	4380	1	MH-MH250-1	Security-Mogul-Open - no lens-Wall	Retrofit	Eiko Litespan Dusk to Dawn LED 60W 5249LM Grey w/120-277V Twistlock Photocell	1	

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	Action	Proposed	Qty	Sensor Type and Quantity
Water Treatment	Interior	Lower level	2360	18	F-F32T8-2	Vapor Tight-4 foot-Clear-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	18	
Water Treatment	Interior	Lower level	8760	2	EXIT-Tritium0-1	Exit-Red-White-Wall	Do Nothing	Do Nothing	2	
Water Treatment	Interior	Lower level	2360	8	UFL-FU31T8/6-2	2X2-Troffer-Prismatic-Recessed	Retrofit	ATG 2X2 LED DOOR KIT	8	
Water Treatment	Interior	Tank Room	2360	29	UFL-FU31T8/6-2	2X2-Troffer-Prismatic-Recessed	Retrofit	ATG 2X2 LED DOOR KIT	29	
Water Treatment	Interior	Tank Room	2360	2	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	2	
Water Treatment	Interior	Tank Room	8760	1	EXIT-Tritium0-1	Exit-Red-White-Wall	Do Nothing	Do Nothing	1	
Water Treatment	Interior	Storage	2360	4	F-F32T8-3	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	4	
Water Treatment	Interior	Restroom	2360	1	UFL-FU31T8/6-2	2X2-Troffer-Prismatic-Recessed	Retrofit	ATG 2X2 LED DOOR KIT	1	Lutron Wall Sensor Switch
Water Treatment	Interior	Restroom	2360	1	CFL-CF13W-2	Vanity-Medium-Clear-Wall	Retrofit	(2) Eiko LED A19, 6W, 4000K	1	Lutron Wall Sensor Switch
Water Treatment	Interior	Office	2360	4	F-F32T8-3	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	4	
Water Treatment	Interior	Lab	2360	16	F-F32T8-3	Troffer-2X4-Prismatic-Recessed	Retrofit	ATG LED 2x4 Troffer Door Kit	16	
Water Treatment	Interior	Chemical Room	2360	15	F-F32T8-2	Vapor Tight-4 foot-Clear-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	15	
Water Treatment	Interior	Chemical Room	8760	1	EXIT-Tritium0-1	Exit-Red-White-Wall	Do Nothing	Do Nothing	1	
Water Treatment	Interior	Chlorine Room	2360	6	F-F32T8-2	Strip-4 foot-Wire Guard-Surface	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	6	
Water Treatment	Exterior	Pole Lights	4380	1	MH-MH1000-1	Shoe Box-Mogul-Clear-Pole	Retrofit	Deco Large Gladetino, 1000W Equal, 222W, Slipfitter, Bronze	1	
Water Treatment	Exterior	Pole Lights	4380	1	MH-MH400-4	Shoe Box-Mogul-Clear-Pole	Retrofit	(4) Deco Gladetino, 120W, 5000K w/ Slip Fitter	1	
Water Treatment	Exterior	Building	4380	5	INCAN-I60-1	Security-Medium-Clear-Wall	Retrofit	Maxlite 15W Architectural Security Light 50K, PC	5	
Water Treatment	Exterior	Building	4380	2	CFL-CF13W-1	Decorative-Candelabra-Clear-Surface	Retrofit	Maxlite 15W Architectural Security Light 50K, PC	2	

Presents the following

Audit / Proposal

to

Navitas, LLC

25501 West Valley Parkway
Olathe, KS 66061

Customer Contact ---- Bob Ades **913-333-7548**
rades@navitas.us.com

Building Envelope Solutions, LLC proposes to upgrade the building envelope for the following buildings noted below. We have reviewed and audited the following buildings and have prepared this quote based on these audits.

Project Site: **City of Gladstone**
Quote Date: **September 1, 2017** **Revision B**

Audit Date: June 1, 2017
Assessor(s): Brandon Flesch
Calculation Method: **EGAM NR-04-01A (Derived from EC-128 - Energy Canada study 128, and ASHRAE Calculations)**

Air leakage is defined as, "the uncontrolled migration of conditioned air through the building envelope". Caused by pressure differences due to wind, chimney (or stack) effect and mechanical systems it has been shown to represent the single largest source of heat loss or gain through the building envelopes of nearly all types of buildings. Tests carried out by the National Research Council of Canada on High Rise Commercial and Residential Buildings, Schools, Supermarkets and Houses have shown levels as high as 20% or 30% of heat loss **could** be attributed to Air Leakage. Typical savings however tend to be in the 5% to 15% range though. Beyond representing potential for energy savings uncontrolled air leakage can affect thermal comfort of occupants air quality through ingress of contaminants from outside and the imbalance of mechanical systems, and the structural integrity of the building envelope through moisture migration. Control of air leakage involves the sealing of gaps cracks and holes using appropriate materials such as Fire Retardant, Poly Urethane Foam, caulks, and appropriate weather stripping materials. The goal is to create a continuous plane of 'air-tightness' to completely encompass the Building Envelope, including the need to "decouple" floor —to- floor, and to "compartmentalize" components of the building in order to equalize pressure differences.

Sites at City of Gladstone include; Animal Control, Public Works, Fire Station #1, Atkins-Johnson House, Community Center, City Hall / Public Safety, Happy Rock Park, Water Treatment Plant, which all show cost and savings per location.

Any Building(s) or Site(s) reviewed by BES and determined to not have sufficient scope to include in the project are: Old Post Office, Fire Station #2, Santa Fe Glass, Linden Square Office, Conference, Fins and Foilage Bldg, Oak Grove Park, which will not be included in the proposal

Project Scope:

The following project Pricing includes materials, and installation for each of the buildings, based on the audit quantities listed. Additionally prints detailing scope of work indicting final location for the upgrades at each site are available.

Drawing Details: Colors of Marks/Lines reference shown on drawings with color coded template on drawing.

Projected Project Schedule.

This project is estimated to take roughly 1 Week to complete including all mobilization, installation, and clean up with roughly 7 - 9 installers and 1 PM on site full time. Please refer to the BES Installation protocol for details of our installation process.

BES - ENERGY CONSERVATION STUDY

Building Envelope Solutions, LLC.

2559 Badger Ave. - Oshkosh, WI 54904

Audit / Proposal

Bldg BES - 1

Animal Control

3948 NE 76th St.
Gladstone, MO 64119

VISUAL COMMENTS or RECOMMENDATIONS:

Exterior doors should be weather-stripped and sealed to prevent air loss.

COST AND PAYBACK ANALYSIS:

Annual Cost of Leakage (Therms):	-	--
Annual Cost of Leakage (Kwh):	-	2,612

TYPE OF MEASURES:

	Building Level	quantity or distance
Ext. Door(s) to be weather-stripped & sealed, see plan for location(s).	Main level	4 Doors

AIR LEAKAGE:

	feet	inches	
Doors	80	1/16	0.42 sq ft
Totals	-		0.42 sq ft
			0.04 sq meter

ASSUMPTIONS & CALCULATIONS:

Power Rate		$0.090	per Kwh
Heating Fuel	100% Electricity	$0.090	per Kwh
Building K	110		

Example Calculation

$$\frac{(\text{leakage x bldg "K"}) \times (\text{wind P factor}) \times (\text{HDD} \times 24 \times 60) \times (.075) \times (.243)}{100{,}000 \times \text{System Efficiency\%}}$$

Building Envelope Solutions, LLC.

2559 Badger Ave. - Oshkosh, WI 54904

Audit / Proposal

Bldg BES - 2

BES - ENERGY CONSERVATION STUDY

Public Works

4000 NE 76th St.
Gladstone, MO 64119

VISUAL COMMENTS or RECOMMENDATIONS:

All exterior doors and OHDs should be weather-stripped and sealed. Roof/wall connection should be sealed with foam.

COST AND PAYBACK ANALYSIS:

Annual Cost of Leakage (Therms):	-	--
Annual Cost of Leakage (Kwh):	-	**50,620**

TYPE OF MEASURES:

TYPE OF MEASURES	Building Level	quantity or distance
Ext. Door(s) to be weather-stripped & sealed, see plan for location(s).	Main level	2 Doors
Ext. Door(s) to be weather-stripped & sealed, see plan for location(s).	All Levels	4 Doors
Int. Door(s) to be weather-stripped & sealed, see plan for location(s).	Main level	3 Doors
Roof / Wall Joint to be Sealed with 2 part foam, see plan for location(s).	All Levels	360 Feet
Over-head Door(s) to be sealed on 4 sides, see plan for location(s).	Main level	8 OHDoors
Ext. Door(s) to be weather-stripped & sealed, see plan for location(s). Separat	Main level	2 Doors
Int. Door(s) to be weather-stripped & sealed, see plan for location(s). Separate	Main level	4 Doors
Over-head Door(s) to be sealed on 4 sides, see plan for location(s). Separate ga	Main level	6 OHDoors
Sealing of air-conditioner w/ weather-strip, & flexible cover up to 14"H x 20"W	Main level	2 Covers

AIR LEAKAGE:

AIR LEAKAGE:	feet	inches		
Doors	40	1/16	0.21	sq ft
Doors	80	1/16	0.42	sq ft
Doors	60	1/32	0.16	sq ft
RoofWall	360	1/16	1.88	sq ft
OHDoors	384	3/32	3.00	sq ft
Doors	40	1/16	0.21	sq ft
Doors	80	1/16	0.42	sq ft
OHDoors	288	3/32	2.25	sq ft
AirConditionerCovers	11	1/8	0.11	sq ft
Totals	-		8.65	sq ft
			0.80	sq meter

ASSUMPTIONS & CALCULATIONS:

Power Rate			$0.090	per Kwh
Heating Fuel	100%	Electricity	$0.090	per Kwh
Building K	110			

Example Calculation

$$\frac{(\text{leakage} \times \text{bldg "K"}) \times (\text{wind P factor}) \times (\text{HDD} \times 24 \times 60) \times (.075) \times (.243)}{100{,}000 \times \text{System Efficiency\%}}$$

Audit / Proposal

Bldg BES - 3

Fire Station #1

6118 N. Oak Trafficway
Gladstone, MO 64119

VISUAL COMMENTS or RECOMMENDATIONS:

Exterior doors and OHDs should be weather-stripped and sealed to prevent air loss. Roof/wall connection in the sleeping quarters area should be sealed with foam.

COST AND PAYBACK ANALYSIS:

Annual Cost of Leakage (Therms):	-	**714**
Annual Cost of Leakage (Kwh):	-	**1,912**

TYPE OF MEASURES:

TYPE OF MEASURES:	Building Level	quantity or distance
Ext. Door(s) to be weather-stripped & sealed, see plan for location(s).	Main level	3 Doors
Int. Door(s) to be weather-stripped & sealed, see plan for location(s).	Main level	3 Doors
Over-head Door(s) to be sealed on 4 sides, see plan for location(s).	Main level	3 OHDoors
Roof / Wall Joint to be Sealed with 2 part foam, see plan for location(s).	Main level	75 Feet

AIR LEAKAGE:

AIR LEAKAGE:	feet	inches		
Doors	60	1/32	0.16	sq ft
Doors	60	1/32	0.16	sq ft
OHDoors	152	3/16	2.38	sq ft
RoofWall	75	1/16	0.39	sq ft

Totals	-	3.08 sq ft
		0.29 sq meter

ASSUMPTIONS & CALCULATIONS:

Power Rate			$0.090	per Kwh
Heating Fuel	100%	Natural Gas	$0.750	perTherm

Building K 110

Example Calculation

$$\frac{\text{(leakage x bldg "K") x (wind P factor) x (HDD x 24 x 60) x (.075) x (.243)}}{\text{100,000 x System Efficiency\%}}$$

BES - ENERGY CONSERVATION STUDY

Building Envelope Solutions, LLC.

2559 Badger Ave. - Oshkosh, WI 54904

Audit / Proposal

Bldg BES - 4

BES - ENERGY CONSERVATION STUDY

Community Center

6901 N. Holmes
Gladstone, MO 64119

VISUAL COMMENTS or RECOMMENDATIONS:

All exterior doors should be weather-stripped and sealed to prevent air loss.

COST AND PAYBACK ANALYSIS:

Annual Cost of Leakage (Therms):	-	**--**
Annual Cost of Leakage (Kwh):	-	**17,631**

TYPE OF MEASURES:

	Building Level	quantity or distance
Ext. Door(s) to be weather-stripped & sealed, see plan for location(s).	Main level	27 Doors

AIR LEAKAGE:

	feet	inches		
Doors	540	1/16	2.81	sq ft
Totals	-		2.81	sq ft
			0.26	sq meter

ASSUMPTIONS & CALCULATIONS:

Power Rate			$0.090	per Kwh
Heating Fuel	100%	Electricity	$0.090	per Kwh
Building K	110			

Example Calculation

$$\frac{(\text{leakage x bldg "K"}) \times (\text{wind P factor}) \times (\text{HDD} \times 24 \times 60) \times (.075) \times (.243)}{100{,}000 \times \text{System Efficiency\%}}$$

Building Envelope Solutions, LLC.

2559 Badger Ave. - Oshkosh, WI 54904

Audit / Proposal

Bldg BES - 5

BES - ENERGY CONSERVATION STUDY

City Hall / Public Safety

7010 N Holmes St.
Gladstone, MO 64119

VISUAL COMMENTS or RECOMMENDATIONS:

Exterior doors should be weather-stripped and sealed to prevent air loss.

COST AND PAYBACK ANALYSIS:

Annual Cost of Leakage (Therms):	-	--
Annual Cost of Leakage (Kwh):	-	5,644

TYPE OF MEASURES:

TYPE OF MEASURES	Building Level	quantity or distance
Ext. Door(s) to be weather-stripped & sealed, see plan for location(s).	All Levels	4 Doors
Ext. Door(s) to be weather-stripped & sealed, see plan for location(s).	All Levels	4 Doors
Int. Door(s) to mechanical room to be sealed for isolation.	Lower	2 Doors

AIR LEAKAGE:

AIR LEAKAGE	feet	inches		
Doors	80	1/16	0.42	sq ft
Doors	80	1/16	0.42	sq ft
Doors	40	1/32	0.10	sq ft
Totals	-		0.94	sq ft
			0.09	sq meter

ASSUMPTIONS & CALCULATIONS:

Power Rate			$0.090	per Kwh
Heating Fuel	100%	Electricity	$0.090	per Kwh
Building K	110			

Example Calculation

$$\frac{(\text{leakage x bldg "K"}) \text{ x } (\text{wind P factor}) \text{ x } (\text{HDD x 24 x 60}) \text{ x } (.075) \text{ x } (.243)}{\text{100,000 x System Efficiency\%}}$$

Building Envelope Solutions, LLC.

2559 Badger Ave. - Oshkosh, WI 54904

Audit / Proposal

Bldg BES - 6

Happy Rock Park

7511 N. Antioch Road
Gladstone, MO 64119

VISUAL COMMENTS or RECOMMENDATIONS:

Exterior doors should be weather-stripped and sealed to prevent air loss. Air conditioner to be sealed with caulk and have flexible cover installed when not in use.

COST AND PAYBACK ANALYSIS:

Annual Cost of Leakage (Therms):	-	--
Annual Cost of Leakage (Kwh):	-	**4,132**

TYPE OF MEASURES:

	Building Level	quantity or distance
Ext. Door(s) to be weather-stripped & sealed.	Main level	4 Doors
Sealing of air-conditioner w/ weather-strip, & flexible cover up to 17"H x 25"W	Main level	1 Covers
Over-head Roll-up Door(s) to be sealed on 3 sides, see plan for location(s).	Main level	2 OHDoors

AIR LEAKAGE:

	feet	inches		
Doors	80	1/16	0.42	sq ft
AirConditionerCovers	6	3/32	0.05	sq ft
OHDoors	31	3/32	0.24	sq ft
Totals	-		0.71	sq ft
			0.07	sq meter

ASSUMPTIONS & CALCULATIONS:

Power Rate			$0.090	per Kwh
Heating Fuel	100%	Electricity	$0.090	per Kwh
Building K	110			

Example Calculation

$$\frac{(\text{leakage x bldg "K"}) \times (\text{wind P factor}) \times (\text{HDD x 24 x 60}) \times (.075) \times (.243)}{100{,}000 \times \text{System Efficiency\%}}$$

BES - ENERGY CONSERVATION STUDY

Audit / Proposal

Bldg BES - 7

Water Treatment Plant

913 NW 44th Terrace
Kansas City, MO 64116

VISUAL COMMENTS or RECOMMENDATIONS:

Exterior doors and OHDs should be weather-stripped and sealed to prevent air loss. Roof/wall connection should be sealed throughout the majority of the building.

COST AND PAYBACK ANALYSIS:

Annual Cost of Leakage (Therms):	-	**575**
Annual Cost of Leakage (Kwh):	-	**2,053**

TYPE OF MEASURES:

	Building Level	quantity or distance
Ext. Door(s) to be weather-stripped & sealed, see plan for location(s).	All Levels	7 Doors
Int. Door(s) to be weather-stripped & sealed, see plan for location(s).	All Levels	1 Doors
Over-head Door(s) to be sealed on 4 sides, see plan for location(s).	Basement	2 OHDoors
Roof / Wall Joint to be Sealed with 2 part foam, see plan for location(s).	Upper	230 Feet

AIR LEAKAGE:

	feet	inches		
Doors	140	1/16	0.73	sq ft
Doors	20	1/32	0.05	sq ft
OHDoors	64	3/32	0.50	sq ft
RoofWall	230	1/16	1.20	sq ft
Totals	-		2.48	sq ft
			0.23	sq meter

ASSUMPTIONS & CALCULATIONS:

Power Rate		$0.090	per Kwh
Heating Fuel	100% Natural Gas	$0.750	perTherm
Building K	110		

Example Calculation

$$\frac{(\text{leakage x bldg "K"}) \times (\text{wind P factor}) \times (\text{HDD} \times 24 \times 60) \times (.075) \times (.243)}{100{,}000 \times \text{System Efficiency\%}}$$

BES - ENERGY CONSERVATION STUDY

Superior Materials

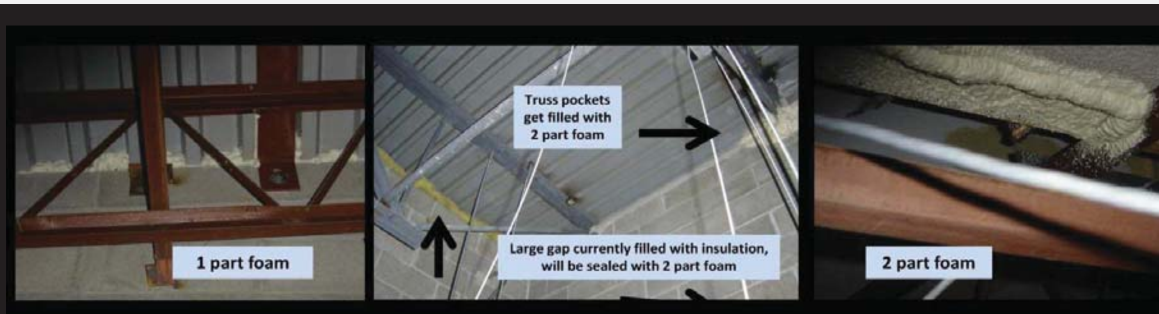
It is in the best interest of Building Envelope Solutions, and any BES Clients, that BES utilizes the highest quality materials and that these materials are installed with careful attention to detail..

We utilize caulk(s) that carry a 50 year warranty from the manufacturer. If properly placed, and applied in areas with typical/standard exposures to UV, etc, the material will perform well for the expected life.

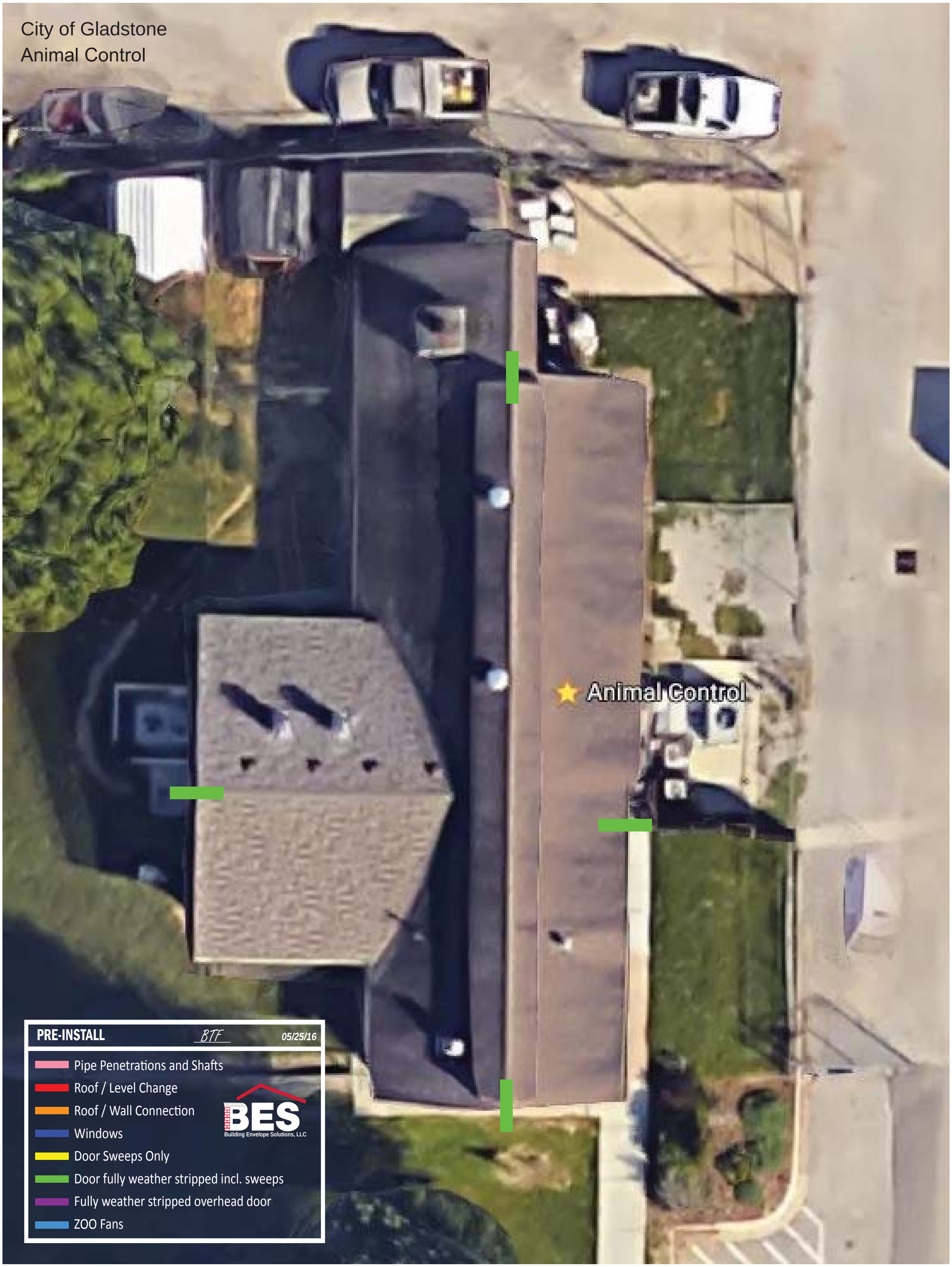
Our door sealing materials consist of a heavy metal aluminum carrier, and strip of Q-lon which is a formed & angled sponge wrapped in vinyl. It's applied to the door frames, secured with screws, and caulked for added durability and air sealing through the carrier. This is a very long life material, and provided it's not physically cut or damaged, we expect it to last 10-20 years.

The sweeps utilize a double fin film seal between a set of brushes, also embedded in a heavy aluminum carrier. The material is typically placed under the kick plate of the door, and secured in the same method as the rest of the door seal. Due to brushing the ground, the sweep protects the film to keep the seal tight,

Our Foams are typically not exposed to UVA or UVB rays. If not exposed to these rays, or covered with paint when in areas that are exposed, the foam has a minimum of 25 year life span according to the manufacturers. The reality is that these foams have been in the field longer than this, but there is not a lot of data for the anticipated life span past 25 years. We apply 1 and 2 part foam depending on the type of joint we are sealing, and it's visibility to the public eye.

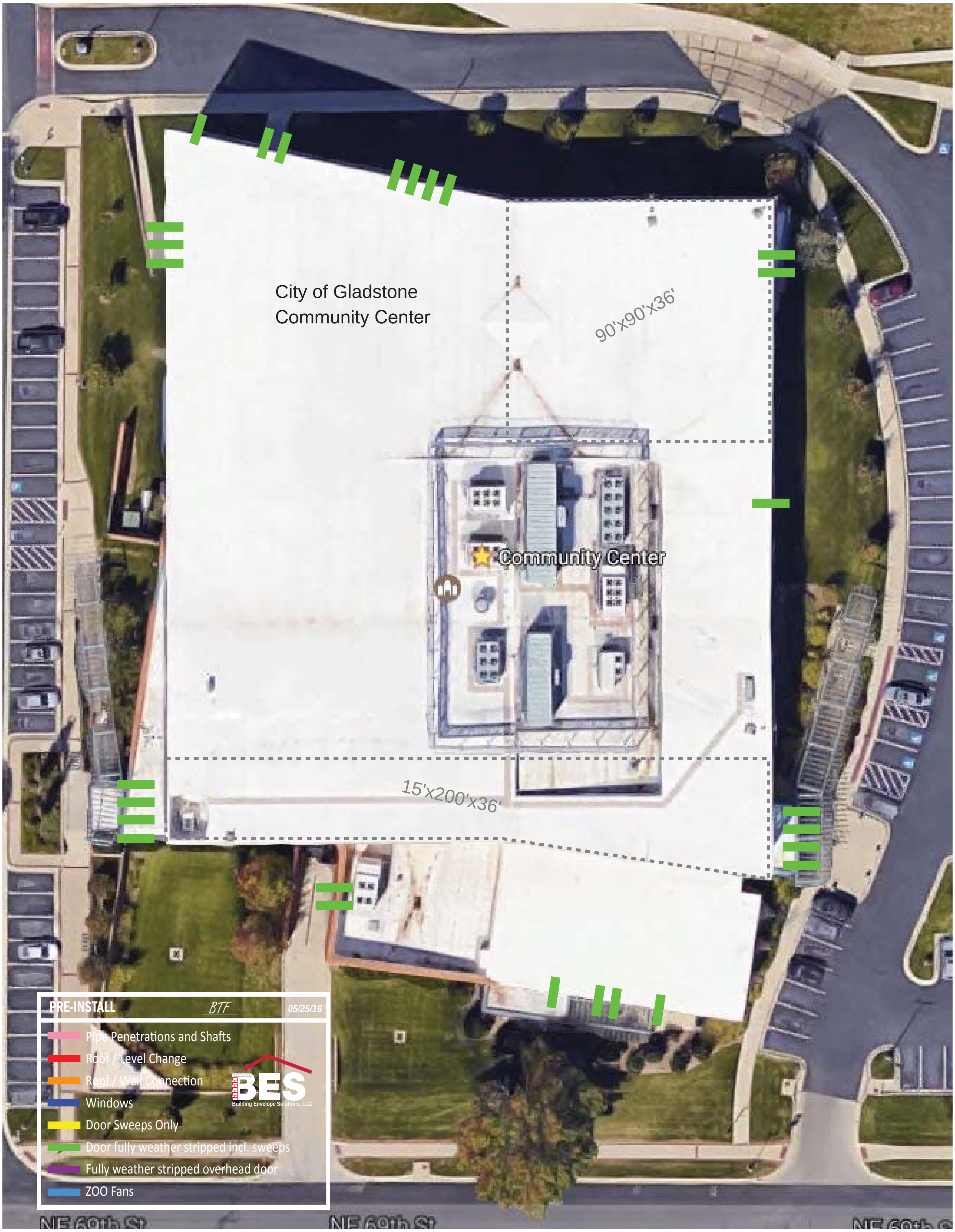


For additional questions regarding the products, or use of the BES Products, please contact us at any time.


City of Gladstone
Animal Control
Animal Control
PRE-INSTALL
BTF
05/25/16
Pipe Penetrations and Shafts
Roof / Level Change
Roof / Wall Connection
Windows
Door Sweeps Only
Door fully weather stripped incl. sweeps
Fully weather stripped overhead door
ZOO Fans
BES
Building Envelope Solutions, LLC

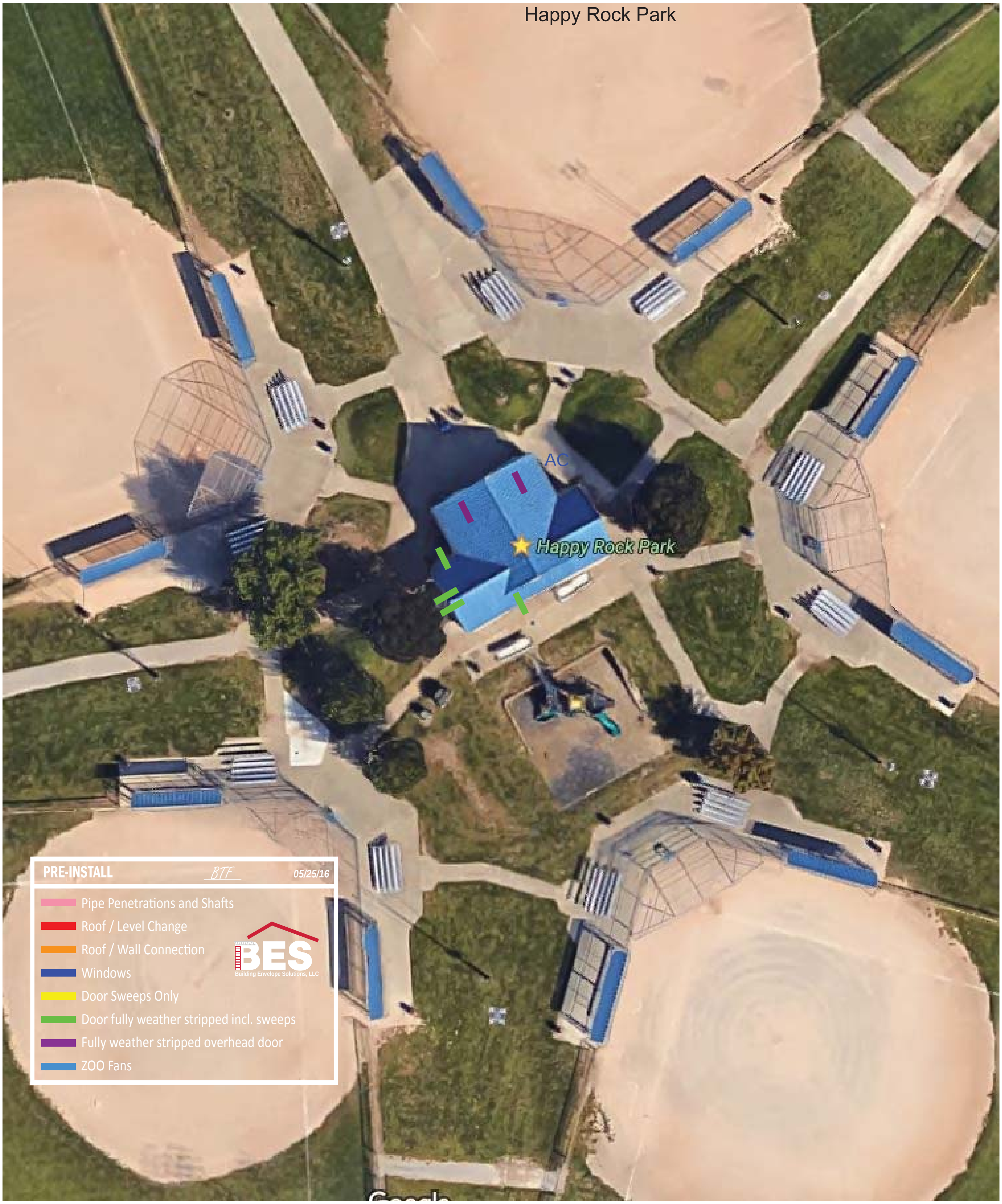

City of Gladstone
Public Works
OHDs 12'x12'
AC
AC
Roof Insulation
OHDs 12'x12'
PRE-INSTALL
BTF
05/25/16
Pipe Penetrations and Shafts
Roof / Level Change
Roof / Wall Connection
Windows
Door Sweeps Only
Door fully weather stripped incl. sweeps
Fully weather stripped overhead door
ZOO Fans
BES
Building Envelope Solutions, LLC
© 2016 Google


City of Gladstone
Fire Station #1
Gladstone Fire
Department Station 1
14'x14'
14'x14'
10'x10'
PRE-INSTALL
BTF
05/25/16
Pipe Penetrations and Shafts
Roof / Level Change
Roof / Wall Connection
Windows
Door Sweeps Only
Door fully weather stripped incl. sweeps
Fully weather stripped overhead door
ZOO Fans
BES
Building Envelope Solutions, LLC


City of Gladstone
Community Center
90'x90'x36'
15'x200'x36'
Community Center
PRE-INSTALL
BTF
05/25/16
Pipe Penetrations and Shafts
Roof / Level Change
Roof / Wall Connection
Windows
Door Sweeps Only
Door fully weather stripped incl. sweeps
Fully weather stripped overhead door
ZOO Fans
BES
Building Envelope Solutions, LLC
NE 69th St
NE 69th St

City of Gladstone
City Hall / Public Safety

City of Gladstone
Happy Rock Park



City of Gladstone
Water Treatment Plant

City of Gladstone
HVAC Improvements

City Hall
7010 N. Holmes Street
Gladstone, Mo. 64118

CS	COVER SHEET
ME100	SYMBOLS AND ABBREVIATIONS - MECHANICAL AND ELECTRICAL
ME201	SCHEDULES AND DETAILS - MECHANICAL AND ELECTRICAL
ME202	SCHEDULES AND DETAILS - MECHANICAL AND ELECTRICAL
DM100	ROOF PLAN - DEMOLITION - MECHANICAL
DM101	GROUND FLOOR PLAN - DEMOLITION - MECHANICAL
DM102	FIRST FLOOR PLAN - DEMOLITION - MECHANICAL
M100	ROOF PLAN - MECHANICAL
M101	GROUND FLOOR PLAN - MECHANICAL
M102	FIRST FLOOR PLAN - MECHANICAL

PROJECT NAME: Navitas - City of Gladstone
AUTOCAD FILE LOCATION \ NAME: X:\17\17210\1721000\Drawings\01-1721000_CS.dwg
LAST CORRECTION BY ◆ DATE ◆ TIME: JCampbell Friday, June 30, 2017 2:36:08 PM
PLOTTED BY ◆ DATE ◆ TIME: Charles Booty Friday, June 30, 2017 2:41:06 PM

City of Gladstone
HVAC Improvements

City Hall
7010 N. Holmes Street
Gladstone, Mo. 64118

PROJECT NO.	1721000
DATE	06-30-2017
DRAWN BY	S&B
CHECKED BY	CEA
CHECKED BY	

REVISED DATE	DESCRIPTION
.	.
.	.
.	.
.	.
.	.

smith&boucher
ENGINEERS
25501 west valley parkway, suite 200 olathe, ks 66061
p.913.345.2127 / 888.299.7540 f.913.345.0617
project number 1721000

COVER SHEET

CS

CONDUIT AND WIRE

- ARROWS INDICATE CONDUIT AND WIRE HOME RUN(S) TO PANEL WITH 2-#12 AWG CONDUCTORS UNLESS NOTED OR OTHERWISE REQUIRED.
- CONDUIT RUN CONCEALED IN WALL OR ABOVE CEILING.
- CONDUIT RUN UNDERGROUND OR CONCEALED IN FLOOR SLAB.
- T — TELEPHONE CONDUIT
- LV — LOW VOLTAGE CONDUIT AND WIRING

LIGHTING

- BATTERY OPERATED EMERGENCY LIGHT (WALL MOUNTED)
- BATTERY OPERATED EMERGENCY LIGHT (CEILING MOUNTED)
- SURFACE/RECESSED LIGHT FIXTURE
- FLUORESCENT LIGHT FIXTURE
- FLUORESCENT STRIP FIXTURE
- SHADING DENOTES EMERGENCY FIXTURE
- POLE MOUNTED LIGHT FIXTURE
- EXIT LIGHT - DOUBLE FACE - ARROWS AS SHOWN
- EXIT LIGHT - SINGLE FACE - ARROWS AS SHOWN
- $ $3 $4 $K $LV $P — LIGHTING SWITCHES-SINGLE POLE, 3-WAY, 4-WAY, KEY, LOW VOLTAGE, PILOT LIGHT
- $D — DIMMER WITH SINGLE POLE SWITCH
- $D3 — DIMMER WITH THREE WAY SWITCH (WATTAGE NOTED)
- $M — WALL MOUNTED MOTION SENSOR
- (A) — CEILING MOUNTED MOTION SENSOR (LETTER DENOTES TYPE)
- SWITCH AND DUPLEX RECEPTACLE
- DENOTES A WALL MOUNTED FIXTURE

WIRING DEVICES

- DUPLEX RECEPTACLE.
- LINE THRU DEVICE INDICATES ABOVE COUNTER
- IG — DUPLEX RECEPTACLE WITH ISOLATED GROUND (SINGLE AND FOURPLEX SIMILAR)
- S — DUPLEX RECEPTACLE - TOP HALF SWITCHED - BOTTOM HALF TO HAVE POWER AT ALL TIMES
- EM — DUPLEX RECEPTACLE ON EMERGENCY POWER (SINGLE AND FOURPLEX SIMILAR)
- FOURPLEX RECEPTACLE
- SINGLE RECEPTACLE
- CEILING MOUNTED RECEPTACLE
- MULTI-SERVICE FLOOR BOX
- DIVIDED POWER POLE
- FLOOR BOX W/DUPLEX RECEPTACLE
- SPECIAL RECEPTACLE W/NEMA CONFIGURATION AS NOTED
- CLOCK RECEPTACLE
- MULTI-OUTLET ASSEMBLY

COMMUNICATIONS

- TELEPHONE OUTLET
- LINE THRU DEVICE INDICATES ABOVE COUNTER
- DATA OUTLET
- TELEPHONE/DATA OUTLET
- FLOOR BOX WITH COMMUNICATIONS OUTLET
- TV — TELEVISION ANTENNA OUTLET
- TELEPHONE CABINET OR PLYWOOD BOARD

SECURITY

- CLOSED CIRCUIT TV CAMERA
- CR — CARD READER
- DL — DOOR LOCK
- M — SECURITY MONITOR
- WT — WATCH TOUR
- EDL — ELECTRIC DOOR LOCK
- S — MOTION SENSOR - SECURITY
- S — MOTION SENSOR (WALL MOUNTED) - SECURITY

PUBLIC ADDRESS

- M — MICROPHONE OUTLET
- S H — SPEAKER. ('H' DENOTES HORN TYPE)
- V — SPEAKER VOLUME CONTROL
- SPEAKER CONDUIT AND WIRING
- PA — PUBLIC ADDRESS AMPLIFIER AND CABINET
- BUZZER
- B — BELL
- I — INTERCOM OUTLET
- I M — INTERCOM OUTLET - MASTER
- C D — CLOCK SYSTEM RECEPTACLE WITH SINGLE FACE ('D' DENOTES DOUBLE FACE)

POWER DEVICE AND CONTROLS

- T — THERMOSTAT
- DISCONNECT SWITCH. 30A-3P, NON-FUSED EXCEPT AS NOTED
- MANUAL MOTOR STARTER
- MAGNETIC MOTOR STARTER
- COMBINATION MOTOR STARTER AND DISCONNECT SWITCH
- MOTOR
- PANELBOARD (SEE ONE-LINE)
- DISTRIBUTION PANELBOARD
- CONTACTOR
- AUTOMATIC TRANSFER SWITCH
- PC — PHOTOCELL
- J — JUNCTION BOX
- PUSHBUTTON
- T — TRANSFORMER

FIRE ALARM

- F — MANUAL PULL STATION
- PE D — PHOTOELECTRIC DETECTOR ('D' DENOTES IN DUCT) ('B' DENOTES BEAM-TYPE) ('R' DENOTES IN RETURN AIR PLENUM)
- ION U D — IONIZATION DETECTOR ('D' DENOTES IN DUCT) ('P' DENOTES PLENUM-TYPE)
- INF D — INFRARED DETECTOR ('D' DENOTES IN DUCT)
- H 190 D — THERMODETECTOR ('D' DENOTES IN DUCT) FIXED TEMPERATURE AS NOTED
- DH — DOOR HOLDER
- C — CHIME
- F — BELL
- FL — FIRE ALARM STROBE LIGHT
- F L — FIRE ALARM SPEAKER - ARROWS DENOTE PROJECTORS IF ANY. ('L' DENOTES COMBINATION SPEAKER AND VISUAL FIRE LIGHT)
- L — FIRE HORN. ('L' DENOTES COMBINATION HORN AND VISUAL FIRE LIGHT)
- RL — REMOTE ALARM LAMP
- PI — POST INDICATOR SWITCH
- FS — FLOW SWITCH
- GS — GATE SWITCH
- F — FIREMAN'S PHONE JACK

FIRE PROTECTION

- FP — FIRE PROTECTION PIPING
- FHC — FIRE HOSE CABINET
- FDV — FIRE DEPARTMENT VALVE
- UPRIGHT SPRINKLER HEAD
- PENDENT SPRINKLER
- RECESSED SPRINKLER
- RECESSED SPRINKLER WITH CLOSURE PLATE
- SIDEWALL SPRINKLER.
- DOUBLE CHECK DETECTOR BACKFLOW PREVENTER
- FIRE PROTECTION SIAMESE CONNECTION
- FIRE PROTECTION SIDEWALK SIAMESE CONNECTION
- POST INDICATOR VALVE

MEDICAL GAS

- VAC — MEDICAL VACUUM
- OX — OXYGEN
- NO — NITROUS OXIDE
- MA — MEDICAL COMPRESSED AIR
- N — NITROGEN
- X — OXYGEN OUTLET
- V — VACUUM OUTLET
- A — MEDICAL AIR OUTLET
- NO — NITROUS OXIDE OUTLET
- N — NITROGEN OUTLET

HVAC

- CWS — CHILLED WATER SUPPLY
- CWR — CHILLED WATER RETURN
- CHWS — CHILLED/HOT WATER SUPPLY
- CHWR — CHILLED/HOT WATER RETURN
- HWS — HEATING HOT WATER SUPPLY
- HWR — HEATING HOT WATER RETURN
- CTS — COOLING TOWER SUPPLY
- CTR — COOLING TOWER RETURN
- STM — LOW PRESSURE STEAM
- RTN — LOW PRESSURE CONDENSATE RETURN
- STM-50 — HIGH PRESSURE STEAM - NO'S GIVE GAUGE PRESSURE IN P.S.I.
- RTN-50 — HIGH PRESSURE RETURN - NO'S GIVE GAUGE PRESSURE IN P.S.I.
- RD — REFRIGERANT DISCHARGE
- RL — REFRIGERANT LIQUID
- RS — REFRIGERANT SUCTION
- FOS — FUEL OIL SUPPLY
- FOR — FUEL OIL RETURN
- A — COMPRESSED AIR
- D — DRAIN (CONDENSATE)
- T S — THERMOSTAT - ('S' DENOTES SENSOR)
- H S — HUMIDISTAT - ('S' DENOTES SENSOR)
- TH — THERMOSTAT/HUMIDITY SENSOR
- CO2 — CARBON DIOXIDE SENSOR
- THC — THERMOSTAT/HUMIDITY SENSOR/CO2 SENSOR
- HUMIDIFIER
- SUPPLY AIR FLOW INDICATOR
- RETURN AND EXHAUST AIR FLOW INDICATOR
- SUPPLY DIFFUSER
- SUPPLY STRIP DIFFUSER
- RETURN GRILLE OR EXHAUST REGISTER

HOSPITAL

- N — NURSE CALL CONDUIT AND WIRING
- M — MONITOR CONDUIT AND WIRING
- NMS — NURSE CALL MASTER STATION
- N — NURSE CALL BEDSIDE STATION - SINGLE PATIENT
- N2 — NURSE CALL BEDSIDE STATION - DOUBLE PATIENT
- E P — EMERGENCY PUSHBUTTON STATION ('P' DENOTES PULL CORD)
- DS — DUTY STATION
- SS — STAFF STATION
- B — DOME LIGHT - CEILING MOUNTED ('B' DENOTES WITH BUZZER)
- B — DOME LIGHT - WALL MOUNTED ('B' DENOTES WITH BUZZER)
- Z — ZONE DOME LIGHT
- B — CODE BLUE PUSHBUTTON

PLUMBING

- DOMESTIC COLD WATER
- DOMESTIC HOT WATER
- RECIRCULATING DOMESTIC HOT WATER
- TW — DOMESTIC TEMPERED WATER
- + — SOFT DOMESTIC COLD WATER
- ++ — SOFT DOMESTIC HOT WATER
- +++ — SOFT RECIRCULATING HOT WATER
- SAN — SOIL OR WASTE ABOVE GRADE OR FLOOR
- SAN — SOIL OR WASTE BELOW GRADE OR FLOOR
- ST — STORM ABOVE GRADE OR FLOOR
- ST — STORM BELOW GRADE OR FLOOR
- ST/O — STORM OVERFLOW ABOVE GRADE OR FLOOR
- ST/O — STORM OVERFLOW BELOW GRADE OR FLOOR
- V — PLUMBING VENT
- G — GAS (NATURAL)
- LP — LIQUIFIED PETROLEUM
- PD — PUMP DISCHARGE
- HB — HOSE BIBB
- WH — WALL HYDRANT
- WCO — WALL CLEAN OUT
- CO — CLEAN OUT
- FCO — FLOOR CLEAN OUT
- FLOOR DRAIN, AREA DRAIN, FLOOR SINK
- RD ORD — ROOF DRAIN, OVERFLOW ROOF DRAIN
- SHOWER HEAD.
- REDUCED PRESSURE BACKFLOW PREVENTER
- P # — PLUMBING VENT RISER CALL-OUT NUMBER

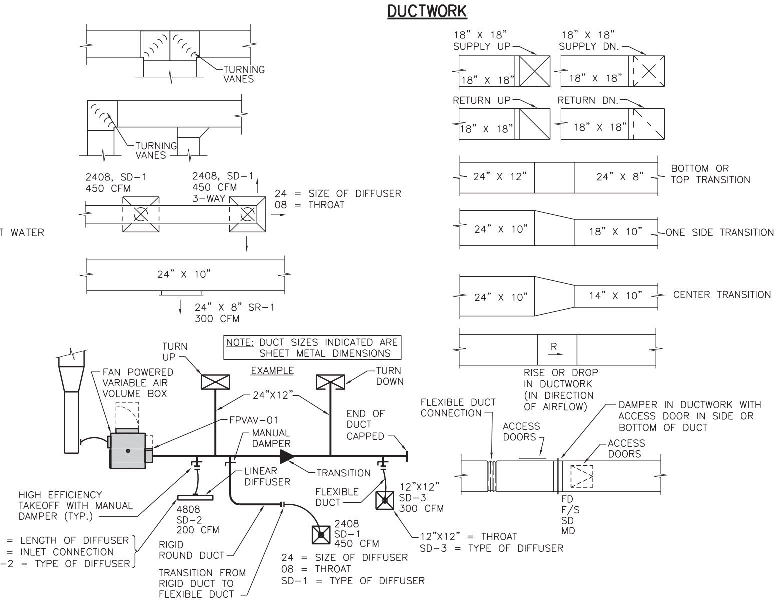
GENERAL

- 1 — MECHANICAL NOTE REFERENCE
- 2 — ELECTRICAL NOTE REFERENCE
- 3 — DEMOLITION NOTE REFERENCE
- 4 — REVISION NOTE REFERENCE
- CONNECT TO EXISTING WORK
- I / MI — DETAIL REFERENCE - NO./SHEET NO.
- A / M1 — SECTION CUT - SECTION/SHEET NO.

PIPING

- ELBOW DOWN
- ELBOW UP
- TEE UP
- TEE DOWN
- CAP
- UNION
- REDUCER (OR INCREASER)
- PIPE FLEX
- STRAINER
- R — RISE IN PIPING
- D — DROP IN PIPING
- GUIDE
- ANCHOR
- PRESSURE GAUGE WITH GAUGE COCK
- T — TEMPERATURE GAUGE
- FLOW INDICATOR
- THERMOMETER.
- SITE GLASS
- EXPANSION JOINT
- FD — FILTER-DRIER
- DRIP ASSEMBLY
- BASKET STRAINER
- SHUTOFF VALVE
- SHUTOFF VALVE IN RISER
- BALANCING VALVE
- CALIBRATED BALANCING VALVE
- RELIEF VALVE
- TEST PLUG
- TRIPLE DUTY VALVE
- CHECK VALVE.
- AUTOMATIC CONTROL VALVE (2-WAY)
- AUTOMATIC CONTROL VALVE (3-WAY)
- AUTO FLOW CONTROL VALVE
- S — SOLENOID VALVE
- P — PRESSURE REDUCING VALVE

DUCTWORK



A	AMPS, AIR (COMPRESSED)	DX	DIRECT EXPANSION	HTG	HEATING	MUAF	MAKE UP AIR FAN	SD	SUPPLY DIFFUSER, SMOKE DAMPER
A/C	AIR CONDITIONING	EA	EXHAUST AIR	HTR	HEATER	MV	MIXING VALVE	SDCW	SOFT DOMESTIC COLD WATER
AD	AREA DRAIN, ACCESS DOOR	EAT	ENTERING AIR TEMPERATURE	HVU	HEATING AND VENTILATING UNIT	N	NITROGEN	SDHW	SOFT DOMESTIC HOT WATER
AFC	ABOVE FINISH CEILING	EC	ELECTRICAL CONTRACTOR, EMPTY CONDUIT	HW	DOMESTIC HOT WATER	N/A	NOT APPLICABLE	SDRHW	SOFT DOMESTIC RECIRCULATION HOT WATER
AFG	ABOVE FINISH GRADE	EF	EXHAUST FAN	HWR	HOT WATER RETURN	N/C	NORMALLY CLOSED	SF	SQUARE FEET
AHU	AIR HANDLING UNIT	EM	INDICATES EMERGENCY CIRCUIT	HWS	HOT WATER SUPPLY	N/O	NORMALLY OPEN	SP	STATIC PRESSURE
AFF	ABOVE FINISHED FLOOR	EPO	EMERGENCY POWER OFF	IE	INVERT ELEVATION	NF	INDICATES NON-FUSED DEVICE	SR	SUPPLY REGISTER
BD	BACKDRAFT DAMPER, BLOWDOWN	ER	EXHAUST REGISTER	IG	ISOLATED GROUND	NIC	NOT IN CONTRACT	ST	STORM
BFP	BACKFLOW PREVENTER	ETR	EXISTING TO REMAIN	KCMIL	1000 CIRCULAR MILS	NL	NIGHT LIGHT	ST/O	STORM OVERFLOW
BKR	BREAKER	EWB	ENTERING WET BULB	KV	KILOVOLT	NO	NITROUS OXIDE	STM	LOW PRESSURE STEAM
BOD	BOTTOM OF DUCT	EWC	ELECTRIC WATER COOLER	KVA	KILOVOLT AMPS	OA	OUTSIDE AIR	SWBD	SWITCHBOARD
BOP	BOTTOM OF PIPE	EWH	ELECTRIC WATER HEATER, ELEC. WALL HTR.	KW	KILOWATT	ORD	OVERFLOW ROOF DRAIN	TSTAT	THERMOSTAT
BOS	BOTTOM OF STRUCTURE	EXH	EXHAUST	KWH	KILOWATT HOUR	OX	OXYGEN	TU	TERMINAL UNIT
BTU	BRITISH THERMAL UNIT	F/S	COMBINATION FIRE AND SMOKE DAMPER	LAT	LEAVING AIR TEMPERATURE	PD	PUMP DISCHARGE	TW	TEMPERED WATER
C	CONDUIT	FACP	FIRE ALARM CONTROL PANEL	LDB	LEAVING DRY BULB	PH	PHASE	UH	UNIT HEATER
CATV	CABLE TELEVISION SYSTEM	FAACP	FIRE ALARM ANNUNCIATOR CONTROL PANEL	LP	LIQUIFIED PETROLEUM	PIV	POST INDICATOR VALVE	UL	UNDERWRITERS LABORATORIES INC.
CB	CIRCUIT BREAKER	FCO	FLOOR CLEANOUT	LRA	LOCKED ROTOR AMPS	PNL	PANEL	UNO	UNLESS NOTED OTHERWISE
CCTV	CLOSED CIRCUIT TELEVISION	FCU	FAN COIL UNIT	LV	LOW VOLTAGE	PRV	PRESSURE REDUCING VALVE	UPS	UNINTERRUPTIBLE POWER SUPPLY
CFM	CUBIC FEET PER MINUTE	FD	FIRE DAMPER, FLOOR DRAIN	LWB	LEAVING WET BULB	QTY	QUANTITY	V	VENT PIPE
CHWR	CHILLED/HOT WATER RETURN	FLA	FULL LOAD AMPS	LWT	LEAVING WATER TEMPERATURE	RA	RETURN AIR	VAC	MEDICAL VACUUM
CHWS	CHILLED/HOT WATER SUPPLY	FLR	FLOOR	MA	MEDICAL AIR	RD	ROOF DRAIN	VAV	VARIABLE AIR VOLUME
CKT	CIRCUIT	FOR	FUEL OIL RETURN	MAU	MAKE UP AIR UNIT	REV	REVISION	VD	VOLUME DAMPER
CO	CLEANOUT, CARBON MONOXIDE	FOS	FUEL OIL SUPPLY	MBH	1000 BTU PER HOUR	RG	RETURN GRILLE	VTR	VENT THROUGH ROOF
CO2	CARBON DIOXIDE	FP	FIRE PROTECTION	MC	MECHANICAL CONTRACTOR	RH	RELATIVE HUMIDITY	W	WIRE, WATT(S)
CTR	COOLING TOWER RETURN	FPB	FAN POWERED TERMINAL UNIT	MCA	MINIMUM CIRCUIT AMPACITY	RHW	DOMESTIC RECIRCULATION HOT WATER	W/	WITH
CTS	COOLING TOWER SUPPLY	FPVAV	FAN POWERED TERMINAL UNIT	MCC	MOTOR CONTROL CENTER	RL	REFRIGERANT LIQUID	W/O	WITHOUT
CU	COPPER, CONDENSING UNIT	FS	FLOOR SINK	MD	MOTORIZED DAMPER	RLA	RUNNING LOAD AMPS	WB	WET BULB
CUH	CABINET UNIT HEATER	G	GAS (NATURAL), GROUND	MDP	MAIN DISTRIBUTION PANEL	RPM	REVOLUTIONS PER MINUTE	WCO	WALL CLEANOUT
CW	DOMESTIC COLD WATER	GCO	GRADE CLEANOUT	MFR	MANUFACTURER	RS	REFRIGERANT SUCTION	WH	WALL HYDRANT
CWR	CHILLED WATER RETURN	GFI/GFCI	GROUND FAULT CIRCUIT INTERRUPTER	MH	MANHOLE	RTN	LOW PRESSURE CONDENSATE RETURN	WP	WEATHERPROOF
CWS	CHILLED WATER SUPPLY	GND	GROUND	MLO	MAIN LUGS ONLY	RTU	ROOF TOP UNIT	XFMR	TRANSFORMER
DDC	DIRECT DIGITAL CONTROL	GPM	GALLONS PER MINUTE	MTD	MOUNTED	SA	SUPPLY AIR	XP	EXPLOSION PROOF
DD	DECK DRAIN	HB	HOSE BIBB	MU	MAKE UP	SAN	SANITARY		
DN	DOWN	HOA	HAND OFF AUTOMATIC						

MECHANICAL AND ELECTRICAL SYMBOLS AND ABBREVIATIONS

"SOME SYMBOLS AND ABBREVIATIONS ON THIS LEGEND MAY NOT BE USED. REFER TO FLOOR PLANS FOR ALL SYMBOLS AND ABBREVIATIONS."

PROJECT NAME: Navitas - City of Gladstone
AUTOCAD FILE LOCATION \ NAME: X:\17\17210\1721000\Drawings\01-1721000_ME100.dwg
LAST CORRECTION BY • DATE • TIME: CBooty Wednesday, June 21, 2017 4:01:40 PM
PLOTTED BY • DATE • TIME: Charles Booty Friday, June 30, 2017 2:41:17 PM

NAVITAS
CONSERVING RESOURCES • RENEWING BUILDINGS

City of Gladstone
HVAC Improvements

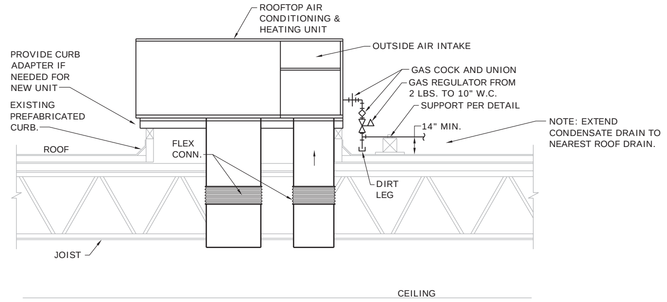
City Hall
7010 N. Holmes Street
Gladstone, Mo. 64118

PROJECT NO.	1721000
DATE	06-30-2017
DRAWN BY	S&B
CHECKED BY	CEA
CHECKED BY	
REVISED DATE	DESCRIPTION
.	.
.	.
.	.
.	.
.	.

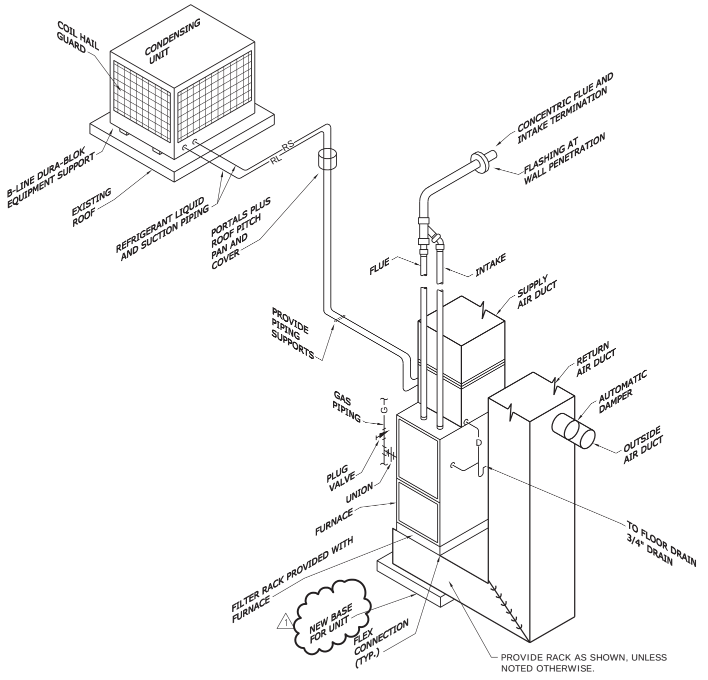
smith&boucher ENGINEERS
25501 west valley parkway, suite 200 olathe, ks 66061
p.913.345.2127 / 888.299.7540 f.913.345.0617
project number 1721000

SYMBOLS AND ABBREVIATIONS MECHANICAL AND ELECTRICAL

ME100



ROOFTOP UNIT DETAIL
NOT TO SCALE



FURNACE AND CONDENSING UNIT DETAIL
NOT TO SCALE

ROOFTOP UNIT SCHEDULE - GAS HEAT

		RTU-1	RTU-2	RTU-3	RTU-4	RTU-5	RTU-6	RTU-7	RTU-8	RTU-9	RTU-10
DESIGNATION		RTU-1	RTU-2	RTU-3	RTU-4	RTU-5	RTU-6	RTU-7	RTU-8	RTU-9	RTU-10
MANUFACTURER		CARRIER	CARRIER	CARRIER	CARRIER	CARRIER	CARRIER	CARRIER	CARRIER	CARRIER	CARRIER
MODEL NO.		48HCEA07A2A5	48KCEA06A2A5	48KCEA04A2A5	48KCEA06A2A5	48KCEA06A2A5	48HCEA07A2A5	48HCED14A2A5	48KCEA06A2A5	48KCEA06A2A5	48KCEA06A2A3
NOMINAL TONNAGE		6	5	3	5	5	6	12.5	5	5	5
CAPACITY	CFM	2100	2000	1265	2000	2000	2100	5000	2000	2000	2000
	TOTAL COOLING CAPACITY (MBH)	66.3	61.8	31	61.8	61.8	66.3	138	61.8	61.8	61.8
	SENSIBLE COOLING CAPACITY (MBH)	49.9	46.2	25	46.2	46.2	49.9	112	46.2	46.2	46.2
	ENT. AIR (DB/WB)	80.0/67.0	80/67	80/67	80/67	80/67	80.0/67.0	80/67	80/67	80/67	80/67
	LVG. AIR (DB/WB)	55/54	57/56	60/57	57/56	57/56	55/54	57/56	57/56	57/56	58.6/57.3
	MINIMUM E.E.R.	12	14	13	14	14	12	12	14	14	13
	HEATING INPUT (MBH)	125	115	115	115	115	125	180	115	115	90
	HEATING OUTPUT (MBH)	103	93	93	93	93	103	146	93	93	74
UNIT DATA	OUTSIDE AIR CFM	200	200	130	200	200	200	500	200	200	200
	EXTERNAL S.P. (IN. W.C.)	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
	TOTAL S.P. (IN. W.C.)	.54	.62	.55	.62	.62	.54	.54	.62	.62	.6
	FAN BRAKE HP	.78	1.19	.48	1.19	1.19	.78	1.91	1.19	1.19	1.22
	FAN MOTOR HP	1	1.5	1	1.5	1.5	1	2	1.5	1.5	1.5
	NO. OF COMPRESSORS	1	1	1	1	1	1	2	1	1	1
	STAGES OF COOLING	1	1	1	1	1	1	2	1	1	1
	SMOKE DETECTORS	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
	RECEPTACLE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	POWERED RELIEF	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	ECONOMIZER OPERATION	INTEGRATED ENTHALPY	INTEGRATED ENTHALPY	INTEGRATED ENTHALPY	INTEGRATED ENTHALPY	INTEGRATED ENTHALPY	INTEGRATED ENTHALPY	INTEGRATED ENTHALPY	INTEGRATED ENTHALPY	INTEGRATED ENTHALPY	INTEGRATED ENTHALPY
FILTER	TYPE	2" 30/30	2" 30/30	2" 30/30	2" 30/30	2" 30/30	2" 30/30	2" 30/30	2" 30/30	2" 30/30	2" 30/30
	MIN. SQ. FT. AREA	—	—	—	—	—	—	—	—	—	—
ELECT./CONT.	VOLTAGE/PHASE	208/3	208/3	208/3	208/3	208/3	208/3	208/3	208/3	208/3	208/3
	MINIMUM CIRCUIT AMPACITY	36	30	19	30	30	36	60	30	30	38
	MAXIMUM OVERCURRENT PROTECTION	50	60	25	60	45	50	70	45	45	60
	PANEL & CIRCUIT	PANEL AC (NOTE 1)	PANEL AC (NOTE 1)	PANEL AC (NOTE 1)	PANEL AC (NOTE 1)	PANEL AC (NOTE 1)	PANEL AC (NOTE 1)	PANEL AC (NOTE 1)	PANEL AC (NOTE 1)	PANEL AC	PANEL AC
	WIRE & CONDUIT	NOTE 1	NOTE 1	NOTE 1	NOTE 1	NOTE 1	NOTE 1	NOTE 1	NOTE 1	3#8, #10G, 3/4"C	3#8, #10G, 3/4"C
	OVERCURRENT DEVICE	50A / 3P	60A / 3P	25A / 3P	60A / 3P	45A / 3P	50A / 3P	70A / 3P	45A / 3P	45A / 3P	60A / 3P
	DISCONNECT	INTEGRAL TO UNIT	INTEGRAL TO UNIT	INTEGRAL TO UNIT	INTEGRAL TO UNIT	INTEGRAL TO UNIT	INTEGRAL TO UNIT	INTEGRAL TO UNIT	INTEGRAL TO UNIT	INTEGRAL TO UNIT	INTEGRAL TO UNIT
	COMBINATION STARTER	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
	VFD	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	CONTROL SEQUENCE	RE: DWG AND SPEC	RE: DWG AND SPEC	RE: DWG AND SPEC	RE: DWG AND SPEC	RE: DWG AND SPEC	RE: DWG AND SPEC	RE: DWG AND SPEC	RE: DWG AND SPEC	RE: DWG AND SPEC	RE: DWG AND SPEC
REFERENCE DRAWING/DETAIL		M100	M100	M100	M100	M100	M100	M100	M100	M100	M100
REMARKS											

NOTES:
1: INTENT IS TO REUSE EXISTING CIRCUIT. CONTRACTOR TO VERIFY LOCATION AND CAPACITY OF EXISTING PANELBOARD, CIRCUIT BREAKER AND CIRCUI 1

FURNACE SCHEDULE - GAS HEAT

			AHU-3	AHU-4	AHU-5	AHU-6A	AHU-6B	AHU-9	AHU-10
DESIGNATION			AHU-3	AHU-4	AHU-5	AHU-6A	AHU-6B	AHU-9	AHU-10
FURNACE	UNIT	MANUFACTURER	CARRIER	CARRIER	CARRIER	CARRIER	CARRIER	CARRIER	CARRIER
		MODEL #	CNPVP4821ALA	CNPVP3017ALA	CNPVP3617ALA	CNPVP6024ALA	CNPVP6024ALA	CNPVP4217ALA	CNPVP4217ALA
		NOMINAL TONNAGE	4	2.5	3	5	5	3.5	3.5
	SUPPLY FA	CFM	1600	1000	1200	2000	2000	1400	1400
		EXTERNAL STATIC PRES. (IN. W.G.)	0.5	0.5	0.5	0.5	0.5	0.5	0.5
		VOLTAGE/PHASE	110/1	110/1	110/1	110/1	110/1	110/1	110/1
	HEAT EXCH.	CFM	1600	1000	1200	2000	2000	1400	1400
		INPUT BTUH	100000	80000	80000	120000	120000	80000	80000
		OUTPUT BTUH	97000	78000	75000	117000	117000	78000	78000
		TEMP RISE (MIN-MAX) °F	65.5	84.2	67.5	63.2	63.2	60.2	60.2
EVAPORATOR		CFM	1600	1000	1200	2000	2000	1400	1400
		OUTSIDE AIR - CFM	160	100	120	200	200	140	140
		ENT. AIR (DB/WB)	80/67	80/67	80/67	80/67	80/67	80/67	80/67
		LVG. AIR (DB/WB)	61/59	61/59	61/59	61/59	61/59	61/59	61/59
		SENSIBLE HEAT MBH	33.6	20	24.5	40.7	40.7	28.8	28.8
		TOTAL MBH	44.6	28	33.4	53.7	53.7	29.8	29.8
ELEC. CONTROL DATA		UNIT MCA	13.4	9.5	7.1	14.9	14.9	10	10
		UNIT MOCP	20	15	20	20	20	15	15
		PANEL AND CIRCUIT	PANEL AC (1)	PANEL AC (1)	PANEL AC (1)	PANEL AC (1)	PANEL AC (1)	PANEL AC (1)	PANEL AC (1)
		WIRE AND CONDUIT	NOTE 1	NOTE 1	NOTE 1	NOTE 1	NOTE 1	NOTE 1	NOTE 1
		OVERCURRENT DEVICE	20A / 1P	15A / 1P	20A / 1P	20A / 1P	20A / 1P	15A / 1P	15A / 1P
		CONTROL SEQUENCE	RE: DRAWINGS	RE: DRAWINGS	RE: DRAWINGS	RE: DRAWINGS	RE: DRAWINGS	RE: DRAWINGS	RE: DRAWINGS
REFERENCE DRAWING/DETAIL			M100	M100	M100	M100	M100	M100	M100
REMARKS						NOTE 2	NOTE 2		

NOTES:
1: INTENT IS TO REUSE EXISTING CIRCUIT. CONTRACTOR TO VERIFY LOCATION AND CAPACITY OF EXISTING PANELBOARD, CIRCUIT BREAKER AND CIRCUIT. REUSE IF POSSIBLE, REPLACE IF NECESSARY.
2: AHU-6A AND AHU-6B ARE TWINNED FURNACES CONNECTED TO SINGLE DUAL-CIRCUIT CONDENSING UNIT (CU-6).

AIR COOLED CONDENSING UNIT SCHEDULE

		CU-3	CU-4	CU-5	CU-6	CU-9	CU-10
DESIGNATION		CU-3	CU-4	CU-5	CU-6	CU-9	CU-10
MANUFACTURER		CARRIER	CARRIER	CARRIER	CARRIER	CARRIER	CARRIER
MODEL NO.		24ABC648A003	24ABC630A003	24ABC636A003	38AUDA12	24ABC642A003	24ABC642A003
NOMINAL TONNAGE		4	2.5	3	10	3.5	3.5
UNIT DATA	MBH (NOTE 1)	44.6	28.3	33.4	107.4	39.8	39.8
	AMBIENT AIR TEMP. (%%DF)	105	105	105	105	105	105
	NO. REFRIG. CKTS.	1	1	1	2	1	1
	NO. COMPRESSORS	1	1	1	2	1	1
ELECTRICAL/CONTROL DA	MINIMUM CIRCUIT AMPS	26.1	16.8	18.1	39	23.6	23.6
	MAXIMUM OVERCURRENT PROTECTION	40	25	30	50	40	40
	VOLTAGE/PHASE	208/1	208/1	208/1	208/3	208/1	208/1
	PANEL & CIRCUIT	PANEL AC	PANEL AC	PANEL AC	PANEL AC	PANEL AC	PANEL AC
	WIRE & CONDUIT	NOTE 2	NOTE 2	NOTE 2	NOTE 2	NOTE 2	NOTE 2
	OVERCURRENT DEVICE	40A / 2P	25A / 2P	30A / 2P	50A / 2P	40A / 2P	40A / 2P
	DISCONNECT	YES	YES	YES	YES	YES	YES
VIBRATION ISOLATION		NOTE 4	NOTE 4	NOTE 4	NOTE 4	NOTE 4	NOTE 4
REFERENCE DRAWING/DETAIL		M100	M100	M100	M100	M100	M100
REMARKS					NOTE 3		

NOTES:
1: CAPACITY WHEN MATCHED WITH SCHEDULED AIR HANDLING UNIT.
2: INTENT IS TO REUSE EXISTING CIRCUIT. CONTRACTOR TO VERIFY LOCATION AND CAPACITY OF EXISTING PANELBOARD, CIRCUIT BREAKER AND CIRCUIT. REUSE IF POSSIBLE, REPLACE IF NECESSARY.
3: AHU-6A AND AHU-6B ARE TWINNED FURNACES CONNECTED TO SINGLE DUAL-CIRCUIT CONDENSING UNIT (CU-6).
4: PLACE UNIT ON B-LINE DURA-BLOK ROOF SUPPORTS.

PIPE INSULATION SCHEDULE - HVAC

SERVICE	PIPE SIZE	INSULATION	NOTES
CONDENSATE DRAIN	1/2" - 1-1/2"	1/2" FIBERGLASS, ASJ	1,2,3,4,5
	2" AND LARGER	1" FIBERGLASS, ASJ	
REFRIGERANT SUCTION REFRIGERANT HOT GAS REFRIGERANT LIQUID	ALL	1/2" FLEXIBLE CLOSED CELL ELASTOMERIC	
REFRIGERANT SUCTION (EXTERIOR) REFRIGERANT HOT GAS (EXTERIOR)	ALL	1/2"FIBERGLASS, ASJ WITH PVC JACKET	

NOTES:
1: FOR ALL PIPING 2-1/2" AND LARGER, PROVIDE RIGID FOAM INSERTS AT ALL HANGERS AND SUPPORT LOCATIONS.
2: ELBOW AND FITTING INSULATION SHALL BE OF SAME THICKNESS AS ADJACENT STRAIGHT PIPE INSULATION.
3: FITTING INSULATION TO HAVE ASJ OR SUPPLEMENTAL VAPOR BARRIER SEALED TO ADJACENT PIPE INSULATION.
4: PROVIDE PVC JACKET ON ALL FITTINGS AND ELBOWS IN EXPOSED AREAS.

DUCTWORK SCHEDULE

SERVICE	DUCT SHAPE	SMACNA REQUIREMENTS			OTHER REQUIREMENTS
		CLASSIFICATION	SEAL CLASS	LEAKAGE CLASS	
SUPPLY AIR DUCTS CONNECTED TO CONSTANT VOLUME AIR HANDLING UNITS	RECTANGULAR	2" WG POSITIVE	B	12	INSULATED - SEE SCHEDULE
RETURN AIR DUCTWORK OUTSIDE AIR DUCTWORK	ROUND (CONCEALED)	2" WG POSITIVE	B	3	
	ROUND (EXPOSED)	4" WG POSITIVE SPIRAL SEAM	B	3	

NOTES:
1: SEE DUCTWORK INSULATION SCHEDULE FOR REQUIREMENTS ON DUCT INSULATION

DUCTWORK INSULATION SCHEDULE

SERVICE	INSULATION
CONCEALED DUCTWORK AS FOLLOWS:	1-1/2", 1 LB. RIGID FIBERGLASS BLANKET, VAPOR BARRIER FACED, WITH HEAVY DUTY FOIL-SCRIM-KRAFT FACING.
OUTSIDE AIR	
SUPPLY AIR (ROUND AND RECTANGULAR)	
ALL ROUND SUPPLY AIR AND UNLINED BRANCH TAKE-OFFS FOR ROUND DUCTS AND IN-LINE TRANSITIONS.	

NOTES:
1: SEE DUCTWORK SCHEDULE FOR ITEMS THAT ARE TO BE LINED.

GRILLE, REGISTER & DIFFUSER SCHEDULE

PLAN MARK	MANUFACTURER MODEL NUMBER	SERVICE	MOUNT TYPE	VOLUME DAMPER	MATERIAL	COLOR	REMARKS
SD-1	TITUS TMS	SUPPLY	LAY-IN	YES	STEEL	WHITE	
RG-1	TITUS 300RL	RETURN	LAY-IN	NO	STEEL	WHITE	

PROJECT NAME: Navitas – City of Gladstone
AUTOCAD FILE LOCATION \ NAME: X:\17\17210\1721000\Drawings\01-1721000_ME201.dwg
LAST CORRECTION BY ◆ DATE ◆ TIME: Atryon Monday, July 17, 2017 4:11:08 PM
PLOTTED BY ◆ DATE ◆ TIME: Prasanta Patro Tuesday, July 18, 2017 9:27:03 AM

smith&boucher ENGINEERS
25501 west valley parkway, suite 200 olathe, ks 66061
p.913.345.2127 / 888.299.7540 f.913.345.0617
project number 1721000

NAVITAS CONSERVING RESOURCES • RENEWING BUILDINGS

City of Gladstone
HVAC Improvements

City Hall
7010 N. Holmes Street
Gladstone, Mo. 64118

PROJECT NO.	1721000
DATE	06–30–2017
DRAWN BY	S&B
CHECKED BY	CEA
CHECKED BY	
REVISED DATE	DESCRIPTION
1 ADD #3	07/18/17

SCHEDULES AND DETAILS
MECHANICAL AND ELECTRICAL

ME201

SINGLE ZONE CONSTANT VOLUME RTU - SEQUENCE OF OPERATION

THE OCCUPANCY MODE (OCCUPIED OR UNOCCUPIED) SHALL BE DETERMINED THROUGH A USER-ADJUSTABLE, GRAPHICAL, SEVEN-DAY SCHEDULE WITH A HOLIDAY SCHEDULE.

WHENEVER THE SUPPLY FAN IS DE-ENERGIZED, AS SENSED BY THE STATUS SENSOR, { THE OUTSIDE {AND RELIEF} AIR DAMPERS SHALL BE CLOSED AND THE RETURN AIR DAMPER SHALL BE OPEN, DX COOLING AND ALL HEATING STAGES SHALL BE DE-ENERGIZED.

THERMOSTAT CONTROLS. THE THERMOSTAT IS USED TO MONITOR ZONE TEMPERATURE, ADJUST TEMPERATURE SETPOINT, AND OVERRIDE UNIT OPERATION OCCUPANCY MODE. THE THERMOSTAT SETPOINT ADJUST SLIDER WILL ALLOW THE TEMPERATURE SETPOINT TO BE ADJUSTED +/- 2F (ADJ.) FOR OCCUPIED SETPOINTS. THE THERMOSTAT MANUAL ON BUTTON WILL OVERRIDE THE UNIT OPERATION MODE SELECTED BY THE CONTROLLER. WHEN THE MANUAL ON BUTTON IS PRESSED, 60 MINUTES (ADJ.) OF OVERRIDE OPERATION WILL BE IMPLEMENTED. TO CANCEL THE OVERRIDE, THE MANUAL ON BUTTON SHALL BE PRESSED AND HELD FOR 3 SECONDS. THE THERMOSTAT SHALL BE EQUIPPED WITH A RED LED THAT WILL LIGHT WHEN THE UNIT IS IN OCCUPIED MODE.

A. OCCUPIED MODE

1. THE SUPPLY {FAN{} SHALL BE ENERGIZED WHEN THE COOLING COMPRESSOR(S) ARE ON OR WHEN ONE OR MULTIPLE STAGES OF HEATING FURNACE IS ACTIVATED. TO PREVENT SHORT CYCLING, THE SUPPLY { FAN{S} SHALL HAVE A MINIMUM RUNTIME OF FIVE MINUTES (ADJ.). THE SUPPLY FAN STATUS SHALL BE MONITORED AND AN ALARM SHALL BE TRANSMITTED IF THE SUPPLY FAN'S STATUS DOES NOT MATCH THE COMMAND GENERATED BY THE CONTROLLER.
2. THERE SHALL BE SEPARATE HEATING AND COOLING SPACE TEMPERATURE SETPOINTS.
3. THE HEATING SHALL {STAGE, MODULATE}, RETURN/OUTSIDE AIR DAMPERS SHALL MODULATE AND THE DX COOLING SHALL STAGE ALL IN SEQUENCE TO MAINTAIN SPACE TEMPERATURE SETPOINT OF {71}F (ADJUSTABLE) WHEN IN HEATING MODE AND {74}F (ADJUSTABLE) WHEN IN COOLING MODE.
4. THROUGH A SELECTION TOGGLE AT THE USER INTERFACE, TWO ALTERNATIVES SHALL BE AVAILABLE FOR OPERATION OF THE FAN{S}: (1) THE SUPPLY {FAN{} SHALL BE DE-ENERGIZED WHEN THE COOLING COMPRESSOR(S) ARE OFF OR WHEN HEATING FURNACE IS DE-ACTIVATED UNLESS THE ECONOMIZER MODE IS ACTIVATED. (2) THE SUPPLY {AND }FAN{} SHALL BE ENERGIZED AT ALL TIMES WHEN IN OCCUPIED MODE.
5. DX COOLING:

A. IF THE OUTSIDE AIR TEMPERATURE IS GREATER THAN THE DX LOCK-OUT TEMPERATURE (50 F, ADJ.) AND THE SYSTEM IS NOT IN MORNING WARM-UP OR MORNING PRE-COOLING, DX COOLING SHALL BE ENABLED.

B. DX OPERATION SHALL OBSERVE THE FOLLOWING TIMING CONSTRAINTS:

1) WHEN A COOLING STAGE IS CALLED TO RUN, IT WILL RUN FOR AT LEAST THE DX MINIMUM ON-TIME.
2) WHEN A COOLING STAGE CYCLES OFF, IT WILL REMAIN OFF FOR AT LEAST THE DX MINIMUM OFF-TIME.

C. DX OPERATION SHALL OBSERVE THE FOLLOWING PERFORMANCE CONSTRAINTS

1) UNDER A STEADY PARTIAL LOAD, IF THE SYSTEM CYCLES, THE CYCLING MUST BE LIMITED TO A SINGLE STAGE, WHILE THE OTHER STAGES STAY ON OR OFF.
2) UNDER A STEADY PARTIAL LOAD, IF THE SYSTEM STABILIZES, THE DIFFERENCE BETWEEN SPACE TEMPERATURE AND SPACE TEMPERATURE SETPOINT MUST BE LESS THAN THE DX TEMPERATURE DEADBAND.

D. SAFETY TRIPS AND LOSS OF FAN STATUS SHALL OVERRIDE THE TIME DELAYS AND DE-ENERGIZE ALL COOLING STAGES.{ }

6. GAS HEATING:

A. IF THE OUTSIDE AIR TEMPERATURE IS LESS THAN THE HEATING LOCK-OUT TEMPERATURE (65 F, ADJ.) AND THE SYSTEM IS NOT IN MORNING COOL-DOWN, FURNACE HEATING SHALL BE ENABLED.

B. HEATING WILL BE ACCOMPLISHED LOCALLY AT THE UNIT. THE CONTROLLER SHALL {STAGE,MODULATE} THE GAS HEAT AS REQUIRED TO MAINTAIN THE ZONE AIR TEMPERATURE AT THE TEMPERATURE SETPOINT, WITHIN THE DEADBAND. HIGH STAGE HEATING SHALL SHUT DOWN IF THE SUPPLY AIR TEMPERATURE EXCEEDS 160 F.

C. FURNACE HEATING OPERATION SHALL OBSERVE THE FOLLOWING TIMING CONSTRAINTS:

1) WHEN A HEATING STAGE IS CALLED TO RUN, IT WILL RUN FOR AT LEAST THE HEATING MINIMUM ON-TIME.
2) WHEN A HEATING STAGE CYCLES OFF, IT WILL REMAIN OFF FOR AT LEAST THE HEATING MINIMUM OFF-TIME.

D. SAFETY TRIPS AND LOSS OF FAN STATUS SHALL OVERRIDE THE TIME DELAYS AND DE-ENERGIZE HEATING.

{7. THE OA DAMPER SHALL NOT CLOSE BELOW THE MINIMUM POSITION REQUIRED FOR OUTSIDE AIR VENTILATION. THIS POSITION SHALL BE SET IN CONJUNCTION WITH THE BALANCE CONTRACTOR.

{8. ECONOMIZER - COMPARATIVE ENTHALPY. ECONOMIZER COOLING IS ENABLED WHENEVER THE OUTSIDE AIR ENTHALPY IS LESS THAN THE RETURN AIR ENTHALPY LESS DEADBAND, AND OUTSIDE AIR TEMPERATURE IS LESS THAN THE RETURN AIR TEMPERATURE LESS DEADBAND, AND COOLING IS REQUIRED AS SENSED BY ZONE THERMOSTAT. WHEN THE OUTSIDE AIR ENTHALPY IS GREATER THAN THE RETURN AIR ENTHALPY LESS DEADBAND, OR OUTSIDE AIR TEMPERATURE IS GREATER THAN RETURN AIR TEMPERATURE LESS DEADBAND, ECONOMIZER COOLING IS LOCKED OUT. PROVIDE DEADBAND TO PREVENT HEATING OPERATION WHENEVER ECONOMIZER COOLING IS ENABLED. THERE SHALL BE A SUPPLY AIR LOW LIMIT FUNCTION TO MODULATE THE OUTSIDE AIR DAMPERS CLOSED TO PREVENT THE SUPPLY AIR TEMPERATURE FROM DROPPING BELOW THE SUPPLY AIR LOW LIMIT SETPOINT OF {50}F (ADJUSTABLE). ONCE THE ECONOMIZER CONTROL STRATEGY IS ACTIVE, THE CONTROLLER SHALL MODULATE THE ECONOMIZER DAMPER ASSEMBLY TO MAINTAIN THE ZONE SETPOINT AND THE SUPPLY { FAN{S} SHALL OPERATE. ONCE THE ZONE COOLING SETPOINT, LESS DEADBAND, IS SATISFIED, THE SUPPLY {AND RETURN} {AND RELIEF} FAN{S} SHALL SHUT DOWN, THE OUTSIDE AIR DAMPER SHALL FULLY CLOSE, AND THE RETURN AIR DAMPER SHALL OPEN FULLY. {THE RELIEF FAN SHALL ONLY OPERATE DURING ECONOMIZER MODE.}}

7. THE OUTSIDE AND RELIEF AIR DAMPERS SHALL CLOSE AND THE RETURN AIR DAMPER SHALL OPEN WHEN THE UNIT IS DE-ENERGIZED.

8. THE CONTROLS SHALL PREVENT:

A. THE HEATING SETPOINT FROM EXCEEDING THE COOLING SETPOINT MINUS {5}°F (ADJ.) (I.E. THE MINIMUM DEADBAND SHALL BE {5}°F);

B. THE UNOCCUPIED HEATING SETPOINT FROM EXCEEDING THE OCCUPIED HEATING SETPOINT; AND THE UNOCCUPIED COOLING SETPOINT FROM BEING LESS THAN THE OCCUPIED COOLING SETPOINT.

B. UNOCCUPIED MODE

1. UNOCCUPIED OFF: THE SUPPLY {FAN SHALL BE DE-ENERGIZED EXCEPT WHEN OPERATION IS CALLED FOR AS DESCRIBED BELOW. OUTSIDE AIR DAMPERS AND RELIEF DAMPERS SHALL BE CLOSED.
2. UNOCCUPIED SETBACK: THE SUPPLY { FAN SHALL CYCLE ON WITH THE OUTSIDE AND RELIEF DAMPERS CLOSED WHEN THE SPACE TEMPERATURE DROPS BELOW THE UNOCCUPIED SETPOINT OF {55}°F (ADJUSTABLE) OR WHEN THE SPACE TEMPERATURE RISES ABOVE THE UNOCCUPIED SETPOINT OF {85}°F (ADJUSTABLE). WHEN THE FAN IS ENERGIZED, AND HEATING IS REQUIRED, THE HEATING SHALL {STAGE,MODULATE} TO MAINTAIN ZONE AIR TEMPERATURE SETPOINT OF 95°F (ADJUSTABLE). WHEN FAN IS ENERGIZED, AND COOLING IS REQUIRED, THE COOLING SHALL STAGE TO MAINTAIN ZONE AIR TEMPERATURE SETPOINT OF 55°F (ADJUSTABLE).
3. OPTIMAL START: THE BAS SHALL INCORPORATE AN ADAPTIVE LEARNING OPTIMAL START ALGORITHM WHICH SHALL START THE UNIT AT THE LATEST POSSIBLE TIME TO REACH THE DESIRED OCCUPIED SPACE TEMPERATURE SETPOINT AT OCCUPANCY TIME. THE TIME THAT THE UNIT STARTS SHALL BE BASED ON ANALYSIS OF HISTORICAL VALUES OF ROOM TEMPERATURES AND OUTDOOR AIR TEMPERATURES AT TIMES BETWEEN START AND OCCUPANCY. DURING OPTIMAL START, A SETPOINT RAMP SHALL BE USED TO GRADUALLY MOVE THE SETPOINT FROM THE SETBACK CONDITION TOWARD THE DESIRED OCCUPIED SETPOINT AT THE TIME OF OCCUPANCY. UNDER MILD CONDITIONS, THIS SETPOINT RAMP WILL DELAY STARTING SYSTEM UNTIL THE SETPOINT REACHES THE SPACE TEMPERATURE.
4. MORNING WARM-UP: IF THE ZONE IS BELOW THE OCCUPIED TEMPERATURE SETPOINT AND THE OUTDOOR AIR TEMPERATURE IS BELOW 40F (ADJUSTABLE) MORNING WARM-UP SHALL BE INITIATED BY THE OPTIMUM START PROGRAM. IF THE AVERAGE ZONE TEMPERATURE IS BELOW THE OCCUPIED ZONE TEMPERATURE SETPOINT, THE SUPPLY FAN SHALL ENERGIZE, THE OUTSIDE AND RELIEF DAMPERS SHALL REMAIN CLOSED AND THE HEATING FURNACE SHALL START FIRING SEQUENCE AND {STAGE,MODULATE} BURNER UNTIL THE ZONE TEMPERATURE EQUALS THE OCCUPIED ZONE TEMPERATURE SETPOINT. IF THE ZONE REACHES THE OCCUPIED ZONE TEMPERATURE SETPOINT BEFORE OCCUPANCY, THE SYSTEM SHUTS OFF. IF OCCUPANCY OCCURS BEFORE THE ZONE REACHES THE HEATING SETPOINT, THE SYSTEM SWITCHES TO OCCUPIED MODE. MORNING WARM-UP SHALL OCCUR ONLY ONCE IN A DAY.

{5. MORNING PRE-COOLING: PRE-COOLING SHALL BE PERMITTED ONLY WHEN THE UNOCCUPIED MODE ZONE TEMPERATURE EXCEEDS THE OCCUPIED MODE COOLING SETPOINT PRIOR TO TIME OF OPTIMAL START. IF, DURING UNOCCUPIED HOURS, ZONE TEMPERATURE EXCEEDS THE COOLING MODE OCCUPIED ZONE TEMPERATURE SETPOINT, AND THE OUTSIDE AIR ENTHALPY IS BELOW THE ZONE AIR ENHALPY, MORNING PRE-COOLING MAY BEGIN. THE OUTSIDE AIR, RETURN AND RELIEF AIR DAMPERS SHALL MODULATE TO PROVIDE 55°F (MINIMUM, ADJUSTABLE) SUPPLY AIR UNTIL THE ZONE TEMPERATURE EQUALS THE OCCUPIED MODE HEATING ZONE TEMPERATURE SETPOINT. HEATING AND MECHANICAL COOLING SHALL BE LOCKED OUT DURING MORNING PRE-COOLING. IF THE ZONE REACHES THE OCCUPIED MODE HEATING ZONE TEMPERATURE SETPOINT BEFORE OCCUPANCY, THE SYSTEM SHUTS OFF. IF OCCUPANCY OCCURS BEFORE THE ZONE REACHES THE OCCUPIED MODE HEATING ZONE TEMPERATURE SETPOINT, THE SYSTEM SWITCHES TO OCCUPIED MODE. ON ANY DAY THAT THE MORNING PRE-COOLING SEQUENCE IS INITATED, THE HEATING SHALL BE LOCKED OUT DURING MORNING COOL-DOWN AND FOR THE FIRST HOUR OF OCCUPANCY AFTER MORNING COOL-DOWN. MORNING PRE-COOLING SHALL OCCUR ONLY ONCE IN A DAY.}

6. MORNING COOL-DOWN: IF THE ZONE IS ABOVE THE OCCUPIED TEMPERATURE SETPOINT AT THE TIME OF OPTIMAL START, MORNING COOL-DOWN SHALL BE INITIATED BY THE OPTIMUM START PROGRAM. IF THE AVERAGE ZONE TEMPERATURE IS ABOVE THE OCCUPIED ZONE TEMPERATURE SETPOINT, AND THE OUTSIDE AIR ENTHALPY IS GREATER THAN THE ZONE AIR ENTHALPY, THE SUPPLY FAN SHALL ENERGIZE, THE OUTSIDE AIR AND RELIEF AIR DAMPERS SHALL REMAIN CLOSED AND THE COOLING SEQUENCE SHALL INITIATE UNTIL THE ZONE TEMPERATURE EQUALS THE OCCUPIED MODE ZONE TEMPERATURE SETPOINT. IF THE OUTSIDE AIR ENTHALPY IS LESS THAN THE RETURN AIR ENTHALPY, THE ECONOMIZER SEQUENCE SHALL COMMENCE. IF THE ZONE REACHES THE OCCUPIED ZONE TEMPERATURE SETPOINT BEFORE OCCUPANCY, THE SYSTEM SHUTS OFF. IF OCCUPANCY OCCURS BEFORE THE ZONE REACHES THE COOLING SETPOINT, THE SYSTEM SWITCHES TO OCCUPIED MODE. MORNING COOL-DOWN SHALL OCCUR ONLY ONCE IN A DAY.
7. OPTIMAL STOP: THE BAS SHALL INCORPORATE AN ADAPTIVE LEARNING OPTIMAL STOP ALGORITHM WHICH SHALL STOP THE UNIT AT THE EARLIEST POSSIBLE TIME TO NOT EXCEED OR FALL BELOW BY MORE THAN 2°F THE DESIRED OCCUPIED SPACE TEMPERATURE SETPOINT AT END OF OCCUPANCY TIME. THE TIME THAT THE UNIT STOPS SHALL BE BASED ON ANALYSIS OF HISTORICAL VALUES OF ROOM TEMPERATURES AND OUTDOOR AIR TEMPERATURES AT TIMES BETWEEN OPTIMAL STOP AND END OF OCCUPANCY PERIOD.

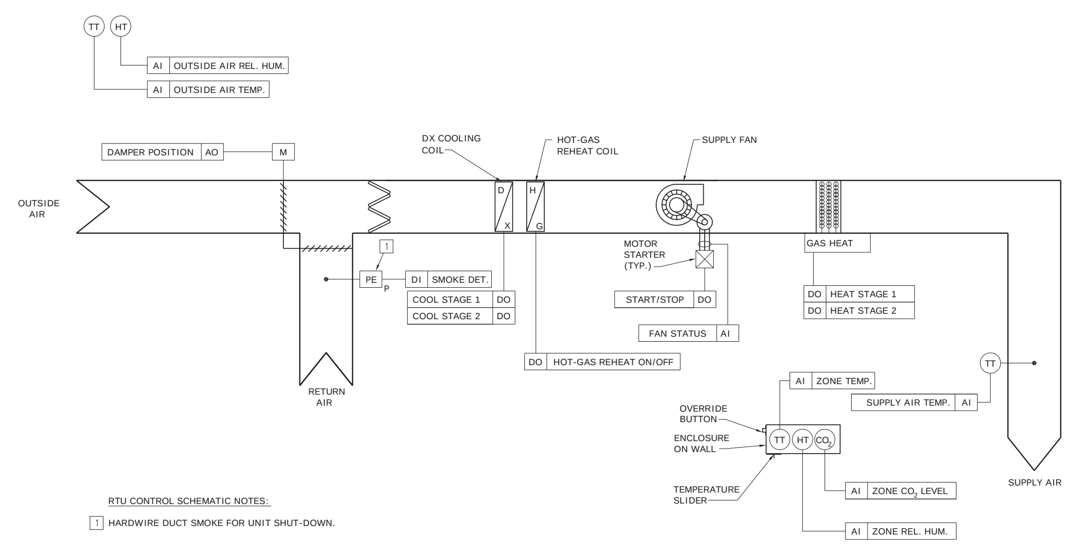
C. SAFETY SHUTDOWNS

DUCT SMOKE DETECTION{, SPACE SMOKE DETECTION,} {AND LOW TEMPERATURE LIMIT} TRIPS SHALL DE-ENERGIZE THE ROOF TOP UNIT AND CLOSE THE OUTSIDE AIR AND RELIEF AIR DAMPERS. MANUAL RESET OF THE TRIPPED DEVICE SHALL BE REQUIRED TO RESTART THE SYSTEM.

D. BUILDING AUTOMATION SYSTEM INTERFACE

THE FOLLOWING CONTROL AND MONITORING CAPABILITIES SHALL BE PRESENT AT THE USER INTERFACE LEVEL IN THE BUILDING AUTOMATION SYSTEM (BAS):

1. SELECT UNIT OCCUPANCY MODE VIA BAS SCHEDULING.
2. MONITOR HEATING AND COOLING STATUS AND ADJUST HEATING AND COOLING SETPOINTS.
3. MONITOR ZONE, SUPPLY AIR, RETURN AIR AND OUTSIDE AIR TEMPERATURES.



RTU CONTROL SCHEMATIC NOTES:

1 HARDWIRE DUCT SMOKE FOR UNIT SHUT-DOWN.

ROOFTOP UNIT CONTROL SCHEMATIC - SINGLE ZONE CONSTANT VOLUME

NO SCALE

FURNACE AND CONDENSING UNIT - SEQUENCE OF OPERATION

THE OCCUPANCY MODE (OCCUPIED OR UNOCCUPIED) SHALL BE DETERMINED THROUGH A USER-ADJUSTABLE, GRAPHICAL, SEVEN-DAY SCHEDULE WITH A HOLIDAY SCHEDULE.

THERMOSTAT CONTROLS. THE THERMOSTAT IS USED TO MONITOR ZONE TEMPERATURE, ADJUST TEMPERATURE SETPOINT, AND OVERRIDE UNIT OPERATION OCCUPANCY MODE. THE THERMOSTAT SETPOINT ADJUST SLIDER WILL ALLOW THE TEMPERATURE SETPOINT TO BE ADJUSTED +/- 2F (ADJ.) FOR OCCUPIED SETPOINTS. THE THERMOSTAT MANUAL ON BUTTON WILL OVERRIDE THE UNIT OPERATION MODE SELECTED BY THE CONTROLLER. WHEN THE MANUAL ON BUTTON IS PRESSED, 60 MINUTES (ADJ.) OF OVERRIDE OPERATION WILL BE IMPLEMENTED. TO CANCEL THE OVERRIDE, THE MANUAL ON BUTTON SHALL BE PRESSED AND HELD FOR 3 SECONDS. THE THERMOSTAT SHALL BE EQUIPPED WITH A RED LED THAT WILL LIGHT WHEN THE UNIT IS IN OCCUPIED MODE.

A. OCCUPIED MODE

1. THE SUPPLY FAN SHALL BE ENERGIZED WHEN THE COOLING COMPRESSOR(S) ARE ON OR WHEN ONE OR MULTIPLE STAGES OF HEATING FURNACE IS ACTIVATED. TO PREVENT SHORT CYCLING, THE SUPPLY FAN SHALL HAVE A MINIMUM RUNTIME OF FIVE MINUTES (ADJ.). THE SUPPLY FAN STATUS SHALL BE MONITORED AND AN ALARM SHALL BE TRANSMITTED IF THE SUPPLY FAN'S STATUS DOES NOT MATCH THE COMMAND GENERATED BY THE CONTROLLER.
2. THERE SHALL BE SEPARATE HEATING AND COOLING SPACE TEMPERATURE SETPOINTS.
3. THE HEATING SHALL {STAGE, MODULATE} AND THE DX COOLING SHALL STAGE ALL IN SEQUENCE TO MAINTAIN SPACE TEMPERATURE SETPOINT OF {71}F (ADJUSTABLE) WHEN IN HEATING MODE AND {74}F (ADJUSTABLE) WHEN IN COOLING MODE.
4. THE OUTSIDE AIR DAMPER SHALL OPEN WHEN THE UNIT FAN IS ON.

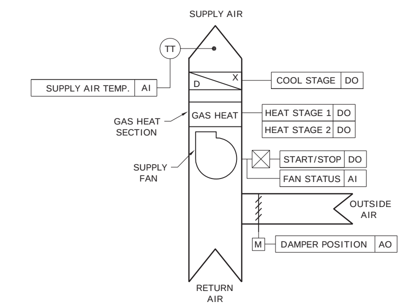
B. UNOCCUPIED MODE

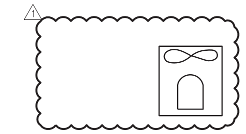
1. UNOCCUPIED OFF: THE SUPPLY {{} FAN SHALL BE DE-ENERGIZED EXCEPT WHEN OPERATION IS CALLED FOR AS DESCRIBED BELOW. OUTSIDE AIR DAMPER SHALL BE CLOSED.
2. UNOCCUPIED SETBACK: THE SUPPLY {AND RETURN} FANS SHALL CYCLE ON WITH THE OUTSIDE AND RELIEF DAMPERS CLOSED WHEN THE SPACE TEMPERATURE DROPS BELOW THE UNOCCUPIED SETPOINT OF {55}°F (ADJUSTABLE) OR WHEN THE SPACE TEMPERATURE RISES ABOVE THE UNOCCUPIED SETPOINT OF {85}°F (ADJUSTABLE). WHEN THE FAN IS ENERGIZED, AND HEATING IS REQUIRED, THE HEATING SHALL {STAGE,MODULATE} TO MAINTAIN ZONE AIR TEMPERATURE SETPOINT OF 95°F (ADJUSTABLE). WHEN FAN IS ENERGIZED, AND COOLING IS REQUIRED, THE COOLING SHALL STAGE TO MAINTAIN ZONE AIR TEMPERATURE SETPOINT OF 55°F (ADJUSTABLE).

D. BUILDING AUTOMATION SYSTEM INTERFACE

THE FOLLOWING CONTROL AND MONITORING CAPABILITIES SHALL BE PRESENT AT THE USER INTERFACE LEVEL IN THE BUILDING AUTOMATION SYSTEM (BAS):

1. SELECT UNIT OCCUPANCY MODE VIA BAS SCHEDULING.
2. MONITOR HEATING AND COOLING STATUS AND ADJUST HEATING AND COOLING SETPOINTS.
3. MONITOR ZONE AND SUPPLY AIR
4. MONITOR AND RESET UNIT ALARMS.





FURNACE AND CONDENSING UNIT CONTROL SCHEMATIC

NO SCALE

City of Gladstone
HVAC Improvements

City Hall
7010 N. Holmes Street
Gladstone, Mo. 64118

CONSERVING RESOURCES • RENEWING BUILDINGS

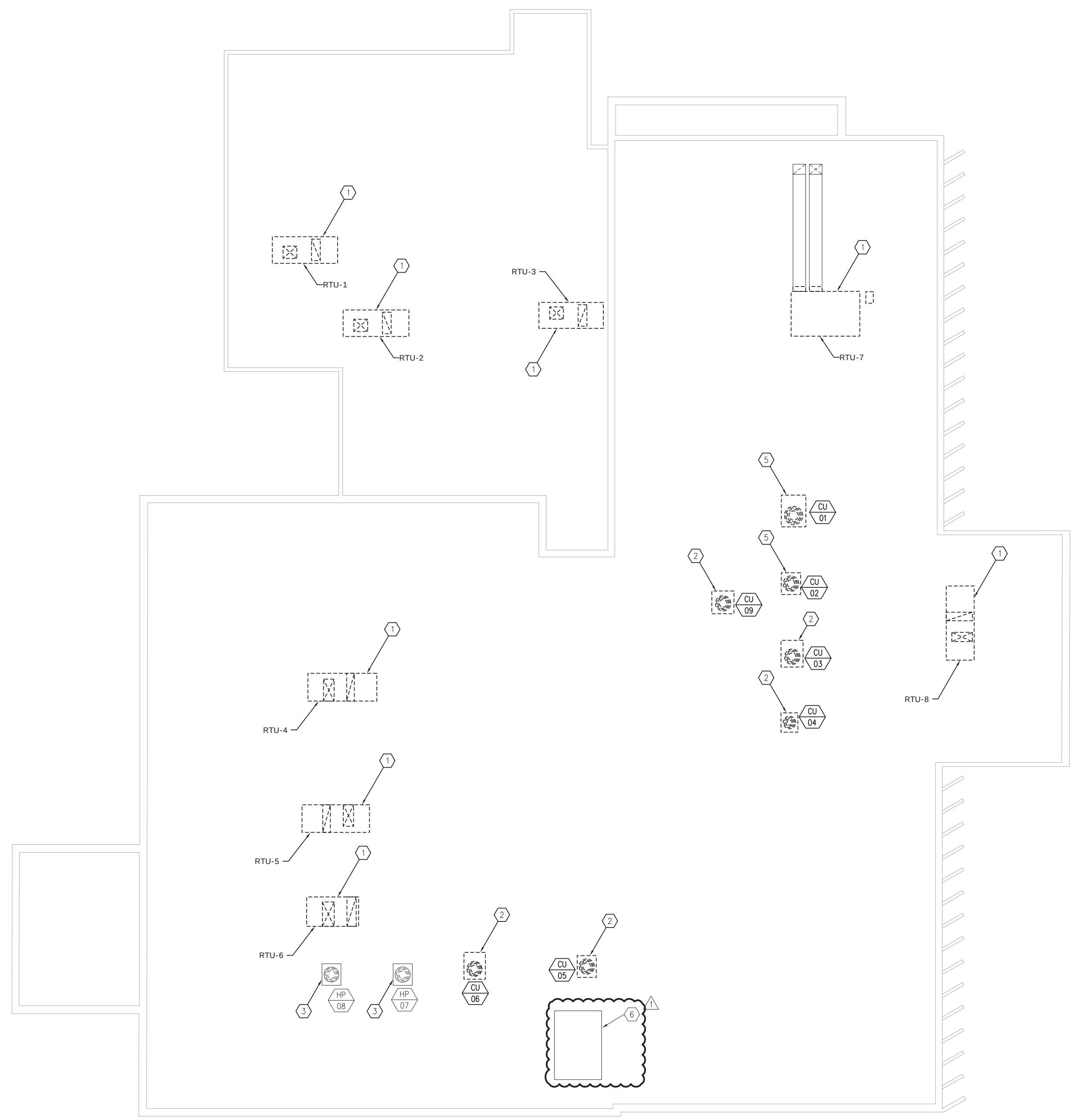
PROJECT NO.	1721000
DATE	06–30–2017
DRAWN BY	S&B
CHECKED BY	CEA
CHECKED BY	
REVISED DATE	DESCRIPTION
1 ADD #3	07/18/17
.	.
.	.
.	.
.	.

smith&boucher
ENGINEERS
25501 west valley parkway, suite 200 olathe, ks 66061
p.913.345.2127 / 888.299.7540 f.913.345.0617
project number 1721000

CONTROL DIAGRAMS
MECHANICAL AND ELECTRICAL

ME202

PROJECT NAME: Navitas - City of Gladstone
AUTOCAD FILE LOCATION \ NAME: X:\17\17210\1721000\Drawings\01-1721000_ME202.dwg
LAST CORRECTION BY • DATE • TIME: PPatro Tuesday, July 18, 2017 9:25:06 AM
PLOTTED BY • DATE • TIME: Prasanta Patro Tuesday, July 18, 2017 9:27:29 AM



ROOF PLAN - DEMOLITION - HVAC

SCALE: 1/8"=1'-0"

scale: 1/8" = 1'-0" 4 0 4 8 12 20 feet

GENERAL DEMOLITION NOTES:

1. THE EXISTING CONDITIONS INDICATED ON THE DRAWINGS ARE TAKEN FROM THE BEST INFORMATION AVAILABLE AND FROM VISUAL SITE INSPECTION AND ARE NOT TO BE CONSTRUED AS "AS BUILT" CONDITIONS. THE INFORMATION IS SHOWN TO HELP ESTABLISH THE EXTENT OF THE NEW WORK. VERIFY ALL ACTUAL EXISTING CONDITIONS AT THE PROJECT SITE AND PERFORM WORK AS REQUIRED TO MEET THE EXISTING CONDITIONS AND THE EXTENT OF THE WORK INDICATED.
2. PATCH ROOFS, WALLS, AND CEILINGS WHERE ANY SERVICES ARE REMOVED UNLESS NOTED OTHERWISE.
3. DISCONNECT AND REMOVE ALL PIPING, WIRING, AND CONDUIT THAT BECOMES UNNECESSARY AS A RESULT OF THE REMOVAL OF EQUIPMENT INDICATED TO BE REMOVED. PROVIDE FOR THE CONTINUITY OF ALL REMAINING SERVICES SYSTEMS AND CIRCUITS.
4. RELOCATE AND RECONNECT AND MECHANICAL AND ELECTRICAL FACILITIES THAT MUST BE RELOCATED IN ORDER TO ACCOMPLISH THE REMODELING SHOW IN THE DRAWINGS OR INDICATED IN THE SPECIFICATIONS. WHERE MECHANICAL AND ELECTRICAL FIXTURES OR EQUIPMENT ARE REMOVED CAP ALL UNUSED CONDUIT, WIRING, AND PIPING BEYOND THE FLOOR LINE OR WALL LINE TO FACILITATE RESTORATION OF FINISH.
5. WHERE REMOVAL OF EXISTING WIRING INTERRUPTS ELECTRICAL CONTINUITY OR CIRCUITS WHICH ARE TO REMAIN IN USE, FURNISH AND INSTALL ALL REQUIRED WIRE, CONDUIT, JUNCTION BOXES, ETC. TO INSURE CONTINUED ELECTRICAL CONTINUITY.
6. DISCONNECT AND REMOVE ALL EXISTING TEMPERATURE CONTROL CABLING BETWEEN EXISTING UNITS AND CONTROLLERS. THERMOSTAT CABLING CAN REMAIN AND BE REUSED.

DEMOLITION PLAN NOTES:

1 DISCONNECT AND REMOVE EXISTING ROOFTOP UNIT. DISCONNECT ALL EXISTING POWER AND CONTROL WIRING. EXISTING POWER CIRCUIT TO REMAIN AND BE REUSED. REMOVE EXISTING CONDUIT AND PITCH PAN AND REPLACE WITH NEW PORTALS PLUS PAN AND COVER.

2 DISCONNECT AND REMOVE EXISTING CONDENSING UNIT. DISCONNECT ALL EXISTING POWER CONTROL WIRING AND REFRIGERANT PIPING. EXISTING POWER CIRCUIT TO REMAIN AND BE REUSED. ALL REFRIGERANT PIPING TO BE REMOVED. REMOVE EXISTING PIPING & CONDUIT PITCH PAN AND REPLACE WITH NEW PORTALS PLUS PAN AND COVER.

3 EXISTING HEAT PUMP CONDENSING UNIT TO REMAIN AND BE REUSED.

4 EXISTING DUCT ON ROOF TO REMAIN.

5 DISCONNECT AND REMOVE EXISTING CONDENSING UNIT, POWER, CONTROL, REFRIGERANT PIPING AND UNIT SUPPORTS. UNITS TO REMAIN IN SERVICE UNTIL FIRST FLOOR RENOVATION STARTS.

1 6 EXISTING INTAKE HOOD.

Navitas
CONSERVING RESOURCES • RENEWING BUILDINGS

City of Gladstone
HVAC Improvements

City Hall
7010 N. Holmes Street
Gladstone, Mo. 64118

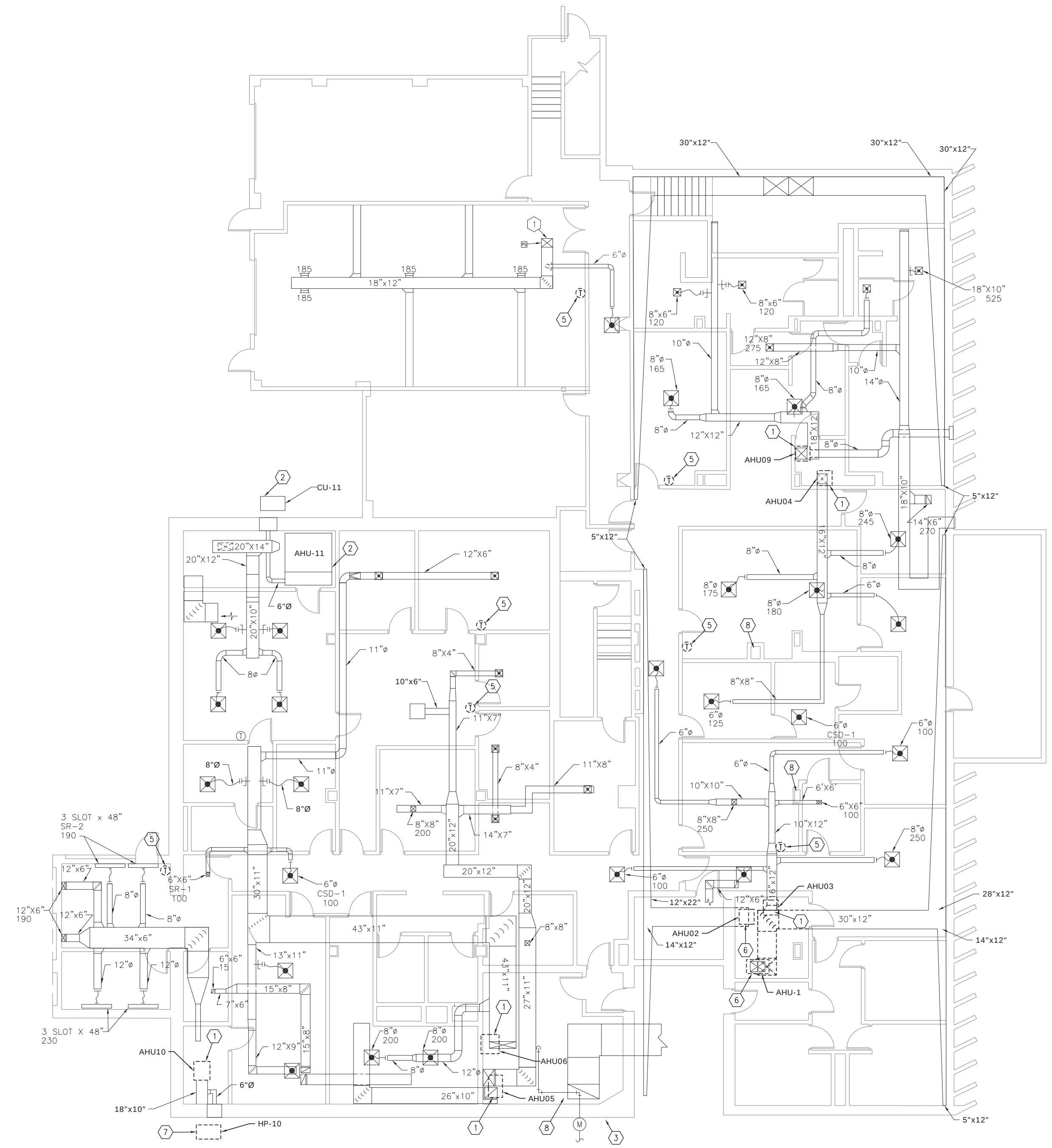
PROJECT NO.	1721000
DATE	06-30-2017
DRAWN BY	S&B
CHECKED BY	CEA
CHECKED BY	
REVISED DATE	DESCRIPTION
1 07/18/17	ADD. #5

smith&boucher ENGINEERS
25501 west valley parkway, suite 200 olathe, ks 66061
p.913.345.2127 / 888.299.7540 f.913.345.0617
project number 1721000

ROOF PLAN
DEMOLITION
HVAC

DM100

PROJECT NAME: Navitas - City of Gladstone
AUTOCAD FILE LOCATION \ NAME: X:\17\17210\1721000\Drawings\03-1721000_DM100.dwg
LAST CORRECTION BY ◆ DATE ◆ TIME: Edrummond Tuesday, July 18, 2017 9:17:11 AM
PLOTTED BY ◆ DATE ◆ TIME: Prasanta Patro Tuesday, July 18, 2017 9:27:55 AM



GROUND FLOOR PLAN - DEMOLITION - HVAC
SCALE: 1/8"=1'-0"

GENERAL DEMOLITION NOTES:

1. THE EXISTING CONDITIONS INDICATED ON THE DRAWINGS ARE TAKEN FROM THE BEST INFORMATION AVAILABLE AND FROM VISUAL SITE INSPECTION AND ARE NOT TO BE CONSTRUED AS "AS BUILT" CONDITIONS. THE INFORMATION IS SHOWN TO HELP ESTABLISH THE EXTENT OF THE NEW WORK. VERIFY ALL ACTUAL EXISTING CONDITIONS AT THE PROJECT SITE AND PERFORM WORK AS REQUIRED TO MEET THE EXISTING CONDITIONS AND THE EXTENT OF THE WORK INDICATED.
2. PATCH ROOFS, WALLS, AND CEILINGS WHERE ANY SERVICES ARE REMOVED UNLESS NOTED OTHERWISE.
3. DISCONNECT AND REMOVE ALL PIPING, WIRING, AND CONDUIT THAT BECOMES UNNECESSARY AS A RESULT OF THE REMOVAL OF EQUIPMENT INDICATED TO BE REMOVED. PROVIDE FOR THE CONTINUITY OF ALL REMAINING SERVICES SYSTEMS AND CIRCUITS.
4. RELOCATE AND RECONNECT AND MECHANICAL AND ELECTRICAL FACILITIES THAT MUST BE RELOCATED IN ORDER TO ACCOMPLISH THE REMODELING SHOW IN THE DRAWINGS OR INDICATED IN THE SPECIFICATIONS. WHERE MECHANICAL AND ELECTRICAL FIXTURES OR EQUIPMENT ARE REMOVED CAP ALL UNUSED CONDUIT, WIRING, AND PIPING BEYOND THE FLOOR LINE OR WALL LINE TO FACILITATE RESTORATION OF FINISH.
5. WHERE REMOVAL OF EXISTING WIRING INTERRUPTS ELECTRICAL CONTINUITY OR CIRCUITS WHICH ARE TO REMAIN IN USE, FURNISH AND INSTALL ALL REQUIRED WIRE, CONDUIT, JUNCTION BOXES, ETC. TO INSURE CONTINUED ELECTRICAL CONTINUITY.
6. DISCONNECT AND REMOVE ALL EXISTING TEMPERATURE CONTROL CABLING BETWEEN EXISTING UNITS AND THE CONTROLLER. THERMOSTAT CABLING CAN REMAIN AND BE REUSED.

DEMOLITION PLAN NOTES:

1 DISCONNECT AND REMOVE EXISTING AIR HANDLING UNIT, BASE, A-COIL AND ELECTRIC HEATER. DISCONNECT ALL EXISTING POWER, CONTROL WIRING AND REFRIGERANT PIPING. EXISTING POWER CIRCUIT TO REMAIN AND BE REUSED. ALL REFRIGERANT PIPING TO BE REMOVED.

2 EXISTING AHU AND CU TO REMAIN AND BE REUSED.

3 EXISTING 2" GAS SERVICE AND METER.

4 EXISTING THERMOSTAT TO BE REMOVED AND REPLACED.

5 EXISTING THERMOSTAT TO REMAIN AND BE REUSED.

6 DISCONNECT AND REMOVE EXISTING AIR HANDLING UNIT, POWER, CONTROLS AND UNIT SUPPORT. REMOVE DUCTWORK TO THE EXTENT OF THE MECHANICAL ROOM AND CAP. AHU-1 AND AHU-2 TO REMAIN IN SERVICE UNTIL FIRST FLOOR RENOVATION STARTS.

7 DISCONNECT AND REMOVE EXISTING CONDENSING UNIT. DISCONNECT ALL EXISTING POWER CONTROL WIRING AND REFRIGERANT PIPING. EXISTING POWER CIRCUIT TO REMAIN AND BE REUSED. ALL REFRIGERANT PIPING TO BE REMOVED. REMOVE EXISTING PIPING & CONDUIT PITCH PAN AND REPLACE WITH NEW PORTALS PLUS PAN AND COVER.

8 EXISTING REFRIGERANT LINE CHASE.

CONSERVING RESOURCES • RENEWING BUILDINGS

City of Gladstone
HVAC Improvements

City Hall
7010 N. Holmes Street
Gladstone, Mo. 64118

PROJECT NO.	1721000
DATE	06-30-2017
DRAWN BY	S&B
CHECKED BY	XXX
CHECKED BY	XXX

REVISED DATE	DESCRIPTION
.	.
.	.
.	.
.	.
.	.

smith&boucher ENGINEERS
25501 west valley parkway, suite 200 olathe, ks 66061
p.913.345.2127 / 888.299.7540 f.913.345.0617
project number 1721000

GROUND FLOOR PLAN
DEMOLITION
HVAC

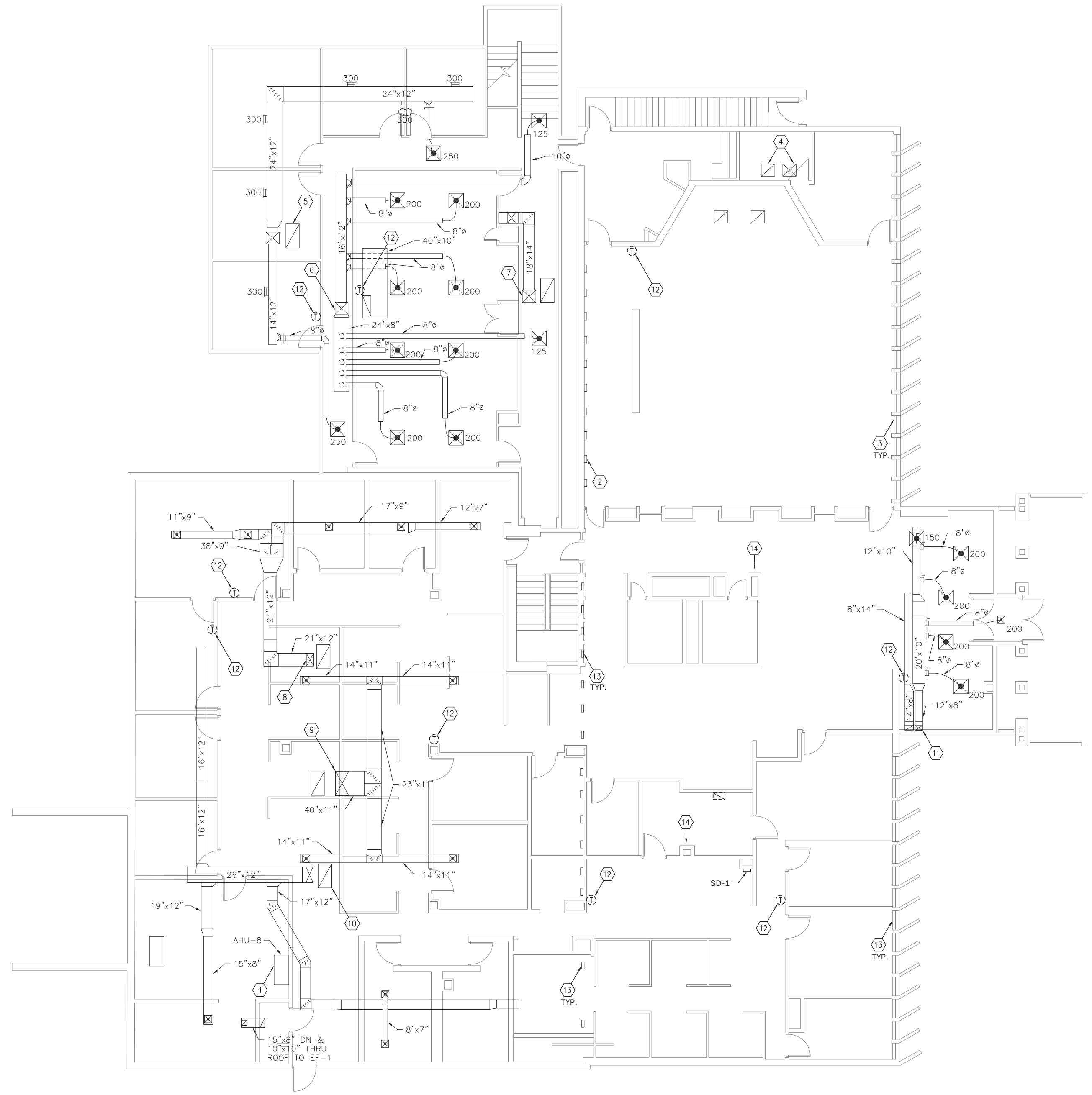
DM101

GENERAL DEMOLITION NOTES:

1. THE EXISTING CONDITIONS INDICATED ON THE DRAWINGS ARE TAKEN FROM THE BEST INFORMATION AVAILABLE AND FROM VISUAL SITE INSPECTION AND ARE NOT TO BE CONSTRUED AS "AS BUILT" CONDITIONS. THE INFORMATION IS SHOWN TO HELP ESTABLISH THE EXTENT OF THE NEW WORK. VERIFY ALL ACTUAL EXISTING CONDITIONS AT THE PROJECT SITE AND PERFORM WORK AS REQUIRED TO MEET THE EXISTING CONDITIONS AND THE EXTENT OF THE WORK INDICATED.
2. PATCH ROOFS, WALLS, AND CEILINGS WHERE ANY SERVICES ARE REMOVED UNLESS NOTED OTHERWISE.
3. DISCONNECT AND REMOVE ALL PIPING, WIRING, AND CONDUIT THAT BECOMES UNNECESSARY AS A RESULT OF THE REMOVAL OF EQUIPMENT INDICATED TO BE REMOVED. PROVIDE FOR THE CONTINUITY OF ALL REMAINING SERVICES SYSTEMS AND CIRCUITS.
4. RELOCATE AND RECONNECT AND MECHANICAL AND ELECTRICAL FACILITIES THAT MUST BE RELOCATED IN ORDER TO ACCOMPLISH THE REMODELING SHOW IN THE DRAWINGS OR INDICATED IN THE SPECIFICATIONS. WHERE MECHANICAL AND ELECTRICAL FIXTURES OR EQUIPMENT ARE REMOVED CAP ALL UNUSED CONDUIT, WIRING, AND PIPING BEYOND THE FLOOR LINE OR WALL LINE TO FACILITATE RESTORATION OF FINISH.
5. WHERE REMOVAL OF EXISTING WIRING INTERRUPTS ELECTRICAL CONTINUITY OR CIRCUITS WHICH ARE TO REMAIN IN USE, FURNISH AND INSTALL ALL REQUIRED WIRE, CONDUIT, JUNCTION BOXES, ETC. TO INSURE CONTINUED ELECTRICAL CONTINUITY.
6. DISCONNECT AND REMOVE ALL EXISTING TEMPERATURE CONTROL CABLING BETWEEN EXISTING BOXES / DAMPERS AND THE EXISTING TRANE CONTROLLER. THERMOSTAT CABLING CAN REMAIN AND BE REUSED.

PLAN NOTES:

1 EXISTING SPLIT SYSTEM AIR HANDLING UNIT TO REMAIN AND BE REUSED.
2 EXISTING WALL SUPPLY DIFFUSERS TO REMAIN.
3 EXISTING FLOOR GRILLES TO REMAIN.
4 EXISTING SUPPLY AND RETURN UP TO RTU-7.
5 EXISTING SUPPLY UP TO RTU-1.
6 EXISTING SUPPLY AND RETURN UP TO RTU-2.
7 EXISTING SUPPLY AND RETURN UP TO RTU-3.
8 EXISTING SUPPLY AND RETURN UP TO RTU-4.
9 EXISTING SUPPLY AND RETURN UP TO RTU-5.
10 EXISTING SUPPLY AND RETURN UP TO RTU-6.
11 EXISTING SUPPLY AND RETURN UP TO RTU-8.
12 EXISTING THERMOSTAT TO BE REMOVED AND REPLACED.'
13 EXISTING FLOOR GRILLES. GRILLES TO BE REMOVED UNDER SEPARATE PROJECT.
14 EXISTING REFRIGERANT LINE CHASE.



FIRST FLOOR PLAN - DEMOLITION - HVAC
SCALE: 1/8"=1'-0"

Navitas
CONSERVING RESOURCES • RENEWING BUILDINGS

City of Gladstone
HVAC Improvements

City Hall
7010 N. Holmes Street
Gladstone, Mo. 64118

PROJECT NO.	1721000
DATE	06-30-2017
DRAWN BY	S&B
CHECKED BY	XXX
CHECKED BY	XXX
REVISED DATE	DESCRIPTION

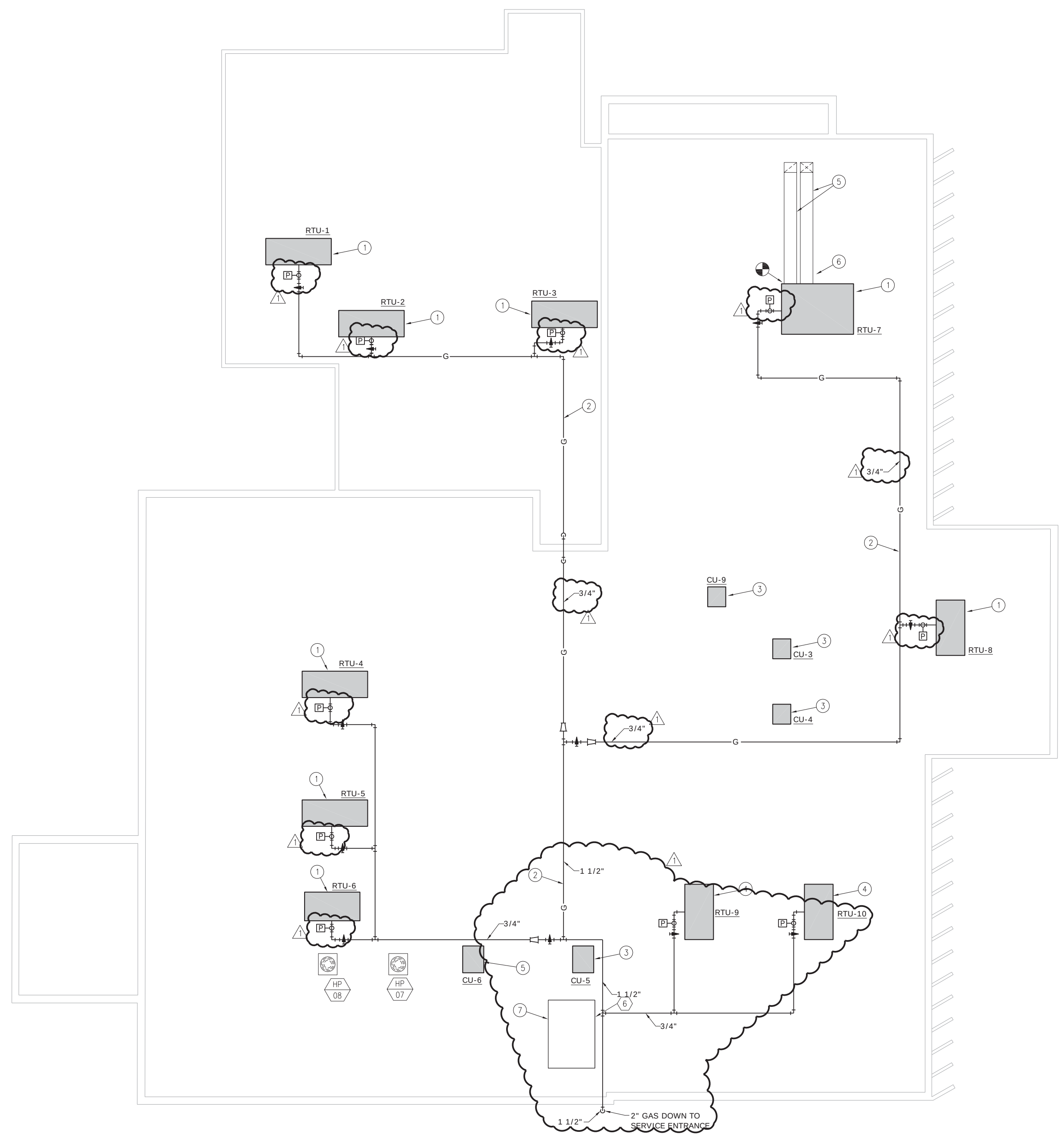
smith&boucher ENGINEERS
25501 west valley parkway, suite 200 olathe, ks 66061
p.913.345.2127 / 888.299.7540 f.913.345.0617
project number 1721000

FIRST FLOOR PLAN
DEMOLITION
HVAC

DM102

PLAN NOTES:

1. PROVIDE AND INSTALL NEW ROOFTOP UNIT. PROVIDE CURB ADAPTER IF NECESSARY FOR NEW EQUIPMENT. RECONNECT POWER FROM EXISTING CIRCUIT TO NEW DISCONNECT SWITCH. CONNECT NEW GAS LINE TO UNIT. CONTRACTOR IS RESPONSIBLE TO EXTEND ELECTRICAL CIRCUIT, CONDUIT, CONTROL CABLE, FIRE ALARM, AND ANY OTHER DEVICES NECESSARY DUE TO INCREASE IN HEIGHT OR WIDTH OF NEW CURB ADAPTER OR LOCATION OF CONNECTIONS ON NEW UNIT.
2. NEW GAS LINE ROUTED ON ROOF. INSTALL ON B-LINE DURA-BLOK PIPE SUPPORTS.
3. PROVIDE AND INSTALL NEW CONDENSING UNIT. SET UNITS ON B-LINE DURA-BLOK EQUIPMENT SUPPORTS. RECONNECT POWER FROM EXISTING CIRCUIT TO NEW DISCONNECT SWITCH. EXTEND NEW REFRIGERANT PIPING DOWN THROUGH BUILDING TO AIR HANDLING UNIT.
4. PROVIDE AND INSTALL NEW ROOFTOP UNIT. CUT ROOF OPENINGS AND SET NEW CURB. EXTEND NEW POWER CIRCUIT AND EXTEND GAS TO NEW UNIT.
5. EXISTING ROOF-MOUNTED DUCTWORK TO REMAIN AND BE REUSED.
6. TRANSITION ROOF-MOUNTED DUCTWORK AS NEEDED TO MATCH NEW UNIT. INSTALL NEW INSULATION AND ALUMINUM JACKET ON ALL NEW DUCT AND MODIFIED EXISTING DUCT.
7. EXISTING INTAKE HOOD.



scale: 1/8" = 1'-0" 0 4 8 12 20 feet

ROOF PLAN - HVAC
SCALE: 1/8"=1'-0"

City of Gladstone
HVAC Improvements
City Hall
7010 N. Holmes Street
Gladstone, Mo. 64118

PROJECT NO.	1721000
DATE	06-30-2017
DRAWN BY	S&B
CHECKED BY	CEA
CHECKED BY	
REVISED DATE	DESCRIPTION
1 07/18/17	ADD. #5

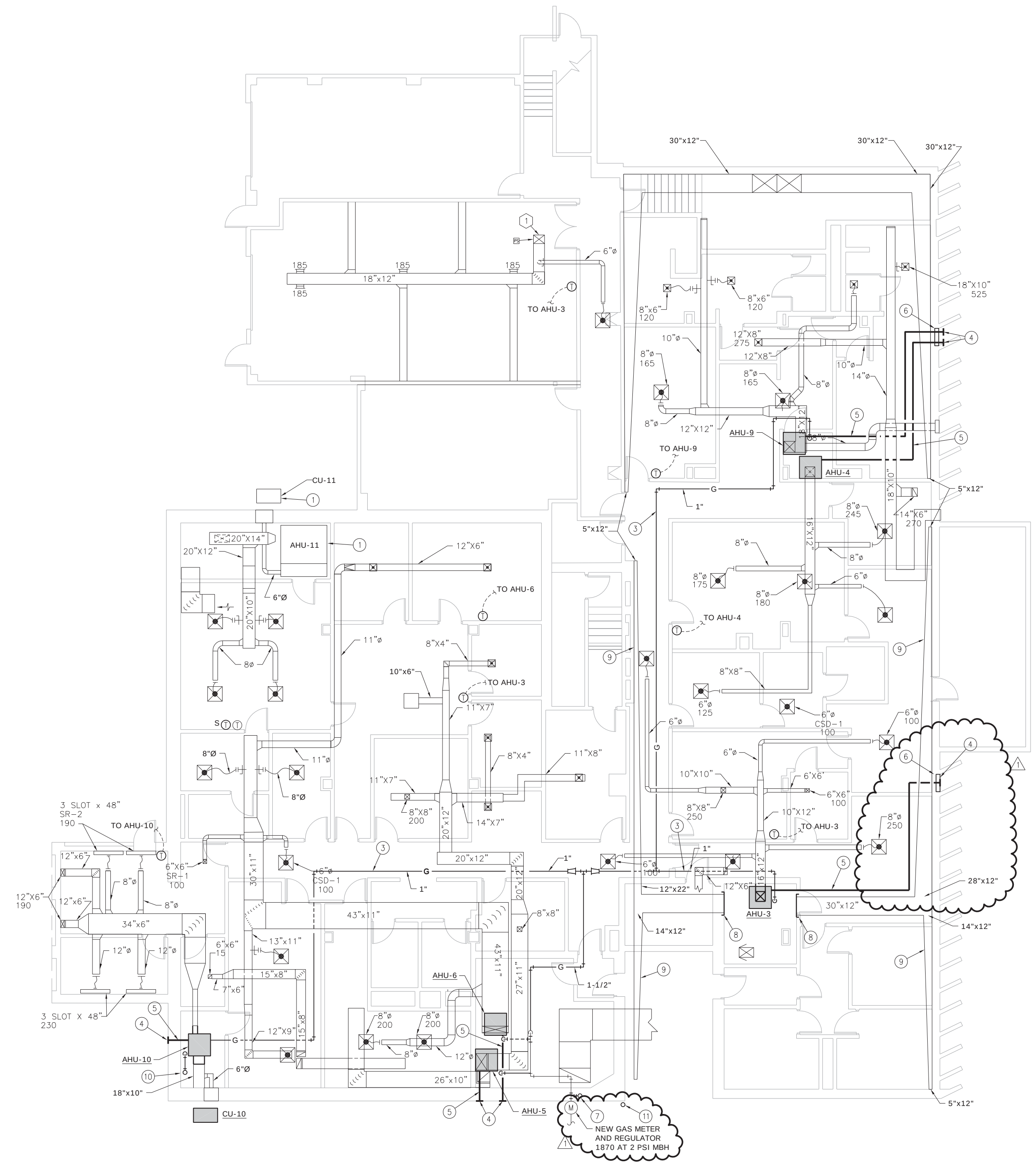
smith&boucher ENGINEERS
25501 west valley parkway, suite 200 olathe, ks 66061
p.913.345.2127 / 888.299.7540 f.913.345.0617
project number 1721000

ROOF PLAN
HVAC

M100

PLAN NOTES:

1. EXISTING AHU AND CU TO REMAIN.
2. PROVIDE AND INSTALL NEW AIR HANDLING UNIT (FURNACE). RECONNECT EXISTING SUPPLY, RETURN AND OUTSIDE AIR DUCTS. PROVIDE TRANSITION DUCTWORK AS NECESSARY FOR NEW UNITS. RECONNECT EXISTING POWER. EXTEND NEW GAS LINE TO UNIT.
3. ROUTE NEW GAS LINE ABOVE CEILING TO EACH NEW AIR HANDLING UNIT. REMOVE AND REPLACE CEILING TILE AS NEEDED TO FACILITATE INSTALLATION. INSTALL NEW PIPE HANGERS FOR THE PIPING AND COORDINATE THE ROUTING IN THE PLENUM AS NEEDED.
4. PROVIDE AND INSTALL A CONCENTRIC FLUE AND INTAKE TERMINATION AT THE EXTERIOR WALL FOR EACH UNIT. SEAL EXTERIOR WALL TO ENSURE WEATHERTIGHT INSTALLATION.
5. INSTALL CPVC FLUE/INTAKE IN PLENUM AND EXTEND TO AHU.
6. PROVIDE MAPES PANEL IN LOWER WINDOW SECTION TO ALLOW FOR FLUE/INTAEK TERMINATION. FIELD VERIFY SIZE REQUIREMENTS.
7. NEW GAS LINE UP TO ROOF.
8. CAP DUCT AFTER UNIT IS REMOVED.
9. EXISTING DUCT TO BE ABANDONED.
10. TIE CONDENSATE FROM FIRST FLOOR UNITS INTO AHU-10 CONDENSATE.
11. 1-1/2" GAS UP TO ROOF.



GROUND FLOOR PLAN - HVAC
SCALE: 1/8"-1'-0"

Navitas
CONSERVING RESOURCES • RENEWING BUILDINGS

City of Gladstone
HVAC Improvements

City Hall
7010 N. Holmes Street
Gladstone, Mo. 64118

PROJECT NO.	1721000
DATE	06-30-2017
DRAWN BY	S&B
CHECKED BY	XXX
CHECKED BY	XXX
REVISED DATE	DESCRIPTION
1 ADD #3	07/18/17

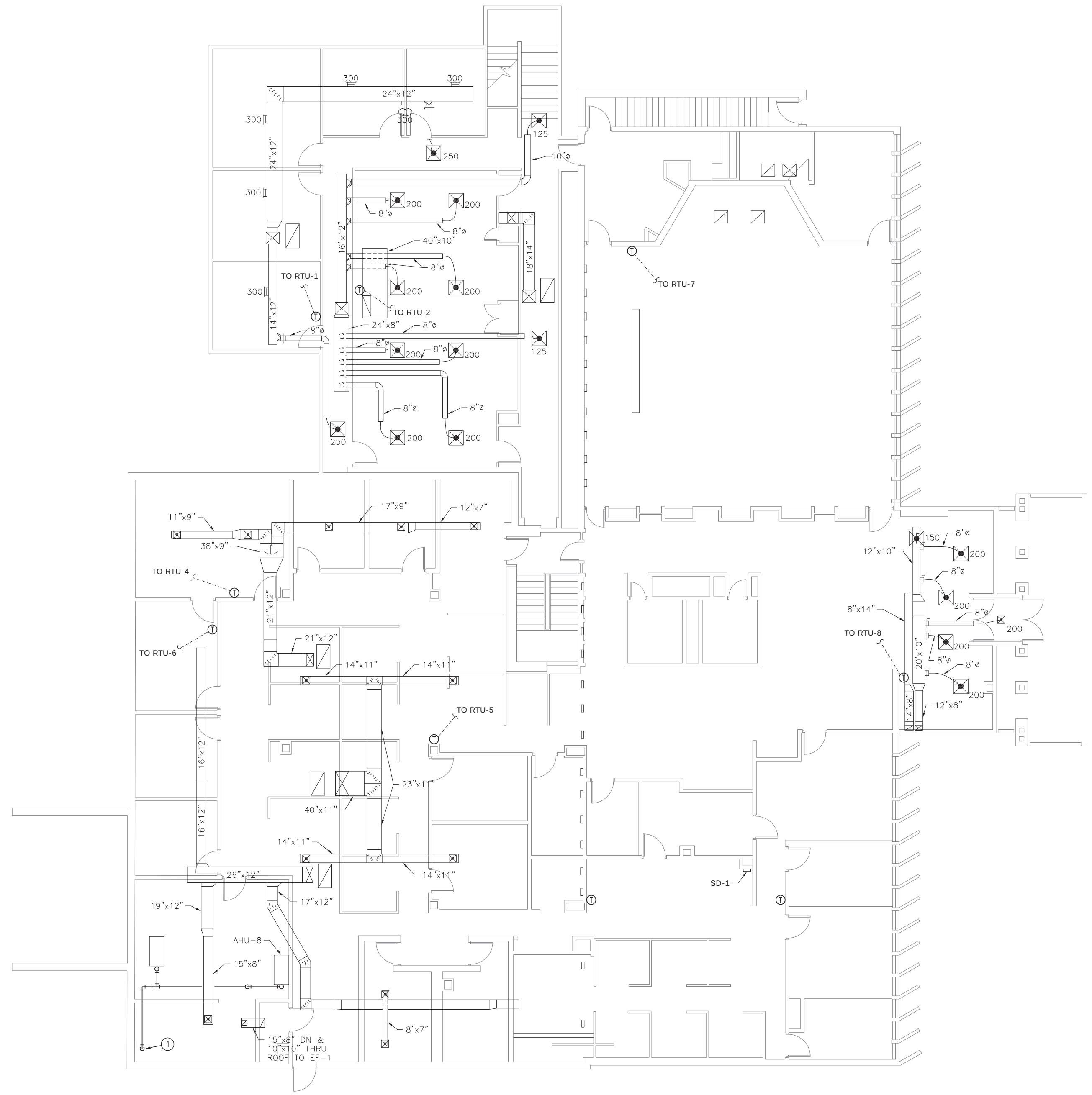
smith&boucher ENGINEERS
25501 west valley parkway, suite 200 olathe, ks 66061
p.913.345.2127 / 888.299.7540 f.913.345.0617
project number 1721000

GROUND FLOOR PLAN
HVAC

M101

PLAN NOTES:

1. EXTEND CONDENSATE FROM THE TWO MINI-SPLIT UNITS AND ROUTE DOWN TO GROUND FLOOR MECHANICAL ROOM. COORDINATE DROP LOCATION WITH OWNER.



FIRST FLOOR PLAN - HVAC

SCALE: 1/8"=1'-0"

Navitas
CONSERVING RESOURCES • RENEWING BUILDINGS

City of Gladstone
HVAC Improvements

City Hall
7010 N. Holmes Street
Gladstone, Mo. 64118

PROJECT NO.	1721000
DATE	06-30-2017
DRAWN BY	S&B
CHECKED BY	CKA
CHECKED BY	XXX
REVISED DATE	DESCRIPTION
.	.
.	.
.	.
.	.
.	.

smith&boucher
ENGINEERS
25501 west valley parkway, suite 200 olathe, ks 66061
p.913.345.2127 / 888.299.7540 f.913.345.0617
project number 1721000

FIRST FLOOR PLAN
HVAC

M102

City of Gladstone
HVAC Improvements

Community Center

6901 N. Holmes Street

Gladstone, Mo. 64118

PROJECT NAME: Navitas - COMMUNITY CENTER
AUTOCAD FILE LOCATION \ NAME: X:\17\17210\1721000\Drawings\Community_Center\01-1721000_CS.dwg
LAST CORRECTION BY ◆ DATE ◆ TIME: CBooty Thursday, June 29, 2017 9:11:34 AM
PLOTTED BY ◆ DATE ◆ TIME: Charles Booty Friday, June 30, 2017 2:45:53 PM

CITY OF GLADSTONE
HVAC Improvements

COMMUNITY CENTER
6901 N. Holmes Street
Gladstone, Mo. 64118

PROJECT NO.	1721000
DATE	06-28-2017
DRAWN BY	S&B
CHECKED BY	
CHECKED BY	
REVISED DATE	DESCRIPTION
.	.
.	.
.	.
.	.
.	.

smith&boucher ENGINEERS
25501 west valley parkway, suite 200 olathe, ks 66061
p.913.345.2127 / 888.299.7540 f.913.345.0617
project number 1721000

COVER SHEET

CS

CONDUIT AND WIRE

- ARROWS INDICATE CONDUIT AND WIRE HOME RUN(S) TO PANEL WITH 2-#12 AWG CONDUCTORS UNLESS NOTED OR OTHERWISE REQUIRED.
- CONDUIT RUN CONCEALED IN WALL OR ABOVE CEILING.
- CONDUIT RUN UNDERGROUND OR CONCEALED IN FLOOR SLAB.
- —T— TELEPHONE CONDUIT
- —LV— LOW VOLTAGE CONDUIT AND WIRING

LIGHTING

- BATTERY OPERATED EMERGENCY LIGHT (WALL MOUNTED)
- BATTERY OPERATED EMERGENCY LIGHT (CEILING MOUNTED)
- SURFACE/RECESSED LIGHT FIXTURE
- FLUORESCENT LIGHT FIXTURE
- FLUORESCENT STRIP FIXTURE
- SHADING DENOTES EMERGENCY FIXTURE
- POLE MOUNTED LIGHT FIXTURE
- EXIT LIGHT - DOUBLE FACE - ARROWS AS SHOWN
- EXIT LIGHT - SINGLE FACE - ARROWS AS SHOWN
- LIGHTING SWITCHES-SINGLE POLE, 3-WAY, 4-WAY, KEY, LOW VOLTAGE, PILOT LIGHT
- DIMMER WITH SINGLE POLE SWITCH
- DIMMER WITH THREE WAY SWITCH (WATTAGE NOTED)
- WALL MOUNTED MOTION SENSOR
- CEILING MOUNTED MOTION SENSOR (LETTER DENOTES TYPE)
- SWITCH AND DUPLEX RECEPTACLE
- DENOTES A WALL MOUNTED FIXTURE

WIRING DEVICES

- DUPLEX RECEPTACLE.
- LINE THRU DEVICE INDICATES ABOVE COUNTER
- DUPLEX RECEPTACLE WITH ISOLATED GROUND (SINGLE AND FOURPLEX SIMILAR)
- DUPLEX RECEPTACLE - TOP HALF SWITCHED - BOTTOM HALF TO HAVE POWER AT ALL TIMES
- DUPLEX RECEPTACLE ON EMERGENCY POWER (SINGLE AND FOURPLEX SIMILAR)
- FOURPLEX RECEPTACLE
- SINGLE RECEPTACLE
- CEILING MOUNTED RECEPTACLE
- MULTI-SERVICE FLOOR BOX
- DIVIDED POWER POLE
- FLOOR BOX W/DUPLEX RECEPTACLE
- SPECIAL RECEPTACLE W/NEMA CONFIGURATION AS NOTED
- CLOCK RECEPTACLE
- MULTI-OUTLET ASSEMBLY

COMMUNICATIONS

- TELEPHONE OUTLET
- LINE THRU DEVICE INDICATES ABOVE COUNTER
- DATA OUTLET
- TELEPHONE/DATA OUTLET
- FLOOR BOX WITH COMMUNICATIONS OUTLET
- TELEVISION ANTENNA OUTLET
- TELEPHONE CABINET OR PLYWOOD BOARD

SECURITY

- CLOSED CIRCUIT TV CAMERA
- CARD READER
- DOOR LOCK
- SECURITY MONITOR
- WATCH TOUR
- ELECTRIC DOOR LOCK
- MOTION SENSOR - SECURITY
- MOTION SENSOR (WALL MOUNTED) - SECURITY

PUBLIC ADDRESS

- MICROPHONE OUTLET
- SPEAKER. ('H' DENOTES HORN TYPE)
- SPEAKER VOLUME CONTROL
- SPEAKER CONDUIT AND WIRING
- PUBLIC ADDRESS AMPLIFIER AND CABINET
- BUZZER
- BELL
- INTERCOM OUTLET
- INTERCOM OUTLET - MASTER
- CLOCK SYSTEM RECEPTACLE WITH SINGLE FACE ('D' DENOTES DOUBLE FACE)

POWER DEVICE AND CONTROLS

- THERMOSTAT
- DISCONNECT SWITCH. 30A-3P, NON-FUSED EXCEPT AS NOTED
- MANUAL MOTOR STARTER
- MAGNETIC MOTOR STARTER
- COMBINATION MOTOR STARTER AND DISCONNECT SWITCH
- MOTOR
- PANELBOARD (SEE ONE-LINE)
- DISTRIBUTION PANELBOARD
- CONTACTOR
- AUTOMATIC TRANSFER SWITCH
- PHOTOCELL
- JUNCTION BOX
- PUSHBUTTON
- TRANSFORMER

FIRE ALARM

- MANUAL PULL STATION
- PHOTOELECTRIC DETECTOR ('D' DENOTES IN DUCT) ('B' DENOTES BEAM-TYPE) ('R' DENOTES IN RETURN AIR PLENUM)
- IONIZATION DETECTOR ('D' DENOTES IN DUCT) ('P' DENOTES PLENUM-TYPE)
- INFRARED DETECTOR ('D' DENOTES IN DUCT)
- THERMODETECTOR ('D' DENOTES IN DUCT) FIXED TEMPERATURE AS NOTED
- DOOR HOLDER
- CHIME
- BELL
- FIRE ALARM STROBE LIGHT
- FIRE ALARM SPEAKER - ARROWS DENOTE PROJECTORS IF ANY. ('L' DENOTES COMBINATION SPEAKER AND VISUAL FIRE LIGHT)
- FIRE HORN. ('L' DENOTES COMBINATION HORN AND VISUAL FIRE LIGHT)
- REMOTE ALARM LAMP
- POST INDICATOR SWITCH
- FLOW SWITCH
- GATE SWITCH
- FIREMAN'S PHONE JACK

FIRE PROTECTION

- —FP— FIRE PROTECTION PIPING
- FHC FIRE HOSE CABINET
- FDV FIRE DEPARTMENT VALVE
- UPRIGHT SPRINKLER HEAD
- PENDENT SPRINKLER
- RECESSED SPRINKLER
- RECESSED SPRINKLER WITH CLOSURE PLATE
- SIDEWALL SPRINKLER.
- DOUBLE CHECK DETECTOR BACKFLOW PREVENTER
- FIRE PROTECTION SIAMESE CONNECTION
- FIRE PROTECTION SIDEWALK SIAMESE CONNECTION
- POST INDICATOR VALVE

MEDICAL GAS

- —VAC— MEDICAL VACUUM
- —OX— OXYGEN
- —NO— NITROUS OXIDE
- —MA— MEDICAL COMPRESSED AIR
- —N— NITROGEN
- OXYGEN OUTLET
- VACUUM OUTLET
- MEDICAL AIR OUTLET
- NITROUS OXIDE OUTLET
- NITROGEN OUTLET

HVAC

- —CWS— CHILLED WATER SUPPLY
- —CWR— CHILLED WATER RETURN
- —CHWS— CHILLED/HOT WATER SUPPLY
- —CHWR— CHILLED/HOT WATER RETURN
- —HWS— HEATING HOT WATER SUPPLY
- —HWR— HEATING HOT WATER RETURN
- —CTS— COOLING TOWER SUPPLY
- —CTR— COOLING TOWER RETURN
- —STM— LOW PRESSURE STEAM
- —RTN— LOW PRESSURE CONDENSATE RETURN
- —STM-50— HIGH PRESSURE STEAM - NO'S GIVE GAUGE PRESSURE IN P.S.I.
- —RTN-50— HIGH PRESSURE RETURN - NO'S GIVE GAUGE PRESSURE IN P.S.I.
- —RD— REFRIGERANT DISCHARGE
- —RL— REFRIGERANT LIQUID
- —RS— REFRIGERANT SUCTION
- —FOS— FUEL OIL SUPPLY
- —FOR— FUEL OIL RETURN
- —A— COMPRESSED AIR
- —D— DRAIN (CONDENSATE)
- THERMOSTAT - ('S' DENOTES SENSOR)
- HUMIDISTAT - ('S' DENOTES SENSOR)
- THERMOSTAT/HUMIDITY SENSOR
- CO2 CARBON DIOXIDE SENSOR
- THC THERMOSTAT/HUMIDITY SENSOR/CO2 SENSOR
- HUMIDIFIER
- SUPPLY AIR FLOW INDICATOR
- RETURN AND EXHAUST AIR FLOW INDICATOR
- SUPPLY DIFFUSER
- SUPPLY STRIP DIFFUSER
- RETURN GRILLE OR EXHAUST REGISTER

HOSPITAL

- —N— NURSE CALL CONDUIT AND WIRING
- —M— MONITOR CONDUIT AND WIRING
- NMS NURSE CALL MASTER STATION
- NURSE CALL BEDSIDE STATION - SINGLE PATIENT
- NURSE CALL BEDSIDE STATION - DOUBLE PATIENT
- EMERGENCY PUSHBUTTON STATION ('P' DENOTES PULL CORD)
- DUTY STATION
- STAFF STATION
- DOME LIGHT - CEILING MOUNTED ('B' DENOTES WITH BUZZER)
- DOME LIGHT - WALL MOUNTED ('B' DENOTES WITH BUZZER)
- ZONE DOME LIGHT
- CODE BLUE PUSHBUTTON

PLUMBING

- DOMESTIC COLD WATER
- DOMESTIC HOT WATER
- RECIRCULATING DOMESTIC HOT WATER
- —TW— DOMESTIC TEMPERED WATER
- SOFT DOMESTIC COLD WATER
- SOFT DOMESTIC HOT WATER
- SOFT RECIRCULATING HOT WATER
- —SAN— SOIL OR WASTE ABOVE GRADE OR FLOOR
- —SAN— SOIL OR WASTE BELOW GRADE OR FLOOR
- —ST— STORM ABOVE GRADE OR FLOOR
- —ST— STORM BELOW GRADE OR FLOOR
- —ST/O— STORM OVERFLOW ABOVE GRADE OR FLOOR
- —ST/O— STORM OVERFLOW BELOW GRADE OR FLOOR
- —V— PLUMBING VENT
- —G— GAS (NATURAL)
- —LP— LIQUIFIED PETROLEUM
- —PD— PUMP DISCHARGE
- HB HOSE BIBB
- WH WALL HYDRANT
- WCO WALL CLEAN OUT
- CO CLEAN OUT
- FCO FLOOR CLEAN OUT
- FLOOR DRAIN, AREA DRAIN, FLOOR SINK
- RD / ORD ROOF DRAIN, OVERFLOW ROOF DRAIN
- SHOWER HEAD.
- REDUCED PRESSURE BACKFLOW PREVENTER
- PLUMBING VENT RISER CALL-OUT NUMBER

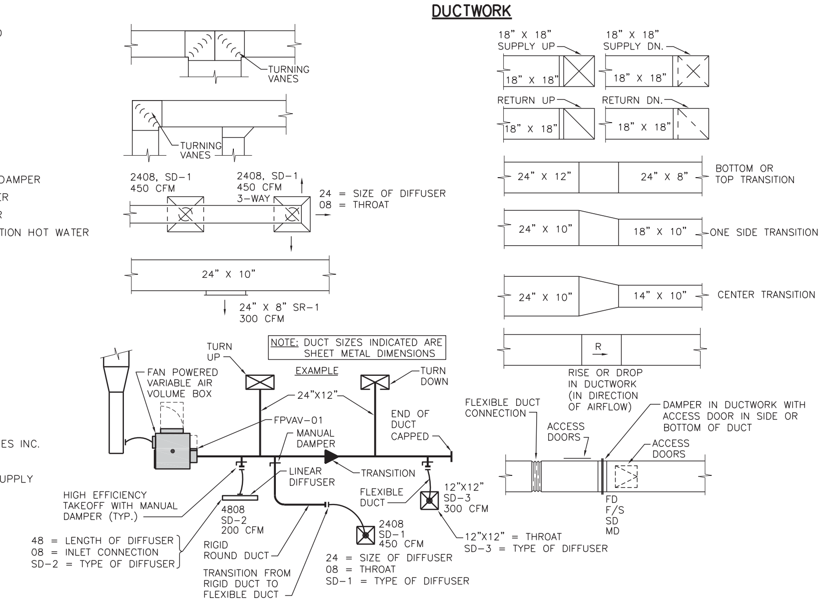
GENERAL

- MECHANICAL NOTE REFERENCE
- ELECTRICAL NOTE REFERENCE
- DEMOLITION NOTE REFERENCE
- REVISION NOTE REFERENCE
- CONNECT TO EXISTING WORK
- DETAIL REFERENCE - NO./SHEET NO.
- SECTION CUT - SECTION/SHEET NO.

PIPING

- ELBOW DOWN
- ELBOW UP
- TEE UP
- TEE DOWN
- CAP
- UNION
- REDUCER (OR INCREASER)
- PIPE FLEX
- STRAINER
- RISE IN PIPING
- DROP IN PIPING
- GUIDE
- ANCHOR
- PRESSURE GAUGE WITH GAUGE COCK
- TEMPERATURE GAUGE
- FLOW INDICATOR
- THERMOMETER.
- SITE GLASS
- EXPANSION JOINT
- FILTER-DRIER
- DRIP ASSEMBLY
- BASKET STRAINER
- SHUTOFF VALVE
- SHUTOFF VALVE IN RISER
- BALANCING VALVE
- CALIBRATED BALANCING VALVE
- RELIEF VALVE
- TEST PLUG
- TRIPLE DUTY VALVE
- CHECK VALVE.
- AUTOMATIC CONTROL VALVE (2-WAY)
- AUTOMATIC CONTROL VALVE (3-WAY)
- AUTO FLOW CONTROL VALVE
- SOLENOID VALVE
- PRESSURE REDUCING VALVE

DUCTWORK



ABBREVIATIONS

A	AMPS, AIR (COMPRESSED)	DX	DIRECT EXPANSION	HTG	HEATING	MUAF	MAKE UP AIR FAN	SD	SUPPLY DIFFUSER, SMOKE DAMPER
A/C	AIR CONDITIONING	EA	EXHAUST AIR	HTR	HEATER	MV	MIXING VALVE	SDCW	SOFT DOMESTIC COLD WATER
AD	AREA DRAIN, ACCESS DOOR	EAT	ENTERING AIR TEMPERATURE	HVU	HEATING AND VENTILATING UNIT	N	NITROGEN	SDHW	SOFT DOMESTIC HOT WATER
AFC	ABOVE FINISH CEILING	EC	ELECTRICAL CONTRACTOR, EMPTY CONDUIT	HW	DOMESTIC HOT WATER	N/A	NOT APPLICABLE	SDRHW	SOFT DOMESTIC RECIRCULATION HOT WATER
AFG	ABOVE FINISH GRADE	EF	EXHAUST FAN	HWR	HOT WATER RETURN	N/C	NORMALLY CLOSED	SF	SQUARE FEET
AHU	AIR HANDLING UNIT	EM	INDICATES EMERGENCY CIRCUIT	HWS	HOT WATER SUPPLY	N/O	NORMALLY OPEN	SP	STATIC PRESSURE
AFF	ABOVE FINISHED FLOOR	EPO	EMERGENCY POWER OFF	IE	INVERT ELEVATION	NF	INDICATES NON-FUSED DEVICE	SR	SUPPLY REGISTER
BD	BACKDRAFT DAMPER, BLOWDOWN	ER	EXHAUST REGISTER	IG	ISOLATED GROUND	NIC	NOT IN CONTRACT	ST	STORM
BFP	BACKFLOW PREVENTER	ETR	EXISTING TO REMAIN	KCMIL	1000 CIRCULAR MILS	NL	NIGHT LIGHT	ST/O	STORM OVERFLOW
BKR	BREAKER	EWB	ENTERING WET BULB	KV	KILOVOLT	NO	NITROUS OXIDE	STM	LOW PRESSURE STEAM
BOD	BOTTOM OF DUCT	EWC	ELECTRIC WATER COOLER	KVA	KILOVOLT AMPS	OA	OUTSIDE AIR	SWBD	SWITCHBOARD
BOP	BOTTOM OF PIPE	EWH	ELECTRIC WATER HEATER, ELEC. WALL HTR.	KW	KILOWATT	ORD	OVERFLOW ROOF DRAIN	TSTAT	THERMOSTAT
BOS	BOTTOM OF STRUCTURE	EXH	EXHAUST	KWH	KILOWATT HOUR	OX	OXYGEN	TU	TERMINAL UNIT
BTU	BRITISH THERMAL UNIT	F/S	COMBINATION FIRE AND SMOKE DAMPER	LAT	LEAVING AIR TEMPERATURE	PD	PUMP DISCHARGE	TW	TEMPERED WATER
C	CONDUIT	FACP	FIRE ALARM CONTROL PANEL	LDB	LEAVING DRY BULB	PH	PHASE	UH	UNIT HEATER
CATV	CABLE TELEVISION SYSTEM	FAACP	FIRE ALARM ANNUNCIATOR CONTROL PANEL	LP	LIQUIFIED PETROLEUM	PIV	POST INDICATOR VALVE	UL	UNDERWRITERS LABORATORIES INC.
CB	CIRCUIT BREAKER	FCO	FLOOR CLEANOUT	LRA	LOCKED ROTOR AMPS	PNL	PANEL	UNO	UNLESS NOTED OTHERWISE
CCTV	CLOSED CIRCUIT TELEVISION	FCU	FAN COIL UNIT	LV	LOW VOLTAGE	PRV	PRESSURE REDUCING VALVE	UPS	UNINTERRUPTIBLE POWER SUPPLY
CFM	CUBIC FEET PER MINUTE	FD	FIRE DAMPER, FLOOR DRAIN	LWB	LEAVING WET BULB	QTY	QUANTITY	V	VENT PIPE
CHWR	CHILLED/HOT WATER RETURN	FLA	FULL LOAD AMPS	LWT	LEAVING WATER TEMPERATURE	RA	RETURN AIR	VAC	MEDICAL VACUUM
CHWS	CHILLED/HOT WATER SUPPLY	FLR	FLOOR	MA	MEDICAL AIR	RD	ROOF DRAIN	VAV	VARIABLE AIR VOLUME
CKT	CIRCUIT	FOR	FUEL OIL RETURN	MAU	MAKE UP AIR UNIT	REV	REVISION	VD	VOLUME DAMPER
CO	CLEANOUT, CARBON MONOXIDE	FOS	FUEL OIL SUPPLY	MBH	1000 BTU PER HOUR	RG	RETURN GRILLE	VTR	VENT THROUGH ROOF
CO2	CARBON DIOXIDE	FP	FIRE PROTECTION	MC	MECHANICAL CONTRACTOR	RH	RELATIVE HUMIDITY	W	WIRE, WATT(S)
CTR	COOLING TOWER RETURN	FPB	FAN POWERED TERMINAL UNIT	MCA	MINIMUM CIRCUIT AMPACITY	RHW	DOMESTIC RECIRCULATION HOT WATER	W/	WITH
CTS	COOLING TOWER SUPPLY	FPVAV	FAN POWERED TERMINAL UNIT	MCC	MOTOR CONTROL CENTER	RL	REFRIGERANT LIQUID	W/O	WITHOUT
CU	COPPER, CONDENSING UNIT	FS	FLOOR SINK	MD	MOTORIZED DAMPER	RLA	RUNNING LOAD AMPS	WB	WET BULB
CUH	CABINET UNIT HEATER	G	GAS (NATURAL), GROUND	MDP	MAIN DISTRIBUTION PANEL	RPM	REVOLUTIONS PER MINUTE	WCO	WALL CLEANOUT
CW	DOMESTIC COLD WATER	GCO	GRADE CLEANOUT	MFR	MANUFACTURER	RS	REFRIGERANT SUCTION	WH	WALL HYDRANT
CWR	CHILLED WATER RETURN	GFI/GFCI	GROUND FAULT CIRCUIT INTERRUPTER	MH	MANHOLE	RTN	LOW PRESSURE CONDENSATE RETURN	WP	WEATHERPROOF
CWS	CHILLED WATER SUPPLY	GND	GROUND	MLO	MAIN LUGS ONLY	RTU	ROOF TOP UNIT	XFMR	TRANSFORMER
DDC	DIRECT DIGITAL CONTROL	GPM	GALLONS PER MINUTE	MTD	MOUNTED	SA	SUPPLY AIR	XP	EXPLOSION PROOF
DD	DECK DRAIN	HB	HOSE BIBB	MU	MAKE UP	SAN	SANITARY		
DN	DOWN	HOA	HAND OFF AUTOMATIC						

MECHANICAL AND ELECTRICAL SYMBOLS AND ABBREVIATIONS

"SOME SYMBOLS AND ABBREVIATIONS ON THIS LEGEND MAY NOT BE USED. REFER TO FLOOR PLANS FOR ALL SYMBOLS AND ABBREVIATIONS."

PROJECT NAME: Navitas - COMMUNITY CENTER
AUTOCAD FILE LOCATION \ NAME: X:\17\17210\1721000\Drawings\Community_Center\01-1721000_ME100.dwg
LAST CORRECTION BY • DATE • TIME: CBooty Thursday, June 29, 2017 9:03:52 AM
PLOTTED BY • DATE • TIME: Charles Booty Friday, June 30, 2017 2:46:05 PM

Navitas
CONSERVING RESOURCES • RENEWING BUILDINGS

CITY OF GLADSTONE
HVAC Improvements

COMMUNITY CENTER
6901 N. Holmes Street
Gladstone, Mo. 64118

PROJECT NO.	1721000
DATE	06-28-2017
DRAWN BY	S&B
CHECKED BY	MJP
CHECKED BY	MJP
REVISED DATE	DESCRIPTION

SYMBOLS AND ABBREVIATIONS MECHANICAL AND ELECTRICAL

smith&boucher ENGINEERS
25501 west valley parkway, suite 200 olathe, ks 66061
p.913.345.2127 / 888.299.7540 f.913.345.0617
project number 1721000

ME100

MECHANICAL PLAN NOTES:

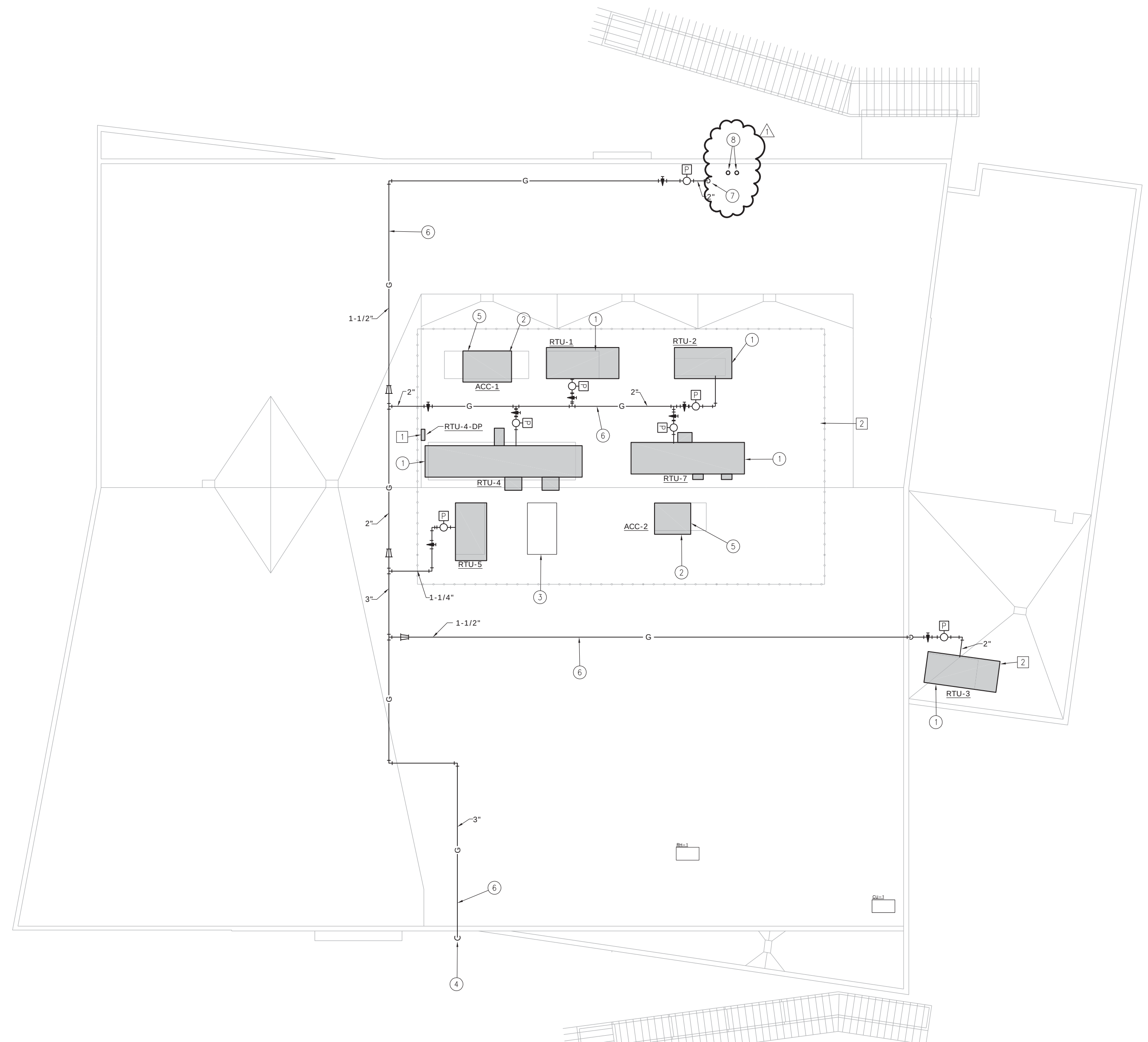
1. DISCONNECT AND REMOVE EXISTING UNIT AND REPLACE WITH NEW AS INDICATED. PROVIDE CURB ADAPTOR FOR NEW UNIT FIELD MEASURE EXACT REQUIREMENTS. CONTRACTOR IS RESPONSIBLE TO EXTEND CONDUIT, CABLE, CONTROL WIRING, FIRE ALARM AND ANY OTHER DEVICES NECESSARY DUE TO AN INCREASE IN HEIGHT OR WIDTH OF NEW UNIT, CURB ADAPTER OR LOCATION OF CONNECTIONS ON NEW UNIT. CONTRACTOR IS RESPONSIBLE FOR ANY NEW DUCT WORK TRANSITIONS FOR SUPPLY AND RETURN DUCT DISTRIBUTION.
2. DISCONNECT AND REMOVE EXISTING POOL CONDENSER AND REPLACE WITH NEW AS INDICATED. MODIFY SUPPORT RAILS AS NEEDED.
3. DISCONNECT AND REMOVE EXISTING RTU-6. PROVIDE R-20 INSULATED, WEATHER TIGHT CURB CAP ON EXISTING CURB.
4. 3" GAS DOWN TO METER LOCATION.
5. CONTRACTOR TO PATCH AND REPAIR ROOFING WHERE RAILS ARE REMOVED OR MODIFIED AND ACC-1 AND ACC-2.
6. NEW GAS LINE ROUTED ON ROOF. INSTALL ON B-LINE DURA, BLOK PIPE SUPPORTS.
7. 2" GAS DOWN TO WATER HEATERS.
8. WATER HEATER FLUE AND COMBUSTION AIR TERMINATION.

1

ELECTRICAL PLAN NOTES:

1. PROVIDE DISTRIBUTION PANEL MOUNTED ADJACENT TO RTU. REFER TO POOL UNIT SCHEDULE FOR ADDITIONAL INFORMATION.
2. ALL EXISTING RECEPTACLES TO REMAIN IN PLACE AND FUNCTIONAL.

1



PROJECT NAME: Navitas - COMMUNITY CENTER
AUTOCAD FILE LOCATION \ NAME: X:\17\17210\1721000\Drawings\Community_Center\01-1721000_ME200.dwg
LAST CORRECTION BY ◆ DATE ◆ TIME: Atryon Monday, July 17, 2017 4:28:11 PM
PLOTTED BY ◆ DATE ◆ TIME: Prasanta Patro Tuesday, July 18, 2017 9:30:56 AM

8 0 8 16 24 40 feet
scale: 1/16" = 1'-0"

CONSERVING RESOURCES • RENEWING BUILDINGS

CITY OF GLADSTONE
HVAC Improvements

COMMUNITY CENTER
6901 N. Holmes Street
Gladstone, Mo. 64118

PROJECT NO.	1721000
DATE	06-28-2017
DRAWN BY	S&B
CHECKED BY	MJP
CHECKED BY	MJP
REVISED DATE	DESCRIPTION
1 ADD #3	07/18/17
.	.
.	.
.	.
.	.

smith&boucher
ENGINEERS
25501 west valley parkway, suite 200 olathe, ks 66061
p.913.345.2127 / 888.299.7540 f.913.345.0617
project number 1721000

ROOF PLAN
MECHANICAL AND ELECTRICAL

ME200

ROOF PLAN - MECHANCIAL AND ELECTRICAL
SCALE: 1/16"=1'-0"

HVAC PUMP SCHEDULE

DESIGNATION		BCP-1
UNIT DATA	MANUFACTURER	BELL & GOSSETT
	LOCATION	MECH ROOM
	MODEL NO.	E-90 2AAC
	SERVICE	HOT WATER
	PUMP TYPE	INLINE
	GPM	76
	PUMP HEAD (FT.)	20
	EFFICIENCY (%)	75.2
	BRAKE HORSEPOWER	0.54
	MOTOR HORSEPOWER	3/4
	MOTOR RPM	1750
ELEC./CONTROL DATA	VOLTAGE/PHASE	120/1
	PANEL & CIRCUIT	LP
	WIRE & CONDUIT	(2)#12,#12G,1/2"C.
	OVERCURRENT DEVICE	30A-1P CB
	DISCONNECT	—
	STARTER	—
	COMBINATION STARTER	VFD
	CONTROL	RE: DWGS
REFERENCE DRAWING/DETAIL		P204
REMARKS		2

NOTES:
1: SELECTION INCLUDES A 25% PROPYLENE GLYCOL SOLUTION
2: PROVIDE PUMP WITH SHAFT GROUNDING KITS.

AIR COOLED CONDENSING UNIT SCHEDULE

DESIGNATION		ACC-1	ACC-2
MANUFACTURER		POOLPAK	POOLPAK
MODEL NO.		MAC1353	MAC0842
WEIGHT (LBS)		4100	3370
SYSTEM		RTU-4 (COMP. POOL)	RTU-7 (REC POOL)
UNIT DATA	MBH (NOTE 1)	1208	798
	AMBIENT AIR TEMP. (°F)	105	105
	NO. FANS	6	4
ELECT. DATA	FLA	27	18
	VOLTAGE/PHASE	480/3	480/3
	PANEL & CIRCUIT	EXISTING	PDP (EXISTING)
	WIRE & CONDUIT	EXISTING	NOTE 4
	OVERCURRENT DEVICE	EXISTING	25A-3P CB (NOTE 3)
	DISCONNECT	INTEGRAL	INTEGRAL
REFERENCE DRAWING/DETAIL		ME200	ME200
REMARKS		2	2

NOTES:
1: CAPACITY WHEN MATCHED WITH SCHEDULED POOL UNIT.
2: REMOVE EXISTING AND PROVIDE NEW EQUIPMENT RAILS FOR UNIT SUPPORT.
3; REPLACE EXISTING CB WITH NEW SIZE NOTED.
4: PROVIDE (3)#10, #10G., IN EXISTING CONDUIT.

DOMESTIC WATER HEATER - GAS

DESIGNATION		GWH-1	GWH-2
UNIT DATA	MANUFACTURER	AO SMITH	AO SMITH
	MODEL	BTH-500	BTH-500
	SERVICE	HOT WATER	HOT WATER
	CAPACITY (GALLONS)	119	119
	RECOVERY @ 80°F RISE (GPH)	720	720
	EFFICIENCY (%)	95	95
	OUTLET TEMP. (°F)	120	120
	TOTAL INPUT (MBH)	500	500
	GAS PRESSURE (IN. W.C)	5 - 14	5 - 14
	WEIGHT (LBS)	855	855
ELEC./CONTROL	VOLTS/PHASE	120/1	120/1
	AMPS	5	5
	PANEL & CIRCUIT	LA2	LA2
	WIRE & CONDUIT	(2)#12,#12G, 1/2"C.	(2)#12,#12G, 1/2"C.
	OVERCURRENT DEVICE	20A-1P CB	20A-1P CB
	DISCONNECT	TOGGLE SWITCH	TOGGLE SWITCH
REFERENCE DRAWING/DETAIL		-	-
REMARKS		1, 2, 3	1, 2, 3

NOTES:
1: FURNISH WITH ALL ACCESSORIES REQUIRED FOR EMERGENCY REMOTE SHUTDOWN.
2: FURNISH AND INSTALL CONDENSATE NEUTRALIZATION KIT.
3: PROVIDE POLYPROPYLENE COMBUSTION AIR AND FLUE VENTING TO ROOF PER MANUFACTURER'S INSTRUCTIONS.

HOT WATER BOILER

DESIGNATION		B-1
LOCATION		MECH RM
WEIGHT (LBS)		1,400
UNIT DATA	MANUFACTURER	LAARS
	MODEL	MGH 1600
	TYPE	CONDENSING
	WATER FLOW (GPM)	76
	WATER PRESSURE DROP (FT)	10
	OPERATING PRESSURE (PSI)	30
BURNER	TYPE OF FUEL	NATURAL GAS
	TYPE OF BURNER	STAINLESS STEEL
	INPUT (MBH)	1600
	OUTPUT (MBH)	1600
	TURNDOWN	5:1
	AHRI EFFICIENCY	96
	MAXIMUM INLET PRESSURE (IN.W.C.)	11
	MINIMUM INLET PRESSURE (IN.W.C.)	4
	GAS TRAIN	FM COMPLIANT
ELEC./CNTRL DATA	VOLTS/PHASE	120/1
	FLA	17
	PANEL & CIRCUIT	LP
	WIRE & CONDUIT	(2)#12,#12G,1/2"C
	OVERCURRENT DEVICE	20A-1P CB
	DISCONNECT	INTEGRAL
	CONTROL	NOTE 1
REFERENCE DRAWING/DETAIL		M101
REMARKS		1, 2, 3

NOTES:
1: PROVIDE WITH INTEGRAL BOILER CONTROL AND BACNET INTERFACE PER CONTROL CONTRACTOR.
2: FURNISH WITH ALL ACCESSORIES REQUIRED FOR EMERGENCY REMOTE SHUTDOWN.
3: FURNISH AND INSTALL CONDENSATE NEUTRALIZATION KIT.

POOL UNIT SCHEDULE

DESIGNATION		RTU-4	RTU-7
MANUFACTURER		POOLPAK	POOLPAK
MODEL NUMBER		MPK0080SEP	MPK0050S[illegible]P
SERVICE		COMP POOL	REC POOL
WEIGHT AHU PORTION (LBS)		23,000	15,0[illegible]
LOCATION		ROOF	ROOF
SUPPLY FAN DATA	AIRFLOW (CFM)	40,000	[illegible],000
	OUTSIDE AIRFLOW (CFM)	7,000	3,500
	EXTERNAL STATIC PRESSURE (IN. W.G.)	1.5	1
	MOTOR BRAKE HORSEPOWER (HP)	46	18
	NO. OF FANS	4	3
	MOTOR HORSEPOWER (HP)	4 @ 15	3 @ 7.5
COOLING COIL	SPACE (DB/WB)	82/67	85/70
	AMBIENT (DB/WB)	96/80	96/80
	TOTAL COOLING CAPACITY (MBH.)	989.0	643.0
	SENSIBLE COOLING CAPACITY (MBH)	526.0	333.0
	MOISTURE REMOVAL CAPACITY (LBS./HR.)	446	299
REHEAT	REHEAT CAPACITY (MBH)	1208	798
AUX. GAS HEAT	ENT. AIR (DB)	75	75
	LVG. AIR (DB)	100	100
	HEATING INPUT (MBH)	15[illegible]2	700
	HEATING OUPUT (MBH)	[illegible]50	560
	STAGES	MODULATING	MODULATING
POOL HX 1	FLOW (GPM)	80	80
	PRESSURE DROP (FT)	32.0	30.0
	TOTAL HEAT (MBH)	800	785
POOL HX 2	FLOW (GPM)	40	-
	PRESSURE DROP (FT)	32.0	-
	TOTAL HEAT (MBH)	400	-
EXH. FAN	AIRFLOW (CFM)	14,000	7,000
	EXTERNAL STATIC PRESSURE (IN. W.G.)	1	0.5
	MOTOR BRAKE HORSEPOWER (HP)	11.9	3.2
	NO. OF FANS	1	1
	MOTOR HORSEPOWER (HP)	1 @ 15	1 @ 7.5
PURGE FAN	AIRFLOW (CFM)	28,000	14,000
	EXTERNAL STATIC PRESSURE (IN. W.G.)	1	1
	MOTOR BRAKE HORSEPOWER (HP)	27.1	10.8
	NO. OF FANS	2	2
	MOTOR HORSEPOWER (HP)	2 @ 20	2 @ 7.5
FILTER	TYPE/EFFICIENCY	MERV 8	MERV 8
	MAX VELOCITY (FPM)	500	500
ELEC./CONTROL DATA	VOLTAGE/PHASE	480/3	480/3
	MCA (MAIN UNIT)	148 / 185	162
	MOP (MAIN UNIT)	175 / 225	200
	PANEL & CIRCUIT	EXISTING	EXISTING
	WIRE & CONDUIT	NOTE 10	EXISTING
	OVERCURRENT DEVICE	NOTE 9	200A - 3P
	DISCONNECT	INTEGRAL	INTEGRAL
	CONTROL	RE: DWGS	RE: DWGS
REFERENCE DRAWING/DETAIL		ME200	ME200
REMARKS		1, 3, 4, 6, 7, 8, 9	1, 2, 4, 5, 7, 8

NOTES:
1: SIZING BASED ON 8[illegible]°F INDOOR TEMPERATURE AND 80°F POOL TEMPERATURE.
2: SIZING BASED ON [illegible]5°F INDOOR TEMPERATURE AND 85°F POOL TEMPERATURE.
3: WIRE EXISTING SMOKE DETECTOR TO SHUT UNIT OFF.
4: PROVIDE WITH MANUFACTURER CONTROLS AND BACNET COMMUNICATION CARD FOR BMS INTEGRATION.
5: UNIT TO INCLUDE HEAT EXHCHANGER FOR WASTE HEAT TO HEAT POOL.
6: UNIT TO INCLUDE TWO HEAT EXHCHANGERS FOR WASTE HEAT TO HEAT POOLS.
7: UNIT TO INCLUDE OUTSIDE AIR ECONOMIZER CONTROL BASED UPON SPACE HUMIDITY.
8: NEW EQUIPMENT NEARLY MATCHES EXISTING FOOTPRINT. REUSE EXISTING CURB AND PROVIDE CURB ADAPTOR AS REQUIRED, FIELD MEASURE.
9: UTILIZE EXISTING BRANCH CIRCUIT AND REUSE AS FEEDER TO SERVE RTU-4 DISTRIBUTION PANEL. PROVIDE 800A, [illegible]0/3, MLO, IN NEMA 3R ENCLOUSURE DISTRIBUTION PANEL MOUNTED ADJACENT TO RTU-4. PROVIDE (1)17[illegible]-3P CB AND (1)225A-3P CB WITH DISTRIBUTION PANEL.
10: FROM DISTRIBUTION PANEL PROVIDE (3)#2/0, #6G., 1-1/2"C. FOR 175A PORTION OF RTU, AND (3)#4/0, #4G., 2"C. FOR 225A PORTION OF RTU.

HEAT EXCHANGER SCHEDULE

DESIGNATION		HX-6
LOCATION		MECH ROOM
UNIT	MANUFACTURER	TRIANGLE TUBE
	MODEL NO.	MF-400
	SERVICE	LEISURE POOL
	LENGTH (IN)	42
	DIAMETER (IN)	6
POOL WATER	CAPACITY (MBH)	340
	FLOW (GPM)	50
	PRESSURE DROP (FT./W.C.)	8
	EWT (°F)	82
	LWT (°F)	89
HOT WATER	CAPACITY (MBH)	340
	FLOW (GPM)	13
	PRESSURE DROP (FT./W.C.)	6
	EWT (°F)	180
	LWT (°F)	130
REFERENCE DRAWINGS/DETAIL		M102
REMARKS		1

NOTE 1: MATCH EXISTING HEAT EXCHANGER PIPE CONFIGURATION..

DOAS RTU SCHEDULE - GAS HEAT

DESIGNATION		RTU-5
UNIT DATA	MANUFACTURER	AAON
	MODEL NO.	RN-050-3
	SERVICE	POOL OA
	WEIGHT (LBS.)	6,000
	LOCATION	ROOF
SUPPLY FAN	SUPPLY AIRFLOW (CFM)	8,000
	OUTSIDE AIRFLOW @99/78 (CFM)	8,000
	CO2 MINIMUM OUTSIDE AIRFLOW (CFM)	2,000
	EXTERNAL S.P. (IN. W.C.)	0.8
	FAN BRAKE HORSE POWER	2 @ 1.44
	FAN MOTOR HORSEPOWER	2 @ 3.0
DX COOLING	AMBIENT AIR TEMPERATURE (DB)	96
	TOTAL COOLING CAPACITY (MBH)	596.0
	SENSIBLE COOLING CAPACITY (MBH)	336.0
	ENT. AIR (DB/WB)	96/77
	LVG. AIR (DB/WB)	53.3/53.3
	MINIMUM EER @ ARI	11.0
	REFRIGERANT TYPE	R410A
	NO. OF COMPRESSORS	4
	STAGES	4 + MODULATING
REHEAT	CAPACITY (MBH)	139
	ENT. AIR (DB)	53
	LVG. AIR (DB)	70
GAS HEATING	AIRFLOW (CFM)	8,000
	ENT. AIR (DB)	0
	LVG. AIR (DB)	90
	HEATING INPUT (MBH)	810
	HEATING OUTPUT (MBH)	648
	STAGES/MODULATION	10:1
FILTER	TYPE	DISPOSABLE
	RATING	MERV 7
	MAX VELOCITY (FPM)	500
ELEC./CONTROL DATA	VOLTAGE/ PHASE	480/3
	MCA	102
	MOP	110
	PANEL & CIRCUIT	EXISTING
	WIRE & CONDUIT	EXISTING
	OVERCURRENT DEVICE	110A-3P (NOTE 8)
	DISCONNECT(S)	INTEGRAL
	COMBINATION STARTER	VFD
	RECEPTACLE	NOTE 2
	CONTROL SEQUENCE	RE: DWGS
REFERENCE DRAWING/DETAIL		ME200
REMARKS		1, 2, 3, 4, 5, 6,7,8,9

NOTES:
1: PROVIDE SINGLE POINT WIRING
2: FURNISH WITH GFI/WP RECEPTACLE, FED FROM CONDUCTORS IN ADVANCE OF INTEGRAL UNIT DISCONNECT.
3: PROVIDE WITH MODULATING GAS BURNER
4: PROVIDE WITH CURB ADAPTOR FOR MOUNTING ON EXISTING CURB.
5: PROVIDE UNIT WITH HOTGAS REHEAT.
6: FURNISH UNIT WITH TERMINAL STRIP FOR BMS CONTROL.
7: FURNISH WITH CO2 SENSOR FOR CONTROL OF OA.
8: REPLACE EXISTING CB WITH NEW SIZE NOTED.
9: WIRE EXISTING SMOKE DETECTOR TO SHUT UNIT DOWN.

SPLIT SYSTEM A/C UNIT SCHEDULE

INDOOR UNIT		
DESIGNATION		AC-1
	MANUFACTURER	LG
	MODEL	LSN120HSV4
	SERVICE	DATA
	CFM	350
	TOTAL COOLING CAP (MBH)	11.2
	TOTAL HEATING CAP @17°F (MBH)	-
	WEIGHT (LBS)	25
ELEC. DATA	VOLTAGE/PHASE	24V DC
	PANEL AND CIRCUIT	SEE ACCU-1
	WIRE AND CONDUIT	(2)#12, #12G., 1/2" C.
	OVERCURRENT DEVICE	SEE ACCU-1
	DISCONNECT	INTEGRAL
	CONTROLS	THERMOSTAT
REMARKS		1, 2, 3, 5
OUTDOOR UNIT		
DESIGNATION		ACCU-1
	MANUFACTURER	LG
	MODEL NO.	LSU120HSV4
	TOTAL COOLING CAP (MBH)	11.2
	TOTAL HEATING CAP (MBH)	-
	SEER	21.5
	AMBIENT AIR TEMP (°F.)	95 / 47
	WEIGHT (LBS)	100.0
ELEC DATA	VOLTAGE/PHASE	208/1
	MCA	10
	MOP	15
	PANEL AND CIRCUIT	LP
	WIRE AND CONDUIT	(2)#12,#12G.,1/2"C.
	OVERCURRENT DEVICE	15A-2P
	DISCONNECT	INTEGRAL
VIBRATION ISOLATION		NOTE 4
REMARKS		1, 2, 3

NOTES:
1: INSULATE ALL REFRIGERANT LINES
2: PROVIDE LOW AMBIENT OPERATION DOWN TO 0°F
3: PROVIDE SUPPORT RAIL TO ELEVATE UNIT 12" ABOVE GRADE.
4: PROVIDE CONTROL WIRING PER MANUFACTURERS RECOMMENDATIONS.
5: PROVIDE DRAIN PAN BELOW INDOOR UNIT WITH CONDENSATE OVERFLOW SENSOR WIRED TO SHUT DOWN UNIT.

DEDICATED OUTSIDE AIR ROOF TOP UNIT SCHEDULE

DESIGNATION			RTU-1	RTU-2	RTU-3
UNIT		MANUFACTURER	AAON	AAON	AAON
		MODEL NO.	RN-070-3	RN-016-3	RN-040-3
		UNIT WEIGHT (LBS)	8,000	3,500	7,000
ENERGY WHEEL	UNIT DATA	MODEL	ERC-5245 (2)	ERC-5245	ERC-5245 (2)
		OUTSIDE AIRFLOW (CFM)	7,980	3,900	3,700
		EXHAUST AIR FLOW (CFM)	7,980	3,900	15,500
		WHEEL POWER (HP)	2 @ 1/6	1/6	2 @ 1/6
	SUMMER	EXHAUST AIR EAT (DB/WB)	75/62	75/62	75/62
		SUPPLY AIR EAT (DB/WB)	96/77	96/77	96/77
		SUPPLY AIR LAT (DB/WB)	81/67.5	80.9/67.5	75.5/65.7
		EXHAUST AIR LAT (DB/WB)	90/72.5	90.1/72.6	92.4/74.1
	WINTER	EXHAUST AIR EAT (DB/WB)	75/53	75/53	75/53
		SUPPLY AIR EAT (DB/WB)	0	0	0
		SUPPLY AIR LAT (DB/WB)	53.6/40.8	50.4/38.8	62.2/45.8
		EXHAUST AIR LAT (DB/WB)	21.3/19.5	21/91.2	12.7/12
FAN DATA	SUPPLY FAN	AIRFLOW (CFM)	22,000	3,900	14,725
		EXTERNAL S.P. (IN. W.C.)	1.1	0.5	1.6
		FAN RPM	1,661	1,264	1,562
		BRAKE HORSEPOWER	2 @ 11.76	2.03	2 @ 5.6
		MOTOR HORSEPOWER	2 @ 15	5	2 @ 7.5
	EXH. FAN	AIRFLOW (CFM)	22,000	3,900	14,725
		EXTERNAL S.P. (IN. W.C.)	0.5	0.5	1.4
		FAN RPM	1480	1195	1025
		BRAKE HORSEPOWER	2 @ 7.92	1.47	2 @ 2.73
		MOTOR HORSEPOWER	2 @ 10	2	2 @ 3
DX COOLING		AMBIENT AIR TEMPERATURE (DB)	96	96	96
		ENT. AIR (DB/WB)	77/64	80.9/67.5	75.8/62.9
		LVG. AIR (DB/WB) INCLUDING FAN HEAT	52/52	51.8/51.3	53.3/52.5
		TOTAL COOLING CAPACITY (MBH)	751	178.8	424
		SENSIBLE COOLING CAPACITY (MBH)	572	115	340
		FINS PER INCH/ MIN. ROWS	14/4	14/4	14/4
		MINIMUM AHRI E.E.R.	10.1	11.8	10
		NO. OF COMPRESSORS	4	2	4
		STAGES OF COOLING	NOTE 8	NOTE 8	NOTE 8
REHEAT		TOTAL CAP. (MBH)	-	74	-
		EAT (°Fdb)	-	55	-
		LAT (°Fdb)	-	70	-
AUX. GAS HEAT		HEATING AIRFLOW (CFM)	16,800	3,900	7,000
		ENT. AIR (DB)	35	50	35
		LVG. AIR (DB)	55	100	55
		HEATING INPUT (MBH)	540	270	540
		HEATING OUTPUT (MBH)	432	218	432
		MODULATION RATIO	10:1	10:1	10:1
FILTER	SUPPLY	TYPE	2"PLEATED	2"PLEATED	2"PLEATED
		RATING	MERV 7	MERV 7	MERV 7
		MAX FACE VELOCITY (FPM)	500	500	500
	EXHAUST	TYPE	2"PLEATED	2"PLEATED	2"PLEATED
		RATING	MERV 7	MERV 7	MERV 7
		MAX FACE VELOCITY (FPM)	500	500	500
ELECTRICAL/CONTROL DATA		VOLTAGE / PHASE	480/3	480/3	480/3
		MCA	199	44	113
		MOCP	225	50	125
		PANEL & CIRCUIT	EXISTING	EXISTING	EXISTING
		WIRE & CONDUIT	EXISTING	EXISTING	EXISTING
		OVERCURRENT DEVICE	EXISTING	50A-3P (NOTE 9)	EXISTING
		DISCONNECT	INTEGRAL	INTEGRAL	INTEGRAL
		STARTER	--	--	--
		COMBINATION STARTER	VFD	VFD	VFD
		CONTROL SEQUENCE	RE: DWGS	RE: DWGS	RE: DWGS
REFERENCE DRAWING/DETAIL			ME200	ME200	ME200
REMARKS			1, 2, 3, 4, 5, 7, 8,10	1, 2, 3, 4, 5, 6, 7, 8,10	1, 2, 3, 4, 5, 7, 8,10

NOTES:
1: FURNISH UNIT FACTORY WIRED WITH SINGLE POINT ELECTRICAL CONNECTION.
2: FURNISH UNIT WITH CONVENIENCE RECEPTACLE TO REMAIN ACTIVE WHEN DISCONNECT IS OFF.
3: FURNISH UNIT WITH MODULATING GAS BURNER
4: FURNISH SUPPLY AND EXHAUST FAN WITH VFDS FOR SOFT START.
5: FURNISH UNIT WITH CURB ADAPTOR FOR MOUNTING ON EXISTING CURB.
6: FURNISH UNIT WITH MODULATING HOT GAS REHEAT.
7: PROVIDE WITH TERMINAL STRIP FOR CONTROL BY BMS.
8: FURNISH UNIT WITH VARIABLE SPEED COMPRESSOR.
9: REPLACE EXISTING CB WITH NEW SIZE NOTED.
10 WIRE EXISTING SMOKE DETECTOR TO SHUT UNIT DOWN.

Navitas
CONSERVING RESOURCES • RENEWING BUILDINGS

CITY OF GLADSTONE
HVAC Improvements

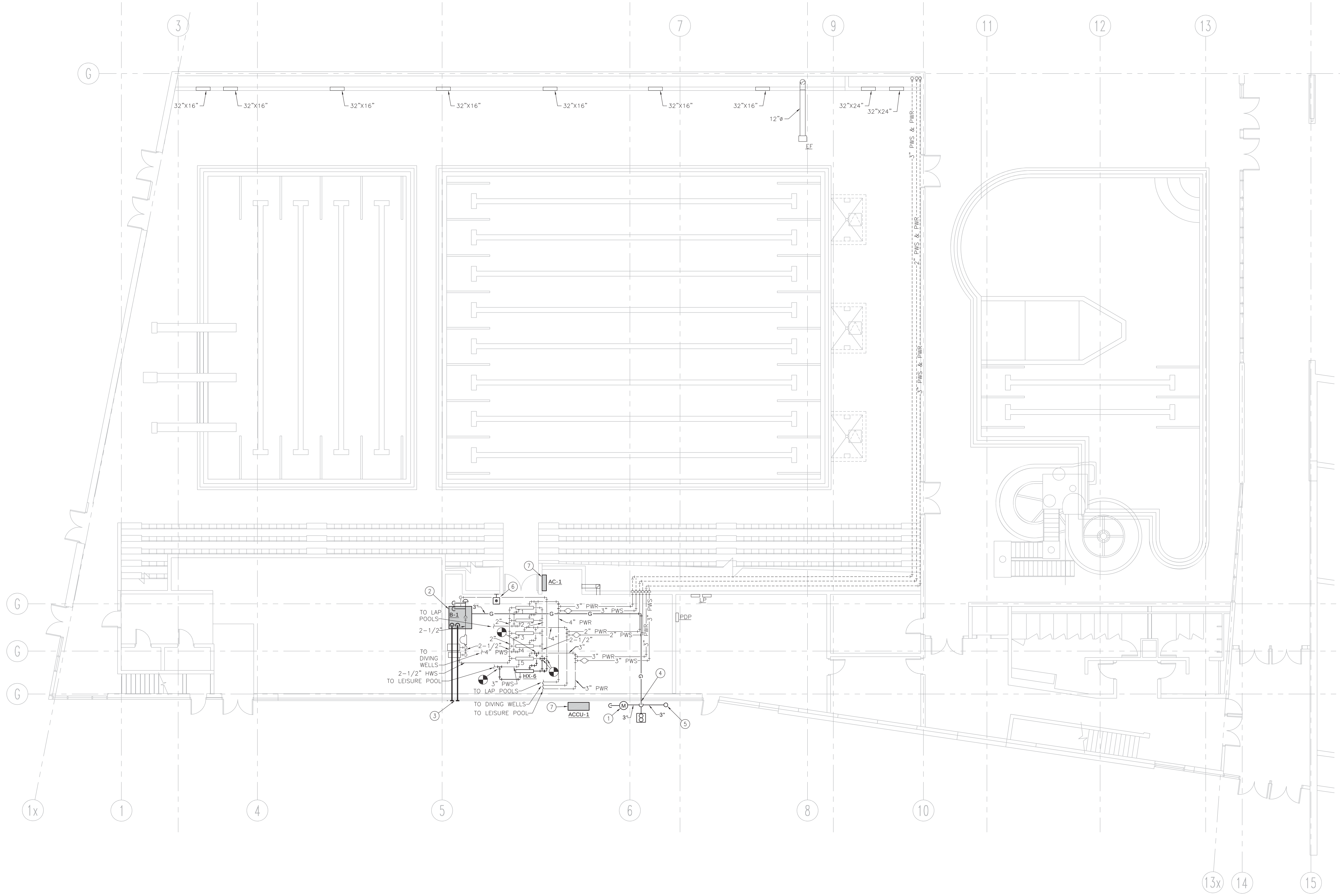
COMMUNITY CENTER
6901 N. Holmes Street
Gladstone, Mo. 64118

PROJECT NO.	1721000
DATE	06-28-2017
DRAWN BY	S&B
CHECKED BY	MJP
CHECKED BY	MJP
REVISED DATE	DESCRIPTION
.	.
.	.
.	.
.	.
.	.

smith&boucher
ENGINEERS
25501 west valley parkway, suite 200 olathe, ks 66061
p.913.345.2127 / 888.299.7540 f.913.345.0617
project number 1721000

SCHEDULES AND DETAILS - MECHANICAL AND ELECTRICAL

ME300



scale: 1/8" = 1'-0" feet

PLAN NOTES

1. NEW GAS METER LOCATION 6570 MBH AT 2 PSI.
2. DISCONNECT AND REMOVE EXISTING ELECTRICAL BOILER AND ASSOCIATED ELECTRICAL WIRING. PROVIDE NEW BOILER IN EXISTING LOCATION. REMOVE ELECTRICAL CIRCUIT BACK TO PANEL BOARD.
3. ROUTE BOILER FLUE AND COMBUSTION AIR DUCT FOR SIDE WALL TERMINATION.
4. EXTEND 3" GAS TO BOILER. PROVIDE 2 PSI TO 11" WC REGULATOR ON EXTERIOR
5. 3" GAS UP TO ROOF.
6. PROVIDE EMERGENCY BOILER SHUT DOWN SWITCH WIRED TO SHUT BOILER DOWN IN ACCORDANCE WITH STATE CODE.
7. INSTALL NEW MINISPLIT. EXTEND REFRIGERANT LINES BETWEEN LIMITS. TERMINATE CONDENSATE DRAIN OVER FLOOR DRAIN IN MECHANICAL ROOM. LOCATE ACCU-1 BEHIND EXISTING SCREEN WALL. INSTALL ACCU-1 ON PLASTIC PREFABRICATED CONDENSING UNIT PAD.

LOWER LEVEL FLOOR PLAN - MECHANICAL

SCALE: 1/8"=1'-0"

PROJECT NAME: Navitas – COMMUNITY CENTER
AUTOCAD FILE LOCATION \ NAME: X:\17\17210\1721000\Drawings\Community_Center\04-1721000_M101.dwg
LAST CORRECTION BY • DATE • TIME: Alyson Monday, July 17, 2017 4:28:07 PM
PLOTTED BY • DATE • TIME: Prasanta Patro Tuesday, July 18, 2017 9:31:22 AM

Navitas
CONSERVING RESOURCES • RENEWING BUILDINGS

CITY OF GLADSTONE
HVAC Improvements

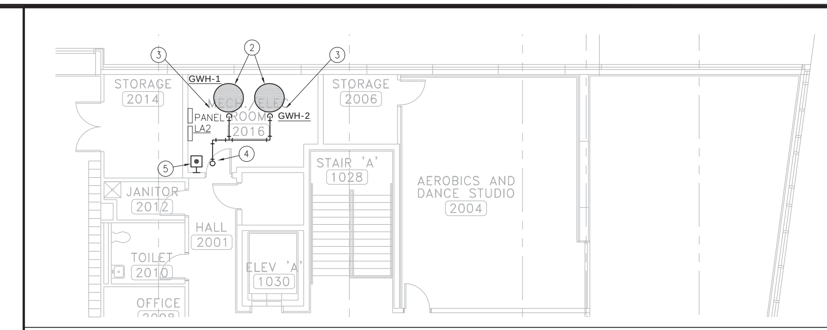
COMMUNITY CENTER
6901 N. Holmes Street
Gladstone, Mo. 64118

PROJECT NO.	1721000
DATE	06-28-2017
DRAWN BY	S&B
CHECKED BY	MJP
CHECKED BY	MJP
REVISED DATE	DESCRIPTION
1 ADD #3	07/18/17

smith&boucher ENGINEERS
25501 west valley parkway, suite 200 olathe, ks 66061
p.913.345.2127 / 888.299.7540 f.913.345.0617
project number 1721000

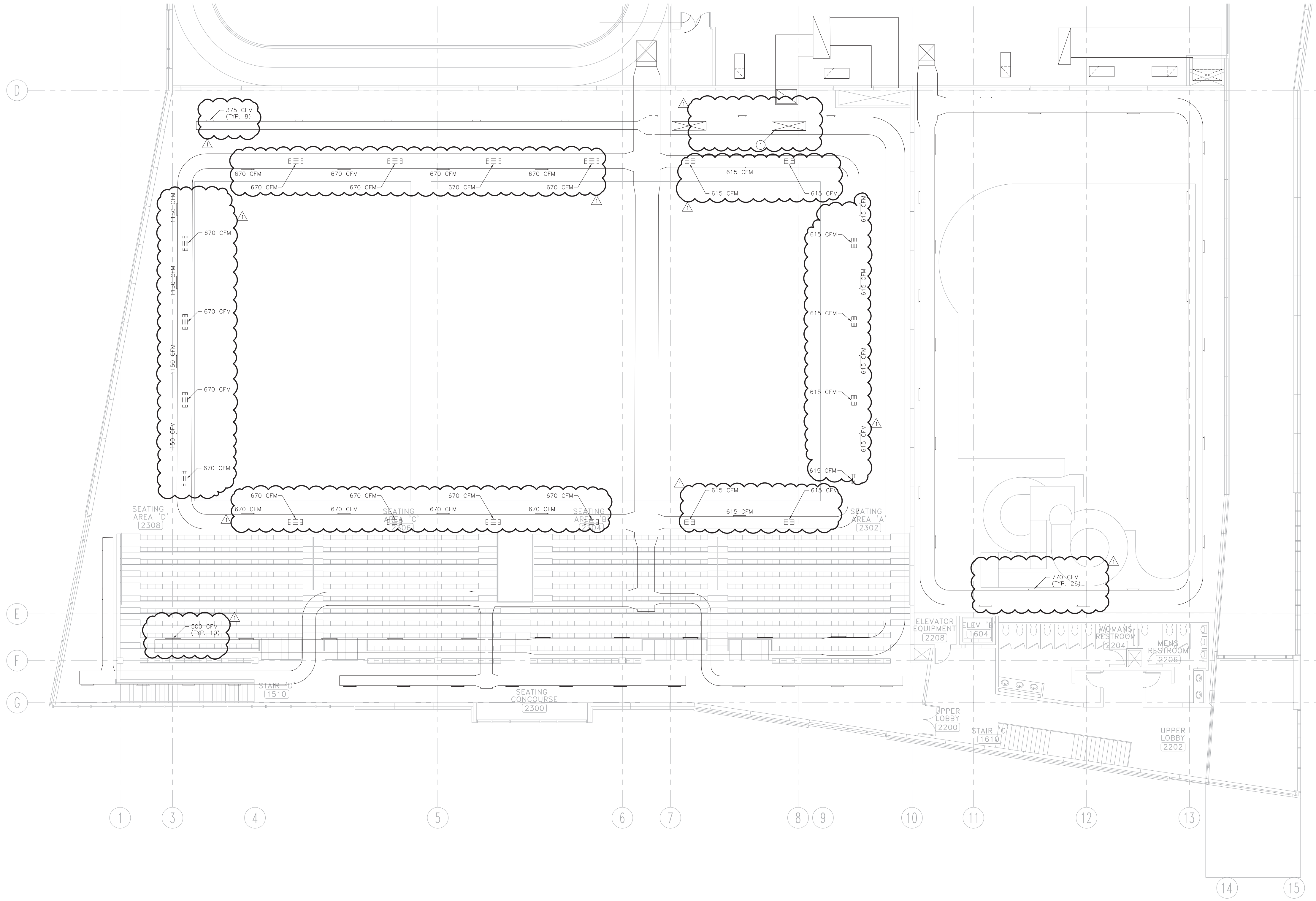
LOWER LEVEL FLOOR PLAN MECHANICAL

M101



UPPER LEVEL FLOOR PLAN - MECHANICAL

SCALE: 1/8"=1'-0"



GENERAL NOTES:

1. REBALANCE GRILLES TO AIR FLOWS SHOWN.

PLAN NOTES:

1. DISCONNECT EXISTING RTU-5 SUPPLY DROP AND MOTORIZED DAMPER. PATCH AND SEAL DUCT.
2. DISCONNECT AND REMOVE EXISTING WATER HEATERS AND ASSOCIATED WIRING. PROVIDE NEW GAS-FIRED WATER HEATER IN EXISTING LOCATIONS.
3. EXTEND WATER HEATER FLUE AND COMBUSTION AIR UP THROUGH ROOF.
4. 2" GAS PIPING UP TO ROOF.
5. PROVIDE EMERGENCY BOILER SHUT DOWN SWITCH WIRED TO SHUT WATER HEATERS DOWN IN ACCORDANCE WITH STATE CODE.

UPPER LEVEL FLOOR PLAN - MECHANICAL

SCALE: 1/8"=1'-0"

Navitas
CONSERVING RESOURCES • RENEWING BUILDINGS

CITY OF GLADSTONE
HVAC Improvements

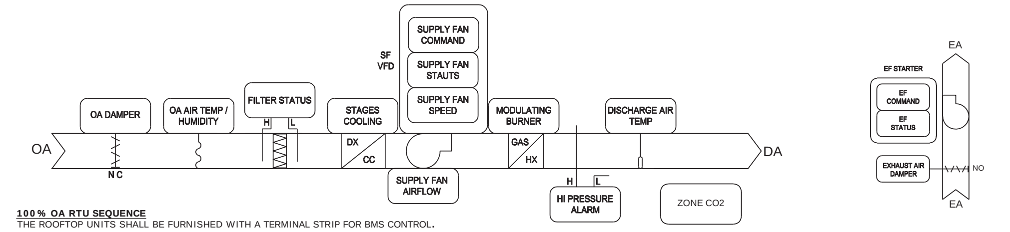
COMMUNITY CENTER
6901 N. Holmes Street
Gladstone, Mo. 64118

PROJECT NO.	1721000
DATE	06-28-2017
DRAWN BY	S&B
CHECKED BY	MJP
CHECKED BY	MJP
REVISED DATE	DESCRIPTION
1 ADD #3	07/18/17

smith&boucher ENGINEERS
25501 west valley parkway, suite 200 olathe, ks 66061
p.913.345.2127 / 888.299.7540 f.913.345.0617
project number 1721000

UPPER LEVEL
FLOOR PLAN
MECHANICAL

M102



100% OA RTU SEQUENCE
THE ROOFTOP UNITS SHALL BE FURNISHED WITH A TERMINAL STRIP FOR BMS CONTROL.

SUPPLY FAN:
THE SUPPLY FAN SHALL BE STARTED ACCORDING TO THE BUILDING OCCUPANCY SCHEDULE. IF THE SUPPLY FAN STATUS DOES NOT MATCH THE COMMANDED VALUE, AN ALARM SHALL BE GENERATED. WHEN THE SUPPLY FAN STATUS INDICATES THE FAN STARTED, THE CONTROL SEQUENCE SHALL BE ENABLED. THE SUPPLY FAN SHALL MODULATE BETWEEN THE MINIMUM AND MAXIMUM AIRFLOW TO MAINTAIN THE CO2 SET POINT, 1000 PPM (ADJ.)

DISCHARGE AIR CONTROL:
THE UNIT DISCHARGE AIR TEMPERATURE SET POINT SHALL BE 2°F (ADJ.) BELOW THE RTU-4 SUPPLY AIR TEMPERATURE.

GAS HEAT EXCHANGER:
THE GAS HEAT EXCHANGER WILL MODULATE TO MAINTAIN THE DISCHARGE TEMPERATURE SET POINT.

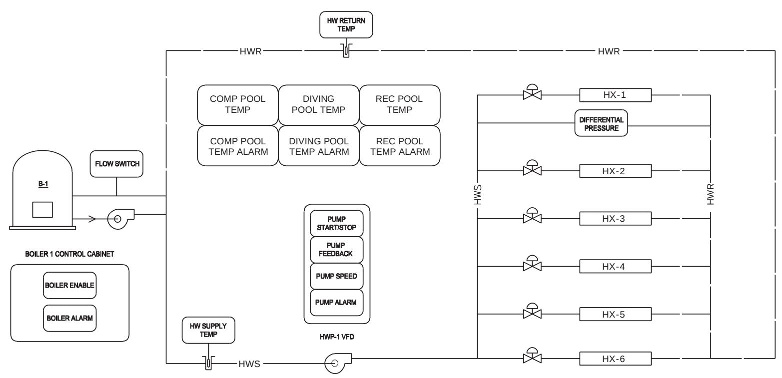
COOLING COIL:
THE DX COOLING COIL SHALL MODULATE TO MAINTAIN THE DISCHARGE TEMPERATURE SET POINT.

EXHAUST FAN CONTROL:
THE EXHAUST FAN SHALL BE BALANCED INITIALLY TO MATCH RTU-5 SUPPLY AIR AT FULL FLOW. WHEN THE RTU-5 SUPPLY FAN SPEED IS ENABLED, THE EXHAUST FAN VFD SHALL TRACK THE SUPPLY FAN SPEED MODULATION.

UNOCCUPIED MODE:
WHEN THE UNIT IS IN UNOCCUPIED MODE ACCORDING TO THE SCHEDULE, THE OUTSIDE AIR DAMPER IS CLOSED AND THE UNIT IS OFF.

FILTER STATUS:
THE DIFFERENTIAL PRESSURE ACROSS THE FILTERS SHALL BE MONITORED AND AN ALARM GENERATED IF THE DIFFERENTIAL PRESSURE RISES ABOVE SET POINT.

100% OA RTU CONTROL DIAGRAM (RTU-5 & EF-1)
NTS



AUXILIARY POOL HEATING

THE EXISTING CONTROL SHALL BE LARGELY MAINTAINED AND SHALL BE MODIFIED AS NEEDED TO WORK WITH THE NEW POOL UNITS.

A NEW BOILER, BOILER CIRCULATION PUMP, HX-6 AND HX-6 CONTROL VALVE ARE NEW COMPONENTS TO BE CONTROLLED.

PROVIDE POOL TEMPERATURE MONITORING AND ALARMING THROUGH THE BMS.

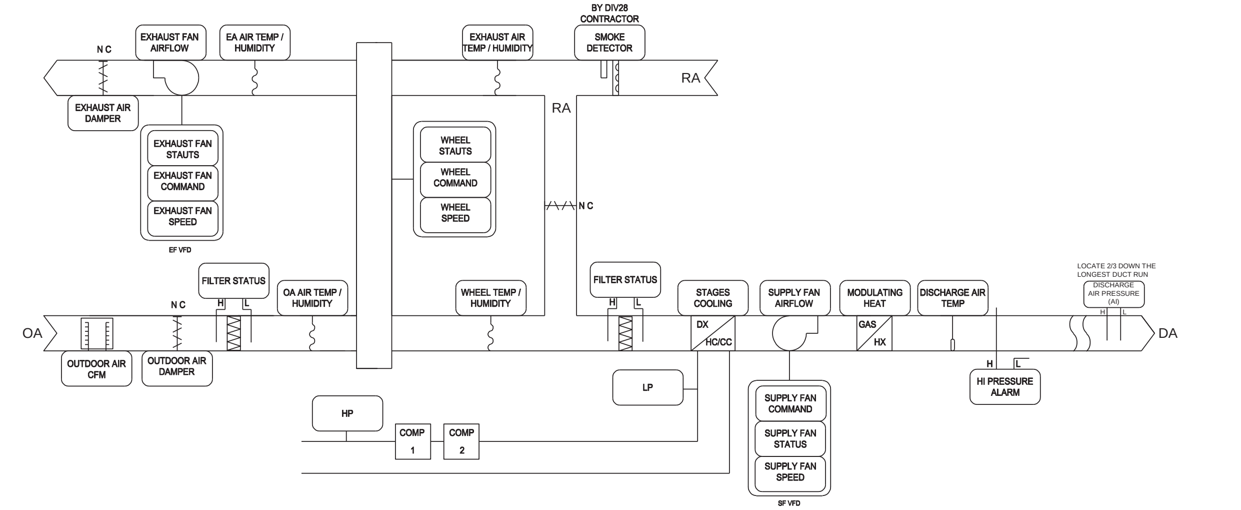
THE BOILER SYSTEM SHALL BE THE 2ND STAGE OF HEATING WITH THE POOL RTU WASTE HEATING AS THE 1ST STAGE OF CONTROL.

WHEN SIGNALED BY ANY OF THE POOL RTU HEATING SYSTEMS, THE ASSOCIATED HX CONTROL VALVE(S) SHALL OPEN (STAGE OR MODULATE TO MATCH EXISTING), THE HOT WATER PUMP SHALL START AND THE BOILER SHALL BE ENABLED.

THE HOT WATER PUMP CONTROL SHALL MATCH THE EXISTING TO VARY THE SPEED BASED UPON SYSTEM DP.

THE BOILER SHALL BE CONTROLLED VIA MANUFACTURER CONTROLS TO MAINTAIN THE HOT WATER SUPPLY SET POINT (ADJ.) SET UP INITIALLY TO MATCH THE EXISTING SET POINT OF 130°F.

POOL HEATING SYSTEM
NO SCALE



VAV AIR ROOFTOP HANDLING UNIT SEQUENCE

THE ROOFTOP UNITS SHALL BE FURNISHED WITH A TERMINAL STRIP FOR CONTROL BY THE BMS.

ENGAGE TAB CONTRACTOR FOR UNIT SETUP MEASUREMENTS AND INITIAL CALIBRATIONS.

OCCUPIED MODE:
THE OCCUPANCY MODE WILL BE CONTROLLED VIA A NETWORK INPUT. THE OCCUPANCY MODE CAN ALSO BE OVERRIDDEN BY A NETWORK INPUT.

SUPPLY FAN:
THE SUPPLY FAN SHALL BE STARTED ACCORDING TO THE BUILDING OCCUPANCY SCHEDULE. IF THE SUPPLY FAN STATUS DOES NOT MATCH THE COMMANDED VALUE, AN ALARM SHALL BE GENERATED. UPON A LOSS OF AIRFLOW, THE SYSTEM WILL AUTOMATICALLY RESTART. WHEN THE SUPPLY FAN STATUS INDICATES THE FAN STARTED, THE CONTROL SEQUENCE SHALL BE ENABLED.

THE SUPPLY FAN SHALL MODULATE TO MAINTAIN THE DISCHARGE STATIC PRESSURE AT SET POINT (ADJ.) ENGAGE THE TAB CONTRACTOR TO MEASURE THE SYSTEM DIFFERENTIAL PRESSURE AT FULL LOAD TO DETERMINE AND SET THE INITIAL DIFFERENTIAL SET POINT.

DISCHARGE AIR CONTROL:
THE UNIT DISCHARGE AIR TEMPERATURE SET POINT SHALL BE 55°F (ADJ.) ON A CALL FOR COOLING, THE DX COOLING SHALL STAGE AND MODULATE AS NEEDED TO MAINTAIN THE DISCHARGE AIR TEMPERATURE AT SET POINT. ON A CALL FOR HEATING, THE ERU WHEEL AND GAS HEAT EXCHANGER SHALL MODULATE TO MAINTAIN DISCHARGE AIR TEMPERATURE AT SET POINT.

GAS HEAT EXCHANGER:
ONCE THE ERU WHEEL IS AT FULL SPEED AND THERE IS STILL A CALL FOR HEATING, THE GAS HEAT EXCHANGER ACTIVATE AND MODULATE TO MAINTAIN THE DISCHARGE TEMPERATURE SET POINT. WHEN THE UNIT IS SHUTDOWN, THE GAS HEAT EXCHANGER WILL BE OFF.

COOLING COIL:
THE DX COOLING COIL WILL BE MODULATED AND STAGED IN SEQUENCE TO MAINTAIN THE DISCHARGE TEMPERATURE SET POINT. THE COOLING COIL WILL BE LOCKED OUT ON A DROP IN OUTDOOR AIR TEMPERATURE BELOW THE LOCKOUT SET POINT.

MINIMUM OUTSIDE AIR CONTROL:
MINIMUM OUTSIDE AIR IS PROVIDED BY THE ASSOCIATED ERU. THE DAMPER SHALL BE OPEN DURING OCCUPIED MODE.

ECONOMIZER MODE:
WHEN THE OUTSIDE AIR ENTHALPY IS LOWER THAN THE RETURN AIR ENTHALPY THE UNIT SHALL BE IN ECONOMIZER MODE. THE ECONOMIZER SHALL ACT AS THE INITIAL STAGE OF COOLING, WORKING IN SEQUENCE WITH THE COOLING COIL TO MAINTAIN THE DISCHARGE AIR TEMPERATURE SET POINT. ONCE ACTIVE COOLING IS NO LONGER NEEDED, MODULATE THE RETURN AIR AND OUTSIDE AIR DAMPERS TO PROVIDE THE SUPPLY AIR DISCHARGE TEMPERATURE SET POINT. WHEN THE OUTSIDE AIR DRY BULB TEMPERATURE FALLS BELOW 40°F (ADJ), ECONOMIZER SHALL BE DISABLED.

BUILDING PRESSURE CONTROL:
THE EXHAUST FAN SHALL RAMP UP TO FULL SPEED WHEN IN ECONOMIZER MODE. THE FAN SPEED SHALL MODULATE IN SEQUENCE WITH THE SUPPLY FAN SPEED SUBJECT TO THE OFFSET. INITIAL SETUP SHALL ESTABLISH THE RELIEF FAN FULL SPEED SETTING THE OFFSET OF THE SUPPLY FAN SPEED SETTING.

WHEEL FAILURE:
IN THE EVENT AN ERU IS DOWN, CLOSE THE MINIMUM OA DAMPER, OPEN THE RA DAMPER, SHUT OFF THE EXHAUST FAN AND GENERATE AN ALARM. THE RTU SHALL OTHERWISE OPERATE ACCORDING TO THE NORMAL SEQUENCE.

UNOCCUPIED MODE:
WHEN THE UNIT IS IN UNOCCUPIED MODE ACCORDING TO THE SCHEDULE, THE OUTSIDE AIR DAMPER IS CLOSED, THE RELIEF AIR DAMPER IS CLOSED, THE RETURN AIR DAMPER IS OPEN, AND THE UNIT IS OFF. UPON A REQUEST FOR COOLING BY A MINIMUM OF FIVE ZONES NEEDING TO MAINTAIN THEIR UNOCCUPIED COOLING TEMPERATURE SET POINT, ACTIVATE THE UNIT SUPPLY FAN, THE OUTSIDE AIR AND RELIEF AIR DAMPERS SHALL REMAIN CLOSED AND THE ENERGY WHEEL REMAINS OFF.

MORNING WARM-UP MODE AND COOL-DOWN MODES:
WHEN THE UNIT TRANSITIONS FROM THE UNOCCUPIED MODE TO OCCUPIED MODE, MORNING WARM-UP OR COOL-DOWN SHALL BE ACTIVATED. WHEN THERE IS A CALL FOR HEATING, A MORNING WARM-UP SEQUENCE SHALL BE INITIATED. DURING MORNING WARM-UP THE FAN SHALL BE TURNED ON, THE OUTSIDE AIR DAMPER SHALL REMAIN CLOSED, THE COOLING SHALL BE DISABLED, THE HEATING SHALL BE ACTIVE, THE ASSOCIATED ERU IS OFF AND THE DISCHARGE AIR TEMPERATURE SET POINT SHALL BE 90 °F (ADJ). DURING MORNING COOL DOWN THE AHU FAN SHALL BE TURNED ON, THE OUTSIDE AIR DAMPER SHALL REMAIN CLOSED, THE HEATING SHALL BE DISABLED, THE COOLING SHALL BE ENABLED, THE ASSOCIATED ERU SHALL BE OFF, AND THE DISCHARGE AIR TEMPERATURE SET POINT SHALL BE 52 °F (ADJ.) WHEN ALL ZONE TERMINALS ARE READY TO SWITCH TO THE OCCUPIED MODE, THE RTU SHALL TRANSITION TO THE OCCUPIED SEQUENCE.

FILTER STATUS:
THE DIFFERENTIAL PRESSURE ACROSS THE FILTERS SHALL BE MONITORED AND AN ALARM GENERATED IF THE DIFFERENTIAL PRESSURE RISES ABOVE SET POINT.

SMOKE DETECTOR ALARM
MONITOR THE SMOKE DETECTOR AND NOTIFY BMS IF IT GOES INTO ALARM.

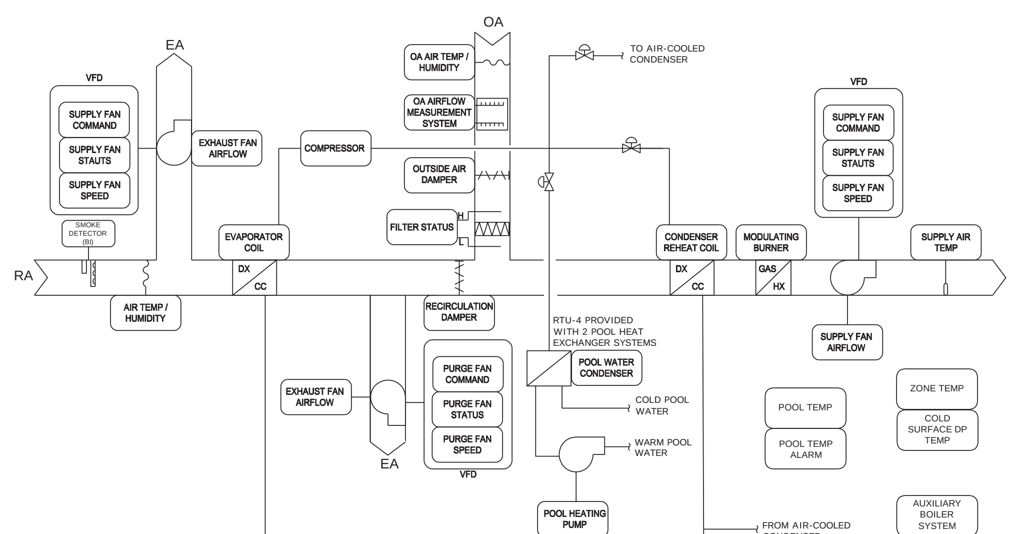
SHUTDOWN:
WHEN THE UNIT IS SHUTDOWN BY EITHER A STOP COMMAND OR SYSTEM SAFETY THE UNIT SHALL BE SET AS FOLLOWS:
- SUPPLY FAN SHALL BE OFF
- OUTSIDE AIR DAMPERS SHALL CLOSED
- RETURN AIR DAMPER SHALL OPEN
- HEATING SHALL BE OFF
- COOLING SHALL BE OFF
- ENERGY WHEEL SHALL BE OFF

SAFETIES:
IF A HIGH STATIC PRESSURE SWITCH LOCATED AFTER THE SUPPLY FAN SENSES A DISCHARGE PRESSURE THAT IS GREATER THAN SET POINT, THE UNIT SHALL BE SHUTDOWN.

GENERATE AN ALARM IN THE EVENT ANY INTERNAL UNIT SAFETY ACTIVATES.

***REFER TO THE RTU SCHEDULE FOR ADDITIONAL INFORMATION AND SCHEDULED VALUES

PACKAGED VAV RTU WITH OUTSIDE AIR ENERGY RECOVERY CONTROL DIAGRAM (RTU-1 & 3)
NTS



POOL UNIT CONTROL

THE POOL UNIT SHALL BE PROVIDED WITH MANUFACTURER CONTROLS WITH A BACNET INTERFACE FOR COMMUNICATION TO THE BMS SYSTEM. BMS SHALL BE ABLE TO MONITOR EQUIPMENT POINTS, SCHEDULE OCCUPIED/UNOCCUPOIED OPERATIONS, AND MODIFY SPACE SET POINTS.

COLD SURFACES:

THE UNIT SHALL BE FURNISHED WITH A COLD SURFACE TEMPERATURE SENSOR TO BE FIELD INSTALLED AND WIRED. UNIT SHALL MONITOR TEMPERATURE AND CONTROL HUMIDITY TO PREVENT CONDENSATION.

ECONOMIZER CONTROL:

WHEN THE OUTSIDE AIR CONDITIONS ARE SUITABLE FOR FREE COOLING, THE ERV BYPASS AIR DAMPER SHALL OPEN TO 100%, THE OUTDOOR AIR DAMPER SHALL OPEN TO 100%, AND THE ERV HEAT WHEEL SHALL STOP. THE COOLING COIL SHALL BE ENABLE AS NECESSARY TO MAINTAIN THE DISCHARGE AIR TEMPERATURE AT THE DISCHARGE AIR TEMPERATURE SET POINT.

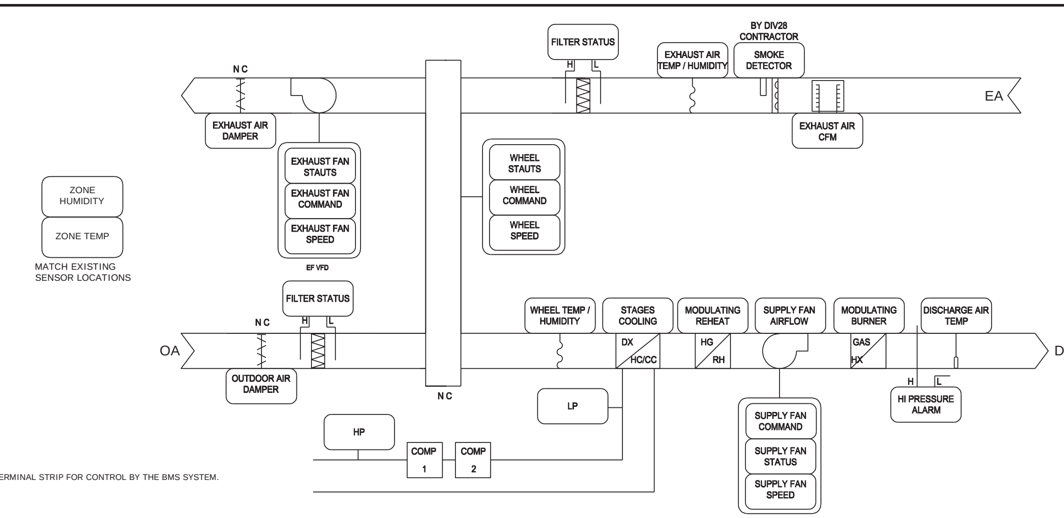
POOL HEATING CONTROL:

THE POOL RTUS SHALL CONTROL THE POOL HEATING SYSTEMS. THE POOL TEMPERATURE SET POINTS SHALL BE INPUT THROUGH THE BMS AND RELAYED TO THE POOL RTUS. POOL RTUS ARE TO MONITOR POOL TEMPERATURES. UPON AN NEED FOR POOL HEATING THE RTU SHALL ACTIVATE THE CIRCULATION PUMP AND REJECT WASTE HEAT TO TO POOL. IN THE EVENT, POOL HEATING IS NOT AVAILABLE FROM THE RTU OR ADDITIONAL HEAT IS NEEDED, SEND A SIGNAL TO ACTIVATE THE AUXILIARY BOILER SYSTEM.

THE POOL AUXILLIARY BOILER SYSTEM SHALL ACTIVATE IN THE EVENT ANY OF THE POOL HEATING ZONES SIGNAL A NEED FOR HEATING.

SMOKE DETECTOR ALARM
NOTIFY BMS AND SHUTDOWN ALL UNITS IN THE EVENT THE SMOKE DETECTOR GOES INTO ALARM.

POOL RTU SCHEMATIC (RTU-4 & 7)
NO SCALE



DEDICATED OUTSIDE AIR ENERGY RECOVERY UNIT CONTROLS

THE DEDICATED OUTSIDE AIR ENERGY RECOVERY UNITS SHALL BE FURNISHED WITH A TERMINAL STRIP FOR CONTROL BY THE BMS SYSTEM.

UNIT SCHEDULING:
A NETWORK UNIT ENABLE SIGNAL WILL CONTROL THE MODE OF THE DOAS

OCCUPIED MODE:
THE OUTSIDE AIR AND EXHAUST AIR DAMPERS WILL OPEN THE RETURN DAMPER SHALL BE CLOSED. THE SUPPLY FAN, EXHAUST FAN, AND ENERGY RECOVERY WHEEL WILL BE STARTED.

TEMPERATURE CONTROL:
DURING COOLING MODE, THE WHEEL WILL OPERATE AND THE THE UNIT WILL MODULATE AND STAGE THE COMPRESSORS TO MAINTAIN A SPACE TEMPERATURE SET POINT OF 75°F (ADJ) DURING HEATING MODE THE ENERGY WHEEL WILL OPERATE AND THE GAS HEAT EXCHANGER SHALL MODULATE TO MAINTAIN THE SPACE HEATING SET POINT 70°F (ADJ).

COOLING COIL:
THE DX COOLING COIL WILL BE STAGED IN SEQUENCE TO MAINTAIN THE TEMPERATURE SET POINT. THE COOLING COIL WILL BE LOCKED OUT ON A DROP IN OUTDOOR AIR TEMPERATURE BELOW THE LOCKOUT SET POINT.

GAS HEAT EXCHANGER:
THE GAS HEAT EXCHANGER WILL MODULATE TO MAINTAIN THE TEMPERATURE SET POINT. WHEN THE UNIT IS SHUTDOWN, THE GAS HEAT EXCHANGER WILL BE OFF.

WHEEL CONTROL:
WHEN THE OA TEMPERATURE IS OUTSIDE OF THE HEATING AND COOLING SET POINT DEADBAND BY 2°F (ADJ) OR MORE, THE WHEEL SHALL BE ON.

DEHUMIDIFICATION:
WHEN THE SPACE HUMIDITY IS ABOVE THE SET POINT OF 50% RH (ADJ.) THE COOLING/DEHUMIDIFICATION MODE IS ENABLED. IN THIS MODE THE REFRIGERANT SOLENOID VALVES INDEX TO DIVERT REFRIGERANT BETWEEN THE DX COOLING COIL AND THE REHEAT COIL TO MAINTAIN THE LEAVING AIR TEMPERATURE SET POINT. THE ELECTRONIC MODULATING REFRIGERANT VALVES WILL INDEX TO RESET THE LEAVING AIR TEMPERATURE TO MAINTAIN THE DISCHARGE AIR TEMPERATURE SET POINT.

FROST CONTROL:
DURING WHEEL OPERATION, IF THE EXHAUST TEMPERATURE ACROSS THE WHEEL FALLS BELOW 20 °F, THE BYPASS DAMPERS WILL MODULATE OPEN TO MAINTAIN 20 °F. IF THE DAMPERS ARE 100% OPEN AND THE TEMPERATURE ACROSS THE WHEEL FALLS BELOW 15 °F THE WHEEL WILL STOP FOR 3 MINUTES OR UNTIL THE TEMPERATURE ACROSS THE WHEEL RISES ABOVE 20 °F.

UNOCCUPIED MORNING WARM-UP/COOL DOWN MODE:
THE OUTSIDE AIR DAMPER IS CLOSED, THE EXHAUST AIR DAMPER IS CLOSED THE RETURN AIR DAMPER IS OPEN, THE SUPPLY FAN, EXHAUST FAN, ENERGY RECOVERY WHEEL, AND COMPRESSORS ARE OFF. IN HEATING MODE, UPON A CALL FOR HEAT BY A BMS SENSOR, THE BMS SHALL ENABLE THE SUPPLY FAN AND GAS HEAT WITH A 110°F SETPOINT UNTIL BMS SENSORS ARE SATISFIED. IN COOL DOWN MODE THE UNIT REMAINS OFF.

SMOKE DETECTOR ALARM
NOTIFY BMS AND SHUTDOWN UNIT IN THE EVENT THE SMOKE DETECTOR GOES INTO ALARM.

PACKAGED DEDICATED OUTSIDE AIR ENERGY RECOVERY UNIT CONTROL DIAGRAM (RTU-2)
NTS

CITY OF GLADSTONE
HVAC Improvements

COMMUNITY CENTER
6901 N. Holmes Street
Gladstone, Mo. 64118

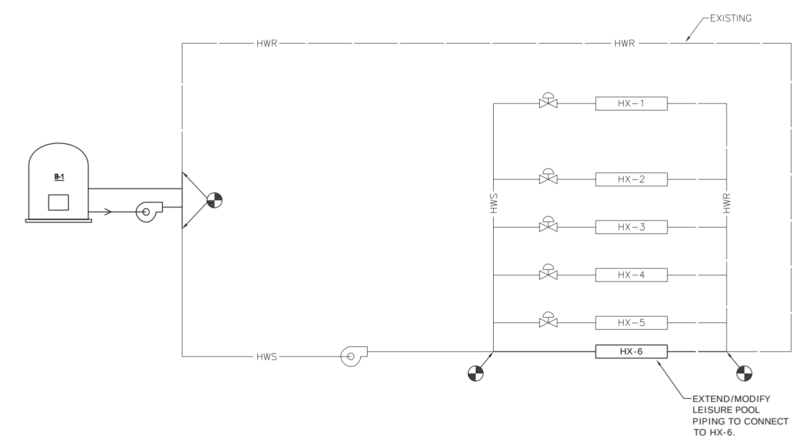
PROJECT NO.	1721000
DATE	06–28–2017
DRAWN BY	S&B
CHECKED BY	MJP
CHECKED BY	MJP
REVISED DATE	DESCRIPTION
.	.
.	.
.	.
.	.
.	.

smith&boucher ENGINEERS
25501 west valley parkway, suite 200 olathe, ks 66061
p.913.345.2127 / 888.299.7540 f.913.345.0617
project number 1721000

CONTROL SCHEMATIC DIAGRAMS- MECHANICAL

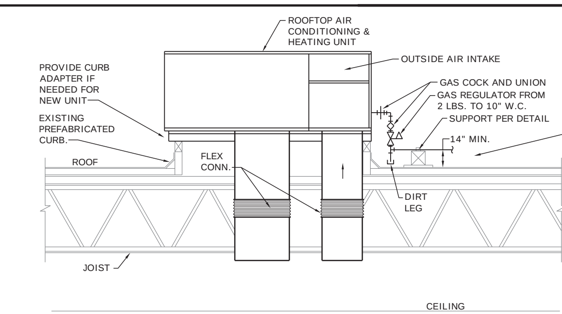
M200

PROJECT NAME: Navitas – COMMUNITY CENTER
AUTOCAD FILE LOCATION \ NAME: X:\17\17210\1721000\Drawings\Community_Center\04-1721000_M200.dwg
LAST CORRECTION BY ◆ DATE ◆ TIME: CBooty Thursday, June 29, 2017 9:09:10 AM
PLOTTED BY ◆ DATE ◆ TIME: Charles Booty Friday, June 30, 2017 2:47:25 PM



AUXILIARY POOL HEATING PIPING DIAGRAM

NO SCALE



ROOFTOP UNIT DETAIL

NOT TO SCALE

CITY OF GLADSTONE
HVAC Improvements

COMMUNITY CENTER
6901 N. Holmes Street
Gladstone, Mo. 64118

PROJECT NO.	1721000
DATE	06-28-2017
DRAWN BY	S&B
CHECKED BY	MJP
CHECKED BY	MJP
REVISED DATE	DESCRIPTION

smith&boucher
ENGINEERS
25501 west valley parkway, suite 200 olathe, ks 66061
p.913.345.2127 / 888.299.7540 f.913.345.0617
project number 1721000

DETAILS - MECHANICAL

M201

PROJECT NAME: Navitas - COMMUNITY CENTER
AUTOCAD FILE LOCATION \ NAME: X:\17\17210\1721000\Drawings\Community_Center\04-1721000_M201.dwg
LAST CORRECTION BY ◆ DATE ◆ TIME: Edrummond Friday, June 30, 2017 10:42:23 AM
PLOTTED BY ◆ DATE ◆ TIME: Charles Booty Friday, June 30, 2017 2:47:37 PM

ROOFTOP UNIT SCHEDULE

	DESIGNATION	PWK-RTU-1	PWK-RTU-2	ASR-RTU-1	ASR-RTU-2				
	AREA SERVED								
	REFERENCE MANUFACTURER	CARRIER	CARRIER	CARRIER	CARRIER				
	UNIT TYPE	CV	CV	CV	CV				
	MODEL NO.	48KCEA06A2A3-0A0A0	48KCEA06A2A3-0A0A0	48VL-C240603-TP	48VL-C601153-TP				
UNIT DATA	NOMINAL TONS	5	5	2	5				
	DESIGN SUPPLY CFM	2000	2000	765	1800				
	DESIGN OUTSIDE AIR CFM	400	400	150	360				
	EXTERNAL STATIC PRESSURE	0.5	0.5	0.5	0.5				
	OUTSIDE AIR CONDITIONS (COOLING)	96 / 77	96 / 77	96 / 77	96 / 77				
	OUTSIDE AIR CONDITIONS (HEATING)	2	2	2	2				
	LAT (COOLING / HEATING)	58 / 104	58 / 104	60 / 130	60 / 104				
	HOT WATER COIL (EWT/LWT = 180/140)	N/A	N/A	N/A	N/A				
	GAS HEAT INPUT, MBH	90	90	60	115				
	GAS HEAT OUTPUT, MBH	73.5	73.5	49	94				
	SMOKE DETECTOR	YES	YES	NO	YES				
	HOT GAS REHEAT (WITH LAT 70F)	NO	NO	NO	NO				
	MIN. UNIT EFFICIENCY (EER / SEER)	11.1 / 14.1	11.1 / 14.1	11.5 / 14.0	10.7 / 14.0				
ELEC./CONTROL DATA	PANEL & CIRCUIT								
	WIRE & CONDUIT	EXISTING	EXISTING	EXISTING	EXISTING				
	VOLTAGE/ PHASE	230 / 1	230 / 1	230 / 1	230 / 1				
	MINIMUM CIRCUIT AMPACITY	38	38	15.2	38				
	OVERCURRENT PROTECTION	60 A	60 A	20 A	60 A				
	DISCONNECTS	INTEGRAL	INTEGRAL	INTEGRAL	INTEGRAL				
	CONTROL	NOTE 4	NOTE 4	NOTE 4	NOTE 4				
	REFERENCE DRAWING/DETAIL								
	REMARKS	NOTE 1,2,3,4,5,6,7	NOTE 1,2,3,4,5,6,7	NOTE 1,2,3,4,5,6	NOTE 1,2,3,4,5,6,7				

NOTE 1: INTEGRAL RECEPTACLE NOT REQUIRED.
NOTE 2: PROVIDE FACTORY INSTALLED ECONOMIZER WITH BAROMETRIC RELIEF, DIFFERENTIAL ENTHALPY CONTROL AND HOOD.
NOTE 3: PROVIDE UNIT WITH SINGLE POINT ELECTRICAL CONNECTION.
NOTE 4: PROVIDE UNIT WITH THERMOSTAT INTERFACE FOR THIRD PARTY CONTROL
NOTE 5: PROVIDE UNIT WITH ADAPTOR ROOF CURB. FIELD VERIFY EXISTING ROOF CURB CONDITIONS.

AIR COOLED CONDENSING UNIT SCHEDULE

DESIGNATION		FS1-CDU-1	FS1-CDU-2	WTT-CDU-1	WTT-CDU-2		
REFERENCE MANUFACTURER		CARRIER	CARRIER	CARRIER	CARRIER		
MODEL NO.		24ABC636A003	24ABC660A003	24ABC636A003	24ABC636A003		
SEER / EER @ ARI CONDITIONS		15.0 / 12.5	15.5 / 12.5	15.0 / 12.5	15.0 / 12.5		
UNIT DATA	MBH (NOTE 1)	36	60	36	36		
	AMBIENT AIR TEMP.	95	95	95	95		
	SUCTION TEMP.						
	NO. REFRIG. CKTS.	1	1	1	1		
	NO. COMPRESSORS	1	1	1	1		
	TOTAL COMPRESSORS KW	2.9	4.5	2.9	2.9		
	CONTROL STEPS	1	1	1	1		
	FANS (NO./HP)	1	1	1	1		
ELECTRICAL/CONTROL DATA	MAXIMUM OVERCURRENT PROTECTION	30	40	30	30		
	MINIMUM WIRE SIZE						
	VOLTAGE/PHASE	208/230-1	208/230-1	208/230-1	208/230-1		
	PANEL & CIRCUIT						
	WIRE & CONDUIT						
	OVERCURRENT DEVICE	BREAKER	BREAKER	BREAKER	BREAKER		
	DISCONNECT	YES	YES	YES	YES		
	CONTROL SEQUENCE	THERMOSTAT	THERMOSTAT	THERMOSTAT	THERMOSTAT		
VIBRATION ISOLATION							
REFERENCE DRAWING/DETAIL							
REMARKS							

NOTE 1 : CAPACITY WHEN MATCHED WITH SCHEDULED AIR HANDLING UNIT.

FURNACE SCHEDULE - GAS HEAT

DESIGNATION			FS1-FURN-1	FS1-FURN-2	WTT-FURN-1	WTT-FURN-2		
FURNACE	UNIT	SIZE						
		REFERENCE MANUFACTURER	CARRIER	CARRIER	CARRIER	CARRIER		
	BLOWER FAN	CFM	1200	2000	1200	1200		
		EXTERNAL STATIC PRES. (IN. W.G.)	0.5	0.5	0.5	0.5		
		FAN RPM						
		MOTOR HORSEPOWER						
		VOLTAGE/PHASE	115 / 1	115 / 1	115 / 1	115 / 1		
	HEAT EXCH.	CFM						
		INPUT BTUH	80,000	120,000	80000	80000		
		OUTPUT BTUH	75,000	117,000	75000	75000		
		TEMP RISE (MIN-MAX)	40 - 70	40 - 70	40 - 70	40 - 70		
EVAPORATOR		CFM	1200	2000	1200	1200		
		OUTSIDE AIR - CFM	240	400	240	240		
		FACE AREA - SQ. FT.						
		ENT. AIR (DB/WB)	80 / 67	80 / 67	80 / 67	80 / 67		
		LVG. AIR (DB/WB)	61 / 58	61 / 58	61 / 58	61 / 58		
		FINS/ROWS						
		SENSIBLE HEAT MBH	24.5	40.7	24.5	24.5		
		TOTAL MBH	33.4	53.8	33.4	33.4		
		SIZE	36	60	36	36		
ELEC. CONTROL DATA		PANEL AND CIRCUIT						
		WIRE AND CONDUIT						
		OVERCURRENT DEVICE						
		CONTROL SEQUENCE	THERMOSTAT	THERMOSTAT	THERMOSTAT	THERMOSTAT		
REFERENCE DRAWING/DETAIL								
REMARKS								

SECTION 230000 – GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY OF WORK

A. The contract documents require the furnishing and installing of complete functioning mechanical systems, and each element thereof, as specified or indicated in the contract documents or reasonably inferred, to completely construct and leave ready for operation the systems as shown on the drawings and herein described, including every article, device or accessory, whether or not specifically called for by item. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.

B. Specifications and drawings are complementary and what is called for in one shall be as binding as if called for by both.

C. All work performed under this section shall be done in a neat and workmanlike manner by experienced mechanics of the proper trade.

1.2 COORDINATION, MEASUREMENTS AND LAYOUTS

A. The contractor shall inspect the site where this work is to be performed and fully familiarize himself with all conditions related to this project.

B. The contractor shall employ a competent foreman on the job to see that work is done in accordance with the best practices and in a satisfactory and workmanlike manner. The foreman shall keep informed as to the work of other trades engaged in the construction of the project, and shall execute his work in such a manner as not to interfere with or delay the work of other trades.

C. Drawings show the general arrangement of all systems and components covered under this section. Where local conditions necessitate a rearrangement, the contractor shall prepare, and submit for approval, drawings of the proposed rearrangement. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The contractor shall carefully investigate the structural and finish conditions affecting all of his work and shall arrange such work accordingly, furnishing such offsets, fittings and accessories as may be required to meet such conditions at no additional cost to the owner. The contractor shall verify all dimensions. Drawings shall not be scaled to determine dimension.

1.3 PERMITS AND FEES

A. The contractor shall obtain and pay for all required permits and licenses and shall make all deposits and pay all fees required for the performance of work under this section, other than those deposits or fees which are fully refundable to the owner.

1.4 SUBMITTALS, MATERIALS AND EQUIPMENT

A. All items of materials and equipment shall be new unless otherwise specified herein, free from defects and of the best quality normally used for the purpose in good commercial practice.

B. As soon as possible after the award of the contract, the contractor shall submit for review six copies of shop drawings for all equipment to be furnished for this project. Submittals shall include manufacturer's name, model number, descriptive engineering data and all necessary information as to finish, material gauges and accessories. After such shop drawings are processed, three copies will be returned to the contractor. The contractor shall, upon receipt of reviewed shop drawings proceed with the procurement and installation of such equipment.

1.5 CODES, LAWS, AND STANDARDS

A. All work shall be installed in compliance with all governing codes, applicable local laws, regulations, ordinances or statutes of regulatory bodies having jurisdiction. The work shall be executed in accordance with said laws, regulations, ordinances, statues or codes, without increased cost to the owner. Any point in question shall be referred to the engineer for approval. Work indicated on the documents that is in excess of code requirements shall not be reduced in quality and/or quantity.

B. Comply with rules and regulations of public utilities and municipal departments affected by connections of services.

1.6 RECORD DOCUMENTS

A. This contractor shall prepare a complete “as-built” set of drawings incorporating all changes made during construction. Location of underground piping shall be located by dimension from column lines.

B. This contractor shall prepare and submit to the owner's representative five bound sets of operating and maintenance manuals including final copies of equipment shop drawings, manufacturer's literature for all equipment installed on the project showing all details of equipment, replacement part data and maintenance and operating instructions. Manuals shall include copies of all equipment warranties.

1.7 GUARANTEES AND WARRANTIES

A. The contractor shall guarantee complete system operation and that the material and equipment furnished and installed will be free from defects in workmanship and materials and will give satisfactory service under the specified operating conditions. The contractor agrees to replace, without expense to the owner, any part of the apparatus which proves or becomes defective within one year after the system is accepted. No equipment warranty or guarantee shall start until the time of building acceptance.

B. All warranties issued by equipment manufacturers shall be filled out in the owner's name and given to the owner prior to final acceptance of work performed under this section.

1.8 FINAL INSPECTION

A. After completion of the entire project the contractor shall request final inspection of this project in written form addressed to the architect along with a statement to the effect that all installations have been completed, checked, adjusted and balanced in accordance with requirements of this project. Upon receipt of written notification of completion and request for final inspection the engineer will perform a final inspection of this work and, if all installations are as represented by the contractor, the engineer will submit written recommendation of acceptance.

1.9 CLEANING

A. Dirt and refuse resulting from the performance of the work shall be removed to keep the premises reasonable clean at all times.

B. After completion of the work described in this specification and shown on the drawings, the contractor shall thoroughly clean all exposed surfaces and equipment, remove all dirt, debris, crating, cartons, etc., and leave all installations finished and ready for operation.

1.10 OPENINGS AND SLEEVES

A. All piping through exterior or foundation walls shall pass through schedule 40 galvanized steel sleeves which shall be large enough to allow for pipe seal material. Sleeves in new construction shall have a minimum 2 inch water stop in the center of the sleeve. No sleeves are permitted through concrete structural members.

1. Space between pipe and sleeve in exterior underground walls shall be sealed with link-seal, flexicraft or metraflex link style pipe seals.
2. In above grade exterior walls pack the space between pipe and sleeve with mineral wool and then complete seal with approved caulking compound flush with finished surface. Provide pipe collar on interior side of wall.

B. All piping through floors shall be provided with schedule 40 galvanized steel pipe sleeves, extending 1 inch above the floor.

C. In fire rated walls: caulking shall be a pure ceramic fiber made of alumina-silica, "CERAFIBER-FS" by Johns-Manville. Sealant shall be gun grade. An acrylic 2-part gun applied, fire retardant elastic sealant, "DYMERIC" by Tremco or equal by Permatite No. 1113FR.

1. Limit the size of the space between the wall or floor and the outside of the pipe or duct to 1 inch maximum. This space is sufficient to allow some movement of the pipes or duct without cracking the caulking or sealant.
2. For openings in walls, the caulking shall be applied to a minimum of 3 inch total depth. Sealant shall then be applied on both sides of the wall opening a minimum of 1/2 inch in depth, finished flush with the wall. D.

D. For openings in floors, the caulking shall be applied from the upper side to a minimum of 3 inch total depth recessed 1/2 inch below the finished floor. This 1/2 inch recess shall then be filled with sealant to flush with finished floor.

1.11 CUTTING AND PATCHING

A. The contractor shall be responsible for any cutting of walls, floors, ceilings and roofs required for performance of his work.

B. No structural member shall be cut without permission from the architect.

C. Patch all openings to match adjacent construction in both material and finish.

D. All cutting of existing concrete floors/slabs on grade in the interior of the building shall be performed by "saw cutting" and shall be performed by this contractor.

1.12 DEMOLITION AND NEW WORK

A. The contractor shall do all demolition, alterations and rework indicated and/or required to maintain the operation of all existing HVAC systems and to integrate the new systems in the renovated building as required. The contractor shall include all work which may be required to alterations and demolition work. This shall include all removal, relocation and reworking of piping, items of HVAC equipment, etc. Existing systems and new systems shall be completely integrated as intended and as indicated on the plans and in the specifications.

B. The contractor shall remove from the premises and dispose of properly all existing material and equipment which no longer serves a purpose in altered areas. The contractor shall remove unused ductwork and piping. Remove piping connected to equipment back to main and cap. Unless otherwise noted, the contractor shall maintain services to all existing areas requiring such services. The contractor shall reroute as required such services where are disrupted due to architectural changes in the existing structure. Any equipment which is designated to be reused and which is damaged in the process shall be replaced by the contractor with new equipment of like kind at no cost to the owner.

1.13 INTERRUPTION OF SERVICES

A. The contractor shall schedule any service interruptions to the existing building with the owner’s representative. Such interruptions shall be planned so as to be at times to cause the least inconvenience and interruption to the facility’s schedule.

1.14 EXISTING CONDITIONS

A. All existing conditions shown on the drawings and described in the specifications for this project have been determined from available drawings and field investigations. Contractors making proposals for this work shall investigate all existing conditions and base their proposals on their observations to provide complete and functioning installations in accordance with the intent of the drawing and specifications for this project and all applicable governing codes, rules, regulations and ordinances. Failure to determine existing conditions which cause additional work will not constitute grounds for additional compensation.

PART 2 - HEATING, VENTILATING AND AIR CONDITIONING

2.1 GENERAL REQUIREMENTS

A. See part 1 for general requirements.

2.2 BELT DRIVES AND GUARDS

A. All belt drives shall be of the multiple "v" type, Dayton, Gates or equal. Standard slide rails or other means of belt adjustment shall be provided for each motor used with a belt drive.

B. Removable steel guards with expanded metal screens of acceptable design shall be provided over all exposed belt drives and couplings.

2.3 FILTERS

A. The contractor shall only run all air handling units in the building during the testing period prior to completion of the work. Units shall not be run without filters in place.

B. Filters shall be as manufactured by American Air Filter, Camfil Farr or Cambridge.

2.4 FLEXIBLE CONNECTORS

A. The contractor shall install flexible duct connections between each piece of equipment having a fan, and its sheet metal supply and return ductwork connections, which, when completed shall be airtight.

B. Connectors shall provide a minimum of 2 inches between metal to insure against transmission of vibration from the fan unit to the ductwork.

2.5 MOTORS AND STARTERS

A. All electric motors shall be furnished for operation on electrical services as designated and shall have starting torque characteristics suitable for the equipment served. Any changes to the electrical wiring due to equipment being furnished, other than that specified, is the responsibility of the contractor.

B. Across-the-line manual starters and magnetic starters shall be cutler-hammer products or approved equal, unless otherwise specified, of sizes required for the motor horsepower and phase served. Starters located in equipment areas and unfinished spaces may be surface mounted types with functions identified by engraved plastic plates.

C. The mechanical contractor shall furnish to the electrical contractor all starters and starter overloads, all necessary wiring diagrams and instructions to facilitate the installation of power and control wiring to all equipment.

2.6 SHEET METAL DUCTWORK

A. Sheet metal ducts and connections shall be constructed of g90 galvanized sheets of mild steel. The ducts shall be constructed to the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) 2” w.g. pressure class standards. No duct shall be constructed with less than 24 gauge metal. Local codes requiring heavier gauges shall govern. All ducts shall be sealed to SMACNA "B" classification.

B. Duct sections shall be joined in accordance with the recommendations of the Sheet Metal and Air Conditioning Contractors National Association and requirements of the building code having jurisdiction.

C. Duct dimensions shown are sheet metal dimensions and do not need to be adjusted for insulation/lining.

D. Curved elbows shall be constructed with inside radius not less than the duct width in the same plane. Square elbows shall have turning vanes. Turning vanes shall be designed in accordance with ASHRAE recommendations. Manufactured vanes shall be by Titus or approved equal.

E. Cross break all ductwork surfaces over 18 inches in width.

F. Full areas shall be maintained in transitions where a change in the configuration of the duct occurs. All tapering joints shall be reduced gradually.

G. Joints in ducts shall be made practically airtight and any open corner shall be neatly patched and soldered tight. Duct tape will not be accepted as a joint patch. Low pressure system duct leakage shall not exceed 2%.

H. Concealed round ducts shall be constructed to SMACNA 2" w.g. standards with grooved longitudinal seams and sleeved type transverse joints.

I. Exposed round ducts shall be constructed to SMACNA 10" w.g. standards, spiral lock seam duct and fittings.

2.7 DUCT LINER

A. All ductwork identified to be lined shall be lined with 1/2" thick 2 lb. Density CertainTeed tough guard duct liner or equal from Manville, Knauf insulation, or Owens Corning unless noted otherwise on the drawings. All duct liner is to comply and be installed in accordance to NAIMA fibrous glass duct liner standard and SMACNA.

2.8 FLEXIBLE DUCT

A. Flexible ducts shall be UL181 class THERMAFLEX M-KE, or approved equal, shall not be longer than 8 feet and shall not have any air flow obstruction.

2.9 DUCTWORK SUPPORTS

A. All horizontal ducts shall be supported with hangers spaced not more than 8'-0" apart. Hangers for ducts smaller than 31 inches shall consist of 22 gauge galvanized steel straps securely fastened to the duct and the building construction. Ducts over 31 inches in width shall be hung with 1/4 inch steel angle on the bottom of the duct supported with steel rods of appropriate size securely fastened to the building structure. All supports to meet SMACNA standards.

2.10 DUCTWORK INSULATION

A. All concealed round ducts shall be insulated with 1-1/2 inch thick, 1 pound per cubic foot density, certain-teed duct wrap insulation faced on one side with .002 inch aluminum foil with a 2 inch tab, or equal products by Manville, Knauf insulation, or Owens Corning unless noted otherwise on the drawings. Insulation shall be applied in strict compliance with the manufacturer's recommendations.

B. All insulation shall be UL listed; flame spread/fuel contributed/smoke developed rating of 25/50/50 or less in accordance with ASTM E84, NFPA 255 and UL 723.

2.11 GRILLES, REGISTERS, DIFFUSERS AND LOUVERS

A. Furnish and install all grilles, registers, diffusers and louvers as shown and described on the drawings or comparable products of Titus or Price.

B. The contractor shall inform the general contractor of the requirements for opening sizes and framing for all equipment and shall coordinate the installation of all such equipment with the structural requirements of this project.

2.12 OPERATING AND MAINTENANCE MANUALS

A. The equipment manufacturer shall furnish the owner two bound sets of operating and maintenance instructions for all systems.

2.13 START-UP/TESTING, ADJUSTING, BALANCING

A. The contractor shall complete all equipment installations, check all control wiring, start up and adjust all equipment and place all systems in operation.

B. After completion and start-up of all systems the contractor shall arrange for testing, adjusting and balancing of all air systems.

C. Testing, adjusting and balancing of all air systems shall be performed in complete accordance with NEBB or SMACNA standards.

D. Upon completion of testing, adjusting and balancing, a complete report of all findings shall be submitted to the engineer prior to final acceptance of this project. Three copies of the report shall be provided.

2.14 CURBS

A. Curbs for exhausters and ductwork through roof shall be pate type pc as required by roof construction, or comparable Thycurb products of the Thybar Corp. All curbs and supports shall be constructed as required to compensate for slopes of the roof structure to provide level support of equipment. Curb heights at the high points of the building structure shall not be less than 14 inches.

B. Curbs for roof mounted heating, ventilating and air conditioning units shall be provided by the equipment manufacturer and shall be designed to compensate for slopes of structural steel to provide level support of equipment. Curbs shall be insulated type with 1-1/2 inch thick insulation and a minimum density of 3 pounds.

2.15 DAMPERS

A. Volume balancing dampers shall be Ruskin CD-35/CDR-25 or approved equal. The dampers shall be constructed of 16 gauge galvanized steel, 6 inch wide opposed blades and the linkage concealed in frame.

B. Fire dampers shall be provided where shown on the drawings and elsewhere as required by authorities having jurisdiction and shall be Ruskin type IBD2, style B, or comparable products of Vent Products Company, Inc., curtain type having 100% free area with 212 degrees F. Fusible link approved for use in partitions with two hour rating unless otherwise noted. Access panels shall be provided in ducts and in the structure for all fire dampers. Installation shall be in accordance with the manufacturer’s standards.

2.16 PAINTING: (SEE ARCHITECTURAL SECTION "PAINTING")

A. Painting, except as specified herein, shall be done by others.

B. Equipment which has damaged finish shall be repainted to match the original factory finish.

C. All exposed ferrous metal furnished under this contract, such as hangers, struts, structural steel, etc., shall be given one coat of tnemec gray primer.

2.17 GAS PIPING

A. Schedule 40 black steel piping: 2” and smaller with screwed joints and 150 lb. Malleable iron screwed fittings. Pipe 2-1/2” and larger shall use standard weight black steel welding fittings with welded joints.

B. Gas valves 2” and smaller shall be Milwaukee bb2-100, butterfly valve, bronze, Viton seats and packing, 175 lbs. AGA/UL listed. Valves 2-1/2” and larger shall be Rockwell 142/143 lubricated cock.

END OF SECTION 230000

SECTION 235416.13 - GAS-FIRED FURNACES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Gas-fired, condensing furnaces and accessories complete with controls.
2. Air filters.
3. Air cleaners.
4. Refrigeration components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:
1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each furnace to include in emergency, operation, and maintenance manuals.
1. In addition to standard items specified, include the following:
a. Furnace and accessories complete with controls.
b. Air filter.
c. Refrigeration components.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Disposable Air Filters: Furnish two complete sets.
2. Fan Belts: Furnish one set for each furnace fan.

3. Disposable Humidifier Media: Furnish one set.

1.7 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

C. Comply with NFPA 70.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace the following components of furnaces that fail in materials or workmanship within specified warranty period:
   1. Warranty Period, Commencing on Date of Substantial Completion:
      a. Furnace Heat Exchanger: Five years.
      b. Integrated Ignition and Blower Control Circuit Board: Five years.
      c. Draft-Inducer Motor: Five years.
      d. Refrigeration Compressors: Five years.
      e. Evaporator and Condenser Coils: Five years.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a qualified testing agency, and marked for intended location and application.

B. General Requirements for Noncondensing Gas-Fired Furnaces: Factory assembled, piped, wired, and tested; complying with ANSI Z21.47/CSA 2.3 and NFPA 54.

2.2 GAS-FIRED FURNACES, CONDENSING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carrier Corporation; a unit of United Technologies Corp.
   2. Trane.
   3. Approved equal.

B. Cabinet: Steel or galvanized steel.
   1. Cabinet interior around heat exchanger shall be factory-installed insulation.
   2. Lift-out panels shall expose burners and all other items requiring access for maintenance.
   3. Factory paint external cabinets in manufacturer's standard color.
   4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Fan: Centrifugal, factory balanced, resilient mounted, direct drive.

1. Special Motor Features: Single speed, premium efficiency, and with internal thermal protection and permanent lubrication.
2. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
3. Special Motor Features: Electronically controlled motor (ECM) controlled by integrated furnace/blower control.

D. Type of Gas: Natural.

E. Heat Exchanger:

1. Primary: Aluminized or stainless steel.
2. Secondary: Polyethylene-coated or stainless steel.

F. Burner:

1. Gas Valve: 100 percent safety two-stage or modulating main gas valve, main shutoff valve, pressure regulator, safety pilot with electronic flame sensor, limit control, transformer, and combination ignition/fan timer control board.
2. Ignition: Electric pilot ignition, with hot-surface igniter or electric spark ignition.

G. Gas-Burner Safety Controls:

1. Electronic Flame Sensor: Prevents gas valve from opening until pilot flame is proven; stops gas flow on ignition failure.
2. Flame Rollout Switch: Installed on burner box; prevents burner operation.
3. Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.

H. Combustion-Air Inducer: Centrifugal fan with thermally protected motor and sleeve bearings prepurges heat exchanger and vents combustion products; pressure switch prevents furnace operation if combustion-air inlet or flue outlet is blocked.

I. Furnace Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds; adjustable fan-on and fan-off timing; terminals for connection to accessories; diagnostic light with viewport.

J. Accessories:

1. Combination Combustion-Air Intake and Vent: PVC plastic fitting to combine combustion-air inlet and vent through outside wall.
2. CPVC Plastic Vent Materials:
   a. CPVC Plastic Pipe: Schedule 40, complying with ASTM F 441/F 441M.
   b. CPVC Plastic Fittings: Schedule 40, complying with ASTM F 438, socket type.
   c. CPVC Solvent Cement: ASTM F 493.
3. PVC Plastic Vent Materials:
   a. PVC Plastic Pipe: Schedule 40, complying with ASTM D 1785.
   b. PVC Plastic Fittings: Schedule 40, complying with ASTM D 2466, socket type.
   c. PVC Solvent Cement: ASTM D 2564.

2.3 THERMOSTATS

A. Controls shall comply with requirements in ASHRAE/IES 90.1, "Controls."

B. Provide conventional thermostat interface for control and integration by building automation system.

2.4 AIR FILTERS

A. Disposable Filters: 1-inch- thick fiberglass media with ASHRAE 52.2 MERV rating of 6 or higher, in sheet metal frame.

B. Charged Media Air Filters: Sheet metal housing arranged to be ducted in return-air duct connection to furnace; generates electrostatic charge; MERV 10 rating.

2.5 REFRIGERATION COMPONENTS

A. General Refrigeration Component Requirements:
   1. Refrigeration compressor, coils, and specialties shall be designed to operate with CFC-free refrigerants.
   2. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IES 90.1.

B. Refrigerant Coil: Copper tubes mechanically expanded into aluminum fins. Comply with AHRI 210/240. Match size with furnace. Include condensate drain pan with accessible drain outlet complying with ASHRAE 62.1.
   1. Refrigerant Coil Enclosure: Steel, matching furnace and evaporator coil, with access panel and flanges for integral mounting at or on furnace cabinet and galvanized sheet metal drain pan coated with black asphaltic base paint.

C. Refrigerant Line Kits: Annealed-copper suction and liquid lines factory cleaned, dried, pressurized with nitrogen, sealed, and with suction line insulated. Provide in standard lengths for installation without joints, except at equipment connections.

D. Air-Cooled Compressor-Condenser Unit:
   1. Casing: Steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
   2. Compressor: Hermetically sealed reciprocating or scroll type.
      a. Crankcase heater.
      b. Restrained vibration or vibration isolation mounts for compressor.
      c. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
      d. Two-speed compressor motors shall have manual-reset high-pressure switch and automatic-reset low-pressure switch.
      e. Refrigerant Charge: R-407C or R-410A.
      f. Refrigerant: R-407C or R-410A.
   3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with liquid subcooler.

4. Heat-Pump Components: Reversing valve and low-temperature air cut-off thermostat.
5. Fan: Aluminum-propeller type, directly connected to motor.
6. Motor: Permanently lubricated, with integral thermal-overload protection.
7. Low Ambient Kit: Permits operation down to 45 deg F.
8. Mounting Base: Polyethylene.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine factory-installed insulation before furnace installation. Reject units that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for gas and refrigerant piping systems to verify actual locations of piping connections before equipment installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install gas-fired furnaces and associated fuel and vent features and systems according to NFPA 54.

B. Suspended Units: Suspend from structure using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.
   1. Install seismic restraints to limit movement of furnace by resisting code-required seismic acceleration.

C. Base-Mounted Units: Secure units to substrate. Provide optional bottom closure base if required by installation conditions.

D. Controls: Install thermostats and humidistats at mounting height of 60 inches above floor.

E. Wiring Method: Install control wiring in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal control wiring except in unfinished spaces.

F. Install roof-mounted compressor-condenser components on equipment supports. Anchor units to supports with removable, cadmium-plated fasteners.

3.3 CONNECTIONS

A. Install piping adjacent to equipment to allow service and maintenance.

B. Vent and Outside-Air Connection, Condensing, Gas-Fired Furnaces: Connect plastic piping vent material to furnace connections and extend outdoors. Terminate vent outdoors with a cap and in an arrangement that will protect against entry of birds, insects, and dirt.

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
    a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
    b. CPVC Piping: Join according to ASTM D 2846/D 2846M, Appendix.
    c. PVC Pressure Piping: Join schedule number ASTM D 1785 PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
4. Slope pipe vent back to furnace or to outside terminal.

C. Connect ducts to furnace with flexible connector.

D. Connect refrigerant tubing kits to refrigerant coil in furnace and to air-cooled compressor-condenser unit.

1. Flared Joints: Use ASME B16.26 fitting and flared ends, following procedures in CDA's "Copper Tube Handbook."
2. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
3. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Perform electrical test and visual and mechanical inspection.
2. Leak Test: After installation, charge systems with refrigerant and test for leaks. Repair leaks, replace lost refrigerant, and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
4. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

3.5 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Inspect for physical damage to unit casings.
2. Verify that access doors move freely and are weathertight.
3. Clean units and inspect for construction debris.

4. Verify that all bolts and screws are tight.
5. Adjust vibration isolation and flexible connections.
6. Verify that controls are connected and operational.

B. Adjust fan belts to proper alignment and tension.

C. Start unit according to manufacturer's written instructions and complete manufacturer's operational checklist.

D. Measure and record airflows.

E. Verify proper operation of capacity control device.

F. After startup and performance test, lubricate bearings.

3.6 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set controls, burner, and other adjustments for optimum heating performance and efficiency. Adjust heat-distribution features, including shutters, dampers, and relays, to provide optimum heating performance and system efficiency.

3.7 CLEANING

A. After completing installation, clean furnaces internally according to manufacturer's written instructions.

B. Install new filters in each furnace within 14 days after Substantial Completion.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain condensing units.

END OF SECTION 235416.13

SECTION 237416 - PACKAGED, ROOFTOP AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Schedules and general provisions of the Request for Proposal apply to this Section.

1.2 SUMMARY

A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories where listed on the schedule:
   1. Direct-expansion cooling.
   2. Gas furnace.
   3. Economizer outdoor- and return-air damper section.
   4. Thermostat interface for operation with building temperature control system.
   5. Roof curb adapter as required.

1.3 DEFINITIONS

A. DDC: Direct-digital controls.

B. ECM: Electrically commutated motor.

C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.4 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Performance:

1. Basic Wind Speed: 90 mph.
2. Building Classification Category: III.
3. Minimum 10 lb/sq. ft multiplied by the maximum area of the mechanical component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

1.5 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Wiring Diagrams: Power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Manufacturer Wind Loading Qualification Certification: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control test reports.

C. Warranty: Special warranty specified in this Section.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fan Belts: One set for each belt-driven fan.
   2. Filters: One set of filters for each unit.

1.9 QUALITY ASSURANCE

A. ARI Compliance:
   1. Comply with ARI 203/110 and ARI 303/110 for testing and rating energy efficiencies for RTUs.
   2. Comply with ARI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

E. UL Compliance: Comply with UL 1995.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.

1. Warranty Period for entire unit: Not less than one year from date of Substantial Completion.
2. Warranty Period for compressors: Not less than five years from date of Substantial Completion.
3. Warranty Period for stainless steel gas furnace heat exchangers: Not less than fifteen years from date of Substantial Completion

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Carrier
2. Trane
3. Approved Equal.

2.2 CASING

A. General Fabrication Requirements for Casings: Formed and reinforced insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed. Service doors shall be hinged with toolless access for easy servicing and maintenance.

B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

1. Exterior Casing Thickness: 0.0626 inch thick, minimum.

C. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1. Materials: ASTM C 1071, Type I.

2. Thickness: 1/2 inch.
3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
4. Liner Adhesive: Comply with ASTM C 916, Type I.

D. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.1.
1. Insulation: Insulation to be thickness required to prevent condensation.
2. Drain Connections: Threaded nipple.
3. Pan-Top Surface Coating: Corrosion-resistant compound.

E. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

F. Vibration isolation shall be provided internal to the unit to prevent transmission of vibration from compressors and fans.

2.3 FANS

A. Direct-Driven Supply-Air Fans: Double width, centrifugal; with permanently lubricated, variable-speed or ECM motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

B. Belt-Driven Supply-Air Fans: Double width, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

C. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.

D. Relief-Air Fan: Centrifugal, shaft mounted on permanently lubricated motor.

E. Fan Motor: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.4 COILS

A. Supply-Air Refrigerant Coil:
1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
3. Coil Split: Interlaced.
4. Condensate Drain Pan: Stainless steel formed with pitch and drain connections complying with ASHRAE 62.1.

B. Outdoor-Air Refrigerant Coil:
1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.

2.5 REFRIGERANT CIRCUIT COMPONENTS

A. Number of Refrigerant Circuits: As shown on schedule.

B. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.

C. Refrigeration Specialties:
1. Refrigerant: R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.
9. Hot-gas reheat solenoid valve with a replaceable magnetic coil.

2.6 AIR FILTRATION

A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
1. Pleated: Minimum MERV 8.

2.7 GAS FURNACE

A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.
1. CSA Approval: Designed and certified by and bearing label of CSA.

B. Burners: Stainless steel.
1. Fuel: Natural gas.
2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.

C. Heat-Exchanger and Drain Pan: Stainless steel.

D. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.

E. Safety Controls:
1. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.8 DAMPERS

A. Outdoor- and Return-Air Mixing Dampers: Opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
   1. Damper Motor: Modulating with adjustable minimum position.
   2. Relief-Air Damper: Gravity actuated, as required by ASHRAE/IESNA 90.1, with bird screen and hood.

2.9 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.10 CONTROLS

A. Basic Unit Controls:
   1. Control-voltage transformer.
   2. Electro-mechanical unit controls
   3. Temperature Control System contractor will provide unit controls which will operate the unit through the conventional thermostat interface.

B. Interface Requirements for HVAC Instrumentation and Control System:
   1. Conventional thermostat interface for temperature controls to be provided by others.

2.11 ACCESSORIES

A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.

B. Hail guards of galvanized steel, painted to match casing.

2.12 ROOF CURB ADAPTERS

A. Materials: Fully welded, galvanized steel with corrosion-protection coating, watertight gaskets, and factory-applied internal insulation.
   1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
      a. Materials: ASTM C 1071, Type I or II.
      b. Thickness: 1-1/2 inches.
   2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb adapter.
      a. Liner Adhesive: Comply with ASTM C 916, Type I.
      b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to adapter without damaging liner when applied as recommended by manufacturer and without causing leakage in adapter.

c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.

d. Liner Adhesive: Comply with ASTM C 916, Type I.

B. Wind: Metal brackets compatible with the curb, adapter and casing, used to anchor unit to the curb adapter, and adapter to the curb, and designed for loads at Project site.

2.13 CAPACITIES AND CHARACTERISTICS

A. Shall be per schedule.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where RTUs will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Equipment Mounting:

1. Roof Curb: Install on existing roof curb, level and secure, according to ARI Guideline B. Secure RTUs to upper curb rail.

3.3 CONNECTIONS

A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain. Paint PVC drain piping with UV-resistant paint.

B. Install piping adjacent to RTUs to allow service and maintenance.

1. Gas Piping: Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service. Provide pressure reducing valves as required to meet manufacturer’s pressure requirements.

C. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.
2. Install return-air duct continuously through roof structure.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Provide a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Tests and Inspections:
1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Provide a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to furnace combustion chamber.
3. Inspect for visible damage to compressor, coils, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean condenser coil and inspect for construction debris.
10. Clean furnace flue and inspect for construction debris.
11. Connect and purge gas line.
12. Remove packing from vibration isolators.
13. Inspect operation of barometric relief dampers.
14. Verify lubrication on fan and motor bearings.
15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
16. Adjust fan belts to proper alignment and tension.
17. Start unit according to manufacturer's written instructions.
    a. Start refrigeration system.
    b. Do not operate below recommended low-ambient temperature.
    c. Complete startup sheets and attach copy with Contractor's startup report.
18. Inspect and record performance of interlocks and protective devices; verify sequences.
19. Operate unit for an initial period as recommended or required by manufacturer.
20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
    a. Measure gas pressure on manifold.

b. Inspect operation of power vents.
c. Measure combustion-air temperature at inlet to combustion chamber.
d. Measure flue-gas temperature at furnace discharge.
e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

21. Calibrate thermostats.
22. Adjust and inspect high-temperature limits.
23. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
24. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.
    c. Outdoor-air, dry-bulb temperature.
    d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
25. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
26. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
    a. Supply-air volume.
    b. Return-air volume.
    c. Relief-air volume.
    d. Outdoor-air intake volume.
27. Simulate maximum cooling demand and inspect the following:
    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
28. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.

B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

A. Provide a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs.

END OF SECTION 237413

SECTION 260000 – GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY OF WORK

A. The contract documents require the furnishing and installing of complete functioning electrical systems, and each element thereof, as specified or indicated in the contract documents or reasonably inferred, to completely construct and leave ready for operation the systems as shown on the drawings and herein described, including every article, device or accessory, whether or not specifically called for by item. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.

B. Specifications and drawings are complementary and what is called for in one shall be as binding as if called for by both.

C. All work performed under this section shall be done in a neat and workmanlike manner by experienced mechanics of the proper trade.

1.2 COORDINATION, MEASUREMENTS AND LAYOUTS

A. The contractor shall inspect the site where this work is to be performed and fully familiarize himself with all conditions related to this project.

B. The contractor shall employ a competent foreman on the job to see that work is done in accordance with the best practices and in a satisfactory and workmanlike manner. The foreman shall keep informed as to the work of other trades engaged in the construction of the project, and shall execute his work in such a manner as not to interfere with or delay the work of other trades.

C. Drawings show the general arrangement of all systems and components covered under this section. Where local conditions necessitate a rearrangement, the contractor shall prepare, and submit for approval, drawings of the proposed rearrangement. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The contractor shall carefully investigate the structural and finish conditions affecting all of his work and shall arrange such work accordingly, furnishing such offsets, fittings and accessories as may be required to meet such conditions at no additional cost to the owner. The contractor shall verify all dimensions. Drawings shall not be scaled to determine dimension.

1.3 PERMITS AND FEES

A. The contractor shall obtain and pay for all required permits and licenses and shall make all deposits and pay all fees required for the performance of work under this section, other than those deposits or fees which are fully refundable to the owner.

1.4 SUBMITTALS, MATERIALS AND EQUIPMENT

A. All items of materials and equipment shall be new unless otherwise specified herein, free from defects and of the best quality normally used for the purpose in good commercial practice.

B. As soon as possible after the award of the contract, the contractor shall submit for review six copies of shop drawings for all equipment to be furnished for this project. Submittals shall include manufacturer's name, model number, descriptive engineering data and all necessary information as to finish, material gauges and accessories. After such shop drawings are processed, three copies will be returned to the contractor. The contractor shall, upon receipt of reviewed shop drawings proceed with the procurement and installation of such equipment.

1.5 CODES, LAWS, AND STANDARDS

A. All work shall be installed in compliance with the national electrical code, the national board of fire underwriters, the national electrical safety code, and all governing codes, applicable local laws, regulations, ordinances or statutes of regulatory bodies having jurisdiction. The work shall be executed in accordance with said laws, regulations, ordinances, statues or codes, without increased cost to the owner. Any point in question shall be referred to the engineer for approval. Work indicated on the documents that is in excess of code requirements shall not be reduced in quality and/or quantity.

B. Comply with rules and regulations of public utilities and municipal departments affected by connections of services.

1.6 RECORD DOCUMENTS

A. This contractor shall prepare a complete “as-built” set of drawings incorporating all changes made during construction. Location of underground conduit shall be located by dimension from column lines.

B. This contractor shall prepare and submit to the owner's representative five bound sets of operating and maintenance manuals including final copies of equipment shop drawings, manufacturer's literature for all equipment installed on the project showing all details of equipment, replacement part data and maintenance and operating instructions. Manuals shall include copies of all equipment warranties.

1.7 GUARANTEES AND WARRANTIES

A. The contractor shall guarantee complete system operation and that the material and equipment furnished and installed will be free from defects in workmanship and materials and will give satisfactory service under the specified operating conditions. The contractor agrees to replace, without expense to the owner, any part of the apparatus which proves or becomes defective within one year after the system is accepted. No equipment warranty or guarantee shall start until the time of building acceptance.

B. All warranties issued by equipment manufacturers shall be filled out in the owner's name and given to the owner prior to final acceptance of work performed under this section.

1.8 FINAL INSPECTION

A. After completion of the entire project the contractor shall request final inspection of this project in written form addressed to the architect along with a statement to the effect that all installations have been completed, checked, adjusted and balanced in accordance with requirements of this project. Upon receipt of written notification of completion and request for final inspection the engineer will perform a final inspection of this work and, if all installations are as represented by the contractor, the engineer will submit written recommendation of acceptance.

1.9 CLEANING

A. Dirt and refuse resulting from the performance of the work shall be removed to keep the premises reasonable clean at all times.

B. After completion of the work described in this specification and shown on the drawings, the contractor shall thoroughly clean all exposed surfaces and equipment, remove all dirt, debris, crating, cartons, etc., and leave all installations finished and ready for operation.

1.10 OPENINGS AND SLEEVES

A. All piping through exterior or foundation walls shall pass through schedule 40 galvanized steel sleeves which shall be large enough to allow for pipe seal material. Sleeves in new construction shall have a minimum 2 inch water stop in the center of the sleeve. No sleeves are permitted through concrete structural members.

1. Space between pipe and sleeve in exterior underground walls shall be sealed with link-seal, Flexicraft or Metraflex link style pipe seals.
2. In above grade exterior walls pack the space between pipe and sleeve with mineral wool and then complete seal with approved caulking compound flush with finished surface. Provide pipe collar on interior side of wall.

B. All piping through floors shall be provided with schedule 40 galvanized steel pipe sleeves, extending 1 inch above the floor.

C. In fire rated walls: caulking shall be a pure ceramic fiber made of alumina-silica, "CERAFIBER-FS" by Johns-Manville. Sealant shall be gun grade. An acrylic 2-part gun applied, fire retardant elastic sealant, "DYMERIC" by Tremco or equal by Permatite No. 1113FR.

1. Limit the size of the space between the wall or floor and the outside of the pipe or duct to 1 inch maximum. This space is sufficient to allow some movement of the pipes or duct without cracking the caulking or sealant.
2. For openings in walls, the caulking shall be applied to a minimum of 3 inch total depth. Sealant shall then be applied on both sides of the wall opening a minimum of 1/2 inch in depth, finished flush with the wall.

D. For openings in floors, the caulking shall be applied from the upper side to a minimum of 3 inch total depth recessed 1/2 inch below the finished floor. This 1/2 inch recess shall then be filled with sealant to flush with finished floor.

1.11 CUTTING AND PATCHING

A. The contractor shall be responsible for any cutting of walls, floors, ceilings and roofs required for performance of his work.

B. No structural member shall be cut without permission from the architect.

C. Patch all openings to match adjacent construction in both material and finish.

D. All cutting of existing concrete floors/slabs on grade in the interior of the building shall be performed by "saw cutting" and shall be performed by this contractor.

1.12 DEMOLITION AND NEW WORK

A. The contractor shall do all demolition, alterations and rework indicated and/or required to maintain the operation of all existing electrical systems and to integrate the new systems in the renovated building as required. The contractor shall include all work which may be required to alterations and demolition work. This shall include all removal, relocation and reworking of wire and conduit, outlet boxes, junction boxes, etc. Existing systems and new systems shall be completely integrated as intended and as indicated on the plans and in the specifications.

B. The contractor shall remove from the premises and dispose of properly all existing material and equipment which no longer serves a purpose in altered areas. The contractor shall remove connections to equipment back to panel or junction box. Maintain circuit connectivity. Unless otherwise noted, the contractor shall maintain services to all existing areas requiring such services. The contractor shall reroute as required such services where are disrupted due to architectural changes in the existing structure. Any equipment which is designated to be reused and which is damaged in the process shall be replaced by the contractor with new equipment of like kind at no cost to the owner.

1.13 INTERRUPTION OF SERVICES

A. The contractor shall schedule any service interruptions to the existing building with the owner’s representative. Such interruptions shall be planned so as to be at times to cause the least inconvenience and interruption to the facility’s schedule.

1.14 EXISTING CONDITIONS

All existing conditions shown on the drawings and described in the specifications for this project have been determined from available drawings and field investigations. Contractors making proposals for this work shall investigate all existing conditions and base their proposals on their observations to provide complete and functioning installations in accordance with the intent of the drawing and specifications for this project and all applicable governing codes, rules, regulations and ordinances. Failure to determine existing conditions which cause additional work will not constitute grounds for additional compensation.

PART 2 - ELECTRICAL

2.1 GENERAL REQUIREMENTS

A. See part 1 for general requirements.

2.2 IDENTIFICATION OF SWITCHES AND APPARATUS

A. All cabinets, safety switches, and other apparatus used for operation and control of circuits, appliances, and equipment under this contract shall be properly identified by means of engraved plastic plates either black with white letters or white with black letters.

2.3 GROUNDING

A. All conductors, motor frames, raceways, cabinets, etc., that require grounding shall be grounded in accordance with the requirements of article 250 of the national electrical code, those of the serving utility and local authorities having jurisdiction.

2.4 SAFETY SWITCHES

A. Safety switches, as manufactured by general electric, Crouse-Hinds, Cutler-Hammer, Square D, Siemens, or approved equal, shall be furnished and installed (where not furnished by others) wherever shown on the drawings specified, or required by the National Electrical Code.

B. Safety switches shall be heavy duty type, Underwriters' Laboratories short circuit labeled for at least 100,000 amperes with class R rejection fuse holders so as to comply with NEC 100-9. Switches inside of building shall be furnished in NEMA 1 general purpose enclosures. Switches outside of building shall be furnished in NEMA 3R enclosures unless otherwise specified.

C. Each motor shall be provided with a disconnecting means in accordance with requirements of the national electrical code.

2.5 FUSES

A. This contractor shall furnish and install cartridge and plug type fuses as manufactured by the Bussman Manufacturing Company, Gould/Shawmut, Cefco, or approved equal, in all fusible equipment. Time-delay Trionic or Fusetron fuses, UL class rk5, shall be installed on all motor circuits. Non time-delay amp-trap (A2K OR A6K) or Bussman Limitron (KTN or KTS), UL class RK1 shall be installed on circuits feeding panelboards. All other circuits shall be protected by fault-trap, UL class RK5, fuses or approved equal. Class K fuses are not acceptable.

2.6 CONDUIT

A. All electrical wiring, including low voltage wiring, shall be installed in conduit as herein specified. No conduit or tubing of less than 3/4 inch nominal size shall be used below grade; no less than 1/2 inch nominal size shall be used above grade.

B. Underground conduit shall be schedule 40 epc-40-pvc. All conduits shall be installed with minimum 24 inch cover.

C. Conduit installed in concrete slabs or above ground shall be galvanized rigid steel or epc-40-pvc.

D. When PVC conduits penetrate concrete floor construction, contractor shall use rigid steel or IMC elbows and extension. PVC conduit/fittings shall not be permitted to be exposed above the floor.

E. Thin wall tubing shall be E.M.T.

F. All fittings shall be of the compression type and watertight for underground and in slab locations. Compression or screwed fittings for indoor.

G. Conduit for interior wiring, in general, shall be thin wall tubing unless otherwise noted.

H. Raceways shall be continuous from outlet to outlet and fitting to fitting. A run of conduit between outlets or fittings shall not contain more than the equivalent of four quarter-bends including those bends located immediately at the outlet or fitting. The radius of bends shall never be shorter than that of the corresponding trade elbow. The system shall be complete with outlets, distribution boxes, etc., smooth inside and mechanically secure in place. Approved straps, hangers, or supports shall be used to secure conduits in place. Conduits shall, in general, be supported at intervals not exceeding 10'-0" and within 3'-0" of each outlet box, junction box, cabinet or fitting.

I. Conduits shall be protected during construction; plug and keep clean and dry. Conduit ends shall be butted in centers of couplings. No cracks or flattened sections will be permitted at bends or elsewhere. All ends of conduit shall be reamed to remove rough edges. Running threads will not be permitted.

J. Conduits shall be concealed within the walls, ceilings, and floors where possible and unless otherwise noted. Exposed conduit shall be run parallel to or at right angles with the building lines.

2.7 WIRE AND CABLE

A. Wire and cable shall be copper.

B. All conductors shall be copper.

C. No. 10 AWG and smaller conductors shall be solid with type THHN insulation and no. 8 AWG and larger conductors shall be stranded with type THHN insulation except that conductors within 3 inches of light fixture ballasts shall have RHH, THHN, or equal insulation rated for 90 degrees c. Application.

2.8 IDENTIFICATION OF EQUIPMENT

A. All service entrance equipment, disconnect switches, panelboards, relays, motor starters, contactors, telephone terminal cabinets, TV equipment and riser junction boxes, and other electrical equipment under this contract, shall be provided with proper identification. Identification shall be by the use of engraved color coded plastic nameplates with white lettering screwed to the cover of the equipment. Use of embossed plastic "tape" labels as prepared by "typewriter" type equipment shall not be used. Color coding shall be as follows:

1. Equipment connected to a normal power source shall be black with white letters.

END OF SECTION 260000

SECTION 223400 – FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Commercial, power-vent, gas-fired, storage, domestic-water heaters.
   2. Domestic-water heater accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:
   1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of commercial, gas-fired domestic-water heater, from manufacturer.

B. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

C. Source quality-control reports.

D. Field quality-control reports.

E. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.

C. ASME Compliance:

1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures including storage tank and supports.
   b. Faulty operation of controls.
   c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Periods: From date of Substantial Completion.
   a. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:
      1) Storage Tank: Three years.
      2) Controls and Other Components: One year(s).
   b. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

A. Commercial, Power-Vent, Gas-Fired, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Water Heaters.
   b. Bradford White Corporation.
   c. Lochinvar, LLC.
   d. Rheem Manufacturing Company.
   e. Smith, A. O. Corporation.
   f. State Industries.
2. Standard: ANSI Z21.10.3/CSA 4.3.
3. Storage-Tank Construction: ASME-code steel with 150-psig working-pressure rating.
   a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.

2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

c. Lining: Glass complying with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

4. Factory-Installed Storage-Tank Appurtenances:

a. Anode Rod: Replaceable magnesium.

b. Dip Tube: Required unless cold-water inlet is near bottom of tank.

c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.

d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.

e. Jacket: Steel with enameled finish.

f. Burner: For use with power-vent, gas-fired, domestic-water heaters and natural-gas fuel.

g. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, electric, automatic, gas-ignition system.

h. Temperature Control: Adjustable thermostat.

i. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.

j. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

5. Special Requirements: NSF 5 construction.

6. Power-Vent System: Exhaust fan, interlocked with burner.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.

B. Heat-Trap Fittings: ASHRAE 90.2.

C. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

D. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include 1/2-psig pressure rating as required to match gas supply.

E. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.

F. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

2. Oil-Fired, Domestic-Water Heaters: ASME rated and stamped.

G. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic-water heaters and storage tanks specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters and storage tanks to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."

B. Install gas-fired, domestic-water heaters according to NFPA 54.

1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 231123 "Facility Natural-Gas Piping."

C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains.

Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."

E. Install thermometer on outlet piping of domestic-water heaters.

F. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

G. Fill domestic-water heaters with water.

H. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

A. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
   2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial, gas-fired, storage domestic-water heaters.

END OF SECTION 223400

SECTION 230000 – GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY OF WORK

A. The contract documents require the furnishing and installing of complete functioning mechanical systems, and each element thereof, as specified or indicated in the contract documents or reasonably inferred, to completely construct and leave ready for operation the systems as shown on the drawings and herein described, including every article, device or accessory, whether or not specifically called for by item. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.

B. Specifications and drawings are complementary and what is called for in one shall be as binding as if called for by both.

C. All work performed under this section shall be done in a neat and workmanlike manner by experienced mechanics of the proper trade.

1.2 COORDINATION, MEASUREMENTS AND LAYOUTS

A. The contractor shall inspect the site where this work is to be performed and fully familiarize himself with all conditions related to this project.

B. The contractor shall employ a competent foreman on the job to see that work is done in accordance with the best practices and in a satisfactory and workmanlike manner. The foreman shall keep informed as to the work of other trades engaged in the construction of the project, and shall execute his work in such a manner as not to interfere with or delay the work of other trades.

C. Drawings show the general arrangement of all systems and components covered under this section. Where local conditions necessitate a rearrangement, the contractor shall prepare, and submit for approval, drawings of the proposed rearrangement. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The contractor shall carefully investigate the structural and finish conditions affecting all of his work and shall arrange such work accordingly, furnishing such offsets, fittings and accessories as may be required to meet such conditions at no additional cost to the owner. The contractor shall verify all dimensions. Drawings shall not be scaled to determine dimension.

1.3 PERMITS AND FEES

A. The contractor shall obtain and pay for all required permits and licenses and shall make all deposits and pay all fees required for the performance of work under this section, other than those deposits or fees which are fully refundable to the owner.

1.4 SUBMITTALS, MATERIALS AND EQUIPMENT

A. All items of materials and equipment shall be new unless otherwise specified herein, free from defects and of the best quality normally used for the purpose in good commercial practice.

B. As soon as possible after the award of the contract, the contractor shall submit for review six copies of shop drawings for all equipment to be furnished for this project. Submittals shall include manufacturer's name, model number, descriptive engineering data and all necessary information as to finish, material gauges and accessories. After such shop drawings are processed, three copies will be returned to the contractor. The contractor shall, upon receipt of reviewed shop drawings proceed with the procurement and installation of such equipment.

1.5 CODES, LAWS, AND STANDARDS

A. All work shall be installed in compliance with all governing codes, applicable local laws, regulations, ordinances or statutes of regulatory bodies having jurisdiction. The work shall be executed in accordance with said laws, regulations, ordinances, statues or codes, without increased cost to the owner. Any point in question shall be referred to the engineer for approval. Work indicated on the documents that is in excess of code requirements shall not be reduced in quality and/or quantity.

B. Comply with rules and regulations of public utilities and municipal departments affected by connections of services.

1.6 RECORD DOCUMENTS

A. This contractor shall prepare a complete “as-built” set of drawings incorporating all changes made during construction. Location of underground piping shall be located by dimension from column lines.

B. This contractor shall prepare and submit to the owner's representative five bound sets of operating and maintenance manuals including final copies of equipment shop drawings, manufacturer's literature for all equipment installed on the project showing all details of equipment, replacement part data and maintenance and operating instructions. Manuals shall include copies of all equipment warranties.

1.7 GUARANTEES AND WARRANTIES

A. The contractor shall guarantee complete system operation and that the material and equipment furnished and installed will be free from defects in workmanship and materials and will give satisfactory service under the specified operating conditions. The contractor agrees to replace, without expense to the owner, any part of the apparatus which proves or becomes defective within one year after the system is accepted. No equipment warranty or guarantee shall start until the time of building acceptance.

B. All warranties issued by equipment manufacturers shall be filled out in the owner's name and given to the owner prior to final acceptance of work performed under this section.

1.8 FINAL INSPECTION

A. After completion of the entire project the contractor shall request final inspection of this project in written form addressed to the architect along with a statement to the effect that all installations have been completed, checked, adjusted and balanced in accordance with requirements of this project. Upon receipt of written notification of completion and request for final inspection the engineer will perform a final inspection of this work and, if all installations are as represented by the contractor, the engineer will submit written recommendation of acceptance.

1.9 CLEANING

A. Dirt and refuse resulting from the performance of the work shall be removed to keep the premises reasonable clean at all times.

B. After completion of the work described in this specification and shown on the drawings, the contractor shall thoroughly clean all exposed surfaces and equipment, remove all dirt, debris, crating, cartons, etc., and leave all installations finished and ready for operation.

1.10 OPENINGS AND SLEEVES

A. All piping through exterior or foundation walls shall pass through schedule 40 galvanized steel sleeves which shall be large enough to allow for pipe seal material. Sleeves in new construction shall have a minimum 2 inch water stop in the center of the sleeve. No sleeves are permitted through concrete structural members.

1. Space between pipe and sleeve in exterior underground walls shall be sealed with link-seal, flexicraft or metraflex link style pipe seals.
2. In above grade exterior walls pack the space between pipe and sleeve with mineral wool and then complete seal with approved caulking compound flush with finished surface. Provide pipe collar on interior side of wall.

B. All piping through floors shall be provided with schedule 40 galvanized steel pipe sleeves, extending 1 inch above the floor.

C. In fire rated walls: caulking shall be a pure ceramic fiber made of alumina-silica, "CERAFIBER-FS" by Johns-Manville. Sealant shall be gun grade. An acrylic 2-part gun applied, fire retardant elastic sealant, "DYMERIC" by Tremco or equal by Permatite No. 1113FR.

1. Limit the size of the space between the wall or floor and the outside of the pipe or duct to 1 inch maximum. This space is sufficient to allow some movement of the pipes or duct without cracking the caulking or sealant.
2. For openings in walls, the caulking shall be applied to a minimum of 3 inch total depth. Sealant shall then be applied on both sides of the wall opening a minimum of 1/2 inch in depth, finished flush with the wall. D.

D. For openings in floors, the caulking shall be applied from the upper side to a minimum of 3 inch total depth recessed 1/2 inch below the finished floor. This 1/2 inch recess shall then be filled with sealant to flush with finished floor.

1.11 CUTTING AND PATCHING

A. The contractor shall be responsible for any cutting of walls, floors, ceilings and roofs required for performance of his work.

B. No structural member shall be cut without permission from the architect.

C. Patch all openings to match adjacent construction in both material and finish.

D. All cutting of existing concrete floors/slabs on grade in the interior of the building shall be performed by "saw cutting" and shall be performed by this contractor.

1.12 DEMOLITION AND NEW WORK

A. The contractor shall do all demolition, alterations and rework indicated and/or required to maintain the operation of all existing HVAC systems and to integrate the new systems in the renovated building as required. The contractor shall include all work which may be required to alterations and demolition work. This shall include all removal, relocation and reworking of piping, items of HVAC equipment, etc. Existing systems and new systems shall be completely integrated as intended and as indicated on the plans and in the specifications.

B. The contractor shall remove from the premises and dispose of properly all existing material and equipment which no longer serves a purpose in altered areas. The contractor shall remove unused ductwork and piping. Remove piping connected to equipment back to main and cap. Unless otherwise noted, the contractor shall maintain services to all existing areas requiring such services. The contractor shall reroute as required such services where are disrupted due to architectural changes in the existing structure. Any equipment which is designated to be reused and which is damaged in the process shall be replaced by the contractor with new equipment of like kind at no cost to the owner.

1.13 INTERRUPTION OF SERVICES

A. The contractor shall schedule any service interruptions to the existing building with the owner’s representative. Such interruptions shall be planned so as to be at times to cause the least inconvenience and interruption to the facility’s schedule.

1.14 EXISTING CONDITIONS

A. All existing conditions shown on the drawings and described in the specifications for this project have been determined from available drawings and field investigations. Contractors making proposals for this work shall investigate all existing conditions and base their proposals on their observations to provide complete and functioning installations in accordance with the intent of the drawing and specifications for this project and all applicable governing codes, rules, regulations and ordinances. Failure to determine existing conditions which cause additional work will not constitute grounds for additional compensation.

PART 2 - HEATING, VENTILATING AND AIR CONDITIONING

2.1 GENERAL REQUIREMENTS

A. See part 1 for general requirements.

2.2 BELT DRIVES AND GUARDS

A. All belt drives shall be of the multiple "v" type, Dayton, Gates or equal. Standard slide rails or other means of belt adjustment shall be provided for each motor used with a belt drive.

B. Removable steel guards with expanded metal screens of acceptable design shall be provided over all exposed belt drives and couplings.

2.3 FILTERS

A. The contractor shall only run all air handling units in the building during the testing period prior to completion of the work. Units shall not be run without filters in place.

B. Filters shall be as manufactured by American Air Filter, Camfil Farr or Cambridge.

2.4 FLEXIBLE CONNECTORS

A. The contractor shall install flexible duct connections between each piece of equipment having a fan, and its sheet metal supply and return ductwork connections, which, when completed shall be airtight.

B. Connectors shall provide a minimum of 2 inches between metal to insure against transmission of vibration from the fan unit to the ductwork.

2.5 MOTORS AND STARTERS

A. All electric motors shall be furnished for operation on electrical services as designated and shall have starting torque characteristics suitable for the equipment served. Any changes to the electrical wiring due to equipment being furnished, other than that specified, is the responsibility of the contractor.

B. Across-the-line manual starters and magnetic starters shall be cutler-hammer products or approved equal, unless otherwise specified, of sizes required for the motor horsepower and phase served. Starters located in equipment areas and unfinished spaces may be surface mounted types with functions identified by engraved plastic plates.

C. The mechanical contractor shall furnish to the electrical contractor all starters and starter overloads, all necessary wiring diagrams and instructions to facilitate the installation of power and control wiring to all equipment.

2.6 SHEET METAL DUCTWORK

A. Sheet metal ducts and connections shall be constructed of g90 galvanized sheets of mild steel. The ducts shall be constructed to the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) 2” w.g. pressure class standards. No duct shall be constructed with less than 24 gauge metal. Local codes requiring heavier gauges shall govern. All ducts shall be sealed to SMACNA “B” classification.

B. Duct sections shall be joined in accordance with the recommendations of the Sheet Metal and Air Conditioning Contractors National Association and requirements of the building code having jurisdiction.

C. Duct dimensions shown are sheet metal dimensions and do not need to be adjusted for insulation/lining.

D. Curved elbows shall be constructed with inside radius not less than the duct width in the same plane. Square elbows shall have turning vanes. Turning vanes shall be designed in accordance with ASHRAE recommendations. Manufactured vanes shall be by Titus or approved equal.

E. Cross break all ductwork surfaces over 18 inches in width.

F. Full areas shall be maintained in transitions where a change in the configuration of the duct occurs. All tapering joints shall be reduced gradually.

G. Joints in ducts shall be made practically airtight and any open corner shall be neatly patched and soldered tight. Duct tape will not be accepted as a joint patch. Low pressure system duct leakage shall not exceed 2%.

H. Concealed round ducts shall be constructed to SMACNA 2” w.g. standards with grooved longitudinal seams and sleeved type transverse joints.

I. Exposed round ducts shall be constructed to SMACNA 10” w.g. standards, spiral lock seam duct and fittings.

2.7 DUCT LINER

A. All rectangular outside air intake, supply, return and transfer air ductwork shall be lined with 1/2" thick 2 lb. Density CertainTeed tough guard duct liner or equal from Manville, Knauf insulation, or Owens Corning unless noted otherwise on the drawings. All duct liner is to comply and be installed in accordance to NAIMA fibrous glass duct liner standard and SMACNA.

2.8 FLEXIBLE DUCT

A. Flexible ducts shall be UL181 class THERMAFLEX M-KE, or approved equal, shall not be longer than 8 feet and shall not have any air flow obstruction.

2.9 DUCTWORK SUPPORTS

A. All horizontal ducts shall be supported with hangers spaced not more than 8'-0" apart. Hangers for ducts smaller than 31 inches shall consist of 22 gauge galvanized steel straps securely fastened to the duct and the building construction. Ducts over 31 inches in width shall be hung with 1/4 inch steel angle on the bottom of the duct supported with steel rods of appropriate size securely fastened to the building structure. All supports to meet SMACNA standards.

2.10 DUCTWORK INSULATION

A. All concealed round ducts shall be insulated with 1-1/2 inch thick, 1 pound per cubic foot density, certain-teed duct wrap insulation faced on one side with .002 inch aluminum foil with a 2 inch tab, or equal products by Manville, Knauf insulation, or Owens Corning unless noted otherwise on the drawings. Insulation shall be applied in strict compliance with the manufacturer's recommendations.

B. All insulation shall be UL listed; flame spread/fuel contributed/smoke developed rating of 25/50/50 or less in accordance with ASTM E84, NFPA 255 and UL 723.

2.11 GRILLES, REGISTERS, DIFFUSERS AND LOUVERS

A. Furnish and install all grilles, registers, diffusers and louvers as shown and described on the drawings or comparable products of Titus or Price.

B. The contractor shall inform the general contractor of the requirements for opening sizes and framing for all equipment and shall coordinate the installation of all such equipment with the structural requirements of this project.

2.12 OPERATING AND MAINTENANCE MANUALS

A. The equipment manufacturer shall furnish the owner two bound sets of operating and maintenance instructions for all systems.

2.13 START-UP/TESTING, ADJUSTING, BALANCING

A. The contractor shall complete all equipment installations, check all control wiring, start up and adjust all equipment and place all systems in operation.

B. After completion and start-up of all systems the contractor shall arrange for testing, adjusting and balancing of all air systems.

C. Testing, adjusting and balancing of all air systems shall be performed in complete accordance with NEBB or SMACNA standards.

D. Upon completion of testing, adjusting and balancing, a complete report of all findings shall be submitted to the engineer prior to final acceptance of this project. Three copies of the report shall be provided.

2.14 CURBS

A. Curbs for exhausters and ductwork through roof shall be pate type pc as required by roof construction, or comparable Thycurb products of the Thybar Corp. All curbs and supports shall be constructed as required to compensate for slopes of the roof structure to provide level support of equipment. Curb heights at the high points of the building structure shall not be less than 14 inches.

B. Curbs for roof mounted heating, ventilating and air conditioning units shall be provided by the equipment manufacturer and shall be designed to compensate for slopes of structural steel to provide level support of equipment. Curbs shall be insulated type with 1-1/2 inch thick insulation and a minimum density of 3 pounds.

2.15 DAMPERS

A. Volume balancing dampers shall be Ruskin CD-35/CDR-25 or approved equal. The dampers shall be constructed of 16 gauge galvanized steel, 6 inch wide opposed blades and the linkage concealed in frame.

B. Fire dampers shall be provided where shown on the drawings and elsewhere as required by authorities having jurisdiction and shall be Ruskin type IBD2, style B, or comparable products of Vent Products Company, Inc., curtain type having 100% free area with 212 degrees F. Fusible link approved for use in partitions with two hour rating unless otherwise noted. Access panels shall be provided in ducts and in the structure for all fire dampers. Installation shall be in accordance with the manufacturer's standards.

2.16 PAINTING: (SEE ARCHITECTURAL SECTION "PAINTING")

A. Painting, except as specified herein, shall be done by others.

B. Equipment which has damaged finish shall be repainted to match the original factory finish.

C. All exposed ferrous metal furnished under this contract, such as hangers, struts, structural steel, etc., shall be given one coat of tnemec gray primer.

2.17 GAS PIPING

A. Schedule 40 black steel piping: 2" and smaller with screwed joints and 150 lb. Malleable iron screwed fittings. Pipe 2-1/2" and larger shall use standard weight black steel welding fittings with welded joints.

B. Gas valves 2" and smaller shall be Milwaukee bb2-100, butterfly valve, bronze, Viton seats and packing, 175 lbs. AGA/UL listed. Valves 2-1/2" and larger shall be Rockwell 142/143 lubricated cock.

END OF SECTION 230000

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Separately coupled, base-mounted, end-suction centrifugal pumps.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of pump.

B. Shop Drawings: For each pump.
1. Show pump layout and connections.
2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
3. Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:
1. Armstrong Pumps Inc.
2. Bell & Gossett; Div. of ITT Industries.
3. Taco, Inc.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for 125-psig minimum working pressure and a continuous water temperature of 200 deg F.

C. Pump Construction:
1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded union end connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
5. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
6. Pump Bearings: Permanently lubricated ball bearings.

D. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Division 15 Section "Motors."

E. Capacities and Characteristics:
1. See schedule on the drawings.

PART 3 - EXECUTION

3.1 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

3.2 ALIGNMENT

A. Engage a factory-authorized service representative to perform alignment service.

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

C. Comply with pump and coupling manufacturers' written instructions.

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.3 CONNECTIONS

A. Where installing piping adjacent to pump, allow space for service and maintenance.

B. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

D. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.

E. Install check valve and gate or ball valve on each condensate pump unit discharge.

3.4 STARTUP SERVICE

A. Perform startup service.
    1. Complete installation and startup checks according to manufacturer's written instructions.
    2. Check piping connections for tightness.
    3. Clean strainers on suction piping.
    4. Perform the following startup checks for each pump before starting:
        a. Verify bearing lubrication.
        b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
        c. Verify that pump is rotating in the correct direction.
    5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
    6. Start motor.
    7. Open discharge valve slowly.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 232123

SECTION 235216 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, finned water-tube boilers, trim, and accessories for generating hot water.

B. This Section includes packaged, water-tube boilers, trim, and accessories for generating hot water with the following configurations, burners, and outputs:
   1. Factory assembled.
   2. Forced-draft gas burner.

1.3 SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Source quality-control test reports.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For boilers, components, and accessories to include in emergency, operation, and maintenance manuals.

F. Warranty: Special warranty specified in this Section.

G. Other Informational Submittals:
   1. Startup service reports.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

D. I=B=R Compliance: Boilers shall be tested and rated according to HI's "Rating Procedure for Heating Boilers" and "Testing Standard for Commercial Boilers," with I=B=R emblem on a nameplate affixed to boiler.

E. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace heat exchangers damaged by thermal shock and vent dampers of boilers that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Heat Exchangers: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FINNED WATER-TUBE BOILERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Laars Heating Systems;
   2. Lochinvar Corporation.
   3. Aerco
   4. Raypak.
   5. HTP

B. Description: Factory-fabricated, -assembled, and -tested boiler with tubes sealed into headers pressure tight, and set on a steel base; including insulated jacket, flue-gas vent, combustion-air intake connections, water supply and return connections, and controls.

C. Heat Exchanger:
   1. Water-tube, stainless-steel rated to 160 psi.

D. Combustion Chamber Internal Insulation: Interlocking panels of refractory insulation, high-temperature cements, mineral fiber, and ceramic refractory tile for service temperatures to 2000 deg F.

E. Casing:
   1. Jacket: Sheet metal, with snap-in or interlocking closures.
   2. Control Compartment Enclosure: NEMA 250, Type 1A.

3. Finish: Baked enamel over primer.
4. Insulation: Minimum 1-inch-thick, mineral-fiber insulation surrounding the heat exchanger.
5. Combustion-Air Connection: Inlet duct collar and sheet metal closure over burner compartment.

F. Burner:
1. Burner Tubes and Orifices: Stainless steel, for natural gas.
   a. Sealed Combustion: Factory-mounted centrifugal fan to draw outside air into boiler and discharge into burner compartment.
   b. Direct Vent: Factory-mounted centrifugal fan to draw flue gas out of boiler and discharge into boiler vent.
2. Gas Train: Control devices and full-modulation control sequence shall comply with requirements in ASME CSD-1. In addition to these requirements, include shutoff cock, pressure regulator, and control valve.
3. Pilot: Intermittent-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.
4. Flue-Gas Recirculation Fans: Centrifugal fans on burner assembly to recirculate flue gas to decrease oxides of nitrogen emissions to less than 30 ppm.
   a. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

G. Trim:
1. Aquastat Controllers: Operating, firing rate, and high limit.
2. Safety Relief Valve: ASME rated.
3. Pressure and Temperature Gage: Minimum 3-1/2-inch-diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
4. Boiler Air Vent: Automatic.
5. Drain Valve: Minimum NPS 3/4 hose-end gate valve.

H. Controls:
1. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
   a. Monitoring: On/off status, common trouble alarm, low water level alarm.
   b. Control: On/off operation, hot water supply temperature set-point adjustment.
   c. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

2.2 ELECTRICAL POWER

A. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
1. House in NEMA 250, Type 1 enclosure.
2. Wiring shall be numbered and color-coded to match wiring diagram.

3. Install factory wiring outside of an enclosure in a metal raceway.
4. Field power interface shall be to fused disconnect switch.
5. Provide branch power circuit to each motor and to controls with disconnect switch or circuit breaker.
6. Provide each motor with overcurrent protection.

2.3 VENTING KITS

A. Vent Damper: Motorized, UL listed for use on atmospheric burner boiler equipped with draft hood; motor to open and close damper; stainless-steel vent coupling and damper blade; keyed wiring harness connector plug; and dual-position switches to permit burner operation.

2.4 CAPACITIES AND CHARACTERISTICS

A. Refer to Schedule on Drawings.

2.5 SOURCE QUALITY CONTROL

A. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

B. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before boiler installation examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations and piping and electrical connections to verify actual locations, sizes and other conditions affecting boiler performance, maintenance and operations.
   1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

A. Install boilers level on concrete bases. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.

B. Install gas-fired boilers according to NFPA 54.

C. Assemble and install boiler trim.

D. Install electrical devices furnished with boiler but not specified to be factory mounted.

E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 sections. Drawings indicate general arrangement of piping, fittings and specialties.

B. Install piping adjacent to boiler to permit service and maintenance.

C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect gas piping to boiler gas-train inlet with unions. Piping shall be at least full size of gas train connection. Provide a reducer if required.

E. Connect hot-water piping to supply and return boiler tappings with shutoff valve and union or flange at each connection.

F. Install piping from safety relief valves to nearest floor drain.

G. Boiler Venting
   1. Install flue venting kit and combustion-air intake.
   2. Connect venting full size to boiler connections.

H. Ground equipment

I. Connect wiring.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections
   1. Perform installation and startup checks according to manufacturer's written instructions.
   2. Perform hydrostatic test. Repair leaks and retest until no leaks exist.
   3. Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
      a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
      b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Remove and replace malfunctioning units and retest as specified above.

D. Occupancy Adjustments: When requested within 2 months of date of Substantial Completion, provide on-site assistance adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

E. Performance Tests:
1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of boilers.
   a. Test for full capacity.
   b. Test for boiler efficiency at low fire 20, 40, 60, 80 and 100 percent of full capacity. Determine efficiency at each test point.
4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
7. Notify Architect in advance of test dates.
8. Document test results in a report and submit to Architect.

END OF SECTION 235216

SECTION 237416 - PACKAGED, ROOFTOP AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Schedules and general provisions of the Request for Proposal apply to this Section.

1.2 SUMMARY

A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories where listed on the schedule:
   1. Direct-expansion cooling.
   2. Hot-gas reheat (as applicable).
   3. Gas furnace.
   4. Economizer outdoor- and return-air damper section.
   5. Thermostat interface for operation with building temperature control system.
   6. Roof curb adapter as required.
   7. Heat Recovery Wheels (as applicable).

1.3 DEFINITIONS

A. DDC: Direct-digital controls.

B. ECM: Electrically commutated motor.

C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.4 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Performance:

1. Basic Wind Speed: 90 mph.
2. Building Classification Category: III.
3. Minimum 10 lb/sq. ft multiplied by the maximum area of the mechanical component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

1.5 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Manufacturer Wind Loading Qualification Certification: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control test reports.

C. Warranty: Special warranty specified in this Section.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: One set for each belt-driven fan.
2. Filters: One set of filters for each unit.

1.9 QUALITY ASSURANCE

A. ARI Compliance:

1. Comply with ARI 203/110 and ARI 303/110 for testing and rating energy efficiencies for RTUs.
2. Comply with ARI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:
1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

E. UL Compliance: Comply with UL 1995.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.
1. Warranty Period for entire unit: Not less than one year from date of Substantial Completion.
2. Warranty Period for compressors: Not less than five years from date of Substantial Completion.
3. Warranty Period for stainless steel gas furnace heat exchangers: Not less than fifteen years from date of Substantial Completion

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Aaon
2. Engineered Air
3. Approved Equal.

2.2 CASING

A. General Fabrication Requirements for Casings: Formed and reinforced insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed. Service doors shall be hinged with toolless access for easy servicing and maintenance.

B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
1. Exterior Casing Thickness: 0.0626 inch thick, minimum.

C. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
   1. Materials: ASTM C 1071, Type I.
   2. Thickness: 1/2 inch.
   3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
   4. Liner Adhesive: Comply with ASTM C 916, Type I.

D. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.1.
   1. Insulation: Insulation to be thickness required to prevent condensation.
   2. Drain Connections: Threaded nipple.
   3. Pan-Top Surface Coating: Corrosion-resistant compound.

E. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

F. Vibration isolation shall be provided internal to the unit to prevent transmission of vibration from compressors and fans.

2.3 FANS

A. Direct-Driven Supply-Air Fans: Double width, centrifugal; with permanently lubricated, variable-speed or ECM motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

B. Belt-Driven Supply-Air Fans: Double width, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

C. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.

D. Relief-Air Fan: Centrifugal, shaft mounted on permanently lubricated motor.

E. Fan Motor: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.4 COILS

A. Supply-Air Refrigerant Coil:
   1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
   2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
   3. Coil Split: Interlaced.
   4. Condensate Drain Pan: Stainless steel formed with pitch and drain connections complying with ASHRAE 62.1.

B. Outdoor-Air Refrigerant Coil:
   1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.

2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.

C. Hot-Gas Reheat Refrigerant Coil:

1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.

2.5 REFRIGERANT CIRCUIT COMPONENTS

A. Number of Refrigerant Circuits: As shown on schedule.

B. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.

C. Refrigeration Specialties:

1. Refrigerant: R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.
9. Hot-gas reheat solenoid valve with a replaceable magnetic coil.

2.6 AIR FILTRATION

A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Pleated: Minimum MERV 8.

2.7 GAS FURNACE

A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.

1. CSA Approval: Designed and certified by and bearing label of CSA.

B. Burners: Stainless steel.

1. Fuel: Natural gas.
2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.

C. Heat-Exchanger and Drain Pan: Stainless steel.

D. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.

E. Safety Controls:

1. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.8 DAMPERS

A. Outdoor- and Return-Air Mixing Dampers: Opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
   1. Damper Motor: Modulating with adjustable minimum position.
   2. Relief-Air Damper: Gravity actuated, as required by ASHRAE/IESNA 90.1, with bird screen and hood.

2.9 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.10 CONTROLS

A. Basic Unit Controls:
   1. Control-voltage transformer.
   2. Electro-mechanical unit controls
   3. Temperature Control System contractor will provide unit controls which will operate the unit through the conventional thermostat interface.

B. Interface Requirements for HVAC Instrumentation and Control System:
   1. Conventional thermostat interface for temperature controls to be provided by others.

2.11 ACCESSORIES

A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.

B. Hail guards of galvanized steel, painted to match casing.

2.12 ROOF CURB ADAPTERS

A. Materials: Fully welded, galvanized steel with corrosion-protection coating, watertight gaskets, and factory-applied internal insulation.
   1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
      a. Materials: ASTM C 1071, Type I or II.
      b. Thickness: 1-1/2 inches.
   2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb adapter.
      a. Liner Adhesive: Comply with ASTM C 916, Type I.

b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to adapter without damaging liner when applied as recommended by manufacturer and without causing leakage in adapter.

c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.

d. Liner Adhesive: Comply with ASTM C 916, Type I.

B. Wind: Metal brackets compatible with the curb, adapter and casing, used to anchor unit to the curb adapter, and adapter to the curb, and designed for loads at Project site.

2.13 CAPACITIES AND CHARACTERISTICS

A. Shall be per schedule.

2.14 HEAT WHEELS

A. Casing:

1. Steel with standard factory-painted finish.
2. Casing seals on periphery of rotor and on duct divider.
3. Support vertical rotors on grease-lubricated ball bearings having extended grease fittings. Support horizontal rotors on tapered roller bearing.

B. Rotor: Aluminum segmented wheel strengthened with radial spokes, with nontoxic, noncorrosive, silica-gel desiccant coating.

1. Maximum Solid Size for Media to Pass: 600 micrometer.

C. Drive: Fractional horsepower motor and gear reducer, and self-adjusting multilink belt around outside of rotor.

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

D. Disposable Panel Filters:

1. Comply with NFPA 90A.
2. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
3. Factory-fabricated, viscous-coated, flat-panel type.
4. Thickness: 1 inch for outside air hood and 2 inch for return air.
5. MERV: 5, according to ASHRAE 52.2 for return air filters.
6. Media: Interlaced glass fibers sprayed with nonflammable adhesive for return air and permanent aluminum washable type for outside air.
7. Frame: Galvanized steel with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where RTUs will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Equipment Mounting:
   1. Roof Curb: Install on existing roof curb, level and secure, according to ARI Guideline B. Secure RTUs to upper curb rail.

3.3 CONNECTIONS

A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain. Paint PVC drain piping with UV-resistant paint.

B. Install piping adjacent to RTUs to allow service and maintenance.
   1. Gas Piping: Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service. Provide pressure reducing valves as required to meet manufacturer's pressure requirements.

C. The following are specific connection requirements:
   1. Install ducts to termination at top of roof curb.
   2. Install return-air duct continuously through roof structure.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Provide a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Tests and Inspections:
   1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
   2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Provide a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to furnace combustion chamber.
3. Inspect for visible damage to compressor, coils, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean condenser coil and inspect for construction debris.
10. Clean furnace flue and inspect for construction debris.
11. Connect and purge gas line.
12. Remove packing from vibration isolators.
13. Inspect operation of barometric relief dampers.
14. Verify lubrication on fan and motor bearings.
15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
16. Adjust fan belts to proper alignment and tension.
17. Start unit according to manufacturer's written instructions.
    a. Start refrigeration system.
    b. Do not operate below recommended low-ambient temperature.
    c. Complete startup sheets and attach copy with Contractor's startup report.
18. Inspect and record performance of interlocks and protective devices; verify sequences.
19. Operate unit for an initial period as recommended or required by manufacturer.
20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
    a. Measure gas pressure on manifold.
    b. Inspect operation of power vents.
    c. Measure combustion-air temperature at inlet to combustion chamber.
    d. Measure flue-gas temperature at furnace discharge.
    e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
    f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
21. Calibrate thermostats.
22. Adjust and inspect high-temperature limits.
23. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
24. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
    a. Coil leaving-air, dry- and wet-bulb temperatures.

b. Coil entering-air, dry- and wet-bulb temperatures.

c. Outdoor-air, dry-bulb temperature.

d. Outdoor-air-coil, discharge-air, dry-bulb temperature.

25. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.

26. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.

a. Supply-air volume.

b. Return-air volume.

c. Relief-air volume.

d. Outdoor-air intake volume.

27. Simulate maximum cooling demand and inspect the following:

a. Compressor refrigerant suction and hot-gas pressures.

b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.

28. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.

B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

A. Provide a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs.

END OF SECTION 237413

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: One set(s) for each air-handling unit.
   2. Gaskets: One set(s) for each access door.
   3. Fan Belts: One set(s) for each air-handling unit fan.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:
   1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:
   a. For Compressor: One year from date of Substantial Completion.
   b. For Parts: One year from date of Substantial Completion.
   c. For Labor: One yeas from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. LG
2. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
3. York.
4. Trane
5. Samsung

2.2 INDOOR UNITS 5 TONS OR LESS)

A. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
3. Fan: Direct drive, centrifugal.
4. Fan Motors:
   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements.
   b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
   c. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
   d. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
   e. Mount unit-mounted disconnect switches on interior of unit.
5. Condensate Drain Pans:

a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
   1) Depth: A minimum of 1 inch deep.
b. Single-wall, galvanized-steel sheet.
c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
   1) Minimum Connection Size: NPS 3/4.

6. Air Filtration Section:
   a. General Requirements for Air Filtration Section:
      1) Comply with NFPA 90A.
      2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
      3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
   b. Disposable Panel Filters:
      1) Factory-fabricated, viscous-coated, flat-panel type.
      2) Thickness: 1 inch.
      3) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

2.3 OUTDOOR UNITS 5 TONS OR LESS

A. Air-Cooled, Compressor-Condenser Components:
1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
   a. Compressor Type: Scroll.
   b. Refrigerant Charge: R-407C or R-410A.
   c. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 45 deg F (7 deg C).
7. Mounting Base: Polyethylene.

2.4 ACCESSORIES

A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

D. Drain Hose: For condensate.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install roof-mounted, compressor-condenser components on equipment supports. Anchor units to supports with removable, cadmium-plated fasteners.

D. Equipment Mounting:
1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s).
2. Comply with requirements for vibration isolation and seismic control devices/

E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

C. Tests and Inspections:
1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126

SECTION 260000 – GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY OF WORK

A. The contract documents require the furnishing and installing of complete functioning electrical systems, and each element thereof, as specified or indicated in the contract documents or reasonably inferred, to completely construct and leave ready for operation the systems as shown on the drawings and herein described, including every article, device or accessory, whether or not specifically called for by item. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.

B. Specifications and drawings are complementary and what is called for in one shall be as binding as if called for by both.

C. All work performed under this section shall be done in a neat and workmanlike manner by experienced mechanics of the proper trade.

1.2 COORDINATION, MEASUREMENTS AND LAYOUTS

A. The contractor shall inspect the site where this work is to be performed and fully familiarize himself with all conditions related to this project.

B. The contractor shall employ a competent foreman on the job to see that work is done in accordance with the best practices and in a satisfactory and workmanlike manner. The foreman shall keep informed as to the work of other trades engaged in the construction of the project, and shall execute his work in such a manner as not to interfere with or delay the work of other trades.

C. Drawings show the general arrangement of all systems and components covered under this section. Where local conditions necessitate a rearrangement, the contractor shall prepare, and submit for approval, drawings of the proposed rearrangement. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The contractor shall carefully investigate the structural and finish conditions affecting all of his work and shall arrange such work accordingly, furnishing such offsets, fittings and accessories as may be required to meet such conditions at no additional cost to the owner. The contractor shall verify all dimensions. Drawings shall not be scaled to determine dimension.

1.3 PERMITS AND FEES

A. The contractor shall obtain and pay for all required permits and licenses and shall make all deposits and pay all fees required for the performance of work under this section, other than those deposits or fees which are fully refundable to the owner.

1.4 SUBMITTALS, MATERIALS AND EQUIPMENT

A. All items of materials and equipment shall be new unless otherwise specified herein, free from defects and of the best quality normally used for the purpose in good commercial practice.

B. As soon as possible after the award of the contract, the contractor shall submit for review six copies of shop drawings for all equipment to be furnished for this project. Submittals shall include manufacturer's name, model number, descriptive engineering data and all necessary information as to finish, material gauges and accessories. After such shop drawings are processed, three copies will be returned to the contractor. The contractor shall, upon receipt of reviewed shop drawings proceed with the procurement and installation of such equipment.

1.5 CODES, LAWS, AND STANDARDS

A. All work shall be installed in compliance with the national electrical code, the national board of fire underwriters, the national electrical safety code, and all governing codes, applicable local laws, regulations, ordinances or statutes of regulatory bodies having jurisdiction. The work shall be executed in accordance with said laws, regulations, ordinances, statues or codes, without increased cost to the owner. Any point in question shall be referred to the engineer for approval. Work indicated on the documents that is in excess of code requirements shall not be reduced in quality and/or quantity.

B. Comply with rules and regulations of public utilities and municipal departments affected by connections of services.

1.6 RECORD DOCUMENTS

A. This contractor shall prepare a complete “as-built” set of drawings incorporating all changes made during construction. Location of underground conduit shall be located by dimension from column lines.

B. This contractor shall prepare and submit to the owner's representative five bound sets of operating and maintenance manuals including final copies of equipment shop drawings, manufacturer's literature for all equipment installed on the project showing all details of equipment, replacement part data and maintenance and operating instructions. Manuals shall include copies of all equipment warranties.

1.7 GUARANTEES AND WARRANTIES

A. The contractor shall guarantee complete system operation and that the material and equipment furnished and installed will be free from defects in workmanship and materials and will give satisfactory service under the specified operating conditions. The contractor agrees to replace, without expense to the owner, any part of the apparatus which proves or becomes defective within one year after the system is accepted. No equipment warranty or guarantee shall start until the time of building acceptance.

B. All warranties issued by equipment manufacturers shall be filled out in the owner's name and given to the owner prior to final acceptance of work performed under this section.

1.8 FINAL INSPECTION

A. After completion of the entire project the contractor shall request final inspection of this project in written form addressed to the architect along with a statement to the effect that all installations have been completed, checked, adjusted and balanced in accordance with requirements of this project. Upon receipt of written notification of completion and request for final inspection the engineer will perform a final inspection of this work and, if all installations are as represented by the contractor, the engineer will submit written recommendation of acceptance.

1.9 CLEANING

A. Dirt and refuse resulting from the performance of the work shall be removed to keep the premises reasonable clean at all times.

B. After completion of the work described in this specification and shown on the drawings, the contractor shall thoroughly clean all exposed surfaces and equipment, remove all dirt, debris, crating, cartons, etc., and leave all installations finished and ready for operation.

1.10 OPENINGS AND SLEEVES

A. All piping through exterior or foundation walls shall pass through schedule 40 galvanized steel sleeves which shall be large enough to allow for pipe seal material. Sleeves in new construction shall have a minimum 2 inch water stop in the center of the sleeve. No sleeves are permitted through concrete structural members.

1. Space between pipe and sleeve in exterior underground walls shall be sealed with link-seal, Flexicraft or Metraflex link style pipe seals.
2. In above grade exterior walls pack the space between pipe and sleeve with mineral wool and then complete seal with approved caulking compound flush with finished surface. Provide pipe collar on interior side of wall.

B. All piping through floors shall be provided with schedule 40 galvanized steel pipe sleeves, extending 1 inch above the floor.

C. In fire rated walls: caulking shall be a pure ceramic fiber made of alumina-silica, "CERAFIBER-FS" by Johns-Manville. Sealant shall be gun grade. An acrylic 2-part gun applied, fire retardant elastic sealant, "DYMERIC" by Tremco or equal by Permatite No. 1113FR.

1. Limit the size of the space between the wall or floor and the outside of the pipe or duct to 1 inch maximum. This space is sufficient to allow some movement of the pipes or duct without cracking the caulking or sealant.
2. For openings in walls, the caulking shall be applied to a minimum of 3 inch total depth. Sealant shall then be applied on both sides of the wall opening a minimum of 1/2 inch in depth, finished flush with the wall.

D. For openings in floors, the caulking shall be applied from the upper side to a minimum of 3 inch total depth recessed 1/2 inch below the finished floor. This 1/2 inch recess shall then be filled with sealant to flush with finished floor.

1.11 CUTTING AND PATCHING

A. The contractor shall be responsible for any cutting of walls, floors, ceilings and roofs required for performance of his work.

B. No structural member shall be cut without permission from the architect.

C. Patch all openings to match adjacent construction in both material and finish.

D. All cutting of existing concrete floors/slabs on grade in the interior of the building shall be performed by "saw cutting" and shall be performed by this contractor.

1.12 DEMOLITION AND NEW WORK

A. The contractor shall do all demolition, alterations and rework indicated and/or required to maintain the operation of all existing electrical systems and to integrate the new systems in the renovated building as required. The contractor shall include all work which may be required to alterations and demolition work. This shall include all removal, relocation and reworking of wire and conduit, outlet boxes, junction boxes, etc. Existing systems and new systems shall be completely integrated as intended and as indicated on the plans and in the specifications.

B. The contractor shall remove from the premises and dispose of properly all existing material and equipment which no longer serves a purpose in altered areas. The contractor shall remove connections to equipment back to panel or junction box. Maintain circuit connectivity. Unless otherwise noted, the contractor shall maintain services to all existing areas requiring such services. The contractor shall reroute as required such services where are disrupted due to architectural changes in the existing structure. Any equipment which is designated to be reused and which is damaged in the process shall be replaced by the contractor with new equipment of like kind at no cost to the owner.

1.13 INTERRUPTION OF SERVICES

A. The contractor shall schedule any service interruptions to the existing building with the owner's representative. Such interruptions shall be planned so as to be at times to cause the least inconvenience and interruption to the facility's schedule.

1.14 EXISTING CONDITIONS

All existing conditions shown on the drawings and described in the specifications for this project have been determined from available drawings and field investigations. Contractors making proposals for this work shall investigate all existing conditions and base their proposals on their observations to provide complete and functioning installations in accordance with the intent of the drawing and specifications for this project and all applicable governing codes, rules, regulations and ordinances. Failure to determine existing conditions which cause additional work will not constitute grounds for additional compensation.

PART 2 - ELECTRICAL

2.1 GENERAL REQUIREMENTS

A. See part 1 for general requirements.

2.2 IDENTIFICATION OF SWITCHES AND APPARATUS

A. All cabinets, safety switches, and other apparatus used for operation and control of circuits, appliances, and equipment under this contract shall be properly identified by means of engraved plastic plates either black with white letters or white with black letters.

2.3 GROUNDING

A. All conductors, motor frames, raceways, cabinets, etc., that require grounding shall be grounded in accordance with the requirements of article 250 of the national electrical code, those of the serving utility and local authorities having jurisdiction.

2.4 SAFETY SWITCHES

A. Safety switches, as manufactured by general electric, Crouse-Hinds, Cutler-Hammer, Square D, Siemens, or approved equal, shall be furnished and installed (where not furnished by others) wherever shown on the drawings specified, or required by the National Electrical Code.

B. Safety switches shall be heavy duty type, Underwriters' Laboratories short circuit labeled for at least 100,000 amperes with class R rejection fuse holders so as to comply with NEC 100-9. Switches inside of building shall be furnished in NEMA 1 general purpose enclosures. Switches outside of building shall be furnished in NEMA 3R enclosures unless otherwise specified.

C. Each motor shall be provided with a disconnecting means in accordance with requirements of the national electrical code.

2.5 FUSES

A. This contractor shall furnish and install cartridge and plug type fuses as manufactured by the Bussman Manufacturing Company, Gould/Shawmut, Cefco, or approved equal, in all fusible equipment. Time-delay Trionic or Fusetron fuses, UL class rk5, shall be installed on all motor circuits. Non time-delay amp-trap (A2K OR A6K) or Bussman Limitron (KTN or KTS), UL class RK1 shall be installed on circuits feeding panelboards. All other circuits shall be protected by fault-trap, UL class RK5, fuses or approved equal. Class K fuses are not acceptable.

2.6 CONDUIT

A. All electrical wiring, including low voltage wiring, shall be installed in conduit as herein specified. No conduit or tubing of less than 3/4 inch nominal size shall be used below grade; no less than 1/2 inch nominal size shall be used above grade.

B. Underground conduit shall be schedule 40 epc-40-pvc. All conduits shall be installed with minimum 24 inch cover.

C. Conduit installed in concrete slabs or above ground shall be galvanized rigid steel or epc-40-pvc.

D. When PVC conduits penetrate concrete floor construction, contractor shall use rigid steel or IMC elbows and extension. PVC conduit/fittings shall not be permitted to be exposed above the floor.

E. Thin wall tubing shall be E.M.T.

F. All fittings shall be of the compression type and watertight for underground and in slab locations. Compression or screwed fittings for indoor.

G. Conduit for interior wiring, in general, shall be thin wall tubing unless otherwise noted.

H. Raceways shall be continuous from outlet to outlet and fitting to fitting. A run of conduit between outlets or fittings shall not contain more than the equivalent of four quarter-bends including those bends located immediately at the outlet or fitting. The radius of bends shall never be shorter than that of the corresponding trade elbow. The system shall be complete with outlets, distribution boxes, etc., smooth inside and mechanically secure in place. Approved straps, hangers, or supports shall be used to secure conduits in place. Conduits shall, in general, be supported at intervals not exceeding 10'-0" and within 3'-0" of each outlet box, junction box, cabinet or fitting.

I. Conduits shall be protected during construction; plug and keep clean and dry. Conduit ends shall be butted in centers of couplings. No cracks or flattened sections will be permitted at bends or elsewhere. All ends of conduit shall be reamed to remove rough edges. Running threads will not be permitted.

J. Conduits shall be concealed within the walls, ceilings, and floors where possible and unless otherwise noted. Exposed conduit shall be run parallel to or at right angles with the building lines.

2.7 WIRE AND CABLE

A. Wire and cable shall be copper.

B. All conductors shall be copper.

C. No. 10 AWG and smaller conductors shall be solid with type THHN insulation and no. 8 AWG and larger conductors shall be stranded with type THHN insulation except that conductors within 3 inches of light fixture ballasts shall have RHH, THHN, or equal insulation rated for 90 degrees c. Application.

2.8 IDENTIFICATION OF EQUIPMENT

A. All service entrance equipment, disconnect switches, panelboards, relays, motor starters, contactors, telephone terminal cabinets, TV equipment and riser junction boxes, and other electrical equipment under this contract, shall be provided with proper identification. Identification shall be by the use of engraved color coded plastic nameplates with white lettering screwed to the cover of the equipment. Use of embossed plastic "tape" labels as prepared by "typewriter" type equipment shall not be used. Color coding shall be as follows:

1. Equipment connected to a normal power source shall be black with white letters.

END OF SECTION 260000

ENERGY CONSERVATION MEASURES

Presents the following

Audit/Proposal

to

Navitas, LLC

25501 West Valley Parkway
Olathe, KS 66061

Customer Contact -- Bob Ades

Reduce Energy Costs and Increase Comfort by Installing Destratification Fans

Project Site: **City of Gladstone**

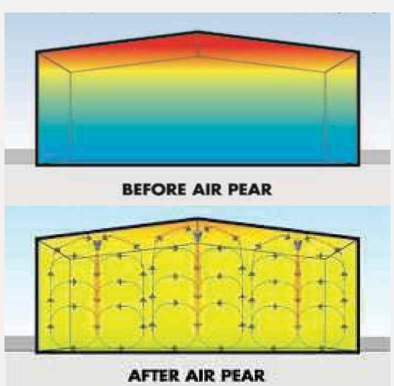
Quote Date: **6/12/2017**

Assessor: Brandon Flesch

Everyone knows hot air rises. In high ceiling areas, this produces layers of stratified air.
Thermal Destratification is the process of mixing the internal air to eliminate stratified layers and achieve temperature equalization throughout the building envelope.

The design of the **Air Pear** will address the issue of temperature differences in high ceiling areas by efficiently moving hot air to the ground and homogenizing the air throughout the space.

When air has little opportunity to move, dramatic temperature differences occur. Hot air rises pushing cooler air near the floor. This temperature difference can be as much as one degree per foot of height. Items such as lighting and ventilation ducts can increase this effect. Since people and thermostats are located near the floor it is imperative to even out this temperature difference.



Air Pear fans get air moving. Their energy efficient motors operate quietly to eliminate hot and cold spots throughout a space. After installation, there is significant energy reduction. The result is a more comfortable space with reduced utility and maintenance costs.

Multiple fans can be connected to a single variable speed controller. **Air Pears'** optional wireless Fan Center Manager controller can operate up to 100 fans using an easy web based interface. Fans can be ordered in white, black, grey, or custom colored to match any area.

Project Scope:

The following project pricing includes materials and installation for each building / area based on the quantities listed.

Projected Project Schedule:

Installation should take roughly 2-4 hours for a certified electrician per fan installed.

Warranty:

A 3-year parts / components warranty is provided on all fans by Arius, LLC. A fan refurbishment program is available after three years. ECM offers a standard 1-year warranty period for installations to be free from defects in material and workmanship.

ECM Holding Group, LLC.

2559 Badger Ave., Oshkosh, WI 54904

www.ECMHoldingGroup.com

Total Project Pricing

Building Name	Fan	Qty	Color	Electrical Increase kWh		Energy Savings kWh
Community Center Main Entry Hallway	E-145P4	2	White	368		9,863

Building Envelope Solutions LLC.

Presents the following

Audit / Proposal

to

Navitas, LLC

25501 West Valley Parkway
Olathe, KS 66061

Customer Contact ---- Bob Ades
913-333-7548
rades@navitas.us.com

Building Envelope Solutions, LLC proposes to upgrade the building envelope for the following buildings noted below. We have reviewed and audited the following buildings and have prepared this quote based on these audits.

Project Site: **City of Gladstone**

Quote Date: **September 1, 2017** **Revision B**

Audit Date: June 1, 2017
Assessor(s): Brandon Flesch

Project Scope:

Install insulation at the Public Works Building for the City of Gladstone. See next page for details.

Total Project Carbon Savings	**7,429**	lbs. CO_2
kWh Saved	3,571.66	kWh
Therms Saved	-	therms

Projected Project Schedule.

TBD.

Thank you for your interest in BES.

Building Envelope Solutions, LLC. is a full service provider air sealing solutions. We perform audits/building assessments, testing, thermal imaging, blower door verification, project management, and installation for building envelope projects.

Project Details

Building	Area	Insulation Material	Thickness (Inches)	Sq Ft	Savings (Therms)	Savings (kwh)
Public Works	Ceiling/roof	Fiberglass Batting	12.0	288		3,571.66
Summary:				**288**	**0.00**	**3,571.66**

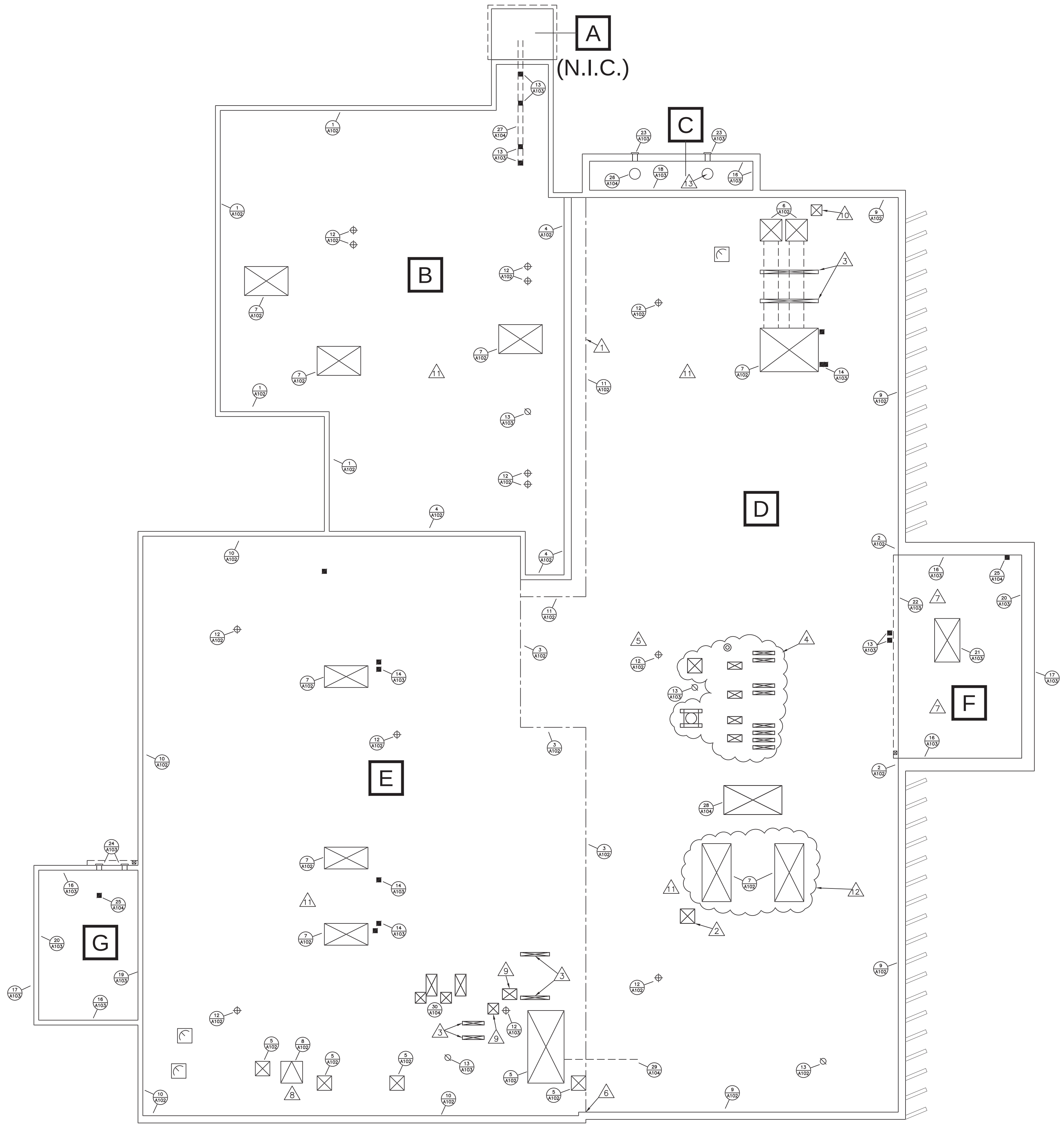
ROOF REPLACEMENT

GLADSTONE CITY HALL

7010 N. HOLMES ST
GLADSTONE, MO 64118

DRAWING NUMBER	DRAWING NAME
A100	ROOF PLAN
A101	TAPER PLAN
A102	DETAILS
A103	DETAILS
A104	DETAILS

RTI Consultants
22117 W. 83rd Street, Lenexa, KS 66227



SYMBOL LEGEND	
AREA DESIGNATOR	D
AREAS NOT IN CONTRACT	N.I.C.
DETAIL NO.	1 A100
CURB	
PLUMBING VENT	
ROOF DRAIN	
FLUE	
PENETRATION	
CONDENSER	
SCUPPER	
ROOF HATCH	
ANTENNAE	

GENERAL NOTES
1. CONTRACTOR RESPONSIBLE FOR PROTECTION OF EXISTING CONCRETE, ASPHALT AND LANDSCAPED AREAS. REPAIR DAMAGE CAUSED BY CONTRACTOR. REPAIRS SHALL BE PER OWNERS REQUIREMENTS.
2. CONTRACTOR RESPONSIBLE FOR PROTECTION OF ALL EXISTING ROOF SURFACES.
3. CONTRACTOR TO FOLLOW ALL SAFETY REQUIREMENTS PER OSHA.
4. CONTRACTOR TO INSTALL NEW HVAC CURBS PROVIDED BY AND SET BY MECHANICAL CONTRACTOR.
5. INSTALL NEW WALK PAD AT FOUR SIDES OF HVAC UNITS AND AT HATCH ACCESS.

NOTES

1 LINE OF ELEVATION CHANGE IN ROOF DECK.

2 CONTRACTOR TO REMOVE ABANDOND ROOF CURB. COVER OPENING IN CONRETE DECK WITH 20 GAUGE METAL PLATE.

3 CONTRACTOR TO REMOVE EXISTING EQUIPMENT RAILS.

4 CONTRACTOR TO REMOVE ALL ROOF PENETRATIONS IN CLOUDED AREA. ALL OPENINGS IN CONCRETE DECK TO BE COVERED WITH 20 GAUGE METAL PLATES. NEW MECHANICAL WORK WILL REQUIRE THREE (3) NEW PORTALS PLUS FLASHINGS TO BE INSTALL AT CURRENT DECK OPENING.

5 CONTRACTOR TO REMOVE ABANDOND ELECTRICAL CONDUIT.

6 CONTRACTOR TO TAPER NEW WOOD BLOCKING ON EXPANSION JOINT AT ROOF EDGE TO MEET NEW ROOF EDGE HEIGHT.

7 CONTRACTOR TO REMOVE AND REINSTALL EXISTING EQUIPMENT SCREEN AND FRAMING.

8 EXISTING WIRING ROUTED THROUGH EXISTING ROOF HATCH TO BE RELOCATED TO NEW OPENING CUT IN CONCRETE ROOF DECK AND FLASHED THROUGH NEW PORTALS PLUS PROVIDED BY CONTRACTOR.

9 EXISTING CURB TO BE REMOVED. COVER OPENING IN CONRETE DECK WITH 20 GAUGE METAL PLATE. INSTALL NEW PORTALS PLUS FLASHING AT NEW OPENING IN CONCRETE DECK LOCATED A MINIMUM OF 4' FROM ROOF DRAIN.

10 REPLACE EXISTING CURBED OPENING WITH NEW PORTALS PLUS FLASHING.

11 CONTRACTOR TO ADD NEW SPECIFIED ANCHOR TIE-OFF POINT.

12 APPROXIMATE LOCATION OF 2 NEW HVAC UNITS.

13 REMOVE UNUSED VENT TO BELOW ROOF DECK. COVER OPENING IN DECK WITH 20 GA. METAL PLATE.

Project Name

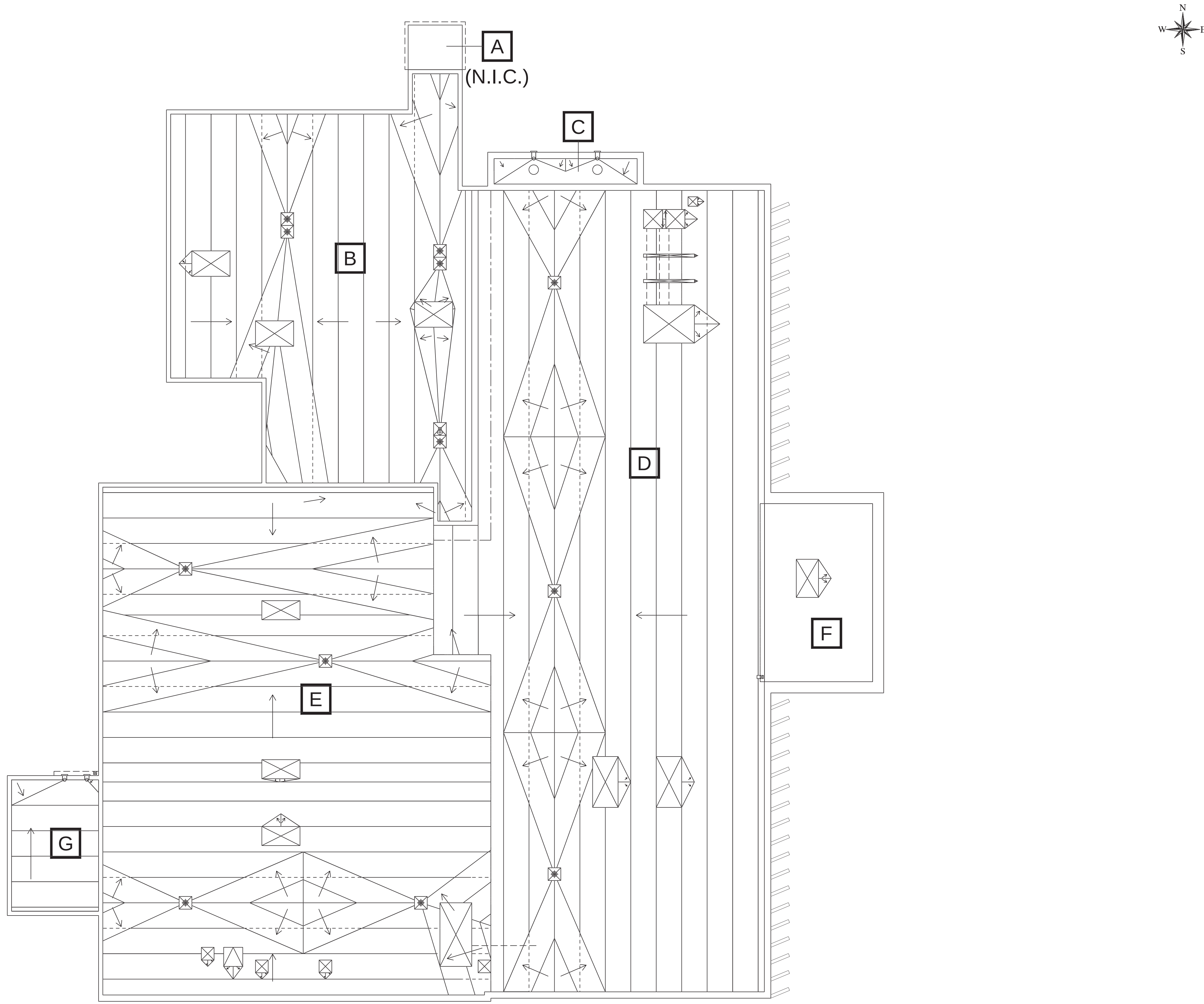
GLADSTONE CITY HALL
7010 N. HOLMES ST
GLADSTONE, MO 64118

RTIConsultants
22117 W. 83rd Street
Lenexa, KS 66227
(913) 649-6565

Date:	SEPTEMBER 2017
Scale:	1/8"=1'-0"
Drawn By:	RTI
Reviewed By:	MJG
Revision No.	Date
RTI No.	17031.04

Drawing Title
ROOF
PLAN

Drawing No.
A100



Project Name

GLADSTONE CITY HALL
7010 N. HOLMES ST
GLADSTONE, MO 64118

Energy Performance Contract
Schedule J: Equipment to be Installed by ESCO - Roof, Page 3 of 56

RTI Consultants
22117 W. 83rd Street
Lenexa, KS 66227
(913) 649-6565

Date:	SEPTEMBER 2017
Scale:	1/8"=1'-0"
Drawn By:	RTI
Reviewed By:	MJG
Revision No.	Date
RTI No.	17031.04

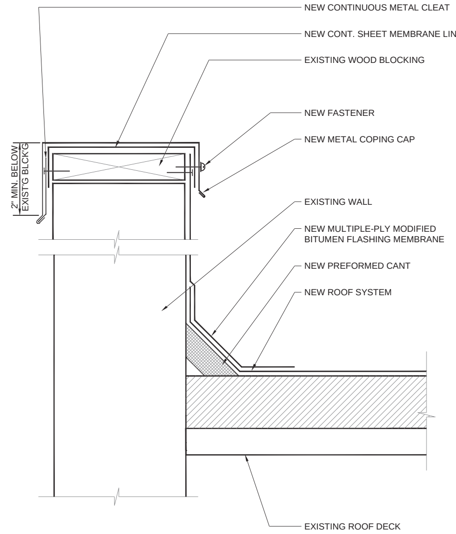
Drawing Title

TAPER
PLAN

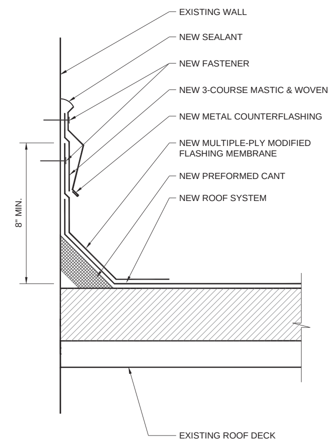
Drawing No.

A101

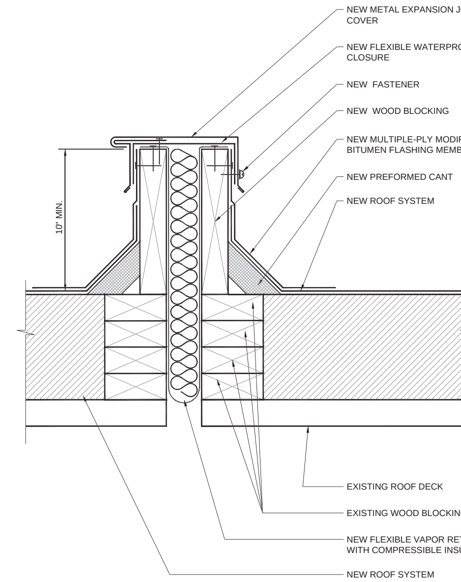
City of Gladstone
September 20, 2017



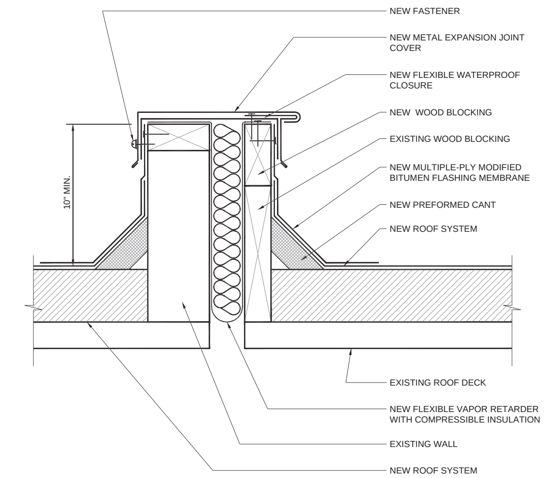
1 A102 PARAPET WALL COPING



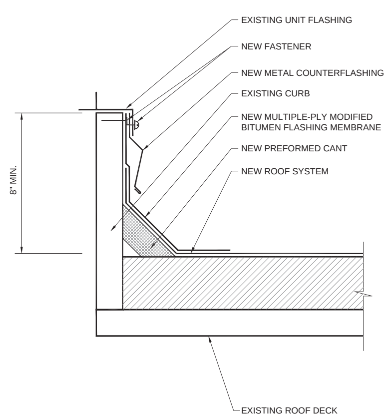
2 A102 WALL SURFACE MOUNT



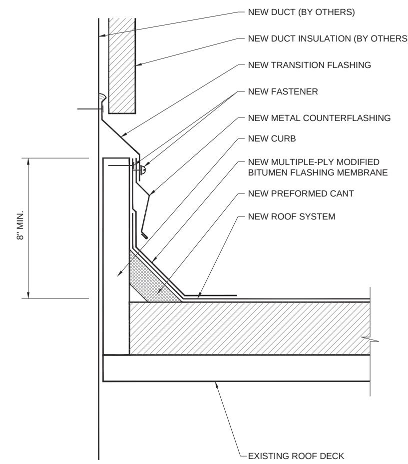
3 A102 EXPANSION JOINT



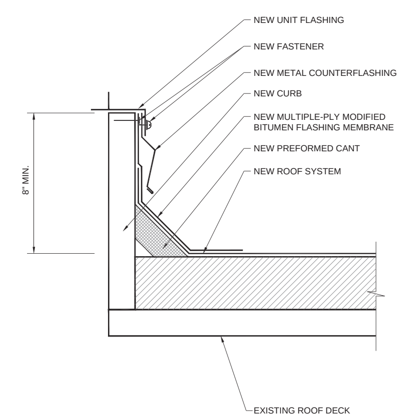
4 A102 EXPANSION JOINT



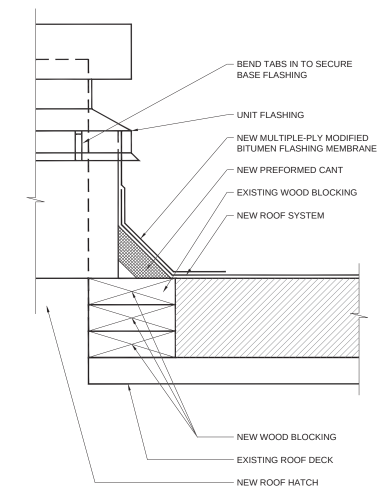
5 A102 CURB



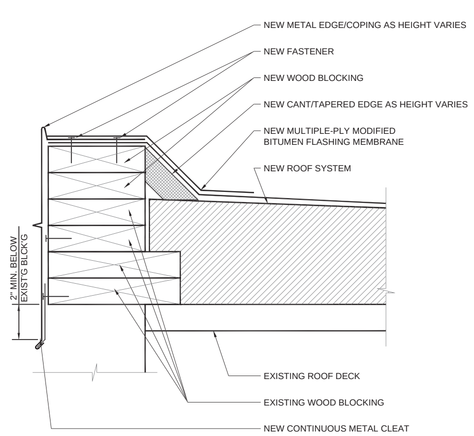
6 A102 DUCT CURB



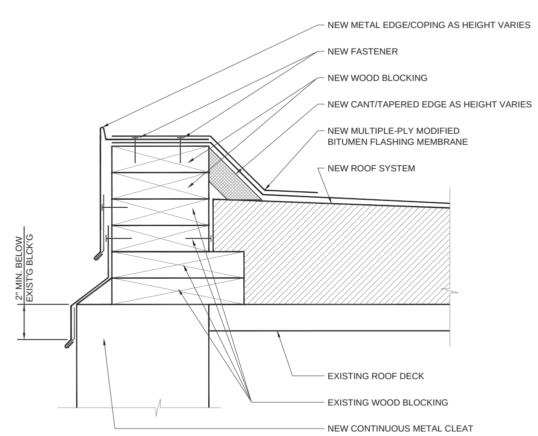
7 A102 NEW CURB



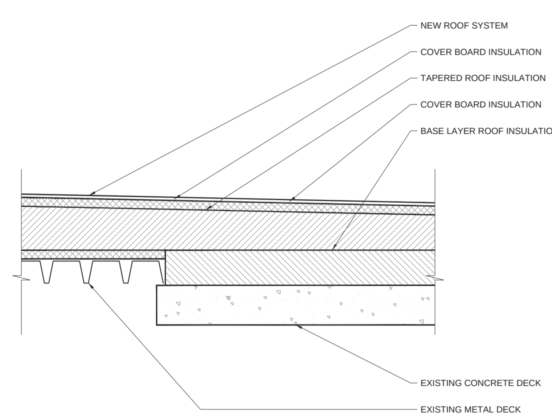
8 A102 ROOF HATCH



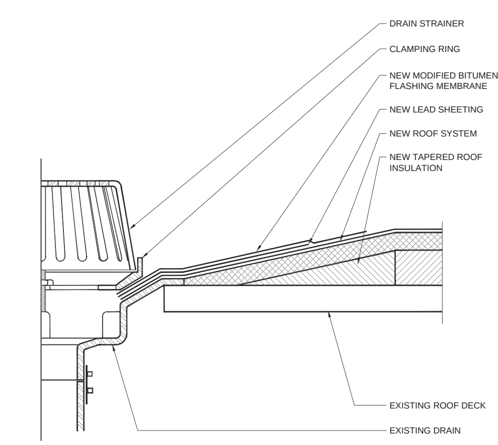
9 A102 RAISED METAL EDGE



10 A102 RAISED METAL EDGE



11 A102 DECK CHANGE



12 A102 DRAIN

Project Name

GLADSTONE CITY HALL
7010 N. HOLMES ST
GLADSTONE, MO 64118

RTI Consultants
22117 W. 83rd Street
Lenexa, KS 66227
(913) 649-6565

Date:	SEPTEMBER 2017
Scale:	N.T.S.
Drawn By:	RTI
Reviewed By:	MJG
Revision No.	Date
RTI No.	17031.04

Drawing Title

DETAILS

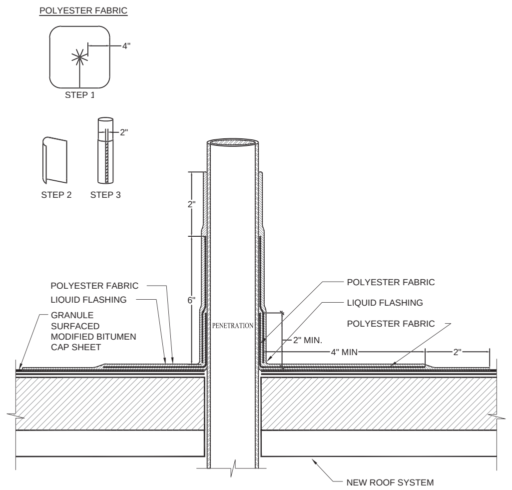
Drawing No.

A102

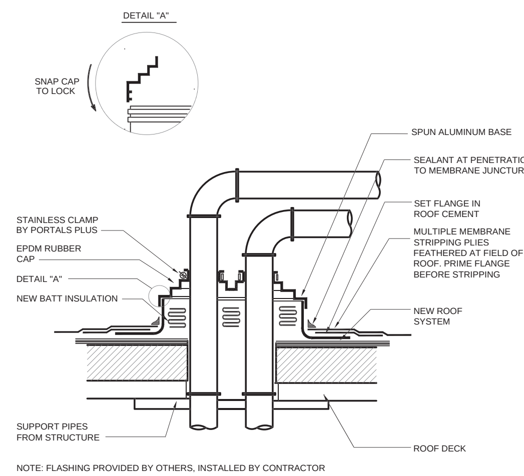
Project Name

GLADSTONE CITY HALL
7010 N. HOLMES ST
GLADSTONE, MO 64118

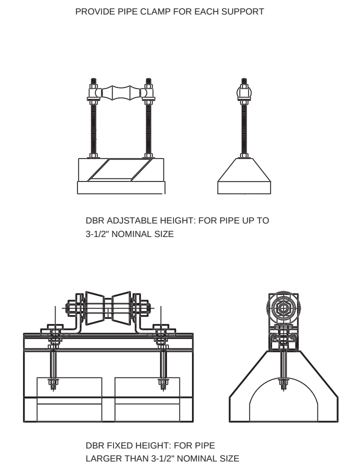
Energy Performance Contract
Schedule J: Equipment to be Installed by ESCO - Roof, Page 5 of 56



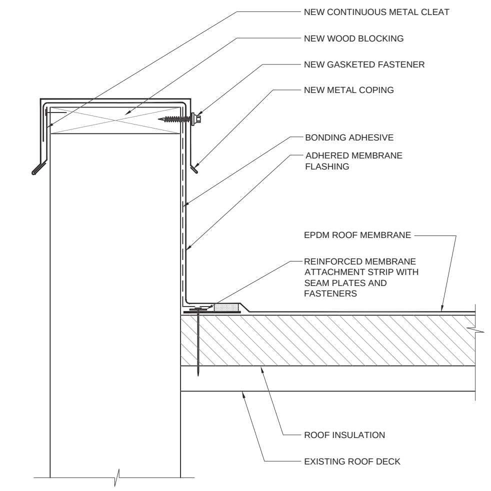
13 A103 PENETRATION FLASHING



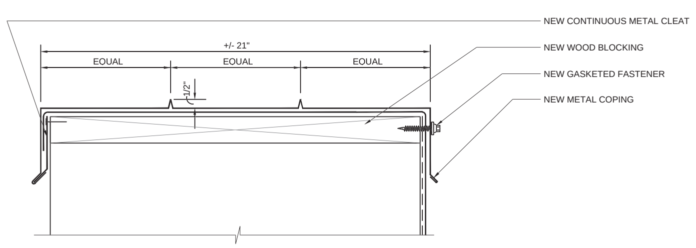
14 A103 MULTIPLE PIPE PENETRATION



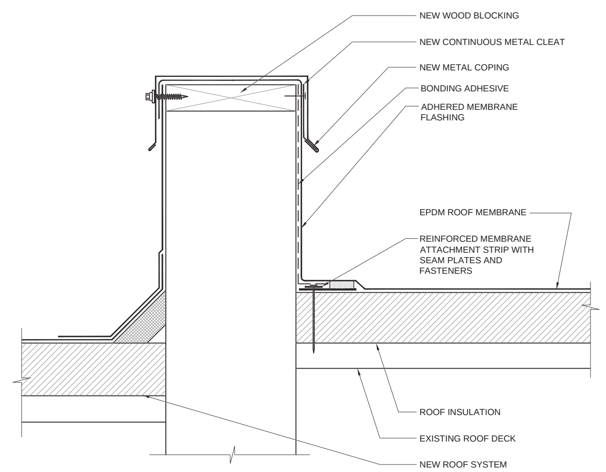
15 A103 PIPE SUPPORTS



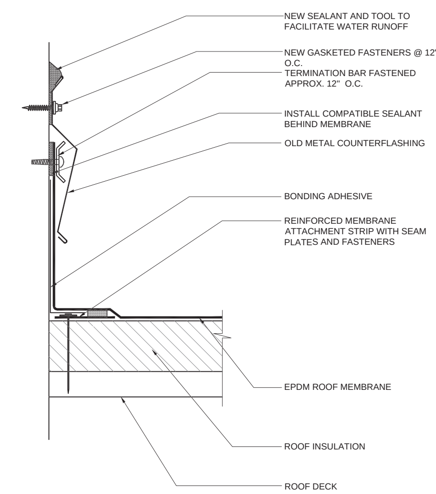
16 A103 PARAPET WALL COPING



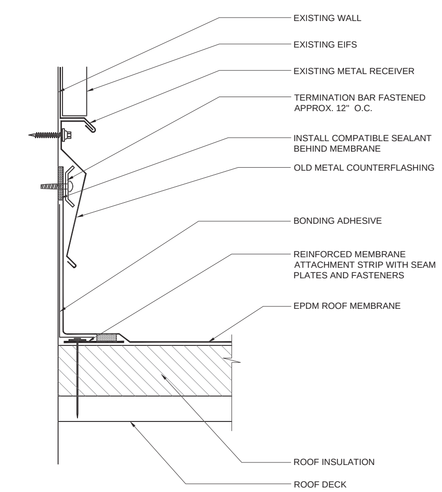
17 A103 COPING



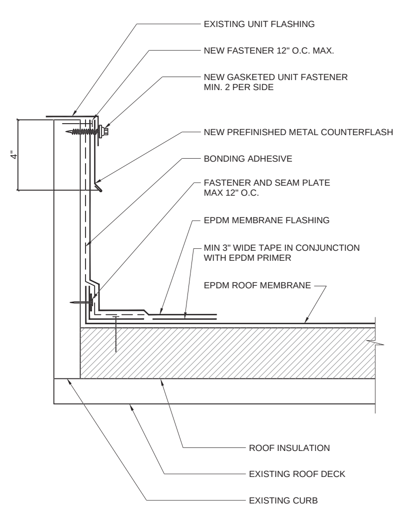
18 A103 PARAPET WALL COPING



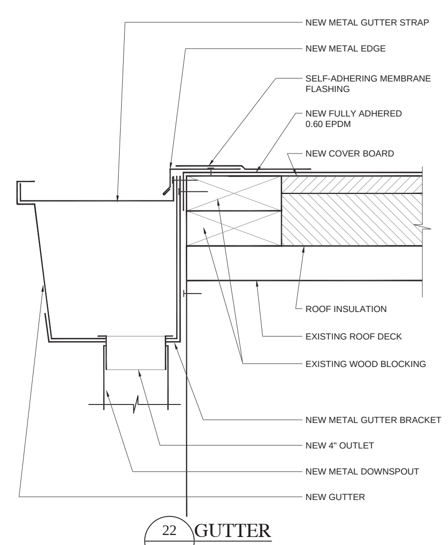
19 A103 WALL



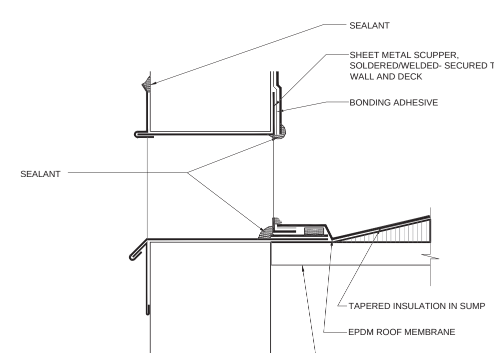
20 A103 WALL



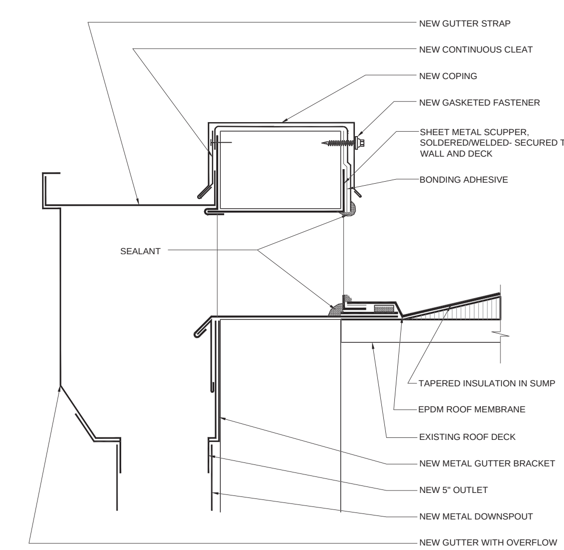
21 A103 CURB



22 A103 GUTTER



23 A103 SCUPPER



24 A103 SCUPPER

RTI Consultants
22117 W. 83rd Street
Lenexa, KS 66227
(913) 649-6565

Date:	SEPTEMBER 2017
Scale:	N.T.S.
Drawn By:	RTI
Reviewed By:	MJG
Revision No.	Date
RTI No.	17031.04

Drawing Title

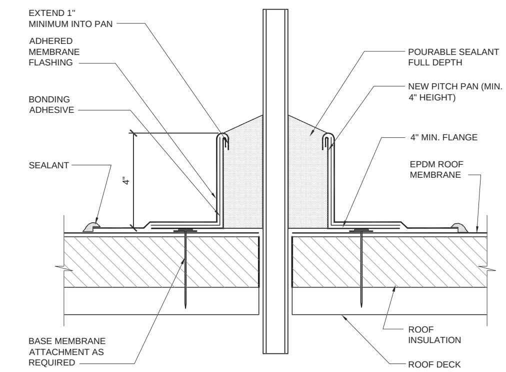
DETAILS

Drawing No.

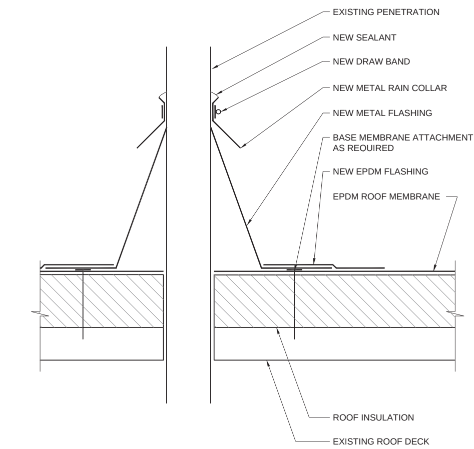
A103

City of Gladstone
September 20, 2017

City of Gladstone
September 20, 2017



25 / A104 PENETRATION POCKET



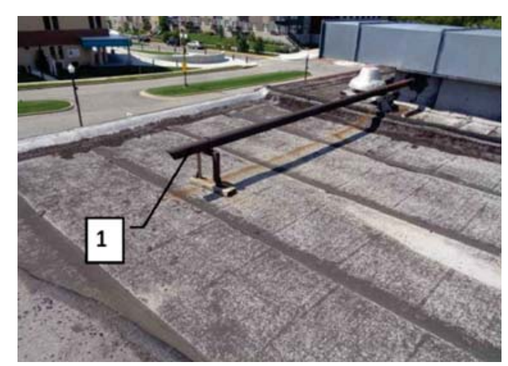
26 / A104 VENT

1. REMOVE LOWER PORTION OF EXISTING SCREEN TO LINE SHOWN. PER EXISTING CONSTRUCTION DRAWINGS SCREEN IS CONSTRUCTED WITH VERTICAL 4” TUBE STEEL COLUMNS WITH 3-5/8” METAL STUD INFILL.
2. REPLACE EXISTING METAL COPING.

27 / A104 SCREEN WALL

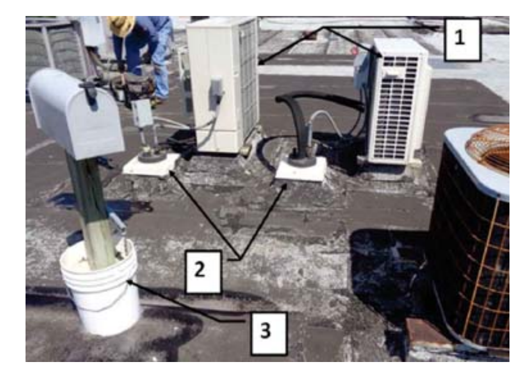
1. REMOVE EXISTING CONCRETE BLOCK STRUCTURE DOWN TO CONCRETE DECK. CONTRACTOR TO INSTALL NEW 0.25” FLAT CHECKERED STEEL FLOOR PLATE. PLATE TO MEET ASTM A-786 MEDIUM 4-WAY PATTERN, COMMERCIAL GRADE. PLATE TO BE MECHANICALLY ATTACHED TO CONCRETE DECK WITH A MINIMUM OF 3 ANCHORS PER SIDE

28 / A104 CURB



1. FLUE TO BE PAINTED WITH A PRIMER AND TWO FINISH COATS OF EPOXY PAINT. FLUE TO BE INSTALLED ON NEW SPECIFIED SUPPORTS.

29 / A104 FLUE



1. EXISTING UNITS TO REMIAN. REMOVE EXISTING CURBS AND INSTALL ON DURA-BLOC SUPPORTS.
2. EXISTING CURBED PORTALS PLUS FLASHING TO REMAIN. RAISE CURB HIEGHT AS REOUIRED TO MAINTAIN 8” FLASHING HIEGHT.
3. MAILBOX AND SUPPORT TO BE REMOVED.

30 / A104 CURBS

Project Name

GLADSTONE CITY HALL
7010 N. HOLMES ST
GLADSTONE, MO 64118

RTI Consultants
22117 W. 83rd Street
Lenexa, KS 66227
(913) 649-6565

Date:	SEPTEMBER 2017
Scale:	N.T.S.
Drawn By:	RTI
Reviewed By:	MJG
Revision No.	Date
RTI No.	17031.04

Drawing Title

DETAILS

Drawing No.

A104

SECTION 01001

GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Summary of Work

B. Payment Procedures

C. Alternates

D. Modification Procedures

E. Coordination and Meetings

F. Submittals

G. Construction Facilities and Temporary Controls

H. Materials and Equipment

I. Product Options and Substitutions

J. Contract Closeout

1.02 RELATED SECTIONS

A. Bidding Requirements

B. Contract Forms

C. Contract Conditions

D. Technical Specifications

E. Drawings

F. Appendices

1.03 SUMMARY OF WORK

A. Reference technical specifications

B. Definitions
1. Owner: When term "Owner" is used in Contract Documents, it is understood to mean City of Gladstone, Missouri or authorized representative.
2. Consultant: When Designer is referenced in Contract Documents it is understood to mean RTI Consultants, (Acting as an agent for Navitas, LLC) or its authorized representative.

C. Work comprises complete construction required by Bidding Documents and includes all labor necessary to produce such construction and all materials and equipment in such construction as well as temporary facilities necessary to construction process. Construct Work under a single lump-sum contract.

1.04 PAYMENT PROCEDURES

A. Forms: Use AIA Document G702 Application and Certification for Payment for request for payments. Use AIA Document G703 Continuation Sheet in conjunction with G702 for payment requests.

B. Schedule of values
   1. Submit one original form and one copy of Application and Certification for Payment on G702, supported by G703.
   2. Identify by building, including a separate line item for each of following:

C. Application for Payment
   1. Present required information consistent with Schedule of Values.
   2. Execute application by signature of authorized officer of Contractor's firm.
   3. Use data from Schedule of Values, indicating dollar value in each column of each line item for portion of Work completed through last day of application period, and for products properly stored in accordance with Contract Documents through last day of previous application period. **Round off dollar values to nearest dollar**. Complete every entry on form.
   4. Indicate each authorized Change Order or Construction Change Directive as separate line items on G703. List by appropriate Change Order Number or Construction Change Directive Number. Indicate dollar value breakdown of each Change Order or Construction Change Directive.
   5. Submit 1 original and 1 copy of each Application for Payment. Include a separate line item for each of following:
      a) Bonds
      b) Mobilization
      c) Roofing material
      d) Roofing labor
      e) Sheet metal material
      f) Sheet metal labor
      h) Guaranty
      i) Contingency (if applicable)
   7. Submit an updated Construction Progress Schedule with each Application for Payment.
   8. Submit waivers of mechanics liens from Contractor, Subcontractors, sub-subcontractors, and material and equipment suppliers for construction period covered by previous application for payment. Submit on acceptable form.
   9. When Owner requires substantiating information to support Contractor's application for payment, submit data justifying dollar amounts, which are in question. Provide one copy of data with cover letter for each copy of Application for Payment and indicate application number and date, Project Number, and list each item in question by continuation sheet identification.

D. Unit prices
   1. Changes to Contract Sum: Unit Prices constitute full compensation or credit, as case may be, for complete provision, fabrication, and installation of each item listed based solely on Work in place, including all necessary labor, products, tools, equipment, transportation, services and incidentals, appurtenances, and connections required to complete Work in place, and including insurance, overhead, profit and supervision.
   2. Measurement:
      a. Take measurements and compute quantities for which Unit Price items are applicable.
      b. Consultant will review measurements and quantities. Contractor shall assist by providing necessary equipment, Workers, and survey personnel, as requires.
      c. Final payment for Work governed by Unit Prices will be made on basis of actual measurements and quantities reviewed by consultant, multiplied by Unit Price for Work, which is incorporated in or made necessary by Work.

1.06 ALTERNATES

A. Procedures
   1. Alternates will be exercised at option of Owner.
   2. Coordinates related Work and modify surrounding Work as required to complete Work, including changes under each alternate, when acceptance is designated in agreement form.

1.07 MODIFICATION PROCEDURES

A. Changes to Work require written documentation.

B. AIA Document G701 to be used for making modifications to Contract Documents, which include but not limited to changes in scope, contract sum, and contract time.

1.08 COORDINATION AND MEETINGS

A. Coordination
   1. Coordinate schedules, submittals, and Work of various sections to assure efficient and orderly sequence of installation of construction elements, with provisions for accommodating items installed later.
   2. Coordinate completion and clean up of Work of separate sections in preparation for substantial completion and for portions of Work designated for Owner's occupancy.
   3. After Owner occupancy of premises, coordinate access to Site for correction of defective Work not in accordance with Contract Documents with Owner, to minimize disruption of Owner's activities.

B. Pre-installation Conference: Conducted prior to construction

C. Progress Meetings: To be conducted during construction

1.09 SUBMITTALS

A. Submittal Procedures
   1. Submit one original and one copy (unless otherwise specified) of each pre-construction submittal no later than two weeks after receipt of a signed contract.
   2. Submit one original and one copy (unless otherwise specified) of each Construction Submittal no later than three weeks after a signed contract.
   3. Submit one original and one copy of each closeout submittal, no later than four weeks after date of Notice of Completion (Exhibit "C").

B. Pre-Construction: Submittals **(Exhibit "A")**

C. Construction: Submittals **(Exhibit "B" and Exhibit "C")**

D. Closeout Submittals: **(Exhibit "D")**

1.10 CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

A. Temporary Utilities
   1. Existing Utilities: Provide protection to prevent damage or interference to existing utilities. In event of accidental interruption of a service or utility, inform Owner and related utility company without delay, and take prompt remedial action.
      a. Schedule Work requiring disconnections, re-connections, and interruptions of services and utilities with Owner and utility companies.
      b. Maintain electrical and mechanical services and utilities unless interruptions are scheduled.
      c. Provide and remove temporary connection devices when no longer required.
   2. Temporary Water: Contractor shall connect to Owner's existing service. Owner will pay cost

of water used.

3. Temporary Sanitary Facilities:
    a. Provide and maintain adequate chemical toilet facilities.
    b. Construction personnel shall not use existing toilets.
    c. Provided drinking water from an approved source.
4. Temporary Fire protection: Provide and maintain fire fighting equipment for duration of construction in accordance with requirements of local authorities and subject to approval of Owner's insurance carriers.
5. Temporary Electricity: Contractor shall connect to Owner's existing service. Owner will pay cost of electricity used. Provide flexible power cords as required.
6. Temporary Lighting: Provide and maintain lighting for construction operations to achieve not less than two watts per square foot of illumination.

B. Temporary Barriers, Enclosures, and Security

1. Provide temporary barriers and enclosures outside building for safety, unauthorized entry, and protection of existing facilities, protection of existing vegetation, protection of materials, and protection against weather. Do not block required egress routes.
2. Provide temporary weather-tight closure of exterior openings to accommodate acceptable Working conditions and protection of Products.
3. Provide temporary protection at existing sidewalks in compliance with regulations of authority having jurisdiction.
4. Provide security and facilities to protect Work, existing facilities, and Owners operations from unauthorized entry, vandalism, and theft. Coordinate with Owner's security program.
5. Temporary Dust Controls: Provide water sprinkling materials and equipment for prevention of nuisance of dust to surrounding areas.

C. Protection of Existing Plant Life

1. Protect trees, shrubs, lawns, and other existing plant growth.
2. Repair or replace existing plant life, which is damaged by construction operations. Obtain services of licensed arbors to repair damage to plant life. Replace plant life, which cannot be repaired and restored to full-growth condition.

D. Protection of Installed Work

1. Protect installed Work and provide special protection where specified in individual Sections of Project Manual.
2. Provide temporary and removable protection for installed Products. Control activity in immediate Work area to minimize damage.
3. Prohibit traffic and storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing manufacturer.

E. Site Access

1. Maintain access to fire hydrants, free of obstructions.
2. Provide means of removing mud from vehicle wheels before entering streets.
3. Parking: Arrange for surface parking areas, subject to Owner's approval, to accommodate construction personnel. When Site space is not adequate, provide additional off Site parking.

F. Removal of Facilities and Controls

1. Clean and repair damage caused by installation and use of temporary Work.
2. Restore existing facilities used during construction to their original condition.
3. Restore permanent facilities used during construction to their specified condition.

1.11 MATERIALS AND EQUIPMENT

A. Reuse of existing material

1. Except as specifically indicated on Drawings or specified in Project Manual, materials and equipment removed from existing Site and building shall not be used in completed Work.
2. For material and equipment specifically indicated on Drawings or specified in Project

Manual to be reused in Work, use special care in removal, handling, storage, and reinstallation to assure proper function in completed Work.

3. Arrange for transportation, storage, and handling of materials, which require off-site storage, restoration, or renovation. Pay cost associated for such Work.

B. Transportation and handling
   1. Transport, handle, and store products and equipment in accordance with manufacturer instructions.
   2. Arrange deliveries of Products and equipment in accordance with Project Construction Schedule.
      a. Coordinate to avoid conflict with Work and conditions at Site.
      b. Immediately upon delivery, inspect shipments to assure compliance with Contract Documents and reviewed Submittals, and that Products and equipment are undamaged.

C. Storage and protection
   1. Store and protect Products and equipment in accordance with manufacturer's instructions, with seals and labels intact and legible.
   2. Provide bonded off-site storage and protection when Site does not permit on-Site storage or protection.
   3. Store Products and equipment subject to damage by elements in weather tight enclosures.
   4. Maintain temperature and humidity within ranges required by manufacturer's instructions.
   5. Exterior Storage:
      a. Store fabricated Products above ground, on blocking or skids.
      b. Cover Products subject to deterioration with impervious sheet covering.
      c. Provide adequate ventilation to avoid condensation or degradation of Product.
   6. Provide equipment and personnel to store Products and equipment by methods to prevent soiling, disfigurement, or damage to Product or packaging.
   7. Arrange storage of Products and equipment to allow access by Consultant for review and verification. Periodically inspect to assure Products are undamaged and are maintained under required and specified conditions.
   8. Provide substantial coverings to protect installed Products from damage caused by traffic and subsequent construction operations.

1.12 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Product
   1. Definition: Products means new material, machinery, components, equipment fixtures, and systems forming Work, but does not include machinery and equipment used for preparation, fabrication, conveying, and installation of Work. Products may also include existing materials or components required to be reused.
   2. Standard of Quality: Specified manufacturers, materials, products, and equipment have been used in preparing Contract Documents, and thus, establish minimum standard of required function, dimension, appearance, and quality for performance and appropriateness.
   3. Provide interchangeable components of same manufacturer for similar components.

B. Product Selection Procedures
   1. Product selection is governed by Contract Documents, not by previous experience or tradition.
   2. Reference Standard Specification: Where product or materials are specified only by reference standard, provide any product meeting that standard. If reference standard is following by a description of materials, special features, or performance criteria, make necessary modifications to standard or custom products to fully comply with description of materials, special features, or performance criteria specified.
   3. Descriptive Specifications: Where products, materials, or equipment are specified by indicating a detailed description of required properties, minimum attributes, special features, or performance criteria, provide any product meeting that description.
      a. If descriptive specification is followed by a list of acceptable manufacturers or

acceptable manufacturers and products, select product from only those manufacturers and products. If manufacturer's standard product is listed, and it does not comply with minimum description indicated, make necessary modifications to standard or custom products to fully comply with required properties, minimum attributes, special features, or performance criteria specified.

b. If a list of specified manufacturers includes statement "Comparable Products" of other specified manufacturers, select product only from those manufacturers specified in that Section of Contract Documents complying with required properties, minimum attributes, special features and performance criteria specified.

c. If a list of specified manufacturers includes statement "Comparable Products" of other manufacturers, select product from any manufacturer complying with required properties, minimum attributes, special features, and performance criteria specified.

4. Proprietary Specifications: Where products, materials, or equipment are specified by specific manufacturer name, model number, type designation, or other unique characteristics, provide only products specified in Contract Documents. When indicated in individual specification Sections as "No Substitutions", provide only specific name product. Substitutions will not be considered.

5. When indicated in individual specification Section, design layout, space allocation, connection details, and other requirements are based on proprietary products of a specific manufacturer so identified under PART 2 of that Section. Other manufacturers, even if specified as acceptable, shall comply with minimum levels of material, detailing and dimensional restrictions established for proprietary product, even if these levels are not indicated in Contract Documents.

C. Base Bid

1. Phrase "or equal" is not implied in Contact Documents. Request for substitution and product options shall be made in accordance with procedures specified in this Section.

2. It is understood, agreed by bidders, Contractors, subcontractors, and material suppliers that bids and contracts shall be based on products exactly as specified in Contract Documents.

3. Base Bid Conditions: Bids and Contract shall be based upon materials, products, and equipment described in Bidding Documents. Where additional products or manufacturers are incorporated by Addenda, Contractor is responsible for coordinating and paying for any necessary changes to Work required incorporating additional products.

1.13 CONTRACT CLOSEOUT

A. Closeout procedures

1. Consultant will make an inspection to review status of completion with reasonable promptness after receipt of contractor notice. Should consultant determine Work is incomplete or defective, consultant will notify contractor in writing listing incomplete and defective Work.

a. Within 2 days of date of consultant's list, contractor to submit written request for any clarification of consultant's list of incomplete or defective Work.

b. Contractor to immediately remedy incomplete and defective Work.

c. Contractor to submit written notice that corrected Work is complete.

B. Re-inspection fees

1. Should consultant perform re-inspections due to failure of Work to comply with claims of status of completion made by contractor, consultant will be compensated for additional services.

a. Cost of consultant's additional services will be calculated in accordance with hourly rates included in Agreement Between Owner and Consultant.

b. Consultant will issue a deductive Change Order in amount of consultants' additional services.

c. Owner will deduct amount of consultant's additional services from final payment to contractor.

C. Final cleaning
1. Complete prior to Substantial Completion.
2. Remove temporary protective coatings, barriers, and labels not required to remain.
3. Clean finishes free of dust, stains, films, and other foreign substances.
4. Clean waste and debris from staging and work areas, and other areas affected by work.
5. Remove waste and surplus materials, rubbish, and construction facilities from Site.
6. Maintain Work in clean condition until consultant certifies Substantial Completion.

D. Closeout submittals: Reference Submittal Section

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 01001

{Exhibit A}

____________________, 2017 (**Date**)

Re: City of Gladstone City Hall Roof Replacement
RTI No.: 17031.04
Pre-construction Submittals

Enclosed are two originals of the following pre-construction submittals for review unless otherwise noted.

1. AIA Document A312: Performance Bond and Payment Bond
2. AIA Document G703: Schedule of Values
   a) Bonds
   b) Mobilization
   c) Roofing material
   d) Roofing labor
   e) Sheet metal material
   f) Sheet metal labor
   g) Guaranty
   h) Contingency (if applicable)
3. Construction schedule
4. Certificate of Insurance (Owner is listed as Certificate Holder)
5. Contractor's Job Specific Safety and Health Plan on USB drive
6. All product MSDS sheets (*one copy*)
7. Contractor Roofing Manufacturers certification
8. Contractor roofing application for guaranty
9. Emergency Contact List

________________________________ (**Contractor Representative**)

________________________________ (**Contracting Company**)

{**Exhibit B**}

____________________, 2017 (**Date**)

Re: City of Gladstone City Hall Roof Replacement
RTI No.: 17031.04
Construction Submittals

Enclosed are the following Construction Submittals:

1. Two copies of completed "Exhibit C" (*Construction Submittal Form)*
2. One copy of Existing Conditions Photos on USB Drive
3. Two copies of sheet metal manufacturers' Color Chart
4. Three copies of tapered insulation manufacturers layout drawing

__________________________________ (**Contractor Representative**)

__________________________________ (**Contracting Company**)

{EXHIBIT C}

Construction Submittal Form - Gladstone City Hall Roof Replacement

ITEMS	ASTM NO./DESCRIPTION	MANUFACTURER/PRODUCT
Section 07245		
Manufacturers product literature		
Insulation board		
Mechanical fasteners		
Primer-sealer		
Adhesives		
Ground base coat		
Reinforcing mesh		
Base coat		
Elastomeric sealants		
Section 07530		
EPDM Membrane	60-mil	
Insulation adhesive		
Membrane adhesive		
Manufacturer Accessories		
Section 07550		
Taper insulation Drawing		
Cover Board		
Polyisocyanurate (flat stock)	ASTM C1289	
Perlite Cant	ASTM C728	
Tapered Edge Strip	ASTM C728	
Vapor Retarder	ASTM ( ) Type ( )	
Base Ply (field and flashing) Grade S, Type I	ASTM ( ) Type ( )	
Surface Ply (field) FR Grade G	ASTM ( ) Type ( )	
Surface Ply (flashing) / heat weld	ASTM ( ) Type ( )	
Asphalt Primer	ASTM D41	
Foam Adhesive		
Membrane Adhesive (cold); Type III; Grade 2	ASTM D3019	
Flashing Cement; Type II	ASTM D2822	
Liquid Flashing		
Pipe Supports		
Roof Hatch		
Anchor tie-off		
Section 07620		
Manufacturer color chart		
Pre-finished sheet metal:	ASTM A 527, 22 gauge	
Zinc-Coated Steel (galvanized)	ASTM A526, G90; 20 gauge.	
Stainless Steel	24 gauge	
Pourable Sealer	ASTM D 0412	
Section 07723		
Roof Hatch	Shop Drawings	
Safety Rail System	Shop Drawings	
Anchor post	Shop Drawings	
Section 07920		
Exterior Sealant (urethane)	ASTM C920	

Section 09900		
Base coat Paint	Kem Kromic Primer	Sherwin Williams (B50WZ1 white)
Top coat Paint	Industrial Enamel VOC	Sherwin Williams (B54Z "P3" grey)

Contractor Company

Contractor Signature

Date

{**Exhibit D**}

__________________, 2017 (**Date**)

Re: City of Gladstone City Hall Roof Replacement
RTI No.: 17031.04
Close out Submittals

Enclosed are the following Closeout Submittals for the above referenced project:

1. AIA Document G706: Contractors Affidavit of payment of Debt and Claims
2. AIA Document G706A: Contractors Affidavit of Release of Liens
3. Subcontractor and material supplier Lien Waivers
4. AIA Document G707: Consent of Surety Company to Final Payment
5. Contractor Guaranty (Included in project manual)
6. Roofing Manufacturer's twenty-year Guaranty
7. Sheet metal Manufacturer's twenty-year finish Guaranty
8. Letter stating "No Asbestos Has Been Used On Project"
9. Letter indicating all items listed at final review have been corrected
10. Affidavit of Compliance with Prevailing Wage Law

______________________________ (**Contractor Representative**)

______________________________ (**Contracting Company**)

SECTION 02225

SELECTIVE DEMOLITION

PART 1 – GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Demolition and removal of existing roof accessories as indicated on drawings.
   2. Temporary removal and reinstallation of existing accessories as indicated on drawings

1.02 RELATED SECTIONS

Drawings and general provisions of the Contract, including general and Supplementary Conditions and Division I Specification sections apply to this section.

1.03 DEFINITIONS

A. Remove: Remove and legally dispose of items indicated.

B. Existing to Remain or be Reinstalled: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by the Consultant, items may be removed to a suitable, protected storage location during selective demolition and then cleaned and reinstalled in their original locations.

1.04 MATERIALS OWNERSHIP

Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, demolished materials shall become Contractor's property and shall be removed from site with further disposition at the Contractor's option.

1.05 QUALITY ASSURANCE

Provide adequate number of experienced workmen regularly engaged in this type of work who are skilled in application techniques of the materials specified including operation of equipment and power supply. Provide at least one thoroughly trained and an experienced superintendent on job at all times work is in progress.

1.06 PROJECT CONDITIONS

Owner may occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so that Owner's operations will not be disrupted. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations. Owner assumes no responsibility for actual condition of buildings to be selectively demolished. Owner will maintain conditions existing at time of inspection for bidding purpose as far as practical. Storage or sale of removed items or materials on-site will not be permitted.

1.07 SCHEDULING

A. Arrange selective demolition schedule so as not to interfere with Owner's on-site operations.

B. Arrange selective demolition so as not to progress beyond where temporary weather protection, temporary security, and temporary bracing can be achieved for all area's demolished at the end of each workday or in case of high winds and/or dangerous threatening weather.

PART 2 – PRODUCTS

2.01 REPAIR MATERIALS

Use repair materials identical to existing materials. Where identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible. Use materials whose installed performance equal or surpasses that of existing materials.

2.02 TEMPORARY PROTECTION MATERIALS

A. Provide temporary weather protection materials that can be removed and installed in large sections.

B. Security closure materials are to be vandal resistant and cover all openings in their entirity.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Verify that utilities have been disconnected and capped.

B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

C. When unanticipated mechanical, electrical, or structural elements that conflict with the intended function or design are encountered, investigate and measure the nature and extent of the conflict. Promptly submit a written report to the Owner.

D. Perform surveys as Work progresses to detect hazards resulting from selective demolition activities.

3.02 UTILITY SERVICES

A. Maintain existing utilities and protect them against damage during selective demolition operations.

B. Do not interrupt existing utilities serving occupied or operating facilities, except when authorized in writing by Owner and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to governing authorities.

C. Provide not less than 72 hours notice to Owner if shutdown of service is required during changeover.

3.03 PREPARATION

A. Conduct demolition operations and remove debris to ensure minimum interference with roads, streets, walks and other adjacent occupied and used facilities.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

B. Conduct demolition operations to prevent injury to people and damage to adjacent buildings and facilities to remain. Ensure safe passage of people around selective demolition area.
   1. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.
   2. Protect existing site improvements, appurtenances, and landscaping to remain.

3. Provide temporary weather protection, during interval between demolition and removal of existing construction, on exterior surfaces and new construction to ensure that no water leakage or damage occurs to structure or interior areas.
4. Protect walls, ceilings, floors, and other existing finish work that are to remain and are exposed during selective demolition operations.

3.04 POLLUTION CONTROLS

A. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level.

B. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before start of selective demolition.

3.05 SELECTIVE DEMOLITION

A. Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required completing Work within limitations of governing regulations and as follows:
   1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. To minimize disturbance of adjacent surfaces, use hand or small power tools designed for sawing or grinding, not hammering and chopping.
   2. Do not use cutting torches.
   3. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
   4. Remove no more existing roofing than can be replaced in one day by new roofing membrane system.

3.06 PATCHING AND REPAIRS

A. Promptly patch and repair holes and damaged surfaces caused to adjacent construction by selective demolition operations.

B. Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.

3.07 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site. Do not allow demolished materials to fall or be stacked against the existing building at any time.

B. Burning: Do not burn demolished materials

C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

END OF SECTION 02225

SECTION 07245

EXTERIOR INSULATION & FINISH SYSTEM REPAIRS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Protection of adjacent surfaces

B. This Section includes Exterior Insulation and Finish System-(EFIS) repairs and surfacing restoration as required from installation of new equipment screen louvers.

1.02 RELATED SECTIONS

Drawings and general provisions of the Contract, including General and Special Conditions and Division I Specification sections apply to this section.

1.03 SYSTEM DESCRIPTION

A. EIFS repair including:
   1. Surface cleaning and preparation.
   2. Repair of areas of surface damage and selective demolition.
   3. Repair of areas of finish coat damage
   4. Replacement of wet and damaged insulation

B. Repairs to match original EIFS physical properties and structural performance.

1.04 SUBMITTALS

A. Reference General Requirements Section

B. Manufacturer's technical product data and installation instructions for each component of exterior insulation and finish systems.

1.05 QUALITY ASSURANCE

A. Contractor Qualifications: Firm experienced in installation if EIFS similar in material types and complexity required for this project, plus the following:
   1. Lead Foreman of the EIFS Contractor shall have received EIFS installation training by the EIFS manufacturer and shall submit documentation to the effect.
   2. Contractor must execute 100 percent of the EIFS restoration, second and third tier subcontractors will not be allowed for installation.

B. Single-Source Responsibility: Obtain materials for system from either a single manufacturer or manufacturers approved by the system manufacturer as compatible with other system components.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in original, unopened packages with manufacturer's labels identifying products legible and intact.

B. Store materials inside and under cover; keeping them dry and protected from the weather, direct sunlight, surface contamination, aging, corrosion, damaging temperatures, damage from construction traffic, and other causes.

C. Store liquid coating materials at temperatures ranging from 40 deg F to 90 deg F.

1.07 PROJECT CONDITIONS

Environmental Conditions: Do not install system when raining or when ambient outdoor temperatures are 40 deg F and falling unless temporary protection and heat are provided to maintain ambient temperatures above 40 deg F during installation of wet materials and until they have dried thoroughly and become weather resistant, but for not less than 24 hours after installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

Use original EIFS manufacturer (if known) recommended procedures and practices for EIFS repair and restoration.

2.02 MATERIALS

A. Compatibility:
   1. Provide board insulation, reinforcing fabric, base and finish coat materials, mechanical anchors, and accessories that are compatible with one another and approved for use by system manufacturer.

   2. Provide color and texture of protective coatings to closely match existing system.

B. Insulation Board: Comply with ASTM C578, Type I, overall thickness to match existing.

C. Mechanical Fasteners: As recommended by EIFS System Manufacturer's to supplement adhesive, provide standard fasteners and disks, non-corrosive to suit substrates and conditions involved.

D. Primer-Sealer: System manufacturer's standard substrate conditioner designed to seal substrates from moisture penetration and to improve the bond between substrate of type indicated and adhesive used for application of insulation.

E. Adhesives: Manufacturer's standard water based acrylic copolymer and acrylic copolymer combined with Portland cement as necessary to suit substrates.

F. Ground Base Coat: Ground coat shall be acrylic copolymer emulsion based, non-Cementitious, glass fiber reinforced ground course. The ground course shall be tinted to the same shade as the finish.

G. Reinforcing Mesh: Balanced, alkali-resistant, open weave glass fiber mesh treated for compatibility with other system materials, made from continuous multi end strands with retained mesh tensile strength of not less than 120 lbf/in (21 and/cm) per EIMA 105.01, complying with ASTM D578 and the following requirements for minimum weight:
   1. Intermediate Reinforcing Mesh: Not less than 9.5 oz/sq yd.
   2. Corner Reinforcing Mesh: Not less than 7.2 oz/sq yd.
   3. Detail Reinforcing Mesh: Not less than 4 oz/sq yd.
   4. Strip Reinforcing Mesh: Not less than 3.75 oz/sq yd.

H. Base Coat: Factory-mixed formulation of polymer-emulsion adhesive and inert fillers that is ready to use without adding other materials

I. Finishes: The finish system shall be ready mixed, acrylic-based exterior wall coating textured to match existing system.

2.03 ELASTOMERIC SEALANTS

Elastomeric Sealant Products: Provide system manufacturer's listed and recommended chemically curing, low-modulus silicone sealant that is compatible with joint fillers, joint substrates, and other related materials, and complies with requirements for products and testing indicated in "EIMA Guide for Use of Sealant with Exterior Insulation and Finish Systems, Class PB".

PART 3 - EXECUTION

3.01 GENERAL CLEANING

A. Follow recommended cleaning solutions and procedures from EIFS manufacturer.
   1. Wet surfaces with clean water prior to applying cleaning solutions.
   2. Protect adjacent surfaces and vegetation from cleaning solutions and activities.

B. Prepare cleaning solutions by mixing recommended amounts of clean water and trisodium phosphate (TSP). For surfaces with biological growth, add recommended amount of household bleach to prepare cleaning solution.

C. CLEANING
   1. Apply cleaning solutions with soft bristle brush or hand sprayers.
   2. Allow cleaning solution to stand for several minutes and lightly scrub soiled areas with soft bristle brush if needed.
   3. Use low pressure spray washing equipment with nozzle tips to form a diffused spray pattern. Do not exceed manufacturers recommended maximum spray pressures.
   4. Thoroughly rinse surfaces to remove cleaning solutions and contaminants.
   5. Clean and rinse EIFS surfaces from top down

3.02 RESTORATION

A. EXAMINATION
   1. EIFS surface restoration and insulation replacement shall be in accordance with manufacturer's instructions.
   2. Examine surfaces to determine if they area in satisfactory condition for installation of system. Do not proceed with installation of system until unsatisfactory conditions have been corrected.

B. PREPARATION
   1. Use a sharp utility knife to remove damaged EIFS surfacing down to insulation surface.
   2. Cut out damaged insulation leaving straight, neat exposed edges.
   3. Cut replacement insulation to fit tightly into existing insulation cutout area. Sand edges of replacement insulation if required to attain a tight fit.
   4. Adhere replacement insulation to substrate and ensure replacement insulation is flush with existing insulation surface.
   5. Carefully sand or grind perimeter of existing finish coat to expose a minimum of 3 inches of the existing base coat reinforcement.
   6. Protect perimeter edge of existing finish coat with masking tape.
   7. Cut new reinforcing mesh to overlap onto exposed existing reinforcement a minimum of 2 ½ inches.

C. BASE COAT
   1. Completely embed new reinforcing fabric in wet base coat applied to face of insulation. Avoid wrinkles in reinforcing fabric.
   2. Trowel in place to eliminate wrinkles.
   3. Lap reinforcement edges and ends 3".
   4. Overlap fabric onto flange of surface mounted accessories.
   5. Continue reinforcing fabric continuous around corners, extending not less than 24" on each side.
   6. Reinforced base coat should be recessed approximately 1/16 inch from existing finish coat.

7. Allow base coat to completely cure (minimum 24 hours) before applying finish coat.

D. FINISH COAT
1. Install new finish coat over cured base coat patch area.
2. Texture finish coat patch to match existing finish.
3. Feather edges of finish coat into existing finish.
4. Apply finish coating in accordance with manufacturer's instruction to a thickness not less than 1/16 inch.

3.03 FINAL CLEANING AND PROTECTION

A. Remove temporary covering and protection of other work. Promptly remove protective coatings from window and doorframes and any other surfaces.

B. Provide final cleaning at time of Substantial Completion.

END OF SECTION 072450

SECTION 07530

ELASTIC SHEET ROOF MEMBRANE

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Demolition of existing roof system and metal flashings to existing roof deck

B. Installation of new roof insulation, EPDM roof membrane, and flashings

1.02 RELATED SECTIONS

Drawings and general provisions of Contract, including general and Supplementary Conditions and Division I Specification sections apply to this section.

1.03 DESCRIPTION

Work includes all labor, material, and temporary facilities necessary to produce such construction. Construct Work under a single lump-sum contract. Specifically, this section includes removal of existing sheet metal flashings and installation of new EPDM roofing membrane and associated flashing.

1.04 REFERENCE

A. Except as modified and supplemented herein, follow published requirements and written recommendations of roofing manufacturer.

B. Industry standards for roofing membranes shall be defined in "Manual of Roofing and Waterproofing" published by National Roofing Contractors Association (NRCA). Methods of application by industry standards for roofing membrane systems apply only when project manual does not address matter

C. Industry standards for sheet metal shall be defined in Architectural Sheet Metal Manual published by Sheet Metal and Air Conditioning Contractors National Association, Inc (SMACNA). Methods of application by industry standards for sheet metal apply only when project manual does not address matter.

D. Specified materials have been rated by American Society for Testing Materials (ASTM) and Federal Specifications Standards (FSS).

E. Occupational Safety and Health Administration (OSHA)

F. Applicable codes, standards, and specifications of City and County of project location. Where conflict occurs, codes establishing requirements that are more stringent shall govern.

1.05 QUALITY ASSURANCE

A. Finished exterior roof system shall comply with Underwriters Laboratories (UL) Roof Assembly Classification UL Class B Fire Hazard Classification.

B. Provide roofing materials, which have been evaluated and tested as a system by Factory Mutual System (FM) for wind-uplift, and are listed in "Factory Mutual Approved Guide" for Class I-90 construction. FM 4474: Evaluating Simulated Wind Uplift Resistance of Roof Assemblies Using Static Positive and/or Negative Differential Pressures.

C. Roof coverings shall resist impact damage based on results of tests conducted in accordance with ASTM D3746, ASTM D4272, CGSB 37-GP-52M, or "Resistance to Foot Traffic Test" in Section 5.5

of FM 4470.

D. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

E. Submittals: Reference General Requirements

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store materials in original tightly sealed or unopened containers clearly labeled with manufacturer's brand name and identifying reference numbers.

B. Store materials in a neat, safe manner, so as not to exceed allowable live load of storage area, and out of wear in a clean dry area.

C. Remove materials damaged from handling or storage, including damaged material such as wet insulation.

D. Comply with fire and safety regulations.

E. Do not store materials on adjacent roof areas.

1.07 PROJECT CONDITIONS

A. Apply roofing in dry wear.

B. If newly constructed roof becomes wet due to rainstorms, faulty water cut-off, or or reasons, remove and dispose of all wet materials, dry affected roof area, and re-construct roof in accordance with specifications at no cost to Owner.

C. Roof surface to be free of ponding water, ice, or snow before installing new roof system

D. Hazards control
1. Store volatile materials in covered metal containers
2. Prevent accumulation of wastes, which create hazardous conditions.
3. Provide adequate ventilation during use of volatile or noxious substances.

E. Conduct cleaning and disposal operations to comply with local ordinances and anti-pollution laws.
1. Do not burn or bury rubbish and waste materials on project site.
2. Do not dispose of volatile wastes, such as mineral spirits, oil, or paint thinner in storm or sanitary sewers.
3. Do not dispose wastes into streams or waterways.
4. Execute cleaning to ensure that building, grounds, and public properties are maintained free from accumulations of waste materials and rubbish.
5. Wet down dry materials and rubbish to lay dust and prevent blowing dust
6. At reasonable intervals during progress of Work, clean site and public properties, and dispose of waste materials, debris, and rubbish.
7. Provide on-site containers for collection of waste materials, debris, and rubbish.
8. Remove waste materials, debris, and rubbish from site and legally dispose of at public or private dumping area, off Owner's property.
9. Owner to assume responsibility for cleaning as of Owner's final acceptance of project
10. At no time is removed roofing, insulation, or material to be stored at job site overnight.

1.08 CONTRACTOR USE OF PREMISES

A. Limit use of site and premises to allow following:
1. Owner will occupy existing facility during entire construction period for conducting Owner's

normal operations.
2. Cooperate with Owner to minimize conflict, and to facilitate Owners operations.
3. Coordinate construction schedule and operations with Owner
4. Use of site and premise by public

B. Storage of contractor's material, equipment, and tools is limited to primary area of construction activity, as determined by Owner.

C. Access to site is limited to locations determined by Owner.

D. Limit construction operations to areas noted on Drawings.

E. Restrict construction activity to hours determined by Owner.

F. Minimize disruption and inconvenience to publics' use of adjacent areas.

G. Do not obstruct existing access and egress from adjacent site facilities.

H. Tobacco Policy: Owner prohibits use of tobacco products in its facilities and on its property. Contractor to enforce policy with contractor's employees and subcontractors

I. Contractor's Duties
1. Except as specifically noted, provide and pay for labor, materials, equipment, tools, construction equipment, machinery, water, heat, utilities, and or facilities and services necessary for proper execution and completion of work.
2. Secure and pay for, as necessary for proper execution and completion of work, and as applicable at time of receipt of bids, permits, government fees, taxes, and licenses.
3. Give required notices.
4. Promptly submit written notice to consultant of observed variance of contract documents from legal requirements. Assume responsibility for work known to be contrary to such requirements, without notice.
5. Comply with codes, ordinances, rules, regulations, orders and or legal requirements of public authorities, which bear on performance of work.
6. Upon removal of existing roofing and flashing, all counter flashing, vents, pitch pans and or items not noted for reuse will become property of contractor. Contractor is responsible for removal from site of all items removed from roof.
7. Contractor to have sole responsibility for accuracy of all measurements and for estimate of material quantities required to satisfy requirements of Contract Documents.
8. Maintain existing facility free from construction debris, waste, dirt and dust.
9. Do not allow existing facility equipment and services to become non-operational due to construction activity.
10. Do not allow access to Site and existing facility to become blocked by construction activity.

1.09 GUARANTY (ROOF MEMBRANE)

Entire installation of roofing and flashing work shall be of quality required for acceptance by membrane manufacturer in order to obtain a twenty-year Full Systems No Dollar Limit material and workmanship guaranty. Provide guaranty from date of substantial completion of project. Manufacturers Guaranty to include a roof moisture survey conducted at substantial completion.

1.10 GUARANTY (MATERIAL/WORKMANSHIP)

Provide two-year material and workmanship guaranty on form provided in these Documents.

1.11 CONSULTANT

A representative may be employed by Owner to observe Work under this section. Presence of this representative is for Owner's interest and any information or assistance furnished by representative shall not relieve contractor of responsibilities for Work. Contractor to provide reasonable notification to representative whenever work is being done to arrange observations.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Provide primary roofing products including each type of roofing membrane, and flashings, successfully produced by a manufacturer, which has produced that type of product for not less than five years. Provide secondary products recommended by primary manufacturer.

B. Provide materials that are compatible with existing conditions and with each other.

C. Provide asbestos free material.

D. Manufacturers: Equal products of below manufacturers will be reviewed for acceptance:
   1. Firestone Building Products
   2. GAF Materials Corporation
   3. Carlisle
   4. Johns Manville

2.02 ROOF SYSTEM MATERIALS

A. Membrane and Flashing:
   1. Ethylene Propylene Diene Monomers (EPDM) .060-inch thick black membrane.
   2. Miscellaneous roof membrane and flashing materials manufactured or as recommended by membrane manufacturer.
      a. Bonding Adhesives
      b. Membrane Cleaner
      c. Seam Tape
      d. Lap Sealant
      e. Water cut off mastic

B. Insulation
   1. Cover Board
      a. Dens-Deck® Prime 1/2-inch
      b. Securock™ 1/2-inch cover board
   2. Base Insulation: Polyisocyanurate ASTM C1289, 1.5-inch and 2.0-inch as indicated, Type II Class I Grade 2.
   3. Taper Insulation (Drainage): Polyisocyanurate ASTM C1289 Type II Class I Grade 2, 1/8-inch per foot, 0.5-inch starting thickness.
   4. Taper Insulation (Crickets): Polyisocyanurate ASTM C1289 Type II Class I Grade 2, 1/4-inch per foot, 0.5-inch starting thickness.
   5. Perlite Tapered Edge Strip: ASTM C728, 18.0-inches in width with a zero starting thickness and a 1.5-inch finished thickness.

C. Insulation Adhesives
   1. Dual component reaction-cure polyurethane or urethane as accepted by roof membrane manufacturer for required full systems guaranty.

2.03 MISCELLANEOUS MATERIALS

A. Fastening strips supplied by membrane manufacturer

B. Termination bar supplied by membrane manufacturer

C. Insulation Fasteners: Tested by fastener manufacturer for required pullout strength and compatible with deck type and roofing products. Roofing membrane manufacturer must approve fasteners. Contractor is responsible for any testing that may be required to substantiate required fastening methods or procedures.

2.05 ROUGH CARPENTRY

A. Wood Nailers: Douglas Fir 2.0-inch x 4.0-inch (minimum)

B. Plywood: Plywood shall meet American Plywood Association (APA) Standard APA PRP-108. Thickness to be 0.75-inch

C. Fasteners: non-exposed, ring or barbed shank nail or screw, with a withdraw resistance of minimum 100-pounds per fastener.

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS

A. To perform Work of this section, not less than five years of successful experience in installation of EPDM membrane roofing systems similar to those required for this project, approved by manufacturer of primary roof materials, and a member of NRCA or one of its affiliates.

B. Maintain full-time supervisor/foreman at job site when Work is in progress.

C. No "sub-contracting" services for installation of roof system covered under this specification to an individual or firm, which is not a full-time employee.

3.02 EXAMINATION

A. Examine surfaces for adequate anchorage, foreign materials, moisture, and or conditions, which would adversely affect roofing application and performance.

B. Responsible for preparing adequate surfaces to receive new roof system and new roofing sheet metal.

C. Prepare written documentation of conditions, which may be, detrimental to completion or performance of specified Work before commencing such Work. Work shall not start until defects have been corrected.

D. Photograph interior and exterior equipment and surrounding areas before and after completion of construction, which might be misconstrued as damage, related to demolition operations. File photographs with Owner's representative.

3.03 PREPARATION

A. Protection shall be provided for, but not necessarily limited to following:
   1. Lawn area and adjacent structures
   2. Building walls, windows, etc.
   3. Building equipment
   4. Building interior, including contents

B. Take all precautions necessary to keep noise, vibration, and dust to minimum to interior to avoid halting or disrupting normal business.

C. Protection shall be defined as minimum requirements necessary to ensure that when project is completed, Owner's property will be left in same condition as it was when project started.

D. Protect building interior from elements at all times. One representative from Contractor shall be available in two-hours' notice should an emergency occur.

E. Roof Tear Off
1. Provide minimum of 48 hours advance notice to Owner of demolition above selected areas to receive dust protection.
2. Provide temporary barricades and or forms of protection to protect Owner's personnel and public from injury due to demolition work.
3. Protect from damage existing finish work that is to remain in place and becomes exposed during demolition operations.
4. Perform demolition work in a systematic manner.
5. Protect against any material or debris dropping into building or damaging new roof membrane.

3.04 INSTALLATION OF ROOFING SYSTEM

A. General
1. Install in accordance with manufacturer's written specifications and recommended details.
2. Surfaces to be thoroughly dry before application.
3. Adhesives applied per manufacturer's recommendations.
4. Inspection to be made by responsible representative of manufacturer during application and after completion.
5. When application is begun, total system to be completed before end of day and before being wet by elements.
6. Precautions to be taken to protect membrane from punctures.

B. Roof Area "C"
1. Remove existing roof system to wood roof deck.
2. Mechanically attach base layer 2.0-inch polyisocyanurate roof insulation to roof deck
3. Fully adhere taper insulation to base layer polyisocyanurate roof insulation
4. Fully adhere cover board to polyisocyanurate roof insulation
5. Fully adhere new EPDM roof membrane to cover board

C. Roof Area "F"
1. Remove existing roof system to metal roof deck.
2. Mechanically attach base layer 1.5-inch polyisocyanurate roof insulation to roof deck
3. Fully second layer 1.5-inch polyisocyanurate roof insulation to base layer roof insulation. Off-set joints a minimum 12-inches each way.
4. Fully adhere cover board to polyisocyanurate roof insulation
5. Fully adhere new EPDM roof membrane to cover board

D. Roof Area "G"
6. Remove existing roof system to metal roof deck.
7. Mechanically attach base layer 1.5-inch polyisocyanurate roof insulation to roof deck
8. Fully adhere taper insulation to base layer polyisocyanurate roof insulation
9. Fully adhere cover board to polyisocyanurate roof insulation
10. Fully adhere new EPDM roof membrane to cover board

E. Membrane: Adhere single ply of membrane using manufacturer's recommended adhesive. Adhere laps with manufacturer's seam tape. Remove and repair any wrinkles in membrane.

F. Vertical Flashing: Install single-ply flashing where horizontal surface meets vertical surface, roof edges, and penetrations through roof. Extend flashing a minimum of 8-inches above roof surface and a minimum of 6-inches onto roof surface. Adhere flashing membrane using manufacturer's recommended adhesive. Care should be taken to eliminate all wrinkles.

G. Horizontal Flashing: Adhere flashing membrane using manufacturer's recommended adhesive to serve as strip in ply for metal flange.

3.05 INSTALLATION OF ROUGH CARPENTRY

A. After existing sheet metal has been removed, provide new wood blocking as detailed.

B. Attach wood 12.0-inches on center staggered. Fasteners to penetrate a minimum of 1 1/4 inches.

3.06 PROTECTION OF ROOFING

A. Contractors whose activities require them to work on or travel across any roof area not specified for replacement are responsible for any damage to roof membrane, flashings, and insulation they create. The following are responsibilities of Contractor and guidelines for protecting roofing system not specified for replacement:

1. As much as conditions permit, access to areas of work on roof should be direct as possible. Travel or transportation of materials across or on adjacent roofs must be avoided. If this is not possible, Contractor must review his/her plan to protect roofs from damage with Consultant and get authorization before proceeding. No demolition debris or materials are to be stored on existing roofs. Contractor is responsible for any damage caused by his activities on or around adjacent roofs y come in contact with. Roof traffic must be kept to a minimum, using walkway systems when available and when not, by taking most direct, safe route possible
2. As much as possible, all preparatory work, storage, and staging shall be completed on ground. At Work areas and where it is necessary to move equipment or materials across existing roof areas not being replaced, a 1/2" minimum exterior grade plywood shall be adhered to a 1" minimum extruded polystyrene insulation board to protect roof. This protection must extend well beyond staging or Work area. When cutting, grinding or welding, protective blankets must be laid over protection boards. Care must be taken to prevent protection layer from being dislodged by wind. If protection will be in place for an extended time, plywood shall be used and strapped toger with a 6" wide, 24 gauge galvanized, and continuous metal flashing secured with screws. Ensure that screws only penetrate bottom of plywood 1/4". If Contractor damages roofing system, immediately contact Consultant to review damage and determine procedure necessary for permanent repairs.

3.07 INSPECTION

Upon completion of installation, an inspection to be made by representative of membrane manufacturer to ascertain roofing system has been installed according to manufacturer's current published specifications. Upon completion of inspection, manufacturer's representative shall submit to owner a written report of ir findings.

3.08 CLEAN UP AND DAMAGE REPAIR

Existing items, structures or areas damaged during course of construction work to be repaired/restored to a condition equal or better than it was before commencement of work.

END OF SECTION 07530

SECTION 07550

MODIFIED BITUMINOUS SHEET ROOFING

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Demolition of existing roofing, base flashing, and sheet metal

B. Installation of a new modified bitumen roof system

1.02 RELATED SECTIONS

Drawings and general provisions of the Contract, including general and Supplementary Conditions and Division I Specification sections apply to this section.

1.03 DESCRIPTION

Work includes all labor, material, and temporary facilities necessary to produce such construction. Construct Work under a single lump-sum contract. Specifically, this section includes the removal of the existing roof system and the installation of a new modified bitumen roofing membrane and associated flashing.

1.04 REFERENCE

A. Except as modified and supplemented herein, follow published requirements and written recommendations of roofing manufacturer.

B. Industry standards for roofing membranes shall be defined in "Manual of Roofing and Waterproofing" published by National Roofing Contractors Association (NRCA). Methods of application by industry standards for roofing membrane systems apply only when project manual does not address matter

C. Industry standards for sheet metal shall be defined in Architectural Sheet Metal Manual published by Sheet Metal and Air Conditioning Contractors National Association, Inc (SMACNA). Methods of application by industry standards for sheet metal apply only when project manual does not address matter.

D. Specified materials have been rated by American Society for Testing Materials (ASTM) and Federal Specifications Standards (FSS).

E. Occupational Safety and Health Administration (OSHA)

F. Applicable codes, standards, and specifications of City and County of project location. Where conflict occurs, codes establishing requirements that are more stringent shall govern.

1.05 CONSTRUCTION SUBMITTALS

A. Submittal Procedure-Reference General Requirements

B. Roofing Submittals-Reference General Requirements

C. Shop Drawings-Reference General Requirements

1.06 QUALITY ASSURANCE

A. Finished exterior roof system shall comply with Underwriters Laboratories (UL) Roof Assembly Classification UL Class A Fire Hazard Classification.

B. Provide roofing materials, which have been evaluated and tested as a system by Factory Mutual System (FM) for wind-uplift, and are listed in "Factory Mutual Approved Guide" for Class I-90 construction.

C. Roof foreman and 50% of installing crew are trained by manufacturer in installation of specified roofing system. In addition, foreman will be full time at project site through roof completion.

1.07 CONTRACTOR USE OF PREMISES

A. Limit use of site and premises to allow following:
   1. Owner occupancy
   2. Work by Owners separate contractors
   3. Use of site and premise by public

B. Storage of contractor's material, equipment, and tools is limited to primary area of construction activity, as determined by Owner.

C. Access to site is limited to locations determined by Owner.

D. Limit construction operations to areas noted on Drawings.

E. Restrict construction activity to hours determined by Owner.

F. Minimize disruption and inconvenience to publics' use of adjacent areas.

G. Do not obstruct existing access and egress from adjacent site facilities.

H. Tobacco Policy: Owner prohibits use of tobacco products in its facilities and on its property. Contractor to enforce policy with contractor's employees and subcontractors

I. Contractor's Duties
   1. Except as specifically noted, provide and pay for labor, materials, equipment, tools, construction equipment, machinery, water, heat, utilities, and other facilities and services necessary for proper execution and completion of work.
   2. Secure and pay for, as necessary for proper execution and completion of work, and as applicable at the time of receipt of bids, permits, government fees, taxes, and licenses.
   3. Give required notices.
   4. Promptly submit written notice to consultant of observed variance of contract documents from legal requirements. Assume responsibility for work known to be contrary to such requirements, without notice.
   5. Comply with codes, ordinances, rules, regulations, orders and other legal requirements of public authorities, which bear on performance of work.
   6. Upon removal of existing roofing and flashing, all counter flashing, vents, pitch pans and other items not noted for reuse will become the property of the contractor. Contractor is responsible for removal from site of all items removed from roof.
   7. Contractor to have sole responsibility for accuracy of all measurements and for estimate of material quantities required to satisfy requirements of Contract Documents.

1.08 REQUIREMENTS

A. Construct Work to accommodate owner's occupancy requirements during construction period.
   1. Owner will occupy existing facility during entire construction period for conducting Owner's normal operations.
   2. Cooperate with Owner to minimize conflict, and to facilitate Owners operations.
   3. Coordinate construction schedule and operations with Owner and consultant.

B. Cooperate with Owner to minimize conflict and to facilitate Owners operations, including but not limited to the following.

1. Maintain existing facility free from construction debris, waste, dirt and dust.
2. Do not allow existing facility equipment and services to become non-operational due to construction activity.
3. Do not allow access to Site and existing facility to become blocked by construction activity.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Store materials in their original tightly sealed or unopened containers clearly labeled with manufacturer's brand name and identifying reference numbers.

B. Store materials in a neat, safe manner, so as not to exceed allowable live load of storage area, and out of weather in a clean dry area

C. Remove materials damaged from handling or storage, including damaged material such as wet insulation.

D. Comply with fire and safety regulations.

1.10 PROJECT CONDITIONS

A. Apply roofing in dry weather.

B. If newly constructed roof becomes wet due to rainstorms, faulty water cut-off, or other reasons, remove and dispose of all wet materials, dry affected roof area, and re-construct roof in accordance with specifications at no cost to Owner.

C. Roof surface to be free of ponded water, ice, or snow before installing new roof system

D. Hazards control
1. Store volatile materials in covered metal containers
2. Prevent accumulation of wastes, which create hazardous conditions.
3. Provide adequate ventilation during use of volatile or noxious substances.

E. Conduct cleaning and disposal operations to comply with local ordinances and anti-pollution laws.
1. Do not burn or bury rubbish and waste materials on project site.
2. Do not dispose of volatile wastes, such as mineral spirits, oil, or paint thinner in storm or sanitary sewers.
3. Do not dispose wastes into streams or waterways.
4. Execute cleaning to ensure that building, grounds, and public properties are maintained free from accumulations of waste materials and rubbish.
5. Wet down dry materials and rubbish to lay dust and prevent blowing dust
6. At reasonable intervals during progress of Work, clean site and public properties, and dispose of waste materials, debris, and rubbish.
7. Provide on-site containers for collection of waste materials, debris, and rubbish.
8. Remove waste materials, debris, and rubbish from site and legally dispose of at public or private dumping area, off Owner's property.
9. Schedule cleaning operations so dust and other contaminants resulting from cleaning process will not fall on wet, newly painted surfaces
10. Owner to assume responsibility for cleaning as of Owner's final acceptance of project
11. At no time is removed roofing, insulation, or other material be stored at job site overnight.

1.11 GUARANTY (ROOF MEMBRANE)

Entire installation of roofing and flashing work shall be of quality required for acceptance by membrane manufacturer in order to obtain a twenty-year Full Systems No Dollar Limit material and workmanship guaranty. Provide guaranty from date of substantial completion of project. Manufacturers Guaranty to include a roof moisture survey conducted at substantial completion and semiannual reviews conducted for the first two years following completion of roof system.

1.12 GUARANTY (MATERIAL/WORKMANSHIP)

Provide two-year material and workmanship guaranty on form provided in these Documents.

1.13 CONSULTANT

A representative may be employed by Owner to observe Work under this section. Presence of this representative is for Owner's interest and any information or assistance furnished by representative shall not relieve contractor of responsibilities for Work. Contractor to provide reasonable notification to representative whenever work is being done to arrange observations.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Provide primary roofing products including each type of roofing felt, bitumen, and flashings, successfully produced by a manufacturer, which has produced that type of product for not less than five years. Provide secondary products recommended by primary manufacturer. Provide materials that are compatible with existing conditions and with each other. Provide asbestos free materials.

B. Manufacturers: Equal products of manufacturers listed will be reviewed for acceptance:
   1. John's Manville
   2. Firestone Building Products
   3. Derbigum Americas
   4. GAF

2.02 ROOF SYSTEM MATERIALS

A. Vapor Retarder
   1. ASTM D6164 SBS, Grade S, Type I, minimum 120 mil thickness or ASTM D5147 APP, Grade S, minimum 120 mil thickness.

B. Insulation
   1. Cover Board
      a. Dens-Deck® Prime 1/2-inch
      b. Securock™ 1/2-inch cover board
   2. Polyisocyanurate (base layer): ASTM C1289, 1.5-inch and 2.0-inch as indicated per area, Type II Class I Grade 2 Size not to exceed 4' x 4'.
   3. Polyisocyanurate (taper insulation): ASTM C1289, 1/8-inch per foot and 1/4-inch per foot as indicated per area, Type II Class I Grade 2, 0.5-inch starting thickness.
   4. Polyisocyanurate (crickets): ASTM C1289, 1/2 -inch per foot Type II Class I Grade 2, 0.5-inch starting thickness.
   5. Perlite (taper insulation): ASTM C728, 1/8-inch per foot, 0.0-inch starting thickness.
   6. Preformed Perlite Cant: ASTM C728, minimum 4-inch wide x 1-inch thick.
   7. Perlite Tapered Edge Strip: ASTM C728, 18.0-inches in width with a zero starting thickness and a 1.5-inch finished thickness. For cricket construction, minimum 6.0-inches in width with a zero starting thickness and a 0.5-inch finished thickness.

C. Membrane
   1. Base Ply Membrane Field/Flashing, (one of the following):
      a. ASTM D6164 SBS polyester reinforcement, Grade S, Type I or Type II (min. 120 mil thickness).
      b. ASTM D6509 APP fiberglass reinforcement, Grade S, (min. 120 mil thickness).
   2. Surface Membrane Field/Flashing (white, provide one of the following based on base ply):
      a. ASTM D6164 SBS polyester reinforcement, grade G, Type II (min. 250 gram mat or minimum 155 mil thickness), FR-fire rated.
      b. ASTM D6223 APP dual reinforcement (polyester and glass fiber), Grade G, Type

II (min. 250 gram mat or minimum 155 mil thickness), FR-fire rated.

D. Adhesives
1. Asphalt Primer: ASTM D41
2. Membrane Adhesive: ASTM D3019, Type III, grade 2 (surface membrane only)
3. Flashing Cement: ASTM D4586 trowel grade, asbestos free, cold modified bitumen flashing membrane adhesive.

E. Fasteners
1. Non-exposed: Ring or barbed shank roofing nail, galvanized or copper
2. Mechanical insulation fasteners: Tested by fastener manufacturer for required pullout strength and compatible with deck type and roofing products. Roofing membrane manufacturer must approve fasteners. Contractor is responsible for any testing that may be required to substantiate required fastening methods or procedures

F. Liquid-Applied Flashing: Catalyzed Acrylic Resin Flashing System: A specialty flashing system consisting of a liquid-applied, fully reinforced, multi-component acrylic membrane installed over a prepared or primed substrate. The flashing system consists of a catalyzed polymethyl methacrylate primer, basecoat and topcoat, combined with a non-woven polyester fleece. The use of the specialty flashing system shall be specifically approved in advance by the membrane manufacturer for each application.

2.03 ROOF ACCESSORIES

A. Walkway or Protection Pad: Additional ply of specified modified bitumen surfacing membrane to be applied to all four sides of RTU's and at roof hatch. Material to be same color as field ply and heat welded.

B. Pipe Supports. Cooper Industries, B-line Dura-Blok roof supports. Dura-Blok bases manufactured from 100% recycled rubber, UV resistant. Equal products to those listed will be reviewed for acceptance during bidding phase.
1. Conduit and Piping less than 2-inches diameter provide Dura-Block DB10 with clamps.
2. Piping greater than 2-inches and less than 3.5-inches diameter provide Dura-Block DBR adjustable height supports with two (2) 1/2" Electro Zinc Plated All Threaded Rod Risers and an Electro Zinc Plated Malleable Iron Double Rod Roller.
3. Piping greater than 3.5-inches diameter provide Dura-Block DBR10-12 fixed height supports with an Electro Zinc Plated Malleable Iron Double Rod Roller. Dimensions - Base - 4" High x 6" Wide x 9.6" Length (base length).

2.04 ROUGH CARPENTRY

A. Wood Curbs and Nailers: Douglas Fir

B. Plywood: Plywood shall meet the American Plywood Association (APA) Standard APA PRP-108. Thickness to be 0. 5-inch

C. Fasteners: non-exposed, ring or barbed shank nail or screw, with a withdraw resistance of minimum 100-pounds per fastener.

2.05 PLUMBING

A. Sheet Lead: Thirty inch (square) 2 ½ - 4 pound per square foot for drains

B. New stainless steel roof drain bolts for all clamping rings

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS

A. To perform Work of this section, not less than five years of successful experience in installation of modified bitumen roofing systems similar to those required for this project, approved by manufacturer of primary roof materials, and a member of NRCA or one of its affiliates.

B. Maintain full-time supervisor/foreman at job site when Work in progress.

C. No "sub-contracting" services for installation of roof system covered under this specification to an individual or firm, which is not a full-time employee. Services include demolition and installation of insulation, roof membrane, surfacing, flashing, and temporary roof walkways for protection of roof system during construction only.

3.02 EXAMINATION

A. Examine surfaces for adequate anchorage, foreign materials, moisture, and other conditions which would adversely affect roofing application and performance.

B. Responsible for preparing adequate surfaces to receive new system

C. Prepare written documentation of conditions, which may be, detrimental to completion or performance of specified Work before commencing such Work. Work shall not start until defects have been corrected.

D. Photograph interior and exterior equipment and surrounding areas before and after completion of construction, which might be misconstrued as damage, related to demolition operations. File photographs with Owner's representative.

3.03 PREPARATION

A. Protection shall be provided for, but not necessarily limited to following:
   1. Lawn area and adjacent structures
   2. Building walls, windows, etc.
   3. Building equipment
   4. Building interior, including contents

B. Take all precautions necessary to keep noise, vibration, and dust to minimum to interior to avoid halting or disrupting normal business.

C. Protection shall be defined as minimum requirements necessary to ensure that when project is completed, Owner's property will be left in same condition as it was when project started.

D. Protect building interior from elements at all times. One representative from Contractor shall be available in two-hour' notice should an emergency occur.

E. Roof Tear Off
   1. Provide minimum of 48 hours advance notice to Owner of demolition above selected areas to receive dust protection.
   2. Provide temporary barricades and other forms of protection to protect Owner's personnel and public from injury due to demolition work.
   3. Protect from damage existing finish work that is to remain in place and becomes exposed during demolition operations.
   4. Remove existing roofing (where designated), insulation, flashings, and sheet metal to deck.
   5. Clear roof drains of any material that would restrict drainage.
   6. Perform demolition work in a systematic manner.
   7. Protect against any material or debris dropping into the building or damaging new roof

membrane.

3.04 APPLICATION GENERAL

A. Install in accordance with manufacturer's written specifications and recommended details.

B. Surfaces to be thoroughly dry before application.

C. Inspection to be made by responsible representative of manufacturer during application and after completion

D. Insulation to be dry when installed and shall be protected from weather. All materials, which become wet, shall be removed before end of day. Insulation board gaps are not to exceed ¼-inch. If joints are greater, then add additional insulation to gap. No more insulation is to be applied than can be covered with required membrane on same day. All layers of roof insulation to meet specified wind uplift requirements. Joints of all layers of multiple layer roof insulation to be offset minimum 12-inches in both directions from each preceding layer.

E. When application is begun, total system to be completed before end of day and before being wet by elements

F. Install water cut-off at completion of each day's work and remove upon resumption of Work.

G. Precautions to be taken to protect membrane from punctures

H. Cold adhesive applied per manufacturer's recommendations.

I. Shingle ply sheets in proper direction to shed water. Install ply sheets uniformly to achieve required number of plies. Precautions to be taken to protect membrane from punctures

J. Protect membrane from spillage and prevent liquid materials from entering or clogging drains and conductors. Replace/restore membrane damaged by other trades.

K. Temporary Walkway Protection: Provide adequate protection for membranes.

3.05 INSTALLATION OF ROOFING SYSTEM

A. Roof Area "B"
   1. Remove existing roof system to metal roof deck.
   2. Mechanically attach one layer of 1.5-inch base layer of polyisocyanurate roof insulation to metal roof deck.
   3. Adhere 1/4-inch per foot tapered polyisocyanurate roof insulation to base layer of polyisocyanurate roof insulation with roof membrane manufacturer's foam adhesive. Transition from edge of tapered insulation using perlite tapered edge.
   4. Adhere cover board roof insulation to tapered roof insulation with roof membrane manufacturer's foam adhesive.
   5. Adhere field ply of membrane with spray adhesive to cover board roof insulation and heat weld laps.
   6. Adhere field ply of flashing membrane by heat-welding.
   7. Adhere surface ply of field membrane with spray adhesive and heat weld laps. Cut rolls of membrane into two equal lengths prior to installation. Embed additional granules; matching sheet color, into laps while adhesive is fluid.
   8. Adhere surface ply of flashing membrane by heat welding.

B. Roof Areas "D" and "E"
   1. Remove existing roof system to concrete roof deck.
   2. Adhere one ply vapor barrier to concrete roof deck with spray adhesive.
   3. Adhere one layer of 2.0-inch base layer of polyisocyanurate roof insulation to vapor barrier.

4. Adhere 1/8-inch per foot tapered polyisocyanurate roof insulation to base layer of polyisocyanurate roof insulation with roof membrane manufacturer's foam adhesive. Transition from edge of tapered insulation using perlite tapered edge.
5. Adhere cover board roof insulation to tapered roof insulation with roof membrane manufacturer's foam adhesive.
6. Adhere field ply of membrane with spray adhesive to cover board roof insulation and heat weld laps.
7. Adhere field ply of flashing membrane by heat-welding.
8. Adhere surface ply of field membrane with spray adhesive and heat weld laps. Cut rolls of membrane into two equal lengths prior to installation. Embed additional granules; matching sheet color, into laps while adhesive is fluid.
9. Adhere surface ply of flashing membrane by heat welding.

3.06 INSTALLATION OF ROOF ACCESSORIES

A. Fully-adhere walkway protection membrane in continuous pieces on all sides of rooftop mechanical equipment with any one side greater than 30-inches in width.

B. Install pipe supports at **six-foot** intervals, under elbows and under joints.

C. Liquid-Applied Flashing: Remove asphalt, loose materials, and other coatings from metal surfaces to receive liquid-applied flashing. Prepare surfaces and apply liquid-applied flashing and fabric reinforcement materials per manufacturer's recommendations. Bare metal surfaces left exposed after flashing application shall be painted as specified.

3.07 INSTALLATION OF ROUGH CARPENTRY

A. After a section of old roofing has been removed, provide additional wood nailers to perimeters in thickness as detailed.

B. On each building level, perimeter height shall be uniform and level.

C. After a section of old roofing has been removed, provide additional wood nailers to top of each curb to bring height of curb a minimum of 8-inches above finished roof surface.

D. Contractor is responsible for extending noted curbs.

E. Attach wood 12-inches on center staggered. Fasteners to penetrate a minimum of 1 1/4 inches

3.08 INSTALLATION OF PLUMBING

Roof Drain: Create 4' x 4' drain sump by starting base layer of 2.0-inch polyisocyanurate roof insulation on roof deck two feet from center of drain and adhering 1 layer 0"-2.0"inch tapered edge strip in adhesive around drain. Specified cover board shall cover tapered roof insulation in roof sump. Install a 30-inch glass fiber fabric mat, set in flashing cement on cover board insulation. Install field plies into drain. Install a 30-inch (square) 4-pound lead flashing set in flashing cement into drain, fold down a minimum of 1.0-inches into roof drain. Surface membrane is to serve as strip in ply if allowed by membrane manufacturer. Surface membrane and lead flashing are to extend under clamping ring. **Install new stainless steel clamping ring bolts (do not re-use existing bolts). Use of "all-thread" will not be accepted. If existing drain strainers and clamping rings or plastic, replace with cast aluminum or cast steel. If existing drain baskets or clamping rings are missing, cracked, or broken, replace with new cast aluminum or cast steel.**

3.09 INSPECTION

Upon completion of installation, an inspection to be made by representative of membrane manufacturer to ascertain roofing system has been installed according to manufacturer's current published specifications. Upon completion of inspection, manufacturer's representative shall submit to owner a written report of their findings.

3.10 CLEAN UP AND DAMAGE REPAIR

Existing items, structures or areas damaged during the course of construction work to be repaired/restored to a condition equal or better than it was before commencement of work. Upon completion of roof system, contractor shall consolidate all excess granules by "power-blowing" entire roof system. Take care not to blow granules and debris into roof drainage systems or off roof edges. Remove excess granules and debris from new roof areas and dispose of off site

END OF SECTION 07550

SECTION 07620

SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.01 WORK INCLUDED

Demolition of existing roofing sheet metal and installation of new sheet metal

1.02 RELATED SECTIONS

Drawings and general provisions of the Contract, including general and Supplementary Conditions and Division I Specification sections apply to this section.

1.03 DESCRIPTION

This section includes the removal of existing sheet metal designated for disposal and the installation of new sheet metal copings, metal edge, and counter flashing.

1.04 REFERENCE

A. Except as modified and supplemented herein, follow the published requirements and written recommendations of the membrane manufacturer and others. Methods of application by industry standards for roofing membrane systems apply only when this project manual does not address the matter. Industry standards for roofing membranes shall be defined in the "Manual of Roofing and Waterproofing" published by the National Roofing Contractors Association (NRCA).

B. Except as modified and supplemented herein, follow the published requirements and written recommendations of the membrane manufacturers and others. Methods of application by industry standards for sheet metal apply only when this project manual does not address the matter. Industry standards for sheet metal shall be defined in the Architectural Sheet Metal Manual published by the Sheet Metal and Air Conditioning Contractors National Association, Inc (SMACNA).

C. Specified materials have been rated by American Society for Testing Materials (ASTM) and Federal Specifications Standards (FSS).

D. Occupational Safety and Health Administration (OSHA)

E. Applicable codes, standards, and specifications of City and County of project location. Where conflict occurs, codes establishing requirements that are more stringent shall govern.

1.05 PERFORMANCE REQUIREMENTS

A. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing.

B. Fabricate and install flashings at roof edges and fascia systems to comply with recommendations of FM Loss prevention Data Sheets 1-49 for the following wind zone:
   1. Wind Zone 1: Wind pressure of 21 to 30 psf.

1.06 CONSTRUCTION SUBMITTALS

A. Submittal Procedure-Reference General Requirements

B. Sheet Metal Submittals-Reference General Requirements

1.07 QUALITY ASSURANCE

Installation of sheet metal flashing and components shall meet the specified wind uplift requirements listed in the thermal and moisture protection section.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Materials to be stored in a neat, safe manner, so as not to exceed allowable live load of the storage area, and out of the weather in a clean dry area

B. Any materials damaged from handling or storage is not to be used and removed from the site.

C. Comply with safety regulations.

1.09 GUARANTY

A. Provide manufacturer's twenty-year guaranty on metal finish against fading, chalking, blistering, pealing, and chipping.

B. Provide two-year Contractor's guaranty on form provided in these Documents.

1.10 CONSULTANT

A representative may be employed by Owner to observe work under this section. The presence of this representative is for Owner's interest and any information or assistance furnished by representative does not relieve Contractor of responsibilities for Work. Contractor to provide reasonable notification to representative whenever work is being done in sufficient time to arrange observations

PART 2 - PRODUCTS

2.01 MATERIALS

A. Pre-finished Steel: ASTM A 527, 22 gauge, 70% Kynar Coated finish, Zinc-coated Steel, with 1.0 mil thickness coating. Owner shall select color from manufacturer's standard colors.

B. Zinc-Coated Steel: (galvanized) ASTM A 526, 20 gauge, with 0.20% copper, G90 hot-dip galvanized.

C. Stainless Steel: ASTM A 666, Type 302, Mill Rolled No. 2D or 2B, 24 gage.

D. Pourable Sealer: ASTM D 0412, two components, 100 percent polyurethane

2.02 FABRICATED SHEET METAL

A. Metal Work to be shop fabricated to configurations and forms in accordance with recognized sheet metal practices.

B. All accessories or items essential to completeness of sheet metal installation, whether specifically indicated or not, are to be provided and of same material as item to which being applied

C. Sheet Metal Components
   1. Parapet Coping: 22 gauge pre-finished
   2. Continuous Cleat: 20 gauge galvanized
   3. Gutter: 22 gauge pre-finished
   4. Downspout: 22 gauge pre-finished
   5. Scupper: 24 gauge stainless steel with 22 gauge pre-finished faceplate
   6. Splash Pans: 26 gauge stainless steel
   7. Counter Flashing: 22 gauge pre-finished

8. Miscellaneous Trim Pieces: 22 gauge pre-finished
9. Expansion Joint: 22 gauge pre-finished
10. Vent: 24 gauge galvanized, 24 rain collar, draw band, sealant

E. Fasteners
1. Exposed screw fasteners shall be 300 series alloy stainless steel with integrally bonded neoprene washers or Zinc Aluminum Cast head covers with integral neoprene gaskets.
2. Exposed pop rivets shall be stainless steel, rivet, and mandrel, self plugging type #44 - 1/8" diameter 1/4" grip minimum. Exposed pop rivets shall be factory painted to match metal.
3. Concealed fasteners for anchor clips shall be #10 -12 - 1" long pancake head #2 Phillips drive.
4. Concealed fasteners for flashing attachment shall be #8 -15 - 1 1/4" long truss head #2 Phillips drive screw.

F. Sheet Membrane Liner/Flexible Vapor Retarder
1. .045 mil EPDM; use EPDM seam tape at all laps

PART 3 - EXECUTION

3.01 ACCEPTABLE INSTALLERS

A. To perform Work of this Section, contractor shall not have less than five years of successful experience in installation of sheet metal products similar to those required for this project. Contractor must be a member of Sheet Metal and Air Conditioning Contractors National Association, Inc (SMACNA).

B. Maintain full-time supervisor/foreman at job site when Work is in progress.

3.02 EXAMINATION

A. Examine surfaces for adequate anchorage, foreign materials, moisture, and other conditions which would adversely affect sheet metal application and performance.

B. Responsible for preparing adequate surfaces to receive new sheet metal

C. Prepare written documentation of conditions, which may be detrimental to completion or performance of specified Work before commencing such Work. Work shall not start until defects have been corrected.

3.03 PREPARATION

A. Protection to be provided for, but not necessarily limited to following:
1. Lawn area and adjacent structures
2. Building walls, windows, etc.
3. Building equipment
4. Building interior, including contents

B. Take all precautions necessary to keep noise, vibration, and dust to a minimum to interior to avoid halting or disrupting normal business.

C. Protection to be defined as minimum requirements necessary to ensure that when project is completed, Owner's property will be left in same condition as it was when project started

D. Protect building interior from elements at all times. One representative from Contractor is to be available in two-hour' notice should an emergency occur.

3.04 APPLICATION GENERAL

A. Precautions to be taken to protect membrane from punctures

B. Temporary Walkway Protection: Provide adequate protection for roofing membranes during sheet metal operation.

3.05 INSTALLATION OF SHEET METAL

A. General
1. Protect contact areas of dissimilar metals with heavy asphaltic or other approved coating specifically made to stop electrolytic action.
2. Install Work watertight, without waves, warps, buckles, fastening stress or distortion, allowing for expansion and contraction.
3. Angle bottom edge of exposed vertical surfaces to form drip
4. Install sheet metal to comply with SMACNA.
5. Set all flanges in asphalt adhesive.
6. Fabricate Work according to SMACNA and NRCA recommendations, except where joint movement is necessary to provide 1-inch deep interlocking hooked flanges filled with asphalt adhesive.
7. Provide 4-inch primed flanges for setting on membrane for concealment by flashing ply.
8. Joints in sheet metal flashing shall be lapped and sealant installed unless otherwise specified.

B. Sheet Metal Installation
1. Parapet wall coping: Fabricate and install coping per SMACNA 7th Ed. FIG 3-1. Loose lay continuous sheet membrane liner over top of coping wall, extending over edges a minimum of 1-inch on both sides. Attach continuous cleat 12- inches on center. Attach metal coping 18-inches on center. Fasteners are to penetrate a minimum of 1-inch. Joints shall be butt seam with backup plates. Backup plates shall be pre-finished and a minimum 6-inches wide.
2. Expansion Joint: Fabricate and install expansion joint cover per SMACNA 7th Ed. Loose lay un-faced glass fiber batt insulation within vapor retarder. Mechanically attach expansion joint metal twelve-inches on center.
3. Counter Flashing: Fabricate and install counter flashing (all) per SMACNA 7th Ed. Attach sheet metal 12-inches on center. Fasteners shall penetrate a minimum of one inch.
4. Down Spout: Fabricate and install downspout per SMACNA 7th Ed. FIG 1-32E. Downspout straps fabricated per SMACNA 7th Ed. Figure 1-35A. Install straps at a maximum spacing of 10-feet, minimum of two straps per downspout.
5. Gutter: Fabricate and install per SMACNA 7th Ed. FIG 1-2H with 1/8"x1" galvanized gutter brackets (wrapped with 24 gauge pre-finished metal to match gutter) spaced 36" on center and 1/8"x1" galvanized gutter straps spaced 36" on center. Alternate spacing of gutter straps and gutter brackets. Gutter size and profile to match existing. Gutter apron (metal edge) to be 22 gage pre-finished metal. Gutter apron (metal edge): install a layer of adhesive; fasten metal flange 3-inches staggered on center, prime surface of metal flange. Installed gutter shall have 2-inch lap joints with continuous sealant and pop riveted (using pre-finished rivets matching gutter) 1-inch on center.
6. Scupper: Fabricate and install per SMACNA 7th Ed. Prime metal surfaces to receive flashing ply. Return outside edges of scupper to interlock with prefinished faceplate.
7. Splash pans to be fabricated from 24-gauge stainless steel matching and fabricated as indicated in SMACNA 7th Ed. Figure 1-36 with a minimum of six corrugations. Install splash pans at all downspout locations that drain onto adjacent roof surfaces. Install splash pans in one part urethane adhesive.
8. Pitch Pan: Fabricate pitch pan per SMACNA 7th Ed. Fill 100% with specified pourable sealer (do not use grout).
9. Vents: Fabricate the vent flashings with minimum 8-inch height and a diameter 1-inch larger than penetration element. Fasten collar flashing using draw band. Caulk where indicated.

END OF SECTION 07620

SECTION 07723

ROOF ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

A. New roof hatch.

B. New roof anchor tie-off posts.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including general and Supplementary Conditions and Division I Specification sections apply to this section.

B. Related Sections:
   1. Section 07620 "Sheet Metal Flashing and Trim" for shop- and field-formed metal flashing and miscellaneous sheet metal trim and accessories.

1.03 PERFORMANCE REQUIREMENTS

General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

1.04 CONSTRUCTION SUBMITTALS

A. Product Data: For each type of roof accessory indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof accessories. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

C. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

1.05 COORDINATION

A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leak-proof, weather-tight, secure, and noncorrosive installation.

B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

PART 2 - PRODUCTS

2.01 ROOF HATCH METAL MATERIALS

A. Aluminum Sheet: ASTM B 209, manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.

B. Mill Finish: As manufactured.

C. Aluminum Extrusions and Tubes: ASTM B 221 manufacturer's standard alloy and temper for type of use, finished to match assembly where used, otherwise mill finished.

D. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2.02 MISCELLANEOUS ROOF HATCH MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Glass-Fiber Board Insulation: ASTM C 726, thickness as indicated.

C. Polyisocyanurate Board Insulation: ASTM C 1289, thickness as indicated.

D. Wood Nailers: Complying with AWPA Douglas fir No.2; nominal 1-1/2 inches thick.

E. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide non-removable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
   1. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A 153/A 153M or ASTM F 2329.
   2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.

F. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

2.03 ROOF HATCH

A. Roof Hatch: Metal roof-hatch units with lids and insulated double-walled curbs, welded and sealed corner joints, continuous lid-to-curb counter flashing and weather-tight perimeter gasketing, and integrally formed deck-mounting flange at perimeter bottom.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
      a. Bilco Company
      b. Milcor Inc.
      c. Nystrom
      d. Babcock-Davis

B. Type and Size: Single-leaf lid, approximately 30 by 36 inches to match existing roof hatch opening.

C. Hatch Material: Aluminum steel sheet, 11 gauge. Mill finish

D. Construction:
   1. Insulation: Glass-fiber or Polyisocyanurate board. Minimum 1.0-inch.
   2. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
   3. Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
   4. Fabricate curbs to provide a minimum roof flashing height of 8-inches unless otherwise indicated.

E. Hardware: Stainless-steel spring latch with turn handles, butt- or pintle-type hinge system, and padlock hasps inside and outside.

2.04 ROOF HATCH SAFETY RAIL SYSTEM

A. Furnish and install fixed roof hatch safety rail system.

1. Size to match roof hatch.
2. Hatch rail system shall attach to the roof hatch and shall not penetrate any roofing material.
3. Hatch rail system shall satisfy the requirements of OSHA 29 CFR 1910.23 and shall meet OSHA strength requirements with a factor of safety of two.
4. Self-closing gate shall be provided with hatch rail system.

B. Posts and Rails shall be constructed of reinforced fiberglass painted safety yellow treated with a UV inhibitor.

C. Hardware: Mounting brackets shall be ¼" (6mm) thick hot dip galvanized steel. Hinges and post guides shall be 6063T5 aluminum. Fasteners shall be Type 316 stainless steel.

2.05 ROOF ANCHOR POST

A. Manufacturer: Guardian Fall Protection. Model CB-18 Anchor Point

B. Galvanized steel one piece anchor post for attachment to metal roof deck. Integral deck plate and stationary top.

C. Manufacturer supplied fasteners for roof deck attachment.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Verify dimensions of roof openings for roof accessories.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General: Install roof accessories according to manufacturer's written instructions.

B Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.

C. Anchor roof accessories securely in place so they are capable of resisting indicated loads.

D. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.

E. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

F. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

G. Roof-Hatch Installation:
1. Install roof hatch so top surface of hatch curb is level.
2. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.

H. Roof-Hatch Safety Rail Installation:
1. Install roof hatch safety rail according to manufacturer's written instructions.
2. Verify that safety rail does not interfere with roof hatch operation. Ensure safety rail self closing gate feature operates properly.

I. ROOF ANCHOR POST: install new anchor post per manufactures instructions.

3.03 REPAIR AND CLEANING

A. Clean exposed surfaces according to manufacturer's written instructions.

B. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

C. Repair finishes damaged during installation.

END OF SECTION 07723

SECTION 07920

SEALANT AND CAULKING

PART 1 - GENERAL

1.01 WORK INCLUDED

The Work includes all labor, material, and temporary facilities necessary to produce such construction. Construct Work under a single lump-sum contract. Specifically, this section includes application of exterior sealants.

1.02 RELATED SECTIONS

Drawings and general provisions of the Contract, including general and Supplementary Conditions and Division I Specification sections apply to this section.

1.03 REFERENCE

A. Except as modified and supplemented herein, follow published requirements and written recommendations of roofing manufacturer.

B. Industry standards for sheet metal shall be defined in Architectural Sheet Metal Manual published by Sheet Metal and Air Conditioning Contractors National Association, Inc (SMACNA). Methods of application by industry standards for sheet metal apply only when project manual does not address matter.

C. Specified materials have been rated by American Society for Testing Materials (ASTM) and Federal Specifications Standards (FSS).

D. Occupational Safety and Health Administration (OSHA)

E. Applicable codes, standards, and specifications of City and County of project location. Where conflict occurs, codes establishing requirements that are more stringent shall govern.

1.04 CONSTRUCTION SUBMITTALS

Submittal Procedure-Reference General Requirements

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store materials in their original tightly sealed or unopened containers clearly labeled with manufacturer's brand name and identifying reference numbers.

B. Store materials in a neat, safe manner and out of weather in a clean dry area

C. Remove materials damaged from handling or storage.

PART 2 - PRODUCTS

2.01 ELASTOMERIC JOINT SEALANT

A. Exterior Applications
   1. Material: One-part urethane sealant, Federal Specification TT-S-00230C, Type II, Class A. ASTM C920-87, Type S, Grade NS, Class 25.
   2. Color: To match new sheet metal flashing

a. Pecora Corporation
b. Sonneborn Div., ChemRex, Inc.
c. Tremco, Inc.

PART 3 - EXECUTION

3.01 EXAMINATION

Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint sealant performance. Do not proceed with installation of joint sealants until satisfactory conditions have been corrected.

3.02 PREPARATION

A. Thoroughly clean joints of all dirt, loose mortar, oil, grease and other foreign materials, which may adversely affect sealant performance.

B. Assure joints are thoroughly dry.

3.03 APPLICATION

Apply sealant using manufacturer's recommended equipment. Fill joints solidly, remove excess compound with proper tool, leaving a smooth surface, and clean adjoining surfaces, tooled at right angles to the sides of the joint. Joints shall be watertight and weather tight. Feather edging of caulking joint is unacceptable. Properly tool sealant to assure adhesion to sides of joint and give correct bead configuration.

3.04 CLEANUP

The surfaces of all material adjoining caulked joints shall be cleaned of any smears of compound or other soiling due to the caulking application.

3.05 PROTECTION

Protect joint sealants during and after curing period from contact with contaminating substances of from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of substantial completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and reseal joints with new materials to produce joint sealant installations with repaired areas indistinguishable from original work.

END OF SECTION 07920

SECTION 09900

PAINTING

PART 1 - GENERAL

1.01 WORK INCLUDED

Painting of gas line and equipment screen structure

1.02 RELATED SECTIONS

Drawings and general provisions of Contract, including general and Supplementary Conditions and Division I Specification sections apply to this Section.

1.03 DESCRIPTION

Work includes all labor, material, and temporary facilities necessary to produce such construction. Construct Work under a single lump-sum contract.

1.04 STORAGE

No materials used on job shall be stored on Owners property. Any oily rags, waste, etc. shall be removed from project site daily and every precaution taken to avoid danger of fire.

1.05 SUBMITTALS

Contractor shall make any samples that may be requested and submit them for approval. All colors, degree of gloss and finish shall be as directed by Consultant and Owner. Color to be determined by Owner.

PART 2 - PRODUCTS

2.01 EXTERIOR METAL SURFACE

A. The exposed surface of any of various materials, exterior, shall be finished as listed. Any items which require painters finish not included in lists shall be painted like similar items in list or as directed by Consultant.

B. It is intended that all gas piping on designated roof replacement areas and additional items as indicated on the drawings shall be painted as part of this Contract. Equal products to those listed below will be reviewed for acceptance during the bidding phase.

   1. Gas Piping:
      a. One Coat (base coat) – Sherwin-Williams Kem Kromic Universal Metal Primer (Series B50WZ1, off-white)
      b. Two Coats (top coat) – Sherwin-Williams Industrial Enamel VOC (Series B54Z, tinted grey with Color-Prime® Primer "P3")

PART 3 - EXECUTION

3.01 SURFACE PREPARATION

A. General

   1. Perform preparation and cleaning procedures in strict accordance with paint manufacturer's instructions and as herein specified, for each particular substrate condition.
   2. Clean surface to be painted before applying paint or coatings. Remove oil, asphalt, and

grease prior to mechanical cleaning. Program cleaning and painting so that contaminants from cleaning process will not fall onto wet, newly painted surfaces.

B. Substrate

1. Applicator shall examine all surfaces and parts of structure to which painting is to be applied, and conditions under which Work is to be performed, and notify Consultant in writing, of any conditions detrimental to performance of this Work. Do not proceed with this Work until unsatisfactory conditions have been corrected and are acceptable to Applicator.
2. Starting of painting Work will be construed as Applicators acceptance of surfaces and conditions within any particular area.
3. Do not paint over dirt, asphalt, rust, scale, grease, moisture, scuffed surfaces, soap residue on finished caulk beads, or conditions otherwise detrimental to formation of a durable paint film.

3.02 EXECUTION

A. Applications

1. Apply paint in accordance with manufacturer direction. Use applicators and techniques best suited for material being applied.
2. Workmanship shall be of very best, all material evenly spread and smooth flowed on without runs or sag. Only skilled mechanics shall be employed.
3. Apply additional coats when undercoats or other conditions show through final coat of paint, until paint film is of uniform finish, color, and appearance.
4. Caulking and sealant shall be painted to match wall or adjacent surface, color as directed by Consultant. Painting Contractor shall be responsible for preparing sealant or caulking surfaces as required assuring that proper adhesion of paint will develop.

B. Restrictions

1. Paint shall not be applied when temperature of surfaces to be painted and surrounding air temperatures are below 50 degrees F, unless otherwise permitted by paint manufacturer printed instructions.
2. Exterior painting shall not be done while surface is damp or during rainy or frosty weather.

C. Coating

1. Apply one prime coat and two coats of finish material (prime and finish coats to be brush applied only) at not less than manufacturer recommended spreading rate, to provide a total dry film thickness of not less than 3.5 mils for entire coating system of finish coats of two-coat Work.
2. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, or other surface imperfections will not be acceptable. Remove, re-finish, or re-paint Work not in compliance with specified requirements.

D. Protection

1. Correct any damages by cleaning, repairing, or replacing and repainting, as directed by Consultant.
2. Provide "Wet Paint" signs as required to protect newly painted finishes. Remove temporary protective wrapping provided by others for protection of their work, after completion of painting operations.

E. Clean-Up

1. During progress of work, remove from project daily, all discarded paint materials, rubbish, cans, and rags.

END OF SECTION 09900

APPENDIX I

TWO YEAR CONTRACTOR'S GUARANTY

PART 1 - GENERAL

1.01 WHEREAS, ____________________________________; herein referred to as Roofing Contractor, certify that they have furnished and installed all roofing, flashing, sheet metal and related components in accordance with the Contract Documents and as required by the Roofing System Manufacturer's installation instructions on the facility described below

PROJECT: Gladstone City Hall Roof Replacement (B, C, D, E, F, G)
7010 N Holmes Street
Gladstone, MO 64118

OWNER: City of Gladstone
7010 N Holmes Street
Gladstone, MO 64118

1.02 Date of Full Completion: ____________________________________

1.03 Approximate Area of Roof: ____________________________________

1.04 Thickness and Type of Roof Insulation: ____________________________________

1.05 Product Name: ____________________________________

1.06 NOW, THEREFORE, Roofing Contractor guarantees to the Owner, subject only to the exclusions stated hereinafter, that all roofing, flashing and sheet metal work is fully and integrally watertight and is free from faults and defects in material or workmanship, and is guaranteed for a period of two years from date of full completion of work.

1.07 EXCLUSIONS: This guaranty does not cover, and Roofing Contractor shall not be liable for the following:

A. Damage to the roofing system caused by fire, lightning, tornado, hurricane or hailstorm.

B. Damage to roofing system caused by significant settlement, distortion or failure of roof deck, walls, or foundation of building.

C. Abuse by the Owner and/or third parties.

D. Consequential damages to the building or contents resulting from any defects in said roof, including interruption of business of the Owner or occupants of the building.

1.08 Contractor's Roofing/Flashing/Sheet Metal Guaranty is not transferable.

1.09 REPAIRS: Owner shall promptly notify Roofing Contractor, in writing, of the need for repair of roofing, flashing or sheet metal.

A. Roofing Contractor, within twenty-four hours after receipt of such notice, shall make emergency repairs at its expense, as required to render the facility watertight.

B. Within five days after receipt of such notice, Roofing Contractor shall at its expense correct any faults or defects in material or workmanship.

C. Should needed repairs not be covered by this guaranty, Roofing Contractor, after having obtained Owner's written consent, shall make such repairs at Owner's expense. Following said repairs, this guaranty shall thereafter remain in effect for the applicable portion of the original term. If Owner does not so consent or others than the Roofing Contractor make repairs, this guaranty shall terminate for those parts of the roof affected by the repair.

D. In the event that Owner has notified the Roofing Contractor of the need for repairs and (I) Roofing Contractor does not immediately make repairs, or (II) Roofing Contractor disclaims responsibility for the repairs and Owner disagrees, or (III) Owner considers Roofing Contractor's quoted cost for repairs not covered by this guaranty to be unreasonable and, an emergency condition exists which requires prompt repair to avoid substantial damage or loss to Owner, then, Owner may make such temporary repairs as he finds necessary and such action shall not be a breach of the provisions of this guaranty.

1.10 ROOF MODIFICATIONS: Should Owner require work to be done on roof of said facility including modifications, alterations, extensions or additions to roof and including installation of vents, platforms, equipment, bracing or fastenings. Owner shall notify Roofing Contractor and give Roofing Contractor an opportunity to make recommendations as to methods necessary to safeguard against damage to roofing covered by this guaranty. Failure of Owner to give Roofing Contractor such opportunity or failure to follow methods recommended by Roofing Contractor shall render this guaranty null and void to the extent such failure should result in damage to roofing covered by this guaranty.

1.11 NOTICES: Notification of Roofing Contractor shall herein be required by Owner and shall be fulfilled by sending notice to Roofing Contractor.

1.12 IN WITNESS WHEREOF, we set our hands this ____________________ day of ________________, 2017

A. By (Name/Title):____

B. Roofing Contractor

1. Name:____

2. Address:____

3. Phone:__________________________ Email:__________________________

PART 2 - PRODUCTS

NOT USED

PART 3 – EXECUTION

NOT USED

END OF APPENDIX I

APPENDIX II

PART 1 – GENERAL

1.01 DRAWINGS

A100	Roof Plan
A101	Taper Plan
A102	Details
A103	Details
A104	Details

PART 2 – PRODUCTS

NOT USED

PART 3 – EXECUTION

NOT USED

END OF APPENDIX II

SCHEDULE K
CONSTRUCTION AND INSTALLATION SCHEDULE

Upon executing this Agreement, Customer will confirm funding for ESCO payment is available by issuing ESCO a written Notice to Proceed which will mark installation commencement ("Construction Commencement Date"). Within three (3) days after receiving a Notice to Proceed, ESCO will meet with Customer to review the project schedule and, as necessary, modify the schedule, building sequence of work, and construction plan to accommodate the requirements of ongoing Customer activities. ESCO will provide a detailed construction installation schedule utilizing critical path method scheduling in the form of both a Gantt chart and itemized activity listing. Project completion is linked directly to the project start date. Any significant delays in starting the project may prolong the completion of the project by the same amount of time or longer. <u>Dates for project scope of work implementation, durations and completion of work of this Agreement are based on a Notice to Proceed no later than **October 6, 2017**</u>**.**

Figure K.1, on the following page, summarizes project installation activities including start and completion dates for each ECM. Should the Notice to Proceed date occur later, it will lead to a corresponding change in the construction schedule and contract price. ESCO and Customer acknowledge that each parties' responsibilities must be executed in a timely manner or the schedule and cost will be impacted.

ESCO's construction manager will manage and coordinate all on-site contractor activities and interaction with Customer facility management and administration personnel. During the installation period, ESCO will conduct regularly scheduled progress meetings at which the construction manager will review current progress toward the schedule and any changes. At each progress meeting, ESCO will furnish an updated Gantt chart project schedule and provide a "two week look-ahead" which will include detailed activity plans for the work that will be occurring in that next two-week period.

Installation of HVAC Equipment at City Hall will be scheduled to minimize downtime with planned equipment outages occurring on weekends except for the HVAC equipment serving the lower level. This HVAC equipment will be replaced during regular working hours and ESCO will be responsible for temporary heating and cooling equipment if necessary.

Installation of HVAC Equipment at Community Center will require a planned building vacancy to allow hoisting equipment to roof. HVAC equipment outages will be necessary and scheduled by ESCO to minimize durations and minimize effect to staff and community users of the facility.

Table K.1 Proposed Activity Timeline / Milestone Schedule Dates

Task Name	Start	Finish
City Council Meeting Contract Approval	Mon 9/25/17	Mon 9/25/17
Navitas-Gladstone Signed Contract [No Later]	Fri 10/6/17	Fri 10/6/17
Subcontractors / Vendors Under Contract	Fri 10/6/17	Wed 10/11/17
Release City Hall HVAC Equipment	Fri 10/6/17	Fri 10/6/17
Material & Equipment Submittal Review	Thu 10/12/17	Wed 10/25/17
City Hall	Mon 10/9/17	Wed 1/10/18
HVAC Equipment Lead Time	Mon 10/9/17	Fri 11/10/17
Lighting Material Lead Time	Thu 10/26/17	Wed 11/22/17
New Roof Installation	Thu 11/2/17	Fri 12/15/17
Weatherization	Thu 11/2/17	Fri 11/10/17
Install/ Retrofit Lighting	Thu 11/23/17	Wed 12/6/17
Install New Gas Lines / Flues / Linesets	Thu 10/12/17	Wed 11/1/17
Install New HVAC Equipment	Thu 11/9/17	Wed 11/22/17
Install BAS	Thu 10/26/17	Wed 12/6/17
Commissioning	Thu 12/7/17	Wed 1/10/18
Community Center	Fri 10/6/17	Wed 1/31/18
HVAC Equipment Lead Time	Thu 10/19/17	Wed 12/13/17
Boiler/Water Heater Lead Time	Thu 10/19/17	Wed 12/13/17
Lighting Material Lead Time	Thu 10/26/17	Wed 11/22/17
Weatherization	Mon 11/13/17	Fri 11/24/17
Install / Retrofit Lighting	Thu 12/7/17	Wed 12/27/17
Install Destratification Fans - Entry	Thu 12/14/17	Wed 12/27/17
Install New Emergency Lighting Inverter	Thu 12/21/17	Wed 1/3/18
Install New Gas Service (MGE)	Fri 10/6/17	Thu 11/30/17
Replace Hot Water Boiler	Thu 12/14/17	Wed 12/20/17
Replace Domestic Hot Water Heaters	Thu 12/14/17	Fri 12/22/17
HVAC Prep Work	Tue 12/5/17	Thu 12/14/17
Install New HVAC Equipment	Thu 12/14/17	Wed 12/20/17
Install BAS	Thu 11/30/17	Wed 1/3/18
Commissioning	Thu 1/4/18	Wed 1/31/18
Other Buildings ECMs	Thu 11/23/17	Wed 1/24/18
Weatherization	Mon 11/27/17	Fri 12/15/17
Install / Retrofit Lighting	Thu 12/28/17	Wed 1/17/18
HVAC Replacement & BAS Controls	Thu 11/23/17	Wed 1/3/18
Commissioning	Thu 1/4/18	Wed 1/24/18
Install Solar PV: Community Center & Water Treatment	Thu 12/14/17	Wed 1/3/18
Install Decorative Street Lighting	Thu 1/18/18	Wed 1/31/18

SCHEDULE L
SYSTEMS START-UP AND COMMISSIONING

It is understood that ESCO and Customer will work together to schedule the start-up and commissioning of equipment. A detailed start-up checklist and commissioning procedure will be completed by ESCO for each major piece of equipment. The start-up and commissioning requirements for equipment include the following:

A. Lighting

Start-up and commissioning of the lighting system will include:

1. Visual inspection of lighting installation (mounting, code compliance, etc.)
2. Physical test of lighting control (switch control and occupancy sensor control)

B. Building Automation System

Start-up and commissioning of the control system will include:

1. Electrical terminations
2. Point to point checkout of inputs and outputs
3. Confirm calibration of temperature sensors
4. Verifying programming and subsequent operation of equipment/systems through all operating scenarios

C. Weatherization

Start-up and commissioning of the weatherization of the facilities will include:

1. Visual inspection of work completed

D. Rooftop Units

Start-up and commissioning of the rooftop air-conditioning units will include:

1. General unit inspection for damage and proper installation per manufacturer's instructions
2. Condensate line leak inspection
3. Electrical terminations
4. Fan rotation
5. Check all inputs and outputs
6. Confirm operation of each mode of operation (cooling, heating, economizer, etc.)
7. Verifying reset schedule programming and subsequent operation of equipment through all operating scenarios.

SCHEDULE M
DETAILED SAVINGS CALCULATIONS

The detailed savings calculations for the energy saving conservation measures contained in this contract can be found immediately following this page.

Community Center - Interior Lighting

Monthly kW savings from Audit	68
Annual kW Savings	816
Diversity Factor	85%
kW Savings	693.6
Lighting kWh Savings from Audit	356109
Cooling Interactive Savings from Calc	99313
Net kWh Savings	455422
Heating therm interactive penalty from Calc	-45.6

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved
GLADSTONE COMM	Interior	Entrance	5250	16	CFL-CF26W-2	Decorative-Plug-in 4 Pin-Frosted-Surface	0.054	0.864	4,536	Retrofit	(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal (1623)	16	0.288	1,512.00	0.576	3,024.00
GLADSTONE COMM	Interior	Main Lobby/Halls	5250	8	F-F54T5HO-3	Decorative-4 foot-Prismatic-Pendant	0.162	1.296	6,804	Retrofit	(3) Eiko LED 4FT T5, 25W, 4000K (1623)	8	0.600	3,150.00	0.696	3,654.00
GLADSTONE COMM	Interior	Main Lobby/Halls	5250	44	CFL-CF42W-3	Decorative-Plug-in 4 Pin-Open - no lens-Surface	0.141	6.204	32,571	Retrofit	Sielo LED Retrofit Kit, (1623)	44	1.540	8,085.00	4.664	24,486.00
GLADSTONE COMM	Interior	Main Lobby/Halls	5250	27	HAL-H50-1	Track-2 Pin-Clear-Track	0.050	1.35	7,088	Retrofit	Eiko 3000K LED GEN5 MR16 GU5.3, 25 deg beam, 7W - 520lm, Dimmable, 3000K	27	0.189	992.25	1.161	6,095.25
GLADSTONE COMM	Interior	Main Lobby/Halls	5250	15	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.048	0.72	3,780	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	15	0.225	1,181.25	0.495	2,598.75
GLADSTONE COMM	Interior	Main Lobby/Halls	5250	14	CFL-CF42W-2	8-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.100	1.4	7,350	Retrofit	MaxLite 23W LED 8 COMMERCIAL DOWNLIGHT RETROFIT 4000K	14	0.322	1,690.50	1.078	5,659.50
GLADSTONE COMM	Interior	Main Lobby/Halls	5250	4	HAL-H35-1	Decorative-2 Pin-Frosted-Pendant	0.035	0.14	735	Retrofit	Eiko LED MR16, 40D, 7W, 12V, GU5.3 (1623)	4	0.028	147.00	0.112	588.00
GLADSTONE COMM	Interior	Main Lobby/Halls	5250	20	F-F17T8-3	Troffer-2X2-Parabolic-Recessed	0.058	1.16	6,090	Retrofit	ATG 2X2 LED DOOR KIT	20	0.600	3,150.00	0.560	2,940.00
GLADSTONE COMM	Interior	Gashland Room	5250	17	HAL-H75-1	6-in Can-Medium-PAR30-Recessed	0.075	1.275	6,694	Retrofit	MaxLite 23W 6 LED COMMERCIAL DOWNLIGHT RETROFIT - 4000K	17	0.391	2,052.75	0.884	4,641.00
GLADSTONE COMM	Interior	Gashland Room	5250	3	QUARTZ-Q150-1	Decorative-Double End-Frosted-Pendant	0.150	0.45	2,363	Do Nothing	Do Nothing	3	0.450	2,362.50	0.000	0.00
GLADSTONE COMM	Interior	Gashland Room	5250	10	F-F17T8-3	Troffer-2X2-Parabolic-Recessed	0.058	0.58	3,045	Retrofit	ATG 2x2 Troffer Door Kit, 30W, 4000K w/ EM Backup (1623)	10	0.400	2,100.00	0.180	945.00
GLADSTONE COMM	Interior	Gladstone Room	5250	18	HAL-H75-1	6-in Can-Medium-PAR30-Recessed	0.075	1.35	7,088	Retrofit	MaxLite 23W 6 LED COMMERCIAL DOWNLIGHT RETROFIT - 4000K	18	0.414	2,173.50	0.936	4,914.00
GLADSTONE COMM	Interior	Gladstone Room	5250	3	QUARTZ-Q150-1	Decorative-Double End-Frosted-Pendant	0.150	0.45	2,363	Do Nothing	Do Nothing	3	0.450	2,362.50	0.000	0.00
GLADSTONE COMM	Interior	Gladstone Room	5250	10	F-F17T8-3	Troffer-2X2-Parabolic-Recessed	0.058	0.58	3,045	Retrofit	ATG 2x2 Troffer Door Kit, 30W, 4000K w/ EM Backup (1623)	10	0.400	2,100.00	0.180	945.00
GLADSTONE COMM	Interior	Linden Room	5250	20	HAL-H75-1	6-in Can-Medium-PAR30-Recessed	0.075	1.5	7,875	Retrofit	MaxLite 23W 6 LED COMMERCIAL DOWNLIGHT RETROFIT - 4000K	20	0.460	2,415.00	1.040	5,460.00
GLADSTONE COMM	Interior	Linden Room	5250	3	QUARTZ-Q150-1	Decorative-Double End-Frosted-Pendant	0.150	0.45	2,363	Do Nothing	Do Nothing	3	0.450	2,362.50	0.000	0.00
GLADSTONE COMM	Interior	Linden Room	5250	10	F-F17T8-3	Troffer-2X2-Parabolic-Recessed	0.058	0.58	3,045	Retrofit	ATG 2x2 Troffer Door Kit, 30W, 4000K w/ EM Backup (1623)	10	0.400	2,100.00	0.180	945.00
GLADSTONE COMM	Interior	Male/Female RR 1st Floor	5250	1	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.048	0.048	252	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	1	0.015	78.75	0.033	173.25
GLADSTONE COMM	Interior	Male/Female RR 1st Floor	5250	2	F-F32T8-2	Strip-4 foot-Open - no lens-Recessed	0.064	0.128	672	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	0.048	252.00	0.080	420.00
GLADSTONE COMM	Interior	Audio/visual	730	1	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	0.064	0.064	47	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	1	0.024	17.52	0.040	29.20
GLADSTONE COMM	Interior	Bathrooms 1st Floor	5250	12	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.048	0.576	3,024	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	12	0.180	945.00	0.396	2,079.00
GLADSTONE COMM	Interior	Bathrooms 1st Floor	5250	6	F-F32T8-2	Strip-4 foot-Open - no lens-Recessed	0.064	0.384	2,016	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	6	0.144	756.00	0.240	1,260.00
GLADSTONE COMM	Interior	Bathrooms 1st Floor	5250	1	F-F25T8-2	Strip-3 foot-Open - no lens-Recessed	0.056	0.056	294	Retrofit	(2) EIKO LED 3' T8 TUBE, BALLAST BYPASS, 12W, 1450LM, 4000K (1623)	1	0.024	126.00	0.032	168.00
GLADSTONE COMM	Interior	1114	5250	6	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.384	2,016	Retrofit	ATG LED 2x4 Troffer Door Kit	6	0.180	945.00	0.204	1,071.00
GLADSTONE COMM	Interior	1114	8760	2	EXIT-I15-1	Exit-White-Green-Surface	0.017	0.034	298	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	2	0.002	14.02	0.032	283.82
GLADSTONE COMM	Interior	1108 Kitchen	5250	7	F-F32T8-3	Troffer-2X4-Prismatic-Recessed	0.109	0.763	4,006	Retrofit	ATG LED 2x4 Troffer Door Kit	7	0.210	1,102.50	0.553	2,903.25
GLADSTONE COMM	Interior	1113 Custodial A	730	1	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	0.064	0.064	47	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	1	0.024	17.52	0.040	29.20
GLADSTONE COMM	Interior	1117 Marketing	5250	2	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.128	672	Retrofit	ATG LED 2x4 Troffer Door Kit	2	0.060	315.00	0.068	357.00
GLADSTONE COMM	Interior	1116 Museum mgr	5250	2	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.128	672	Retrofit	ATG LED 2x4 Troffer Door Kit	2	0.060	315.00	0.068	357.00
GLADSTONE COMM	Interior	1110 operations	5250	6	F-F32T8-2	Troffer-2X4-Indirect-Recessed	0.064	0.384	2,016	Retrofit	ATG LED 2x4 Troffer Door Kit	6	0.180	945.00	0.204	1,071.00
GLADSTONE COMM	Interior	1119 Banquet	5250	2	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.128	672	Retrofit	ATG LED 2x4 Troffer Door Kit	2	0.060	315.00	0.068	357.00
GLADSTONE COMM	Interior	1118 Asst Admin	5250	2	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.128	672	Retrofit	ATG LED 2x4 Troffer Door Kit	2	0.060	315.00	0.068	357.00
GLADSTONE COMM	Interior	Natatorium Entryway	5250	37	F-F14T5-2	Troffer-2X2-Indirect-Recessed	0.028	1.036	5,439	Retrofit	ATG 2X2 LED DOOR KIT	37	1.110	5,827.50	-0.074	-388.50
GLADSTONE COMM	Interior	Natatorium Entryway	5250	3	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.048	0.144	756	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	3	0.045	236.25	0.099	519.75
GLADSTONE COMM	Interior	2204/2206 bathrooms	5250	15	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.048	0.72	3,780	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	15	0.225	1,181.25	0.495	2,598.75
GLADSTONE COMM	Interior	2204/2206 bathrooms	5250	9	F-F32T8-2	Strip-4 foot-Open - no lens-Recessed	0.064	0.576	3,024	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	9	0.216	1,134.00	0.360	1,890.00
GLADSTONE COMM	Interior	2204/2206 bathrooms	5250	1	F-F17T8-2	Strip-2 foot-Open - no lens-Recessed	0.038	0.038	200	Retrofit	(2) Eiko 2FT LED T8, 9W, 4000K (1623)	1	0.018	94.50	0.020	105.00
GLADSTONE COMM	Interior	2204/2206 bathrooms	5250	1	F-F25T8-2	Strip-3 foot-Open - no lens-Recessed	0.056	0.056	294	Retrofit	(2) EIKO LED 3' T8 TUBE, BALLAST BYPASS, 12W, 1450LM, 4000K (1623)	1	0.024	126.00	0.032	168.00
GLADSTONE COMM	Interior	1522 Water Service	5250	4	F-F32T8-2	Strip-4 foot-Wire Guard-Suspended	0.064	0.256	1,344	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	4	0.096	504.00	0.160	840.00
GLADSTONE COMM	Interior	1520 Electrical	5250	4	F-F32T8-2	Strip-4 foot-Wire Guard-Suspended	0.064	0.256	1,344	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	4	0.096	504.00	0.160	840.00
GLADSTONE COMM	Interior	1520 Electrical	5250	8	F-F32T8-2	Strip-4 foot-Wire Guard-Surface	0.064	0.512	2,688	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	8	0.192	1,008.00	0.320	1,680.00
GLADSTONE COMM	Interior	1608 Storage	5250	3	F-F32T8-3	Troffer-2X4-Prismatic-Recessed	0.109	0.327	1,717	Retrofit	ATG LED 2x4 Troffer Door Kit	3	0.090	472.50	0.237	1,244.25
GLADSTONE COMM	Interior	1608 Storage	5250	5	F-F32T8-4	Troffer-2X4-Prismatic-Recessed	0.145	0.725	3,806	Retrofit	ATG LED 2x4 Troffer Door Kit	5	0.150	787.50	0.575	3,018.75
GLADSTONE COMM	Interior	1608 Storage	5250	3	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.048	0.144	756	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	3	0.045	236.25	0.099	519.75
GLADSTONE COMM	Interior	1506 Life Guard Offic	5250	6	UFL-FU31T8/6-2	2X2-Troffer-Prismatic-Recessed	0.072	0.432	2,268	Retrofit	ATG 2X2 LED DOOR KIT	6	0.180	945.00	0.252	1,323.00
GLADSTONE COMM	Interior	1329 Storage	730	1	F-F32T8-3	Troffer-2X4-Prismatic-Suspended	0.109	0.109	80	Retrofit	Eiko 3L 12W T8 Ballast Bypass DLCP	1	0.036	26.28	0.073	53.29
GLADSTONE COMM	Interior	Room 1313 Break Room	5250	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.064	336	Retrofit	ATG LED 2x4 Troffer Door Kit	1	0.030	157.50	0.034	178.50
GLADSTONE COMM	Interior	Men's Locker Room	5250	19	F-F17T8-3	Troffer-2X2-Parabolic-Recessed	0.058	1.102	5,786	Retrofit	ATG 2X2 LED DOOR KIT	19	0.570	2,992.50	0.532	2,793.00
GLADSTONE COMM	Interior	Men's Locker Room	5250	14	CFL-CF42W-1	8-in Can-Plug-in 4 Pin-Frosted-Recessed	0.048	0.672	3,528	Retrofit	NICOR CLR8 8" DOWNLIGHT KIT.	14	0.350	1,837.50	0.322	1,690.50
GLADSTONE COMM	Interior	Men's Locker Room	5250	5	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.048	0.24	1,260	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	5	0.075	393.75	0.165	866.25
GLADSTONE COMM	Interior	Men's Locker Room	5250	8	F-F54T5HO-1	Vanity-4 foot-Frost-Wall	0.054	0.432	2,268	Retrofit	Eiko LED 4FT T5, 25W, 4000K (1623)	8	0.200	1,050.00	0.232	1,218.00
GLADSTONE COMM	Interior	Men's Locker Room	5250	4	F-F32T8-2	Strip-4 foot-Open - no lens-Recessed	0.064	0.256	1,344	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	4	0.096	504.00	0.160	840.00
GLADSTONE COMM	Interior	Women's Locker Room	5250	20	F-F17T8-3	Troffer-2X2-Parabolic-Recessed	0.058	1.16	6,090	Retrofit	ATG 2X2 LED DOOR KIT	20	0.600	3,150.00	0.560	2,940.00
GLADSTONE COMM	Interior	Women's Locker Room	5250	21	CFL-CF42W-1	8-in Can-Plug-in 4 Pin-Frosted-Recessed	0.048	1.008	5,292	Retrofit	NICOR CLR8 8" DOWNLIGHT KIT.	21	0.525	2,756.25	0.483	2,535.75
GLADSTONE COMM	Interior	Women's Locker Room	5250	6	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.048	0.288	1,512	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	6	0.090	472.50	0.198	1,039.50
GLADSTONE COMM	Interior	Women's Locker Room	5250	9	F-F54T5HO-1	Vanity-4 foot-Frost-Wall	0.054	0.486	2,552	Retrofit	Eiko LED 4FT T5, 25W, 4000K (1623)	9	0.225	1,181.25	0.261	1,370.25
GLADSTONE COMM	Interior	Women's Locker Room	5250	4	F-F32T8-2	Strip-4 foot-Open - no lens-Recessed	0.064	0.256	1,344	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	4	0.096	504.00	0.160	840.00
GLADSTONE COMM	Interior	1300 Family Changing Rooms	5250	7	F-F32T8-3	Troffer-2X4-Parabolic-Recessed	0.109	0.763	4,006	Retrofit	ATG LED 2x4 Troffer Door Kit	7	0.210	1,102.50	0.553	2,903.25
GLADSTONE COMM	Interior	1300 Family Changing Rooms	5250	10	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.048	0.48	2,520	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	10	0.150	787.50	0.330	1,732.50
GLADSTONE COMM	Interior	1300 Family Changing Rooms	5250	5	CFL-CF42W-1	8-in Can-Plug-in 4 Pin-Frosted-Recessed	0.048	0.24	1,260	Retrofit	NICOR CLR8 8" DOWNLIGHT KIT.	5	0.125	656.25	0.115	603.75
GLADSTONE COMM	Interior	1300 Family Changing Rooms	5250	5	F-F32T8-2	Strip-4 foot-Open - no lens-Recessed	0.064	0.32	1,680	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	5	0.120	630.00	0.200	1,050.00
GLADSTONE COMM	Interior	1300 Family Changing Rooms	8760	1	EXIT-I15-1	Exit-White-Green-Surface	0.017	0.017	149	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	0.001	7.01	0.016	141.91
GLADSTONE COMM	Interior	1300 Family Changing Rooms	5250	5	F-F25T8-2	Strip-3 Foot-Open - no lens-Recessed	0.056	0.28	1,470	Retrofit	(2) EIKO LED 3' T8 TUBE, BALLAST BYPASS, 12W, 1450LM, 4000K (1623)	5	0.120	630.00	0.160	840.00
GLADSTONE COMM	Interior	1303 Custodial B	730	2	F-F32T8-2	Strip-4 foot-Wire Guard-Suspended	0.064	0.128	93	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	0.048	35.04	0.080	58.40
GLADSTONE COMM	Interior	1020 Party Room	5250	11	F-F17T8-3	Troffer-2X2-Parabolic-Recessed	0.058	0.638	3,350	Retrofit	ATG 2X2 LED DOOR KIT	11	0.330	1,732.50	0.308	1,617.00
GLADSTONE COMM	Interior	1020 Party Room	8760	1	EXIT-I15-1	Exit-White-Green-Surface	0.017	0.017	149	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	0.001	7.01	0.016	141.91
GLADSTONE COMM	Interior	1018 Meeting Room	5250	8	F-F17T8-3	Troffer-2X2-Parabolic-Recessed	0.058	0.464	2,436	Retrofit	ATG 2X2 LED DOOR KIT	8	0.240	1,260.00	0.224	1,176.00
GLADSTONE COMM	Interior	1022 Child Watch	5250	9	F-F32T8-2	Troffer-2X4-Indirect-Recessed	0.064	0.576	3,024	Retrofit	ATG LED 2x4 Troffer Door Kit	9	0.270	1,417.50	0.306	1,606.50
GLADSTONE COMM	Interior	1200 Offices	5250	27	F-F32T8-3	Troffer-2X4-Parabolic-Recessed	0.109	2.943	15,451	Retrofit	ATG LED 2x4 Troffer Door Kit	27	0.810	4,252.50	2.133	11,198.25
GLADSTONE COMM	Interior	1200 Offices	8760	1	EXIT-I15-1	Exit-White-Green-Surface	0.017	0.017	149	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	0.001	7.01	0.016	141.91
GLADSTONE COMM	Interior	1200 Offices	5250	9	HAL-H75-1	6-in Can-Medium-PAR30-Recessed	0.075	0.675	3,544	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	9	0.135	708.75	0.540	2,835.00
GLADSTONE COMM	Interior	1200 Offices	5250	1	F-F54T5HO-2	Strip-4 foot-Clear-Pendant	0.108	0.108	567	Retrofit	(2) Eiko LED 4FT T5, 25W, 4000K (1623)	1	0.050	262.50	0.058	304.50
GLADSTONE COMM	Interior	Fitness Stairs	5250	6	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.048	0.288	1,512	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	6	0.090	472.50	0.198	1,039.50
GLADSTONE COMM	Interior	Fitness Stairs	5250	2	F-F32T8-2	Indirect-4 foot-Prismatic-Wall	0.064	0.128	672	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	0.048	252.00	0.080	420.00
GLADSTONE COMM	Interior	Fitness Room	5250	18	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.048	0.864	4,536	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	18	0.270	1,417.50	0.594	3,118.50
GLADSTONE COMM	Interior	Fitness Room	5250	64	F-F32T8-3	Direct/Indirect-4 foot-Frost-Aircraft Cable	0.109	6.976	36,624	Retrofit	Eiko 3L 12W T8 Ballast Bypass DLCP	64	2.304	12,096.00	4.672	24,528.00

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved
GLADSTONE COMM	Interior	2004 Studio B	5250	12	F-F17T8-3	Troffer-2X2-Parabolic-Recessed	0.058	0.696	3,654	Retrofit	ATG 2X2 LED DOOR KIT	12	0.360	1,890.00	0.336	1,764.00
GLADSTONE COMM	Interior	2004 Studio B	5250	10	HAL-H75-1	6-in Can-Medium-PAR30-Recessed	0.075	0.75	3,938	Retrofit	MaxLite 23W 6 LED COMMERCIAL DOWNLIGHT RETROFIT - 4000K	10	0.230	1,207.50	0.520	2,730.00
GLADSTONE COMM	Interior	2008 Fitness Supervisor	5250	2	F-F32T8-3	Troffer-2X4-Parabolic-Recessed	0.109	0.218	1,145	Retrofit	ATG LED 2x4 Troffer Door Kit	2	0.060	315.00	0.158	829.50
GLADSTONE COMM	Interior	2010 Restroom	5250	1	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.048	0.048	252	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	1	0.015	78.75	0.033	173.25
GLADSTONE COMM	Interior	2010 Restroom	5250	2	F-F32T8-2	Strip-4 foot-Open - no lens-Recessed	0.064	0.128	672	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	0.048	252.00	0.080	420.00
GLADSTONE COMM	Interior	2012/2016	5250	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.064	336	Retrofit	ATG LED 2x4 Troffer Door Kit	1	0.030	157.50	0.034	178.50
GLADSTONE COMM	Interior	2012/2016	5250	2	F-F32T8-2	Strip-4 foot-Wire Guard-Suspended	0.064	0.128	672	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	0.048	252.00	0.080	420.00
GLADSTONE COMM	Interior	2020 Studio A	5250	24	F-F17T8-3	Troffer-2X2-Parabolic-Recessed	0.058	1.392	7,308	Retrofit	ATG 2X2 LED DOOR KIT	24	0.720	3,780.00	0.672	3,528.00
GLADSTONE COMM	Interior	2020 Studio A	5250	20	HAL-H75-1	6-in Can-Medium-PAR30-Recessed	0.075	1.5	7,875	Retrofit	MaxLite 23W 6 LED COMMERCIAL DOWNLIGHT RETROFIT - 4000K	20	0.460	2,415.00	1.040	5,460.00
GLADSTONE COMM	Interior	2020 Studio A	5250	2	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.128	672	Retrofit	ATG LED 2x4 Troffer Door Kit	2	0.060	315.00	0.068	357.00
GLADSTONE COMM	Interior	Track	5250	8	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	0.064	0.512	2,688	Retrofit	Cree LS4 4' LED Surface Ambient Luminaire 44W, 40K, 40lm	8	0.352	1,848.00	0.160	840.00
GLADSTONE COMM	Interior	Gym	5250	16	F-F54T5HO-4	Highbay-2X4-Open - no lens-Aircraft Cable	0.216	3.456	18,144	Retrofit	Lithonia IBG LED Highbay, 114W, 18000lm, 50K	16	1.824	9,576.00	1.632	8,568.00
GLADSTONE COMM	Interior	Gym	5250	32	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	0.064	2.048	10,752	Retrofit	Cree LS4 4' LED Surface Ambient Luminaire 44W, 40K, 40lm	32	1.408	7,392.00	0.640	3,360.00
GLADSTONE COMM	Interior	Gym	8760	4	EXIT-I15-1	Exit-White-Green-Surface	0.017	0.068	596	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	4	0.003	28.03	0.065	567.65
GLADSTONE COMM	Interior	Gym	5250	8	CFL-CF42W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.048	0.384	2,016	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	8	0.120	630.00	0.264	1,386.00
GLADSTONE COMM	Interior	Natatorium	5250	23	MH-MH400-2	Flood-Mogul-Clear-Surface	0.910	20.93	109,883	Replace	Meteor Bolt Series Flood, 280W, 4000K, 32900 Lumen	23	6.440	33,810.00	14.490	76,072.50
GLADSTONE COMM	Interior	Natatorium	5250	10	MH-MH400-2	Flood-Mogul-Clear-Surface	0.910	9.1	47,775	Remove	Remove Existing Fixtures	0	0.000	0.00	9.100	47,775.00
GLADSTONE COMM	Interior	Natatorium	8760	3	EXIT-I15-1	Exit-White-Green-Surface	0.017	0.051	447	Retrofit	E-conolight Wet Location LED Exit Sign (1623)	3	0.008	70.96	0.043	375.80
GLADSTONE COMM	Interior	Natatorium	5250	4	MH-MH400-1	Flood-Mogul-Clear-Wall	0.455	1.82	9,555	Remove	Remove Existing Fixtures	0	0.000	0.00	1.820	9,555.00
GLADSTONE COMM	Interior	Natatorium	5250	6	MH-MH400-1	Wallpack-Mogul-Clear-Wall	0.455	2.73	14,333	Replace	Meteor Bolt Series Flood, 280W, 4000K, 32900 Lumen	6	1.680	8,820.00	1.050	5,512.50
GLADSTONE COMM	Interior	Pool	5250	12	MH-MH400-1	Flood-Mogul-Clear-Wall	0.455	5.46	28,665	Replace	Meteor Bolt Series Flood, 280W, 4000K, 32900 Lumen	12	3.360	17,640.00	2.100	11,025.00
GLADSTONE COMM	Interior	Pool	8760	2	EXIT-I15-1	Exit-White-Green-Surface	0.017	0.034	298	Retrofit	E-conolight Wet Location LED Exit Sign (1623)	2	0.005	47.30	0.029	250.54
GLADSTONE COMM	Interior	Gym Storage	730	4	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	0.064	0.256	187	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	4	0.096	70.08	0.160	116.80
GLADSTONE COMM	Interior	Natatorium BOH	5250	25	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	0.064	1.6	8,400	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	25	0.600	3,150.00	1.000	5,250.00
GLADSTONE COMM	Interior	Natatorium BOH	5250	11	F-F32T8-4	Strip-8 foot-Open - no lens-Surface	0.145	1.595	8,374	Retrofit	Eiko 4L 12W T8 Ballast Bypass DLCP	11	0.528	2,772.00	1.067	5,601.75

Exterior	7.051	30883.380
Interior	68.023	356108.688

Lighting HVAC Interactive Savings Calculation

**Information and table values come from the Article "Calculating lighting and HVAC interactions" ASHRAE Journal November 1993

Robert A Rundquist, P.E.; Karl F. Johnson; Donald Aumann, P.E.

Project Name

Project Location

Kansas, Kansas City

Fraction to Cooling (C) 0.4

Fraction to Heating (E) 0.32

Btu per kWh (G) 3,413

Constant of Heating Natural gas 0.046

Electric resistance 1

		Lighting Energy Savings				Cooling Savings Calculation			Heating Savings Calculation						
	Location	kW Reduced (A)	kWh Reduced (B)	Area		Fraction to Cooling (C)	System MCOP (D)	Cooling kWh (B*C/D)	Fraction to Heating (E)	Fraction Area on Perimeter (F)	Convert to Therms (I)	Heating System Efficiency (H)	Heating Therms	Heating MCF	Heating kWh
1	Community Center	68.0	356,109	77,350		0.70	2.51	99,313	0.32	0.20	100,000	80%	-45.6	-4.4	-18606.5
2	City Hall / Public Safety	16.8	107,566	37,850		0.70	2.95	25,524	0.32	0.28	100,000	92%	-16.7	-1.6	-9013.33
3	Fire Station #1	5.1	28,432	7,950		0.40	2.95	3,855	0.32	0.56	100,000	92%	-8.7	-0.8	-4685.06
4	Fire Station #2	5.5	32,418	7,700		0.40	2.95	4,396	0.32	0.57	100,000	92%	-10.0	-1.0	-5410.23
5	Public Works	7.0	18,998	6,541		0.52	2.95	3,349	0.32	0.60	100,000	92%	-6.3	-0.6	-3379.74
6	Animal Shelter	1.3	2,656	2,304		0.52	2.95	468	0.32	0.86	100,000	92%	-1.2	-0.1	-671.968
7	Water Treatment	5.2	12,159	21,200		0.52	2.95	2,143	0.32	0.37	100,000	92%	-2.5	-0.2	-1323.13
8	Atkins-Johnson Museum	1.2	2,883	2,504		0.40	2.30	501	0.32	0.84	100,000	80%	-1.5	-0.1	-619.677
10	Fins and Foilage Bldg	5.1	2,662	7,560		0.40	3.11	342	0.32	0.57	100,000	92%	-0.8	-0.1	-447.503
11	Oak Grove Park	1.2	2,100	3,843		0.40	2.30	365	0.32	0.73	100,000	80%	-1.0	-0.1	-394.424
12	Linden Square Office	2.5	5,791	2,400		0.61	2.30	1,536	0.32	0.85	100,000	92%	-2.7	-0.3	-1448.7
	Total Energy Savings	**118.9**	**571,774**					**141,793**					**-97.1**	**-9.4**	**-46000.3**

Sum of Qty	
Row Labels	**GLADSTONE COMM**
Interior	
Detail	
(2) Eiko 4' LED Strip 23W, 3013lm, 40K	
F-F96T12-2	
(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal	16
CFL-CF26W-2	16
ATG 2X2 LED DOOR KIT	157
CFL-CF36W-2	
F-F14T5-2	37
F-F17T8-2	
F-F17T8-3	114
UFL-FU31T8/6-2	6
ATG LED 2x4 Troffer Door Kit	84
F-F32T8-2	33
F-F32T8-3	46
F-F32T8-4	5
Cree LS4 4' LED Surface Ambient Luminaire 44W, 40K, 40lm	40
F-F32T8-2	40
Deco Adjustable LED Wall Pack, 120W, White	22
MH-MH400-1	22
Deco Gladetino 311W, 50K, Large Yoke Mount, White	25
MH-MH400-2	25
Do Nothing	9
EXIT-Tritium0-1	
LED-L20-1	
LED-L8-1	
QUARTZ-Q150-1	9
Eiko 2L 12W T8 Ballast Bypass DLCP	85
F-F32T8-2	85
Eiko 3L 12W T8 Ballast Bypass DLCP	65
F-F32T8-3	65
Eiko LED T5, 12.5W, 4000K	
F-F28T5-2	
Lithonia IBG LED Highbay, 114W, 18000lm, 50K	16
F-F54T5HO-4	16
NICOR CLR8 8" DOWNLIGHT KIT.	40
CFL-CF42W-1	40
Sielo LED Retrofit Kit,	44
CFL-CF42W-3	44
Typical	**339**
(blank)	
(blank)	
(blank)	
(blank)	

Typical Interior Lighting Savings	$0.00

City of Gladstone IGA	Project		
Gladstone, MO	Location		
Interior - downlight kit	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 8" cfl can	Proposed - LED Retro		
Replace Lamps&Ballast	Not Required	Repair Type #1	
4.3		Repair Frequency (Years)	
☑		Include Repair Labor?	
0.44		Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$121.61	$121.61	Repair Labor Rate ($/hour)	Staff Gen. Maint. Worker
$37.90		Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Fixture	Replace Fixture	Repair Type #2	
20	21.4	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
0.6	0.6	Replacement Labor Required (Hours)	
$111.92	$111.92	Replacement Labor Rate ($/hour)	Electrician
$100.00	$400.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$30.67	$23.35	Average Annual Repair Cost in 2018 Dollars	
$13.27		**Annual O&M Savings per unit**	
$583.74		**Total Savings**	No. of Units: 44

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
Original Installation	2007	0.2	$ 4.44					x	1	0	107	6.05
	2008	1	$ 22.19					x	2	0	108	6.1
	2009	1.02	$ 22.64					x	3	0	109	6.15
	2010	1.05	$ 23.30					x	4	0	110	6.2
	2011	1.06	$ 23.52					x	5	0	111	6.25
	2012	1.07	$ 23.75					x	6	0	112	6.3
	2013	1.08	$ 23.97					x	7	0	113	6.35
	2014	1.1	$ 24.41					x	8	0	114	6.4
	2015	1.15	$ 25.52					x	9	0	115	6.45
	2016	1.2	$ 26.63					x	10	0	116	6.5
	2017	1.25	$ 27.74					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 28.85	2018	0.2	$4.20	$24.65	x	12	1	118	6.6
	2019	1.35	$ 29.96	2019	1	$21.00	$8.96	x	13	2	119	6.65
	2020	1.4	$ 31.07	2020	1.02	$21.42	$9.65	x	14	3	120	6.7
	2021	1.45	$ 32.18	2021	1.05	$22.05	$10.13	x	15	4	121	6.75
	2022	1.5	$ 33.29	2022	1.06	$22.26	$11.03	x	16	5	122	6.8
	2023	1.55	$ 34.40	2023	1.07	$22.47	$11.93	x	17	6	123	6.85
	2024	1.6	$ 35.51	2024	1.08	$22.68	$12.83	x	18	7	124	6.9
	2025	1.65	$ 36.62	2025	1.1	$23.10	$13.52	x	19	8	125	6.95
	2026	1.7	$ 37.73	2026	1.15	$24.15	$13.58	x	20	9	126	7
	2027	1.75	$ 38.84	2027	1.2	$25.20	$13.64	x	21	10	127	7.05
	2028	1.8	$ 39.95	2028	1.25	$26.25	$13.70	x	22	11	128	7.1
	2029	1.85	$ 41.05	2029	1.3	$27.30	$13.76	x	23	12	129	7.15
	2030	1.9	$ 42.16	2030	1.35	$28.35	$13.82	x	24	13	130	7.2
	2031	1.95	$ 43.27	2031	1.4	$29.40	$13.88	x	25	14	131	7.25
	2032	2	$ 44.38	2032	1.45	$30.45	$13.94	x	26	15	132	7.3
Totals	26	35.93	$ 797.35	15	16.68	$350.25	$199.00					

Existing	Proposed		
City of Gladstone IGA	Project		
Gladstone, MO	Location		
Interior - downlight kit	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 8" cfl can	Proposed - LED Retro		
Replace Lamps&Ballast	Not Required	Repair Type #1	
4.3		Repair Frequency (Years)	
☑		Include Repair Labor?	
0.44		Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$121.61	$121.61	Repair Labor Rate ($/hour)	Staff Gen. Maint. Worker
$37.90		Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Fixture	Replace Fixture	Repair Type #2	
20	21.4	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
0.6	0.6	Replacement Labor Required (Hours)	
$111.92	$111.92	Replacement Labor Rate ($/hour)	Electrician
$44.15	$180.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$27.64	$12.23	Average Annual Repair Cost in 2018 Dollars	
$20.77		**Annual O&M Savings per unit**	
$436.27		**Total Savings**	No. of Units: 21

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
Original Installation	2007	0.2	$ 4.00					x	1	0	107	6.05
	2008	1	$ 20.00					x	2	0	108	6.1
	2009	1.02	$ 20.40					x	3	0	109	6.15
	2010	1.05	$ 21.00					x	4	0	110	6.2
	2011	1.06	$ 21.20					x	5	0	111	6.25
	2012	1.07	$ 21.40					x	6	0	112	6.3
	2013	1.08	$ 21.60					x	7	0	113	6.35
	2014	1.1	$ 22.00					x	8	0	114	6.4
	2015	1.15	$ 23.00					x	9	0	115	6.45
	2016	1.2	$ 24.00					x	10	0	116	6.5
	2017	1.25	$ 25.00					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 26.00	2018	0.2	$2.20	$23.80	x	12	1	118	6.6
	2019	1.35	$ 27.00	2019	1	$11.00	$16.01	x	13	2	119	6.65
	2020	1.4	$ 28.00	2020	1.02	$11.22	$16.79	x	14	3	120	6.7
	2021	1.45	$ 29.00	2021	1.05	$11.55	$17.46	x	15	4	121	6.75
	2022	1.5	$ 30.01	2022	1.06	$11.66	$18.35	x	16	5	122	6.8
	2023	1.55	$ 31.01	2023	1.07	$11.77	$19.24	x	17	6	123	6.85
	2024	1.6	$ 32.01	2024	1.08	$11.88	$20.13	x	18	7	124	6.9
	2025	1.65	$ 33.01	2025	1.1	$12.10	$20.91	x	19	8	125	6.95
	2026	1.7	$ 34.01	2026	1.15	$12.65	$21.36	x	20	9	126	7
	2027	1.75	$ 35.01	2027	1.2	$13.20	$21.81	x	21	10	127	7.05
	2028	1.8	$ 36.01	2028	1.25	$13.75	$22.26	x	22	11	128	7.1
	2029	1.85	$ 37.01	2029	1.3	$14.30	$22.71	x	23	12	129	7.15
	2030	1.9	$ 38.01	2030	1.35	$14.85	$23.16	x	24	13	130	7.2
	2031	1.95	$ 39.01	2031	1.4	$15.40	$23.61	x	25	14	131	7.25
	2032	2	$ 40.01	2032	1.45	$15.95	$24.06	x	26	15	132	7.3
Totals	26	35.93	$ 718.72	15	16.68	$183.46	$311.62					

City of Gladstone IGA	Project	
Gladstone, MO	Location	
Interior - T5HO HB LED Retr	Equipment	
108.3%	Location Cost Index	Kansas City, MO
Existing - 4' 32W T8	Proposed - LED Retro	
Replace Lamps&Ballast	Not Required	Repair Type #1
5.0		Repair Frequency (Years)
☑		Include Repair Labor?
0.66		Repair Labor Required (Hours)
In-House		Select In-House or Contract Labor
$121.61	$121.61	Repair Labor Rate ($/hour) — Staff Gen. Maint. Worker
$46.00		Repair Material Cost
☑		Include End-of-Life Replacement Cost in Analysis?
Replace Fixture	Replace Fixture	Repair Type #2
20	25	Replacement Frequency (Years)
☑		Include Replacement Labor?
0.6	0.6	Replacement Labor Required (Hours)
$111.92	$111.92	Replacement Labor Rate ($/hour) — Electrician
$115.00	$200.00	Replacement Material Cost
2007	Year Equipment Originally Installed	
2018	Year New Equipment to be Installed	
15	Length of Performance Contract (Years)	
$35.43	$11.35	Average Annual Repair Cost in 2018 Dollars
$30.96		**Annual O&M Savings per unit**
$30.96		**Total Savings** — No. of Units: 1

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
Original Installation	2007	0.2	$ 5.13					x	1	0	107	6.05
	2008	1	$ 25.64					x	2	0	108	6.1
	2009	1.02	$ 26.15					x	3	0	109	6.15
	2010	1.05	$ 26.92					x	4	0	110	6.2
	2011	1.06	$ 27.18					x	5	0	111	6.25
	2012	1.07	$ 27.44					x	6	0	112	6.3
	2013	1.08	$ 27.69					x	7	0	113	6.35
	2014	1.1	$ 28.20					x	8	0	114	6.4
	2015	1.15	$ 29.49					x	9	0	115	6.45
	2016	1.2	$ 30.77					x	10	0	116	6.5
	2017	1.25	$ 32.05					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 33.33	2018	0.2	$2.04	$31.29	x	12	1	118	6.6
	2019	1.35	$ 34.61	2019	1	$10.21	$24.41	x	13	2	119	6.65
	2020	1.4	$ 35.90	2020	1.02	$10.41	$25.49	x	14	3	120	6.7
	2021	1.45	$ 37.18	2021	1.05	$10.72	$26.46	x	15	4	121	6.75
	2022	1.5	$ 38.46	2022	1.06	$10.82	$27.64	x	16	5	122	6.8
	2023	1.55	$ 39.74	2023	1.07	$10.92	$28.82	x	17	6	123	6.85
	2024	1.6	$ 41.02	2024	1.08	$11.02	$30.00	x	18	7	124	6.9
	2025	1.65	$ 42.31	2025	1.1	$11.23	$31.08	x	19	8	125	6.95
	2026	1.7	$ 43.59	2026	1.15	$11.74	$31.85	x	20	9	126	7
	2027	1.75	$ 44.87	2027	1.2	$12.25	$32.62	x	21	10	127	7.05
	2028	1.8	$ 46.15	2028	1.25	$12.76	$33.39	x	22	11	128	7.1
	2029	1.85	$ 47.43	2029	1.3	$13.27	$34.17	x	23	12	129	7.15
	2030	1.9	$ 48.72	2030	1.35	$13.78	$34.94	x	24	13	130	7.2
	2031	1.95	$ 50.00	2031	1.4	$14.29	$35.71	x	25	14	131	7.25
	2032	2	$ 51.28	2032	1.45	$14.80	$36.48	x	26	15	132	7.3
Totals	26	35.93	$ 921.26	15	16.68	$170.25	$464.35					

City of Gladstone IGA	Project		
Gladstone, MO	Location		
Interior - 2x4 2L LED Retro	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 4' 32W T8	Proposed - LED Retro		
Replace Lamps&Ballast	Not Required	Repair Type #1	
4.3		Repair Frequency (Years)	
☑		Include Repair Labor?	
0.66		Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$121.61	$121.61	Repair Labor Rate ($/hour)	Staff Gen. Maint. Worker
$42.00		Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Fixture	Replace Fixture	Repair Type #2	
20	25	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
0.6	0.6	Replacement Labor Required (Hours)	
$111.92	$111.92	Replacement Labor Rate ($/hour)	Electrician
$115.00	$200.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$38.76	$11.35	Average Annual Repair Cost in 2018 Dollars	
$34.93		**Annual O&M Savings per unit**	
$2,235.33		**Total Savings**	No. of Units: 64

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
Original Installation	2007	0.2	$ 5.61					x	1	0	107	6.05
	2008	1	$ 28.05					x	2	0	108	6.1
	2009	1.02	$ 28.61					x	3	0	109	6.15
	2010	1.05	$ 29.45					x	4	0	110	6.2
	2011	1.06	$ 29.73					x	5	0	111	6.25
	2012	1.07	$ 30.01					x	6	0	112	6.3
	2013	1.08	$ 30.29					x	7	0	113	6.35
	2014	1.1	$ 30.85					x	8	0	114	6.4
	2015	1.15	$ 32.25					x	9	0	115	6.45
	2016	1.2	$ 33.66					x	10	0	116	6.5
	2017	1.25	$ 35.06					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 36.46	2018	0.2	$2.04	$34.42	x	12	1	118	6.6
	2019	1.35	$ 37.86	2019	1	$10.21	$27.66	x	13	2	119	6.65
	2020	1.4	$ 39.27	2020	1.02	$10.41	$28.85	x	14	3	120	6.7
	2021	1.45	$ 40.67	2021	1.05	$10.72	$29.95	x	15	4	121	6.75
	2022	1.5	$ 42.07	2022	1.06	$10.82	$31.25	x	16	5	122	6.8
	2023	1.55	$ 43.47	2023	1.07	$10.92	$32.55	x	17	6	123	6.85
	2024	1.6	$ 44.87	2024	1.08	$11.02	$33.85	x	18	7	124	6.9
	2025	1.65	$ 46.28	2025	1.1	$11.23	$35.05	x	19	8	125	6.95
	2026	1.7	$ 47.68	2026	1.15	$11.74	$35.94	x	20	9	126	7
	2027	1.75	$ 49.08	2027	1.2	$12.25	$36.83	x	21	10	127	7.05
	2028	1.8	$ 50.48	2028	1.25	$12.76	$37.73	x	22	11	128	7.1
	2029	1.85	$ 51.89	2029	1.3	$13.27	$38.62	x	23	12	129	7.15
	2030	1.9	$ 53.29	2030	1.35	$13.78	$39.51	x	24	13	130	7.2
	2031	1.95	$ 54.69	2031	1.4	$14.29	$40.40	x	25	14	131	7.25
	2032	2	$ 56.09	2032	1.45	$14.80	$41.29	x	26	15	132	7.3
Totals	26	35.93	$ 1,007.72	15	16.68	$170.25	$523.91					

City of Gladstone IGA	Project	
Gladstone, MO	Location	
Interior - 2x4 2L LED Retro	Equipment	
108.3%	Location Cost Index	Kansas City, MO
Existing - 4' 32W T8	Proposed - LED Retro	
Replace Lamps&Ballast	Not Required	Repair Type #1
4.3		Repair Frequency (Years)
☑		Include Repair Labor?
0.66		Repair Labor Required (Hours)
In-House		Select In-House or Contract Labor
$121.61	$121.61	Repair Labor Rate ($/hour) — Staff Gen. Maint. Worker
$36.00		Repair Material Cost
☑		Include End-of-Life Replacement Cost in Analysis?
Replace Fixture	Replace Fixture	Repair Type #2
20	25	Replacement Frequency (Years)
☑		Include Replacement Labor?
0.6	0.6	Replacement Labor Required (Hours)
$111.92	$111.92	Replacement Labor Rate ($/hour) — Electrician
$99.95	$180.00	Replacement Material Cost
2007	Year Equipment Originally Installed	
2018	Year New Equipment to be Installed	
15	Length of Performance Contract (Years)	
$36.43	$10.48	Average Annual Repair Cost in 2018 Dollars
$33.01		**Annual O&M Savings per unit**
$33.01		**Total Savings** — No. of Units: 1

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
Original Installation	2007	0.2	$ 5.27					x	1	0	107	6.05
	2008	1	$ 26.36					x	2	0	108	6.1
	2009	1.02	$ 26.89					x	3	0	109	6.15
	2010	1.05	$ 27.68					x	4	0	110	6.2
	2011	1.06	$ 27.94					x	5	0	111	6.25
	2012	1.07	$ 28.21					x	6	0	112	6.3
	2013	1.08	$ 28.47					x	7	0	113	6.35
	2014	1.1	$ 29.00					x	8	0	114	6.4
	2015	1.15	$ 30.31					x	9	0	115	6.45
	2016	1.2	$ 31.63					x	10	0	116	6.5
	2017	1.25	$ 32.95					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 34.27	2018	0.2	$1.89	$32.38	x	12	1	118	6.6
	2019	1.35	$ 35.59	2019	1	$9.43	$26.16	x	13	2	119	6.65
	2020	1.4	$ 36.90	2020	1.02	$9.62	$27.29	x	14	3	120	6.7
	2021	1.45	$ 38.22	2021	1.05	$9.90	$28.32	x	15	4	121	6.75
	2022	1.5	$ 39.54	2022	1.06	$9.99	$29.55	x	16	5	122	6.8
	2023	1.55	$ 40.86	2023	1.07	$10.09	$30.77	x	17	6	123	6.85
	2024	1.6	$ 42.18	2024	1.08	$10.18	$31.99	x	18	7	124	6.9
	2025	1.65	$ 43.49	2025	1.1	$10.37	$33.12	x	19	8	125	6.95
	2026	1.7	$ 44.81	2026	1.15	$10.84	$33.97	x	20	9	126	7
	2027	1.75	$ 46.13	2027	1.2	$11.31	$34.82	x	21	10	127	7.05
	2028	1.8	$ 47.45	2028	1.25	$11.78	$35.66	x	22	11	128	7.1
	2029	1.85	$ 48.77	2029	1.3	$12.26	$36.51	x	23	12	129	7.15
	2030	1.9	$ 50.08	2030	1.35	$12.73	$37.36	x	24	13	130	7.2
	2031	1.95	$ 51.40	2031	1.4	$13.20	$38.20	x	25	14	131	7.25
	2032	2	$ 52.72	2032	1.45	$13.67	$39.05	x	26	15	132	7.3
Totals	26	35.93	$ 947.11	15	16.68	$157.26	$495.15					

City of Gladstone IGA		Project	
Gladstone, MO		Location	
Interior - Deco Pool Yoke		Equipment	
108.3%		Location Cost Index	Kansas City, MO
Existing - 400 W M-H	Proposed - LED Retro		
Replace Lamps&Ballast	Not Required	Repair Type #1	
4.3		Repair Frequency (Years)	
☑		Include Repair Labor?	
0.46		Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$121.61	$121.61	Repair Labor Rate ($/hour)	Staff Gen. Maint. Worker
$169.65		Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Fixture	Replace Fixture	Repair Type #2	
20	21	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
0.3	0.3	Replacement Labor Required (Hours)	
$111.92	$111.92	Replacement Labor Rate ($/hour)	Electrician
$426.00	$1,566.00	Replacement Material Cost	
2007		Year Equipment Originally Installed	
2018		Year New Equipment to be Installed	
15		Length of Performance Contract (Years)	
$80.89	$80.92	Average Annual Repair Cost in 2018 Dollars	
$15.67		**Annual O&M Savings per unit**	
$391.63		**Total Savings**	No. of Units: 25

	Existing			Proposed								
	Year	**Increase Factor**	**Annual Repair Cost**	**Year**	**Increase Factor**	**Annual Repair Cost**	**Savings**	**Include Year?**	**Original Life**	**New Life**	**Increase Factor Year**	**Increase Factor**
Original Installation	2007	0.2	$ 11.71					x	1	0	107	6.05
	2008	1	$ 58.54					x	2	0	108	6.1
	2009	1.02	$ 59.71					x	3	0	109	6.15
	2010	1.05	$ 61.46					x	4	0	110	6.2
	2011	1.06	$ 62.05					x	5	0	111	6.25
	2012	1.07	$ 62.63					x	6	0	112	6.3
	2013	1.08	$ 63.22					x	7	0	113	6.35
	2014	1.1	$ 64.39					x	8	0	114	6.4
	2015	1.15	$ 67.32					x	9	0	115	6.45
	2016	1.2	$ 70.24					x	10	0	116	6.5
	2017	1.25	$ 73.17					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 76.10	2018	0.2	$14.55	$61.54	x	12	1	118	6.6
	2019	1.35	$ 79.03	2019	1	$72.77	$6.25	x	13	2	119	6.65
	2020	1.4	$ 81.95	2020	1.02	$74.23	$7.73	x	14	3	120	6.7
	2021	1.45	$ 84.88	2021	1.05	$76.41	$8.47	x	15	4	121	6.75
	2022	1.5	$ 87.81	2022	1.06	$77.14	$10.67	x	16	5	122	6.8
	2023	1.55	$ 90.73	2023	1.07	$77.87	$12.87	x	17	6	123	6.85
	2024	1.6	$ 93.66	2024	1.08	$78.59	$15.07	x	18	7	124	6.9
	2025	1.65	$ 96.59	2025	1.1	$80.05	$16.54	x	19	8	125	6.95
	2026	1.7	$ 99.51	2026	1.15	$83.69	$15.83	x	20	9	126	7
	2027	1.75	$ 102.44	2027	1.2	$87.33	$15.11	x	21	10	127	7.05
	2028	1.8	$ 105.37	2028	1.25	$90.96	$14.40	x	22	11	128	7.1
	2029	1.85	$ 108.29	2029	1.3	$94.60	$13.69	x	23	12	129	7.15
	2030	1.9	$ 111.22	2030	1.35	$98.24	$12.98	x	24	13	130	7.2
	2031	1.95	$ 114.15	2031	1.4	$101.88	$12.27	x	25	14	131	7.25
	2032	2	$ 117.07	2032	1.45	$105.52	$11.56	x	26	15	132	7.3
Totals	26	35.93	$ 2,103.24	15	16.68	$1,213.82	$234.98					

Existing	Proposed		
City of Gladstone IGA	Project		
Gladstone, MO	Location		
Interior - Deco WP	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 400 W M-H	Proposed - LED Retro		
Replace Lamps&Ballast	Not Required	Repair Type #1	
4.3		Repair Frequency (Years)	
☑		Include Repair Labor?	
0.46		Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$121.61	$121.61	Repair Labor Rate ($/hour)	Staff Gen. Maint. Worker
$169.65		Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Fixture	Replace Fixture	Repair Type #2	
20	21	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
0.3	0.3	Replacement Labor Required (Hours)	
$111.92	$111.92	Replacement Labor Rate ($/hour)	Electrician
$426.00	$426.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$80.89	$23.31	Average Annual Repair Cost in 2018 Dollars	
$73.28		**Annual O&M Savings per unit**	
$879.37		**Total Savings**	No. of Units: 12

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
Original Installation	2007	0.2	$ 11.71					x	1	0	107	6.05
	2008	1	$ 58.54					x	2	0	108	6.1
	2009	1.02	$ 59.71					x	3	0	109	6.15
	2010	1.05	$ 61.46					x	4	0	110	6.2
	2011	1.06	$ 62.05					x	5	0	111	6.25
	2012	1.07	$ 62.63					x	6	0	112	6.3
	2013	1.08	$ 63.22					x	7	0	113	6.35
	2014	1.1	$ 64.39					x	8	0	114	6.4
	2015	1.15	$ 67.32					x	9	0	115	6.45
	2016	1.2	$ 70.24					x	10	0	116	6.5
	2017	1.25	$ 73.17					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 76.10	2018	0.2	$4.19	$71.91	x	12	1	118	6.6
	2019	1.35	$ 79.03	2019	1	$20.96	$58.07	x	13	2	119	6.65
	2020	1.4	$ 81.95	2020	1.02	$21.38	$60.57	x	14	3	120	6.7
	2021	1.45	$ 84.88	2021	1.05	$22.01	$62.87	x	15	4	121	6.75
	2022	1.5	$ 87.81	2022	1.06	$22.22	$65.59	x	16	5	122	6.8
	2023	1.55	$ 90.73	2023	1.07	$22.43	$68.31	x	17	6	123	6.85
	2024	1.6	$ 93.66	2024	1.08	$22.64	$71.02	x	18	7	124	6.9
	2025	1.65	$ 96.59	2025	1.1	$23.05	$73.53	x	19	8	125	6.95
	2026	1.7	$ 99.51	2026	1.15	$24.10	$75.41	x	20	9	126	7
	2027	1.75	$ 102.44	2027	1.2	$25.15	$77.29	x	21	10	127	7.05
	2028	1.8	$ 105.37	2028	1.25	$26.20	$79.17	x	22	11	128	7.1
	2029	1.85	$ 108.29	2029	1.3	$27.25	$81.05	x	23	12	129	7.15
	2030	1.9	$ 111.22	2030	1.35	$28.29	$82.93	x	24	13	130	7.2
	2031	1.95	$ 114.15	2031	1.4	$29.34	$84.81	x	25	14	131	7.25
	2032	2	$ 117.07	2032	1.45	$30.39	$86.68	x	26	15	132	7.3
Totals	26	35.93	$ 2,103.24	15	16.68	$349.59	$1,099.21					

City of Gladstone IGA	Project		
Gladstone, MO	Location		
Interior - 2x4 Cree Surface	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 4' 32W T8 Wrap	Proposed - LED Retro		
Replace Lamps&Ballast	Not Required	Repair Type #1	
6.0		Repair Frequency (Years)	
☑		Include Repair Labor?	
0.66		Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$121.61	$121.61	Repair Labor Rate ($/hour)	Staff Gen. Maint. Worker
$36.00		Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Fixture	Replace Fixture	Repair Type #2	
20	25	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
0.6	0.6	Replacement Labor Required (Hours)	
$111.92	$111.92	Replacement Labor Rate ($/hour)	Electrician
$99.95	$156.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$28.48	$9.44	Average Annual Repair Cost in 2018 Dollars	
$24.56		**Annual O&M Savings per unit**	
$785.84		**Total Savings**	No. of Units: 32

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
Original Installation	2007	0.2	$ 4.12					x	1	0	107	6.05
	2008	1	$ 20.61					x	2	0	108	6.1
	2009	1.02	$ 21.02					x	3	0	109	6.15
	2010	1.05	$ 21.64					x	4	0	110	6.2
	2011	1.06	$ 21.84					x	5	0	111	6.25
	2012	1.07	$ 22.05					x	6	0	112	6.3
	2013	1.08	$ 22.26					x	7	0	113	6.35
	2014	1.1	$ 22.67					x	8	0	114	6.4
	2015	1.15	$ 23.70					x	9	0	115	6.45
	2016	1.2	$ 24.73					x	10	0	116	6.5
	2017	1.25	$ 25.76					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 26.79	2018	0.2	$1.70	$25.09	x	12	1	118	6.6
	2019	1.35	$ 27.82	2019	1	$8.49	$19.33	x	13	2	119	6.65
	2020	1.4	$ 28.85	2020	1.02	$8.66	$20.19	x	14	3	120	6.7
	2021	1.45	$ 29.88	2021	1.05	$8.92	$20.96	x	15	4	121	6.75
	2022	1.5	$ 30.91	2022	1.06	$9.00	$21.91	x	16	5	122	6.8
	2023	1.55	$ 31.94	2023	1.07	$9.09	$22.85	x	17	6	123	6.85
	2024	1.6	$ 32.97	2024	1.08	$9.17	$23.80	x	18	7	124	6.9
	2025	1.65	$ 34.00	2025	1.1	$9.34	$24.66	x	19	8	125	6.95
	2026	1.7	$ 35.03	2026	1.15	$9.77	$25.27	x	20	9	126	7
	2027	1.75	$ 36.06	2027	1.2	$10.19	$25.87	x	21	10	127	7.05
	2028	1.8	$ 37.09	2028	1.25	$10.62	$26.48	x	22	11	128	7.1
	2029	1.85	$ 38.12	2029	1.3	$11.04	$27.08	x	23	12	129	7.15
	2030	1.9	$ 39.15	2030	1.35	$11.47	$27.69	x	24	13	130	7.2
	2031	1.95	$ 40.18	2031	1.4	$11.89	$28.29	x	25	14	131	7.25
	2032	2	$ 41.21	2032	1.45	$12.31	$28.90	x	26	15	132	7.3
Totals	26	35.93	$ 740.41	15	16.68	$141.66	$368.36					

City of Gladstone IGA	Project		
Gladstone, MO	Location		
Interior - 2x4 LED Door Retr	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 4' 32W T8	Proposed - LED Retro		
Replace Lamps&Ballast	Not Required	Repair Type #1	
6.0		Repair Frequency (Years)	
☑		Include Repair Labor?	
0.66		Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$121.61	$121.61	Repair Labor Rate ($/hour)	Staff Gen. Maint. Worker
$36.00		Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Fixture	Replace Fixture	Repair Type #2	
20	25	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
0.6	0.6	Replacement Labor Required (Hours)	
$111.92	$111.92	Replacement Labor Rate ($/hour)	Electrician
$99.95	$180.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$28.48	$10.48	Average Annual Repair Cost in 2018 Dollars	
$23.52		**Annual O&M Savings per unit**	
$23.52		**Total Savings**	No. of Units: 1

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
Original Installation	2007	0.2	$ 4.12					x	1	0	107	6.05
	2008	1	$ 20.61					x	2	0	108	6.1
	2009	1.02	$ 21.02					x	3	0	109	6.15
	2010	1.05	$ 21.64					x	4	0	110	6.2
	2011	1.06	$ 21.84					x	5	0	111	6.25
	2012	1.07	$ 22.05					x	6	0	112	6.3
	2013	1.08	$ 22.26					x	7	0	113	6.35
	2014	1.1	$ 22.67					x	8	0	114	6.4
	2015	1.15	$ 23.70					x	9	0	115	6.45
	2016	1.2	$ 24.73					x	10	0	116	6.5
	2017	1.25	$ 25.76					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 26.79	2018	0.2	$1.89	$24.90	x	12	1	118	6.6
	2019	1.35	$ 27.82	2019	1	$9.43	$18.39	x	13	2	119	6.65
	2020	1.4	$ 28.85	2020	1.02	$9.62	$19.23	x	14	3	120	6.7
	2021	1.45	$ 29.88	2021	1.05	$9.90	$19.98	x	15	4	121	6.75
	2022	1.5	$ 30.91	2022	1.06	$9.99	$20.92	x	16	5	122	6.8
	2023	1.55	$ 31.94	2023	1.07	$10.09	$21.85	x	17	6	123	6.85
	2024	1.6	$ 32.97	2024	1.08	$10.18	$22.79	x	18	7	124	6.9
	2025	1.65	$ 34.00	2025	1.1	$10.37	$23.63	x	19	8	125	6.95
	2026	1.7	$ 35.03	2026	1.15	$10.84	$24.19	x	20	9	126	7
	2027	1.75	$ 36.06	2027	1.2	$11.31	$24.75	x	21	10	127	7.05
	2028	1.8	$ 37.09	2028	1.25	$11.78	$25.31	x	22	11	128	7.1
	2029	1.85	$ 38.12	2029	1.3	$12.26	$25.87	x	23	12	129	7.15
	2030	1.9	$ 39.15	2030	1.35	$12.73	$26.43	x	24	13	130	7.2
	2031	1.95	$ 40.18	2031	1.4	$13.20	$26.98	x	25	14	131	7.25
	2032	2	$ 41.21	2032	1.45	$13.67	$27.54	x	26	15	132	7.3
Totals	26	35.93	$ 740.41	15	16.68	$157.26	$352.77					

City of Gladstone IGA	Project		
Gladstone, MO	Location		
Interior - 2x2 LED Door Retr	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 2' 17W T8	Proposed - LED Retro		
Replace Lamps&Ballast	Not Required	Repair Type #1	
6		Repair Frequency (Years)	
☑		Include Repair Labor?	
0.66		Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$121.61	$121.61	Repair Labor Rate ($/hour)	Staff Gen. Maint. Worker
$32.50		Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Fixture	Replace Fixture	Repair Type #2	
20	30	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
0.6	0.6	Replacement Labor Required (Hours)	
$111.92	$111.92	Replacement Labor Rate ($/hour)	Electrician
$99.95	$150.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$27.85	$7.65	Average Annual Repair Cost in 2018 Dollars	
$25.59		**Annual O&M Savings per unit**	
$25.59		**Total Savings**	No. of Units: 1

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
Original Installation	2007	0.2	$ 4.03					x	1	0	107	6.05
	2008	1	$ 20.15					x	2	0	108	6.1
	2009	1.02	$ 20.55					x	3	0	109	6.15
	2010	1.05	$ 21.16					x	4	0	110	6.2
	2011	1.06	$ 21.36					x	5	0	111	6.25
	2012	1.07	$ 21.56					x	6	0	112	6.3
	2013	1.08	$ 21.76					x	7	0	113	6.35
	2014	1.1	$ 22.16					x	8	0	114	6.4
	2015	1.15	$ 23.17					x	9	0	115	6.45
	2016	1.2	$ 24.18					x	10	0	116	6.5
	2017	1.25	$ 25.19					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 26.19	2018	0.2	$1.38	$24.82	x	12	1	118	6.6
	2019	1.35	$ 27.20	2019	1	$6.88	$20.32	x	13	2	119	6.65
	2020	1.4	$ 28.21	2020	1.02	$7.02	$21.19	x	14	3	120	6.7
	2021	1.45	$ 29.22	2021	1.05	$7.23	$21.99	x	15	4	121	6.75
	2022	1.5	$ 30.22	2022	1.06	$7.30	$22.93	x	16	5	122	6.8
	2023	1.55	$ 31.23	2023	1.07	$7.36	$23.87	x	17	6	123	6.85
	2024	1.6	$ 32.24	2024	1.08	$7.43	$24.81	x	18	7	124	6.9
	2025	1.65	$ 33.25	2025	1.1	$7.57	$25.68	x	19	8	125	6.95
	2026	1.7	$ 34.25	2026	1.15	$7.91	$26.34	x	20	9	126	7
	2027	1.75	$ 35.26	2027	1.2	$8.26	$27.00	x	21	10	127	7.05
	2028	1.8	$ 36.27	2028	1.25	$8.60	$27.67	x	22	11	128	7.1
	2029	1.85	$ 37.28	2029	1.3	$8.95	$28.33	x	23	12	129	7.15
	2030	1.9	$ 38.28	2030	1.35	$9.29	$28.99	x	24	13	130	7.2
	2031	1.95	$ 39.29	2031	1.4	$9.64	$29.66	x	25	14	131	7.25
	2032	2	$ 40.30	2032	1.45	$9.98	$30.32	x	26	15	132	7.3
Totals	26	35.93	$ 723.98	15	16.68	$114.80	$383.91					

City Hall / Public Safety - Interior Lighting	
Monthly kW savings from Audit	16.8
Annual kW Savings	201.6
Diversity Factor	85%
kW Savings	171.36
Lighting kWh Savings from Audit	107566
Cooling Interactive Savings from Calc	25524
Net kWh Savings	133090
Heating therm interactive penalty from Calc	-16.7

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved
City Hall / Public Safety	City Hall Interior	Lobby	4959	17	INCAN-I75-1	8-in Can-Medium-Open - no lens-Recessed	0.075	1.275	6,323	Retrofit	MaxLite 23W LED 8 COMMERCIAL DOWNLIGHT RETROFIT 4000K	17	0.391	1938.969	0.884	4,383.76
City Hall / Public Safety	City Hall Interior	Lobby	8760	1	EXIT-I15-1	Emergency w/BBU-White-Red-Surface	0.017	0.017	149	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	0.001	7.008	0.016	141.91
City Hall / Public Safety	City Hall Interior	Lobby	4959	4	LED-L10-1	6-in Can-Medium-Eyeball-Recessed	0.010	0.04	198	Retrofit	Eiko LED BR30, 8W, 4000K	4	0.032	158.688	0.008	39.67
City Hall / Public Safety	City Hall Interior	Lobby	4959	6	LED-L10-1	8-in Can-Medium-Open - no lens-Recessed	0.010	0.06	298	Retrofit	Eiko LED BR30, 8W, 4000K	6	0.048	238.032	0.012	59.51
City Hall / Public Safety	City Hall Interior	Lobby	4959	6	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.384	1,904	Retrofit	ATG LED 2x4 Troffer Door Kit	6	0.180	892.62	0.204	1,011.64
City Hall / Public Safety	City Hall Interior	Lobby	4959	2	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.128	635	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	2	0.080	396.72	0.048	238.03
City Hall / Public Safety	City Hall Interior	Lobby	4959	4	INCAN-I60-1	Decorative-Medium-Frosted-Wall	0.060	0.24	1,190	Retrofit	Eiko 4000K LED LiteSpan A19 Omnidirectional 300 Degree Beam 6W - 470lm Dimmable E26	4	0.024	119.016	0.216	1,071.14
City Hall / Public Safety	City Hall Interior	Lobby Bathroom	4959	2	F-F32T8-2	Strip-4 foot-Parabolic-Recessed	0.064	0.128	635	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	0.048	238.032	0.080	396.72
City Hall / Public Safety	City Hall Interior	1st Floor Hall	4959	4	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.256	1,270	Retrofit	ATG LED 2x4 Troffer Door Kit	4	0.120	595.08	0.136	674.42
City Hall / Public Safety	City Hall Interior	1st Floor Hall	4959	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.064	317	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	1	0.040	198.36	0.024	119.02
City Hall / Public Safety	City Hall Interior	1st Floor Hall	8760	3	EXIT-I15-1	Emergency w/BBU-White-Red-Surface	0.017	0.051	447	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	3	0.002	21.024	0.049	425.74
City Hall / Public Safety	City Hall Interior	Employee Entrance	4959	3	CFL-CF36W-2	Troffer-Plug-in 4 Pin-Parabolic-Recessed	0.076	0.228	1,131	Retrofit	ATG 2X2 LED DOOR KIT	3	0.090	446.31	0.138	684.34
City Hall / Public Safety	City Hall Interior	Employee Entrance	4959	1	CFL-CF36W-2	Troffer-Plug-in 4 Pin-Parabolic-Recessed	0.076	0.076	377	Retrofit	ATG LED 2x2 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	1	0.040	198.36	0.036	178.52
City Hall / Public Safety	City Hall Interior	Employee Entrance	4959	2	HAL-H50-1	8-in Can-Medium-PAR20-Recessed	0.050	0.1	496	Retrofit	MaxLite 15W LED 8 COMMERCIAL DOWNLIGHT RETROFIT 4000K RR81540W	2	0.030	148.77	0.070	347.13
City Hall / Public Safety	City Hall Interior	Employee Entrance	8760	1	EXIT-Tritium0-1	Exit-Red-White-Wall	0.017	0.017	149	Do Nothing	Do Nothing	1	0.017	148.92	0.000	0.00
City Hall / Public Safety	City Hall Interior	South Conference	4959	16	CFL-CF36W-2	Troffer-Plug-in 4 Pin-Parabolic-Recessed	0.076	1.216	6,030	Retrofit	ATG 2X2 LED DOOR KIT	16	0.480	2380.32	0.736	3,649.82
City Hall / Public Safety	City Hall Interior	South Conference	4959	2	CFL-CF36W-2	Troffer-Plug-in 4 Pin-Parabolic-Recessed	0.076	0.152	754	Retrofit	ATG LED 2x2 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	2	0.080	396.72	0.072	357.05
City Hall / Public Safety	City Hall Interior	South Conference	4959	12	INCAN-I60-1	6-in Can-Medium-Open - no lens-Recessed	0.060	0.72	3,570	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	12	0.180	892.62	0.540	2,677.86
City Hall / Public Safety	City Hall Interior	South Conference	8760	4	EXIT-I15-1	Emergency w/BBU-White-Red-Surface	0.017	0.068	596	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	4	0.003	28.032	0.065	567.65
City Hall / Public Safety	City Hall Interior	Breakroom	4959	4	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.256	1,270	Retrofit	ATG LED 2x4 Troffer Door Kit	4	0.120	595.08	0.136	674.42
City Hall / Public Safety	City Hall Interior	Breakroom	4959	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.064	317	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	1	0.040	198.36	0.024	119.02
City Hall / Public Safety	City Hall Interior	Breakroom	4959	1	UFL-FU31T8/6-2	2X2-Troffer-Prismatic-Recessed	0.072	0.072	357	Retrofit	ATG 2X2 LED DOOR KIT	1	0.030	148.77	0.042	208.28
City Hall / Public Safety	City Hall Interior	City Council Chambers	4959	15	UFL-FU31T8/6-2	2X2-Troffer-Prismatic-Recessed	0.072	1.08	5,356	Retrofit	ATG 2X2 LED DOOR KIT	15	0.450	2231.55	0.630	3,124.17
City Hall / Public Safety	City Hall Interior	City Council Chambers	4959	6	UFL-FU31T8/6-2	2X2-Troffer-Parabolic-Recessed	0.072	0.432	2,142	Retrofit	ATG LED 2x2 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	6	0.240	1190.16	0.192	952.13
City Hall / Public Safety	City Hall Interior	City Council Chambers	4959	5	CFL-CF13W-1	6-in Can-Medium-Open - no lens-Recessed	0.015	0.075	372	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	5	0.075	371.925	0.000	0.00
City Hall / Public Safety	City Hall Interior	City Council Chambers	4959	8	LED-L12-1	6-in Can-Medium-Open - no lens-Recessed	0.012	0.096	476	Retrofit	Eiko LED BR30, 8W, 4000K	8	0.064	317.376	0.032	158.69
City Hall / Public Safety	City Hall Interior	City Council Chambers	4959	2	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.128	635	Retrofit	ATG LED 2x4 Troffer Door Kit	2	0.060	297.54	0.068	337.21
City Hall / Public Safety	City Hall Interior	Back Offices	4959	84	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	5.376	26,660	Retrofit	ATG LED 2x4 Troffer Door Kit	84	2.520	12496.68	2.856	14,162.90
City Hall / Public Safety	City Hall Interior	Back Offices	4959	2	CFL-CF13W-1	6-in Can-Medium-Open - no lens-Recessed	0.015	0.03	149	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	2	0.030	148.77	0.000	0.00
City Hall / Public Safety	City Hall Interior	Back Offices	4959	28	F-F32T8-3	Troffer-2X4-Parabolic-Recessed	0.109	3.052	15,135	Retrofit	ATG LED 2x4 Troffer Door Kit	28	0.840	4165.56	2.212	10,969.31
City Hall / Public Safety	City Hall Interior	Back Offices	8760	5	EXIT-I15-1	Emergency w/BBU-White-Red-Surface	0.017	0.085	745	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	5	0.004	35.04	0.081	709.56
City Hall / Public Safety	City Hall Interior	Back office bathrooms	4959	4	F-F32T8-2	Wrap-4 foot-Prismatic-Wall	0.064	0.256	1,270	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	4	0.096	476.064	0.160	793.44
City Hall / Public Safety	Public Safety Interior	Dispatch Electric Closet	730	3	F-F32T8-2	Strip-4 foot-Wire Guard-Surface	0.064	0.192	140	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	3	0.072	52.56	0.120	87.60
City Hall / Public Safety	Public Safety Interior	Main Dispatch	8760	3	F-F17T8-2	Troffer-2X2-Indirect-Recessed	0.038	0.114	999	Retrofit	ATG 2X2 LED DOOR KIT	3	0.090	788.4	0.024	210.24
City Hall / Public Safety	Public Safety Interior	Main Dispatch	8760	1	F-F17T8-2	Troffer-2X2-Indirect-Recessed	0.038	0.038	333	Retrofit	ATG LED 2x2 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	1	0.040	350.4	-0.002	-17.52
City Hall / Public Safety	Public Safety Interior	Dispatch Kitchen/Bath	8760	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.064	561	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	1	0.040	350.4	0.024	210.24
City Hall / Public Safety	Public Safety Interior	Dispatch Kitchen/Bath	8760	2	HAL-H50-1	4-in Can-Medium-PAR20-Recessed	0.050	0.1	876	Retrofit	MaxLite 15W LED 4 COMMERCIAL DOWNLIGHT RETROFIT 4000K	2	0.028	245.28	0.072	630.72
City Hall / Public Safety	Public Safety Interior	Dispatch Kitchen/Bath	8760	1	CFL-CF32W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.034	0.034	298	Retrofit	Nicor LED 6" Can Retrofit, 18W, 4000K w/ Emergency Blst	1	0.018	157.68	0.016	140.16
City Hall / Public Safety	Public Safety Interior	Dispatch Kitchen/Bath	8760	2	F-F32T8-2	Strip-4 foot-Open - no lens-Recessed	0.064	0.128	1,121	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	0.048	420.48	0.080	700.80
City Hall / Public Safety	Public Safety Interior	Admin Office Area #139	8760	12	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.768	6,728	Retrofit	ATG LED 2x4 Troffer Door Kit	12	0.360	3153.6	0.408	3,574.08
City Hall / Public Safety	Public Safety Interior	Admin Office Area #139	8760	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.064	561	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	1	0.040	350.4	0.024	210.24
City Hall / Public Safety	Public Safety Interior	Main Hall Baths	8760	2	CFL-CF32W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.034	0.068	596	Retrofit	Nicor LED 6" Can Retrofit, 18W, 4000K w/ Emergency Blst	2	0.036	315.36	0.032	280.32
City Hall / Public Safety	Public Safety Interior	Main Hall Baths	8760	4	F-F32T8-2	Strip-4 foot-Open - no lens-Recessed	0.064	0.256	2,243	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	4	0.096	840.96	0.160	1,401.60
City Hall / Public Safety	Public Safety Interior	Restricted Records #138	8760	4	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.256	2,243	Retrofit	ATG LED 2x4 Troffer Door Kit	4	0.120	1051.2	0.136	1,191.36
City Hall / Public Safety	Public Safety Interior	Main Hall	8760	6	CFL-CF32W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.034	0.204	1,787	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	6	0.090	788.4	0.114	998.64
City Hall / Public Safety	Public Safety Interior	Main Hall	8760	9	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.576	5,046	Retrofit	ATG LED 2x4 Troffer Door Kit	9	0.270	2365.2	0.306	2,680.56
City Hall / Public Safety	Public Safety Interior	Main Hall	8760	6	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.384	3,364	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	6	0.240	2102.4	0.144	1,261.44
City Hall / Public Safety	Public Safety Interior	Main Hall	8760	1	UFL-FU31T8/6-2	2X2-Troffer-Prismatic-Recessed	0.072	0.072	631	Retrofit	ATG 2X2 LED DOOR KIT	1	0.030	262.8	0.042	367.92
City Hall / Public Safety	Public Safety Interior	Cell Area	8760	6	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.384	3,364	Retrofit	ATG LED 2x4 Troffer Door Kit	6	0.180	1576.8	0.204	1,787.04
City Hall / Public Safety	Public Safety Interior	Cell Area	8760	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.064	561	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	1	0.040	350.4	0.024	210.24
City Hall / Public Safety	Public Safety Interior	Cell Area	8760	7	F-F32T8-2	Vapor Tight-4 foot-Clear-Surface	0.064	0.448	3,924	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	7	0.168	1471.68	0.280	2,452.80
City Hall / Public Safety	Public Safety Interior	Cell Area	8760	5	CFL-CF13W-2	Security-Medium-Frosted-Surface	0.030	0.15	1,314	Retrofit	(2) Eiko LED A19 9W, 4000K	5	0.090	788.4	0.060	525.60
City Hall / Public Safety	Public Safety Interior	Cell Area	8760	2	CFL-CF13W-1	Open Socket-Medium-Open - no lens-Surface	0.015	0.03	263	Retrofit	Eiko 4000K LED LiteSpan A19 Omni-Directional 300 Degree Beam 9W - 800lm Dimmable E26	2	0.018	157.68	0.012	105.12
City Hall / Public Safety	Public Safety Interior	Maint 2	730	4	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	0.064	0.256	187	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	4	0.096	70.08	0.160	116.80
City Hall / Public Safety	Public Safety Interior	Armory	8760	2	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.128	1,121	Retrofit	ATG LED 2x4 Troffer Door Kit	2	0.060	525.6	0.068	595.68
City Hall / Public Safety	Public Safety Interior	Maint 3	730	1	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	0.064	0.064	47	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	1	0.024	17.52	0.040	29.20
City Hall / Public Safety	Public Safety Interior	Men's Locker	8760	5	F-F32T8-2	Troffer-1X4-Prismatic-Recessed	0.064	0.32	2,803	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	5	0.120	1051.2	0.200	1,752.00
City Hall / Public Safety	Public Safety Interior	Men's Locker	8760	1	F-F32T8-2	Troffer-1X4-Prismatic-Recessed	0.064	0.064	561	Retrofit	(2) Remphos 4' LED Totaltube, 4000K w/ Emergency Blst	1	0.024	210.24	0.040	350.40
City Hall / Public Safety	Public Safety Interior	Men's Locker	8760	1	F-F32T8-4	Strip-4 foot-Direct/Indirect-Wall	0.145	0.145	1,270	Retrofit	Eiko 4L 12W T8 Ballast Bypass DLCP	1	0.048	420.48	0.097	849.72
City Hall / Public Safety	Public Safety Interior	Women's Locker Room	8760	3	F-F32T8-2	Troffer-1X4-Prismatic-Recessed	0.064	0.192	1,682	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	3	0.072	630.72	0.120	1,051.20
City Hall / Public Safety	Public Safety Interior	Women's Locker Room	8760	1	F-F32T8-2	Troffer-1X4-Prismatic-Recessed	0.064	0.064	561	Retrofit	(2) Remphos 4' LED Totaltube, 4000K w/ Emergency Blst	1	0.024	210.24	0.040	350.40
City Hall / Public Safety	Public Safety Interior	Women's Locker Room	8760	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.064	561	Retrofit	ATG LED 2x4 Troffer Door Kit	1	0.030	262.8	0.034	297.84
City Hall / Public Safety	Public Safety Interior	Women's Locker Room	8760	2	F-F32T8-2	Vanity-4 foot-Prismatic-Wall	0.064	0.128	1,121	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	0.048	420.48	0.080	700.80
City Hall / Public Safety	Public Safety Interior	Hall CLoset	730	1	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	0.064	0.064	47	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	1	0.024	17.52	0.040	29.20
City Hall / Public Safety	Public Safety Interior	Supervisors Office #152	8760	5	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.32	2,803	Retrofit	ATG LED 2x4 Troffer Door Kit	5	0.150	1314	0.170	1,489.20
City Hall / Public Safety	Public Safety Interior	Supervisors Office #152	8760	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.064	561	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	1	0.040	350.4	0.024	210.24
City Hall / Public Safety	Public Safety Interior	Hall 161	8760	5	F-F32T8-3	Troffer-2X4-Prismatic-Surface	0.109	0.545	4,774	Retrofit	Eiko 3L 12W T8 Ballast Bypass DLCP	5	0.180	1576.8	0.365	3,197.40
City Hall / Public Safety	Public Safety Interior	Room 134	8760	14	F-F32T8-2	Strip-4 foot-Reflector-Surface	0.064	0.896	7,849	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	14	0.336	2943.36	0.560	4,905.60
City Hall / Public Safety	Public Safety Interior	Room 132	8760	7	F-F32T8-2	Strip-4 foot-Reflector-Surface	0.064	0.448	3,924	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	7	0.168	1471.68	0.280	2,452.80
City Hall / Public Safety	Public Safety Interior	Briefing	8760	6	F-F32T8-3	Troffer-2X4-Parabolic-Recessed	0.109	0.654	5,729	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	6	0.240	2102.4	0.414	3,626.64
City Hall / Public Safety	Public Safety Interior	Briefing	8760	4	HAL-H50-1	4-in Can-Medium-PAR20-Recessed	0.050	0.2	1,752	Retrofit	MaxLite 15W LED 4 COMMERCIAL DOWNLIGHT RETROFIT 4000K	4	0.056	490.56	0.144	1,261.44
City Hall / Public Safety	Public Safety Interior	Briefing	8760	2	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.128	1,121	Retrofit	ATG LED 2x4 Troffer Door Kit	2	0.060	525.6	0.068	595.68
City Hall / Public Safety	Public Safety Interior	Briefing	8760	5	HAL-H50-1	Track-Medium-PAR30-Track	0.050	0.25	2,190	Retrofit	Eiko LED PAR30, 11W, 4000K	5	0.055	481.8	0.195	1,708.20
City Hall / Public Safety	Public Safety Interior	Traffic	8760	2	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.128	1,121	Retrofit	ATG LED 2x4 Troffer Door Kit	2	0.060	525.6	0.068	595.68
City Hall / Public Safety	Public Safety Interior	Criminal Interest	8760	10	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.64	5,606	Retrofit	ATG LED 2x4 Troffer Door Kit	10	0.300	2628	0.340	2,978.40
City Hall / Public Safety	Public Safety Interior	Criminal Interest	8760	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.064	561	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	1	0.040	350.4	0.024	210.24
City Hall / Public Safety	Public Safety Interior	Criminal Interest	8760	4	F-F32T8-4	Wrap-4 foot-Prismatic-Surface	0.145	0.58	5,081	Retrofit	Eiko 4L 12W T8 Ballast Bypass DLCP	4	0.192	1681.92	0.388	3,398.88
City Hall / Public Safety	Public Safety Interior	Crime Prevention	8760	4	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.256	2,243	Retrofit	ATG LED 2x4 Troffer Door Kit	4	0.120	1051.2	0.136	1,191.36
City Hall / Public Safety	Public Safety Interior	Crime Prevention	8760	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.064	561	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	1	0.040	350.4	0.024	210.24
City Hall / Public Safety	Public Safety Interior	Records Office	8760	5	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.32	2,803	Retrofit	ATG LED 2x4 Troffer Door Kit	5	0.150	1314	0.170	1,489.20
City Hall / Public Safety	Public Safety Interior	Records Office	8760	1	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.064	561	Retrofit	ATG LED 2x4 Troffer Door Kit, 30W, 4000K w/ Emerg Blst	1	0.040	350.4	0.024	210.24
City Hall / Public Safety	Public Safety Interior	Records Office	8760	1	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	0.064	0.064	561	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	1	0.024	210.24	0.040	350.40
City Hall / Public Safety	Public Safety Interior	Lobby	8760	6	CFL-CF32W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.034	0.204	1,787	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	6	0.090	788.4	0.114	998.64
City Hall / Public Safety	Public Safety Interior	Lobby	8760	1	CFL-CF32W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.034	0.034	298	Retrofit	Nicor LED 6" Can Retrofit, 18W, 4000K w/ Emergency Blst	1	0.018	157.68	0.016	140.16
City Hall / Public Safety	Public Safety Interior	Lobby	8760	2	F-F32T8-3	Wrap-4 foot-Prismatic-Surface	0.109	0.218	1,910	Retrofit	Eiko 3L 12W T8 Ballast Bypass DLCP	2	0.072	630.72	0.146	1,278.96
City Hall / Public Safety	Public Safety Interior	Lobby	8760	2	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	0.064	0.128	1,121	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	0.048	420.48	0.080	700.80

Interior 16.7556 107565.9

Lighting HVAC Interactive Savings Calculation

**Information and table values come from the Article "Calculating lighting and HVAC interactions" ASHRAE Journal November 1993
Robert A Rundquist, P.E.; Karl F. Johnson; Donald Aumann, P.E.

Project Name

<u>**Project Location**</u>
Kansas, Kansas City

Fraction to Cooling (C)	0.4	Btu per kWh (G)	3,413	
Fraction to Heating (E)	0.32			
Constant of Heating	Natural gas	0.046		
	Electric resistance	1		

		Lighting Energy Savings				Cooling Savings Calculation			Heating Savings Calculation						
	Location	kW Reduced (A)	kWh Reduced (B)	Area		Fraction to Cooling (C)	System MCOP (D)	Cooling kWh (B*C/D)	Fraction to Heating (E)	Fraction Area on Perimeter (F)	Convert to Therms (I)	Heating System Efficiency (H)	Heating Therms	Heating MCF	Heating kWh
1	Community Center	68.0	356,109	77,350		0.70	2.51	99,313	0.32	0.20	100,000	80%	-45.6	-4.4	-18606.5
2	City Hall / Public Safety	16.8	107,566	37,850		0.70	2.95	25,524	0.32	0.28	100,000	92%	-16.7	-1.6	-9013.33
3	Fire Station #1	5.1	28,432	7,950		0.40	2.95	3,855	0.32	0.56	100,000	92%	-8.7	-0.8	-4685.06
4	Fire Station #2	5.5	32,418	7,700		0.40	2.95	4,396	0.32	0.57	100,000	92%	-10.0	-1.0	-5410.23
5	Public Works	7.0	18,998	6,541		0.52	2.95	3,349	0.32	0.60	100,000	92%	-6.3	-0.6	-3379.74
6	Animal Shelter	1.3	2,656	2,304		0.52	2.95	468	0.32	0.86	100,000	92%	-1.2	-0.1	-671.968
7	Water Treatment	5.2	12,159	21,200		0.52	2.95	2,143	0.32	0.37	100,000	92%	-2.5	-0.2	-1323.13
8	Atkins-Johnson Museum	1.2	2,883	2,504		0.40	2.30	501	0.32	0.84	100,000	80%	-1.5	-0.1	-619.677
10	Fins and Foilage Bldg	5.1	2,662	7,560		0.40	3.11	342	0.32	0.57	100,000	92%	-0.8	-0.1	-447.503
11	Oak Grove Park	1.2	2,100	3,843		0.40	2.30	365	0.32	0.73	100,000	80%	-1.0	-0.1	-394.424
12	Linden Square Office	2.5	5,791	2,400		0.61	2.30	1,536	0.32	0.85	100,000	92%	-2.7	-0.3	-1448.7
	Total Energy Savings	**118.9**	**571,774**					**141,793**					**-97.1**	**-9.4**	**-46000.3**

Sum of Qty	
Row Labels	**City Hall / Public Safety**
Interior	
Detail	
(2) Eiko 4' LED Strip 23W, 3013lm, 40K	
F-F96T12-2	
(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal	
CFL-CF26W-2	
ATG 2X2 LED DOOR KIT	39
CFL-CF36W-2	19
F-F14T5-2	
F-F17T8-2	3
F-F17T8-3	
UFL-FU31T8/6-2	17
ATG LED 2x4 Troffer Door Kit	190
F-F32T8-2	162
F-F32T8-3	28
F-F32T8-4	
Cree LS4 4' LED Surface Ambient Luminaire 44W, 40K, 40lm	
F-F32T8-2	
Deco Adjustable LED Wall Pack, 120W, White	
MH-MH400-1	
Deco Gladetino 311W, 50K, Large Yoke Mount, White	
MH-MH400-2	
Do Nothing	1
EXIT-Tritium0-1	1
LED-L20-1	
LED-L8-1	
QUARTZ-Q150-1	
Eiko 2L 12W T8 Ballast Bypass DLCP	62
F-F32T8-2	62
Eiko 3L 12W T8 Ballast Bypass DLCP	7
F-F32T8-3	7
Eiko LED T5, 12.5W, 4000K	
F-F28T5-2	
Lithonia IBG LED Highbay, 114W, 18000lm, 50K	
F-F54T5HO-4	
NICOR CLR8 8" DOWNLIGHT KIT.	
CFL-CF42W-1	
Sielo LED Retrofit Kit,	
CFL-CF42W-3	
Typical	**147**
Typical Interior Lighting Savings	$0.00

Most common remaining typical fixture is a downlight can retrofit

City of Gladstone IGA	Project		
Gladstone, MO	Location		
Interior - downlight kit	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 8" cfl can	Proposed - LED Retro		
Replace Lamps&Ballast	Not Required	Repair Type #1	
2.9		Repair Frequency (Years)	
☐		Include Repair Labor?	
0.44		Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$121.61	$121.61	Repair Labor Rate ($/hour)	Staff Gen. Maint. Worker
$37.90		Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Fixture	Replace Fixture	Repair Type #2	
20	21.4	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
0.57	0.6	Replacement Labor Required (Hours)	
$111.92	$111.92	Replacement Labor Rate ($/hour)	Electrician
$44.15	$235.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$19.95	$14.85	Average Annual Repair Cost in 2018 Dollars	
$8.96		**Annual O&M Savings per unit**	
$8.96		**Total Savings**	No. of Units: 1

	Existing			Proposed								
	Year	**Increase Factor**	**Annual Repair Cost**	**Year**	**Increase Factor**	**Annual Repair Cost**	**Savings**	**Include Year?**	**Original Life**	**New Life**	**Increase Factor Year**	**Increase Factor**
Original Installation	2007	0.2	$ 2.89					x	1	0	107	6.05
	2008	1	$ 14.43					x	2	0	108	6.1
	2009	1.02	$ 14.72					x	3	0	109	6.15
	2010	1.05	$ 15.16					x	4	0	110	6.2
	2011	1.06	$ 15.30					x	5	0	111	6.25
	2012	1.07	$ 15.44					x	6	0	112	6.3
	2013	1.08	$ 15.59					x	7	0	113	6.35
	2014	1.1	$ 15.88					x	8	0	114	6.4
	2015	1.15	$ 16.60					x	9	0	115	6.45
	2016	1.2	$ 17.32					x	10	0	116	6.5
	2017	1.25	$ 18.04					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 18.76	2018	0.2	$2.67	$16.09	x	12	1	118	6.6
	2019	1.35	$ 19.49	2019	1	$13.36	$6.13	x	13	2	119	6.65
	2020	1.4	$ 20.21	2020	1.02	$13.63	$6.58	x	14	3	120	6.7
	2021	1.45	$ 20.93	2021	1.05	$14.03	$6.90	x	15	4	121	6.75
	2022	1.5	$ 21.65	2022	1.06	$14.16	$7.49	x	16	5	122	6.8
	2023	1.55	$ 22.37	2023	1.07	$14.29	$8.08	x	17	6	123	6.85
	2024	1.6	$ 23.09	2024	1.08	$14.43	$8.67	x	18	7	124	6.9
	2025	1.65	$ 23.82	2025	1.1	$14.69	$9.12	x	19	8	125	6.95
	2026	1.7	$ 24.54	2026	1.15	$15.36	$9.18	x	20	9	126	7
	2027	1.75	$ 25.26	2027	1.2	$16.03	$9.23	x	21	10	127	7.05
	2028	1.8	$ 25.98	2028	1.25	$16.70	$9.28	x	22	11	128	7.1
	2029	1.85	$ 26.70	2029	1.3	$17.37	$9.34	x	23	12	129	7.15
	2030	1.9	$ 27.42	2030	1.35	$18.03	$9.39	x	24	13	130	7.2
	2031	1.95	$ 28.15	2031	1.4	$18.70	$9.44	x	25	14	131	7.25
	2032	2	$ 28.87	2032	1.45	$19.37	$9.50	x	26	15	132	7.3
Totals	26	35.93	$ 518.61	15	16.68	$222.81	$134.43					

City of Gladstone IGA	Project		
Gladstone, MO	Location		
Interior - 2x4 LED Door Retr	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 4' 32W T8	Proposed - LED Retro		
Replace Lamps&Ballast	Not Required	Repair Type #1	
6.0		Repair Frequency (Years)	
☑		Include Repair Labor?	
0.66		Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$121.61	$121.61	Repair Labor Rate ($/hour)	Staff Gen. Maint. Worker
$36.00		Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Fixture	Replace Fixture	Repair Type #2	
20	25	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
0.6	0.6	Replacement Labor Required (Hours)	
$111.92	$111.92	Replacement Labor Rate ($/hour)	Electrician
$99.95	$180.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$28.48	$10.48	Average Annual Repair Cost in 2018 Dollars	
$23.52		**Annual O&M Savings per unit**	
$23.52		**Total Savings**	No. of Units: 1

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
Original Installation	2007	0.2	$ 4.12					x	1	0	107	6.05
	2008	1	$ 20.61					x	2	0	108	6.1
	2009	1.02	$ 21.02					x	3	0	109	6.15
	2010	1.05	$ 21.64					x	4	0	110	6.2
	2011	1.06	$ 21.84					x	5	0	111	6.25
	2012	1.07	$ 22.05					x	6	0	112	6.3
	2013	1.08	$ 22.26					x	7	0	113	6.35
	2014	1.1	$ 22.67					x	8	0	114	6.4
	2015	1.15	$ 23.70					x	9	0	115	6.45
	2016	1.2	$ 24.73					x	10	0	116	6.5
	2017	1.25	$ 25.76					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 26.79	2018	0.2	$1.89	$24.90	x	12	1	118	6.6
	2019	1.35	$ 27.82	2019	1	$9.43	$18.39	x	13	2	119	6.65
	2020	1.4	$ 28.85	2020	1.02	$9.62	$19.23	x	14	3	120	6.7
	2021	1.45	$ 29.88	2021	1.05	$9.90	$19.98	x	15	4	121	6.75
	2022	1.5	$ 30.91	2022	1.06	$9.99	$20.92	x	16	5	122	6.8
	2023	1.55	$ 31.94	2023	1.07	$10.09	$21.85	x	17	6	123	6.85
	2024	1.6	$ 32.97	2024	1.08	$10.18	$22.79	x	18	7	124	6.9
	2025	1.65	$ 34.00	2025	1.1	$10.37	$23.63	x	19	8	125	6.95
	2026	1.7	$ 35.03	2026	1.15	$10.84	$24.19	x	20	9	126	7
	2027	1.75	$ 36.06	2027	1.2	$11.31	$24.75	x	21	10	127	7.05
	2028	1.8	$ 37.09	2028	1.25	$11.78	$25.31	x	22	11	128	7.1
	2029	1.85	$ 38.12	2029	1.3	$12.26	$25.87	x	23	12	129	7.15
	2030	1.9	$ 39.15	2030	1.35	$12.73	$26.43	x	24	13	130	7.2
	2031	1.95	$ 40.18	2031	1.4	$13.20	$26.98	x	25	14	131	7.25
	2032	2	$ 41.21	2032	1.45	$13.67	$27.54	x	26	15	132	7.3
Totals	26	35.93	$ 740.41	15	16.68	$157.26	$352.77					

Fire Station #1 - Interior Lighting	
Monthly kW savings from Audit	5.1
Annual kW Savings	61.2
Diversity Factor	85%
kW Savings	52.02
Lighting kWh Savings from Audit	28432
Cooling Interactive Savings from Calc	3855
Net kWh Savings	32287
Heating therm interactive penalty from Calc	-8.7

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved
Public Fire #1	Interior	Entrance	5800	2	CFL-CF26W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.028	0.056	325	Retrofit	Nicor 6in Can LED Retrofit, 18W, 4000K	2	0.036	208.8	0.020	116.00
Public Fire #1	Interior	Entrance	5800	2	CFL-CF26W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.028	0.056	325	Retrofit	Nicor 6" LED Can Light, 18W, 4000K w/ Emergency Blst	2	0.036	208.8	0.020	116.00
Public Fire #1	Interior	Entrance	8760	1	EXIT-I15-1	Exit-White-Red-Surface	0.017	0.017	149	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	0.001	7.008	0.016	141.91
Public Fire #1	Interior	Entrance	5800	1	F-F32T8-1	Direct/Indirect-4 foot-Reflector-Pendant	0.036	0.036	209	Retrofit	Eiko 1L 12W T8 Ballast Bypass DLCP	1	0.012	69.6	0.024	139.20
Public Fire #1	Interior	Hallway	5800	1	HAL-H50-1	Decorative-GU10-None-Wall	0.050	0.05	290	Retrofit	Eiko LED MR16, GU10, 120V, 7W, 4000K	1	0.007	40.6	0.043	249.40
Public Fire #1	Interior	Hallway	8760	1	EXIT-I15-1	Exit-White-Red-Wall	0.017	0.017	149	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	0.001	7.008	0.016	141.91
Public Fire #1	Interior	Hallway	5800	19	F-F32T8-1	Direct/Indirect-4 foot-Reflector-Pendant	0.036	0.684	3,967	Retrofit	Eiko 1L 12W T8 Ballast Bypass DLCP	19	0.228	1322.4	0.456	2,644.80
Public Fire #1	Interior	Hallway	8760	1	EXIT-I15-1	Exit-White-Red-Surface	0.017	0.017	149	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	0.001	7.008	0.016	141.91
Public Fire #1	Interior	103	5800	2	F-F32T8-1	Direct/Indirect-4 foot-Reflector-Pendant	0.036	0.072	418	Retrofit	Eiko 1L 12W T8 Ballast Bypass DLCP	2	0.024	139.2	0.048	278.40
Public Fire #1	Interior	104	5800	3	F-F32T8-1	Direct/Indirect-4 foot-Reflector-Pendant	0.036	0.108	626	Retrofit	Eiko 1L 12W T8 Ballast Bypass DLCP	3	0.036	208.8	0.072	417.60
Public Fire #1	Interior	105	730	1	F-F32T8-2	Strip-4 foot-Open - no lens-Wall	0.064	0.064	47	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	1	0.024	17.52	0.040	29.20
Public Fire #1	Interior	Kitchen	5800	4	F-F32T8-1	Strip-4 foot-Prismatic-Surface	0.036	0.144	835	Retrofit	Eiko 1L 12W T8 Ballast Bypass DLCP	4	0.048	278.4	0.096	556.80
Public Fire #1	Interior	Kitchen	5800	10	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	0.064	0.64	3,712	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	10	0.240	1392	0.400	2,320.00
Public Fire #1	Interior	Kitchen	5800	5	LED-L8-1	Pendant-Candelabra-Open - no lens-Pendant	0.008	0.04	232	Do Nothing	Do Nothing	5	0.040	232	0.000	0.00
Public Fire #1	Interior	Lounge	5800	8	CFL-CF26W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.028	0.224	1,299	Retrofit	Nicor 6in Can LED Retrofit, 18W, 4000K	8	0.144	835.2	0.080	464.00
Public Fire #1	Interior	Lounge	5800	1	CFL-CF26W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.028	0.028	162	Retrofit	Nicor 6" LED Can Light, 18W, 4000K w/ Emergency Blst	1	0.018	104.4	0.010	58.00
Public Fire #1	Interior	Lounge	5800	4	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	0.064	0.256	1,485	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	4	0.096	556.8	0.160	928.00
Public Fire #1	Interior	Back Hallway	5800	5	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.32	1,856	Retrofit	ATG LED 2x4 Troffer Door Kit	5	0.150	870	0.170	986.00
Public Fire #1	Interior	Back Hallway	5800	4	CFL-CF26W-1	4-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.028	0.112	650	Retrofit	MaxLite 15W LED 4 COMMERCIAL DOWNLIGHT RETROFIT 4000K	4	0.056	324.8	0.056	324.80
Public Fire #1	Interior	Back Hallway	8760	1	EXIT-I15-1	Exit-White-Red-Wall	0.017	0.017	149	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	0.001	7.008	0.016	141.91
Public Fire #1	Interior	Back Hallway	8760	1	EXIT-I15-1	Exit-White-Red-Surface	0.017	0.017	149	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	0.001	7.008	0.016	141.91
Public Fire #1	Interior	Sleeping Rooms	5800	7	F-F32T8-2	Troffer-2X4-Prismatic-Recessed	0.064	0.448	2,598	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	7	0.168	974.4	0.280	1,624.00
Public Fire #1	Interior	Bathrooms	5800	6	F-F32T8-2	Troffer-1X4-Prismatic-Recessed	0.064	0.384	2,227	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	6	0.144	835.2	0.240	1,392.00
Public Fire #1	Interior	Bathrooms	5800	2	F-F32T8-2	Troffer-1X4-Prismatic-Recessed	0.064	0.128	742	Retrofit	(2) Remphos Total Tube 15W, 4000K w/ Emergency Blst	2	0.048	278.4	0.080	464.00
Public Fire #1	Interior	Bathrooms	5800	3	CFL-CF13W-1	6-in Can-Medium-Frosted-Recessed	0.015	0.045	261	Retrofit	Eiko 4000K LED LiteSpan A19 Omni-Directional 300 Degree Beam 9W - 800lm Dimmable E26	3	0.027	156.6	0.018	104.40
Public Fire #1	Interior	Bathrooms	5800	8	F-F32T8-1	Strip-4 foot-Eggcrate-Recessed	0.036	0.288	1,670	Retrofit	Eiko 1L 12W T8 Ballast Bypass DLCP	8	0.096	556.8	0.192	1,113.60
Public Fire #1	Interior	Office	5800	6	HAL-H35/LV-1	Track-2 Pin-None-Surface	0.045	0.27	1,566	Retrofit	Eiko LED MR16, 7W, 4000K	6	0.042	243.6	0.228	1,322.40
Public Fire #1	Interior	Office	5800	9	HAL-H35/LV-1	Track-MR16-None-Pendant	0.045	0.405	2,349	Retrofit	Eiko LED MR16, 7W, 4000K	9	0.063	365.4	0.342	1,983.60
Public Fire #1	Interior	Garage	5800	9	CFL-CF27W-9	Highbay-2G11-Prismatic-Pendant	0.245	2.205	12,789	Retrofit	Lithonia IBG HighBay, 95W, 5000K w/ EM Backup	9	0.855	4959	1.350	7,830.00
Public Fire #1	Interior	Garage	730	7	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	0.064	0.448	327	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	7	0.168	122.64	0.280	204.40
Public Fire #1	Interior	Garage	5800	6	F-F32T8-2	Strip-4 foot-Prismatic-Wall	0.064	0.384	2,227	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	6	0.144	835.2	0.240	1,392.00
Public Fire #1	Interior	Garage	5800	2	F-F32T8-2	Troffer-1X4-Prismatic-Recessed	0.064	0.128	742	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	0.048	278.4	0.080	464.00
Public Fire #1	Interior	Garage	5800	1	CFL-CF26W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.028	0.028	162	Retrofit	Nicor 6in Can LED Retrofit, 18W, 4000K	1	0.018	104.4	0.010	58.00
Public Fire #1	Interior	Garage	8760	1	EXIT-I15-1	Exit-White-Red-Surface	0.017	0.017	149	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	0.001	7.008	0.016	141.91
														Interior	5.1322	28432.072

Lighting HVAC Interactive Savings Calculation

**Information and table values come from the Article "Calculating lighting and HVAC interactions" ASHRAE Journal November 1993

Robert A Rundquist, P.E.; Karl F. Johnson; Donald Aumann, P.E.

Project Name

Project Location

Kansas, Kansas City

Fraction to Cooling (C) 0.4

Fraction to Heating (E) 0.32

Btu per kWh (G) 3,413

Constant of Heating Natural gas 0.046

Electric resistance 1

		Lighting Energy Savings				Cooling Savings Calculation			Heating Savings Calculation						
	Location	**kW Reduced (A)**	**kWh Reduced (B)**	**Area**		**Fraction to Cooling (C)**	**System MCOP (D)**	**Cooling kWh (B*C/D)**	**Fraction to Heating (E)**	**Fraction Area on Perimeter (F)**	**Convert to Therms (I)**	**Heating System Efficiency (H)**	**Heating Therms**	**Heating MCF**	**Heating kWh**
1	Community Center	68.0	356,109	77,350		0.70	2.51	99,313	0.32	0.20	100,000	80%	-45.6	-4.4	-18606.5
2	City Hall / Public Safety	16.8	107,566	37,850		0.70	2.95	25,524	0.32	0.28	100,000	92%	-16.7	-1.6	-9013.33
3	Fire Station #1	5.1	28,432	7,950		0.40	2.95	3,855	0.32	0.56	100,000	92%	-8.7	-0.8	-4685.06
4	Fire Station #2	5.5	32,418	7,700		0.40	2.95	4,396	0.32	0.57	100,000	92%	-10.0	-1.0	-5410.23
5	Public Works	7.0	18,998	6,541		0.52	2.95	3,349	0.32	0.60	100,000	92%	-6.3	-0.6	-3379.74
6	Animal Shelter	1.3	2,656	2,304		0.52	2.95	468	0.32	0.86	100,000	92%	-1.2	-0.1	-671.968
7	Water Treatment	5.2	12,159	21,200		0.52	2.95	2,143	0.32	0.37	100,000	92%	-2.5	-0.2	-1323.13
8	Atkins-Johnson Museum	1.2	2,883	2,504		0.40	2.30	501	0.32	0.84	100,000	80%	-1.5	-0.1	-619.677
10	Fins and Foilage Bldg	5.1	2,662	7,560		0.40	3.11	342	0.32	0.57	100,000	92%	-0.8	-0.1	-447.503
11	Oak Grove Park	1.2	2,100	3,843		0.40	2.30	365	0.32	0.73	100,000	80%	-1.0	-0.1	-394.424
12	Linden Square Office	2.5	5,791	2,400		0.61	2.30	1,536	0.32	0.85	100,000	92%	-2.7	-0.3	-1448.7
	Total Energy Savings	**118.9**	**571,774**					**141,793**					**-97.1**	**-9.4**	**-46000.3**

Sum of Qty	
Row Labels	**Public Fire #1**
Interior	
Detail	
(2) Eiko 4' LED Strip 23W, 3013lm, 40K	
F-F96T12-2	
(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal	
CFL-CF26W-2	
ATG 2X2 LED DOOR KIT	
CFL-CF36W-2	
F-F14T5-2	
F-F17T8-2	
F-F17T8-3	
UFL-FU31T8/6-2	
ATG LED 2x4 Troffer Door Kit	5
F-F32T8-2	5
F-F32T8-3	
F-F32T8-4	
Cree LS4 4' LED Surface Ambient Luminaire 44W, 40K, 40lm	
F-F32T8-2	
Deco Adjustable LED Wall Pack, 120W, White	
MH-MH400-1	
Deco Gladetino 311W, 50K, Large Yoke Mount, White	
MH-MH400-2	
Do Nothing	5
EXIT-Tritium0-1	
LED-L20-1	
LED-L8-1	5
QUARTZ-Q150-1	
Eiko 2L 12W T8 Ballast Bypass DLCP	43
F-F32T8-2	43
Eiko 3L 12W T8 Ballast Bypass DLCP	
F-F32T8-3	
Eiko LED T5, 12.5W, 4000K	
F-F28T5-2	
Lithonia IBG LED Highbay, 114W, 18000lm, 50K	
F-F54T5HO-4	
NICOR CLR8 8" DOWNLIGHT KIT.	
CFL-CF42W-1	
Sielo LED Retrofit Kit,	
CFL-CF42W-3	
Typical	**91**

Typical Interior Lighting Savings $0.00

City of Gladstone IGA	Project		
Gladstone, MO	Location		
Interior - downlight kit	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 8" cfl can	Proposed - LED Retro		
Replace Lamps&Ballast	Not Required	Repair Type #1	
2.9		Repair Frequency (Years)	
☐		Include Repair Labor?	
0.44		Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$121.61	$121.61	Repair Labor Rate ($/hour)	Staff Gen. Maint. Worker
$37.90		Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Fixture	Replace Fixture	Repair Type #2	
20	21.4	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
0.57	0.6	Replacement Labor Required (Hours)	
$111.92	$111.92	Replacement Labor Rate ($/hour)	Electrician
$44.15	$235.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$19.95	$14.85	Average Annual Repair Cost in 2018 Dollars	
$8.96		**Annual O&M Savings per unit**	
$8.96		**Total Savings**	No. of Units: 1

Most common remaining typical fixture is a downlight can retrofit

	Existing			Proposed								
	Year	**Increase Factor**	**Annual Repair Cost**	**Year**	**Increase Factor**	**Annual Repair Cost**	**Savings**	**Include Year?**	**Original Life**	**New Life**	**Increase Factor Year**	**Increase Factor**
Original Installation	2007	0.2	$ 2.89					x	1	0	107	6.05
	2008	1	$ 14.43					x	2	0	108	6.1
	2009	1.02	$ 14.72					x	3	0	109	6.15
	2010	1.05	$ 15.16					x	4	0	110	6.2
	2011	1.06	$ 15.30					x	5	0	111	6.25
	2012	1.07	$ 15.44					x	6	0	112	6.3
	2013	1.08	$ 15.59					x	7	0	113	6.35
	2014	1.1	$ 15.88					x	8	0	114	6.4
	2015	1.15	$ 16.60					x	9	0	115	6.45
	2016	1.2	$ 17.32					x	10	0	116	6.5
	2017	1.25	$ 18.04					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 18.76	2018	0.2	$2.67	$16.09	x	12	1	118	6.6
	2019	1.35	$ 19.49	2019	1	$13.36	$6.13	x	13	2	119	6.65
	2020	1.4	$ 20.21	2020	1.02	$13.63	$6.58	x	14	3	120	6.7
	2021	1.45	$ 20.93	2021	1.05	$14.03	$6.90	x	15	4	121	6.75
	2022	1.5	$ 21.65	2022	1.06	$14.16	$7.49	x	16	5	122	6.8
	2023	1.55	$ 22.37	2023	1.07	$14.29	$8.08	x	17	6	123	6.85
	2024	1.6	$ 23.09	2024	1.08	$14.43	$8.67	x	18	7	124	6.9
	2025	1.65	$ 23.82	2025	1.1	$14.69	$9.12	x	19	8	125	6.95
	2026	1.7	$ 24.54	2026	1.15	$15.36	$9.18	x	20	9	126	7
	2027	1.75	$ 25.26	2027	1.2	$16.03	$9.23	x	21	10	127	7.05
	2028	1.8	$ 25.98	2028	1.25	$16.70	$9.28	x	22	11	128	7.1
	2029	1.85	$ 26.70	2029	1.3	$17.37	$9.34	x	23	12	129	7.15
	2030	1.9	$ 27.42	2030	1.35	$18.03	$9.39	x	24	13	130	7.2
	2031	1.95	$ 28.15	2031	1.4	$18.70	$9.44	x	25	14	131	7.25
	2032	2	$ 28.87	2032	1.45	$19.37	$9.50	x	26	15	132	7.3
Totals	26	35.93	$ 518.61	15	16.68	$222.81	$134.43					

Fire Station #2 - Interior Lighting	
Monthly kW savings from Audit	5.5
Annual kW Savings	66
Diversity Factor	85%
kW Savings	56.1
Lighting kWh Savings from Audit	32418
Cooling Interactive Savings from Calc	4396
Net kWh Savings	36814
Heating therm interactive penalty from Calc	-10

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved
Public Fire #2	Interior	Hallway/Lounge	5800	20	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	0.064	1.28	7,424	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	20	0.460	2668	0.820	4,756.00
Public Fire #2	Interior	Hallway/Lounge	8760	4	EXIT-I15-1	Emergency w/BBU-White-Red-Surface	0.017	0.068	596	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	4	0.003	28.032	0.065	567.65
Public Fire #2	Interior	Watch	5800	2	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	0.064	0.128	742	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	2	0.046	266.8	0.082	475.60
Public Fire #2	Interior	103	5800	2	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	0.064	0.128	742	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	2	0.046	266.8	0.082	475.60
Public Fire #2	Interior	Division Chief	5800	3	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	0.064	0.192	1,114	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	3	0.069	400.2	0.123	713.40
Public Fire #2	Interior	105	5800	2	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	0.064	0.128	742	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	2	0.046	266.8	0.082	475.60
Public Fire #2	Interior	Dormitories	5800	2	F-F32T8-2	Wrap-4 foot-Prismatic-Wall	0.064	0.128	742	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	0.048	278.4	0.080	464.00
Public Fire #2	Interior	Dormitories	5800	4	INCAN-I60-2	Decorative-Medium-Clear-Surface	0.120	0.48	2,784	Retrofit	(2) Eiko LED A19, 9W, 4000K	4	0.072	417.6	0.408	2,366.40
Public Fire #2	Interior	Dormitories	5800	4	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	0.064	0.256	1,485	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	4	0.092	533.6	0.164	951.20
Public Fire #2	Interior	Dormitories	5800	8	F-F32T8-3	Troffer-2X4-Prismatic-Recessed	0.109	0.872	5,058	Retrofit	ATG LED 2x4 Troffer Door Kit	8	0.240	1392	0.632	3,665.60
Public Fire #2	Interior	Training Room	5800	10	F-F32T8-3	Troffer-2X4-Prismatic-Recessed	0.109	1.09	6,322	Retrofit	ATG LED 2x4 Troffer Door Kit	10	0.300	1740	0.790	4,582.00
Public Fire #2	Interior	Training Room	8760	1	EXIT-I15-1	Emergency w/BBU-White-Red-Surface	0.017	0.017	149	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	0.001	7.008	0.016	141.91
Public Fire #2	Interior	Apparatus Bay	5800	20	F-F54T5HO-4	Highbay-2X4-Open - no lens-Surface	0.216	4.32	25,056	Retrofit	Lithonia IBG LED Highbay, 114W, 18000lm, 50K	20	2.280	13224	2.040	11,832.00
Public Fire #2	Interior	Apparatus Bay	5800	4	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	0.064	0.256	1,485	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	4	0.092	533.6	0.164	951.20

Lighting HVAC Interactive Savings Calculation

**Information and table values come from the Article "Calculating lighting and HVAC interactions" ASHRAE Journal November 1993
Robert A Rundquist, P.E.; Karl F. Johnson; Donald Aumann, P.E.

Project Name

Project Location
Kansas, Kansas City

Fraction to Cooling (C)	0.4	Btu per kWh (G)	3,413
Fraction to Heating (E)	0.32		

Constant of Heating		
	Natural gas	0.046
	Electric resistance	1

		Lighting Energy Savings				Cooling Savings Calculation			Heating Savings Calculation						
	Location	kW Reduced (A)	kWh Reduced (B)	Area		Fraction to Cooling (C)	System MCOP (D)	Cooling kWh (B*C/D)	Fraction to Heating (E)	Fraction Area on Perimeter (F)	Convert to Therms (I)	Heating System Efficiency (H)	Heating Therms	Heating MCF	Heating kWh
1	Community Center	68.0	356,109	77,350		0.70	2.51	99,313	0.32	0.20	100,000	80%	-45.6	-4.4	-18606.5
2	City Hall / Public Safety	16.8	107,566	37,850		0.70	2.95	25,524	0.32	0.28	100,000	92%	-16.7	-1.6	-9013.33
3	Fire Station #1	5.1	28,432	7,950		0.40	2.95	3,855	0.32	0.56	100,000	92%	-8.7	-0.8	-4685.06
4	Fire Station #2	5.5	32,418	7,700		0.40	2.95	4,396	0.32	0.57	100,000	92%	-10.0	-1.0	-5410.23
5	Public Works	7.0	18,998	6,541		0.52	2.95	3,349	0.32	0.60	100,000	92%	-6.3	-0.6	-3379.74
6	Animal Shelter	1.3	2,656	2,304		0.52	2.95	468	0.32	0.86	100,000	92%	-1.2	-0.1	-671.968
7	Water Treatment	5.2	12,159	21,200		0.52	2.95	2,143	0.32	0.37	100,000	92%	-2.5	-0.2	-1323.13
8	Atkins-Johnson Museum	1.2	2,883	2,504		0.40	2.30	501	0.32	0.84	100,000	80%	-1.5	-0.1	-619.677
10	Fins and Foilage Bldg	5.1	2,662	7,560		0.40	3.11	342	0.32	0.57	100,000	92%	-0.8	-0.1	-447.503
11	Oak Grove Park	1.2	2,100	3,843		0.40	2.30	365	0.32	0.73	100,000	80%	-1.0	-0.1	-394.424
12	Linden Square Office	2.5	5,791	2,400		0.61	2.30	1,536	0.32	0.85	100,000	92%	-2.7	-0.3	-1448.7
	Total Energy Savings	**118.9**	**571,774**					**141,793**					**-97.1**	**-9.4**	**-46000.3**

Row Labels	Public Fire #2
Interior	
Detail	
(2) Eiko 4' LED Strip 23W, 3013lm, 40K	
F-F96T12-2	
(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal	
CFL-CF26W-2	
ATG 2X2 LED DOOR KIT	
CFL-CF36W-2	
F-F14T5-2	
F-F17T8-2	
F-F17T8-3	
UFL-FU31T8/6-2	
ATG LED 2x4 Troffer Door Kit	18
F-F32T8-2	
F-F32T8-3	18
F-F32T8-4	
Cree LS4 4' LED Surface Ambient Luminaire 44W, 40K, 40lm	
F-F32T8-2	
Deco Adjustable LED Wall Pack, 120W, White	
MH-MH400-1	
Deco Gladetino 311W, 50K, Large Yoke Mount, White	
MH-MH400-2	
Do Nothing	
EXIT-Tritium0-1	
LED-L20-1	
LED-L8-1	
QUARTZ-Q150-1	
Eiko 2L 12W T8 Ballast Bypass DLCP	2
F-F32T8-2	2
Eiko 3L 12W T8 Ballast Bypass DLCP	
F-F32T8-3	
Eiko LED T5, 12.5W, 4000K	
F-F28T5-2	
Lithonia IBG LED Highbay, 114W, 18000lm, 50K	20
F-F54T5HO-4	20
NICOR CLR8 8" DOWNLIGHT KIT.	
CFL-CF42W-1	
Sielo LED Retrofit Kit,	
CFL-CF42W-3	
Typical	**46**

Typical Interior Lighting Savings	$0.00

City of Gladstone IGA	Project		
Gladstone, MO	Location		
Interior - downlight kit	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 8" cfl can	Proposed - LED Retro		
Replace Lamps&Ballast	Not Required	Repair Type #1	
2.9		Repair Frequency (Years)	
☐		Include Repair Labor?	
0.44		Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$121.61	$121.61	Repair Labor Rate ($/hour)	Staff Gen. Maint. Worker
$37.90		Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Fixture	Replace Fixture	Repair Type #2	
20	21.4	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
0.57	0.6	Replacement Labor Required (Hours)	
$111.92	$111.92	Replacement Labor Rate ($/hour)	Electrician
$44.15	$235.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$19.95	$14.85	Average Annual Repair Cost in 2018 Dollars	
$8.96		**Annual O&M Savings per unit**	
$8.96		**Total Savings**	No. of Units: 1

Most common remaining typical fixture is a downlight can retrofit

	Year	Existing Increase Factor	Existing Annual Repair Cost	Proposed Year	Proposed Increase Factor	Proposed Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
Original Installation	2007	0.2	$ 2.89					x	1	0	107	6.05
	2008	1	$ 14.43					x	2	0	108	6.1
	2009	1.02	$ 14.72					x	3	0	109	6.15
	2010	1.05	$ 15.16					x	4	0	110	6.2
	2011	1.06	$ 15.30					x	5	0	111	6.25
	2012	1.07	$ 15.44					x	6	0	112	6.3
	2013	1.08	$ 15.59					x	7	0	113	6.35
	2014	1.1	$ 15.88					x	8	0	114	6.4
	2015	1.15	$ 16.60					x	9	0	115	6.45
	2016	1.2	$ 17.32					x	10	0	116	6.5
	2017	1.25	$ 18.04					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 18.76	2018	0.2	$2.67	$16.09	x	12	1	118	6.6
	2019	1.35	$ 19.49	2019	1	$13.36	$6.13	x	13	2	119	6.65
	2020	1.4	$ 20.21	2020	1.02	$13.63	$6.58	x	14	3	120	6.7
	2021	1.45	$ 20.93	2021	1.05	$14.03	$6.90	x	15	4	121	6.75
	2022	1.5	$ 21.65	2022	1.06	$14.16	$7.49	x	16	5	122	6.8
	2023	1.55	$ 22.37	2023	1.07	$14.29	$8.08	x	17	6	123	6.85
	2024	1.6	$ 23.09	2024	1.08	$14.43	$8.67	x	18	7	124	6.9
	2025	1.65	$ 23.82	2025	1.1	$14.69	$9.12	x	19	8	125	6.95
	2026	1.7	$ 24.54	2026	1.15	$15.36	$9.18	x	20	9	126	7
	2027	1.75	$ 25.26	2027	1.2	$16.03	$9.23	x	21	10	127	7.05
	2028	1.8	$ 25.98	2028	1.25	$16.70	$9.28	x	22	11	128	7.1
	2029	1.85	$ 26.70	2029	1.3	$17.37	$9.34	x	23	12	129	7.15
	2030	1.9	$ 27.42	2030	1.35	$18.03	$9.39	x	24	13	130	7.2
	2031	1.95	$ 28.15	2031	1.4	$18.70	$9.44	x	25	14	131	7.25
	2032	2	$ 28.87	2032	1.45	$19.37	$9.50	x	26	15	132	7.3
Totals	26	35.93	$ 518.61	15	16.68	$222.81	$134.43					

City of Gladstone IGA	Project	
Gladstone, MO	Location	
Interior - T5HO HB LED Retr	Equipment	
108.3%	Location Cost Index	Kansas City, MO
Existing - 4' 32W T8	Proposed - LED Retro	
Replace Lamps&Ballast	Not Required	Repair Type #1
5.0		Repair Frequency (Years)
☑		Include Repair Labor?
0.66		Repair Labor Required (Hours)
In-House		Select In-House or Contract Labor
$121.61	$121.61	Repair Labor Rate ($/hour) Staff Gen. Maint. Worker
$46.00		Repair Material Cost
☑		Include End-of-Life Replacement Cost in Analysis?
Replace Fixture	Replace Fixture	Repair Type #2
20	25	Replacement Frequency (Years)
☑		Include Replacement Labor?
0.6	0.6	Replacement Labor Required (Hours)
$111.92	$111.92	Replacement Labor Rate ($/hour) Electrician
$115.00	$200.00	Replacement Material Cost
2007	Year Equipment Originally Installed	
2018	Year New Equipment to be Installed	
15	Length of Performance Contract (Years)	
$35.43	$11.35	Average Annual Repair Cost in 2018 Dollars
$30.96		**Annual O&M Savings per unit**
$30.96		**Total Savings** No. of Units: 1

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
Original Installation	2007	0.2	$ 5.13					x	1	0	107	6.05
	2008	1	$ 25.64					x	2	0	108	6.1
	2009	1.02	$ 26.15					x	3	0	109	6.15
	2010	1.05	$ 26.92					x	4	0	110	6.2
	2011	1.06	$ 27.18					x	5	0	111	6.25
	2012	1.07	$ 27.44					x	6	0	112	6.3
	2013	1.08	$ 27.69					x	7	0	113	6.35
	2014	1.1	$ 28.20					x	8	0	114	6.4
	2015	1.15	$ 29.49					x	9	0	115	6.45
	2016	1.2	$ 30.77					x	10	0	116	6.5
	2017	1.25	$ 32.05					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 33.33	2018	0.2	$2.04	$31.29	x	12	1	118	6.6
	2019	1.35	$ 34.61	2019	1	$10.21	$24.41	x	13	2	119	6.65
	2020	1.4	$ 35.90	2020	1.02	$10.41	$25.49	x	14	3	120	6.7
	2021	1.45	$ 37.18	2021	1.05	$10.72	$26.46	x	15	4	121	6.75
	2022	1.5	$ 38.46	2022	1.06	$10.82	$27.64	x	16	5	122	6.8
	2023	1.55	$ 39.74	2023	1.07	$10.92	$28.82	x	17	6	123	6.85
	2024	1.6	$ 41.02	2024	1.08	$11.02	$30.00	x	18	7	124	6.9
	2025	1.65	$ 42.31	2025	1.1	$11.23	$31.08	x	19	8	125	6.95
	2026	1.7	$ 43.59	2026	1.15	$11.74	$31.85	x	20	9	126	7
	2027	1.75	$ 44.87	2027	1.2	$12.25	$32.62	x	21	10	127	7.05
	2028	1.8	$ 46.15	2028	1.25	$12.76	$33.39	x	22	11	128	7.1
	2029	1.85	$ 47.43	2029	1.3	$13.27	$34.17	x	23	12	129	7.15
	2030	1.9	$ 48.72	2030	1.35	$13.78	$34.94	x	24	13	130	7.2
	2031	1.95	$ 50.00	2031	1.4	$14.29	$35.71	x	25	14	131	7.25
	2032	2	$ 51.28	2032	1.45	$14.80	$36.48	x	26	15	132	7.3
Totals	26	35.93	$ 921.26	15	16.68	$170.25	$464.35					

Public Works - Interior Lighting	
Monthly kW savings from Audit	7
Annual kW Savings	84
Diversity Factor	85%
kW Savings	71.4
Lighting kWh Savings from Audit	18998
Cooling Interactive Savings from Calc	3349
Net kWh Savings	22347
Heating therm interactive penalty from Calc	-6.3

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved
Public Works	Public Works	Ext Wallpacks	4380	9	LED-L20-1	Wallpack-LED-Clear-Wall	0.020	0.18	788	Do Nothing	Do Nothing	9	0.180	788.4	0.000	0.00
Public Works	Public Works	Upstairs Offices	2650	7	UFL-FU31T8/6-2	2X2-Troffer-Prismatic-Recessed	0.072	0.504	1,336	Retrofit	ATG 2X2 LED DOOR KIT	7	0.210	556.5	0.294	779.10
Public Works	Public Works	Upstairs Offices	2650	22	F-F32T8-3	Troffer-2X4-Prismatic-Recessed	0.109	2.398	6,355	Retrofit	ATG LED 2x4 Troffer Door Kit	22	0.660	1749	1.738	4,605.70
Public Works	Public Works	Upstairs Offices	2650	4	F-F32T8-2	Strip-4 foot-Parabolic-Recessed	0.064	0.256	678	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	4	0.096	254.4	0.160	424.00
Public Works	Public Works	Upstairs Offices	8760	3	EXIT-I15-1	Exit-Black-Red-Surface	0.017	0.051	447	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	3	0.002	21.024	0.049	425.74
Public Works	Public Works	Shop	2650	15	F-F54T5HO-4	Highbay-2X4-Open - no lens-Aircraft Cable	0.216	3.24	8,586	Retrofit	Lithonia IBG LED Highbay, 114W, 18000lm, 50K	15	1.710	4531.5	1.530	4,054.50
Public Works	Public Works	Shop	2650	3	F-F96T8-2	Strip-8 foot-Open - no lens-Surface	0.134	0.402	1,065	Retrofit	LED Strip Retro Kit w/ (4) Eiko LED T8, 12W, 4000K	3	0.144	381.6	0.258	683.70
Public Works	Public Works	1st Floor Offices	2650	13	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	0.064	0.832	2,205	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	13	0.299	792.35	0.533	1,412.45
Public Works	Public Works	1st Floor Offices	2650	8	F-F32T8-3	Troffer-2X4-Prismatic-Recessed	0.109	0.872	2,311	Retrofit	ATG LED 2x4 Troffer Door Kit	8	0.240	636	0.632	1,674.80
Public Works	Public Works	1st Floor Offices	8760	1	EXIT-I15-1	Emergency w/BBU-White-Red-Surface	0.017	0.017	149	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	1	0.001	7.008	0.016	141.91
Public Works	Public Works	Restrooms	2650	4	F-F32T8-2	Strip-4 foot-Parabolic-Recessed	0.064	0.256	678	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	4	0.096	254.4	0.160	424.00
Public Works	Storage West	Interior	2650	13	F-F54T5HO-4	Highbay-2X4-Open - no lens-Aircraft Cable	0.216	2.808	7,441	Retrofit	Lithonia IBG LED Highbay, 114W, 18000lm, 50K	13	1.482	3927.3	1.326	3,513.90
Public Works	Storage West	Interior	2650	2	F-F32T8-4	Wrap-2X4-Prismatic-Aircraft Cable	0.145	0.29	769	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	2	0.046	121.9	0.244	646.60
Public Works	Storage West	Interior	2650	2	F-F32T8-2	Strip-4 foot-Open - no lens-Aircraft Cable	0.064	0.128	339	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	0.048	127.2	0.080	212.00
Public Works	Salt Dome	Dusk to dawn	4380	1	MH-MH250-1	Security-Mogul-Open - no lens-Pole	0.295	0.295	1,292	Retrofit	Eiko Litespan Dusk to Dawn LED 60W 5249LM Grey w/120-277V Twistlock Photocell	1	0.060	262.8	0.235	1,029.30
Public Works	Salt Dome	Inside	2650	2	MH-MH175-1	Wallpack-Mogul-Clear-Surface	0.205	0.41	1,087	Retrofit	ATG 28W LED WallPack	2	0.056	148.4	0.354	938.10
Public Works	New Property Barn	Exterior	4380	10	LED-L20-1	Wallpack-LED-Clear-Wall	0.020	0.2	876	Do Nothing	Do Nothing	10	0.200	876	0.000	0.00
Public Works	New Property Barn	Imside	2650	6	LED-L20-1	Wallpack-LED-Clear-Wall	0.020	0.12	318	Do Nothing	Do Nothing	6	0.120	318	0.000	0.00
Public Works	Storage	Wallpacks	2650	3	LED-L20-1	Wallpack-LED-Clear-Wall	0.020	0.06	159	Do Nothing	Do Nothing	3	0.060	159	0.000	0.00
Public Works	Storage East	Imterior	2650	32	F-F32T8-2	Strip-4 foot-Wire Guard-Suspended	0.064	2.048	5,427	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	32	0.768	2035.2	1.280	3,392.00
														Interior	7.0198	18998.398

Lighting HVAC Interactive Savings Calculation

**Information and table values come from the Article "Calculating lighting and HVAC interactions" ASHRAE Journal November 1993
Robert A Rundquist, P.E.; Karl F. Johnson; Donald Aumann, P.E.

Project Name

Project Location

Kansas, Kansas City

Fraction to Cooling (C)	0.4	Btu per kWh (G)	3,413
Fraction to Heating (E)	0.32		

Constant of Heating		
	Natural gas	0.046
	Electric resistance	1

		Lighting Energy Savings				Cooling Savings Calculation			Heating Savings Calculation						
	Location	kW Reduced (A)	kWh Reduced (B)	Area		Fraction to Cooling (C)	System MCOP (D)	Cooling kWh (B*C/D)	Fraction to Heating (E)	Fraction Area on Perimeter (F)	Convert to Therms (I)	Heating System Efficiency (H)	Heating Therms	Heating MCF	Heating kWh
1	Community Center	68.0	356,109	77,350		0.70	2.51	99,313	0.32	0.20	100,000	80%	-45.6	-4.4	-18606.5
2	City Hall / Public Safety	16.8	107,566	37,850		0.70	2.95	25,524	0.32	0.28	100,000	92%	-16.7	-1.6	-9013.33
3	Fire Station #1	5.1	28,432	7,950		0.40	2.95	3,855	0.32	0.56	100,000	92%	-8.7	-0.8	-4685.06
4	Fire Station #2	5.5	32,418	7,700		0.40	2.95	4,396	0.32	0.57	100,000	92%	-10.0	-1.0	-5410.23
5	Public Works	7.0	18,998	6,541		0.52	2.95	3,349	0.32	0.60	100,000	92%	-6.3	-0.6	-3379.74
6	Animal Shelter	1.3	2,656	2,304		0.52	2.95	468	0.32	0.86	100,000	92%	-1.2	-0.1	-671.968
7	Water Treatment	5.2	12,159	21,200		0.52	2.95	2,143	0.32	0.37	100,000	92%	-2.5	-0.2	-1323.13
8	Atkins-Johnson Museum	1.2	2,883	2,504		0.40	2.30	501	0.32	0.84	100,000	80%	-1.5	-0.1	-619.677
10	Fins and Foilage Bldg	5.1	2,662	7,560		0.40	3.11	342	0.32	0.57	100,000	92%	-0.8	-0.1	-447.503
11	Oak Grove Park	1.2	2,100	3,843		0.40	2.30	365	0.32	0.73	100,000	80%	-1.0	-0.1	-394.424
12	Linden Square Office	2.5	5,791	2,400		0.61	2.30	1,536	0.32	0.85	100,000	92%	-2.7	-0.3	-1448.7
	Total Energy Savings	**118.9**	**571,774**					**141,793**					**-97.1**	**-9.4**	**-46000.3**

Row Labels	Public Works
Interior	
Detail	
(2) Eiko 4' LED Strip 23W, 3013lm, 40K	
F-F96T12-2	
(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal	
CFL-CF26W-2	
ATG 2X2 LED DOOR KIT	7
CFL-CF36W-2	
F-F14T5-2	
F-F17T8-2	
F-F17T8-3	
UFL-FU31T8/6-2	7
ATG LED 2x4 Troffer Door Kit	30
F-F32T8-2	
F-F32T8-3	30
F-F32T8-4	
Cree LS4 4' LED Surface Ambient Luminaire 44W, 40K, 40lm	
F-F32T8-2	
Deco Adjustable LED Wall Pack, 120W, White	
MH-MH400-1	
Deco Gladetino 311W, 50K, Large Yoke Mount, White	
MH-MH400-2	
Do Nothing	6
EXIT-Tritium0-1	
LED-L20-1	6
LED-L8-1	
QUARTZ-Q150-1	
Eiko 2L 12W T8 Ballast Bypass DLCP	42
F-F32T8-2	42
Eiko 3L 12W T8 Ballast Bypass DLCP	
F-F32T8-3	
Eiko LED T5, 12.5W, 4000K	
F-F28T5-2	
Lithonia IBG LED Highbay, 114W, 18000lm, 50K	28
F-F54T5HO-4	28
NICOR CLR8 8" DOWNLIGHT KIT.	
CFL-CF42W-1	
Sielo LED Retrofit Kit,	
CFL-CF42W-3	
Typical	**24**

Typical Interior Lighting Savings $0.00

City of Gladstone IGA	Project		
Gladstone, MO	Location		
Interior - downlight kit	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 8" cfl can	Proposed - LED Retro		
Replace Lamps&Ballast	Not Required	Repair Type #1	
2.9		Repair Frequency (Years)	
☐		Include Repair Labor?	
0.44		Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$121.61	$121.61	Repair Labor Rate ($/hour)	Staff Gen. Maint. Worker
$37.90		Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Fixture	Replace Fixture	Repair Type #2	
20	21.4	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
0.57	0.6	Replacement Labor Required (Hours)	
$111.92	$111.92	Replacement Labor Rate ($/hour)	Electrician
$44.15	$235.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$19.95	$14.85	Average Annual Repair Cost in 2018 Dollars	
$8.96		**Annual O&M Savings per unit**	
$8.96		**Total Savings**	No. of Units: 1

Most common remaining typical fixture is a downlight can retrofit

	Existing			Proposed								
	Year	**Increase Factor**	**Annual Repair Cost**	**Year**	**Increase Factor**	**Annual Repair Cost**	**Savings**	**Include Year?**	**Original Life**	**New Life**	**Increase Factor Year**	**Increase Factor**
Original Installation	2007	0.2	$ 2.89					x	1	0	107	6.05
	2008	1	$ 14.43					x	2	0	108	6.1
	2009	1.02	$ 14.72					x	3	0	109	6.15
	2010	1.05	$ 15.16					x	4	0	110	6.2
	2011	1.06	$ 15.30					x	5	0	111	6.25
	2012	1.07	$ 15.44					x	6	0	112	6.3
	2013	1.08	$ 15.59					x	7	0	113	6.35
	2014	1.1	$ 15.88					x	8	0	114	6.4
	2015	1.15	$ 16.60					x	9	0	115	6.45
	2016	1.2	$ 17.32					x	10	0	116	6.5
	2017	1.25	$ 18.04					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 18.76	2018	0.2	$2.67	$16.09	x	12	1	118	6.6
	2019	1.35	$ 19.49	2019	1	$13.36	$6.13	x	13	2	119	6.65
	2020	1.4	$ 20.21	2020	1.02	$13.63	$6.58	x	14	3	120	6.7
	2021	1.45	$ 20.93	2021	1.05	$14.03	$6.90	x	15	4	121	6.75
	2022	1.5	$ 21.65	2022	1.06	$14.16	$7.49	x	16	5	122	6.8
	2023	1.55	$ 22.37	2023	1.07	$14.29	$8.08	x	17	6	123	6.85
	2024	1.6	$ 23.09	2024	1.08	$14.43	$8.67	x	18	7	124	6.9
	2025	1.65	$ 23.82	2025	1.1	$14.69	$9.12	x	19	8	125	6.95
	2026	1.7	$ 24.54	2026	1.15	$15.36	$9.18	x	20	9	126	7
	2027	1.75	$ 25.26	2027	1.2	$16.03	$9.23	x	21	10	127	7.05
	2028	1.8	$ 25.98	2028	1.25	$16.70	$9.28	x	22	11	128	7.1
	2029	1.85	$ 26.70	2029	1.3	$17.37	$9.34	x	23	12	129	7.15
	2030	1.9	$ 27.42	2030	1.35	$18.03	$9.39	x	24	13	130	7.2
	2031	1.95	$ 28.15	2031	1.4	$18.70	$9.44	x	25	14	131	7.25
	2032	2	$ 28.87	2032	1.45	$19.37	$9.50	x	26	15	132	7.3
Totals	26	35.93	$ 518.61	15	16.68	$222.81	$134.43					

Existing	Proposed		
City of Gladstone IGA	Project		
Gladstone, MO	Location		
Interior - T5HO HB LED Retr	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 4' 32W T8	Proposed - LED Retro		
Replace Lamps&Ballast	Not Required	Repair Type #1	
5.0		Repair Frequency (Years)	
☑		Include Repair Labor?	
0.66		Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$121.61	$121.61	Repair Labor Rate ($/hour)	Staff Gen. Maint. Worker
$46.00		Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Fixture	Replace Fixture	Repair Type #2	
20	25	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
0.6	0.6	Replacement Labor Required (Hours)	
$111.92	$111.92	Replacement Labor Rate ($/hour)	Electrician
$115.00	$200.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$35.43	$11.35	Average Annual Repair Cost in 2018 Dollars	
$30.96		**Annual O&M Savings per unit**	
$30.96		**Total Savings**	No. of Units: 1

	Existing			Proposed								
	Year	**Increase Factor**	**Annual Repair Cost**	**Year**	**Increase Factor**	**Annual Repair Cost**	**Savings**	**Include Year?**	**Original Life**	**New Life**	**Increase Factor Year**	**Increase Factor**
Original Installation	2007	0.2	$ 5.13					x	1	0	107	6.05
	2008	1	$ 25.64					x	2	0	108	6.1
	2009	1.02	$ 26.15					x	3	0	109	6.15
	2010	1.05	$ 26.92					x	4	0	110	6.2
	2011	1.06	$ 27.18					x	5	0	111	6.25
	2012	1.07	$ 27.44					x	6	0	112	6.3
	2013	1.08	$ 27.69					x	7	0	113	6.35
	2014	1.1	$ 28.20					x	8	0	114	6.4
	2015	1.15	$ 29.49					x	9	0	115	6.45
	2016	1.2	$ 30.77					x	10	0	116	6.5
	2017	1.25	$ 32.05					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 33.33	2018	0.2	$2.04	$31.29	x	12	1	118	6.6
	2019	1.35	$ 34.61	2019	1	$10.21	$24.41	x	13	2	119	6.65
	2020	1.4	$ 35.90	2020	1.02	$10.41	$25.49	x	14	3	120	6.7
	2021	1.45	$ 37.18	2021	1.05	$10.72	$26.46	x	15	4	121	6.75
	2022	1.5	$ 38.46	2022	1.06	$10.82	$27.64	x	16	5	122	6.8
	2023	1.55	$ 39.74	2023	1.07	$10.92	$28.82	x	17	6	123	6.85
	2024	1.6	$ 41.02	2024	1.08	$11.02	$30.00	x	18	7	124	6.9
	2025	1.65	$ 42.31	2025	1.1	$11.23	$31.08	x	19	8	125	6.95
	2026	1.7	$ 43.59	2026	1.15	$11.74	$31.85	x	20	9	126	7
	2027	1.75	$ 44.87	2027	1.2	$12.25	$32.62	x	21	10	127	7.05
	2028	1.8	$ 46.15	2028	1.25	$12.76	$33.39	x	22	11	128	7.1
	2029	1.85	$ 47.43	2029	1.3	$13.27	$34.17	x	23	12	129	7.15
	2030	1.9	$ 48.72	2030	1.35	$13.78	$34.94	x	24	13	130	7.2
	2031	1.95	$ 50.00	2031	1.4	$14.29	$35.71	x	25	14	131	7.25
	2032	2	$ 51.28	2032	1.45	$14.80	$36.48	x	26	15	132	7.3
Totals	26	35.93	$ 921.26	15	16.68	$170.25	$464.35					

City of Gladstone IGA	Project		
Gladstone, MO	Location		
Interior - 2x4 2L LED Retro	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 4' 32W T8	Proposed - LED Retro		
Replace Lamps&Ballast	Not Required	Repair Type #1	
4.3		Repair Frequency (Years)	
☑		Include Repair Labor?	
0.66		Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$121.61	$121.61	Repair Labor Rate ($/hour)	Staff Gen. Maint. Worker
$36.00		Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Fixture	Replace Fixture	Repair Type #2	
20	25	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
0.6	0.6	Replacement Labor Required (Hours)	
$111.92	$111.92	Replacement Labor Rate ($/hour)	Electrician
$99.95	$180.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$36.43	$10.48	Average Annual Repair Cost in 2018 Dollars	
$33.01		**Annual O&M Savings per unit**	
$33.01		**Total Savings**	No. of Units: 1

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
Original Installation	2007	0.2	$ 5.27					x	1	0	107	6.05
	2008	1	$ 26.36					x	2	0	108	6.1
	2009	1.02	$ 26.89					x	3	0	109	6.15
	2010	1.05	$ 27.68					x	4	0	110	6.2
	2011	1.06	$ 27.94					x	5	0	111	6.25
	2012	1.07	$ 28.21					x	6	0	112	6.3
	2013	1.08	$ 28.47					x	7	0	113	6.35
	2014	1.1	$ 29.00					x	8	0	114	6.4
	2015	1.15	$ 30.31					x	9	0	115	6.45
	2016	1.2	$ 31.63					x	10	0	116	6.5
	2017	1.25	$ 32.95					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 34.27	2018	0.2	$1.89	$32.38	x	12	1	118	6.6
	2019	1.35	$ 35.59	2019	1	$9.43	$26.16	x	13	2	119	6.65
	2020	1.4	$ 36.90	2020	1.02	$9.62	$27.29	x	14	3	120	6.7
	2021	1.45	$ 38.22	2021	1.05	$9.90	$28.32	x	15	4	121	6.75
	2022	1.5	$ 39.54	2022	1.06	$9.99	$29.55	x	16	5	122	6.8
	2023	1.55	$ 40.86	2023	1.07	$10.09	$30.77	x	17	6	123	6.85
	2024	1.6	$ 42.18	2024	1.08	$10.18	$31.99	x	18	7	124	6.9
	2025	1.65	$ 43.49	2025	1.1	$10.37	$33.12	x	19	8	125	6.95
	2026	1.7	$ 44.81	2026	1.15	$10.84	$33.97	x	20	9	126	7
	2027	1.75	$ 46.13	2027	1.2	$11.31	$34.82	x	21	10	127	7.05
	2028	1.8	$ 47.45	2028	1.25	$11.78	$35.66	x	22	11	128	7.1
	2029	1.85	$ 48.77	2029	1.3	$12.26	$36.51	x	23	12	129	7.15
	2030	1.9	$ 50.08	2030	1.35	$12.73	$37.36	x	24	13	130	7.2
	2031	1.95	$ 51.40	2031	1.4	$13.20	$38.20	x	25	14	131	7.25
	2032	2	$ 52.72	2032	1.45	$13.67	$39.05	x	26	15	132	7.3
Totals	26	35.93	$ 947.11	15	16.68	$157.26	$495.15					

Animal Shelter - Interior Lighting	
Monthly kW savings from Audit	1.3
Annual kW Savings	15.6
Diversity Factor	85%
kW Savings	13.26
Lighting kWh Savings from Audit	2656
Cooling Interactive Savings from Calc	468
Net kWh Savings	3124
Heating therm interactive penalty from Calc	-1.2

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved
Public Safety / Animal Control	Interior	Lobby/Halls	1825	8	F-F32T8-3	Troffer-2X4-Prismatic-Surface	0.109	0.872	1,591	Retrofit	Eiko 3L 12W T8 Ballast Bypass DLCP	8	0.288	525.6	0.584	1,065.80
Public Safety / Animal Control	Interior	Lobby/Halls	1825	5	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	0.064	0.32	584	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	5	0.115	209.875	0.205	374.13
Public Safety / Animal Control	Interior	Lobby/Halls	8760	2	EXIT-I15-1	Emergency w/BBU-White-Red-Surface	0.017	0.034	298	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	2	0.002	14.016	0.032	283.82
Public Safety / Animal Control	Interior	Restrooms	1825	1	CFL-CF32W-1	6-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.034	0.034	62	Retrofit	MaxLite 15W LED 6 COMMERCIAL DOWNLIGHT RETROFIT 4000K	1	0.015	27.375	0.019	34.68
Public Safety / Animal Control	Interior	Dog Kennels	1825	12	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	0.064	0.768	1,402	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	12	0.276	503.7	0.492	897.90
														Interior	1.3324	2656.324

Lighting HVAC Interactive Savings Calculation

**Information and table values come from the Article "Calculating lighting and HVAC interactions" ASHRAE Journal November 1993
Robert A Rundquist, P.E.; Karl F. Johnson; Donald Aumann, P.E.

Project Name

Project Location

Kansas, Kansas City

Fraction to Cooling (C) 0.4

Fraction to Heating (E) 0.32

Btu per kWh (G) 3,413

Constant of Heating Natural gas 0.046

Electric resistance 1

		Lighting Energy Savings				Cooling Savings Calculation			Heating Savings Calculation						
	Location	kW Reduced (A)	kWh Reduced (B)	Area		Fraction to Cooling (C)	System MCOP (D)	Cooling kWh (B*C/D)	Fraction to Heating (E)	Fraction Area on Perimeter (F)	Convert to Therms (I)	Heating System Efficiency (H)	Heating Therms	Heating MCF	Heating kWh
1	Community Center	68.0	356,109	77,350		0.70	2.51	99,313	0.32	0.20	100,000	80%	-45.6	-4.4	-18606.5
2	City Hall / Public Safety	16.8	107,566	37,850		0.70	2.95	25,524	0.32	0.28	100,000	92%	-16.7	-1.6	-9013.33
3	Fire Station #1	5.1	28,432	7,950		0.40	2.95	3,855	0.32	0.56	100,000	92%	-8.7	-0.8	-4685.06
4	Fire Station #2	5.5	32,418	7,700		0.40	2.95	4,396	0.32	0.57	100,000	92%	-10.0	-1.0	-5410.23
5	Public Works	7.0	18,998	6,541		0.52	2.95	3,349	0.32	0.60	100,000	92%	-6.3	-0.6	-3379.74
6	Animal Shelter	1.3	2,656	2,304		0.52	2.95	468	0.32	0.86	100,000	92%	-1.2	-0.1	-671.968
7	Water Treatment	5.2	12,159	21,200		0.52	2.95	2,143	0.32	0.37	100,000	92%	-2.5	-0.2	-1323.13
8	Atkins-Johnson Museum	1.2	2,883	2,504		0.40	2.30	501	0.32	0.84	100,000	80%	-1.5	-0.1	-619.677
10	Fins and Foilage Bldg	5.1	2,662	7,560		0.40	3.11	342	0.32	0.57	100,000	92%	-0.8	-0.1	-447.503
11	Oak Grove Park	1.2	2,100	3,843		0.40	2.30	365	0.32	0.73	100,000	80%	-1.0	-0.1	-394.424
12	Linden Square Office	2.5	5,791	2,400		0.61	2.30	1,536	0.32	0.85	100,000	92%	-2.7	-0.3	-1448.7
	Total Energy Savings	**118.9**	**571,774**					**141,793**					**-97.1**	**-9.4**	**-46000.3**

Row Labels	Public Safety / Animal Control
Interior	
Detail	
(2) Eiko 4' LED Strip 23W, 3013lm, 40K	
F-F96T12-2	
(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal	
CFL-CF26W-2	
ATG 2X2 LED DOOR KIT	
CFL-CF36W-2	
F-F14T5-2	
F-F17T8-2	
F-F17T8-3	
UFL-FU31T8/6-2	
ATG LED 2x4 Troffer Door Kit	
F-F32T8-2	
F-F32T8-3	
F-F32T8-4	
Cree LS4 4' LED Surface Ambient Luminaire 44W, 40K, 40lm	
F-F32T8-2	
Deco Adjustable LED Wall Pack, 120W, White	
MH-MH400-1	
Deco Gladetino 311W, 50K, Large Yoke Mount, White	
MH-MH400-2	
Do Nothing	
EXIT-Tritium0-1	
LED-L20-1	
LED-L8-1	
QUARTZ-Q150-1	
Eiko 2L 12W T8 Ballast Bypass DLCP	
F-F32T8-2	
Eiko 3L 12W T8 Ballast Bypass DLCP	8
F-F32T8-3	8
Eiko LED T5, 12.5W, 4000K	
F-F28T5-2	
Lithonia IBG LED Highbay, 114W, 18000lm, 50K	
F-F54T5HO-4	
NICOR CLR8 8" DOWNLIGHT KIT.	
CFL-CF42W-1	
Sielo LED Retrofit Kit,	
CFL-CF42W-3	
Typical	**20**

Typical Interior Lighting Savings $0.00

Water Treatement - Interior Lighting	
Monthly kW savings from Audit	5.2
Annual kW Savings	62.4
Diversity Factor	85%
kW Savings	53.04
Lighting kWh Savings from Audit	12159
Cooling Interactive Savings from Calc	2143
Net kWh Savings	14302
Heating therm interactive penalty from Calc	-2.5

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved
Water Treatment	Interior	Lower level	2360	18	F-F32T8-2	Vapor Tight-4 foot-Clear-Surface	0.064	1.152	2,719	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	18	0.432	1019.52	0.720	1,699.20
Water Treatment	Interior	Lower level	8760	2	EXIT-Tritium0-1	Exit-Red-White-Wall	0.017	0.034	298	Do Nothing	Do Nothing	2	0.034	297.84	0.000	0.00
Water Treatment	Interior	Lower level	2360	8	UFL-FU31T8/6-2	2X2-Troffer-Prismatic-Recessed	0.072	0.576	1,359	Retrofit	ATG 2X2 LED DOOR KIT	8	0.240	566.4	0.336	792.96
Water Treatment	Interior	Tank Room	2360	29	UFL-FU31T8/6-2	2X2-Troffer-Prismatic-Recessed	0.072	2.088	4,928	Retrofit	ATG 2X2 LED DOOR KIT	29	0.870	2053.2	1.218	2,874.48
Water Treatment	Interior	Tank Room	2360	2	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	0.064	0.128	302	Retrofit	Columbia Lighting Wide Low Profile Wraparound 4' LAW-4-35-LW-E-U	2	0.046	108.56	0.082	193.52
Water Treatment	Interior	Tank Room	8760	1	EXIT-Tritium0-1	Exit-Red-White-Wall	0.017	0.017	149	Do Nothing	Do Nothing	1	0.017	148.92	0.000	0.00
Water Treatment	Interior	Storage	2360	4	F-F32T8-3	Troffer-2X4-Prismatic-Recessed	0.109	0.436	1,029	Retrofit	ATG LED 2x4 Troffer Door Kit	4	0.120	283.2	0.316	745.76
Water Treatment	Interior	Restroom	2360	1	UFL-FU31T8/6-2	2X2-Troffer-Prismatic-Recessed	0.072	0.072	170	Retrofit	ATG 2X2 LED DOOR KIT	1	0.030	70.8	0.042	99.12
Water Treatment	Interior	Restroom	2360	1	CFL-CF13W-2	Vanity-Medium-Clear-Wall	0.030	0.03	71	Retrofit	(2) Eiko LED A19, 6W, 4000K	1	0.012	28.32	0.018	42.48
Water Treatment	Interior	Office	2360	4	F-F32T8-3	Troffer-2X4-Prismatic-Recessed	0.109	0.436	1,029	Retrofit	ATG LED 2x4 Troffer Door Kit	4	0.120	283.2	0.316	745.76
Water Treatment	Interior	Lab	2360	16	F-F32T8-3	Troffer-2X4-Prismatic-Recessed	0.109	1.744	4,116	Retrofit	ATG LED 2x4 Troffer Door Kit	16	0.480	1132.8	1.264	2,983.04
Water Treatment	Interior	Chemical Room	2360	15	F-F32T8-2	Vapor Tight-4 foot-Clear-Surface	0.064	0.96	2,266	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	15	0.360	849.6	0.600	1,416.00
Water Treatment	Interior	Chemical Room	8760	1	EXIT-Tritium0-1	Exit-Red-White-Wall	0.017	0.017	149	Do Nothing	Do Nothing	1	0.017	148.92	0.000	0.00
Water Treatment	Interior	Chlorine Room	2360	6	F-F32T8-2	Strip-4 foot-Wire Guard-Surface	0.064	0.384	906	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	6	0.144	339.84	0.240	566.40
														Interior	5.152	12158.72

Lighting HVAC Interactive Savings Calculation

**Information and table values come from the Article "Calculating lighting and HVAC interactions" ASHRAE Journal November 1993

Robert A Rundquist, P.E.; Karl F. Johnson; Donald Aumann, P.E.

Project Name

Project Location

Kansas, Kansas City

Fraction to Cooling (C)	0.4	Btu per kWh (G)	3,413	
Fraction to Heating (E)	0.32			
Constant of Heating	Natural gas	0.046		
	Electric resistance	1		

		Lighting Energy Savings				Cooling Savings Calculation			Heating Savings Calculation						
	Location	kW Reduced (A)	kWh Reduced (B)	Area		Fraction to Cooling (C)	System MCOP (D)	Cooling kWh (B*C/D)	Fraction to Heating (E)	Fraction Area on Perimeter (F)	Convert to Therms (I)	Heating System Efficiency (H)	Heating Therms	Heating MCF	Heating kWh
1	Community Center	68.0	356,109	77,350		0.70	2.51	99,313	0.32	0.20	100,000	80%	-45.6	-4.4	-18606.5
2	City Hall / Public Safety	16.8	107,566	37,850		0.70	2.95	25,524	0.32	0.28	100,000	92%	-16.7	-1.6	-9013.33
3	Fire Station #1	5.1	28,432	7,950		0.40	2.95	3,855	0.32	0.56	100,000	92%	-8.7	-0.8	-4685.06
4	Fire Station #2	5.5	32,418	7,700		0.40	2.95	4,396	0.32	0.57	100,000	92%	-10.0	-1.0	-5410.23
5	Public Works	7.0	18,998	6,541		0.52	2.95	3,349	0.32	0.60	100,000	92%	-6.3	-0.6	-3379.74
6	Animal Shelter	1.3	2,656	2,304		0.52	2.95	468	0.32	0.86	100,000	92%	-1.2	-0.1	-671.968
7	Water Treatment	5.2	12,159	21,200		0.52	2.95	2,143	0.32	0.37	100,000	92%	-2.5	-0.2	-1323.13
8	Atkins-Johnson Museum	1.2	2,883	2,504		0.40	2.30	501	0.32	0.84	100,000	80%	-1.5	-0.1	-619.677
10	Fins and Foilage Bldg	5.1	2,662	7,560		0.40	3.11	342	0.32	0.57	100,000	92%	-0.8	-0.1	-447.503
11	Oak Grove Park	1.2	2,100	3,843		0.40	2.30	365	0.32	0.73	100,000	80%	-1.0	-0.1	-394.424
12	Linden Square Office	2.5	5,791	2,400		0.61	2.30	1,536	0.32	0.85	100,000	92%	-2.7	-0.3	-1448.7
	Total Energy Savings	**118.9**	**571,774**					**141,793**					**-97.1**	**-9.4**	**-46000.3**

Row Labels	Water Treatment
Interior	
Detail	
(2) Eiko 4' LED Strip 23W, 3013lm, 40K	
F-F96T12-2	
(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal	
CFL-CF26W-2	
ATG 2X2 LED DOOR KIT	38
CFL-CF36W-2	
F-F14T5-2	
F-F17T8-2	
F-F17T8-3	
UFL-FU31T8/6-2	38
ATG LED 2x4 Troffer Door Kit	24
F-F32T8-2	
F-F32T8-3	24
F-F32T8-4	
Cree LS4 4' LED Surface Ambient Luminaire 44W, 40K, 40lm	
F-F32T8-2	
Deco Adjustable LED Wall Pack, 120W, White	
MH-MH400-1	
Deco Gladetino 311W, 50K, Large Yoke Mount, White	
MH-MH400-2	
Do Nothing	4
EXIT-Tritium0-1	4
LED-L20-1	
LED-L8-1	
QUARTZ-Q150-1	
Eiko 2L 12W T8 Ballast Bypass DLCP	39
F-F32T8-2	39
Eiko 3L 12W T8 Ballast Bypass DLCP	
F-F32T8-3	
Eiko LED T5, 12.5W, 4000K	
F-F28T5-2	
Lithonia IBG LED Highbay, 114W, 18000lm, 50K	
F-F54T5HO-4	
NICOR CLR8 8" DOWNLIGHT KIT.	
CFL-CF42W-1	
Sielo LED Retrofit Kit,	
CFL-CF42W-3	
Typical	**3**

Typical Interior Lighting Savings $0.00

City of Gladstone IGA	Project		
Gladstone, MO	Location		
Interior - 2x2 LED Door Retr	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 2' 17W T8	Proposed - LED Retro		
Replace Lamps&Ballast	Not Required	Repair Type #1	
6		Repair Frequency (Years)	
☑		Include Repair Labor?	
0.66		Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$121.61	$121.61	Repair Labor Rate ($/hour)	Staff Gen. Maint. Worker
$32.50		Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Fixture	Replace Fixture	Repair Type #2	
20	30	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
0.6	0.6	Replacement Labor Required (Hours)	
$111.92	$111.92	Replacement Labor Rate ($/hour)	Electrician
$99.95	$150.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$27.85	$7.65	Average Annual Repair Cost in 2018 Dollars	
$25.59		**Annual O&M Savings per unit**	
$25.59		**Total Savings**	No. of Units: 1

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
Original Installation	2007	0.2	$ 4.03					x	1	0	107	6.05
	2008	1	$ 20.15					x	2	0	108	6.1
	2009	1.02	$ 20.55					x	3	0	109	6.15
	2010	1.05	$ 21.16					x	4	0	110	6.2
	2011	1.06	$ 21.36					x	5	0	111	6.25
	2012	1.07	$ 21.56					x	6	0	112	6.3
	2013	1.08	$ 21.76					x	7	0	113	6.35
	2014	1.1	$ 22.16					x	8	0	114	6.4
	2015	1.15	$ 23.17					x	9	0	115	6.45
	2016	1.2	$ 24.18					x	10	0	116	6.5
	2017	1.25	$ 25.19					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 26.19	2018	0.2	$1.38	$24.82	x	12	1	118	6.6
	2019	1.35	$ 27.20	2019	1	$6.88	$20.32	x	13	2	119	6.65
	2020	1.4	$ 28.21	2020	1.02	$7.02	$21.19	x	14	3	120	6.7
	2021	1.45	$ 29.22	2021	1.05	$7.23	$21.99	x	15	4	121	6.75
	2022	1.5	$ 30.22	2022	1.06	$7.30	$22.93	x	16	5	122	6.8
	2023	1.55	$ 31.23	2023	1.07	$7.36	$23.87	x	17	6	123	6.85
	2024	1.6	$ 32.24	2024	1.08	$7.43	$24.81	x	18	7	124	6.9
	2025	1.65	$ 33.25	2025	1.1	$7.57	$25.68	x	19	8	125	6.95
	2026	1.7	$ 34.25	2026	1.15	$7.91	$26.34	x	20	9	126	7
	2027	1.75	$ 35.26	2027	1.2	$8.26	$27.00	x	21	10	127	7.05
	2028	1.8	$ 36.27	2028	1.25	$8.60	$27.67	x	22	11	128	7.1
	2029	1.85	$ 37.28	2029	1.3	$8.95	$28.33	x	23	12	129	7.15
	2030	1.9	$ 38.28	2030	1.35	$9.29	$28.99	x	24	13	130	7.2
	2031	1.95	$ 39.29	2031	1.4	$9.64	$29.66	x	25	14	131	7.25
	2032	2	$ 40.30	2032	1.45	$9.98	$30.32	x	26	15	132	7.3
Totals	26	35.93	$ 723.98	15	16.68	$114.80	$383.91					

Atkins-Johnson Museum - Interior Lighting	
Monthly kW savings from Audit	1.2
Annual kW Savings	14.4
Diversity Factor	85%
kW Savings	12.24
Lighting kWh Savings from Audit	2883
Cooling Interactive Savings from Calc	501
Net kWh Savings	3384
Heating kWh interactive penalty from Calc	-619

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved
Atkin-Johnson House	House	Interior	2400	17	HAL-H35/LV-1	4-in Can-MR16-Clear-Recessed	0.045	0.765	1,836	Retrofit	Eiko LED MR16, 7W, 3000K	17	0.119	285.6	0.646	1,550.40
Atkin-Johnson House	House	Interior	2400	2	CFL-CF13W-1	Decorative-Medium-Frosted-Surface	0.015	0.03	72	Retrofit	Eiko LED A19, 9W, 3000K	2	0.018	43.2	0.012	28.80
Atkin-Johnson House	House	Interior	2400	1	INCAN-I42-3	Chandelier-Medium-Clear-Pendant	0.126	0.126	302	Retrofit	(3) Eiko LED A19, 9W, 3000K	1	0.027	64.8	0.099	237.60
Atkin-Johnson House	House	Interior	2400	2	INCAN-I42-2	Decorative-Medium-Frosted-Wall	0.084	0.168	403	Retrofit	(2) Eiko LED A19, 9W, 3000K	2	0.036	86.4	0.132	316.80
Atkin-Johnson House	House	Interior	2400	1	F-F32T8-2	Wrap-4 foot-Prismatic-Surface	0.064	0.064	154	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	1	0.024	57.6	0.040	96.00
Atkin-Johnson House	House	Interior	2400	4	CFL-CF13W-1	Decorative-Medium-Clear-Wall	0.015	0.06	144	Retrofit	Eiko LED A19, 9W, 3000K	4	0.036	86.4	0.024	57.60
Atkin-Johnson House	House	Interior	2400	2	EXIT-I15-1	Exit-White-Red-Wall	0.017	0.034	82	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	2	0.002	3.84	0.032	77.76
														Interior	1.2014	2883.36

Lighting HVAC Interactive Savings Calculation

**Information and table values come from the Article "Calculating lighting and HVAC interactions" ASHRAE Journal November 1993

Robert A Rundquist, P.E.; Karl F. Johnson; Donald Aumann, P.E.

Project Name

Project Location

Kansas, Kansas City

Fraction to Cooling (C) 0.4

Fraction to Heating (E) 0.32

Btu per kWh (G) 3,413

Constant of Heating: Natural gas 0.046; Electric resistance 1

		Lighting Energy Savings				Cooling Savings Calculation			Heating Savings Calculation						
	Location	kW Reduced (A)	kWh Reduced (B)	Area		Fraction to Cooling (C)	System MCOP (D)	Cooling kWh (B*C/D)	Fraction to Heating (E)	Fraction Area on Perimeter (F)	Convert to Therms (I)	Heating System Efficiency (H)	Heating Therms	Heating MCF	Heating kWh
1	Community Center	68.0	356,109	77,350		0.70	2.51	99,313	0.32	0.20	100,000	80%	-45.6	-4.4	-18606.5
2	City Hall / Public Safety	16.8	107,566	37,850		0.70	2.95	25,524	0.32	0.28	100,000	92%	-16.7	-1.6	-9013.33
3	Fire Station #1	5.1	28,432	7,950		0.40	2.95	3,855	0.32	0.56	100,000	92%	-8.7	-0.8	-4685.06
4	Fire Station #2	5.5	32,418	7,700		0.40	2.95	4,396	0.32	0.57	100,000	92%	-10.0	-1.0	-5410.23
5	Public Works	7.0	18,998	6,541		0.52	2.95	3,349	0.32	0.60	100,000	92%	-6.3	-0.6	-3379.74
6	Animal Shelter	1.3	2,656	2,304		0.52	2.95	468	0.32	0.86	100,000	92%	-1.2	-0.1	-671.968
7	Water Treatment	5.2	12,159	21,200		0.52	2.95	2,143	0.32	0.37	100,000	92%	-2.5	-0.2	-1323.13
8	Atkins-Johnson Museum	1.2	2,883	2,504		0.40	2.30	501	0.32	0.84	100,000	80%	-1.5	-0.1	-619.677
10	Fins and Foilage Bldg	5.1	2,662	7,560		0.40	3.11	342	0.32	0.57	100,000	92%	-0.8	-0.1	-447.503
11	Oak Grove Park	1.2	2,100	3,843		0.40	2.30	365	0.32	0.73	100,000	80%	-1.0	-0.1	-394.424
12	Linden Square Office	2.5	5,791	2,400		0.61	2.30	1,536	0.32	0.85	100,000	92%	-2.7	-0.3	-1448.7
	Total Energy Savings	**118.9**	**571,774**					**141,793**					**-97.1**	**-9.4**	**-46000.3**

Row Labels	Atkin-Johnson House
Interior	
Detail	
(2) Eiko 4' LED Strip 23W, 3013lm, 40K	
F-F96T12-2	
(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal	
CFL-CF26W-2	
ATG 2X2 LED DOOR KIT	
CFL-CF36W-2	
F-F14T5-2	
F-F17T8-2	
F-F17T8-3	
UFL-FU31T8/6-2	
ATG LED 2x4 Troffer Door Kit	
F-F32T8-2	
F-F32T8-3	
F-F32T8-4	
Cree LS4 4' LED Surface Ambient Luminaire 44W, 40K, 40lm	
F-F32T8-2	
Deco Adjustable LED Wall Pack, 120W, White	
MH-MH400-1	
Deco Gladetino 311W, 50K, Large Yoke Mount, White	
MH-MH400-2	
Do Nothing	
EXIT-Tritium0-1	
LED-L20-1	
LED-L8-1	
QUARTZ-Q150-1	
Eiko 2L 12W T8 Ballast Bypass DLCP	1
F-F32T8-2	1
Eiko 3L 12W T8 Ballast Bypass DLCP	
F-F32T8-3	
Eiko LED T5, 12.5W, 4000K	
F-F28T5-2	
Lithonia IBG LED Highbay, 114W, 18000lm, 50K	
F-F54T5HO-4	
NICOR CLR8 8" DOWNLIGHT KIT.	
CFL-CF42W-1	
Sielo LED Retrofit Kit,	
CFL-CF42W-3	
Typical	**34**
Typical Interior Lighting Savings	$0.00

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved
Central Park Pool	Interior	Passes	1460	2	F-F32T8-2	Vapor Tight-4 foot-Clear-Surface	0.064	0.128	187	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	0.048	70.08	0.080	116.80
Central Park Pool	Interior	Closet	1460	7	F-F32T8-2	Vapor Tight-4 foot-Clear-Surface	0.064	0.448	654	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	7	0.168	245.28	0.280	408.80
Central Park Pool	Interior	Concessions	1460	5	F-F32T8-2	Vapor Tight-4 foot-Clear-Surface	0.064	0.32	467	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	5	0.120	175.2	0.200	292.00
Central Park Pool	Interior	Lifeguard Area	1460	8	F-F32T8-2	Vapor Tight-4 foot-Clear-Surface	0.064	0.512	748	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	8	0.192	280.32	0.320	467.20
Central Park Pool	Interior	Bathrooms	1460	12	F-F32T8-2	Vapor Tight-4 foot-Clear-Surface	0.064	0.768	1,121	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	12	0.288	420.48	0.480	700.80
														Interior	1.36	1985.6

Row Labels	Central Park Pool
Interior	
Detail	
(2) Eiko 4' LED Strip 23W, 3013lm, 40K	
F-F96T12-2	
(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal	
CFL-CF26W-2	
ATG 2X2 LED DOOR KIT	
CFL-CF36W-2	
F-F14T5-2	
F-F17T8-2	
F-F17T8-3	
UFL-FU31T8/6-2	
ATG LED 2x4 Troffer Door Kit	
F-F32T8-2	
F-F32T8-3	
F-F32T8-4	
Cree LS4 4' LED Surface Ambient Luminaire 44W, 40K, 40lm	
F-F32T8-2	
Deco Adjustable LED Wall Pack, 120W, White	
MH-MH400-1	
Deco Gladetino 311W, 50K, Large Yoke Mount, White	
MH-MH400-2	
Do Nothing	
EXIT-Tritium0-1	
LED-L20-1	
LED-L8-1	
QUARTZ-Q150-1	
Eiko 2L 12W T8 Ballast Bypass DLCP	34
F-F32T8-2	34
Eiko 3L 12W T8 Ballast Bypass DLCP	
F-F32T8-3	
Eiko LED T5, 12.5W, 4000K	
F-F28T5-2	
Lithonia IBG LED Highbay, 114W, 18000lm, 50K	
F-F54T5HO-4	
NICOR CLR8 8" DOWNLIGHT KIT.	
CFL-CF42W-1	
Sielo LED Retrofit Kit,	
CFL-CF42W-3	
Typical	
Typical Interior Lighting Savings	$0.00

Oak Grove Park - Interior Lighting	
Monthly kW savings from Audit	1.2
Annual kW Savings	14.4
Diversity Factor	85%
kW Savings	12.24
Lighting kWh Savings from Audit	2100
Cooling Interactive Savings from Calc	365
Net kWh Savings	2465
Heating kWh interactive penalty from Calc	-394

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved
Oak Grove Park	Amphitheater	Interior	1460	17	F-F32T8-2	Strip-4 foot-Open - no lens-Surface	0.064	1.088	1,588	Retrofit	Eiko 4FT LED Strip, 23W, 4000K	17	0.391	570.86	0.697	1,017.62
Oak Grove Park	Amphitheater	Interior	1460	2	MH-MH175-1	Flood-Mogul-Clear-Wall	0.205	0.41	599	Retrofit	Deco D211 40W Flood, Slipfitter, Bronze	2	0.080	116.8	0.330	481.80
Oak Grove Park	Amphitheater	Interior	8760	3	EXIT-I15-1	Exit-White-Red-Wall	0.017	0.051	447	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	3	0.002	21.024	0.049	425.74
Oak Grove Park	Bathrooms	Men's/womens/closet	1460	3	F-F32T8-2	Vapor Tight-4 foot-Clear-Surface	0.064	0.192	280	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	3	0.072	105.12	0.120	175.20
														Interior	1.1956	2100.356

Lighting HVAC Interactive Savings Calculation

**Information and table values come from the Article "Calculating lighting and HVAC interactions" ASHRAE Journal November 1993
Robert A Rundquist, P.E.; Karl F. Johnson; Donald Aumann, P.E.

Project Name

Project Location
Kansas, Kansas City

Fraction to Cooling (C) 0.4
Fraction to Heating (E) 0.32
Btu per kWh (G) 3,413

Constant of Heating: Natural gas 0.046; Electric resistance 1

		Lighting Energy Savings				Cooling Savings Calculation			Heating Savings Calculation						
	Location	kW Reduced (A)	kWh Reduced (B)	Area		Fraction to Cooling (C)	System MCOP (D)	Cooling kWh (B*C/D)	Fraction to Heating (E)	Fraction Area on Perimeter (F)	Convert to Therms (I)	Heating System Efficiency (H)	Heating Therms	Heating MCF	Heating kWh
1	Community Center	68.0	356,109	77,350		0.70	2.51	99,313	0.32	0.20	100,000	80%	-45.6	-4.4	-18606.5
2	City Hall / Public Safety	16.8	107,566	37,850		0.70	2.95	25,524	0.32	0.28	100,000	92%	-16.7	-1.6	-9013.33
3	Fire Station #1	5.1	28,432	7,950		0.40	2.95	3,855	0.32	0.56	100,000	92%	-8.7	-0.8	-4685.06
4	Fire Station #2	5.5	32,418	7,700		0.40	2.95	4,396	0.32	0.57	100,000	92%	-10.0	-1.0	-5410.23
5	Public Works	7.0	18,998	6,541		0.52	2.95	3,349	0.32	0.60	100,000	92%	-6.3	-0.6	-3379.74
6	Animal Shelter	1.3	2,656	2,304		0.52	2.95	468	0.32	0.86	100,000	92%	-1.2	-0.1	-671.968
7	Water Treatment	5.2	12,159	21,200		0.52	2.95	2,143	0.32	0.37	100,000	92%	-2.5	-0.2	-1323.13
8	Atkins-Johnson Museum	1.2	2,883	2,504		0.40	2.30	501	0.32	0.84	100,000	80%	-1.5	-0.1	-619.677
10	Fins and Foilage Bldg	5.1	2,662	7,560		0.40	3.11	342	0.32	0.57	100,000	92%	-0.8	-0.1	-447.503
11	Oak Grove Park	1.2	2,100	3,843		0.40	2.30	365	0.32	0.73	100,000	80%	-1.0	-0.1	-394.424
12	Linden Square Office	2.5	5,791	2,400		0.61	2.30	1,536	0.32	0.85	100,000	92%	-2.7	-0.3	-1448.7
	Total Energy Savings	**118.9**	**571,774**					**141,793**					**-97.1**	**-9.4**	**-46000.3**

Row Labels	Oak Grove Park
Interior	
Detail	
(2) Eiko 4' LED Strip 23W, 3013lm, 40K	
F-F96T12-2	
(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal	
CFL-CF26W-2	
ATG 2X2 LED DOOR KIT	
CFL-CF36W-2	
F-F14T5-2	
F-F17T8-2	
F-F17T8-3	
UFL-FU31T8/6-2	
ATG LED 2x4 Troffer Door Kit	
F-F32T8-2	
F-F32T8-3	
F-F32T8-4	
Cree LS4 4' LED Surface Ambient Luminaire 44W, 40K, 40lm	
F-F32T8-2	
Deco Adjustable LED Wall Pack, 120W, White	
MH-MH400-1	
Deco Gladetino 311W, 50K, Large Yoke Mount, White	
MH-MH400-2	
Do Nothing	
EXIT-Tritium0-1	
LED-L20-1	
LED-L8-1	
QUARTZ-Q150-1	
Eiko 2L 12W T8 Ballast Bypass DLCP	3
F-F32T8-2	3
Eiko 3L 12W T8 Ballast Bypass DLCP	
F-F32T8-3	
Eiko LED T5, 12.5W, 4000K	
F-F28T5-2	
Lithonia IBG LED Highbay, 114W, 18000lm, 50K	
F-F54T5HO-4	
NICOR CLR8 8" DOWNLIGHT KIT.	
CFL-CF42W-1	
Sielo LED Retrofit Kit,	
CFL-CF42W-3	
Typical	**22**
Typical Interior Lighting Savings	$0.00

Oak Grove Park - Interior Lighting	
Monthly kW savings from Audit	2.524
Annual kW Savings	30.288
Diversity Factor	85%
kW Savings	25.7448
Lighting kWh Savings from Audit	5791
Cooling Interactive Savings from Calc	1536
Net kWh Savings	7327
Heating therm interactive penalty from Calc	-2.7

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved	Total Saved $	Solution $
Linden Office	Concessions	Interior	2080	40	F-F28T5-2	Strip-4 foot-Open - no lens-Suspended	0.056	2.24	4,659	Retrofit	Eiko LED T5, 12.5W, 4000K (1633)	40	1.000	2,080.00	1.240	2,579.20	$ 206.34	$3,052.50
Linden Office	Concessions	Interior	2080	5	F-F32T8-3	Troffer-2X4-Prismatic-Recessed	0.109	0.545	1,134	Retrofit	ATG LED 2x4 Troffer Door Kit	5	0.150	312.00	0.395	821.60	$ 65.73	$866.10
Linden Office	Concessions	Interior	2080	6	F-F17T8-3	Troffer-2X2-Prismatic-Recessed	0.058	0.348	724	Retrofit	ATG 2X2 LED DOOR KIT	6	0.180	374.40	0.168	349.44	$ 27.96	$808.53
Linden Office	Concessions	Interior	2080	4	CFL-CF32W-1	8-in Can-Plug-in 4 Pin-Clear-Recessed	0.034	0.136	283	Retrofit	MaxLite 15W LED 8 COMMERCIAL DOWNLIGHT RETROFIT 4000K RR81540W	4	0.060	124.80	0.076	158.08	$ 12.65	$711.53
Linden Office	Concessions	Interior	8760	3	EXIT-I15-1	Exit-White-Red-Wall	0.017	0.051	447	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	3	0.002	21.02	0.049	425.74	$ 34.06	$280.01
Linden Office	Concessions	Bathrooms	2080	6	F-F17T8-3	Troffer-2X2-Prismatic-Recessed	0.058	0.348	724	Retrofit	ATG 2X2 LED DOOR KIT	6	0.180	374.40	0.168	349.44	$ 27.96	$808.53
Linden Office	Concessions	Bathrooms	2080	8	F-F32T8-2	Wrap-4 foot-Prismatic-Wall	0.064	0.512	1,065	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	8	0.192	399.36	0.320	665.60	$ 53.25	$541.16
Linden Office	Concessions	Bathrooms	2080	4	CFL-CF32W-1	8-in Can-Plug-in 4 Pin-Clear-Recessed	0.034	0.136	283	Retrofit	MaxLite 15W LED 8 COMMERCIAL DOWNLIGHT RETROFIT 4000K RR81540W	4	0.060	124.80	0.076	158.08	$ 12.65	$711.53
Linden Office	Concessions	Bathrooms	8760	2	EXIT-I15-1	Exit-White-Red-Wall	0.017	0.034	298	Retrofit	e-conolight Exit Sign with Battery Backup E-XPL2RBW (17)	2	0.002	14.02	0.032	283.82	$ 22.71	$186.67

Lighting HVAC Interactive Savings Calculation

**Information and table values come from the Article "Calculating lighting and HVAC interactions" ASHRAE Journal November 1993

Robert A Rundquist, P.E.; Karl F. Johnson; Donald Aumann, P.E.

Project Name

Project Location

Kansas, Kansas City

Fraction to Cooling (C) 0.4

Fraction to Heating (E) 0.32

Btu per kWh (G) 3,413

Constant of Heating Natural gas 0.046

Electric resistance 1

		Lighting Energy Savings				Cooling Savings Calculation			Heating Savings Calculation						
	Location	kW Reduced (A)	kWh Reduced (B)	Area		Fraction to Cooling (C)	System MCOP (D)	Cooling kWh (B*C/D)	Fraction to Heating (E)	Fraction Area on Perimeter (F)	Convert to Therms (I)	Heating System Efficiency (H)	Heating Therms	Heating MCF	Heating kWh
1	Community Center	68.0	356,109	77,350		0.70	2.51	99,313	0.32	0.20	100,000	80%	-45.6	-4.4	-18606.5
2	City Hall / Public Safety	16.8	107,566	37,850		0.70	2.95	25,524	0.32	0.28	100,000	92%	-16.7	-1.6	-9013.33
3	Fire Station #1	5.1	28,432	7,950		0.40	2.95	3,855	0.32	0.56	100,000	92%	-8.7	-0.8	-4685.06
4	Fire Station #2	5.5	32,418	7,700		0.40	2.95	4,396	0.32	0.57	100,000	92%	-10.0	-1.0	-5410.23
5	Public Works	7.0	18,998	6,541		0.52	2.95	3,349	0.32	0.60	100,000	92%	-6.3	-0.6	-3379.74
6	Animal Shelter	1.3	2,656	2,304		0.52	2.95	468	0.32	0.86	100,000	92%	-1.2	-0.1	-671.968
7	Water Treatment	5.2	12,159	21,200		0.52	2.95	2,143	0.32	0.37	100,000	92%	-2.5	-0.2	-1323.13
8	Atkins-Johnson Museum	1.2	2,883	2,504		0.40	2.30	501	0.32	0.84	100,000	80%	-1.5	-0.1	-619.677
10	Fins and Foilage Bldg	5.1	2,662	7,560		0.40	3.11	342	0.32	0.57	100,000	92%	-0.8	-0.1	-447.503
11	Oak Grove Park	1.2	2,100	3,843		0.40	2.30	365	0.32	0.73	100,000	80%	-1.0	-0.1	-394.424
12	Linden Square Office	2.5	5,791	2,400		0.61	2.30	1,536	0.32	0.85	100,000	92%	-2.7	-0.3	-1448.7
	Total Energy Savings	**118.9**	**571,774**					**141,793**					**-97.1**	**-9.4**	**-46000.3**

Row Labels	Linden Office
Interior	
Detail	
(2) Eiko 4' LED Strip 23W, 3013lm, 40K	
F-F96T12-2	
(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal	
CFL-CF26W-2	
ATG 2X2 LED DOOR KIT	12
CFL-CF36W-2	
F-F14T5-2	
F-F17T8-2	
F-F17T8-3	12
UFL-FU31T8/6-2	
ATG LED 2x4 Troffer Door Kit	5
F-F32T8-2	
F-F32T8-3	5
F-F32T8-4	
Cree LS4 4' LED Surface Ambient Luminaire 44W, 40K, 40lm	
F-F32T8-2	
Deco Adjustable LED Wall Pack, 120W, White	
MH-MH400-1	
Deco Gladetino 311W, 50K, Large Yoke Mount, White	
MH-MH400-2	
Do Nothing	
EXIT-Tritium0-1	
LED-L20-1	
LED-L8-1	
QUARTZ-Q150-1	
Eiko 2L 12W T8 Ballast Bypass DLCP	8
F-F32T8-2	8
Eiko 3L 12W T8 Ballast Bypass DLCP	
F-F32T8-3	
Eiko LED T5, 12.5W, 4000K	40
F-F28T5-2	40
Lithonia IBG LED Highbay, 114W, 18000lm, 50K	
F-F54T5HO-4	
NICOR CLR8 8" DOWNLIGHT KIT.	
CFL-CF42W-1	
Sielo LED Retrofit Kit,	
CFL-CF42W-3	
Typical	**13**
Typical Interior Lighting Savings	$0.00

City of Gladstone IGA	Project		
Gladstone, MO	Location		
Interior - 2x4 LED Door Retr	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 4' 32W T8	Proposed - LED Retro		
Replace Lamps&Ballast	Not Required	Repair Type #1	
6.0		Repair Frequency (Years)	
☑		Include Repair Labor?	
0.66		Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$121.61	$121.61	Repair Labor Rate ($/hour)	Staff Gen. Maint. Worker
$36.00		Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Fixture	Replace Fixture	Repair Type #2	
20	25	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
0.6	0.6	Replacement Labor Required (Hours)	
$111.92	$111.92	Replacement Labor Rate ($/hour)	Electrician
$99.95	$180.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$28.48	$10.48	Average Annual Repair Cost in 2018 Dollars	
$23.52		**Annual O&M Savings per unit**	
$23.52		**Total Savings**	No. of Units: 1

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
Original Installation	2007	0.2	$ 4.12					x	1	0	107	6.05
	2008	1	$ 20.61					x	2	0	108	6.1
	2009	1.02	$ 21.02					x	3	0	109	6.15
	2010	1.05	$ 21.64					x	4	0	110	6.2
	2011	1.06	$ 21.84					x	5	0	111	6.25
	2012	1.07	$ 22.05					x	6	0	112	6.3
	2013	1.08	$ 22.26					x	7	0	113	6.35
	2014	1.1	$ 22.67					x	8	0	114	6.4
	2015	1.15	$ 23.70					x	9	0	115	6.45
	2016	1.2	$ 24.73					x	10	0	116	6.5
	2017	1.25	$ 25.76					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 26.79	2018	0.2	$1.89	$24.90	x	12	1	118	6.6
	2019	1.35	$ 27.82	2019	1	$9.43	$18.39	x	13	2	119	6.65
	2020	1.4	$ 28.85	2020	1.02	$9.62	$19.23	x	14	3	120	6.7
	2021	1.45	$ 29.88	2021	1.05	$9.90	$19.98	x	15	4	121	6.75
	2022	1.5	$ 30.91	2022	1.06	$9.99	$20.92	x	16	5	122	6.8
	2023	1.55	$ 31.94	2023	1.07	$10.09	$21.85	x	17	6	123	6.85
	2024	1.6	$ 32.97	2024	1.08	$10.18	$22.79	x	18	7	124	6.9
	2025	1.65	$ 34.00	2025	1.1	$10.37	$23.63	x	19	8	125	6.95
	2026	1.7	$ 35.03	2026	1.15	$10.84	$24.19	x	20	9	126	7
	2027	1.75	$ 36.06	2027	1.2	$11.31	$24.75	x	21	10	127	7.05
	2028	1.8	$ 37.09	2028	1.25	$11.78	$25.31	x	22	11	128	7.1
	2029	1.85	$ 38.12	2029	1.3	$12.26	$25.87	x	23	12	129	7.15
	2030	1.9	$ 39.15	2030	1.35	$12.73	$26.43	x	24	13	130	7.2
	2031	1.95	$ 40.18	2031	1.4	$13.20	$26.98	x	25	14	131	7.25
	2032	2	$ 41.21	2032	1.45	$13.67	$27.54	x	26	15	132	7.3
Totals	26	35.93	$ 740.41	15	16.68	$157.26	$352.77					

City of Gladstone IGA	Project		
Gladstone, MO	Location		
Interior - 2x2 LED Door Retr	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 2' 17W T8	Proposed - LED Retro		
Replace Lamps&Ballast	Not Required	Repair Type #1	
6		Repair Frequency (Years)	
☑		Include Repair Labor?	
0.66		Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$121.61	$121.61	Repair Labor Rate ($/hour)	Staff Gen. Maint. Worker
$32.50		Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Fixture	Replace Fixture	Repair Type #2	
20	30	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
0.6	0.6	Replacement Labor Required (Hours)	
$111.92	$111.92	Replacement Labor Rate ($/hour)	Electrician
$99.95	$150.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$27.85	$7.65	Average Annual Repair Cost in 2018 Dollars	
$25.59		**Annual O&M Savings per unit**	
$25.59		**Total Savings**	No. of Units: 1

	Existing			Proposed								
	Year	**Increase Factor**	**Annual Repair Cost**	**Year**	**Increase Factor**	**Annual Repair Cost**	**Savings**	**Include Year?**	**Original Life**	**New Life**	**Increase Factor Year**	**Increase Factor**
Original Installation	2007	0.2	$ 4.03					x	1	0	107	6.05
	2008	1	$ 20.15					x	2	0	108	6.1
	2009	1.02	$ 20.55					x	3	0	109	6.15
	2010	1.05	$ 21.16					x	4	0	110	6.2
	2011	1.06	$ 21.36					x	5	0	111	6.25
	2012	1.07	$ 21.56					x	6	0	112	6.3
	2013	1.08	$ 21.76					x	7	0	113	6.35
	2014	1.1	$ 22.16					x	8	0	114	6.4
	2015	1.15	$ 23.17					x	9	0	115	6.45
	2016	1.2	$ 24.18					x	10	0	116	6.5
	2017	1.25	$ 25.19					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 26.19	2018	0.2	$1.38	$24.82	x	12	1	118	6.6
	2019	1.35	$ 27.20	2019	1	$6.88	$20.32	x	13	2	119	6.65
	2020	1.4	$ 28.21	2020	1.02	$7.02	$21.19	x	14	3	120	6.7
	2021	1.45	$ 29.22	2021	1.05	$7.23	$21.99	x	15	4	121	6.75
	2022	1.5	$ 30.22	2022	1.06	$7.30	$22.93	x	16	5	122	6.8
	2023	1.55	$ 31.23	2023	1.07	$7.36	$23.87	x	17	6	123	6.85
	2024	1.6	$ 32.24	2024	1.08	$7.43	$24.81	x	18	7	124	6.9
	2025	1.65	$ 33.25	2025	1.1	$7.57	$25.68	x	19	8	125	6.95
	2026	1.7	$ 34.25	2026	1.15	$7.91	$26.34	x	20	9	126	7
	2027	1.75	$ 35.26	2027	1.2	$8.26	$27.00	x	21	10	127	7.05
	2028	1.8	$ 36.27	2028	1.25	$8.60	$27.67	x	22	11	128	7.1
	2029	1.85	$ 37.28	2029	1.3	$8.95	$28.33	x	23	12	129	7.15
	2030	1.9	$ 38.28	2030	1.35	$9.29	$28.99	x	24	13	130	7.2
	2031	1.95	$ 39.29	2031	1.4	$9.64	$29.66	x	25	14	131	7.25
	2032	2	$ 40.30	2032	1.45	$9.98	$30.32	x	26	15	132	7.3
Totals	26	35.93	$ 723.98	15	16.68	$114.80	$383.91					

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved
GLADSTONE COMM	Exterior	Parking Lot	4380	12	MH-MH250-1	Cobra Head-Mogul-Frosted-Pole	0.295	3.54	15,505	Retrofit	Eiko LED Post Top, 54W, 5000K, Mog Base (1623)	12	0.648	2,838.24	2.892	12,666.96
GLADSTONE COMM	Exterior	Parking Lot	4380	8	MH-MH250-2	Cobra Head-Mogul-Frosted-Pole	0.250	2	8,760	Retrofit	(2) Eiko LED Post Top, 54W, 5000K, Mog Base (1623)	8	0.864	3,784.32	1.136	4,975.68
GLADSTONE COMM	Exterior	Entrance	4380	25	CFL-CF26W-2	Decorative-Plug-in 4 Pin-Frosted-Surface	0.054	1.35	5,913	Retrofit	(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal (1623)	25	0.450	1,971.00	0.900	3,942.00
GLADSTONE COMM	Exterior	Pathway	4380	22	MH-MH35-1	6-in Ground-G8.5-Clear-Ground	0.042	0.924	4,047	Do Nothing	Do Nothing	22	0.924	4,047.12	0.000	0.00
GLADSTONE COMM	Exterior	Wall Lights	4380	7	HAL-H35/LV-2	Decorative-MR16-Clear-Wall	0.070	0.49	2,146	Retrofit	(2) Eiko LED MR16, 7W, 4000K (1623)	7	0.098	429.24	0.392	1,716.96
GLADSTONE COMM	Exterior	Wall Flood	4380	12	MH-MH70-1	12-in Ground-Medium-Clear-Ground	0.095	1.14	4,993	Retrofit	Eiko 70W HIF Equal, 19W, 4000K, Med Base (1623)	12	0.228	998.64	0.912	3,994.56
GLADSTONE COMM	Exterior	Bollards	4380	4	MH-MH70-1	Bollard-Medium-Frosted-Ground	0.095	0.38	1,664	Retrofit	Wayne Tyler Concrete Bollard 32W, 4000K, 120/277V (1623)	4	0.128	560.64	0.252	1,103.76
GLADSTONE COMM	Exterior	Flag Poles	4380	3	MH-MH70-1	Flood-Medium-Clear-Ground	0.095	0.285	1,248	Retrofit	ATG LED FLOOD, 30W, 50K (1623)	3	0.090	394.20	0.195	854.10
GLADSTONE COMM	Exterior	South Patio	4380	12	MH-MH35-1	Bullet-G8.5-Clear-Wall	0.042	0.504	2,208	Retrofit	MaxLite Bullet Flood, 11W, 50K, 3 Beam Angles	12	0.132	578.16	0.372	1,629.36

Sum of Qty	
Row Labels	GLADSTONE COMM
Exterior	
Detail	
(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal	25
CFL-CF26W-2	25
(2) RemPhos LED Post Top Retro Kit, 40W, 4000K	
MH-MH175-2	
Do Nothing	22
LED-L20-1	
LED-L40-1	
MH-MH35-1	22
Eiko 2L 12W T8 Ballast Bypass DLCP	
F-F32T8-2	
RemPhos LED Block Retro Kit, 150W, 5000K, 24000 Lumen	
MH-MH400-1	
RemPhos LED BLock Retrofit, 277W, 5000K, 43000 Lumen	
MH-MH1000-1	
RemPhos LEDSSEXT 40W 4400LM 4000K	
MH-MH175-1	
Typical	**58**

Typical Exterior Lighting Savings $979.49

City of Gladstone IGA	Project		
Gladstone, MO	Location		
Exterior - Typical	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 175 W M-H	Proposed - LED Retro		
Replace Lamps & Ballast	Not Required	Repair Type #1	
3.7		Repair Frequency (Years)	
☐		Include Repair Labor?	
0.69		Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$121.61	$121.61	Repair Labor Rate ($/hour)	Staff Gen. Maint. Worker
$73.82		Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Fixture	Replace Fixture	Repair Type #2	
20	17.1	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
0.34	0.34	Replacement Labor Required (Hours)	
$111.92	$111.92	Replacement Labor Rate ($/hour)	Electrician
$348.00	$500.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$42.49	$33.85	Average Annual Repair Cost in 2018 Dollars	
$16.89		**Annual O&M Savings per unit**	
$16.89		**Total Savings**	No. of Units: 1

Base typical exterior on replacing a 175W wall pack

	Existing			Proposed								
	Year	**Increase Factor**	**Annual Repair Cost**	**Year**	**Increase Factor**	**Annual Repair Cost**	**Savings**	**Include Year?**	**Original Life**	**New Life**	**Increase Factor Year**	**Increase Factor**
Original Installation	2007	0.2	$ 6.15					x	1	0	107	6.05
	2008	1	$ 30.75					x	2	0	108	6.1
	2009	1.02	$ 31.36					x	3	0	109	6.15
	2010	1.05	$ 32.29					x	4	0	110	6.2
	2011	1.06	$ 32.59					x	5	0	111	6.25
	2012	1.07	$ 32.90					x	6	0	112	6.3
	2013	1.08	$ 33.21					x	7	0	113	6.35
	2014	1.1	$ 33.82					x	8	0	114	6.4
	2015	1.15	$ 35.36					x	9	0	115	6.45
	2016	1.2	$ 36.90					x	10	0	116	6.5
	2017	1.25	$ 38.43					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 39.97	2018	0.2	$6.09	$33.88	x	12	1	118	6.6
	2019	1.35	$ 41.51	2019	1	$30.44	$11.07	x	13	2	119	6.65
	2020	1.4	$ 43.05	2020	1.02	$31.05	$12.00	x	14	3	120	6.7
	2021	1.45	$ 44.58	2021	1.05	$31.96	$12.63	x	15	4	121	6.75
	2022	1.5	$ 46.12	2022	1.06	$32.26	$13.86	x	16	5	122	6.8
	2023	1.55	$ 47.66	2023	1.07	$32.57	$15.09	x	17	6	123	6.85
	2024	1.6	$ 49.20	2024	1.08	$32.87	$16.32	x	18	7	124	6.9
	2025	1.65	$ 50.73	2025	1.1	$33.48	$17.25	x	19	8	125	6.95
	2026	1.7	$ 52.27	2026	1.15	$35.00	$17.27	x	20	9	126	7
	2027	1.75	$ 53.81	2027	1.2	$36.52	$17.28	x	21	10	127	7.05
	2028	1.8	$ 55.35	2028	1.25	$38.05	$17.30	x	22	11	128	7.1
	2029	1.85	$ 56.88	2029	1.3	$39.57	$17.32	x	23	12	129	7.15
	2030	1.9	$ 58.42	2030	1.35	$41.09	$17.33	x	24	13	130	7.2
	2031	1.95	$ 59.96	2031	1.4	$42.61	$17.35	x	25	14	131	7.25
	2032	2	$ 61.50	2032	1.45	$44.13	$17.36	x	26	15	132	7.3
Totals	26	35.93	$ 1,104.77	15	16.68	$507.69	$253.32					

City of Gladstone IGA	Project	
Gladstone, MO	Location	
Exterior - Retro Dec Street	Equipment	
108.3%	Location Cost Index	Kansas City, MO
Existing - 26W CFL	Proposed - LED Retro 9 W	
Replace Lamps&Ballast	Not Required	Repair Type #1
3.42		Repair Frequency (Years)
☑		Include Repair Labor?
0.44		Repair Labor Required (Hours)
In-House		Select In-House or Contract Labor
$121.61	$121.61	Repair Labor Rate ($/hour) Staff Gen. Maint. Worker
$37.90		Repair Material Cost
☑		Include End-of-Life Replacement Cost in Analysis?
Replace Fixture	Replace Fixture	Repair Type #2
20	22.8	Replacement Frequency (Years)
☑		Include Replacement Labor?
0.3	0.3	Replacement Labor Required (Hours)
$111.92	$111.92	Replacement Labor Rate ($/hour) Electrician
$134.12	$384.21	Replacement Material Cost
2007	Year Equipment Originally Installed	
2018	Year New Equipment to be Installed	
15	Length of Performance Contract (Years)	
$36.78	$19.92	Average Annual Repair Cost in 2018 Dollars
$23.99		**Annual O&M Savings per unit**
$599.75		**Total Savings** No. of Units: 25

	Year	Existing Increase Factor	Existing Annual Repair Cost	Proposed Year	Proposed Increase Factor	Proposed Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
Original Installation	2007	0.2	$ 5.32					x	1	0	107	6.05
	2008	1	$ 26.61					x	2	0	108	6.1
	2009	1.02	$ 27.14					x	3	0	109	6.15
	2010	1.05	$ 27.94					x	4	0	110	6.2
	2011	1.06	$ 28.21					x	5	0	111	6.25
	2012	1.07	$ 28.47					x	6	0	112	6.3
	2013	1.08	$ 28.74					x	7	0	113	6.35
	2014	1.1	$ 29.27					x	8	0	114	6.4
	2015	1.15	$ 30.60					x	9	0	115	6.45
	2016	1.2	$ 31.93					x	10	0	116	6.5
	2017	1.25	$ 33.26					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 34.60	2018	0.2	$3.58	$31.01	x	12	1	118	6.6
	2019	1.35	$ 35.93	2019	1	$17.91	$18.01	x	13	2	119	6.65
	2020	1.4	$ 37.26	2020	1.02	$18.27	$18.99	x	14	3	120	6.7
	2021	1.45	$ 38.59	2021	1.05	$18.81	$19.78	x	15	4	121	6.75
	2022	1.5	$ 39.92	2022	1.06	$18.99	$20.93	x	16	5	122	6.8
	2023	1.55	$ 41.25	2023	1.07	$19.17	$22.08	x	17	6	123	6.85
	2024	1.6	$ 42.58	2024	1.08	$19.35	$23.23	x	18	7	124	6.9
	2025	1.65	$ 43.91	2025	1.1	$19.70	$24.21	x	19	8	125	6.95
	2026	1.7	$ 45.24	2026	1.15	$20.60	$24.64	x	20	9	126	7
	2027	1.75	$ 46.57	2027	1.2	$21.50	$25.07	x	21	10	127	7.05
	2028	1.8	$ 47.90	2028	1.25	$22.39	$25.51	x	22	11	128	7.1
	2029	1.85	$ 49.23	2029	1.3	$23.29	$25.94	x	23	12	129	7.15
	2030	1.9	$ 50.56	2030	1.35	$24.18	$26.38	x	24	13	130	7.2
	2031	1.95	$ 51.89	2031	1.4	$25.08	$26.81	x	25	14	131	7.25
	2032	2	$ 53.22	2032	1.45	$25.97	$27.25	x	26	15	132	7.3
Totals	26	35.93	$ 956.15	15	16.68	$298.78	$359.85					

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved
City Hall / Public Safety	Exterior	Front Entrance	4380	6	INCAN-I60-1	6-in Can-Medium-Frosted-Recessed	0.060	0.36	1,577	Retrofit	Eiko 4000K LED LiteSpan A19 Omni-Directional 300 Degree Beam 9W - 800lm Dimmable E26	6	0.054	236.52	0.306	1,340.28
City Hall / Public Safety	Exterior	Flag Poles	4380	6	MH-MH70-1	Flood-Medium-Clear-Ground	0.095	0.57	2,497	Retrofit	ATG LED Flood, 30W, 5000K	6	0.180	788.4	0.390	1,708.20
City Hall / Public Safety	Exterior	Spotlights	4380	2	MH-MH70-1	Flood-Medium-Clear-Ground	0.095	0.19	832	Retrofit	ATG LED Flood, 30W, 5000K	2	0.060	262.8	0.130	569.40
City Hall / Public Safety	Exterior	Spotlights	4380	2	MH-MH175-1	Flood-Mogul-Clear-Ground	0.205	0.41	1,796	Retrofit	ATG LED Flood, 50W, 50K	2	0.100	438	0.310	1,357.80
City Hall / Public Safety	Exterior	Walkway	4380	4	MH-MH35-1	Security-Medium-Frosted-Wall	0.042	0.168	736	Retrofit	Eiko 4000K LED LiteSpan A19 Omni-Directional 300 Degree Beam 9W - 800lm Dimmable E26	4	0.036	157.68	0.132	578.16
City Hall / Public Safety	Exterior	Back Entrance	4380	2	MH-MH100-1	Flood-Medium-Clear-Wall	0.120	0.24	1,051	Retrofit	ATG LED Flood, 30W, 5000K	2	0.060	262.8	0.180	788.40
City Hall / Public Safety	Exterior	Back Entrance	4380	5	MH-MH70-1	Wallpack-Medium-Clear-Wall	0.095	0.475	2,081	Retrofit	ATG Trapezoid Wall Pack, 28W, 5000K	5	0.140	613.2	0.335	1,467.30
City Hall / Public Safety	Exterior	Employee Entrance	4380	2	MH-MH35-1	Flood-G12-Clear-Wall	0.042	0.084	368	Retrofit	ATG LED Flood 15W, 5000K	2	0.030	131.4	0.054	236.52
														Exterior	1.837	8046.06

Sum of Qty	
Row Labels	**City Hall / Public Safety**
Exterior	
Detail	
(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal	
CFL-CF26W-2	
(2) RemPhos LED Post Top Retro Kit, 40W, 4000K	
MH-MH175-2	
Do Nothing	
LED-L20-1	
LED-L40-1	
MH-MH35-1	
Eiko 2L 12W T8 Ballast Bypass DLCP	
F-F32T8-2	
RemPhos LED Block Retro Kit, 150W, 5000K, 24000 Lumen	
MH-MH400-1	
RemPhos LED BLock Retrofit, 277W, 5000K, 43000 Lumen	
MH-MH1000-1	
RemPhos LEDSSEXT 40W 4400LM 4000K	
MH-MH175-1	
Typical	**29**

Typical Exterior Lighting Savings $489.75

City of Gladstone IGA	Project		
Gladstone, MO	Location		
Exterior - Typical	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 175 W M-H	Proposed - LED Retro		
Replace Lamps & Ballast	Not Required	Repair Type #1	
3.7		Repair Frequency (Years)	
☐		Include Repair Labor?	
0.69		Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$121.61	$121.61	Repair Labor Rate ($/hour)	Staff Gen. Maint. Worker
$73.82		Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Fixture	Replace Fixture	Repair Type #2	
20	17.1	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
0.34	0.34	Replacement Labor Required (Hours)	
$111.92	$111.92	Replacement Labor Rate ($/hour)	Electrician
$348.00	$500.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$42.49	$33.85	Average Annual Repair Cost in 2018 Dollars	
$16.89		**Annual O&M Savings per unit**	
$16.89		**Total Savings**	No. of Units: 1

Base typical exterior on replacing a 175W wall pack

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
Original Installation	2007	0.2	$ 6.15					x	1	0	107	6.05
	2008	1	$ 30.75					x	2	0	108	6.1
	2009	1.02	$ 31.36					x	3	0	109	6.15
	2010	1.05	$ 32.29					x	4	0	110	6.2
	2011	1.06	$ 32.59					x	5	0	111	6.25
	2012	1.07	$ 32.90					x	6	0	112	6.3
	2013	1.08	$ 33.21					x	7	0	113	6.35
	2014	1.1	$ 33.82					x	8	0	114	6.4
	2015	1.15	$ 35.36					x	9	0	115	6.45
	2016	1.2	$ 36.90					x	10	0	116	6.5
	2017	1.25	$ 38.43					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 39.97	2018	0.2	$6.09	$33.88	x	12	1	118	6.6
	2019	1.35	$ 41.51	2019	1	$30.44	$11.07	x	13	2	119	6.65
	2020	1.4	$ 43.05	2020	1.02	$31.05	$12.00	x	14	3	120	6.7
	2021	1.45	$ 44.58	2021	1.05	$31.96	$12.63	x	15	4	121	6.75
	2022	1.5	$ 46.12	2022	1.06	$32.26	$13.86	x	16	5	122	6.8
	2023	1.55	$ 47.66	2023	1.07	$32.57	$15.09	x	17	6	123	6.85
	2024	1.6	$ 49.20	2024	1.08	$32.87	$16.32	x	18	7	124	6.9
	2025	1.65	$ 50.73	2025	1.1	$33.48	$17.25	x	19	8	125	6.95
	2026	1.7	$ 52.27	2026	1.15	$35.00	$17.27	x	20	9	126	7
	2027	1.75	$ 53.81	2027	1.2	$36.52	$17.28	x	21	10	127	7.05
	2028	1.8	$ 55.35	2028	1.25	$38.05	$17.30	x	22	11	128	7.1
	2029	1.85	$ 56.88	2029	1.3	$39.57	$17.32	x	23	12	129	7.15
	2030	1.9	$ 58.42	2030	1.35	$41.09	$17.33	x	24	13	130	7.2
	2031	1.95	$ 59.96	2031	1.4	$42.61	$17.35	x	25	14	131	7.25
	2032	2	$ 61.50	2032	1.45	$44.13	$17.36	x	26	15	132	7.3
Totals	26	35.93	$ 1,104.77	15	16.68	$507.69	$253.32					

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved
Public Fire #1	Exterior	Canopy	4380	8	CFL-CF13W-1	6-in Can-Medium-Open - no lens-Recessed	0.015	0.12	526	Retrofit	Eiko 4000K LED LiteSpan A19 Omni-Directional 300 Degree Beam 9W - 800lm Dimmable E26	8	0.072	315.36	0.048	210.24
Public Fire #1	Exterior	Security	4380	1	CFL-CF15W-2	Security-Medium-Open - no lens-Surface	0.034	0.034	149	Retrofit	Eiko 13W PAR38 Lamp Flood Beam, 40K 1050lm 2L	1	0.026	113.88	0.008	35.04
Public Fire #1	Exterior	Parking	4380	2	MH-MH175-1	Shoe Box-Mogul-Clear-Pole	0.205	0.41	1,796	Retrofit	Deco D824 LED Glade Luminaire, D824-LED4050UNVT5PMBZ	2	0.080	350.4	0.330	1,445.40
														Exterior	0.386	1690.68

Sum of Qty	
Row Labels	**Public Fire #1**
Exterior	
Detail	
(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal	
CFL-CF26W-2	
(2) RemPhos LED Post Top Retro Kit, 40W, 4000K	
MH-MH175-2	
Do Nothing	
LED-L20-1	
LED-L40-1	
MH-MH35-1	
Eiko 2L 12W T8 Ballast Bypass DLCP	
F-F32T8-2	
RemPhos LED Block Retro Kit, 150W, 5000K, 24000 Lumen	
MH-MH400-1	
RemPhos LED BLock Retrofit, 277W, 5000K, 43000 Lumen	
MH-MH1000-1	
RemPhos LEDSSEXT 40W 4400LM 4000K	
MH-MH175-1	
Typical	**11**

Typical Exterior Lighting Savings $185.77

City of Gladstone IGA	Project		
Gladstone, MO	Location		
Exterior - Typical	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 175 W M-H	Proposed - LED Retro		
Replace Lamps & Ballast	Not Required	Repair Type #1	
3.7		Repair Frequency (Years)	
☐		Include Repair Labor?	
0.69		Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$121.61	$121.61	Repair Labor Rate ($/hour)	Staff Gen. Maint. Worker
$73.82		Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Fixture	Replace Fixture	Repair Type #2	
20	17.1	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
0.34	0.34	Replacement Labor Required (Hours)	
$111.92	$111.92	Replacement Labor Rate ($/hour)	Electrician
$348.00	$500.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$42.49	$33.85	Average Annual Repair Cost in 2018 Dollars	
$16.89		**Annual O&M Savings per unit**	
$16.89		**Total Savings**	No. of Units: 1

Base typical exterior on replacing a 175W wall pack

	Year	Existing Increase Factor	Existing Annual Repair Cost	Proposed Year	Proposed Increase Factor	Proposed Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
Original Installation	2007	0.2	$ 6.15					x	1	0	107	6.05
	2008	1	$ 30.75					x	2	0	108	6.1
	2009	1.02	$ 31.36					x	3	0	109	6.15
	2010	1.05	$ 32.29					x	4	0	110	6.2
	2011	1.06	$ 32.59					x	5	0	111	6.25
	2012	1.07	$ 32.90					x	6	0	112	6.3
	2013	1.08	$ 33.21					x	7	0	113	6.35
	2014	1.1	$ 33.82					x	8	0	114	6.4
	2015	1.15	$ 35.36					x	9	0	115	6.45
	2016	1.2	$ 36.90					x	10	0	116	6.5
	2017	1.25	$ 38.43					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 39.97	2018	0.2	$6.09	$33.88	x	12	1	118	6.6
	2019	1.35	$ 41.51	2019	1	$30.44	$11.07	x	13	2	119	6.65
	2020	1.4	$ 43.05	2020	1.02	$31.05	$12.00	x	14	3	120	6.7
	2021	1.45	$ 44.58	2021	1.05	$31.96	$12.63	x	15	4	121	6.75
	2022	1.5	$ 46.12	2022	1.06	$32.26	$13.86	x	16	5	122	6.8
	2023	1.55	$ 47.66	2023	1.07	$32.57	$15.09	x	17	6	123	6.85
	2024	1.6	$ 49.20	2024	1.08	$32.87	$16.32	x	18	7	124	6.9
	2025	1.65	$ 50.73	2025	1.1	$33.48	$17.25	x	19	8	125	6.95
	2026	1.7	$ 52.27	2026	1.15	$35.00	$17.27	x	20	9	126	7
	2027	1.75	$ 53.81	2027	1.2	$36.52	$17.28	x	21	10	127	7.05
	2028	1.8	$ 55.35	2028	1.25	$38.05	$17.30	x	22	11	128	7.1
	2029	1.85	$ 56.88	2029	1.3	$39.57	$17.32	x	23	12	129	7.15
	2030	1.9	$ 58.42	2030	1.35	$41.09	$17.33	x	24	13	130	7.2
	2031	1.95	$ 59.96	2031	1.4	$42.61	$17.35	x	25	14	131	7.25
	2032	2	$ 61.50	2032	1.45	$44.13	$17.36	x	26	15	132	7.3
Totals	26	35.93	$ 1,104.77	15	16.68	$507.69	$253.32					

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved
Public Fire #2	Exterior	Security	4380	1	LED-L40-1	Security-Led-Clear-Wall	0.040	0.04	175	Do Nothing	Do Nothing	1	0.040	175.2	0.000	0.00
Public Fire #2	Exterior	Security	4380	1	MH-MH175-1	Security-Mogul-Clear-Wall	0.205	0.205	898	Retrofit	Eiko Litespan Dusk to Dawn LED 40W 3200LM Grey w/120-277V Twistlock Photocell	1	0.040	175.2	0.165	722.70
Public Fire #2	Exterior	Security	4380	1	MH-MH150-1	Wallpack-Medium-Clear-Wall	0.190	0.19	832	Retrofit	ATG 28W LED WallPack	1	0.028	122.64	0.162	709.56

Row Labels	Public Fire #2
Exterior	
Detail	
(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal	
CFL-CF26W-2	
(2) RemPhos LED Post Top Retro Kit, 40W, 4000K	
MH-MH175-2	
Do Nothing	1
LED-L20-1	
LED-L40-1	1
MH-MH35-1	
Eiko 2L 12W T8 Ballast Bypass DLCP	
F-F32T8-2	
RemPhos LED Block Retro Kit, 150W, 5000K, 24000 Lumen	
MH-MH400-1	
RemPhos LED BLock Retrofit, 277W, 5000K, 43000 Lumen	
MH-MH1000-1	
RemPhos LEDSSEXT 40W 4400LM 4000K	
MH-MH175-1	
Typical	**2**

Typical Exterior Lighting Savings	$33.78

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved
Public Works	Storage West	Exterior	4380	4	LED-L20-1	Wallpack-LED-Clear-Wall	0.020	0.08	350	Do Nothing	Do Nothing	4	0.080	350.4	0.000	0.00
Public Works	Storage West	Exterior	2650	4	F-F54T5HO-4	Vapor Tight-2X4-Clear-Aircraft Cable	0.216	0.864	2,290	Retrofit	Eiko 4L LED T5HO Lamp, Direct Fit 25W, 3200lm, 40K	4	0.400	1060	0.464	1,229.60
Public Works	New Property Barn	Exterior	4380	10	LED-L20-1	Wallpack-LED-Clear-Wall	0.020	0.2	876	Do Nothing	Do Nothing	10	0.200	876	0.000	0.00
Public Works	Storage East	Exterior	4380	4	HAL-H50-2	Security-Medium-PAR38-Wall	0.100	0.4	1,752	Retrofit	Eiko LED PAR38, Flood 40D, 17W, 1300lm, 40K	4	0.068	297.84	0.332	1,454.16
Public Works	Water Barn	Exterior	4380	1	MH-MH250-1	Security-Mogul-Open - no lens-Wall	0.295	0.295	1,292	Retrofit	Eiko Litespan Dusk to Dawn LED 60W 5249LM Grey w/120-277V Twistlock Photocell	1	0.060	262.8	0.235	1,029.30
														Exterior	2.9	9072.46

Row Labels	Public Works
Exterior	
Detail	
(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal	
CFL-CF26W-2	
(2) RemPhos LED Post Top Retro Kit, 40W, 4000K	
MH-MH175-2	
Do Nothing	26
LED-L20-1	26
LED-L40-1	
MH-MH35-1	
Eiko 2L 12W T8 Ballast Bypass DLCP	
F-F32T8-2	
RemPhos LED Block Retro Kit, 150W, 5000K, 24000 Lumen	
MH-MH400-1	
RemPhos LED BLock Retrofit, 277W, 5000K, 43000 Lumen	
MH-MH1000-1	
RemPhos LEDSSEXT 40W 4400LM 4000K	
MH-MH175-1	
Typical	**10**

Typical Exterior Lighting Savings $168.88

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved
Public Safety / Animal Control	Exterior	Wallpack	4380	4	CFL-CF26W-1	Wallpack-Plug-in 4 Pin-Clear-Wall	0.028	0.112	491	Retrofit	Deco D400 LED Wall Pack, D400-LED1050UNVBZ	4	0.040	175.2	0.072	315.36
														Exterior	0.072	315.36

Row Labels	Public Safety / Animal Control
Exterior	
Detail	
(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal	
CFL-CF26W-2	
(2) RemPhos LED Post Top Retro Kit, 40W, 4000K	
MH-MH175-2	
Do Nothing	
LED-L20-1	
LED-L40-1	
MH-MH35-1	
Eiko 2L 12W T8 Ballast Bypass DLCP	
F-F32T8-2	
RemPhos LED Block Retro Kit, 150W, 5000K, 24000 Lumen	
MH-MH400-1	
RemPhos LED BLock Retrofit, 277W, 5000K, 43000 Lumen	
MH-MH1000-1	
RemPhos LEDSSEXT 40W 4400LM 4000K	
MH-MH175-1	
Typical	**4**

Typical Exterior Lighting Savings $67.55

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved
Water Treatment	Exterior	Pole Lights	4380	1	MH-MH1000-1	Shoe Box-Mogul-Clear-Pole	1.075	1.075	4,709	Retrofit	Deco Large Gladetino, 1000W Equal, 222W, Slipfitter, Bronze	1	0.222	972.36	0.853	3,736.14
Water Treatment	Exterior	Pole Lights	4380	1	MH-MH400-4	Shoe Box-Mogul-Clear-Pole	1.600	1.6	7,008	Retrofit	(4) Deco Gladetino, 120W, 5000K w/ Slip Fitter	1	0.480	2102.4	1.120	4,905.60
Water Treatment	Exterior	Building	4380	5	INCAN-I60-1	Security-Medium-Clear-Wall	0.060	0.3	1,314	Retrofit	Maxlite 15W Architectural Security Light 50K, PC	5	0.075	328.5	0.225	985.50
Water Treatment	Exterior	Building	4380	2	CFL-CF13W-1	Decorative-Candelabra-Clear-Surface	0.015	0.03	131	Retrofit	Maxlite 15W Architectural Security Light 50K, PC	2	0.030	131.4	0.000	0.00
														Exterior	2.198	9627.24

Row Labels	Water Treatment
Exterior	
Detail	
(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal	
CFL-CF26W-2	
(2) RemPhos LED Post Top Retro Kit, 40W, 4000K	
MH-MH175-2	
Do Nothing	
LED-L20-1	
LED-L40-1	
MH-MH35-1	
Eiko 2L 12W T8 Ballast Bypass DLCP	
F-F32T8-2	
RemPhos LED Block Retro Kit, 150W, 5000K, 24000 Lumen	
MH-MH400-1	
RemPhos LED BLock Retrofit, 277W, 5000K, 43000 Lumen	
MH-MH1000-1	
RemPhos LEDSSEXT 40W 4400LM 4000K	
MH-MH175-1	
Typical	**9**

Typical Exterior Lighting Savings $151.99

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved
Atkin-Johnson House	Bathrooms	Exterior	2400	2	INCAN-I40-1	Decorative-Medium-Open - no lens-Wall	0.040	0.08	192	Retrofit	Eiko LED Filament ST19, 5W, 2200K	2	0.010	24	0.070	168.00
Atkin-Johnson House	Bathrooms	Exterior	2400	1	CFL-CF13W-1	Decorative-Medium-Frosted-Surface	0.015	0.015	36	Retrofit	Eiko 3000K LED LiteSpan A19 Omni-Directional 300 Degree Beam 9W - 800lm Dimmable E26	1	0.009	21.6	0.006	14.40
Atkin-Johnson House	Bathrooms	Interior	2400	6	UFL-FU31T8/6-2	2X2-Troffer-Prismatic-Surface	0.072	0.432	1,037	Retrofit	(2) Eiko LED 6" U-Bend, 18W, 4000K	6	0.216	518.4	0.216	518.40
														Exterior	0.076	182.4

Row Labels	Atkin-Johnson House
Exterior	
Detail	
(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal	
CFL-CF26W-2	
(2) RemPhos LED Post Top Retro Kit, 40W, 4000K	
MH-MH175-2	
Do Nothing	
LED-L20-1	
LED-L40-1	
MH-MH35-1	
Eiko 2L 12W T8 Ballast Bypass DLCP	
F-F32T8-2	
RemPhos LED Block Retro Kit, 150W, 5000K, 24000 Lumen	
MH-MH400-1	
RemPhos LED BLock Retrofit, 277W, 5000K, 43000 Lumen	
MH-MH1000-1	
RemPhos LEDSSEXT 40W 4400LM 4000K	
MH-MH175-1	
Typical	**3**

Typical Exterior Lighting Savings	$50.66

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved
Central Park Pool	Exterior	Break Area	2920	2	MH-MH70-1	Wallpack-Medium-Clear-Wall	0.095	0.19	555	Retrofit	ATG 28W LED WallPack	2	0.056	163.52	0.134	391.28
Central Park Pool	Exterior	Pool Lights	2920	13	MH-MH400-1	Shoe Box-Mogul-Clear-Pole	1.075	13.975	40,807	Retrofit	RemPhos LED Block Retro Kit, 150W, 5000K, 24000 Lumen	13	1.950	5694	12.025	35,113.00
Central Park Pool	Exterior	Canopy	2920	2	F-F32T8-2	Vapor Tight-4 foot-Clear-Surface	0.064	0.128	374	Retrofit	Eiko 2L 12W T8 Ballast Bypass DLCP	2	0.048	140.16	0.080	233.60
														Exterior	12.239	35737.88

Row Labels	Central Park Pool
Exterior	
Detail	
(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal	
CFL-CF26W-2	
(2) RemPhos LED Post Top Retro Kit, 40W, 4000K	
MH-MH175-2	
Do Nothing	
LED-L20-1	
LED-L40-1	
MH-MH35-1	
Eiko 2L 12W T8 Ballast Bypass DLCP	2
F-F32T8-2	2
RemPhos LED Block Retro Kit, 150W, 5000K, 24000 Lumen	13
MH-MH400-1	13
RemPhos LED BLock Retrofit, 277W, 5000K, 43000 Lumen	
MH-MH1000-1	
RemPhos LEDSSEXT 40W 4400LM 4000K	
MH-MH175-1	
Typical	**2**

Typical Exterior Lighting Savings $33.78

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved	Total Saved $	Solution $
Linden Office	Concessions	Exterior	4380	12	HAL-H50-1	Decorative-MR16-Clear-Surface	0.050	0.6	2,628	Retrofit	Eiko LED MR16, GU10, 7W, 4000K (1633)	12	0.084	367.92	0.516	2,260.08	$ 180.81	$254.55
Linden Office	Concessions	Exterior	4380	2	CFL-CF26W-2	8-in Can-Plug-in 4 Pin-Open - no lens-Recessed	0.054	0.108	473	Retrofit	Nicor 8" Retrofit Can, 18W, 4000K w/ Emerg Blst (1633)	2	0.036	157.68	0.072	315.36	$ 25.23	$698.03

Row Labels	Linden Office
Exterior	
Detail	
(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal	
CFL-CF26W-2	
(2) RemPhos LED Post Top Retro Kit, 40W, 4000K	
MH-MH175-2	
Do Nothing	
LED-L20-1	
LED-L40-1	
MH-MH35-1	
Eiko 2L 12W T8 Ballast Bypass DLCP	
F-F32T8-2	
RemPhos LED Block Retro Kit, 150W, 5000K, 24000 Lumen	
MH-MH400-1	
RemPhos LED BLock Retrofit, 277W, 5000K, 43000 Lumen	
MH-MH1000-1	
RemPhos LEDSSEXT 40W 4400LM 4000K	
MH-MH175-1	
Typical	**14**

Typical Exterior Lighting Savings $236.43

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved
Oak Grove Park	Amphitheater	Exterior	4380	1	MH-MH175-1	Wallpack-Mogul-Prismatic-Wall	0.205	0.205	898	Retrofit	ATG 28W LED WallPack	1	0.028	122.64	0.177	775.26
Oak Grove Park	Amphitheater	Exterior	4380	2	MH-MH175-1	Acorn-Mogul-Clear-Wall	0.205	0.41	1,796	Retrofit	Eiko LED Litespan Post Top 36W 4000lm 4K Non-Dim E39 Universal Burn Position Mogule Base	2	0.072	315.36	0.338	1,480.44
Oak Grove Park	Garage/storage	Exterior	4380	6	MH-MH100-1	Wallpack-Medium-Prismatic-Wall	0.120	0.72	3,154	Retrofit	ATG 28W LED WallPack	6	0.168	735.84	0.552	2,417.76
														Exterior	1.067	4673.46

Row Labels	Oak Grove Park
Exterior	
Detail	
(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal	
CFL-CF26W-2	
(2) RemPhos LED Post Top Retro Kit, 40W, 4000K	
MH-MH175-2	
Do Nothing	
LED-L20-1	
LED-L40-1	
MH-MH35-1	
Eiko 2L 12W T8 Ballast Bypass DLCP	
F-F32T8-2	
RemPhos LED Block Retro Kit, 150W, 5000K, 24000 Lumen	
MH-MH400-1	
RemPhos LED BLock Retrofit, 277W, 5000K, 43000 Lumen	
MH-MH1000-1	
RemPhos LEDSSEXT 40W 4400LM 4000K	
MH-MH175-1	
Typical	**9**

Typical Exterior Lighting Savings $151.99

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved
Hamilton Heights Picnic Shelter	Parking Lot	Pole Lights	4380	2	MH-MH175-2	Acorn-Mogul-Clear-Pole	0.350	0.7	3,066	Retrofit	(2) RemPhos LED Po	2	0.160	700.8	0.540	2,365.20

Row Labels	Hamilton Heights Picnic Shelter
Exterior	
Detail	
(2) EIKO LED 9W CFL REPLACEMENT, 2 Pin, Horizontal	
CFL-CF26W-2	
(2) RemPhos LED Post Top Retro Kit, 40W, 4000K	
MH-MH175-2	
Do Nothing	
LED-L20-1	
LED-L40-1	
MH-MH35-1	
Eiko 2L 12W T8 Ballast Bypass DLCP	
F-F32T8-2	
RemPhos LED Block Retro Kit, 150W, 5000K, 24000 Lumen	
MH-MH400-1	
RemPhos LED BLock Retrofit, 277W, 5000K, 43000 Lumen	
MH-MH1000-1	
RemPhos LEDSSEXT 40W 4400LM 4000K	
MH-MH175-1	
Typical	**2**

Typical Exterior Lighting Savings	$33.78

Location	Area	Room	Burn	Qty	Fixture	Fixture Attributes	kW	kW Total	kWh	Action	Proposed	Qty	kW New	kWh New	Total kW Saved	Total kWh Saved
City Hall/Community Center Decorative Street Light	City Hall / Community Center Street Lights	Single Head	4380	45	MH-MH175-1	Acorn-Mogul-Prismatic-Pole	0.205	9.225	40,406	Retrofit	RemPhos LEDSSEXT 40W 4400LM 4000K	45	1.800	7884	7.425	32,521.50
City Hall/Community Center Decorative Street Light	City Hall / Community Center Street Lights	Double Head	4380	46	MH-MH175-2	Acorn-Mogul-Prismatic-Pole	0.350	16.1	70,518	Retrofit	(2) RemPhos LED Post Top Retro Kit, 40W, 4000K	46	3.680	16118.4	12.420	54,399.60
															19.845	86,921.10

City of Gladstone IGA		Project
Gladstone, MO		Location
Exterior - Retro Dec Street		Equipment
108.3%		Location Cost Index — Kansas City, MO
Existing - 175 W M-H	Proposed - LED Retro	
Replace Lamps	Not Required	Repair Type #1
3.42		Repair Frequency (Years)
☑		Include Repair Labor?
0.46		Repair Labor Required (Hours)
In-House		Select In-House or Contract Labor
$121.61	$121.61	Repair Labor Rate ($/hour) — Staff Gen. Maint. Worker
$14.75		Repair Material Cost
☑		Include End-of-Life Replacement Cost in Analysis?
Replace Fixture	Replace Fixture	Repair Type #2
20	22.8	Replacement Frequency (Years)
☑		Include Replacement Labor?
0.3	0.3	Replacement Labor Required (Hours)
$111.92	$111.92	Replacement Labor Rate ($/hour) — Electrician
$134.12	$384.21	Replacement Material Cost
2007		Year Equipment Originally Installed
2018		Year New Equipment to be Installed
15		Length of Performance Contract (Years)
$30.19	$19.92	Average Annual Repair Cost in 2018 Dollars
$16.13		**Annual O&M Savings per unit**
$1,467.94		**Total Savings** — No. of Units: 91

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
Original Installation	2007	0.2	$ 4.37					x	1	0	107	6.05
	2008	1	$ 21.85					x	2	0	108	6.1
	2009	1.02	$ 22.29					x	3	0	109	6.15
	2010	1.05	$ 22.94					x	4	0	110	6.2
	2011	1.06	$ 23.16					x	5	0	111	6.25
	2012	1.07	$ 23.38					x	6	0	112	6.3
	2013	1.08	$ 23.60					x	7	0	113	6.35
	2014	1.1	$ 24.03					x	8	0	114	6.4
	2015	1.15	$ 25.13					x	9	0	115	6.45
	2016	1.2	$ 26.22					x	10	0	116	6.5
	2017	1.25	$ 27.31					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 28.40	2018	0.2	$3.58	$24.82	x	12	1	118	6.6
	2019	1.35	$ 29.50	2019	1	$17.91	$11.58	x	13	2	119	6.65
	2020	1.4	$ 30.59	2020	1.02	$18.27	$12.32	x	14	3	120	6.7
	2021	1.45	$ 31.68	2021	1.05	$18.81	$12.87	x	15	4	121	6.75
	2022	1.5	$ 32.77	2022	1.06	$18.99	$13.79	x	16	5	122	6.8
	2023	1.55	$ 33.87	2023	1.07	$19.17	$14.70	x	17	6	123	6.85
	2024	1.6	$ 34.96	2024	1.08	$19.35	$15.61	x	18	7	124	6.9
	2025	1.65	$ 36.05	2025	1.1	$19.70	$16.35	x	19	8	125	6.95
	2026	1.7	$ 37.14	2026	1.15	$20.60	$16.54	x	20	9	126	7
	2027	1.75	$ 38.24	2027	1.2	$21.50	$16.74	x	21	10	127	7.05
	2028	1.8	$ 39.33	2028	1.25	$22.39	$16.94	x	22	11	128	7.1
	2029	1.85	$ 40.42	2029	1.3	$23.29	$17.13	x	23	12	129	7.15
	2030	1.9	$ 41.51	2030	1.35	$24.18	$17.33	x	24	13	130	7.2
	2031	1.95	$ 42.60	2031	1.4	$25.08	$17.53	x	25	14	131	7.25
	2032	2	$ 43.70	2032	1.45	$25.97	$17.72	x	26	15	132	7.3
Totals	26	35.93	$ 785.02	15	16.68	$298.78	$241.97					

ECM 40 - Community Center RTU Replacement Fuel Switch and Energy Savings

Rebate calc:

Replace 5 RTUs		Cooling, tons	heat, kW	new gas unit, MBH input	replace MBH cooling	replace tons	Spec. EER/SEER	
	RTU-1	65	40	170.6	751	62.6	10.1	EER
	RTU-2	14.3	60	255.9	179	14.9	11.8	EER
	RTU-3	36.7	40	170.6	424	35.3	10	EER
	RTU-5	68.25	240	1023.6	596	49.7	11	EER
		68.25	240	1023.6				
		252.5	620	2644.3				

Total electric heating in building except for boiler					
	1495	kW			
We would convert	41%	of it to gas	excludes Dectrons, AHU-1,2,3, and reheat coils		
	1,842	kW	based on utility analysis balance	4441	kW per year
	696,181	kWh	based on utility analysis balance	1678694	kWh
New units with	82%	efficient furnaces			
Gas used	2,897	MM Btu			
	28,968	therms			

There is additional savings due to more efficient compressor operation

Baseline of cooling energy from UA	807121	kWh
Subtract dehumidification compressor energy	297635	kWh
Subtract controls savings	66,437	kWh
Net energy baseline	443049	kWh
Existing Unit efficiency	7.3	EER
New unit efficiency	10.1	EER
Cooling Efficiency Savings	122,825	kWh

Demand Savings

baseline of cooling demand from UA	1668	kW
Subtract dehumidification compressor demand	615	
RTU demand	1053	
Cooling Demand Savings	292	

City of Gladstone EPC	Project		
Gladstone, MO	Location		
Rooftop Unit 60T VAV	Equipment		
108.3%	Location Cost Index	Kansas City, MO	
Repair RTU	Repair Type #1		
10	Repair Frequency (Years)		
☑	Include Repair Labor?		
298	Repair Labor Required (Hours)		
Contract	Select In-House or Contract Labor		
$114.43	Repair Labor Rate ($/hour)	HVAC Technician	
$27,391.56	Repair Material Cost	$ 22,940	From 2011-2012 Whitestone
☑	Include End-of-Life Replacement Cost in Analysis?		
Replace RTU	Repair Type #2		
15	Replacement Frequency (Years)		
☑	Include Replacement Labor?		
374.0	Replacement Labor Required (Hours)		
$114.43	Replacement Labor Rate ($/hour)	HVAC Technician	
$66,629.31	Replacement Material Cost	$ 55,801	From 2011-2012 Whitestone
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$14,040.27	Average Annual Repair Cost in 2016 Dollars		
$2,723.65	**Annual O&M Savings per unit**		
$2,723.65	**Total Savings**	No. of Units:	1

3% Est. Inflation on Equipment

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
Original Installation	2007	0.2	$ 2,031.99					x	1	0	107	6.05
	2008	1	$ 10,159.95					x	2	0	108	6.1
	2009	1.02	$ 10,363.15					x	3	0	109	6.15
	2010	1.05	$ 10,667.95					x	4	0	110	6.2
	2011	1.06	$ 10,769.55					x	5	0	111	6.25
	2012	1.07	$ 10,871.15					x	6	0	112	6.3
	2013	1.08	$ 10,972.75					x	7	0	113	6.35
	2014	1.1	$ 11,175.94					x	8	0	114	6.4
	2015	1.15	$ 11,683.94					x	9	0	115	6.45
	2016	1.2	$ 12,191.94					x	10	0	116	6.5
	2017	1.25	$ 12,699.94					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 13,207.93	2018	0.2	$2,525.23	$10,682.71	x	12	1	118	6.6
	2019	1.35	$ 13,715.93	2019	1	$12,626.14	$1,089.79	x	13	2	119	6.65
	2020	1.4	$ 14,223.93	2020	1.02	$12,878.66	$1,345.27	x	14	3	120	6.7
	2021	1.45	$ 14,731.93	2021	1.05	$13,257.45	$1,474.48	x	15	4	121	6.75
	2022	1.5	$ 15,239.92	2022	1.06	$13,383.71	$1,856.21	x	16	5	122	6.8
	2023	1.55	$ 15,747.92	2023	1.07	$13,509.97	$2,237.95	x	17	6	123	6.85
	2024	1.6	$ 16,255.92	2024	1.08	$13,636.23	$2,619.69	x	18	7	124	6.9
	2025	1.65	$ 16,763.92	2025	1.1	$13,888.76	$2,875.16	x	19	8	125	6.95
	2026	1.7	$ 17,271.91	2026	1.15	$14,520.06	$2,751.85	x	20	9	126	7
	2027	1.75	$ 17,779.91	2027	1.2	$15,151.37	$2,628.54	x	21	10	127	7.05
	2028	1.8	$ 18,287.91	2028	1.25	$15,782.68	$2,505.23	x	22	11	128	7.1
	2029	1.85	$ 18,795.91	2029	1.3	$16,413.98	$2,381.92	x	23	12	129	7.15
	2030	1.9	$ 19,303.90	2030	1.35	$17,045.29	$2,258.61	x	24	13	130	7.2
	2031	1.95	$ 19,811.90	2031	1.4	$17,676.60	$2,135.30	x	25	14	131	7.25
Totals	26	35.93	##########	15	16.68	$210,604.04	$40,854.72					

City of Gladstone EPC	Project		
Gladstone, MO	Location		
Rooftop Unit 15T SZ	Equipment		
108.3%	Location Cost Index	Kansas City, MO	
Repair RTU	Repair Type #1		
10	Repair Frequency (Years)		
☑	Include Repair Labor?		
77	Repair Labor Required (Hours)		
Contract	Select In-House or Contract Labor		
$114.43	Repair Labor Rate ($/hour)	HVAC Technician	
$15,250.44	Repair Material Cost	$ 12,772	From 2011-2012 Whitestone
☑	Include End-of-Life Replacement Cost in Analysis?		
Replace RTU	Repair Type #2		
15	Replacement Frequency (Years)		
☑	Include Replacement Labor?		
106.0	Replacement Labor Required (Hours)		
$114.43	Replacement Labor Rate ($/hour)	HVAC Technician	
$19,030.81	Replacement Material Cost	$ 15,938	From 2011-2012 Whitestone
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$4,715.39	Average Annual Repair Cost in 2016 Dollars		
$914.73	**Annual O&M Savings per unit**		
$914.73	**Total Savings**	No. of Units:	1

3% Est. Inflation on Equipment

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
Original Installation	2007	0.2	$ 682.44					x	1	0	107	6.05
	2008	1	$ 3,412.20					x	2	0	108	6.1
	2009	1.02	$ 3,480.44					x	3	0	109	6.15
	2010	1.05	$ 3,582.81					x	4	0	110	6.2
	2011	1.06	$ 3,616.93					x	5	0	111	6.25
	2012	1.07	$ 3,651.05					x	6	0	112	6.3
	2013	1.08	$ 3,685.17					x	7	0	113	6.35
	2014	1.1	$ 3,753.42					x	8	0	114	6.4
	2015	1.15	$ 3,924.03					x	9	0	115	6.45
	2016	1.2	$ 4,094.64					x	10	0	116	6.5
	2017	1.25	$ 4,265.25					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 4,435.86	2018	0.2	$848.09	$3,587.76	x	12	1	118	6.6
	2019	1.35	$ 4,606.47	2019	1	$4,240.46	$366.00	x	13	2	119	6.65
	2020	1.4	$ 4,777.08	2020	1.02	$4,325.27	$451.80	x	14	3	120	6.7
	2021	1.45	$ 4,947.69	2021	1.05	$4,452.49	$495.20	x	15	4	121	6.75
	2022	1.5	$ 5,118.30	2022	1.06	$4,494.89	$623.41	x	16	5	122	6.8
	2023	1.55	$ 5,288.91	2023	1.07	$4,537.29	$751.61	x	17	6	123	6.85
	2024	1.6	$ 5,459.52	2024	1.08	$4,579.70	$879.82	x	18	7	124	6.9
	2025	1.65	$ 5,630.13	2025	1.1	$4,664.51	$965.62	x	19	8	125	6.95
	2026	1.7	$ 5,800.73	2026	1.15	$4,876.53	$924.20	x	20	9	126	7
	2027	1.75	$ 5,971.34	2027	1.2	$5,088.55	$882.79	x	21	10	127	7.05
	2028	1.8	$ 6,141.95	2028	1.25	$5,300.58	$841.38	x	22	11	128	7.1
	2029	1.85	$ 6,312.56	2029	1.3	$5,512.60	$799.96	x	23	12	129	7.15
	2030	1.9	$ 6,483.17	2030	1.35	$5,724.62	$758.55	x	24	13	130	7.2
	2031	1.95	$ 6,653.78	2031	1.4	$5,936.65	$717.14	x	25	14	131	7.25
Totals	26	35.93	##########	15	16.68	$70,730.91	$13,720.97					

City of Gladstone EPC	Project		
Gladstone, MO	Location		
Rooftop Unit 35T VAV	Equipment		
108.3%	Location Cost Index	Kansas City, MO	
Repair RTU	Repair Type #1		
10	Repair Frequency (Years)		
☑	Include Repair Labor?		
114	Repair Labor Required (Hours)		
Contract	Select In-House or Contract Labor		
$114.43	Repair Labor Rate ($/hour)	HVAC Technician	
$20,620.09	Repair Material Cost		$ 17,269 From 2011-2012 Whitestone
☑	Include End-of-Life Replacement Cost in Analysis?		
Replace RTU	Repair Type #2		
15	Replacement Frequency (Years)		
☑	Include Replacement Labor?		
196.0	Replacement Labor Required (Hours)		
$114.43	Replacement Labor Rate ($/hour)	HVAC Technician	
$42,307.66	Replacement Material Cost		$ 35,432 From 2011-2012 Whitestone
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$8,087.49	Average Annual Repair Cost in 2016 Dollars		
$1,568.88	**Annual O&M Savings per unit**		
$1,568.88	**Total Savings**	No. of Units: 1	

3% Est. Inflation on Equipment

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
Original Installation	2007	0.2	$ 1,170.47					x	1	0	107	6.05
	2008	1	$ 5,852.34					x	2	0	108	6.1
	2009	1.02	$ 5,969.39					x	3	0	109	6.15
	2010	1.05	$ 6,144.96					x	4	0	110	6.2
	2011	1.06	$ 6,203.48					x	5	0	111	6.25
	2012	1.07	$ 6,262.01					x	6	0	112	6.3
	2013	1.08	$ 6,320.53					x	7	0	113	6.35
	2014	1.1	$ 6,437.58					x	8	0	114	6.4
	2015	1.15	$ 6,730.19					x	9	0	115	6.45
	2016	1.2	$ 7,022.81					x	10	0	116	6.5
	2017	1.25	$ 7,315.43					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 7,608.04	2018	0.2	$1,454.58	$6,153.46	x	12	1	118	6.6
	2019	1.35	$ 7,900.66	2019	1	$7,272.92	$627.74	x	13	2	119	6.65
	2020	1.4	$ 8,193.28	2020	1.02	$7,418.38	$774.90	x	14	3	120	6.7
	2021	1.45	$ 8,485.90	2021	1.05	$7,636.56	$849.33	x	15	4	121	6.75
	2022	1.5	$ 8,778.51	2022	1.06	$7,709.29	$1,069.22	x	16	5	122	6.8
	2023	1.55	$ 9,071.13	2023	1.07	$7,782.02	$1,289.11	x	17	6	123	6.85
	2024	1.6	$ 9,363.75	2024	1.08	$7,854.75	$1,508.99	x	18	7	124	6.9
	2025	1.65	$ 9,656.36	2025	1.1	$8,000.21	$1,656.15	x	19	8	125	6.95
	2026	1.7	$ 9,948.98	2026	1.15	$8,363.86	$1,585.12	x	20	9	126	7
	2027	1.75	$ 10,241.60	2027	1.2	$8,727.50	$1,514.09	x	21	10	127	7.05
	2028	1.8	$ 10,534.21	2028	1.25	$9,091.15	$1,443.07	x	22	11	128	7.1
	2029	1.85	$ 10,826.83	2029	1.3	$9,454.79	$1,372.04	x	23	12	129	7.15
	2030	1.9	$ 11,119.45	2030	1.35	$9,818.44	$1,301.01	x	24	13	130	7.2
	2031	1.95	$ 11,412.07	2031	1.4	$10,182.09	$1,229.98	x	25	14	131	7.25
Totals	26	35.93	##########	15	16.68	$121,312.29	$23,533.17					

City of Gladstone EPC	Project		
Gladstone, MO	Location		
Spectator Seating DOAS	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 55 ton (2 ea)	Proposed - 50 ton (1 ea.)		
Repair Unit	Repair Unit	Repair Type #1	
15	15	Repair Frequency (Years)	
☑		Include Repair Labor?	
430	215	Repair Labor Required (Hours)	
Contract		Select In-House or Contract Labor	
$114.43	$114.43	Repair Labor Rate ($/hour)	HVAC Technician
$39,664.00	$19,832.00	Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Unit	Replace Unit	Repair Type #2	
25	25	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
614.0	307.0	Replacement Labor Required (Hours)	
$114.43	$114.43	Replacement Labor Rate ($/hour)	HVAC Technician
$105,986.00	$52,993.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$13,545.77	$6,772.89	Average Annual Repair Cost in 2016 Dollars	
$9,400.61		**Annual O&M Savings per unit**	
$9,400.61		**Total Savings**	No. of Units: 1

streched out repair and replace frequency since this unit doesn't get used much.

	Existing			**Proposed**							
Year	**Increase Factor**	**Annual Repair Cost**	**Year**	**Increase Factor**	**Annual Repair Cost**	**Savings**	**Include Year?**	**Original Life**	**New Life**	**Increase Factor Year**	**Increase Factor**
1900								0	0	0	
1901								0	0	1	0.2
1902								0	0	2	1
1903								0	0	3	1.02
1904								0	0	4	1.05
1905								0	0	5	1.06
1906								0	0	6	1.07
1907								0	0	7	1.08
1908								0	0	8	1.1
1909								0	0	9	1.15
1910								0	0	10	1.2
1911								0	0	11	1.25
1912								0	0	12	1.3
1913								0	0	13	1.35
1914								0	0	14	1.4
1915								0	0	15	1.45
1916								0	0	16	1.5
1917								0	0	17	1.55
1918								0	0	18	1.6
1919								0	0	19	1.65
1920								0	0	20	1.7
1921								0	0	21	1.75
1922								0	0	22	1.8
1923								0	0	23	1.85

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1924								0	0	24	1.9
1925								0	0	25	1.95
1926								0	0	26	2
1927								0	0	27	2.05
1928								0	0	28	2.1
1929								0	0	29	2.15
1930								0	0	30	2.2
1931								0	0	31	2.25
1932								0	0	32	2.3
1933								0	0	33	2.35
1934								0	0	34	2.4
1935								0	0	35	2.45
1936								0	0	36	2.5
1937								0	0	37	2.55
1938								0	0	38	2.6
1939								0	0	39	2.65
1940								0	0	40	2.7
1941								0	0	41	2.75
1942								0	0	42	2.8
1943								0	0	43	2.85
1944								0	0	44	2.9
1945								0	0	45	2.95
1946								0	0	46	3
1947								0	0	47	3.05
1948								0	0	48	3.1
1949								0	0	49	3.15
1950								0	0	50	3.2
1951								0	0	51	3.25
1952								0	0	52	3.3
1953								0	0	53	3.35
1954								0	0	54	3.4
1955								0	0	55	3.45
1956								0	0	56	3.5
1957								0	0	57	3.55
1958								0	0	58	3.6
1959								0	0	59	3.65
1960								0	0	60	3.7
1961								0	0	61	3.75
1962								0	0	62	3.8
1963								0	0	63	3.85
1964								0	0	64	3.9
1965								0	0	65	3.95
1966								0	0	66	4
1967								0	0	67	4.05
1968								0	0	68	4.1
1969								0	0	69	4.15
1970								0	0	70	4.2
1971								0	0	71	4.25
1972								0	0	72	4.3
1973								0	0	73	4.35
1974								0	0	74	4.4

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	1975								0	0	75	4.45
	1976								0	0	76	4.5
	1977								0	0	77	4.55
	1978								0	0	78	4.6
	1979								0	0	79	4.65
	1980								0	0	80	4.7
	1981								0	0	81	4.75
	1982								0	0	82	4.8
	1983								0	0	83	4.85
	1984								0	0	84	4.9
	1985								0	0	85	4.95
	1986								0	0	86	5
	1987								0	0	87	5.05
	1988								0	0	88	5.1
	1989								0	0	89	5.15
	1990								0	0	90	5.2
	1991								0	0	91	5.25
	1992								0	0	92	5.3
	1993								0	0	93	5.35
	1994								0	0	94	5.4
	1995								0	0	95	5.45
	1996								0	0	96	5.5
	1997								0	0	97	5.55
	1998								0	0	98	5.6
	1999								0	0	99	5.65
	2000								0	0	100	5.7
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
Original Installation	2007	0.2	$ 1,960.42					x	1	0	107	6.05
	2008	1	$ 9,802.12					x	2	0	108	6.1
	2009	1.02	$ 9,998.16					x	3	0	109	6.15
	2010	1.05	$ 10,292.22					x	4	0	110	6.2
	2011	1.06	$ 10,390.25					x	5	0	111	6.25
	2012	1.07	$ 10,488.27					x	6	0	112	6.3
	2013	1.08	$ 10,586.29					x	7	0	113	6.35
	2014	1.1	$ 10,782.33					x	8	0	114	6.4
	2015	1.15	$ 11,272.44					x	9	0	115	6.45
	2016	1.2	$ 11,762.54					x	10	0	116	6.5
	2017	1.25	$ 12,252.65					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 12,742.75	2018	0.2	$1,218.15	$11,524.61	x	12	1	118	6.6
	2019	1.35	$ 13,232.86	2019	1	$6,090.73	$7,142.13	x	13	2	119	6.65
	2020	1.4	$ 13,722.97	2020	1.02	$6,212.54	$7,510.43	x	14	3	120	6.7
	2021	1.45	$ 14,213.07	2021	1.05	$6,395.26	$7,817.81	x	15	4	121	6.75
	2022	1.5	$ 14,703.18	2022	1.06	$6,456.17	$8,247.01	x	16	5	122	6.8
	2023	1.55	$ 15,193.28	2023	1.07	$6,517.08	$8,676.21	x	17	6	123	6.85
	2024	1.6	$ 15,683.39	2024	1.08	$6,577.98	$9,105.41	x	18	7	124	6.9
	2025	1.65	$ 16,173.50	2025	1.1	$6,699.80	$9,473.70	x	19	8	125	6.95

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
2026	1.7	$ 16,663.60	2026	1.15	$7,004.33	$9,659.27	x	20	9	126	7
2027	1.75	$ 17,153.71	2027	1.2	$7,308.87	$9,844.84	x	21	10	127	7.05
2028	1.8	$ 17,643.81	2028	1.25	$7,613.41	$10,030.41	x	22	11	128	7.1
2029	1.85	$ 18,133.92	2029	1.3	$7,917.94	$10,215.98	x	23	12	129	7.15
2030	1.9	$ 18,624.03	2030	1.35	$8,222.48	$10,401.55	x	24	13	130	7.2
2031	1.95	$ 19,114.13	2031	1.4	$8,527.02	$10,587.12	x	25	14	131	7.25
2032	2	$ 19,604.24	2032	1.45	$8,831.55	$10,772.68	x	26	15	132	7.3
2033								0	0	133	7.35
2034								0	0	134	7.4
2035								0	0	135	7.45
2036								0	0	136	7.5
2037								0	0	137	7.55
2038								0	0	138	7.6
2039								0	0	139	7.65
2040								0	0	140	7.7
2041								0	0	141	7.75
2042								0	0	142	7.8
2043								0	0	143	7.85
2044								0	0	144	7.9
2045								0	0	145	7.95
2046								0	0	146	8
2047								0	0	147	8.05
2048								0	0	148	8.1
2049								0	0	149	8.15
2050								0	0	150	8.2
2051								0	0	151	8.25
2052								0	0	152	8.3
2053								0	0	153	8.35
2054								0	0	154	8.4
2055								0	0	155	8.45
2056								0	0	156	8.5
2057								0	0	157	8.55
2058								0	0	158	8.6
2059								0	0	159	8.65
2060								0	0	160	8.7
2061								0	0	161	8.75
2062								0	0	162	8.8
2063								0	0	163	8.85
2064								0	0	164	8.9
2065								0	0	165	8.95
2066								0	0	166	9
2067								0	0	167	9.05
2068								0	0	168	9.1
2069								0	0	169	9.15
2070								0	0	170	9.2
2071								0	0	171	9.25
2072								0	0	172	9.3
2073								0	0	173	9.35
2074								0	0	174	9.4
2075								0	0	175	9.45
2076								0	0	176	9.5

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2077								0	0	177	9.55
	2078								0	0	178	9.6
	2079								0	0	179	9.65
	2080								0	0	180	9.7
	2081								0	0	181	9.75
	2082								0	0	182	9.8
	2083								0	0	183	9.85
	2084								0	0	184	9.9
	2085								0	0	185	9.95
	2086								0	0	186	10
	2087								0	0	187	10.05
	2088								0	0	188	10.1
	2089								0	0	189	10.15
	2090								0	0	190	10.2
	2091								0	0	191	10.25
	2092								0	0	192	10.3
	2093								0	0	193	10.35
	2094								0	0	194	10.4
	2095								0	0	195	10.45
	2096								0	0	196	10.5
	2097								0	0	197	10.55
	2098								0	0	198	10.6
	2099								0	0	199	10.65
	2100								0	0	200	10.7
Totals	26	35.93	##########	15	16.68	$101,593.30	$141,009.13					

City Hall / Public Safety Fuel Switch and Energy Savings Calculation

Rebate calculation

Units to be replaced:				MBH cooling	Required EER/SEER		Spec. EER/SEER	
RTU-1	6	ton	RTU	66.3	11.7	EER	12	EER
RTU-2	5	ton	RTU	61.8	14.0	SEER	14	EER
RTU-3	3	ton	RTU	31.0	14.0	SEER	13	EER
RTU-4	5	ton	RTU	61.8	14.0	SEER	14	EER
RTU-5	5	ton	RTU	61.8	14.0	SEER	14	EER
RTU-6	6	ton	RTU	66.3	11.7	EER	12	EER
RTU-7	12.5	ton	RTU	138.0	11.7	EER	12	EER
RTU-8	5	ton	RTU	61.8	14.0	SEER	14	EER
RTU-9	5	ton	RTU	61.8	14.0	SEER	14	EER
RTU-10	5	ton	RTU	61.8	14.0	SEER	13	EER
CDU-1	5	ton	split system	53.7	14.0	SEER	15.5	SEER
CDU-2	4	ton	split system	44.6	14.0	SEER	15	SEER
CDU-3	4	ton	split system	44.6	14.0	SEER	15	SEER
CDU-4	2.5	ton	split system	28.3	14.0	SEER	14	SEER
CDU-5	3	ton	split system	33.4	14.0	SEER	15	SEER
CDU-6	10	ton	split system	107.4	11.7	EER	11.2	EER
CDU-9	3.5	ton	split system	39.8	14.0	SEER	15	SEER
CDU-10	3.5	ton	split system	39.8	14.0	SEER	15	SEER
	93	100%						
total installed	91	tons						

Cooling Savings:	Annual Cooling from UA	33,264	kWh less controls savings		
	Old efficiency	1.2	kW/ton	10	SEER
	New efficiency	0.86	kW/ton	14	SEER
	Cooling Savings	9,504	kWh		
	Annual Demand from UA	340	kW		
	Demand Savings	77.7	kW		

Replace electric heat pump units with standard RTUs and furnaces with gas heat

Annual heating energy	99,784	kWh			
Amount being replaced less controls heating savings	70,592.91	kWh	71%		
Demand saved during heating season based on UA	401.2	kW	Use 85% diversity		
New unit eff	85%	average between RTUs and condensing furnaces in splits			
New unit gas use	7,084.21	therms	0.19	therms/sf	used COP of existing HPs of 2.5

City of Gladstone EPC	Project			
City Hall Gladstone, MO	Location			
Rooftop Unit 3 T SZ	Equipment			
108.3%	Location Cost Index	Kansas City, MO		
Repair RTU	Repair Type #1			
10	Repair Frequency (Years)			
☑	Include Repair Labor?			
17.8	Repair Labor Required (Hours)			
Contract	Select In-House or Contract Labor			
$114.43	Repair Labor Rate ($/hour)	HVAC Technician		
$1,003.00	Repair Material Cost		$ 840 From 2011-2012 Whitestone	3% Est. Inflation on Equipment
☑	Include End-of-Life Replacement Cost in Analysis?			
Replace RTU	Repair Type #2			
15	Replacement Frequency (Years)			
☑	Include Replacement Labor?			
38.5	Replacement Labor Required (Hours)			
$114.43	Replacement Labor Rate ($/hour)	HVAC Technician		
$4,371.43	Replacement Material Cost		$ 3,661 From 2011-2012 Whitestone	
2007	Year Equipment Originally Installed			
2018	Year New Equipment to be Installed			
15	Length of Performance Contract (Years)			
$921.63	Average Annual Repair Cost in 2016 Dollars			
$178.79	**Annual O&M Savings per unit**			
$178.79	**Total Savings**	No. of Units: 1		

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
Original Installation	2007	0.2	$ 133.38					x	1	0	107	6.05
	2008	1	$ 666.92					x	2	0	108	6.1
	2009	1.02	$ 680.26					x	3	0	109	6.15
	2010	1.05	$ 700.26					x	4	0	110	6.2
	2011	1.06	$ 706.93					x	5	0	111	6.25
	2012	1.07	$ 713.60					x	6	0	112	6.3
	2013	1.08	$ 720.27					x	7	0	113	6.35
	2014	1.1	$ 733.61					x	8	0	114	6.4
	2015	1.15	$ 766.96					x	9	0	115	6.45
	2016	1.2	$ 800.30					x	10	0	116	6.5
	2017	1.25	$ 833.65					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 866.99	2018	0.2	$165.76	$701.23	x	12	1	118	6.6
	2019	1.35	$ 900.34	2019	1	$828.80	$71.54	x	13	2	119	6.65
	2020	1.4	$ 933.69	2020	1.02	$845.38	$88.31	x	14	3	120	6.7
	2021	1.45	$ 967.03	2021	1.05	$870.24	$96.79	x	15	4	121	6.75
	2022	1.5	$ 1,000.38	2022	1.06	$878.53	$121.85	x	16	5	122	6.8
	2023	1.55	$ 1,033.72	2023	1.07	$886.82	$146.90	x	17	6	123	6.85
	2024	1.6	$ 1,067.07	2024	1.08	$895.11	$171.96	x	18	7	124	6.9
	2025	1.65	$ 1,100.42	2025	1.1	$911.68	$188.73	x	19	8	125	6.95
	2026	1.7	$ 1,133.76	2026	1.15	$953.13	$180.64	x	20	9	126	7
	2027	1.75	$ 1,167.11	2027	1.2	$994.57	$172.54	x	21	10	127	7.05
	2028	1.8	$ 1,200.45	2028	1.25	$1,036.01	$164.45	x	22	11	128	7.1
	2029	1.85	$ 1,233.80	2029	1.3	$1,077.45	$156.35	x	23	12	129	7.15
	2030	1.9	$ 1,267.15	2030	1.35	$1,118.89	$148.26	x	24	13	130	7.2
	2031	1.95	$ 1,300.49	2031	1.4	$1,160.33	$140.17	x	25	14	131	7.25
Totals	26	35.93	$ 23,962.40	15	16.68	$13,824.46	$2,681.78					

City of Gladstone EPC	Project	
City Hall Gladstone, MO	Location	
Rooftop Unit 5&6 T SZ	Equipment	
108.3%	Location Cost Index	Kansas City, MO
Repair RTU	Repair Type #1	
10	Repair Frequency (Years)	
☑	Include Repair Labor?	
18.3	Repair Labor Required (Hours)	
Contract	Select In-House or Contract Labor	
$114.43	Repair Labor Rate ($/hour)	HVAC Technician
$1,459.13	Repair Material Cost	
☑	Include End-of-Life Replacement Cost in Analysis?	
Replace RTU	Repair Type #2	
15	Replacement Frequency (Years)	
☑	Include Replacement Labor?	
56.6	Replacement Labor Required (Hours)	
$114.43	Replacement Labor Rate ($/hour)	HVAC Technician
$5,610.85	Replacement Material Cost	
2007	Year Equipment Originally Installed	
2018	Year New Equipment to be Installed	
15	Length of Performance Contract (Years)	
$1,204.32	Average Annual Repair Cost in 2016 Dollars	
$233.62	**Annual O&M Savings per unit**	
$1,401.74	**Total Savings**	No. of Units: 6

$ 1,222 From 2011-2012 Whitestone

3% Est. Inflation on Equipment

$ 4,699 From 2011-2012 Whitestone

		Existing		Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
Original Installation	2007	0.2	$ 174.30					x	1	0	107	6.05
	2008	1	$ 871.48					x	2	0	108	6.1
	2009	1.02	$ 888.91					x	3	0	109	6.15
	2010	1.05	$ 915.05					x	4	0	110	6.2
	2011	1.06	$ 923.77					x	5	0	111	6.25
	2012	1.07	$ 932.48					x	6	0	112	6.3
	2013	1.08	$ 941.20					x	7	0	113	6.35
	2014	1.1	$ 958.63					x	8	0	114	6.4
	2015	1.15	$ 1,002.20					x	9	0	115	6.45
	2016	1.2	$ 1,045.77					x	10	0	116	6.5
	2017	1.25	$ 1,089.35					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 1,132.92	2018	0.2	$216.60	$916.32	x	12	1	118	6.6
	2019	1.35	$ 1,176.50	2019	1	$1,083.02	$93.48	x	13	2	119	6.65
	2020	1.4	$ 1,220.07	2020	1.02	$1,104.68	$115.39	x	14	3	120	6.7
	2021	1.45	$ 1,263.64	2021	1.05	$1,137.17	$126.47	x	15	4	121	6.75
	2022	1.5	$ 1,307.22	2022	1.06	$1,148.00	$159.22	x	16	5	122	6.8
	2023	1.55	$ 1,350.79	2023	1.07	$1,158.83	$191.96	x	17	6	123	6.85
	2024	1.6	$ 1,394.37	2024	1.08	$1,169.66	$224.71	x	18	7	124	6.9
	2025	1.65	$ 1,437.94	2025	1.1	$1,191.32	$246.62	x	19	8	125	6.95
	2026	1.7	$ 1,481.51	2026	1.15	$1,245.47	$236.04	x	20	9	126	7
	2027	1.75	$ 1,525.09	2027	1.2	$1,299.62	$225.47	x	21	10	127	7.05
	2028	1.8	$ 1,568.66	2028	1.25	$1,353.77	$214.89	x	22	11	128	7.1
	2029	1.85	$ 1,612.23	2029	1.3	$1,407.92	$204.31	x	23	12	129	7.15
	2030	1.9	$ 1,655.81	2030	1.35	$1,462.07	$193.73	x	24	13	130	7.2
	2031	1.95	$ 1,699.38	2031	1.4	$1,516.23	$183.16	x	25	14	131	7.25
Totals	26	35.93	$ 31,312.22	15	16.68	$18,064.74	$3,504.35					

City of Gladstone EPC	Project		
City Hall Gladstone, MO	Location		
Rooftop Unit 12.5T SZ	Equipment		
108.3%	Location Cost Index	Kansas City, MO	
Repair RTU	Repair Type #1		
10	Repair Frequency (Years)		
☑	Include Repair Labor?		
54.8	Repair Labor Required (Hours)		
Contract	Select In-House or Contract Labor		
$114.43	Repair Labor Rate ($/hour)	HVAC Technician	
$10,367.96	Repair Material Cost	$ 8,683	From 2011-2012 Whitestone
☑	Include End-of-Life Replacement Cost in Analysis?		
Replace RTU	Repair Type #2		
15	Replacement Frequency (Years)		
☑	Include Replacement Labor?		
91.9	Replacement Labor Required (Hours)		
$114.43	Replacement Labor Rate ($/hour)	HVAC Technician	
$12,709.49	Replacement Material Cost	$ 10,644	From 2011-2012 Whitestone
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$3,368.62	Average Annual Repair Cost in 2016 Dollars		
$653.47	**Annual O&M Savings per unit**		
$653.47	**Total Savings**	No. of Units:	1

3% Est. Inflation on Equipment

	Existing			Proposed									
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
Original Installation	2007	0.2	$ 487.53					x	1	0	107	6.05
	2008	1	$ 2,437.64					x	2	0	108	6.1
	2009	1.02	$ 2,486.39					x	3	0	109	6.15
	2010	1.05	$ 2,559.52					x	4	0	110	6.2
	2011	1.06	$ 2,583.89					x	5	0	111	6.25
	2012	1.07	$ 2,608.27					x	6	0	112	6.3
	2013	1.08	$ 2,632.65					x	7	0	113	6.35
	2014	1.1	$ 2,681.40					x	8	0	114	6.4
	2015	1.15	$ 2,803.28					x	9	0	115	6.45
	2016	1.2	$ 2,925.16					x	10	0	116	6.5
	2017	1.25	$ 3,047.04					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 3,168.93	2018	0.2	$605.87	$2,563.06	x	12	1	118	6.6
	2019	1.35	$ 3,290.81	2019	1	$3,029.34	$261.47	x	13	2	119	6.65
	2020	1.4	$ 3,412.69	2020	1.02	$3,089.92	$322.76	x	14	3	120	6.7
	2021	1.45	$ 3,534.57	2021	1.05	$3,180.81	$353.77	x	15	4	121	6.75
	2022	1.5	$ 3,656.45	2022	1.06	$3,211.10	$445.35	x	16	5	122	6.8
	2023	1.55	$ 3,778.33	2023	1.07	$3,241.39	$536.94	x	17	6	123	6.85
	2024	1.6	$ 3,900.22	2024	1.08	$3,271.69	$628.53	x	18	7	124	6.9
	2025	1.65	$ 4,022.10	2025	1.1	$3,332.27	$689.83	x	19	8	125	6.95
	2026	1.7	$ 4,143.98	2026	1.15	$3,483.74	$660.24	x	20	9	126	7
	2027	1.75	$ 4,265.86	2027	1.2	$3,635.21	$630.66	x	21	10	127	7.05
	2028	1.8	$ 4,387.74	2028	1.25	$3,786.67	$601.07	x	22	11	128	7.1
	2029	1.85	$ 4,509.62	2029	1.3	$3,938.14	$571.49	x	23	12	129	7.15
	2030	1.9	$ 4,631.51	2030	1.35	$4,089.61	$541.90	x	24	13	130	7.2
	2031	1.95	$ 4,753.39	2031	1.4	$4,241.07	$512.31	x	25	14	131	7.25
Totals	26	35.93	$ 87,584.23	15	16.68	$50,529.36	$9,802.11					

City of Gladstone EPC	Project		
City Hall, Gladstone, MO	Location		
5T RTUs replacing Splits	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 5T Split HP	Proposed - 5T Gas/Elect RTU		
Repair Unit	Repair Unit	Repair Type #1	
10	10	Repair Frequency (Years)	
☑	☑	Include Repair Labor?	
17.7	18.3	Repair Labor Required (Hours)	
Contract	Contract	Select In-House or Contract Labor	
$114.43	$114.43	Repair Labor Rate ($/hour)	HVAC Technician
$1,570.18	$1,222.00	Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Unit	Replace Unit	Repair Type #2	
20	15	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
62.4	56.6	Replacement Labor Required (Hours)	
$114.43	$114.43	Replacement Labor Rate ($/hour)	HVAC Technician
$4,890.84	$4,699.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$994.45	$1,112.80	Average Annual Repair Cost in 2016 Dollars	
$74.56		**Annual O&M Savings per unit**	
$149.13		**Total Savings**	No. of Units: 2

streched out repair and replace frequency since this unit doesn't get used much.

	Existing		Proposed								
Year	**Increase Factor**	**Annual Repair Cost**	**Year**	**Increase Factor**	**Annual Repair Cost**	**Savings**	**Include Year?**	**Original Life**	**New Life**	**Increase Factor Year**	**Increase Factor**
1900								0	0	0	
1901								0	0	1	0.2
1902								0	0	2	1
1903								0	0	3	1.02
1904								0	0	4	1.05
1905								0	0	5	1.06
1906								0	0	6	1.07
1907								0	0	7	1.08
1908								0	0	8	1.1
1909								0	0	9	1.15
1910								0	0	10	1.2
1911								0	0	11	1.25
1912								0	0	12	1.3
1913								0	0	13	1.35
1914								0	0	14	1.4
1915								0	0	15	1.45
1916								0	0	16	1.5
1917								0	0	17	1.55
1918								0	0	18	1.6
1919								0	0	19	1.65
1920								0	0	20	1.7
1921								0	0	21	1.75
1922								0	0	22	1.8
1923								0	0	23	1.85

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1924								0	0	24	1.9
1925								0	0	25	1.95
1926								0	0	26	2
1927								0	0	27	2.05
1928								0	0	28	2.1
1929								0	0	29	2.15
1930								0	0	30	2.2
1931								0	0	31	2.25
1932								0	0	32	2.3
1933								0	0	33	2.35
1934								0	0	34	2.4
1935								0	0	35	2.45
1936								0	0	36	2.5
1937								0	0	37	2.55
1938								0	0	38	2.6
1939								0	0	39	2.65
1940								0	0	40	2.7
1941								0	0	41	2.75
1942								0	0	42	2.8
1943								0	0	43	2.85
1944								0	0	44	2.9
1945								0	0	45	2.95
1946								0	0	46	3
1947								0	0	47	3.05
1948								0	0	48	3.1
1949								0	0	49	3.15
1950								0	0	50	3.2
1951								0	0	51	3.25
1952								0	0	52	3.3
1953								0	0	53	3.35
1954								0	0	54	3.4
1955								0	0	55	3.45
1956								0	0	56	3.5
1957								0	0	57	3.55
1958								0	0	58	3.6
1959								0	0	59	3.65
1960								0	0	60	3.7
1961								0	0	61	3.75
1962								0	0	62	3.8
1963								0	0	63	3.85
1964								0	0	64	3.9
1965								0	0	65	3.95
1966								0	0	66	4
1967								0	0	67	4.05
1968								0	0	68	4.1
1969								0	0	69	4.15
1970								0	0	70	4.2
1971								0	0	71	4.25
1972								0	0	72	4.3
1973								0	0	73	4.35
1974								0	0	74	4.4

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	1975								0	0	75	4.45
	1976								0	0	76	4.5
	1977								0	0	77	4.55
	1978								0	0	78	4.6
	1979								0	0	79	4.65
	1980								0	0	80	4.7
	1981								0	0	81	4.75
	1982								0	0	82	4.8
	1983								0	0	83	4.85
	1984								0	0	84	4.9
	1985								0	0	85	4.95
	1986								0	0	86	5
	1987								0	0	87	5.05
	1988								0	0	88	5.1
	1989								0	0	89	5.15
	1990								0	0	90	5.2
	1991								0	0	91	5.25
	1992								0	0	92	5.3
	1993								0	0	93	5.35
	1994								0	0	94	5.4
	1995								0	0	95	5.45
	1996								0	0	96	5.5
	1997								0	0	97	5.55
	1998								0	0	98	5.6
	1999								0	0	99	5.65
	2000								0	0	100	5.7
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
Original Installation	2007	0.2	$ 143.92					x	1	0	107	6.05
	2008	1	$ 719.61					x	2	0	108	6.1
	2009	1.02	$ 734.01					x	3	0	109	6.15
	2010	1.05	$ 755.59					x	4	0	110	6.2
	2011	1.06	$ 762.79					x	5	0	111	6.25
	2012	1.07	$ 769.99					x	6	0	112	6.3
	2013	1.08	$ 777.18					x	7	0	113	6.35
	2014	1.1	$ 791.58					x	8	0	114	6.4
	2015	1.15	$ 827.56					x	9	0	115	6.45
	2016	1.2	$ 863.54					x	10	0	116	6.5
	2017	1.25	$ 899.52					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 935.50	2018	0.2	$200.14	$735.35	x	12	1	118	6.6
	2019	1.35	$ 971.48	2019	1	$1,000.72	($29.24)	x	13	2	119	6.65
	2020	1.4	$ 1,007.46	2020	1.02	$1,020.73	($13.27)	x	14	3	120	6.7
	2021	1.45	$ 1,043.44	2021	1.05	$1,050.75	($7.31)	x	15	4	121	6.75
	2022	1.5	$ 1,079.42	2022	1.06	$1,060.76	$18.66	x	16	5	122	6.8
	2023	1.55	$ 1,115.40	2023	1.07	$1,070.77	$44.63	x	17	6	123	6.85
	2024	1.6	$ 1,151.38	2024	1.08	$1,080.78	$70.61	x	18	7	124	6.9
	2025	1.65	$ 1,187.36	2025	1.1	$1,100.79	$86.57	x	19	8	125	6.95

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
2026	1.7	$ 1,223.34	2026	1.15	$1,150.83	$72.52	x	20	9	126	7
2027	1.75	$ 1,259.32	2027	1.2	$1,200.86	$58.46	x	21	10	127	7.05
2028	1.8	$ 1,295.31	2028	1.25	$1,250.90	$44.41	x	22	11	128	7.1
2029	1.85	$ 1,331.29	2029	1.3	$1,300.93	$30.35	x	23	12	129	7.15
2030	1.9	$ 1,367.27	2030	1.35	$1,350.97	$16.30	x	24	13	130	7.2
2031	1.95	$ 1,403.25	2031	1.4	$1,401.01	$2.24	x	25	14	131	7.25
2032	2	$ 1,439.23	2032	1.45	$1,451.04	($11.81)	x	26	15	132	7.3
2033								0	0	133	7.35
2034								0	0	134	7.4
2035								0	0	135	7.45
2036								0	0	136	7.5
2037								0	0	137	7.55
2038								0	0	138	7.6
2039								0	0	139	7.65
2040								0	0	140	7.7
2041								0	0	141	7.75
2042								0	0	142	7.8
2043								0	0	143	7.85
2044								0	0	144	7.9
2045								0	0	145	7.95
2046								0	0	146	8
2047								0	0	147	8.05
2048								0	0	148	8.1
2049								0	0	149	8.15
2050								0	0	150	8.2
2051								0	0	151	8.25
2052								0	0	152	8.3
2053								0	0	153	8.35
2054								0	0	154	8.4
2055								0	0	155	8.45
2056								0	0	156	8.5
2057								0	0	157	8.55
2058								0	0	158	8.6
2059								0	0	159	8.65
2060								0	0	160	8.7
2061								0	0	161	8.75
2062								0	0	162	8.8
2063								0	0	163	8.85
2064								0	0	164	8.9
2065								0	0	165	8.95
2066								0	0	166	9
2067								0	0	167	9.05
2068								0	0	168	9.1
2069								0	0	169	9.15
2070								0	0	170	9.2
2071								0	0	171	9.25
2072								0	0	172	9.3
2073								0	0	173	9.35
2074								0	0	174	9.4
2075								0	0	175	9.45
2076								0	0	176	9.5

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2077								0	0	177	9.55
	2078								0	0	178	9.6
	2079								0	0	179	9.65
	2080								0	0	180	9.7
	2081								0	0	181	9.75
	2082								0	0	182	9.8
	2083								0	0	183	9.85
	2084								0	0	184	9.9
	2085								0	0	185	9.95
	2086								0	0	186	10
	2087								0	0	187	10.05
	2088								0	0	188	10.1
	2089								0	0	189	10.15
	2090								0	0	190	10.2
	2091								0	0	191	10.25
	2092								0	0	192	10.3
	2093								0	0	193	10.35
	2094								0	0	194	10.4
	2095								0	0	195	10.45
	2096								0	0	196	10.5
	2097								0	0	197	10.55
	2098								0	0	198	10.6
	2099								0	0	199	10.65
	2100								0	0	200	10.7
Totals	26	35.93	$ 25,855.73	15	16.68	$16,691.98	$1,118.46					

City of Gladstone EPC	Project			
City Hall Gladstone, MO	Location			
Split Systems, 4T (average)	Equipment			
108.3%	Location Cost Index	Kansas City, MO		
Repair RTU	Repair Type #1			
10	Repair Frequency (Years)			
☑	Include Repair Labor?			
27.64	Repair Labor Required (Hours)			
Contract	Select In-House or Contract Labor			
$114.43	Repair Labor Rate ($/hour)	HVAC Technician		
$2,180.34	Repair Material Cost		$ 1,826 From 2011-2012 Whitestone	3% Est. Inflation on Equip
☑	Include End-of-Life Replacement Cost in Analysis?			
Replace RTU	Repair Type #2			
20	Replacement Frequency (Years)			
☑	Include Replacement Labor?			
39.0	Replacement Labor Required (Hours)			
$114.43	Replacement Labor Rate ($/hour)	HVAC Technician		
$4,569.64	Replacement Material Cost		$ 3,827 From 2011-2012 Whitestone	
2007	Year Equipment Originally Installed			
2018	Year New Equipment to be Installed			
15	Length of Performance Contract (Years)			
$1,023.00	Average Annual Repair Cost in 2016 Dollars			
$198.45	**Annual O&M Savings per unit**			
$1,587.60	**Total Savings**	No. of Units: 8		

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
Original Installation	2007	0.2	$ 148.05					x	1	0	107	6.05
	2008	1	$ 740.27					x	2	0	108	6.1
	2009	1.02	$ 755.08					x	3	0	109	6.15
	2010	1.05	$ 777.29					x	4	0	110	6.2
	2011	1.06	$ 784.69					x	5	0	111	6.25
	2012	1.07	$ 792.09					x	6	0	112	6.3
	2013	1.08	$ 799.49					x	7	0	113	6.35
	2014	1.1	$ 814.30					x	8	0	114	6.4
	2015	1.15	$ 851.31					x	9	0	115	6.45
	2016	1.2	$ 888.33					x	10	0	116	6.5
	2017	1.25	$ 925.34					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 962.35	2018	0.2	$183.99	$778.36	x	12	1	118	6.6
	2019	1.35	$ 999.37	2019	1	$919.96	$79.40	x	13	2	119	6.65
	2020	1.4	$ 1,036.38	2020	1.02	$938.36	$98.02	x	14	3	120	6.7
	2021	1.45	$ 1,073.39	2021	1.05	$965.96	$107.43	x	15	4	121	6.75
	2022	1.5	$ 1,110.41	2022	1.06	$975.16	$135.25	x	16	5	122	6.8
	2023	1.55	$ 1,147.42	2023	1.07	$984.36	$163.06	x	17	6	123	6.85
	2024	1.6	$ 1,184.44	2024	1.08	$993.56	$190.88	x	18	7	124	6.9
	2025	1.65	$ 1,221.45	2025	1.1	$1,011.96	$209.49	x	19	8	125	6.95
	2026	1.7	$ 1,258.46	2026	1.15	$1,057.96	$200.50	x	20	9	126	7
	2027	1.75	$ 1,295.48	2027	1.2	$1,103.96	$191.52	x	21	10	127	7.05
	2028	1.8	$ 1,332.49	2028	1.25	$1,149.95	$182.54	x	22	11	128	7.1

	2029	1.85	$ 1,369.50	2029	1.3	$1,195.95	$173.55	x	23	12		129	7.15
	2030	1.9	$ 1,406.52	2030	1.35	$1,241.95	$164.57	x	24	13		130	7.2
	2031	1.95	$ 1,443.53	2031	1.4	$1,287.95	$155.58	x	25	14		131	7.25
Totals	26	35.93	$ 26,597.97	15	16.68	$15,344.98	$2,976.75						

RTU-4 Savings

Vendor energy models included pool water heating from separate source. We will not include that in the evaluation of the dehum unit savings since it will be dealt with in the boiler replacement ecm.

	Dectron	Poolpak	Saved
Electric Rate Used, $/kWh	$ 0.0943	$ 0.0810	
Gas Rate Used, $/therm	$ 0.59	$ 0.791	
Annual Fan Cost	$ 32,041	$ 25,152	
Annual Fan Energy, kWh	339,777	310,519	29,259
Annual Compressor Cost	$ 17,618	$ 14,208	
Annual Compressor Energy, kWh	186,829	175,407	11,422
Annual Air Heating Cost	$ 2,942	$ 2,086	
Annual Air Heating Energy, kWh	182,686		182,686
Annual Air Heating Energy, therms		2,637	(2,637)
Net Savings, kWh			223,367
Net Savings, therms			(2,637)

For comparison to predicted pool water heating energy determined from UA, below is the vendor model info

	Dectron	Poolpak
Annual Cost	$ 12,402	$ 14,967
Annual Energy, therms	21,020	18,922
Convert to kWh to compare to UA	684,523	853,171

RTU-4 DECTRON

Simulation Parameters

User	lochner_G
TMY3 Weather Location	KANSAS CITY DOWNTOWN AP
Project State/Province	MISSOURI
Project City	Gladstone
Date Created	6/7/2017 2:55:51 PM
Date Last Saved	6/7/2017 3:02:11 PM
Project Name	Gladstone Competition Pool MD
Owner	
Engineer	
Contractor	
InnoventRep	AAP
Elevation (ft)	0
Pool Unit Type	RA DX with Exhaust Fan and Three Condensers

Pool Water Information

Tag	Water temp (°F)	Surface Area (ft^2)	Occupied Activity Factor	Unoccupied Evap Rate (lb/hr)
Diving	82	2816	1	
Lap Pool	80	5295	1	

Supply Airflow (SCFM)	47100
Infiltration Airflow (SCFM)	2355
Occupied Minimum Outside Air (SCFM)	11715
Unoccupied Minimum Outside Air	7536
DX Coil Airflow (SCFM)	18700
Enable Economizer	
* Use Smart Saver	False True.
Indoor Dry Bulb Temp (°F)	82
Indoor Maximum Relative Humidity (%)	60
Design Minimum Outside Air Dry Bulb Temp (°F)	-1
Design Sensible Envelope Heatloss	-199000
Adjacent Space Temperature (°F)	75
Adjacent Space Maximum Relative Humidity (%)	50
Maximum Cooling/DX Coil (MBH)	1400
Minimum Cooling/DX coil Leaving Air Temp (°F)	43
Maximum Pool Water Heater Capacity	
Supply Duct External Static Pressure (in H20)	1.05
Return Duct External Static Pressure (in H20)	0.91
Supply Fan Efficiency (0 - 1)	0.72
Exhaust Fan Efficiency (0 - 1)	0.55
Unoccupied Start Hour (1 - 24)	22
Unoccupied End Hour (1 - 24)	6

PoolPak®
DEHUMIDIFICATION THAT WORKS

Energy Analysis

Build Date 160616-00
6/21/2017
5:53:18 PM

RTU - 4
Comp. Pool

Project Name	Gladstone CC Lap Pool
Project Location	Kanas City MO

Weather Station Summary

80 Tons.

Weather Station Location	USA, MO - KANSAS CITY INT'L ARPT
World Meteorological Organization Weather Station ID	724460
Design Summer DB Temperature (°F)	96
Design Summer WB Temperature (°F)	80
Design Winter DB Temperature (°F)	2

Room Summary

Room Dry Bulb (°F)	82	Room Schedule	Weekday
Room RH (%)	60		8:00am - 10:00pm (14 Hrs)
Number of Spectators	20		
Utility Costs			
Electric ($/kWh)	0.081		Weekend
Gas/Steam ($/Therm)	0.791		8:00am - 10:00pm (14 Hrs)

Total Annual Occupied Hours: 5,110

Equipment Detail

Model Number	MPK0080SEP-60E-DLM-R410	Evaporator Latent Capacity (lbs/hr)	446
Number of Units	1	Evaporator Sensible Capacity (Mbtuh)	526
Supply BHP	46.0	Evaporator TotalCapacity (Mbtuh)	989
Exhaust BHP	11.9	Reheat Capacity (Mbtuh)	1,208
Purge BHP	27.1		
Compressor Input Power (kW)	71.43	Pool Water Condenser Capacity (Mbtuh)	1,220

PoolPak Control Strategy

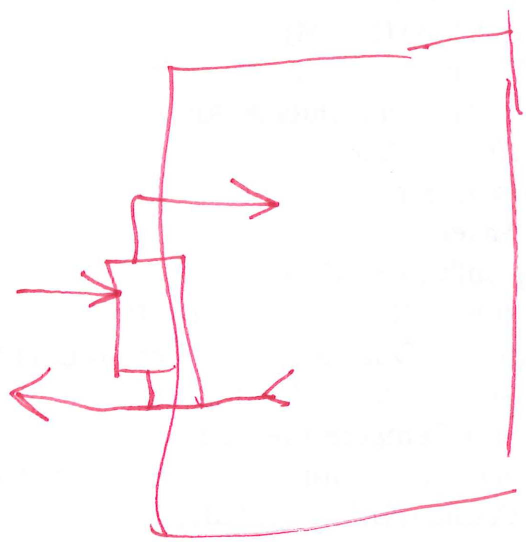
Pool Water Heating	Yes	Smart Pump	Yes
Auxiliary Heat First	No	Exhaust Before Evaporator Coil	Yes
20% Unoccupied Airflow Setback	Yes	Exhaust After Evaporator Coil	Yes

Auxiliary HVAC Systems Detail

Air Heating System		Air Cooling System	
Type	Indirect Fired Gas Furnace	Type	Room Cooling
Seasonal Efficiency (%)	80	Efficiency (kW/Ton)	1.2

Chilled Water Mode	False
Fuel Cost ($/therm)	0.59
Electricity Cost ($/kWh)	0.0943
Heating System Efficiency (0 - 1)	0.8
Pool Water Heater Efficiency (0 - 1)	0.9
ACCU kW/ton @ 125°F Condensing	1.1

The information provided in this document is for comparative purposes only and is not a guarantee of savings or actual energy performance.



PoolPak®
DEHUMIDIFICATION THAT WORKS

Energy Analysis

Build Date 160616-00
6/21/2017
5:53:18 PM

Project Name	Gladstone CC Lap Pool
Project Location	Kanas City MO

Pool Heating

Pool Water Condenser		Auxiliary Pool Heating System	
Pool Water Condenser Loop		Type	Pool Heater
Pump Flow Rate (GPM)	95	Seasonal Efficiency (%)	65
Differential Head (ft)	30		
Pump Efficiency (%)	60		

Equipment Runtime Summary and Operation Costs

	Occupied	Unoccupied
Total Annual Hours	5,110	3,650
Supply Airflow (CFM)	40,000	32,000
Pool Evaporation Load (lbs/hr)	313	96
Spectator Load (lbs/hr)	5	0
Total Load (lbs/hr)	318	96
Economizer Hours	954	270
Fan Cost	*$ 18,630*	*$ 6,522*
Compressor Cost	*$ 10,277*	*$ 3,931*
Pool Water Heat Cost (Actual)	$ 17,821	$ 3,585
Pool Water Heat Savings *	$ -4,678	$ -1,761
Pool Water Heat NET Cost	*$ 13,143*	*$ 1,824*
Aux. Air Heating Cost (Actual)	$ 8,888	$ 2,669
Aux. Air Heating Savings **	$ -6,801	$ -2,669
Aux. Air Heating NET Cost	*$ 2,086*	*$ 0*
Supplemental Air Cooling	*$ 0*	*$ 0*
Total Cost	$ 44,137	$ 12,276

Electric
$\Sigma = \$39360$
gas.
$\Sigma = \$14967$
~~electric~~ = gas.
$\Sigma = \$2086$

2086
~~[illegible]~~
8888 + 2669
= 18%

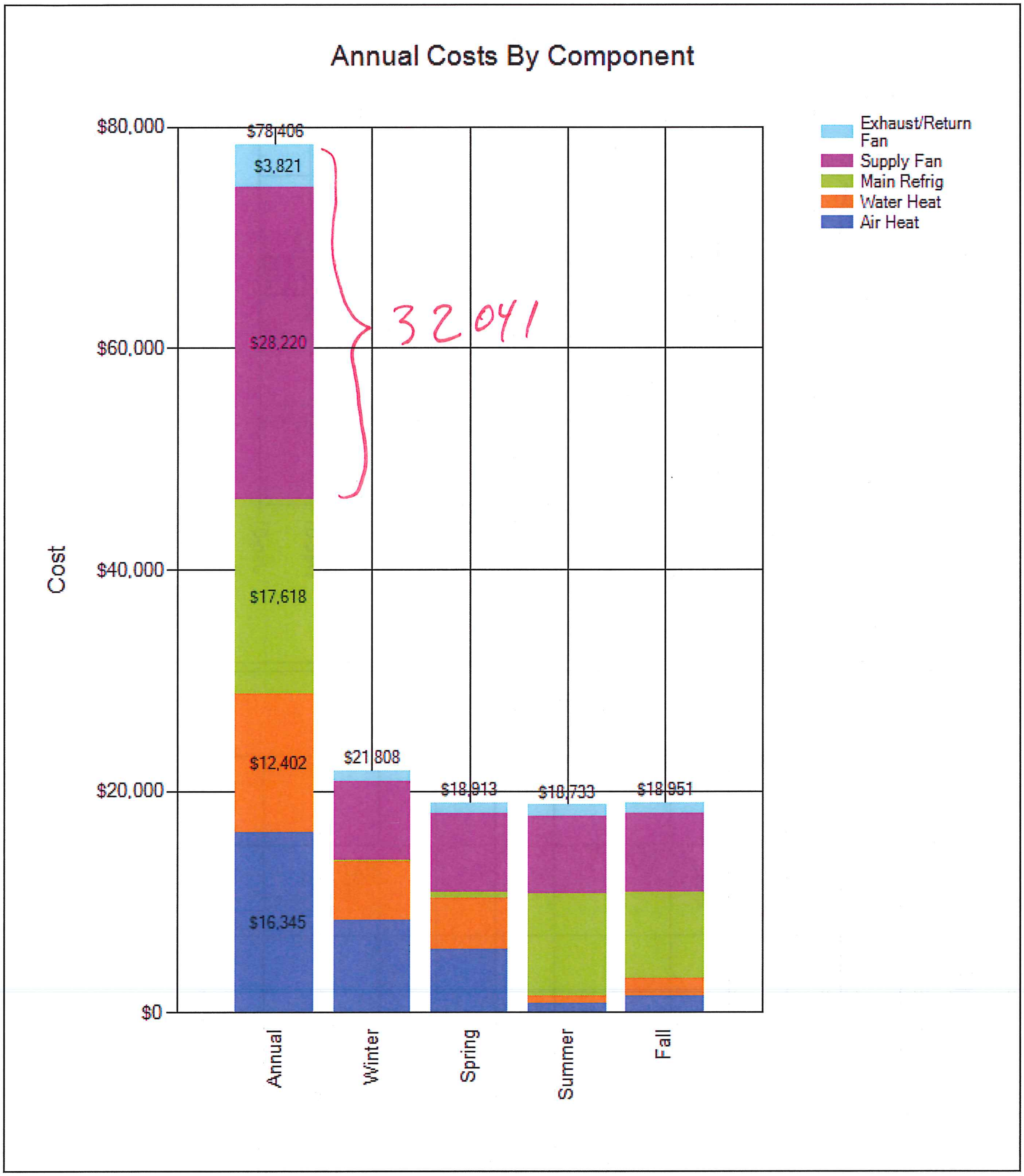
Estimated annual cost for the unit required: $ 56,413

Notes:

* Savings due to heat energy being removed from the air and placed into the pool water when both pool heating *and* air cooling are required (if present).

** Savings gained by recovering heat energy from the return air and placing it into the supply air through the reheat coil, and Air to air Heat Recovery (if present).

- Calculations for the Equipment Runtime Summary are based on 5°F weather bins.
- Weather bins are created based on the user defined occupancy schedule.


Annual Costs By Component
Exhaust/Return Fan
Supply Fan
Main Refrig
Water Heat
Air Heat
Cost
$80,000
$60,000
$40,000
$20,000
$0
$78,406
$3,821
$28,220
$17,618
$12,402
$16,345
$21,808
$18,913
$18,733
$18,951
Annual
Winter
Spring
Summer
Fall
32041

RTU-7 Savings

Vendor energy models included pool water heating from separate source. We will not include that in the evaluation of the dehum unit savings since it will be dealt with in the boiler replacement ecm.

	Dectron	Poolpak	Saved
Electric Rate Used, $/kWh	$ 0.0943	$ 0.0810	
Gas Rate Used, $/therm	$ 0.59	$ 0.791	
Annual Fan Cost	$ 11,089	$ 9,316	
Annual Fan Energy, kWh	117,593	115,012	2,580
Annual Compressor Cost	$ 10,449	$ 10,199	
Annual Compressor Energy, kWh	110,806	125,914	(15,108)
Annual Air Heating Cost	$ 941	$ 680	
Annual Air Heating Energy, kWh	58,405		58,405
Annual Air Heating Energy, therms		860	(860)
Net Savings, kWh			45,878
Net Savings, therms			(860)

For comparison to predicted pool water heating energy determined from UA, below is the vendor model info

	Dectron	Poolpak
Annual Cost	$ 7,965	$ 11,026
Annual Energy, therms	13,500	13,939
Convert to kWh to compare to UA	439,625	628,520

RTU 7 - DECTRON

Simulation Parameters

User	lochner_G
TMY3 Weather Location	KANSAS CITY DOWNTOWN AP
Project State/Province	MISSOURI
Project City	Gladstone
Date Created	6/7/2017 3:17:58 PM
Date Last Saved	6/7/2017 3:19:06 PM
Project Name	Gladstone Leisure Pool MD
Owner	
Engineer	
Contractor	
InnoventRep	AAP
Elevation (ft)	0
Pool Unit Type	RA DX with Exhaust Fan and Three Condensers

Pool Water Information

Tag	Water temp (°F)	Surface Area (ft^2)	Occupied Activity Factor	Unoccupied Evap Rate (lb/hr)
Leisure	85	3724	1.4	

Supply Airflow (SCFM)	20000
Infiltration Airflow (SCFM)	1000
Occupied Minimum Outside Air (SCFM)	6400
Unoccupied Minimum Outside Air	3125
DX Coil Airflow (SCFM)	10000
Enable Economizer	
Use Smart Saver	False True.
Indoor Dry Bulb Temp (°F)	85
Indoor Maximum Relative Humidity (%)	60
Design Minimum Outside Air Dry Bulb Temp (°F)	-1
Design Sensible Envelope Heatloss	-81600
Adjacent Space Temperature (°F)	75
Adjacent Space Maximum Relative Humidity (%)	50
Maximum Cooling/DX Coil (MBH)	800
Minimum Cooling/DX coil Leaving Air Temp (°F)	
Maximum Pool Water Heater Capacity	
Supply Duct External Static Pressure (in H20)	0.73
Return Duct External Static Pressure (in H20)	0.4
Supply Fan Efficiency (0 - 1)	0.72
Exhaust Fan Efficiency (0 - 1)	0.55
Unoccupied Start Hour (1 - 24)	22
Unoccupied End Hour (1 - 24)	6
Chilled Water Mode	False

RTU-7

Rec Pool

PoolPak®
DEHUMIDIFICATION THAT WORKS

Energy Analysis

Build Date 160616-00
6/21/2017
5:24:19 PM

Project Name	Gladstone CC Rec Pool
Project Location	Kanas City MO

Weather Station Summary

Weather Station Location	USA, MO - KANSAS CITY INT'L ARPT
World Meteorological Organization Weather Station ID	724460
Design Summer DB Temperature (°F)	96
Design Summer WB Temperature (°F)	80
Design Winter DB Temperature (°F)	2

Room Summary

Room Dry Bulb (°F)	85	Room Schedule	Weekday
Room RH (%)	60		8:00am - 10:00pm (14 Hrs)
Number of Spectators	25		
Utility Costs			
Electric ($/kWh)	0.081		Weekend
Gas/Steam ($/Therm)	0.791		8:00am - 10:00pm (14 Hrs)

Total Annual Occupied Hours: 5,110

Equipment Detail

Model Number	MPK0050SEP-25E-CHH-R410	Evaporator Latent Capacity (lbs/hr)	298
Number of Units	1	Evaporator Sensible Capacity (Mbtuh)	333
Supply BHP	18.0	Evaporator TotalCapacity (Mbtuh)	642
Exhaust BHP	3.2	Reheat Capacity (Mbtuh)	799
Purge BHP	10.0		
Compressor Input Power (kW)	51.01	Pool Water Condenser Capacity (Mbtuh)	785

PoolPak Control Strategy

Pool Water Heating	Yes	Smart Pump	Yes
Auxiliary Heat First	No	Exhaust Before Evaporator Coil	Yes
20% Unoccupied Airflow Setback	Yes	Exhaust After Evaporator Coil	Yes

Auxiliary HVAC Systems Detail

Air Heating System		Air Cooling System	
Type	Indirect Fired Gas Furnace	Type	Room Cooling
Seasonal Efficiency (%)	80	Efficiency (kW/Ton)	1.2

Fuel Cost ($/therm)	0.59
Electricity Cost ($/kWh)	0.0943
Heating System Efficiency (0 - 1)	0.8
Pool Water Heater Efficiency (0 - 1)	0.9
ACCU kW/ton @ 125°F Condensing	1.1

The information provided in this document is for comparative purposes only and is not a guarantee of savings or actual energy performance.

PoolPak®
DEHUMIDIFICATION THAT WORKS

Energy Analysis

Build Date 160616-00
6/21/2017
5:24:19 PM

Project Name Gladstone CC Rec Pool
Project Location Kanas City MO

Pool Heating

Pool Water Condenser
Pool Water Condenser Loop

Pump Flow Rate (GPM)	95
Differential Head (ft)	30
Pump Efficiency (%)	60

Auxiliary Pool Heating System

Type	Pool Heater
Seasonal Efficiency (%)	65

Equipment Runtime Summary and Operation Costs

	Occupied	Unoccupied	
Total Annual Hours	5,110	3,650	
Supply Airflow (CFM)	20,000	16,000	
Pool Evaporation Load (lbs/hr)	261	53	Elect
Spectator Load (lbs/hr)	6	0	
Total Load (lbs/hr)	267	53	
Economizer Hours	1,278	609	
Fan Cost	*$ 6,992*	*$ 2,324*	Σ = $9316
Compressor Cost	*$ 8,630*	*$ 1,569*	Σ = $10199
Pool Water Heat Cost (Actual)	$ 14,454	$ 2,054	
Pool Water Heat Savings *	$ -4,617	$ -865	
Pool Water Heat NET Cost	*$ 9,837*	*$ 1,189*	Σ = $11026 gas
Aux. Air Heating Cost (Actual)	$ 6,834	$ 810	gas
Aux. Air Heating Savings **	$ -6,189	$ -774	
Aux. Air Heating NET Cost	*$ 645*	*$ 35*	$680
Supplemental Air Cooling	*$ 0*	*$ 0*	
Total Cost	$ 26,104	$ 5,118	

$\frac{680}{6834+810} = 9\%$

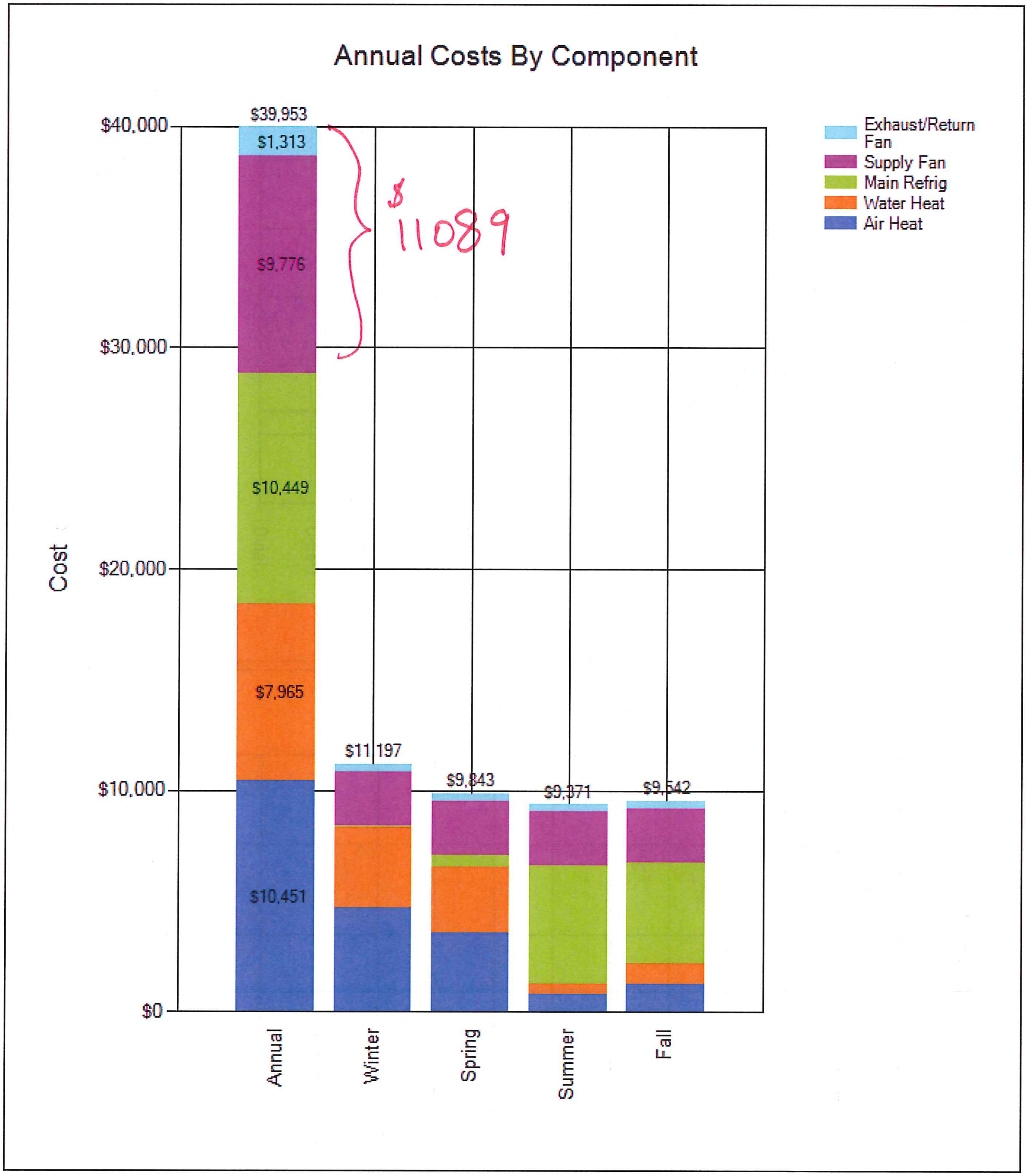
Estimated annual cost for the unit required: $ 31,222

Notes:

* Savings due to heat energy being removed from the air and placed into the pool water when both pool heating *and* air cooling are required (if present).

** Savings gained by recovering heat energy from the return air and placing it into the supply air through the reheat coil, and Air to air Heat Recovery (if present).

- Calculations for the Equipment Runtime Summary are based on 5°F weather bins.
- Weather bins are created based on the user defined occupancy schedule.


Annual Costs By Component
$39,953
$1,313
$9,776
$10,449
$7,965
$10,451
$11,197
$9,843
$9,371
$9,542
$40,000
$30,000
$20,000
$10,000
$0
Cost
Annual
Winter
Spring
Summer
Fall
Exhaust/Return Fan
Supply Fan
Main Refrig
Water Heat
Air Heat
$ 11089

City of Gladstone EPC	Project		
Gladstone, MO	Location		
Comp Pool Dehum Unit	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 119 ton	Proposed - 82 ton		
Repair Unit	Repair Unit	Repair Type #1	
10	10	Repair Frequency (Years)	
☑		Include Repair Labor?	
353	245	Repair Labor Required (Hours)	
Contract		Select In-House or Contract Labor	
$114.43	$114.43	Repair Labor Rate ($/hour)	HVAC Technician
$22,582.00	$21,395.00	Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Unit	Replace Unit	Repair Type #2	
15	15	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
719.0	481.0	Replacement Labor Required (Hours)	
$114.43	$114.43	Replacement Labor Rate ($/hour)	HVAC Technician
$127,794.00	$86,138.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$21,196.74	$15,009.16	Average Annual Repair Cost in 2016 Dollars	
$10,299.50		**Annual O&M Savings per unit**	
$10,299.50		**Total Savings**	No. of Units: 1

	Existing		Proposed								
Year	**Increase Factor**	**Annual Repair Cost**	**Year**	**Increase Factor**	**Annual Repair Cost**	**Savings**	**Include Year?**	**Original Life**	**New Life**	**Increase Factor Year**	**Increase Factor**
1900								0	0	0	
1901								0	0	1	0.2
1902								0	0	2	1
1903								0	0	3	1.02
1904								0	0	4	1.05
1905								0	0	5	1.06
1906								0	0	6	1.07
1907								0	0	7	1.08
1908								0	0	8	1.1
1909								0	0	9	1.15
1910								0	0	10	1.2
1911								0	0	11	1.25
1912								0	0	12	1.3
1913								0	0	13	1.35
1914								0	0	14	1.4
1915								0	0	15	1.45
1916								0	0	16	1.5
1917								0	0	17	1.55
1918								0	0	18	1.6
1919								0	0	19	1.65
1920								0	0	20	1.7
1921								0	0	21	1.75
1922								0	0	22	1.8
1923								0	0	23	1.85

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1924								0	0	24	1.9
1925								0	0	25	1.95
1926								0	0	26	2
1927								0	0	27	2.05
1928								0	0	28	2.1
1929								0	0	29	2.15
1930								0	0	30	2.2
1931								0	0	31	2.25
1932								0	0	32	2.3
1933								0	0	33	2.35
1934								0	0	34	2.4
1935								0	0	35	2.45
1936								0	0	36	2.5
1937								0	0	37	2.55
1938								0	0	38	2.6
1939								0	0	39	2.65
1940								0	0	40	2.7
1941								0	0	41	2.75
1942								0	0	42	2.8
1943								0	0	43	2.85
1944								0	0	44	2.9
1945								0	0	45	2.95
1946								0	0	46	3
1947								0	0	47	3.05
1948								0	0	48	3.1
1949								0	0	49	3.15
1950								0	0	50	3.2
1951								0	0	51	3.25
1952								0	0	52	3.3
1953								0	0	53	3.35
1954								0	0	54	3.4
1955								0	0	55	3.45
1956								0	0	56	3.5
1957								0	0	57	3.55
1958								0	0	58	3.6
1959								0	0	59	3.65
1960								0	0	60	3.7
1961								0	0	61	3.75
1962								0	0	62	3.8
1963								0	0	63	3.85
1964								0	0	64	3.9
1965								0	0	65	3.95
1966								0	0	66	4
1967								0	0	67	4.05
1968								0	0	68	4.1
1969								0	0	69	4.15
1970								0	0	70	4.2
1971								0	0	71	4.25
1972								0	0	72	4.3
1973								0	0	73	4.35
1974								0	0	74	4.4

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	1975								0	0	75	4.45
	1976								0	0	76	4.5
	1977								0	0	77	4.55
	1978								0	0	78	4.6
	1979								0	0	79	4.65
	1980								0	0	80	4.7
	1981								0	0	81	4.75
	1982								0	0	82	4.8
	1983								0	0	83	4.85
	1984								0	0	84	4.9
	1985								0	0	85	4.95
	1986								0	0	86	5
	1987								0	0	87	5.05
	1988								0	0	88	5.1
	1989								0	0	89	5.15
	1990								0	0	90	5.2
	1991								0	0	91	5.25
	1992								0	0	92	5.3
	1993								0	0	93	5.35
	1994								0	0	94	5.4
	1995								0	0	95	5.45
	1996								0	0	96	5.5
	1997								0	0	97	5.55
	1998								0	0	98	5.6
	1999								0	0	99	5.65
	2000								0	0	100	5.7
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
Original Installation	2007	0.2	$ 3,067.72					x	1	0	107	6.05
	2008	1	$ 15,338.58					x	2	0	108	6.1
	2009	1.02	$ 15,645.35					x	3	0	109	6.15
	2010	1.05	$ 16,105.51					x	4	0	110	6.2
	2011	1.06	$ 16,258.89					x	5	0	111	6.25
	2012	1.07	$ 16,412.28					x	6	0	112	6.3
	2013	1.08	$ 16,565.66					x	7	0	113	6.35
	2014	1.1	$ 16,872.44					x	8	0	114	6.4
	2015	1.15	$ 17,639.36					x	9	0	115	6.45
	2016	1.2	$ 18,406.29					x	10	0	116	6.5
	2017	1.25	$ 19,173.22					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 19,940.15	2018	0.2	$2,699.49	$17,240.66	x	12	1	118	6.6
	2019	1.35	$ 20,707.08	2019	1	$13,497.44	$7,209.64	x	13	2	119	6.65
	2020	1.4	$ 21,474.01	2020	1.02	$13,767.39	$7,706.62	x	14	3	120	6.7
	2021	1.45	$ 22,240.94	2021	1.05	$14,172.32	$8,068.62	x	15	4	121	6.75
	2022	1.5	$ 23,007.87	2022	1.06	$14,307.29	$8,700.58	x	16	5	122	6.8
	2023	1.55	$ 23,774.80	2023	1.07	$14,442.26	$9,332.53	x	17	6	123	6.85
	2024	1.6	$ 24,541.73	2024	1.08	$14,577.24	$9,964.49	x	18	7	124	6.9
	2025	1.65	$ 25,308.65	2025	1.1	$14,847.19	$10,461.47	x	19	8	125	6.95

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
2026	1.7	$ 26,075.58	2026	1.15	$15,522.06	$10,553.52	x	20	9	126	7
2027	1.75	$ 26,842.51	2027	1.2	$16,196.93	$10,645.58	x	21	10	127	7.05
2028	1.8	$ 27,609.44	2028	1.25	$16,871.80	$10,737.64	x	22	11	128	7.1
2029	1.85	$ 28,376.37	2029	1.3	$17,546.68	$10,829.69	x	23	12	129	7.15
2030	1.9	$ 29,143.30	2030	1.35	$18,221.55	$10,921.75	x	24	13	130	7.2
2031	1.95	$ 29,910.23	2031	1.4	$18,896.42	$11,013.81	x	25	14	131	7.25
2032	2	$ 30,677.16	2032	1.45	$19,571.29	$11,105.86	x	26	15	132	7.3
2033								0	0	133	7.35
2034								0	0	134	7.4
2035								0	0	135	7.45
2036								0	0	136	7.5
2037								0	0	137	7.55
2038								0	0	138	7.6
2039								0	0	139	7.65
2040								0	0	140	7.7
2041								0	0	141	7.75
2042								0	0	142	7.8
2043								0	0	143	7.85
2044								0	0	144	7.9
2045								0	0	145	7.95
2046								0	0	146	8
2047								0	0	147	8.05
2048								0	0	148	8.1
2049								0	0	149	8.15
2050								0	0	150	8.2
2051								0	0	151	8.25
2052								0	0	152	8.3
2053								0	0	153	8.35
2054								0	0	154	8.4
2055								0	0	155	8.45
2056								0	0	156	8.5
2057								0	0	157	8.55
2058								0	0	158	8.6
2059								0	0	159	8.65
2060								0	0	160	8.7
2061								0	0	161	8.75
2062								0	0	162	8.8
2063								0	0	163	8.85
2064								0	0	164	8.9
2065								0	0	165	8.95
2066								0	0	166	9
2067								0	0	167	9.05
2068								0	0	168	9.1
2069								0	0	169	9.15
2070								0	0	170	9.2
2071								0	0	171	9.25
2072								0	0	172	9.3
2073								0	0	173	9.35
2074								0	0	174	9.4
2075								0	0	175	9.45
2076								0	0	176	9.5

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2077								0	0	177	9.55
	2078								0	0	178	9.6
	2079								0	0	179	9.65
	2080								0	0	180	9.7
	2081								0	0	181	9.75
	2082								0	0	182	9.8
	2083								0	0	183	9.85
	2084								0	0	184	9.9
	2085								0	0	185	9.95
	2086								0	0	186	10
	2087								0	0	187	10.05
	2088								0	0	188	10.1
	2089								0	0	189	10.15
	2090								0	0	190	10.2
	2091								0	0	191	10.25
	2092								0	0	192	10.3
	2093								0	0	193	10.35
	2094								0	0	194	10.4
	2095								0	0	195	10.45
	2096								0	0	196	10.5
	2097								0	0	197	10.55
	2098								0	0	198	10.6
	2099								0	0	199	10.65
	2100								0	0	200	10.7
Totals	26	35.93	##########	15	16.68	$225,137.36	$154,492.45					

City of Gladstone EPC	Project		
Gladstone, MO	Location		
Leisure Pool Dehum Unit	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 69 ton	Proposed - 54 ton		
Repair Unit	Repair Unit	Repair Type #1	
10	10	Repair Frequency (Years)	
☑		Include Repair Labor?	
254	239	Repair Labor Required (Hours)	
Contract		Select In-House or Contract Labor	
$114.43	$114.43	Repair Labor Rate ($/hour)	HVAC Technician
$20,768.00	$19,987.00	Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Unit	Replace Unit	Repair Type #2	
15	15	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
425.0	338.0	Replacement Labor Required (Hours)	
$114.43	$114.43	Replacement Labor Rate ($/hour)	HVAC Technician
$74,859.00	$58,287.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$13,802.69	$11,686.27	Average Annual Repair Cost in 2016 Dollars	
$4,793.98		**Annual O&M Savings per unit**	
$4,793.98		**Total Savings**	No. of Units: 1

Existing			Proposed								
Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1900								0	0	0	
1901								0	0	1	0.2
1902								0	0	2	1
1903								0	0	3	1.02
1904								0	0	4	1.05
1905								0	0	5	1.06
1906								0	0	6	1.07
1907								0	0	7	1.08
1908								0	0	8	1.1
1909								0	0	9	1.15
1910								0	0	10	1.2
1911								0	0	11	1.25
1912								0	0	12	1.3
1913								0	0	13	1.35
1914								0	0	14	1.4
1915								0	0	15	1.45
1916								0	0	16	1.5
1917								0	0	17	1.55
1918								0	0	18	1.6
1919								0	0	19	1.65
1920								0	0	20	1.7
1921								0	0	21	1.75
1922								0	0	22	1.8
1923								0	0	23	1.85

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1924								0	0	24	1.9
1925								0	0	25	1.95
1926								0	0	26	2
1927								0	0	27	2.05
1928								0	0	28	2.1
1929								0	0	29	2.15
1930								0	0	30	2.2
1931								0	0	31	2.25
1932								0	0	32	2.3
1933								0	0	33	2.35
1934								0	0	34	2.4
1935								0	0	35	2.45
1936								0	0	36	2.5
1937								0	0	37	2.55
1938								0	0	38	2.6
1939								0	0	39	2.65
1940								0	0	40	2.7
1941								0	0	41	2.75
1942								0	0	42	2.8
1943								0	0	43	2.85
1944								0	0	44	2.9
1945								0	0	45	2.95
1946								0	0	46	3
1947								0	0	47	3.05
1948								0	0	48	3.1
1949								0	0	49	3.15
1950								0	0	50	3.2
1951								0	0	51	3.25
1952								0	0	52	3.3
1953								0	0	53	3.35
1954								0	0	54	3.4
1955								0	0	55	3.45
1956								0	0	56	3.5
1957								0	0	57	3.55
1958								0	0	58	3.6
1959								0	0	59	3.65
1960								0	0	60	3.7
1961								0	0	61	3.75
1962								0	0	62	3.8
1963								0	0	63	3.85
1964								0	0	64	3.9
1965								0	0	65	3.95
1966								0	0	66	4
1967								0	0	67	4.05
1968								0	0	68	4.1
1969								0	0	69	4.15
1970								0	0	70	4.2
1971								0	0	71	4.25
1972								0	0	72	4.3
1973								0	0	73	4.35
1974								0	0	74	4.4

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	1975								0	0	75	4.45
	1976								0	0	76	4.5
	1977								0	0	77	4.55
	1978								0	0	78	4.6
	1979								0	0	79	4.65
	1980								0	0	80	4.7
	1981								0	0	81	4.75
	1982								0	0	82	4.8
	1983								0	0	83	4.85
	1984								0	0	84	4.9
	1985								0	0	85	4.95
	1986								0	0	86	5
	1987								0	0	87	5.05
	1988								0	0	88	5.1
	1989								0	0	89	5.15
	1990								0	0	90	5.2
	1991								0	0	91	5.25
	1992								0	0	92	5.3
	1993								0	0	93	5.35
	1994								0	0	94	5.4
	1995								0	0	95	5.45
	1996								0	0	96	5.5
	1997								0	0	97	5.55
	1998								0	0	98	5.6
	1999								0	0	99	5.65
	2000								0	0	100	5.7
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
Original Installation	2007	0.2	$ 1,997.61					x	1	0	107	6.05
	2008	1	$ 9,988.03					x	2	0	108	6.1
	2009	1.02	$ 10,187.79					x	3	0	109	6.15
	2010	1.05	$ 10,487.43					x	4	0	110	6.2
	2011	1.06	$ 10,587.31					x	5	0	111	6.25
	2012	1.07	$ 10,687.19					x	6	0	112	6.3
	2013	1.08	$ 10,787.07					x	7	0	113	6.35
	2014	1.1	$ 10,986.83					x	8	0	114	6.4
	2015	1.15	$ 11,486.24					x	9	0	115	6.45
	2016	1.2	$ 11,985.64					x	10	0	116	6.5
	2017	1.25	$ 12,485.04					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 12,984.44	2018	0.2	$2,101.85	$10,882.59	x	12	1	118	6.6
	2019	1.35	$ 13,483.84	2019	1	$10,509.24	$2,974.60	x	13	2	119	6.65
	2020	1.4	$ 13,983.24	2020	1.02	$10,719.42	$3,263.82	x	14	3	120	6.7
	2021	1.45	$ 14,482.65	2021	1.05	$11,034.70	$3,447.95	x	15	4	121	6.75
	2022	1.5	$ 14,982.05	2022	1.06	$11,139.79	$3,842.26	x	16	5	122	6.8
	2023	1.55	$ 15,481.45	2023	1.07	$11,244.88	$4,236.56	x	17	6	123	6.85
	2024	1.6	$ 15,980.85	2024	1.08	$11,349.98	$4,630.87	x	18	7	124	6.9
	2025	1.65	$ 16,480.25	2025	1.1	$11,560.16	$4,920.09	x	19	8	125	6.95

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
2026	1.7	$ 16,979.65	2026	1.15	$12,085.62	$4,894.03	x	20	9	126	7
2027	1.75	$ 17,479.06	2027	1.2	$12,611.09	$4,867.97	x	21	10	127	7.05
2028	1.8	$ 17,978.46	2028	1.25	$13,136.55	$4,841.91	x	22	11	128	7.1
2029	1.85	$ 18,477.86	2029	1.3	$13,662.01	$4,815.85	x	23	12	129	7.15
2030	1.9	$ 18,977.26	2030	1.35	$14,187.47	$4,789.79	x	24	13	130	7.2
2031	1.95	$ 19,476.66	2031	1.4	$14,712.93	$4,763.73	x	25	14	131	7.25
2032	2	$ 19,976.06	2032	1.45	$15,238.40	$4,737.67	x	26	15	132	7.3
2033								0	0	133	7.35
2034								0	0	134	7.4
2035								0	0	135	7.45
2036								0	0	136	7.5
2037								0	0	137	7.55
2038								0	0	138	7.6
2039								0	0	139	7.65
2040								0	0	140	7.7
2041								0	0	141	7.75
2042								0	0	142	7.8
2043								0	0	143	7.85
2044								0	0	144	7.9
2045								0	0	145	7.95
2046								0	0	146	8
2047								0	0	147	8.05
2048								0	0	148	8.1
2049								0	0	149	8.15
2050								0	0	150	8.2
2051								0	0	151	8.25
2052								0	0	152	8.3
2053								0	0	153	8.35
2054								0	0	154	8.4
2055								0	0	155	8.45
2056								0	0	156	8.5
2057								0	0	157	8.55
2058								0	0	158	8.6
2059								0	0	159	8.65
2060								0	0	160	8.7
2061								0	0	161	8.75
2062								0	0	162	8.8
2063								0	0	163	8.85
2064								0	0	164	8.9
2065								0	0	165	8.95
2066								0	0	166	9
2067								0	0	167	9.05
2068								0	0	168	9.1
2069								0	0	169	9.15
2070								0	0	170	9.2
2071								0	0	171	9.25
2072								0	0	172	9.3
2073								0	0	173	9.35
2074								0	0	174	9.4
2075								0	0	175	9.45
2076								0	0	176	9.5

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2077								0	0	177	9.55
	2078								0	0	178	9.6
	2079								0	0	179	9.65
	2080								0	0	180	9.7
	2081								0	0	181	9.75
	2082								0	0	182	9.8
	2083								0	0	183	9.85
	2084								0	0	184	9.9
	2085								0	0	185	9.95
	2086								0	0	186	10
	2087								0	0	187	10.05
	2088								0	0	188	10.1
	2089								0	0	189	10.15
	2090								0	0	190	10.2
	2091								0	0	191	10.25
	2092								0	0	192	10.3
	2093								0	0	193	10.35
	2094								0	0	194	10.4
	2095								0	0	195	10.45
	2096								0	0	196	10.5
	2097								0	0	197	10.55
	2098								0	0	198	10.6
	2099								0	0	199	10.65
	2100								0	0	200	10.7
Totals	26	35.93	##########	15	16.68	$175,294.09	$71,909.69					

ECM44 - Boiler Fuel Switch and Energy Savings Calcualation

Electricity used by boiler per UA balance	1215	kW per year	101.25	per month
	537,098	kWh		

Average of Poolpak and Dectron analysis shows the pool heating to be

	1,302,920	kWh
Use	920,009	kWh for existing boiler use

Pool Heating will be accomplished by new gas-fired boiler

98%	average efficiency (can use low water temperature all of the time since we are only heating pool water to 82 F
32,031	therms gas used by new boiler

To check the accuracy of utility balance, a power meter was installed for a few days in mid-April and the average draw was

	52.7	kW
with several peaks of	160	kW
and relative peaks of	80	kW

UA balance showed	90	kW in April
	45	kW in May

City of Gladstone EPC	Project		
Gladstone, MO	Location		
Pool Heating Boiler	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - 480 kW Electric	Proposed - 1600 MBH Gas		
Repair Unit	Repair Unit	Repair Type #1	
15	15	Repair Frequency (Years)	
☑		Include Repair Labor?	
16	18.7	Repair Labor Required (Hours)	
Contract		Select In-House or Contract Labor	
$114.43	$114.43	Repair Labor Rate ($/hour)	HVAC Technician
$2,044.00	$2,268.00	Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Unit	Replace Unit	Repair Type #2	
30	30	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
101.0	146.0	Replacement Labor Required (Hours)	
$114.43	$114.43	Replacement Labor Rate ($/hour)	HVAC Technician
$34,490.00	$31,291.00	Replacement Material Cost	
2007	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$1,899.97	$1,992.90	Average Annual Repair Cost in 2016 Dollars	
$275.64		**Annual O&M Savings per unit**	
$275.64		**Total Savings**	No. of Units: 1

streched out repair and replace frequency since this unit doesn't get used much.

	Existing			Proposed							
Year	**Increase Factor**	**Annual Repair Cost**	**Year**	**Increase Factor**	**Annual Repair Cost**	**Savings**	**Include Year?**	**Original Life**	**New Life**	**Increase Factor Year**	**Increase Factor**
1900								0	0	0	
1901								0	0	1	0.2
1902								0	0	2	1
1903								0	0	3	1.02
1904								0	0	4	1.05
1905								0	0	5	1.06
1906								0	0	6	1.07
1907								0	0	7	1.08
1908								0	0	8	1.1
1909								0	0	9	1.15
1910								0	0	10	1.2
1911								0	0	11	1.25
1912								0	0	12	1.3
1913								0	0	13	1.35
1914								0	0	14	1.4
1915								0	0	15	1.45
1916								0	0	16	1.5
1917								0	0	17	1.55
1918								0	0	18	1.6
1919								0	0	19	1.65
1920								0	0	20	1.7
1921								0	0	21	1.75
1922								0	0	22	1.8
1923								0	0	23	1.85

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1924								0	0	24	1.9
1925								0	0	25	1.95
1926								0	0	26	2
1927								0	0	27	2.05
1928								0	0	28	2.1
1929								0	0	29	2.15
1930								0	0	30	2.2
1931								0	0	31	2.25
1932								0	0	32	2.3
1933								0	0	33	2.35
1934								0	0	34	2.4
1935								0	0	35	2.45
1936								0	0	36	2.5
1937								0	0	37	2.55
1938								0	0	38	2.6
1939								0	0	39	2.65
1940								0	0	40	2.7
1941								0	0	41	2.75
1942								0	0	42	2.8
1943								0	0	43	2.85
1944								0	0	44	2.9
1945								0	0	45	2.95
1946								0	0	46	3
1947								0	0	47	3.05
1948								0	0	48	3.1
1949								0	0	49	3.15
1950								0	0	50	3.2
1951								0	0	51	3.25
1952								0	0	52	3.3
1953								0	0	53	3.35
1954								0	0	54	3.4
1955								0	0	55	3.45
1956								0	0	56	3.5
1957								0	0	57	3.55
1958								0	0	58	3.6
1959								0	0	59	3.65
1960								0	0	60	3.7
1961								0	0	61	3.75
1962								0	0	62	3.8
1963								0	0	63	3.85
1964								0	0	64	3.9
1965								0	0	65	3.95
1966								0	0	66	4
1967								0	0	67	4.05
1968								0	0	68	4.1
1969								0	0	69	4.15
1970								0	0	70	4.2
1971								0	0	71	4.25
1972								0	0	72	4.3
1973								0	0	73	4.35
1974								0	0	74	4.4

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	**Savings**	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	1975								0	0	75	4.45
	1976								0	0	76	4.5
	1977								0	0	77	4.55
	1978								0	0	78	4.6
	1979								0	0	79	4.65
	1980								0	0	80	4.7
	1981								0	0	81	4.75
	1982								0	0	82	4.8
	1983								0	0	83	4.85
	1984								0	0	84	4.9
	1985								0	0	85	4.95
	1986								0	0	86	5
	1987								0	0	87	5.05
	1988								0	0	88	5.1
	1989								0	0	89	5.15
	1990								0	0	90	5.2
	1991								0	0	91	5.25
	1992								0	0	92	5.3
	1993								0	0	93	5.35
	1994								0	0	94	5.4
	1995								0	0	95	5.45
	1996								0	0	96	5.5
	1997								0	0	97	5.55
	1998								0	0	98	5.6
	1999								0	0	99	5.65
	2000								0	0	100	5.7
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
Original Installation	2007	0.2	$ 274.97					x	1	0	107	6.05
	2008	1	$ 1,374.87					x	2	0	108	6.1
	2009	1.02	$ 1,402.37					x	3	0	109	6.15
	2010	1.05	$ 1,443.62					x	4	0	110	6.2
	2011	1.06	$ 1,457.37					x	5	0	111	6.25
	2012	1.07	$ 1,471.12					x	6	0	112	6.3
	2013	1.08	$ 1,484.86					x	7	0	113	6.35
	2014	1.1	$ 1,512.36					x	8	0	114	6.4
	2015	1.15	$ 1,581.11					x	9	0	115	6.45
	2016	1.2	$ 1,649.85					x	10	0	116	6.5
	2017	1.25	$ 1,718.59					x	11	0	117	6.55
Proposed Replacement	2018	1.3	$ 1,787.34	2018	0.2	$358.44	$1,428.90	x	12	1	118	6.6
	2019	1.35	$ 1,856.08	2019	1	$1,792.18	$63.90	x	13	2	119	6.65
	2020	1.4	$ 1,924.82	2020	1.02	$1,828.02	$96.80	x	14	3	120	6.7
	2021	1.45	$ 1,993.57	2021	1.05	$1,881.79	$111.78	x	15	4	121	6.75
	2022	1.5	$ 2,062.31	2022	1.06	$1,899.71	$162.60	x	16	5	122	6.8
	2023	1.55	$ 2,131.06	2023	1.07	$1,917.63	$213.43	x	17	6	123	6.85
	2024	1.6	$ 2,199.80	2024	1.08	$1,935.55	$264.25	x	18	7	124	6.9
	2025	1.65	$ 2,268.54	2025	1.1	$1,971.40	$297.15	x	19	8	125	6.95

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
2026	1.7	$ 2,337.29	2026	1.15	$2,061.01	$276.28	x	20	9	126	7
2027	1.75	$ 2,406.03	2027	1.2	$2,150.61	$255.42	x	21	10	127	7.05
2028	1.8	$ 2,474.77	2028	1.25	$2,240.22	$234.55	x	22	11	128	7.1
2029	1.85	$ 2,543.52	2029	1.3	$2,329.83	$213.69	x	23	12	129	7.15
2030	1.9	$ 2,612.26	2030	1.35	$2,419.44	$192.82	x	24	13	130	7.2
2031	1.95	$ 2,681.01	2031	1.4	$2,509.05	$171.96	x	25	14	131	7.25
2032	2	$ 2,749.75	2032	1.45	$2,598.66	$151.09	x	26	15	132	7.3
2033								0	0	133	7.35
2034								0	0	134	7.4
2035								0	0	135	7.45
2036								0	0	136	7.5
2037								0	0	137	7.55
2038								0	0	138	7.6
2039								0	0	139	7.65
2040								0	0	140	7.7
2041								0	0	141	7.75
2042								0	0	142	7.8
2043								0	0	143	7.85
2044								0	0	144	7.9
2045								0	0	145	7.95
2046								0	0	146	8
2047								0	0	147	8.05
2048								0	0	148	8.1
2049								0	0	149	8.15
2050								0	0	150	8.2
2051								0	0	151	8.25
2052								0	0	152	8.3
2053								0	0	153	8.35
2054								0	0	154	8.4
2055								0	0	155	8.45
2056								0	0	156	8.5
2057								0	0	157	8.55
2058								0	0	158	8.6
2059								0	0	159	8.65
2060								0	0	160	8.7
2061								0	0	161	8.75
2062								0	0	162	8.8
2063								0	0	163	8.85
2064								0	0	164	8.9
2065								0	0	165	8.95
2066								0	0	166	9
2067								0	0	167	9.05
2068								0	0	168	9.1
2069								0	0	169	9.15
2070								0	0	170	9.2
2071								0	0	171	9.25
2072								0	0	172	9.3
2073								0	0	173	9.35
2074								0	0	174	9.4
2075								0	0	175	9.45
2076								0	0	176	9.5

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2077								0	0	177	9.55
	2078								0	0	178	9.6
	2079								0	0	179	9.65
	2080								0	0	180	9.7
	2081								0	0	181	9.75
	2082								0	0	182	9.8
	2083								0	0	183	9.85
	2084								0	0	184	9.9
	2085								0	0	185	9.95
	2086								0	0	186	10
	2087								0	0	187	10.05
	2088								0	0	188	10.1
	2089								0	0	189	10.15
	2090								0	0	190	10.2
	2091								0	0	191	10.25
	2092								0	0	192	10.3
	2093								0	0	193	10.35
	2094								0	0	194	10.4
	2095								0	0	195	10.45
	2096								0	0	196	10.5
	2097								0	0	197	10.55
	2098								0	0	198	10.6
	2099								0	0	199	10.65
	2100								0	0	200	10.7
Totals	26	35.93	$ 49,399.26	15	16.68	$29,893.54	$4,134.62					

ECM45 - Water Treatment Plant HVAC Equipment Replacement Energy Savings

Total installed cooling capacity	10	tons		
amount we are replacing	10	tons	100%	
Annual cooling demand from Water Treatment UA	42.1	kw		WTT UA not possible use similar size system (ASR)
Annual cooling energy from Water Treatment UA	7,738	kWh less controls savings		
Old efficiency	1.2	kW/ton	10 SEER	
New efficiency	0.86	kW/ton	14 SEER	
Cooling Savings	2,211	kWh		
Demand Savings	9.6	kW		
Annual Heating energy from UA	2289	therms		
Old Efficiency	72%	derated by 10% for age		
New Efficiency	92%			
Heating Savings	498	therms		

City of Gladstone EPC	Project		
City Hall Gladstone, MO	Location		
Rooftop Unit 5 T SZ	Equipment		
108.3%	Location Cost Index	Kansas City, MO	
Repair RTU	Repair Type #1		
10	Repair Frequency (Years)		
☑	Include Repair Labor?		
18.3	Repair Labor Required (Hours)		
Contract	Select In-House or Contract Labor		
$114.43	Repair Labor Rate ($/hour)	HVAC Technician	
$1,459.13	Repair Material Cost		$ 1,222 From 2011-2012 Whitestone
☑	Include End-of-Life Replacement Cost in Analysis?		
Replace RTU	Repair Type #2		
15	Replacement Frequency (Years)		
☑	Include Replacement Labor?		
56.6	Replacement Labor Required (Hours)		
$114.43	Replacement Labor Rate ($/hour)	HVAC Technician	
$5,610.85	Replacement Material Cost		$ 4,699 From 2011-2012 Whitestone
1998	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$1,204.32	Average Annual Repair Cost in 2016 Dollars		
$371.28	**Annual O&M Savings per unit**		
$371.28	**Total Savings**	No. of Units:	1

3% Est. Inflation on Equip

	Existing			Proposed								
	Year	**Increase Factor**	**Annual Repair Cost**	**Year**	**Increase Factor**	**Annual Repair Cost**	**Savings**	**Include Year?**	**Original Life**	**New Life**	**Increase Factor Year**	**Increase Factor**
	2001	1.05	$ 787.80					x	4	0	101	5.75
	2002	1.06	$ 795.30					x	5	0	102	5.8
	2003	1.07	$ 802.81					x	6	0	103	5.85
	2004	1.08	$ 810.31					x	7	0	104	5.9
	2005	1.1	$ 825.31					x	8	0	105	5.95
	2006	1.15	$ 862.83					x	9	0	106	6
	2007	1.2	$ 900.34					x	10	0	107	6.05
	2008	1.25	$ 937.86					x	11	0	108	6.1
	2009	1.3	$ 975.37					x	12	0	109	6.15
	2010	1.35	$ 1,012.89					x	13	0	110	6.2
	2011	1.4	$ 1,050.40					x	14	0	111	6.25
	2012	1.45	$ 1,087.91					x	15	0	112	6.3
	2013	1.5	$ 1,125.43					x	16	0	113	6.35
	2014	1.55	$ 1,162.94					x	17	0	114	6.4
	2015	1.6	$ 1,200.46					x	18	0	115	6.45
	2016	1.65	$ 1,237.97					x	19	0	116	6.5
	2017	1.7	$ 1,275.49					x	20	0	117	6.55
Proposed Replacement	2018	1.75	$ 1,313.00	2018	0.2	$216.60	$1,096.40	x	21	1	118	6.6
	2019	1.8	$ 1,350.51	2019	1	$1,083.02	$267.50	x	22	2	119	6.65
	2020	1.85	$ 1,388.03	2020	1.02	$1,104.68	$283.35	x	23	3	120	6.7
	2021	1.9	$ 1,425.54	2021	1.05	$1,137.17	$288.37	x	24	4	121	6.75
	2022	1.95	$ 1,463.06	2022	1.06	$1,148.00	$315.06	x	25	5	122	6.8
	2023	2	$ 1,500.57	2023	1.07	$1,158.83	$341.74	x	26	6	123	6.85
	2024	2.05	$ 1,538.09	2024	1.08	$1,169.66	$368.43	x	27	7	124	6.9
	2025	2.1	$ 1,575.60	2025	1.1	$1,191.32	$384.28	x	28	8	125	6.95
	2026	2.15	$ 1,613.11	2026	1.15	$1,245.47	$367.64	x	29	9	126	7
	2027	2.2	$ 1,650.63	2027	1.2	$1,299.62	$351.01	x	30	10	127	7.05
	2028	2.25	$ 1,688.14	2028	1.25	$1,353.77	$334.37	x	31	11	128	7.1

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2029	2.3	$ 1,725.66	2029	1.3	$1,407.92	$317.73	x	32	12	129	7.15
	2030	2.35	$ 1,763.17	2030	1.35	$1,462.07	$301.10	x	33	13	130	7.2
	2031	2.4	$ 1,800.69	2031	1.4	$1,516.23	$284.46	x	34	14	131	7.25
Totals	35	56.18	$ 42,151.06	15	16.68	$18,064.74	$5,569.27					

City of Gladstone EPC	Project			
City Hall Gladstone, MO	Location			
Split Systems, 4T (average)	Equipment			
108.3%	Location Cost Index	Kansas City, MO		
Repair RTU	Repair Type #1			
10	Repair Frequency (Years)			
☑	Include Repair Labor?			
27.64	Repair Labor Required (Hours)			
Contract	Select In-House or Contract Labor			
$114.43	Repair Labor Rate ($/hour)	HVAC Technician		
$2,180.34	Repair Material Cost		$ 1,826 From 2011-2012 Whitestone	3% Est. Inflation on Equip
☑	Include End-of-Life Replacement Cost in Analysis?			
Replace RTU	Repair Type #2			
20	Replacement Frequency (Years)			
☑	Include Replacement Labor?			
39.0	Replacement Labor Required (Hours)			
$114.43	Replacement Labor Rate ($/hour)	HVAC Technician		
$4,569.64	Replacement Material Cost		$ 3,827 From 2011-2012 Whitestone	
2003	Year Equipment Originally Installed			
2018	Year New Equipment to be Installed			
15	Length of Performance Contract (Years)			
$1,023.00	Average Annual Repair Cost in 2016 Dollars			
$254.89	**Annual O&M Savings per unit**			
$509.77	**Total Savings**	No. of Units: 2		

	Existing			Proposed								
	Year	**Increase Factor**	**Annual Repair Cost**	**Year**	**Increase Factor**	**Annual Repair Cost**	**Savings**	**Include Year?**	**Original Life**	**New Life**	**Increase Factor Year**	**Increase Factor**
	2001								0	0	101	5.75
	2002								0	0	102	5.8
Original Installation	2003	0.2	$ 138.15					x	1	0	103	5.85
	2004	1	$ 690.75					x	2	0	104	5.9
	2005	1.02	$ 704.56					x	3	0	105	5.95
	2006	1.05	$ 725.29					x	4	0	106	6
	2007	1.06	$ 732.19					x	5	0	107	6.05
	2008	1.07	$ 739.10					x	6	0	108	6.1
	2009	1.08	$ 746.01					x	7	0	109	6.15
	2010	1.1	$ 759.82					x	8	0	110	6.2
	2011	1.15	$ 794.36					x	9	0	111	6.25
	2012	1.2	$ 828.90					x	10	0	112	6.3
	2013	1.25	$ 863.44					x	11	0	113	6.35
	2014	1.3	$ 897.97					x	12	0	114	6.4
	2015	1.35	$ 932.51					x	13	0	115	6.45
	2016	1.4	$ 967.05					x	14	0	116	6.5
	2017	1.45	$ 1,001.59					x	15	0	117	6.55
Proposed Replacement	2018	1.5	$ 1,036.12	2018	0.2	$183.99	$852.13	x	16	1	118	6.6
	2019	1.55	$ 1,070.66	2019	1	$919.96	$150.70	x	17	2	119	6.65
	2020	1.6	$ 1,105.20	2020	1.02	$938.36	$166.84	x	18	3	120	6.7
	2021	1.65	$ 1,139.74	2021	1.05	$965.96	$173.77	x	19	4	121	6.75
	2022	1.7	$ 1,174.27	2022	1.06	$975.16	$199.11	x	20	5	122	6.8
	2023	1.75	$ 1,208.81	2023	1.07	$984.36	$224.45	x	21	6	123	6.85
	2024	1.8	$ 1,243.35	2024	1.08	$993.56	$249.79	x	22	7	124	6.9
	2025	1.85	$ 1,277.89	2025	1.1	$1,011.96	$265.93	x	23	8	125	6.95
	2026	1.9	$ 1,312.42	2026	1.15	$1,057.96	$254.47	x	24	9	126	7
	2027	1.95	$ 1,346.96	2027	1.2	$1,103.96	$243.00	x	25	10	127	7.05
	2028	2	$ 1,381.50	2028	1.25	$1,149.95	$231.54	x	26	11	128	7.1

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	**Savings**	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2029	2.05	$ 1,416.04	2029	1.3	$1,195.95	$220.08	x	27	12	129	7.15
	2030	2.1	$ 1,450.57	2030	1.35	$1,241.95	$208.62	x	28	13	130	7.2
	2031	2.15	$ 1,485.11	2031	1.4	$1,287.95	$197.16	x	29	14	131	7.25
Totals	30	44.43	$ 30,689.97	15	16.68	$15,344.98	$3,823.29					

ECM46 - Fire Station #1 HVAC Equipment Replacement Savings

Total installed cooling capacity	13	tons	
amount we are replacing	8	tons	62%
Annual cooling demand from UA	92.9	kw	
Annual cooling energy from UA	31,370	kWh less controls savings	
Old efficiency	1.2	kW/ton	10 SEER
New efficiency	0.86	kW/ton	14 SEER
Cooling Savings	5,516	kWh	
Demand Savings	13.1	kW	
Annual Heating energy from UA	3506	therms	
Old Efficiency	72%	derated by 10% for age	
New Efficiency	92%		
Heating Savings	762	therms	

City of Gladstone EPC	Project		
City Hall Gladstone, MO	Location		
Split Systems, 4T (average)	Equipment		
108.3%	Location Cost Index	Kansas City, MO	
Repair RTU	Repair Type #1		
10	Repair Frequency (Years)		
☑	Include Repair Labor?		
27.64	Repair Labor Required (Hours)		
Contract	Select In-House or Contract Labor		
$114.43	Repair Labor Rate ($/hour)	HVAC Technician	
$2,180.34	Repair Material Cost	$ 1,826	From 2011-2012 Whitestone
☑	Include End-of-Life Replacement Cost in Analysis?		
Replace RTU	Repair Type #2		
20	Replacement Frequency (Years)		
☑	Include Replacement Labor?		
39.0	Replacement Labor Required (Hours)		
$114.43	Replacement Labor Rate ($/hour)	HVAC Technician	
$4,569.64	Replacement Material Cost	$ 3,827	From 2011-2012 Whitestone
2004	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$1,023.00	Average Annual Repair Cost in 2016 Dollars		
$241.52	**Annual O&M Savings per unit**		
$483.04	**Total Savings**	No. of Units:	2

3% Est. Inflation on Equipment

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
Original Installation	2004	0.2	$ 140.50					x	1	0	104	5.9
	2005	1	$ 702.51					x	2	0	105	5.95
	2006	1.02	$ 716.56					x	3	0	106	6
	2007	1.05	$ 737.63					x	4	0	107	6.05
	2008	1.06	$ 744.66					x	5	0	108	6.1
	2009	1.07	$ 751.69					x	6	0	109	6.15
	2010	1.08	$ 758.71					x	7	0	110	6.2
	2011	1.1	$ 772.76					x	8	0	111	6.25
	2012	1.15	$ 807.89					x	9	0	112	6.3
	2013	1.2	$ 843.01					x	10	0	113	6.35
	2014	1.25	$ 878.14					x	11	0	114	6.4
	2015	1.3	$ 913.26					x	12	0	115	6.45
	2016	1.35	$ 948.39					x	13	0	116	6.5
	2017	1.4	$ 983.51					x	14	0	117	6.55
Proposed Replacement	2018	1.45	$ 1,018.64	2018	0.2	$183.99	$834.65	x	15	1	118	6.6
	2019	1.5	$ 1,053.76	2019	1	$919.96	$133.80	x	16	2	119	6.65
	2020	1.55	$ 1,088.89	2020	1.02	$938.36	$150.53	x	17	3	120	6.7
	2021	1.6	$ 1,124.01	2021	1.05	$965.96	$158.05	x	18	4	121	6.75
	2022	1.65	$ 1,159.14	2022	1.06	$975.16	$183.98	x	19	5	122	6.8
	2023	1.7	$ 1,194.27	2023	1.07	$984.36	$209.91	x	20	6	123	6.85
	2024	1.75	$ 1,229.39	2024	1.08	$993.56	$235.83	x	21	7	124	6.9
	2025	1.8	$ 1,264.52	2025	1.1	$1,011.96	$252.56	x	22	8	125	6.95
	2026	1.85	$ 1,299.64	2026	1.15	$1,057.96	$241.68	x	23	9	126	7
	2027	1.9	$ 1,334.77	2027	1.2	$1,103.96	$230.81	x	24	10	127	7.05
	2028	1.95	$ 1,369.89	2028	1.25	$1,149.95	$219.94	x	25	11	128	7.1
	2029	2	$ 1,405.02	2029	1.3	$1,195.95	$209.07	x	26	12	129	7.15
	2030	2.05	$ 1,440.14	2030	1.35	$1,241.95	$198.19	x	27	13	130	7.2
	2031	2.1	$ 1,475.27	2031	1.4	$1,287.95	$187.32	x	28	14	131	7.25
Totals	29	42.23	$ 29,666.97	15	16.68	$15,344.98	$3,622.77					

ECM47 - Fire Station #2 HVAC Equipment Replacement Savings

Total installed cooling capacity	12.5	tons		
amount we are replacing	12.5	tons	100%	
Annual cooling demand from UA	75.4	kw		
Annual cooling energy from UA	25,919	kWh less controls savings		
Old efficiency	1.2	kW/ton	10	SEER
New efficiency	0.86	kW/ton	14	SEER
Cooling Savings	7,405	kWh		
Demand Savings	17.2	kW		

Annual Heating energy from UA	2354	therms
Old Efficiency	80%	
New Efficiency	92%	
Heating Savings	307	therms

City of Gladstone EPC	Project
City Hall Gladstone, MO	Location
Split Systems, 4T (average)	Equipment
108.3%	Location Cost Index — Kansas City, MO
Repair RTU	Repair Type #1
10	Repair Frequency (Years)
☑	Include Repair Labor?
27.64	Repair Labor Required (Hours)
Contract	Select In-House or Contract Labor
$114.43	Repair Labor Rate ($/hour) — HVAC Technician
$2,180.34	Repair Material Cost
☑	Include End-of-Life Replacement Cost in Analysis?
Replace RTU	Repair Type #2
20	Replacement Frequency (Years)
☑	Include Replacement Labor?
39.0	Replacement Labor Required (Hours)
$114.43	Replacement Labor Rate ($/hour) — HVAC Technician
$4,569.64	Replacement Material Cost
2001	Year Equipment Originally Installed
2018	Year New Equipment to be Installed
15	Length of Performance Contract (Years)
$1,023.00	Average Annual Repair Cost in 2016 Dollars
$280.29	**Annual O&M Savings per unit**
$840.87	**Total Savings** — No. of Units: 3

$ 1,826 From 2011-2012 Whitestone

3% Est. Inflation on Equipment

$ 3,827 From 2011-2012 Whitestone

Existing **Proposed**

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
Original Installation	2001	0.2	$ 133.67					x	1	0	101	5.75
	2002	1	$ 668.35					x	2	0	102	5.8
	2003	1.02	$ 681.72					x	3	0	103	5.85
	2004	1.05	$ 701.77					x	4	0	104	5.9
	2005	1.06	$ 708.45					x	5	0	105	5.95
	2006	1.07	$ 715.14					x	6	0	106	6
	2007	1.08	$ 721.82					x	7	0	107	6.05
	2008	1.1	$ 735.19					x	8	0	108	6.1
	2009	1.15	$ 768.61					x	9	0	109	6.15
	2010	1.2	$ 802.02					x	10	0	110	6.2
	2011	1.25	$ 835.44					x	11	0	111	6.25
	2012	1.3	$ 868.86					x	12	0	112	6.3
	2013	1.35	$ 902.28					x	13	0	113	6.35
	2014	1.4	$ 935.70					x	14	0	114	6.4
	2015	1.45	$ 969.11					x	15	0	115	6.45
	2016	1.5	$ 1,002.53					x	16	0	116	6.5
	2017	1.55	$ 1,035.95					x	17	0	117	6.55
Proposed Replacement	2018	1.6	$ 1,069.37	2018	0.2	$183.99	$885.37	x	18	1	118	6.6
	2019	1.65	$ 1,102.78	2019	1	$919.96	$182.82	x	19	2	119	6.65
	2020	1.7	$ 1,136.20	2020	1.02	$938.36	$197.84	x	20	3	120	6.7
	2021	1.75	$ 1,169.62	2021	1.05	$965.96	$203.66	x	21	4	121	6.75
	2022	1.8	$ 1,203.04	2022	1.06	$975.16	$227.88	x	22	5	122	6.8
	2023	1.85	$ 1,236.45	2023	1.07	$984.36	$252.09	x	23	6	123	6.85
	2024	1.9	$ 1,269.87	2024	1.08	$993.56	$276.31	x	24	7	124	6.9
	2025	1.95	$ 1,303.29	2025	1.1	$1,011.96	$291.33	x	25	8	125	6.95
	2026	2	$ 1,336.71	2026	1.15	$1,057.96	$278.75	x	26	9	126	7
	2027	2.05	$ 1,370.13	2027	1.2	$1,103.96	$266.17	x	27	10	127	7.05
	2028	2.1	$ 1,403.54	2028	1.25	$1,149.95	$253.59	x	28	11	128	7.1
	2029	2.15	$ 1,436.96	2029	1.3	$1,195.95	$241.01	x	29	12	129	7.15
	2030	2.2	$ 1,470.38	2030	1.35	$1,241.95	$228.43	x	30	13	130	7.2
	2031	2.25	$ 1,503.80	2031	1.4	$1,287.95	$215.85	x	31	14	131	7.25
Totals	32	48.98	$ 32,735.97	15	16.68	$15,344.98	$4,204.36					

ECM48 - Public Works HVAC Equipment Replacement Savings

Total installed cooling capacity	17	tons		
amount we are replacing	17	tons	100%	
Annual cooling demand from UA	74.7	kw		
Annual cooling energy from UA	22,685	kWh less controls savings		
Old efficiency	1.2	kW/ton	10	SEER
New efficiency	0.86	kW/ton	14	SEER
Cooling Savings	6,481	kWh		
Demand Savings	17.1	kW		
Annual Heating energy from UA	1717	therms		
Old Efficiency	72%	derated by 10% for age		
New Efficiency	82%			
Heating Savings	209	therms		

City of Gladstone EPC	Project		
City Hall Gladstone, MO	Location		
Rooftop Unit 5 T SZ	Equipment		
108.3%	Location Cost Index	Kansas City, MO	
Repair RTU	Repair Type #1		
10	Repair Frequency (Years)		
☑	Include Repair Labor?		
18.3	Repair Labor Required (Hours)		
Contract	Select In-House or Contract Labor		
$114.43	Repair Labor Rate ($/hour)	HVAC Technician	
$1,459.13	Repair Material Cost		$ 1,222 From 2011-2012 Whitestone
☑	Include End-of-Life Replacement Cost in Analysis?		
Replace RTU	Repair Type #2		
15	Replacement Frequency (Years)		
☑	Include Replacement Labor?		
56.6	Replacement Labor Required (Hours)		
$114.43	Replacement Labor Rate ($/hour)	HVAC Technician	
$5,610.85	Replacement Material Cost		$ 4,699 From 2011-2012 Whitestone
2004	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$1,204.32	Average Annual Repair Cost in 2016 Dollars		
$284.32	**Annual O&M Savings per unit**		
$568.65	**Total Savings**	No. of Units: 2	

3% Est. Inflation on Equipment

		Existing		Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
Original Installation	2004	0.2	$ 165.40					x	1	0	104	5.9
	2005	1	$ 827.02					x	2	0	105	5.95
	2006	1.02	$ 843.56					x	3	0	106	6
	2007	1.05	$ 868.37					x	4	0	107	6.05
	2008	1.06	$ 876.64					x	5	0	108	6.1
	2009	1.07	$ 884.91					x	6	0	109	6.15
	2010	1.08	$ 893.18					x	7	0	110	6.2
	2011	1.1	$ 909.72					x	8	0	111	6.25
	2012	1.15	$ 951.08					x	9	0	112	6.3
	2013	1.2	$ 992.43					x	10	0	113	6.35
	2014	1.25	$ 1,033.78					x	11	0	114	6.4
	2015	1.3	$ 1,075.13					x	12	0	115	6.45
	2016	1.35	$ 1,116.48					x	13	0	116	6.5
	2017	1.4	$ 1,157.83					x	14	0	117	6.55
Proposed Replacement	2018	1.45	$ 1,199.18	2018	0.2	$216.60	$982.58	x	15	1	118	6.6
	2019	1.5	$ 1,240.53	2019	1	$1,083.02	$157.52	x	16	2	119	6.65
	2020	1.55	$ 1,281.89	2020	1.02	$1,104.68	$177.21	x	17	3	120	6.7
	2021	1.6	$ 1,323.24	2021	1.05	$1,137.17	$186.07	x	18	4	121	6.75
	2022	1.65	$ 1,364.59	2022	1.06	$1,148.00	$216.59	x	19	5	122	6.8
	2023	1.7	$ 1,405.94	2023	1.07	$1,158.83	$247.11	x	20	6	123	6.85
	2024	1.75	$ 1,447.29	2024	1.08	$1,169.66	$277.63	x	21	7	124	6.9
	2025	1.8	$ 1,488.64	2025	1.1	$1,191.32	$297.32	x	22	8	125	6.95
	2026	1.85	$ 1,529.99	2026	1.15	$1,245.47	$284.52	x	23	9	126	7
	2027	1.9	$ 1,571.34	2027	1.2	$1,299.62	$271.72	x	24	10	127	7.05
	2028	1.95	$ 1,612.69	2028	1.25	$1,353.77	$258.92	x	25	11	128	7.1
	2029	2	$ 1,654.05	2029	1.3	$1,407.92	$246.12	x	26	12	129	7.15
	2030	2.05	$ 1,695.40	2030	1.35	$1,462.07	$233.32	x	27	13	130	7.2
	2031	2.1	$ 1,736.75	2031	1.4	$1,516.23	$220.52	x	28	14	131	7.25
Totals	29	42.23	$ 34,925.17	15	16.68	$18,064.74	$4,264.87					

ECM49 - Animal Shelter HVAC Equipment Replacement Savings

Total installed cooling capacity	9.5	tons		
amount we are replacing	7	tons	74%	
Annual cooling demand from UA	42.1	kw		
Annual cooling energy from UA	4,315	kWh less controls savings		
Old efficiency	1.2	kW/ton	10	SEER
New efficiency	0.86	kW/ton	14	SEER
Cooling Savings	908	kWh		
Demand Savings	7.1	kW		
Annual Heating energy from UA	2289	therms		
Old Efficiency	72%	derated by 10% for age		
New Efficiency	82%			
Heating Savings	279	therms		

Project Name	Project		
City, State	Location		
2 Ton RTU	Equipment		
108.3%	Location Cost Index	Kansas City, MO	
Repair RTU	Repair Type #1		
10	Repair Frequency (Years)		
☑	Include Repair Labor?		
12	Repair Labor Required (Hours)		
Contract	Select In-House or Contract Labor		
$114.43	Repair Labor Rate ($/hour)	HVAC Technician	
$597.03	Repair Material Cost		$ 500 From 2011-2012 Whitestone; 3% Est. Inflation on Equipment
☑	Include End-of-Life Replacement Cost in Analysis?		
Replace RTU	Repair Type #2		
15	Replacement Frequency (Years)		
☑	Include Replacement Labor?		
24.1	Replacement Labor Required (Hours)		
$114.43	Replacement Labor Rate ($/hour)	HVAC Technician	
$5,922.50	Replacement Material Cost		$ 4,960 From 2011-2012 Whitestone
2002	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$813.43	Average Annual Repair Cost in 2016 Dollars		
$212.94	**Annual O&M Savings per unit**		
$212.94	**Total Savings**	No. of Units:	1

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2001								0	0	101	5.75
Original Installation	2002	0.2	$ 108.04					x	1	0	102	5.8
	2003	1	$ 540.19					x	2	0	103	5.85
	2004	1.02	$ 551.00					x	3	0	104	5.9
	2005	1.05	$ 567.20					x	4	0	105	5.95
	2006	1.06	$ 572.61					x	5	0	106	6
	2007	1.07	$ 578.01					x	6	0	107	6.05
	2008	1.08	$ 583.41					x	7	0	108	6.1
	2009	1.1	$ 594.21					x	8	0	109	6.15
	2010	1.15	$ 621.22					x	9	0	110	6.2
	2011	1.2	$ 648.23					x	10	0	111	6.25
	2012	1.25	$ 675.24					x	11	0	112	6.3
	2013	1.3	$ 702.25					x	12	0	113	6.35
	2014	1.35	$ 729.26					x	13	0	114	6.4
	2015	1.4	$ 756.27					x	14	0	115	6.45
	2016	1.45	$ 783.28					x	15	0	116	6.5
	2017	1.5	$ 810.29					x	16	0	117	6.55
Proposed Replacement	2018	1.55	$ 837.30	2018	0.2	$146.30	$691.00	x	17	1	118	6.6
	2019	1.6	$ 864.31	2019	1	$731.50	$132.81	x	18	2	119	6.65
	2020	1.65	$ 891.32	2020	1.02	$746.13	$145.19	x	19	3	120	6.7
	2021	1.7	$ 918.33	2021	1.05	$768.08	$150.26	x	20	4	121	6.75
	2022	1.75	$ 945.34	2022	1.06	$775.39	$169.95	x	21	5	122	6.8
	2023	1.8	$ 972.35	2023	1.07	$782.71	$189.64	x	22	6	123	6.85
	2024	1.85	$ 999.36	2024	1.08	$790.02	$209.34	x	23	7	124	6.9
	2025	1.9	$ 1,026.37	2025	1.1	$804.65	$221.72	x	24	8	125	6.95
	2026	1.95	$ 1,053.38	2026	1.15	$841.23	$212.15	x	25	9	126	7
	2027	2	$ 1,080.39	2027	1.2	$877.80	$202.59	x	26	10	127	7.05
	2028	2.05	$ 1,107.40	2028	1.25	$914.38	$193.02	x	27	11	128	7.1
	2029	2.1	$ 1,134.41	2029	1.3	$950.95	$183.46	x	28	12	129	7.15
	2030	2.15	$ 1,161.42	2030	1.35	$987.53	$173.89	x	29	13	130	7.2
	2031	2.2	$ 1,188.43	2031	1.4	$1,024.10	$164.33	x	30	14	131	7.25
Totals	31	46.68	$ 25,216.29	15	16.68	$12,201.43	$3,194.12					

City of Gladstone EPC	Project	
City Hall Gladstone, MO	Location	
Rooftop Unit 5 T SZ	Equipment	
108.3%	Location Cost Index	Kansas City, MO
Repair RTU	Repair Type #1	
10	Repair Frequency (Years)	
☑	Include Repair Labor?	
18.3	Repair Labor Required (Hours)	
Contract	Select In-House or Contract Labor	
$114.43	Repair Labor Rate ($/hour)	HVAC Technician
$1,459.13	Repair Material Cost	
☑	Include End-of-Life Replacement Cost in Analysis?	
Replace RTU	Repair Type #2	
15	Replacement Frequency (Years)	
☑	Include Replacement Labor?	
56.6	Replacement Labor Required (Hours)	
$114.43	Replacement Labor Rate ($/hour)	HVAC Technician
$5,610.85	Replacement Material Cost	
2006	Year Equipment Originally Installed	
2018	Year New Equipment to be Installed	
15	Length of Performance Contract (Years)	
$1,204.32	Average Annual Repair Cost in 2016 Dollars	
$251.14	**Annual O&M Savings per unit**	
$251.14	**Total Savings**	No. of Units: 1

$ 1,222 From 2011-2012 Whitestone

3% Est. Inflation on Equipment

$ 4,699 From 2011-2012 Whitestone

	Existing			Proposed								
	Year	**Increase Factor**	**Annual Repair Cost**	**Year**	**Increase Factor**	**Annual Repair Cost**	**Savings**	**Include Year?**	**Original Life**	**New Life**	**Increase Factor Year**	**Increase Factor**
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
Original Installation	2006	0.2	$ 171.23					x	1	0	106	6
	2007	1	$ 856.15					x	2	0	107	6.05
	2008	1.02	$ 873.27					x	3	0	108	6.1
	2009	1.05	$ 898.96					x	4	0	109	6.15
	2010	1.06	$ 907.52					x	5	0	110	6.2
	2011	1.07	$ 916.08					x	6	0	111	6.25
	2012	1.08	$ 924.64					x	7	0	112	6.3
	2013	1.1	$ 941.76					x	8	0	113	6.35
	2014	1.15	$ 984.57					x	9	0	114	6.4
	2015	1.2	$ 1,027.38					x	10	0	115	6.45
	2016	1.25	$ 1,070.19					x	11	0	116	6.5
	2017	1.3	$ 1,112.99					x	12	0	117	6.55
Proposed Replacement	2018	1.35	$ 1,155.80	2018	0.2	$216.60	$939.20	x	13	1	118	6.6
	2019	1.4	$ 1,198.61	2019	1	$1,083.02	$115.59	x	14	2	119	6.65
	2020	1.45	$ 1,241.42	2020	1.02	$1,104.68	$136.74	x	15	3	120	6.7
	2021	1.5	$ 1,284.22	2021	1.05	$1,137.17	$147.05	x	16	4	121	6.75
	2022	1.55	$ 1,327.03	2022	1.06	$1,148.00	$179.03	x	17	5	122	6.8
	2023	1.6	$ 1,369.84	2023	1.07	$1,158.83	$211.01	x	18	6	123	6.85
	2024	1.65	$ 1,412.65	2024	1.08	$1,169.66	$242.99	x	19	7	124	6.9
	2025	1.7	$ 1,455.45	2025	1.1	$1,191.32	$264.13	x	20	8	125	6.95
	2026	1.75	$ 1,498.26	2026	1.15	$1,245.47	$252.79	x	21	9	126	7
	2027	1.8	$ 1,541.07	2027	1.2	$1,299.62	$241.45	x	22	10	127	7.05
	2028	1.85	$ 1,583.88	2028	1.25	$1,353.77	$230.10	x	23	11	128	7.1
	2029	1.9	$ 1,626.68	2029	1.3	$1,407.92	$218.76	x	24	12	129	7.15
	2030	1.95	$ 1,669.49	2030	1.35	$1,462.07	$207.42	x	25	13	130	7.2
	2031	2	$ 1,712.30	2031	1.4	$1,516.23	$196.07	x	26	14	131	7.25
Totals	27	37.98	$ 32,516.53	15	16.68	$18,064.74	$3,767.05					

Existing Conditions

73.125	North Window Area (ft^2)
0	South Window Area (ft^2)
914	East Window Area (ft^2)
170.625	West Window Area (ft^2)
0	Horizontal Window Area (ft^2)
7:00 AM to 5:00 PM	Occupied Schedule
70	Heating Occupied Setpoint (°F)
75	Cooling Occupied Setpoint (°F)
60	Heating Unoccupied Setpoint (°F)
85	Cooling Unoccupied Setpoint (°F)
85%	Heating Equipment Efficiency
3.00	Cooling Equipment Coefficient of Performance (COP)
1.04	U-Valu Single-Glazed with Bronze or Gray Tint
0.73	SHGC (Solar Heat Gain Coefficient or Shading Coefficient)
50%	Percentage Multiplier for SHGC (0=No Shading, 100= Completely Shaded)
0.56	AL Rate (Air Leakage or Infiltration Rate) (CFM/ft^2)

Heating Source

○ Gas (MCF) ● Gas (Therms) ○ Electric

New Conditions

73.125	North Window Area (ft^2)
0	South Window Area (ft^2)
914	East Window Area (ft^2)
170.625	West Window Area (ft^2)
0	Horizontal Window Area (ft^2)
70	Heating Occupied Setpoint (°F)
75	Cooling Occupied Setpoint (°F)
60	Heating Unoccupied Setpoint (°F)
85	Cooling Unoccupied Setpoint (°F)
0.5	U-Valu Double-Glazed with High-Performance Tint
0.51	SHGC (Solar Heat Gain Coefficient or Shading Coefficient)
50%	Percentage Multiplier for SHGC (0=No Shading, 100= Completely Shaded)
0.1	AL Rate (Air Leakage or Infiltration Rate) (CFM/ft^2)

Location

Kansas City, MO

Heating

Total Therms Saved	1,409	
January	368	Therms Saved
February	279	Therms Saved
March	204	Therms Saved
April	16	Therms Saved
October	23	Therms Saved
November	204	Therms Saved
December	315	Therms Saved

Cooling

Total kWh Saved	411	
June	-111	kWh Saved
July	551	kWh Saved
August	-29	kWh Saved

Total kW Saved	2	
June	0.7	kW Saved
July	0.7	kW Saved
August	0.7	kW Saved

smith&boucher ENGINEERS
25501 W. Valley Parkway, Suite 200
Olathe, Kansas 66061
(913) 345-2127
Fax (913) 345-0617

Job # Gladstone
Date 7/24/17

Window infiltration

Crack length.

A1 – 9.75'x2 + 2.5x2 = 24.5' per wind.
x 32 = 784'

A3 – 2.5x2 + 2x2 = 9' per wind.
x22 = 198'

A4 9' per wind
x 4 = 36'

A5 8' per wind
x 1 = 8'

A6 24.5
x 10 245'

1271'

Average crack width = 1/64"

leak area = $(1271')(\frac{1}{64}")(\frac{1'}{12"}) = 1.65\ ft^2$

$Q = 88\ C_v A U$

$C_v = 0.6 \quad U = 7.5$ mph

Q = 653 cfm. 653/1158 = 0.56 cfm/sf

Mapko Specs show new windows limited to 0.1 cfm/sf

City of Gladstone EPC	Project	Square Footage:	1157.75
Gladstone, MO City Hall	Location		
Front Windows	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Existing - Single Pane Fixed	Proposed - Double Pane Fixed		
Repair Windows	Repair Windows	Repair Type #1	
20	20	Repair Frequency (Years)	
☑		Include Repair Labor?	1
31.8	31.8	Repair Labor Required (Hours)	
Contract		Select In-House or Contract Labor	
$100.67	$100.67	Repair Labor Rate ($/hour)	Carpenter
$210.32	$196.82	Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace Windows	Replace Windows	Repair Type #2	
75	75	Replacement Frequency (Years)	
☑		Include Replacement Labor?	1
245.1	245.1	Replacement Labor Required (Hours)	
$100.67	$100.67	Replacement Labor Rate ($/hour)	Carpenter
$30,661.08	$54,386.27	Replacement Material Cost	
1961	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$943.33	$1,285.19	Average Annual Repair Cost in 2016 Dollars	
$189.06		**Annual O&M Savings per unit**	
$189.06		**Total Savings**	No. of Units: 1

Demand information from Bills

Billing Month	Billing Season	Prior to ECMs Maximum Measured Demand	Facilities Demand	After all other ECMs Demand Reduction Lights	Demand Reduction HVAC	Total Demand Reduction	New Max Measured Demand	New Facilities Demand	Demand Bill
April	Winter	707	1014	59	97	156	551	745	$ 4,374
May	Winter	804	1014	59	0	59	745	745	$ 5,058
June	Summer	737	1014	59	0	59	678	745	$ 6,871
July	Summer	705	1014	59	0	59	646	745	$ 6,658
August	Summer	719	1014	59	0	59	660	745	$ 6,753
September	Summer	698	1014	59	0	59	639	745	$ 6,615
October	Winter	759	1014	59	97	156	603	745	$ 4,560
November	Winter	845	1014	59	193	252	593	745	$ 4,525
December	Winter	948	1014	59	290	349	600	745	$ 4,548
January	Winter	1014	1014	59	386	445	569	745	$ 4,438
February	Winter	952	1014	59	290	349	603	745	$ 4,560
March	Winter	956	1014	59	193	252	704	745	$ 4,913

Manage Heating coils in VAV boxes

Qty.	size, kW	Group
1	2	I
1	2.5	II
1	2.5	III
1	2.5	IV
1	5.5	I
1	5.5	II
1	6	III
1	7.5	IV
1	9.5	I
1	10.5	II
1	10.5	III
1	10.5	IV
1	11.5	I
1	11.5	II
1	11.5	III
1	12	IV
1	12	I
1	15	II
1	15.5	III
1	24	IV
1	25	I
1	25	II
1	25	III
23	263	

average size	11.4
Group I load	65.5
Group II Load	70
Group III Load	71
Group IV Load	56.5

assume max of 50% of coils were on when demand was set

	131.5	kW

Now one group will be locked out while other 3 allowed to operate freely

Expected peak demand will be

	103.25	
Demand save	28.25	per month during heating season

RTU-1	RTU-3	
4	4	compressors
26.9	16.7	A each
460	460	V
19.3	12.0	kW per compressor

lock out one compressor from each unit during periods of high demand

31.3 kW saved per month during summer

AHU-1

Lock out top stage of the 28 kW heat during the winter season

9.3 kW

Savings Analysis

VAV box Coils	RTU-1,3 compressors	AHU-1	Demand Saved	Expected Max Measured Demand	Expected Facilities Demand	Demand rate	Facilities Rate	Demand Bill	Demand Savings	demand rates	Demand savings to go in GS
28.25	0	9	38	513	745	3.516	3.272	$ 4,242	$ 132	$ 6.788	19.5
0	0	0	0	745	745	3.516	3.272	$ 5,058	$ -	$ 6.788	0.0
0	31.26329	0	31	647	745	6.534	3.272	$ 6,667	$ 204	$ 9.806	20.8
0	31.26329	0	31	615	745	6.534	3.272	$ 6,454	$ 204	$ 9.806	20.8
0	31.26329	0	31	629	745	6.534	3.272	$ 6,549	$ 204	$ 9.806	20.8
0	31.26329	0	31	608	745	6.534	3.272	$ 6,410	$ 204	$ 9.806	20.8
0	0	0	0	603	745	3.516	3.272	$ 4,560	$ -	$ 6.788	0.0
28.25	0	9	38	556	745	3.516	3.272	$ 4,392	$ 132	$ 6.788	19.5
28.25	0	9	38	562	745	3.516	3.272	$ 4,416	$ 132	$ 6.788	19.5
28.25	0	9	38	531	745	3.516	3.272	$ 4,306	$ 132	$ 6.788	19.5
28.25	0	9	38	566	745	3.516	3.272	$ 4,428	$ 132	$ 6.788	19.5
28.25	0	9	38	666	745	3.516	3.272	$ 4,781	$ 132	$ 6.788	19.5
											200.1
			351	per year						Summer	83.3
			125	summer demand						winter	116.8
			226	winter demand							

City of Gladstone EPC	Project	
Gladstone, MO	Location	
Emergency Lighting Inverter	Equipment	
108.3%	Location Cost Index	Kansas City, MO
Replace Battery (52 ea.)	Repair Type #1	
10	Repair Frequency (Years)	
☑	Include Repair Labor?	
19.8	Repair Labor Required (Hours)	
Contract	Select In-House or Contract Labor	
$107.81	Repair Labor Rate ($/hour)	Electrician
$15,188.35	Repair Material Cost	
☑	Include End-of-Life Replacement Cost in Analysis?	
Replace RTU	Repair Type #2	
15	Replacement Frequency (Years)	
☑	Include Replacement Labor?	
84.8	Replacement Labor Required (Hours)	
$107.81	Replacement Labor Rate ($/hour)	Electrician
$28,234.88	Replacement Material Cost	
2007	Year Equipment Originally Installed	
2018	Year New Equipment to be Installed	
15	Length of Performance Contract (Years)	
$4,506.03	Average Annual Repair Cost in 2016 Dollars	
$874.12	**Annual O&M Savings per unit**	
$874.12	**Total Savings**	No. of Units: 1

Information on Existing DHW Heaters:

Quantity	2	
Manufacturer	Precision	
Model	HWS-3086V-120A-480-150PS/CEM	
Input Each	120	kW
No of Stages ea.	4	
Input per stage	30	
Storage	250	gallons ea.

List of fixtures on the HW system:

Tag	Desc.	Qty	Demand ea. Gpm	F.U./fixt	ext. F.U.	ext peak demand	
L-2	Wall Mtd Lavatory	7	1	1	7	7	
SK-1	ADA sink 15x17.5	2	1.6	1	2	3.2	
DW	Dishwasher (residential type)	1	2	1	1	2	
SK-2	Double Sink	1	2.2	1	1	2.2	
JS	Janitor Sink 24x24	2	3	2.5	5	6	
L-1	Undercounter LAV	6	1	1	6	6	
SV-1	Shower Valve	5	1.5	1.5	7.5	7.5	
SV-2	Same as SV-1 but with hand held	7	1.5	1.5	10.5	10.5	
SV-3	Gang Shower Head	4	1.5	1.5	6	6	
					46	50.4	gpm

Using Hunters Curve D the continuous demand is

12 gpm

Energy Use per ASHRAE Applications 2015 page 50.29 is

Qtotal = (Qwater + Qtankloss + Qpiping)/n

Qwater = (gal/min)x(8.33 lbm/gal)x(1 Btu/lbm x F)x(120 - 58 F)x(60 min / hr)

Qwater = 371,851 Btu/hr

This seems very high (ASHRAE method very conservative) use half of this value

185,926 Btu/hr

Qtankloss = (11.27 Btu/hr . F)x(140 - 72 F)

Qtankloss = 766 Btu/hr

Qpiping = (x Btu/hr.ft.F)x(length ft)x(120 - 70 F) for each size and length of pipe

For 2" supply, UA = 0.42, for 1/2" return, UA = .25

300 feet of each HW and HWR

Qpiping =	6300	Btu/hr for HW
	3750	Btu/hr for HWR
	10050	Btu/hr for both

Total Energy loss is Qwater during operating hours + Qtankloss and Qpiping for 24/7

Operating Hours	5260	hrs
Total Energy loss =	1,072,719,970	Btus/year
	314,396	kWh/year

Efficiency of new condensing water heaters

95%

New gas usage 11,292

Average demand 60 kW

Assume worst case all 4 stages of one boiler comes on once a month

120 kW

Annual demand 1440 kW

City of Gladstone EPC	Project	
Gladstone, MO	Location	
Locker Room DHW Heater	Equipment	
108.3%	Location Cost Index	Kansas City, MO
Existing - 125 kW Electric	Proposed - 500 MBH Gas	
Repair Unit	Repair Unit	Repair Type #1
10	5	Repair Frequency (Years)
☑		Include Repair Labor?
0	1.84	Repair Labor Required (Hours)
Contract		Select In-House or Contract Labor
$114.43	$114.43	Repair Labor Rate ($/hour) HVAC Technician
$0.00	$23.00	Repair Material Cost
☑		Include End-of-Life Replacement Cost in Analysis?
Replace Unit	Replace Unit	Repair Type #2
15	16	Replacement Frequency (Years)
☑		Include Replacement Labor?
21.0	9.5	Replacement Labor Required (Hours)
$114.43	$114.43	Replacement Labor Rate ($/hour) HVAC Technician
$19,325.00	$10,993.00	Replacement Material Cost
2007	Year Equipment Originally Installed	
2018	Year New Equipment to be Installed	
15	Length of Performance Contract (Years)	
$1,555.47	$859.41	Average Annual Repair Cost in 2016 Dollars
$997.80		**Annual O&M Savings per unit**
$1,995.60		**Total Savings** No. of Units: 2

Calculation Parameters **INPUTS**

Kansas City, MO

500	Maximum Heating Load (MBtu/h)
0.00929	Humidity Ratio Setpoint (lb_{wat}/lb_{air})
13	Maximum Cooling Load (tons)
1.33	Cooling Equipment Eff (kW/Ton)
0.8	Heating Equipment Eff (COP)
520	Affected Occupied Outside Air CFM

Heating Source
- ○ Gas Heat-MCF
- ◉ Gas Heat-Therms
- ○ Electric Heat

OA Temp	% of Max Heating Load
-2.5 & Below	**100%**
2.5	**93%**
7.5	**86%**
12.5	**79%**
17.5	**72%**
22.5	**65%**
27.5	**58%**
32.5	**51%**
37.5	**44%**
42.5	**37%**
47.5	**30%**

OA Temp	% of Max Cooling Load
55	**0%**
60	**0%**
65	**5%**
70	**19%**
75	**32%**
80	**46%**
85	**59%**
90	**73%**
95	**86%**
100 & Above	**100%**

Existing Conditions

74.0	Cooling Occupied Setpoint (°F)
74.0	Cooling Un-Occupied Setpoint (°F)
70.0	Heating Occupied Setpoint (°F)
70.0	Heating Unoccupied Setpoint (°F)
No	Is OA Shut Off When Not Occupied?
Controls Schedule	
	Monday through Friday:
0	Hour of day system is turned ON
24	Hour of day system is turned OFF
	Saturday:
0	Hour of day system is turned ON
24	Hour of day system is turned OFF
	Sunday:
0	Hour of day system is turned ON
24	Hour of day system is turned OFF

New Conditions

74	Cooling Occupied Setpoint (°F)
85	Cooling Un-Occupied Setpoint (°F)
70	Heating Occupied Setpoint (°F)
60	Heating Unoccupied Setpoint (°F)
Controls Schedule	
	Monday through Friday:
7	Hour of day system is turned ON
23	Hour of day system is turned OFF
	Saturday:
7	Hour of day system is turned ON
23	Hour of day system is turned OFF
	Sunday:
7	Hour of day system is turned ON
23	Hour of day system is turned OFF

Notes/Comments:

This calculation was calibrated for a 50,000 sq ft single story building in Kansas City. The building use type in the calibration was an elementary school and met, but did not exceed, ASHRAE 90.1. System types were single zone RTUs with gas heat and constant volume air distribution. No economizer was included. Windows were 20% of wall area. Lights were 32 W T8. Occupancy was 15 persons/1000 square feet.

Calculation will be reasonably accurate for preliminary calcs and CEA type calcs where M&V is IPMVP Option D (Calibrated Simulation). If IPMVP option C (Utility Bill Guarantee) is used, Engineer is advised to consider modeling with Carrier HAP or similar.

Do not confuse Maximum Heating Load and Maximum Cooling Load with installed equipment capacities. Often (heating systems in particular) are oversized and maximum load is considerably less than installed capacity. Conservative estimates of sq.ft./ton and Btu/hr/sf can be used to estimate load if calculations are not performed or actual historical operating data is not available.

Savings Realized from Schedule Change

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total Usage Savings	
0	0	0	0	149	829	2,265	1,226	326	234	0	0	**5,028**	**Cooling kWh**
78	69	65	34	0	0	0	0	0	0	60	74	**381**	**Heating Therms**

Calibration of pre-retrofit energy use to match utility analysis baseline.

Cooling Energy Use from Utility Analysis	34,739	kWh
Pre-Retrofit Cooling Energy Use in this calc.	34,739	kWh
Adjustment Factor	2.086	
Heating Energy Use from Utility Analysis	3,506	therms
Pre-Retrofit Heating Energy Use in this calc.	3,506	therms
Adjustment Factor	0.327	

Since the station is served by 3 single zone units and the sleeping zone needs to not be set back at night, use 2/3 of the savings calculated.

Cooling kWh Savings	3368.9
Heating therm savings	255.3194

City of Gladstone EPC	Project		
Gladstone, MO	Location		
Rooftop Unit 3T	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Proposed Old Hrs	Proposed New Hours		
Repair RTU	Repair RTU	Repair Type #1	
10	13.3	Repair Frequency (Years)	
☑		Include Repair Labor?	
27.64	27.64	Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$140.26	$140.26	Repair Labor Rate ($/hour)	HVAC Technician
$2,180.34	$2,180.34	Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace RTU	Replace RTU	Repair Type #2	
15	20.0	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
39.0	39.0	Replacement Labor Required (Hours)	
$114.43	$114.43	Replacement Labor Rate ($/hour)	HVAC Technician
$4,569.64	$4,569.64	Replacement Material Cost	
2018	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$1,251.25	$938.44	Average Annual Repair Cost in 2016 Dollars	
$208.54		**Annual O&M Savings per unit**	
$625.63		**Total Savings**	No. of Units: 3

1st floor

Old Hours	8760	hrs
New Hours	5840.0	
	33%	reduction

use 2/3 of savings because of same logic in BMS energy saving calc

	Existing			Proposed							
Year	**Increase Factor**	**Annual Repair Cost**	**Year**	**Increase Factor**	**Annual Repair Cost**	**Savings**	**Include Year?**	**Original Life**	**New Life**	**Increase Factor Year**	**Increase Factor**
1900								0	0	0	
1901								0	0	1	0.2
1902								0	0	2	1
1903								0	0	3	1.02
1904								0	0	4	1.05
1905								0	0	5	1.06
1906								0	0	6	1.07
1907								0	0	7	1.08
1908								0	0	8	1.1
1909								0	0	9	1.15
1910								0	0	10	1.2
1911								0	0	11	1.25
1912								0	0	12	1.3
1913								0	0	13	1.35
1914								0	0	14	1.4
1915								0	0	15	1.45
1916								0	0	16	1.5
1917								0	0	17	1.55
1918								0	0	18	1.6
1919								0	0	19	1.65
1920								0	0	20	1.7
1921								0	0	21	1.75
1922								0	0	22	1.8
1923								0	0	23	1.85

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1924								0	0	24	1.9
1925								0	0	25	1.95
1926								0	0	26	2
1927								0	0	27	2.05
1928								0	0	28	2.1
1929								0	0	29	2.15
1930								0	0	30	2.2
1931								0	0	31	2.25
1932								0	0	32	2.3
1933								0	0	33	2.35
1934								0	0	34	2.4
1935								0	0	35	2.45
1936								0	0	36	2.5
1937								0	0	37	2.55
1938								0	0	38	2.6
1939								0	0	39	2.65
1940								0	0	40	2.7
1941								0	0	41	2.75
1942								0	0	42	2.8
1943								0	0	43	2.85
1944								0	0	44	2.9
1945								0	0	45	2.95
1946								0	0	46	3
1947								0	0	47	3.05
1948								0	0	48	3.1
1949								0	0	49	3.15
1950								0	0	50	3.2
1951								0	0	51	3.25
1952								0	0	52	3.3
1953								0	0	53	3.35
1954								0	0	54	3.4
1955								0	0	55	3.45
1956								0	0	56	3.5
1957								0	0	57	3.55
1958								0	0	58	3.6
1959								0	0	59	3.65
1960								0	0	60	3.7
1961								0	0	61	3.75
1962								0	0	62	3.8
1963								0	0	63	3.85
1964								0	0	64	3.9
1965								0	0	65	3.95
1966								0	0	66	4
1967								0	0	67	4.05
1968								0	0	68	4.1
1969								0	0	69	4.15
1970								0	0	70	4.2
1971								0	0	71	4.25
1972								0	0	72	4.3
1973								0	0	73	4.35
1974								0	0	74	4.4

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	1975								0	0	75	4.45
	1976								0	0	76	4.5
	1977								0	0	77	4.55
	1978								0	0	78	4.6
	1979								0	0	79	4.65
	1980								0	0	80	4.7
	1981								0	0	81	4.75
	1982								0	0	82	4.8
	1983								0	0	83	4.85
	1984								0	0	84	4.9
	1985								0	0	85	4.95
	1986								0	0	86	5
	1987								0	0	87	5.05
	1988								0	0	88	5.1
	1989								0	0	89	5.15
	1990								0	0	90	5.2
	1991								0	0	91	5.25
	1992								0	0	92	5.3
	1993								0	0	93	5.35
	1994								0	0	94	5.4
	1995								0	0	95	5.45
	1996								0	0	96	5.5
	1997								0	0	97	5.55
	1998								0	0	98	5.6
	1999								0	0	99	5.65
	2000								0	0	100	5.7
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
	2007								0	0	107	6.05
	2008								0	0	108	6.1
	2009								0	0	109	6.15
	2010								0	0	110	6.2
	2011								0	0	111	6.25
	2012								0	0	112	6.3
	2013								0	0	113	6.35
	2014								0	0	114	6.4
	2015								0	0	115	6.45
	2016								0	0	116	6.5
	2017								0	0	117	6.55
Original Installation	2018	0.2	$ 225.05	2018	0.2	$168.78	$56.26	x	1	1	118	6.6
	2019	1	$ 1,125.23	2019	1	$843.92	$281.31	x	2	2	119	6.65
	2020	1.02	$ 1,147.73	2020	1.02	$860.80	$286.93	x	3	3	120	6.7
	2021	1.05	$ 1,181.49	2021	1.05	$886.12	$295.37	x	4	4	121	6.75
	2022	1.06	$ 1,192.74	2022	1.06	$894.56	$298.19	x	5	5	122	6.8
	2023	1.07	$ 1,203.99	2023	1.07	$903.00	$301.00	x	6	6	123	6.85
	2024	1.08	$ 1,215.25	2024	1.08	$911.43	$303.81	x	7	7	124	6.9
	2025	1.1	$ 1,237.75	2025	1.1	$928.31	$309.44	x	8	8	125	6.95

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
2026	1.15	$ 1,294.01	2026	1.15	$970.51	$323.50	x	9	9	126	7
2027	1.2	$ 1,350.27	2027	1.2	$1,012.71	$337.57	x	10	10	127	7.05
2028	1.25	$ 1,406.54	2028	1.25	$1,054.90	$351.63	x	11	11	128	7.1
2029	1.3	$ 1,462.80	2029	1.3	$1,097.10	$365.70	x	12	12	129	7.15
2030	1.35	$ 1,519.06	2030	1.35	$1,139.29	$379.76	x	13	13	130	7.2
2031	1.4	$ 1,575.32	2031	1.4	$1,181.49	$393.83	x	14	14	131	7.25
2032	1.45	$ 1,631.58	2032	1.45	$1,223.69	$407.90	x	15	15	132	7.3
2033								0	0	133	7.35
2034								0	0	134	7.4
2035								0	0	135	7.45
2036								0	0	136	7.5
2037								0	0	137	7.55
2038								0	0	138	7.6
2039								0	0	139	7.65
2040								0	0	140	7.7
2041								0	0	141	7.75
2042								0	0	142	7.8
2043								0	0	143	7.85
2044								0	0	144	7.9
2045								0	0	145	7.95
2046								0	0	146	8
2047								0	0	147	8.05
2048								0	0	148	8.1
2049								0	0	149	8.15
2050								0	0	150	8.2
2051								0	0	151	8.25
2052								0	0	152	8.3
2053								0	0	153	8.35
2054								0	0	154	8.4
2055								0	0	155	8.45
2056								0	0	156	8.5
2057								0	0	157	8.55
2058								0	0	158	8.6
2059								0	0	159	8.65
2060								0	0	160	8.7
2061								0	0	161	8.75
2062								0	0	162	8.8
2063								0	0	163	8.85
2064								0	0	164	8.9
2065								0	0	165	8.95
2066								0	0	166	9
2067								0	0	167	9.05
2068								0	0	168	9.1
2069								0	0	169	9.15
2070								0	0	170	9.2
2071								0	0	171	9.25
2072								0	0	172	9.3
2073								0	0	173	9.35
2074								0	0	174	9.4
2075								0	0	175	9.45
2076								0	0	176	9.5

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2077								0	0	177	9.55
	2078								0	0	178	9.6
	2079								0	0	179	9.65
	2080								0	0	180	9.7
	2081								0	0	181	9.75
	2082								0	0	182	9.8
	2083								0	0	183	9.85
	2084								0	0	184	9.9
	2085								0	0	185	9.95
	2086								0	0	186	10
	2087								0	0	187	10.05
	2088								0	0	188	10.1
	2089								0	0	189	10.15
	2090								0	0	190	10.2
	2091								0	0	191	10.25
	2092								0	0	192	10.3
	2093								0	0	193	10.35
	2094								0	0	194	10.4
	2095								0	0	195	10.45
	2096								0	0	196	10.5
	2097								0	0	197	10.55
	2098								0	0	198	10.6
	2099								0	0	199	10.65
	2100								0	0	200	10.7
Totals	15	16.68	$ 18,768.81	15	16.68	$14,076.61	$4,692.20					

Calculation Parameters **INPUTS**

Kansas City, MO

400	Maximum Heating Load (MBtu/h)
0.00929	Humidity Ratio Setpoint (lb_{wat}/lb_{air})
14	Maximum Cooling Load (tons)
1.33	Cooling Equipment Eff (kW/Ton)
0.8	Heating Equipment Eff (COP)
520	Affected Occupied Outside Air CFM

Heating Source
- ○ Gas Heat-MCF
- ● Gas Heat-Therms
- ○ Electric Heat

OA Temp	% of Max Heating Load
-2.5 & Below	100%
2.5	93%
7.5	86%
12.5	79%
17.5	72%
22.5	65%
27.5	58%
32.5	51%
37.5	44%
42.5	37%
47.5	30%

OA Temp	% of Max Cooling Load
55	0%
60	0%
65	5%
70	19%
75	32%
80	46%
85	59%
90	73%
95	86%
100 & Above	100%

Existing Conditions

74.0	Cooling Occupied Setpoint (°F)
74.0	Cooling Un-Occupied Setpoint (°F)
70.0	Heating Occupied Setpoint (°F)
70.0	Heating Unoccupied Setpoint (°F)
No	Is OA Shut Off When Not Occupied?

Controls Schedule

	Monday through Friday:
0	Hour of day system is turned ON
24	Hour of day system is turned OFF
	Saturday:
0	Hour of day system is turned ON
24	Hour of day system is turned OFF
	Sunday:
0	Hour of day system is turned ON
24	Hour of day system is turned OFF

New Conditions

74	Cooling Occupied Setpoint (°F)
85	Cooling Un-Occupied Setpoint (°F)
70	Heating Occupied Setpoint (°F)
60	Heating Unoccupied Setpoint (°F)

Controls Schedule

	Monday through Friday:
7	Hour of day system is turned ON
23	Hour of day system is turned OFF
	Saturday:
7	Hour of day system is turned ON
23	Hour of day system is turned OFF
	Sunday:
7	Hour of day system is turned ON
23	Hour of day system is turned OFF

Notes/Comments:

This calculation was calibrated for a 50,000 sq ft single story building in Kansas City. The building use type in the calibration was an elementary school and met, but did not exceed, ASHRAE 90.1. System types were single zone RTUs with gas heat and constant volume air distribution. No economizer was included. Windows were 20% of wall area. Lights were 32 W T8. Occupancy was 15 persons/1000 square feet.

Calculation will be reasonably accurate for preliminary calcs and CEA type calcs where M&V is IPMVP Option D (Calibrated Simulation). If IPMVP option C (Utility Bill Guarantee) is used, Engineer is advised to consider modeling with Carrier HAP or similar.

Do not confuse Maximum Heating Load and Maximum Cooling Load with installed equipment capacities. Often (heating systems in particular) are oversized and maximum load is considerably less than installed capacity. Conservative estimates of sq.ft./ton and Btu/hr/sf can be used to estimate load if calculations are not performed or actual historical operating data is not available.

Savings Realized from Schedule Change

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total Usage Savings	
0	0	0	0	123	678	1,872	1,006	266	192	0	0	4,136	Cooling kWh
55	48	46	24	0	0	0	0	0	0	42	52	268	Heating Therms

Yes
No

Calibration of pre-retrofit energy use to match utility analysis baseline.

Cooling Energy Use from Utility Analysis	28,690	kWh
Pre-Retrofit Cooling Energy Use in this calc.	28,690	kWh
Adjustment Factor	1.557	
Heating Energy Use from Utility Analysis	2,354	therms
Pre-Retrofit Heating Energy Use in this calc.	2,354	therms
Adjustment Factor	0.274	

Since the station is served by 3 single zone units and the sleeping zone needs to not be set back at night, use 2/3 of the savings calculated.

Cooling kWh Savings	2771.082
Heating therm savings	179.6941

City of Gladstone EPC	Project		
Gladstone, MO	Location		
Rooftop Unit 3T	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Proposed Old Hrs	Proposed New Hours		
Repair RTU	Repair RTU	Repair Type #1	
10	13.3	Repair Frequency (Years)	
☑		Include Repair Labor?	
27.64	27.64	Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$140.26	$140.26	Repair Labor Rate ($/hour)	HVAC Technician
$2,180.34	$2,180.34	Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace RTU	Replace RTU	Repair Type #2	
15	20.0	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
39.0	39.0	Replacement Labor Required (Hours)	
$114.43	$114.43	Replacement Labor Rate ($/hour)	HVAC Technician
$4,569.64	$4,569.64	Replacement Material Cost	
2018	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$1,251.25	$938.44	Average Annual Repair Cost in 2016 Dollars	
$208.54		**Annual O&M Savings per unit**	
$625.63		**Total Savings**	No. of Units: 3

	1st floor	
Old Hours	8760	hrs
New Hours	5840.0	
	33%	reduction

use 2/3 of savings because of same logic in BMS energy saving calc

Year	Existing Increase Factor	Existing Annual Repair Cost	Year	Proposed Increase Factor	Proposed Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1900								0	0	0	
1901								0	0	1	0.2
1902								0	0	2	1
1903								0	0	3	1.02
1904								0	0	4	1.05
1905								0	0	5	1.06
1906								0	0	6	1.07
1907								0	0	7	1.08
1908								0	0	8	1.1
1909								0	0	9	1.15
1910								0	0	10	1.2
1911								0	0	11	1.25
1912								0	0	12	1.3
1913								0	0	13	1.35
1914								0	0	14	1.4
1915								0	0	15	1.45
1916								0	0	16	1.5
1917								0	0	17	1.55
1918								0	0	18	1.6
1919								0	0	19	1.65
1920								0	0	20	1.7
1921								0	0	21	1.75
1922								0	0	22	1.8
1923								0	0	23	1.85

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1924								0	0	24	1.9
1925								0	0	25	1.95
1926								0	0	26	2
1927								0	0	27	2.05
1928								0	0	28	2.1
1929								0	0	29	2.15
1930								0	0	30	2.2
1931								0	0	31	2.25
1932								0	0	32	2.3
1933								0	0	33	2.35
1934								0	0	34	2.4
1935								0	0	35	2.45
1936								0	0	36	2.5
1937								0	0	37	2.55
1938								0	0	38	2.6
1939								0	0	39	2.65
1940								0	0	40	2.7
1941								0	0	41	2.75
1942								0	0	42	2.8
1943								0	0	43	2.85
1944								0	0	44	2.9
1945								0	0	45	2.95
1946								0	0	46	3
1947								0	0	47	3.05
1948								0	0	48	3.1
1949								0	0	49	3.15
1950								0	0	50	3.2
1951								0	0	51	3.25
1952								0	0	52	3.3
1953								0	0	53	3.35
1954								0	0	54	3.4
1955								0	0	55	3.45
1956								0	0	56	3.5
1957								0	0	57	3.55
1958								0	0	58	3.6
1959								0	0	59	3.65
1960								0	0	60	3.7
1961								0	0	61	3.75
1962								0	0	62	3.8
1963								0	0	63	3.85
1964								0	0	64	3.9
1965								0	0	65	3.95
1966								0	0	66	4
1967								0	0	67	4.05
1968								0	0	68	4.1
1969								0	0	69	4.15
1970								0	0	70	4.2
1971								0	0	71	4.25
1972								0	0	72	4.3
1973								0	0	73	4.35
1974								0	0	74	4.4

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	1975								0	0	75	4.45
	1976								0	0	76	4.5
	1977								0	0	77	4.55
	1978								0	0	78	4.6
	1979								0	0	79	4.65
	1980								0	0	80	4.7
	1981								0	0	81	4.75
	1982								0	0	82	4.8
	1983								0	0	83	4.85
	1984								0	0	84	4.9
	1985								0	0	85	4.95
	1986								0	0	86	5
	1987								0	0	87	5.05
	1988								0	0	88	5.1
	1989								0	0	89	5.15
	1990								0	0	90	5.2
	1991								0	0	91	5.25
	1992								0	0	92	5.3
	1993								0	0	93	5.35
	1994								0	0	94	5.4
	1995								0	0	95	5.45
	1996								0	0	96	5.5
	1997								0	0	97	5.55
	1998								0	0	98	5.6
	1999								0	0	99	5.65
	2000								0	0	100	5.7
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
	2007								0	0	107	6.05
	2008								0	0	108	6.1
	2009								0	0	109	6.15
	2010								0	0	110	6.2
	2011								0	0	111	6.25
	2012								0	0	112	6.3
	2013								0	0	113	6.35
	2014								0	0	114	6.4
	2015								0	0	115	6.45
	2016								0	0	116	6.5
	2017								0	0	117	6.55
Original Installation	2018	0.2	$ 225.05	2018	0.2	$168.78	$56.26	x	1	1	118	6.6
	2019	1	$ 1,125.23	2019	1	$843.92	$281.31	x	2	2	119	6.65
	2020	1.02	$ 1,147.73	2020	1.02	$860.80	$286.93	x	3	3	120	6.7
	2021	1.05	$ 1,181.49	2021	1.05	$886.12	$295.37	x	4	4	121	6.75
	2022	1.06	$ 1,192.74	2022	1.06	$894.56	$298.19	x	5	5	122	6.8
	2023	1.07	$ 1,203.99	2023	1.07	$903.00	$301.00	x	6	6	123	6.85
	2024	1.08	$ 1,215.25	2024	1.08	$911.43	$303.81	x	7	7	124	6.9
	2025	1.1	$ 1,237.75	2025	1.1	$928.31	$309.44	x	8	8	125	6.95

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
2026	1.15	$ 1,294.01	2026	1.15	$970.51	$323.50	x	9	9	126	7
2027	1.2	$ 1,350.27	2027	1.2	$1,012.71	$337.57	x	10	10	127	7.05
2028	1.25	$ 1,406.54	2028	1.25	$1,054.90	$351.63	x	11	11	128	7.1
2029	1.3	$ 1,462.80	2029	1.3	$1,097.10	$365.70	x	12	12	129	7.15
2030	1.35	$ 1,519.06	2030	1.35	$1,139.29	$379.76	x	13	13	130	7.2
2031	1.4	$ 1,575.32	2031	1.4	$1,181.49	$393.83	x	14	14	131	7.25
2032	1.45	$ 1,631.58	2032	1.45	$1,223.69	$407.90	x	15	15	132	7.3
2033								0	0	133	7.35
2034								0	0	134	7.4
2035								0	0	135	7.45
2036								0	0	136	7.5
2037								0	0	137	7.55
2038								0	0	138	7.6
2039								0	0	139	7.65
2040								0	0	140	7.7
2041								0	0	141	7.75
2042								0	0	142	7.8
2043								0	0	143	7.85
2044								0	0	144	7.9
2045								0	0	145	7.95
2046								0	0	146	8
2047								0	0	147	8.05
2048								0	0	148	8.1
2049								0	0	149	8.15
2050								0	0	150	8.2
2051								0	0	151	8.25
2052								0	0	152	8.3
2053								0	0	153	8.35
2054								0	0	154	8.4
2055								0	0	155	8.45
2056								0	0	156	8.5
2057								0	0	157	8.55
2058								0	0	158	8.6
2059								0	0	159	8.65
2060								0	0	160	8.7
2061								0	0	161	8.75
2062								0	0	162	8.8
2063								0	0	163	8.85
2064								0	0	164	8.9
2065								0	0	165	8.95
2066								0	0	166	9
2067								0	0	167	9.05
2068								0	0	168	9.1
2069								0	0	169	9.15
2070								0	0	170	9.2
2071								0	0	171	9.25
2072								0	0	172	9.3
2073								0	0	173	9.35
2074								0	0	174	9.4
2075								0	0	175	9.45
2076								0	0	176	9.5

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2077								0	0	177	9.55
	2078								0	0	178	9.6
	2079								0	0	179	9.65
	2080								0	0	180	9.7
	2081								0	0	181	9.75
	2082								0	0	182	9.8
	2083								0	0	183	9.85
	2084								0	0	184	9.9
	2085								0	0	185	9.95
	2086								0	0	186	10
	2087								0	0	187	10.05
	2088								0	0	188	10.1
	2089								0	0	189	10.15
	2090								0	0	190	10.2
	2091								0	0	191	10.25
	2092								0	0	192	10.3
	2093								0	0	193	10.35
	2094								0	0	194	10.4
	2095								0	0	195	10.45
	2096								0	0	196	10.5
	2097								0	0	197	10.55
	2098								0	0	198	10.6
	2099								0	0	199	10.65
	2100								0	0	200	10.7
Totals	15	16.68	$ 18,768.81	15	16.68	$14,076.61	$4,692.20					

Calculation Parameters **INPUTS**

Kansas City, MO

621	Maximum Heating Load (MBtu/h)
0.00929	Humidity Ratio Setpoint (lb_{wat}/lb_{air})
127	Maximum Cooling Load (tons)
0.80	Cooling Equipment Eff (kW/Ton)
0.8	Heating Equipment Eff (COP)
16,300	Affected Occupied Outside Air CFM

Heating Source
- ○ Gas Heat-MCF
- ● Gas Heat-Therms
- ○ Electric Heat

OA Temp	% of Max Heating Load
-2.5 & Below	**100%**
2.5	**93%**
7.5	**86%**
12.5	**79%**
17.5	**72%**
22.5	**65%**
27.5	**58%**
32.5	**51%**
37.5	**44%**
42.5	**37%**
47.5	**30%**

OA Temp	% of Max Cooling Load
55	**0%**
60	**0%**
65	**5%**
70	**19%**
75	**32%**
80	**46%**
85	**59%**
90	**73%**
95	**86%**
100 & Above	**100%**

Existing Conditions

70	Cooling Occupied Setpoint (°F)
79	Cooling Un-Occupied Setpoint (°F)
68	Heating Occupied Setpoint (°F)
61	Heating Unoccupied Setpoint (°F)
Yes	Is OA Shut Off When Not Occupied?

Controls Schedule

	Monday through Friday:
5	Hour of day system is turned ON
22.5	Hour of day system is turned OFF
	Saturday:
5	Hour of day system is turned ON
22.5	Hour of day system is turned OFF
	Sunday:
5	Hour of day system is turned ON
22.5	Hour of day system is turned OFF

New Conditions

75	Cooling Occupied Setpoint (°F)
85	Cooling Un-Occupied Setpoint (°F)
70	Heating Occupied Setpoint (°F)
60	Heating Unoccupied Setpoint (°F)

Controls Schedule

	Monday through Friday:
5	Hour of day system is turned ON
21	Hour of day system is turned OFF
	Saturday:
7	Hour of day system is turned ON
19	Hour of day system is turned OFF
	Sunday:
9	Hour of day system is turned ON
18	Hour of day system is turned OFF

Notes/Comments:

This calculation was calibrated for a 50,000 sq ft single story building in Kansas City. The building use type in the calibration was an elementary school and met, but did not exceed, ASHRAE 90.1. System types were single zone RTUs with gas heat and constant volume air distribution. No economizer was included. Windows were 20% of wall area. Lights were 32 W T8. Occupancy was 15 persons/1000 square feet.

Calculation will be reasonably accurate for preliminary calcs and CEA type calcs where M&V is IPMVP Option D (Calibrated Simulation). If IPMVP option C (Utility Bill Guarantee) is used, Engineer is advised to consider modeling with Carrier HAP or similar.

Do not confuse Maximum Heating Load and Maximum Cooling Load with installed equipment capacities. Often (heating systems in particular) are oversized and maximum load is considerably less than installed capacity. Conservative estimates of sq.ft./ton and Btu/hr/sf can be used to estimate load if calculations are not performed or actual historical operating data is not available.

This calc is for the non-Natatorium part of the building

Savings Realized from Schedule Change

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total Usage Savings	
0	0	0	0	6,947	12,706	19,987	13,197	8,762	4,839	0	0	**66,437**	**Cooling kWh**
301	234	178	59	0	0	0	0	0	0	165	248	**1,186**	**Heating Therms**

Calibration of pre-retrofit energy use to match utility analysis baseline.

Cooling Energy Use from Utility Analysis	242,136	kWh
Pre-Retrofit Cooling Energy Use in this calc.	242,136	kWh
Adjustment Factor	2.632	
Heating Energy Use from Utility Analysis	10,739	therms
Pre-Retrofit Heating Energy Use in this calc.	10,739	therms
Adjustment Factor	0.525	

City of Gladstone EPC	Project		
Gladstone, MO	Location		
Rooftop Unit 60T VAV	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Proposed Old Hrs	Proposed New Hours		
Repair RTU	Repair RTU	Repair Type #1	
10	11.8	Repair Frequency (Years)	
☑		Include Repair Labor?	
298	298	Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$140.26	$140.26	Repair Labor Rate ($/hour)	HVAC Technician
$27,391.56	$27,391.56	Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace RTU	Replace RTU	Repair Type #2	
15	17.63265306	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
374.0	374.0	Replacement Labor Required (Hours)	
$114.43	$114.43	Replacement Labor Rate ($/hour)	HVAC Technician
$66,629.31	$66,629.31	Replacement Material Cost	
2018		Year Equipment Originally Installed	
2018		Year New Equipment to be Installed	
15		Length of Performance Contract (Years)	
$14,810.00	$12,598.78	Average Annual Repair Cost in 2016 Dollars	
$2,211.21		**Annual O&M Savings per unit**	
$2,211.21		**Total Savings**	No. of Units: 1

Old Hours	6387.5	hrs
New Hours	5266.4	
	18%	reduction

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	**Savings**	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
Original Installation	2018	0.2	$ 2,663.67	2018	0.2	$2,265.97	$397.70	x	1	1	118	6.6
	2019	1	$ 13,318.34	2019	1	$11,329.84	$1,988.50	x	2	2	119	6.65
	2020	1.02	$ 13,584.71	2020	1.02	$11,556.44	$2,028.27	x	3	3	120	6.7
	2021	1.05	$ 13,984.26	2021	1.05	$11,896.33	$2,087.93	x	4	4	121	6.75
	2022	1.06	$ 14,117.44	2022	1.06	$12,009.63	$2,107.81	x	5	5	122	6.8
	2023	1.07	$ 14,250.63	2023	1.07	$12,122.93	$2,127.70	x	6	6	123	6.85
	2024	1.08	$ 14,383.81	2024	1.08	$12,236.23	$2,147.58	x	7	7	124	6.9
	2025	1.1	$ 14,650.18	2025	1.1	$12,462.82	$2,187.35	x	8	8	125	6.95
	2026	1.15	$ 15,316.09	2026	1.15	$13,029.32	$2,286.78	x	9	9	126	7
	2027	1.2	$ 15,982.01	2027	1.2	$13,595.81	$2,386.20	x	10	10	127	7.05
	2028	1.25	$ 16,647.93	2028	1.25	$14,162.30	$2,485.63	x	11	11	128	7.1
	2029	1.3	$ 17,313.84	2029	1.3	$14,728.79	$2,585.05	x	12	12	129	7.15
	2030	1.35	$ 17,979.76	2030	1.35	$15,295.28	$2,684.48	x	13	13	130	7.2
	2031	1.4	$ 18,645.68	2031	1.4	$15,861.78	$2,783.90	x	14	14	131	7.25
	2032	1.45	$ 19,311.60	2032	1.45	$16,428.27	$2,883.33	x	15	15	132	7.3
Totals	15	16.68	##########	15	16.68	$188,981.72	$33,168.22					

City of Gladstone EPC	Project		
Gladstone, MO	Location		
Rooftop Unit 15T	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Proposed Old Hrs	Proposed New Hours		
Repair RTU	Repair RTU	Repair Type #1	
10	11.8	Repair Frequency (Years)	
☑		Include Repair Labor?	
77	77	Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$140.26	$140.26	Repair Labor Rate ($/hour)	HVAC Technician
$15,250.44	$15,250.44	Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace RTU	Replace RTU	Repair Type #2	
15	17.63265306	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
106.0	106.0	Replacement Labor Required (Hours)	
$114.43	$114.43	Replacement Labor Rate ($/hour)	HVAC Technician
$19,030.81	$19,030.81	Replacement Material Cost	
2018	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$4,914.28	$4,180.55	Average Annual Repair Cost in 2016 Dollars	
$733.73		**Annual O&M Savings per unit**	
$733.73		**Total Savings**	No. of Units: 1

Old Hours	6387.5	hrs
New Hours	5266.4	
	18%	reduction

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
Original Installation	2018	0.2	$ 883.86	2018	0.2	$751.90	$131.97	x	1	1	118	6.6
	2019	1	$ 4,419.32	2019	1	$3,759.49	$659.83	x	2	2	119	6.65
	2020	1.02	$ 4,507.71	2020	1.02	$3,834.68	$673.03	x	3	3	120	6.7
	2021	1.05	$ 4,640.29	2021	1.05	$3,947.46	$692.82	x	4	4	121	6.75
	2022	1.06	$ 4,684.48	2022	1.06	$3,985.06	$699.42	x	5	5	122	6.8
	2023	1.07	$ 4,728.67	2023	1.07	$4,022.65	$706.02	x	6	6	123	6.85
	2024	1.08	$ 4,772.86	2024	1.08	$4,060.25	$712.62	x	7	7	124	6.9
	2025	1.1	$ 4,861.25	2025	1.1	$4,135.44	$725.81	x	8	8	125	6.95
	2026	1.15	$ 5,082.22	2026	1.15	$4,323.41	$758.80	x	9	9	126	7
	2027	1.2	$ 5,303.18	2027	1.2	$4,511.39	$791.79	x	10	10	127	7.05
	2028	1.25	$ 5,524.15	2028	1.25	$4,699.36	$824.79	x	11	11	128	7.1
	2029	1.3	$ 5,745.12	2029	1.3	$4,887.34	$857.78	x	12	12	129	7.15
	2030	1.35	$ 5,966.08	2030	1.35	$5,075.31	$890.77	x	13	13	130	7.2
	2031	1.4	$ 6,187.05	2031	1.4	$5,263.29	$923.76	x	14	14	131	7.25
	2032	1.45	$ 6,408.01	2032	1.45	$5,451.26	$956.75	x	15	15	132	7.3
Totals	15	16.68	$ 73,714.24	15	16.68	$62,708.30	$11,005.95					

City of Gladstone EPC		Project
Gladstone, MO		Location
Rooftop Unit 35T		Equipment
108.3%		Location Cost Index: Kansas City, MO
Proposed Old Hrs	Proposed New Hours	
Repair RTU	Repair RTU	Repair Type #1
10	11.8	Repair Frequency (Years)
☑		Include Repair Labor?
114	114	Repair Labor Required (Hours)
In-House		Select In-House or Contract Labor
$140.26	$140.26	Repair Labor Rate ($/hour): HVAC Technician
$20,620.09	$20,620.09	Repair Material Cost
☑		Include End-of-Life Replacement Cost in Analysis?
Replace RTU	Replace RTU	Repair Type #2
15	17.63265306	Replacement Frequency (Years)
☑		Include Replacement Labor?
196.0	196.0	Replacement Labor Required (Hours)
$114.43	$114.43	Replacement Labor Rate ($/hour): HVAC Technician
$42,307.66	$42,307.66	Replacement Material Cost
2018		Year Equipment Originally Installed
2018		Year New Equipment to be Installed
15		Length of Performance Contract (Years)
$8,381.95	$7,130.47	Average Annual Repair Cost in 2016 Dollars
$1,251.47		**Annual O&M Savings per unit**
$1,251.47		**Total Savings** — No. of Units: 1

Old Hours	6387.5	hrs
New Hours	5266.4	
	18%	reduction

	Existing			Proposed								
	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
Original Installation	2018	0.2	$ 1,507.54	2018	0.2	$1,282.46	$225.08	x	1	1	118	6.6
	2019	1	$ 7,537.72	2019	1	$6,412.30	$1,125.42	x	2	2	119	6.65
	2020	1.02	$ 7,688.47	2020	1.02	$6,540.54	$1,147.93	x	3	3	120	6.7
	2021	1.05	$ 7,914.61	2021	1.05	$6,732.91	$1,181.69	x	4	4	121	6.75
	2022	1.06	$ 7,989.98	2022	1.06	$6,797.03	$1,192.95	x	5	5	122	6.8
	2023	1.07	$ 8,065.36	2023	1.07	$6,861.16	$1,204.20	x	6	6	123	6.85
	2024	1.08	$ 8,140.74	2024	1.08	$6,925.28	$1,215.46	x	7	7	124	6.9
	2025	1.1	$ 8,291.49	2025	1.1	$7,053.53	$1,237.97	x	8	8	125	6.95
	2026	1.15	$ 8,668.38	2026	1.15	$7,374.14	$1,294.24	x	9	9	126	7
	2027	1.2	$ 9,045.26	2027	1.2	$7,694.76	$1,350.51	x	10	10	127	7.05
	2028	1.25	$ 9,422.15	2028	1.25	$8,015.37	$1,406.78	x	11	11	128	7.1
	2029	1.3	$ 9,799.04	2029	1.3	$8,335.99	$1,463.05	x	12	12	129	7.15
	2030	1.35	$ 10,175.92	2030	1.35	$8,656.60	$1,519.32	x	13	13	130	7.2
	2031	1.4	$ 10,552.81	2031	1.4	$8,977.22	$1,575.59	x	14	14	131	7.25
	2032	1.45	$ 10,929.69	2032	1.45	$9,297.83	$1,631.86	x	15	15	132	7.3
Totals	15	16.68	##########	15	16.68	$106,957.11	$18,772.06					

Calculation Parameters

INPUTS

Kansas City, MO

781	Maximum Heating Load (MBtu/h)
0.00929	Humidity Ratio Setpoint (lb_{wat}/lb_{air})
60	Maximum Cooling Load (tons)
1.17	Cooling Equipment Eff (kW/Ton)
0.9	Heating Equipment Eff (COP)
2,525	Affected Occupied Outside Air CFM

Heating Source

- ○ Gas Heat-MCF
- ◉ Gas Heat-Therms
- ○ Electric Heat

OA Temp	% of Max Heating Load
-2.5 & Below	100%
2.5	93%
7.5	86%
12.5	79%
17.5	72%
22.5	65%
27.5	58%
32.5	51%
37.5	44%
42.5	37%
47.5	30%

OA Temp	% of Max Cooling Load
55	0%
60	0%
65	5%
70	19%
75	32%
80	46%
85	59%
90	73%
95	86%
100 & Above	100%

Existing Conditions

71.9	Cooling Occupied Setpoint (°F)
76.4	Cooling Un-Occupied Setpoint (°F)
67.0	Heating Occupied Setpoint (°F)
65.9	Heating Unoccupied Setpoint (°F)
Yes	Is OA Shut Off When Not Occupied?

Controls Schedule

	Monday through Friday:
7	Hour of day system is turned ON
21.5	Hour of day system is turned OFF
	Saturday:
7	Hour of day system is turned ON
21.5	Hour of day system is turned OFF
	Sunday:
7	Hour of day system is turned ON
21.5	Hour of day system is turned OFF

New Conditions

75	Cooling Occupied Setpoint (°F)
85	Cooling Un-Occupied Setpoint (°F)
70	Heating Occupied Setpoint (°F)
60	Heating Unoccupied Setpoint (°F)

Controls Schedule

	Monday through Friday:
6	Hour of day system is turned ON
18	Hour of day system is turned OFF
	Saturday:
8	Hour of day system is turned ON
12	Hour of day system is turned OFF
	Sunday:
0	Hour of day system is turned ON
0	Hour of day system is turned OFF

Notes/Comments:

This calculation was calibrated for a 50,000 sq ft single story building in Kansas City. The building use type in the calibration was an elementary school and met, but did not exceed, ASHRAE 90.1. System types were single zone RTUs with gas heat and constant volume air distribution. No economizer was included. Windows were 20% of wall area. Lights were 32 W T8. Occupancy was 15 persons/1000 square feet.

Calculation will be reasonably accurate for preliminary calcs and CEA type calcs where M&V is IPMVP Option D (Calibrated Simulation). If IPMVP option C (Utility Bill Guarantee) is used, Engineer is advised to consider modeling with Carrier HAP or similar.

Do not confuse Maximum Heating Load and Maximum Cooling Load with installed equipment capacities. Often (heating systems in particular) are oversized and maximum load is considerably less than installed capacity. Conservative estimates of sq.ft./ton and Btu/hr/sf can be used to estimate load if calculations are not performed or actual historical operating data is not available.

Savings Realized from Schedule Change

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total Usage Savings	
0	0	0	0	2,422	5,151	8,032	5,761	3,141	1,612	0	0	**26,119**	**Cooling kWh**
136	113	94	34	0	0	0	0	0	0	97	123	**598**	**Heating Therms**

Calibration of pre-retrofit energy use to match utility analysis baseline.

Cooling Energy Use from Utility Analysis	55,045	kWh
Pre-Retrofit Cooling Energy Use in this calc.	55,045	kWh
Adjustment Factor	1.028	
Heating Energy Use from Utility Analysis	5,651	therms
Pre-Retrofit Heating Energy Use in this calc.	5,651	therms
Adjustment Factor	0.425	

Calculation Parameters

INPUTS

Kansas City, MO

413	Maximum Heating Load (MBtu/h)
0.00929	Humidity Ratio Setpoint (lb_{wat}/lb_{air})
32	Maximum Cooling Load (tons)
1.17	Cooling Equipment Eff (kW/Ton)
0.9	Heating Equipment Eff (COP)
1,690	Affected Occupied Outside Air CFM

Heating Source

- ○ Gas Heat-MCF
- ● Gas Heat-Therms
- ○ Electric Heat

OA Temp	% of Max Heating Load
-2.5 & Below	100%
2.5	93%
7.5	86%
12.5	79%
17.5	72%
22.5	65%
27.5	58%
32.5	51%
37.5	44%
42.5	37%
47.5	30%

OA Temp	% of Max Cooling Load
55	0%
60	0%
65	5%
70	19%
75	32%
80	46%
85	59%
90	73%
95	86%
100 & Above	100%

Existing Conditions

73.0	Cooling Occupied Setpoint (°F)
75.4	Cooling Un-Occupied Setpoint (°F)
68.6	Heating Occupied Setpoint (°F)
67.0	Heating Unoccupied Setpoint (°F)
Yes	Is OA Shut Off When Not Occupied?

Controls Schedule

	Monday through Friday:
0	Hour of day system is turned ON
24	Hour of day system is turned OFF
	Saturday:
0	Hour of day system is turned ON
24	Hour of day system is turned OFF
	Sunday:
0	Hour of day system is turned ON
24	Hour of day system is turned OFF

New Conditions

75	Cooling Occupied Setpoint (°F)
85	Cooling Un-Occupied Setpoint (°F)
70	Heating Occupied Setpoint (°F)
60	Heating Unoccupied Setpoint (°F)

Controls Schedule

	Monday through Friday:
3	Hour of day system is turned ON
20	Hour of day system is turned OFF
	Saturday:
6	Hour of day system is turned ON
18	Hour of day system is turned OFF
	Sunday:
6	Hour of day system is turned ON
18	Hour of day system is turned OFF

Notes/Comments:

This calculation was calibrated for a 50,000 sq ft single story building in Kansas City. The building use type in the calibration was an elementary school and met, but did not exceed, ASHRAE 90.1. System types were single zone RTUs with gas heat and constant volume air distribution. No economizer was included. Windows were 20% of wall area. Lights were 32 W T8. Occupancy was 15 persons/1000 square feet.

Calculation will be reasonably accurate for preliminary calcs and CEA type calcs where M&V is IPMVP Option D (Calibrated Simulation). If IPMVP option C (Utility Bill Guarantee) is used, Engineer is advised to consider modeling with Carrier HAP or similar.

Do not confuse Maximum Heating Load and Maximum Cooling Load with installed equipment capacities. Often (heating systems in particular) are oversized and maximum load is considerably less than installed capacity. Conservative estimates of sq.ft./ton and Btu/hr/sf can be used to estimate load if calculations are not performed or actual historical operating data is not available.

Savings Realized from Schedule Change

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total Usage Savings	
0	0	0	0	696	1,730	3,370	2,125	969	559	0	0	9,450	Cooling kWh
90	75	65	28	0	0	0	0	0	0	61	80	398	Heating Therms

Calibration of pre-retrofit energy use to match utility analysis baseline.

Cooling Energy Use from Utility Analysis	29,142	kWh
Pre-Retrofit Cooling Energy Use in this calc.	29,142	kWh
Adjustment Factor	0.819	
Heating Energy Use from Utility Analysis	2,992	therms
Pre-Retrofit Heating Energy Use in this calc.	2,992	therms
Adjustment Factor	0.374	

Reduction in hours:
Some areas on the ground floor need to remain 24/7
Some zones may be set back to weekdays only

Approx. 50% can be set back to 7am to 5 pm	10	hours
Week days	17	hours average
Weekends	12	hours average

City of Gladstone EPC	Project		
Gladstone, MO	Location		
Rooftop Unit 3T	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Proposed Old Hrs	Proposed New Hours		
Repair RTU	Repair RTU	Repair Type #1	
10	13.7	Repair Frequency (Years)	
☑		Include Repair Labor?	
17.8	17.8	Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$140.26	$140.26	Repair Labor Rate ($/hour)	HVAC Technician
$1,003.00	$1,003.00	Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace RTU	Replace RTU	Repair Type #2	
15	20.54187192	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
38.5	38.5	Replacement Labor Required (Hours)	
$114.43	$114.43	Replacement Labor Rate ($/hour)	HVAC Technician
$4,371.43	$4,371.43	Replacement Material Cost	
2018	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$967.61	$706.56	Average Annual Repair Cost in 2016 Dollars	
$261.05		**Annual O&M Savings per unit**	
$261.05		**Total Savings**	No. of Units: 1

Old Hours	5292.5	hrs
New Hours	3337.1	
	37%	reduction

	Existing			Proposed							
Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1900								0	0	0	
1901								0	0	1	0.2
1902								0	0	2	1
1903								0	0	3	1.02
1904								0	0	4	1.05
1905								0	0	5	1.06
1906								0	0	6	1.07
1907								0	0	7	1.08
1908								0	0	8	1.1
1909								0	0	9	1.15
1910								0	0	10	1.2
1911								0	0	11	1.25
1912								0	0	12	1.3
1913								0	0	13	1.35
1914								0	0	14	1.4
1915								0	0	15	1.45
1916								0	0	16	1.5
1917								0	0	17	1.55
1918								0	0	18	1.6
1919								0	0	19	1.65
1920								0	0	20	1.7
1921								0	0	21	1.75
1922								0	0	22	1.8
1923								0	0	23	1.85

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1924								0	0	24	1.9
1925								0	0	25	1.95
1926								0	0	26	2
1927								0	0	27	2.05
1928								0	0	28	2.1
1929								0	0	29	2.15
1930								0	0	30	2.2
1931								0	0	31	2.25
1932								0	0	32	2.3
1933								0	0	33	2.35
1934								0	0	34	2.4
1935								0	0	35	2.45
1936								0	0	36	2.5
1937								0	0	37	2.55
1938								0	0	38	2.6
1939								0	0	39	2.65
1940								0	0	40	2.7
1941								0	0	41	2.75
1942								0	0	42	2.8
1943								0	0	43	2.85
1944								0	0	44	2.9
1945								0	0	45	2.95
1946								0	0	46	3
1947								0	0	47	3.05
1948								0	0	48	3.1
1949								0	0	49	3.15
1950								0	0	50	3.2
1951								0	0	51	3.25
1952								0	0	52	3.3
1953								0	0	53	3.35
1954								0	0	54	3.4
1955								0	0	55	3.45
1956								0	0	56	3.5
1957								0	0	57	3.55
1958								0	0	58	3.6
1959								0	0	59	3.65
1960								0	0	60	3.7
1961								0	0	61	3.75
1962								0	0	62	3.8
1963								0	0	63	3.85
1964								0	0	64	3.9
1965								0	0	65	3.95
1966								0	0	66	4
1967								0	0	67	4.05
1968								0	0	68	4.1
1969								0	0	69	4.15
1970								0	0	70	4.2
1971								0	0	71	4.25
1972								0	0	72	4.3
1973								0	0	73	4.35
1974								0	0	74	4.4

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	1975								0	0	75	4.45
	1976								0	0	76	4.5
	1977								0	0	77	4.55
	1978								0	0	78	4.6
	1979								0	0	79	4.65
	1980								0	0	80	4.7
	1981								0	0	81	4.75
	1982								0	0	82	4.8
	1983								0	0	83	4.85
	1984								0	0	84	4.9
	1985								0	0	85	4.95
	1986								0	0	86	5
	1987								0	0	87	5.05
	1988								0	0	88	5.1
	1989								0	0	89	5.15
	1990								0	0	90	5.2
	1991								0	0	91	5.25
	1992								0	0	92	5.3
	1993								0	0	93	5.35
	1994								0	0	94	5.4
	1995								0	0	95	5.45
	1996								0	0	96	5.5
	1997								0	0	97	5.55
	1998								0	0	98	5.6
	1999								0	0	99	5.65
	2000								0	0	100	5.7
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
	2007								0	0	107	6.05
	2008								0	0	108	6.1
	2009								0	0	109	6.15
	2010								0	0	110	6.2
	2011								0	0	111	6.25
	2012								0	0	112	6.3
	2013								0	0	113	6.35
	2014								0	0	114	6.4
	2015								0	0	115	6.45
	2016								0	0	116	6.5
	2017								0	0	117	6.55
Original Installation	2018	0.2	$ 174.03	2018	0.2	$127.08	$46.95	x	1	1	118	6.6
	2019	1	$ 870.15	2019	1	$635.40	$234.75	x	2	2	119	6.65
	2020	1.02	$ 887.55	2020	1.02	$648.11	$239.45	x	3	3	120	6.7
	2021	1.05	$ 913.66	2021	1.05	$667.17	$246.49	x	4	4	121	6.75
	2022	1.06	$ 922.36	2022	1.06	$673.52	$248.84	x	5	5	122	6.8
	2023	1.07	$ 931.06	2023	1.07	$679.88	$251.19	x	6	6	123	6.85
	2024	1.08	$ 939.76	2024	1.08	$686.23	$253.53	x	7	7	124	6.9
	2025	1.1	$ 957.17	2025	1.1	$698.94	$258.23	x	8	8	125	6.95

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
2026	1.15	$ 1,000.67	2026	1.15	$730.71	$269.97	x	9	9	126	7
2027	1.2	$ 1,044.18	2027	1.2	$762.48	$281.70	x	10	10	127	7.05
2028	1.25	$ 1,087.69	2028	1.25	$794.25	$293.44	x	11	11	128	7.1
2029	1.3	$ 1,131.20	2029	1.3	$826.02	$305.18	x	12	12	129	7.15
2030	1.35	$ 1,174.70	2030	1.35	$857.79	$316.92	x	13	13	130	7.2
2031	1.4	$ 1,218.21	2031	1.4	$889.56	$328.65	x	14	14	131	7.25
2032	1.45	$ 1,261.72	2032	1.45	$921.33	$340.39	x	15	15	132	7.3
2033								0	0	133	7.35
2034								0	0	134	7.4
2035								0	0	135	7.45
2036								0	0	136	7.5
2037								0	0	137	7.55
2038								0	0	138	7.6
2039								0	0	139	7.65
2040								0	0	140	7.7
2041								0	0	141	7.75
2042								0	0	142	7.8
2043								0	0	143	7.85
2044								0	0	144	7.9
2045								0	0	145	7.95
2046								0	0	146	8
2047								0	0	147	8.05
2048								0	0	148	8.1
2049								0	0	149	8.15
2050								0	0	150	8.2
2051								0	0	151	8.25
2052								0	0	152	8.3
2053								0	0	153	8.35
2054								0	0	154	8.4
2055								0	0	155	8.45
2056								0	0	156	8.5
2057								0	0	157	8.55
2058								0	0	158	8.6
2059								0	0	159	8.65
2060								0	0	160	8.7
2061								0	0	161	8.75
2062								0	0	162	8.8
2063								0	0	163	8.85
2064								0	0	164	8.9
2065								0	0	165	8.95
2066								0	0	166	9
2067								0	0	167	9.05
2068								0	0	168	9.1
2069								0	0	169	9.15
2070								0	0	170	9.2
2071								0	0	171	9.25
2072								0	0	172	9.3
2073								0	0	173	9.35
2074								0	0	174	9.4
2075								0	0	175	9.45
2076								0	0	176	9.5

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2077								0	0	177	9.55
	2078								0	0	178	9.6
	2079								0	0	179	9.65
	2080								0	0	180	9.7
	2081								0	0	181	9.75
	2082								0	0	182	9.8
	2083								0	0	183	9.85
	2084								0	0	184	9.9
	2085								0	0	185	9.95
	2086								0	0	186	10
	2087								0	0	187	10.05
	2088								0	0	188	10.1
	2089								0	0	189	10.15
	2090								0	0	190	10.2
	2091								0	0	191	10.25
	2092								0	0	192	10.3
	2093								0	0	193	10.35
	2094								0	0	194	10.4
	2095								0	0	195	10.45
	2096								0	0	196	10.5
	2097								0	0	197	10.55
	2098								0	0	198	10.6
	2099								0	0	199	10.65
	2100								0	0	200	10.7
Totals	15	16.68	$ 14,514.11	15	16.68	$10,598.44	$3,915.68					

City of Gladstone EPC	Project		
Gladstone, MO	Location		
Rooftop Unit 3T	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Proposed Old Hrs	Proposed New Hours		
Repair RTU	Repair RTU	Repair Type #1	
10	13.6	Repair Frequency (Years)	
☑		Include Repair Labor?	
18.3	18.3	Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$140.26	$140.26	Repair Labor Rate ($/hour)	HVAC Technician
$1,459.13	$1,459.13	Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace RTU	Replace RTU	Repair Type #2	
15	20.4	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
56.6	56.6	Replacement Labor Required (Hours)	
$114.43	$114.43	Replacement Labor Rate ($/hour)	HVAC Technician
$5,610.85	$5,610.85	Replacement Material Cost	
2018	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$1,251.58	$921.59	Average Annual Repair Cost in 2016 Dollars	
$329.99		**Annual O&M Savings per unit**	
$1,979.97		**Total Savings**	No. of Units: 6

	1st floor	ground floor	average
Old Hours	5292.5 hrs	8760	7026.25
New Hours	3337.1	5683.6	4510.4
	37% reduction	35%	36%

	Existing			**Proposed**							
Year	**Increase Factor**	**Annual Repair Cost**	**Year**	**Increase Factor**	**Annual Repair Cost**	**Savings**	**Include Year?**	**Original Life**	**New Life**	**Increase Factor Year**	**Increase Factor**
1900								0	0	0	
1901								0	0	1	0.2
1902								0	0	2	1
1903								0	0	3	1.02
1904								0	0	4	1.05
1905								0	0	5	1.06
1906								0	0	6	1.07
1907								0	0	7	1.08
1908								0	0	8	1.1
1909								0	0	9	1.15
1910								0	0	10	1.2
1911								0	0	11	1.25
1912								0	0	12	1.3
1913								0	0	13	1.35
1914								0	0	14	1.4
1915								0	0	15	1.45
1916								0	0	16	1.5
1917								0	0	17	1.55
1918								0	0	18	1.6
1919								0	0	19	1.65
1920								0	0	20	1.7
1921								0	0	21	1.75
1922								0	0	22	1.8
1923								0	0	23	1.85

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1924								0	0	24	1.9
1925								0	0	25	1.95
1926								0	0	26	2
1927								0	0	27	2.05
1928								0	0	28	2.1
1929								0	0	29	2.15
1930								0	0	30	2.2
1931								0	0	31	2.25
1932								0	0	32	2.3
1933								0	0	33	2.35
1934								0	0	34	2.4
1935								0	0	35	2.45
1936								0	0	36	2.5
1937								0	0	37	2.55
1938								0	0	38	2.6
1939								0	0	39	2.65
1940								0	0	40	2.7
1941								0	0	41	2.75
1942								0	0	42	2.8
1943								0	0	43	2.85
1944								0	0	44	2.9
1945								0	0	45	2.95
1946								0	0	46	3
1947								0	0	47	3.05
1948								0	0	48	3.1
1949								0	0	49	3.15
1950								0	0	50	3.2
1951								0	0	51	3.25
1952								0	0	52	3.3
1953								0	0	53	3.35
1954								0	0	54	3.4
1955								0	0	55	3.45
1956								0	0	56	3.5
1957								0	0	57	3.55
1958								0	0	58	3.6
1959								0	0	59	3.65
1960								0	0	60	3.7
1961								0	0	61	3.75
1962								0	0	62	3.8
1963								0	0	63	3.85
1964								0	0	64	3.9
1965								0	0	65	3.95
1966								0	0	66	4
1967								0	0	67	4.05
1968								0	0	68	4.1
1969								0	0	69	4.15
1970								0	0	70	4.2
1971								0	0	71	4.25
1972								0	0	72	4.3
1973								0	0	73	4.35
1974								0	0	74	4.4

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	1975								0	0	75	4.45
	1976								0	0	76	4.5
	1977								0	0	77	4.55
	1978								0	0	78	4.6
	1979								0	0	79	4.65
	1980								0	0	80	4.7
	1981								0	0	81	4.75
	1982								0	0	82	4.8
	1983								0	0	83	4.85
	1984								0	0	84	4.9
	1985								0	0	85	4.95
	1986								0	0	86	5
	1987								0	0	87	5.05
	1988								0	0	88	5.1
	1989								0	0	89	5.15
	1990								0	0	90	5.2
	1991								0	0	91	5.25
	1992								0	0	92	5.3
	1993								0	0	93	5.35
	1994								0	0	94	5.4
	1995								0	0	95	5.45
	1996								0	0	96	5.5
	1997								0	0	97	5.55
	1998								0	0	98	5.6
	1999								0	0	99	5.65
	2000								0	0	100	5.7
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
	2007								0	0	107	6.05
	2008								0	0	108	6.1
	2009								0	0	109	6.15
	2010								0	0	110	6.2
	2011								0	0	111	6.25
	2012								0	0	112	6.3
	2013								0	0	113	6.35
	2014								0	0	114	6.4
	2015								0	0	115	6.45
	2016								0	0	116	6.5
	2017								0	0	117	6.55
Original Installation	2018	0.2	$ 225.11	2018	0.2	$165.75	$59.35	x	1	1	118	6.6
	2019	1	$ 1,125.53	2019	1	$828.77	$296.76	x	2	2	119	6.65
	2020	1.02	$ 1,148.04	2020	1.02	$845.34	$302.69	x	3	3	120	6.7
	2021	1.05	$ 1,181.80	2021	1.05	$870.21	$311.60	x	4	4	121	6.75
	2022	1.06	$ 1,193.06	2022	1.06	$878.49	$314.56	x	5	5	122	6.8
	2023	1.07	$ 1,204.31	2023	1.07	$886.78	$317.53	x	6	6	123	6.85
	2024	1.08	$ 1,215.57	2024	1.08	$895.07	$320.50	x	7	7	124	6.9
	2025	1.1	$ 1,238.08	2025	1.1	$911.65	$326.43	x	8	8	125	6.95

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
2026	1.15	$ 1,294.35	2026	1.15	$953.08	$341.27	x	9	9	126	7
2027	1.2	$ 1,350.63	2027	1.2	$994.52	$356.11	x	10	10	127	7.05
2028	1.25	$ 1,406.91	2028	1.25	$1,035.96	$370.95	x	11	11	128	7.1
2029	1.3	$ 1,463.18	2029	1.3	$1,077.40	$385.78	x	12	12	129	7.15
2030	1.35	$ 1,519.46	2030	1.35	$1,118.84	$400.62	x	13	13	130	7.2
2031	1.4	$ 1,575.74	2031	1.4	$1,160.28	$415.46	x	14	14	131	7.25
2032	1.45	$ 1,632.01	2032	1.45	$1,201.71	$430.30	x	15	15	132	7.3
2033								0	0	133	7.35
2034								0	0	134	7.4
2035								0	0	135	7.45
2036								0	0	136	7.5
2037								0	0	137	7.55
2038								0	0	138	7.6
2039								0	0	139	7.65
2040								0	0	140	7.7
2041								0	0	141	7.75
2042								0	0	142	7.8
2043								0	0	143	7.85
2044								0	0	144	7.9
2045								0	0	145	7.95
2046								0	0	146	8
2047								0	0	147	8.05
2048								0	0	148	8.1
2049								0	0	149	8.15
2050								0	0	150	8.2
2051								0	0	151	8.25
2052								0	0	152	8.3
2053								0	0	153	8.35
2054								0	0	154	8.4
2055								0	0	155	8.45
2056								0	0	156	8.5
2057								0	0	157	8.55
2058								0	0	158	8.6
2059								0	0	159	8.65
2060								0	0	160	8.7
2061								0	0	161	8.75
2062								0	0	162	8.8
2063								0	0	163	8.85
2064								0	0	164	8.9
2065								0	0	165	8.95
2066								0	0	166	9
2067								0	0	167	9.05
2068								0	0	168	9.1
2069								0	0	169	9.15
2070								0	0	170	9.2
2071								0	0	171	9.25
2072								0	0	172	9.3
2073								0	0	173	9.35
2074								0	0	174	9.4
2075								0	0	175	9.45
2076								0	0	176	9.5

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2077								0	0	177	9.55
	2078								0	0	178	9.6
	2079								0	0	179	9.65
	2080								0	0	180	9.7
	2081								0	0	181	9.75
	2082								0	0	182	9.8
	2083								0	0	183	9.85
	2084								0	0	184	9.9
	2085								0	0	185	9.95
	2086								0	0	186	10
	2087								0	0	187	10.05
	2088								0	0	188	10.1
	2089								0	0	189	10.15
	2090								0	0	190	10.2
	2091								0	0	191	10.25
	2092								0	0	192	10.3
	2093								0	0	193	10.35
	2094								0	0	194	10.4
	2095								0	0	195	10.45
	2096								0	0	196	10.5
	2097								0	0	197	10.55
	2098								0	0	198	10.6
	2099								0	0	199	10.65
	2100								0	0	200	10.7
Totals	15	16.68	$ 18,773.77	15	16.68	$13,823.85	$4,949.91					

City of Gladstone EPC	Project		
Gladstone, MO	Location		
Rooftop Unit 3T	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Proposed Old Hrs	Proposed New Hours		
Repair RTU	Repair RTU	Repair Type #1	
10	13.7	Repair Frequency (Years)	
☑		Include Repair Labor?	
54.8	54.8	Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$140.26	$140.26	Repair Labor Rate ($/hour)	HVAC Technician
$10,367.96	$10,367.96	Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace RTU	Replace RTU	Repair Type #2	
15	20.54187192	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
91.9	91.9	Replacement Labor Required (Hours)	
$114.43	$114.43	Replacement Labor Rate ($/hour)	HVAC Technician
$12,709.49	$12,709.49	Replacement Material Cost	
2018	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$3,510.17	$2,563.18	Average Annual Repair Cost in 2016 Dollars	
$946.99		**Annual O&M Savings per unit**	
$946.99		**Total Savings**	No. of Units: 1

Old Hours	5292.5	hrs
New Hours	3337.1	
	37%	reduction

	Existing		Proposed							
Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1900								0	0	0	
1901								0	0	1	0.2
1902								0	0	2	1
1903								0	0	3	1.02
1904								0	0	4	1.05
1905								0	0	5	1.06
1906								0	0	6	1.07
1907								0	0	7	1.08
1908								0	0	8	1.1
1909								0	0	9	1.15
1910								0	0	10	1.2
1911								0	0	11	1.25
1912								0	0	12	1.3
1913								0	0	13	1.35
1914								0	0	14	1.4
1915								0	0	15	1.45
1916								0	0	16	1.5
1917								0	0	17	1.55
1918								0	0	18	1.6
1919								0	0	19	1.65
1920								0	0	20	1.7
1921								0	0	21	1.75
1922								0	0	22	1.8
1923								0	0	23	1.85

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1924								0	0	24	1.9
1925								0	0	25	1.95
1926								0	0	26	2
1927								0	0	27	2.05
1928								0	0	28	2.1
1929								0	0	29	2.15
1930								0	0	30	2.2
1931								0	0	31	2.25
1932								0	0	32	2.3
1933								0	0	33	2.35
1934								0	0	34	2.4
1935								0	0	35	2.45
1936								0	0	36	2.5
1937								0	0	37	2.55
1938								0	0	38	2.6
1939								0	0	39	2.65
1940								0	0	40	2.7
1941								0	0	41	2.75
1942								0	0	42	2.8
1943								0	0	43	2.85
1944								0	0	44	2.9
1945								0	0	45	2.95
1946								0	0	46	3
1947								0	0	47	3.05
1948								0	0	48	3.1
1949								0	0	49	3.15
1950								0	0	50	3.2
1951								0	0	51	3.25
1952								0	0	52	3.3
1953								0	0	53	3.35
1954								0	0	54	3.4
1955								0	0	55	3.45
1956								0	0	56	3.5
1957								0	0	57	3.55
1958								0	0	58	3.6
1959								0	0	59	3.65
1960								0	0	60	3.7
1961								0	0	61	3.75
1962								0	0	62	3.8
1963								0	0	63	3.85
1964								0	0	64	3.9
1965								0	0	65	3.95
1966								0	0	66	4
1967								0	0	67	4.05
1968								0	0	68	4.1
1969								0	0	69	4.15
1970								0	0	70	4.2
1971								0	0	71	4.25
1972								0	0	72	4.3
1973								0	0	73	4.35
1974								0	0	74	4.4

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	1975								0	0	75	4.45
	1976								0	0	76	4.5
	1977								0	0	77	4.55
	1978								0	0	78	4.6
	1979								0	0	79	4.65
	1980								0	0	80	4.7
	1981								0	0	81	4.75
	1982								0	0	82	4.8
	1983								0	0	83	4.85
	1984								0	0	84	4.9
	1985								0	0	85	4.95
	1986								0	0	86	5
	1987								0	0	87	5.05
	1988								0	0	88	5.1
	1989								0	0	89	5.15
	1990								0	0	90	5.2
	1991								0	0	91	5.25
	1992								0	0	92	5.3
	1993								0	0	93	5.35
	1994								0	0	94	5.4
	1995								0	0	95	5.45
	1996								0	0	96	5.5
	1997								0	0	97	5.55
	1998								0	0	98	5.6
	1999								0	0	99	5.65
	2000								0	0	100	5.7
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
	2007								0	0	107	6.05
	2008								0	0	108	6.1
	2009								0	0	109	6.15
	2010								0	0	110	6.2
	2011								0	0	111	6.25
	2012								0	0	112	6.3
	2013								0	0	113	6.35
	2014								0	0	114	6.4
	2015								0	0	115	6.45
	2016								0	0	116	6.5
	2017								0	0	117	6.55
Original Installation	2018	0.2	$ 631.33	2018	0.2	$461.00	$170.32	x	1	1	118	6.6
	2019	1	$ 3,156.63	2019	1	$2,305.02	$851.61	x	2	2	119	6.65
	2020	1.02	$ 3,219.76	2020	1.02	$2,351.12	$868.64	x	3	3	120	6.7
	2021	1.05	$ 3,314.46	2021	1.05	$2,420.27	$894.19	x	4	4	121	6.75
	2022	1.06	$ 3,346.03	2022	1.06	$2,443.32	$902.71	x	5	5	122	6.8
	2023	1.07	$ 3,377.59	2023	1.07	$2,466.37	$911.22	x	6	6	123	6.85
	2024	1.08	$ 3,409.16	2024	1.08	$2,489.42	$919.74	x	7	7	124	6.9
	2025	1.1	$ 3,472.29	2025	1.1	$2,535.52	$936.77	x	8	8	125	6.95

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
2026	1.15	$ 3,630.12	2026	1.15	$2,650.77	$979.35	x	9	9	126	7
2027	1.2	$ 3,787.95	2027	1.2	$2,766.02	$1,021.93	x	10	10	127	7.05
2028	1.25	$ 3,945.79	2028	1.25	$2,881.28	$1,064.51	x	11	11	128	7.1
2029	1.3	$ 4,103.62	2029	1.3	$2,996.53	$1,107.09	x	12	12	129	7.15
2030	1.35	$ 4,261.45	2030	1.35	$3,111.78	$1,149.67	x	13	13	130	7.2
2031	1.4	$ 4,419.28	2031	1.4	$3,227.03	$1,192.25	x	14	14	131	7.25
2032	1.45	$ 4,577.11	2032	1.45	$3,342.28	$1,234.83	x	15	15	132	7.3
2033								0	0	133	7.35
2034								0	0	134	7.4
2035								0	0	135	7.45
2036								0	0	136	7.5
2037								0	0	137	7.55
2038								0	0	138	7.6
2039								0	0	139	7.65
2040								0	0	140	7.7
2041								0	0	141	7.75
2042								0	0	142	7.8
2043								0	0	143	7.85
2044								0	0	144	7.9
2045								0	0	145	7.95
2046								0	0	146	8
2047								0	0	147	8.05
2048								0	0	148	8.1
2049								0	0	149	8.15
2050								0	0	150	8.2
2051								0	0	151	8.25
2052								0	0	152	8.3
2053								0	0	153	8.35
2054								0	0	154	8.4
2055								0	0	155	8.45
2056								0	0	156	8.5
2057								0	0	157	8.55
2058								0	0	158	8.6
2059								0	0	159	8.65
2060								0	0	160	8.7
2061								0	0	161	8.75
2062								0	0	162	8.8
2063								0	0	163	8.85
2064								0	0	164	8.9
2065								0	0	165	8.95
2066								0	0	166	9
2067								0	0	167	9.05
2068								0	0	168	9.1
2069								0	0	169	9.15
2070								0	0	170	9.2
2071								0	0	171	9.25
2072								0	0	172	9.3
2073								0	0	173	9.35
2074								0	0	174	9.4
2075								0	0	175	9.45
2076								0	0	176	9.5

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2077								0	0	177	9.55
	2078								0	0	178	9.6
	2079								0	0	179	9.65
	2080								0	0	180	9.7
	2081								0	0	181	9.75
	2082								0	0	182	9.8
	2083								0	0	183	9.85
	2084								0	0	184	9.9
	2085								0	0	185	9.95
	2086								0	0	186	10
	2087								0	0	187	10.05
	2088								0	0	188	10.1
	2089								0	0	189	10.15
	2090								0	0	190	10.2
	2091								0	0	191	10.25
	2092								0	0	192	10.3
	2093								0	0	193	10.35
	2094								0	0	194	10.4
	2095								0	0	195	10.45
	2096								0	0	196	10.5
	2097								0	0	197	10.55
	2098								0	0	198	10.6
	2099								0	0	199	10.65
	2100								0	0	200	10.7
Totals	15	16.68	$ 52,652.57	15	16.68	$38,447.74	$14,204.83					

City of Gladstone EPC		Project	
Gladstone, MO		Location	
Rooftop Unit 3T		Equipment	
108.3%		Location Cost Index	Kansas City, MO
Proposed Old Hrs	Proposed New Hours		
Repair RTU	Repair RTU	Repair Type #1	
10	13.7	Repair Frequency (Years)	
☑		Include Repair Labor?	
18.3	18.3	Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$140.26	$140.26	Repair Labor Rate ($/hour)	HVAC Technician
$1,222.00	$1,222.00	Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace RTU	Replace RTU	Repair Type #2	
15	20.5	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
56.6	56.6	Replacement Labor Required (Hours)	
$114.43	$114.43	Replacement Labor Rate ($/hour)	HVAC Technician
$4,699.00	$4,699.00	Replacement Material Cost	
2018	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$1,160.07	$847.10	Average Annual Repair Cost in 2016 Dollars	
$312.97		**Annual O&M Savings per unit**	
$625.94		**Total Savings**	No. of Units: 2

Old Hours	5292.5	hrs
New Hours	3337.1	
	37%	reduction

	Existing			**Proposed**							
Year	**Increase Factor**	**Annual Repair Cost**	**Year**	**Increase Factor**	**Annual Repair Cost**	**Savings**	**Include Year?**	**Original Life**	**New Life**	**Increase Factor Year**	**Increase Factor**
1900								0	0	0	
1901								0	0	1	0.2
1902								0	0	2	1
1903								0	0	3	1.02
1904								0	0	4	1.05
1905								0	0	5	1.06
1906								0	0	6	1.07
1907								0	0	7	1.08
1908								0	0	8	1.1
1909								0	0	9	1.15
1910								0	0	10	1.2
1911								0	0	11	1.25
1912								0	0	12	1.3
1913								0	0	13	1.35
1914								0	0	14	1.4
1915								0	0	15	1.45
1916								0	0	16	1.5
1917								0	0	17	1.55
1918								0	0	18	1.6
1919								0	0	19	1.65
1920								0	0	20	1.7
1921								0	0	21	1.75
1922								0	0	22	1.8
1923								0	0	23	1.85

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1924								0	0	24	1.9
1925								0	0	25	1.95
1926								0	0	26	2
1927								0	0	27	2.05
1928								0	0	28	2.1
1929								0	0	29	2.15
1930								0	0	30	2.2
1931								0	0	31	2.25
1932								0	0	32	2.3
1933								0	0	33	2.35
1934								0	0	34	2.4
1935								0	0	35	2.45
1936								0	0	36	2.5
1937								0	0	37	2.55
1938								0	0	38	2.6
1939								0	0	39	2.65
1940								0	0	40	2.7
1941								0	0	41	2.75
1942								0	0	42	2.8
1943								0	0	43	2.85
1944								0	0	44	2.9
1945								0	0	45	2.95
1946								0	0	46	3
1947								0	0	47	3.05
1948								0	0	48	3.1
1949								0	0	49	3.15
1950								0	0	50	3.2
1951								0	0	51	3.25
1952								0	0	52	3.3
1953								0	0	53	3.35
1954								0	0	54	3.4
1955								0	0	55	3.45
1956								0	0	56	3.5
1957								0	0	57	3.55
1958								0	0	58	3.6
1959								0	0	59	3.65
1960								0	0	60	3.7
1961								0	0	61	3.75
1962								0	0	62	3.8
1963								0	0	63	3.85
1964								0	0	64	3.9
1965								0	0	65	3.95
1966								0	0	66	4
1967								0	0	67	4.05
1968								0	0	68	4.1
1969								0	0	69	4.15
1970								0	0	70	4.2
1971								0	0	71	4.25
1972								0	0	72	4.3
1973								0	0	73	4.35
1974								0	0	74	4.4

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	1975								0	0	75	4.45
	1976								0	0	76	4.5
	1977								0	0	77	4.55
	1978								0	0	78	4.6
	1979								0	0	79	4.65
	1980								0	0	80	4.7
	1981								0	0	81	4.75
	1982								0	0	82	4.8
	1983								0	0	83	4.85
	1984								0	0	84	4.9
	1985								0	0	85	4.95
	1986								0	0	86	5
	1987								0	0	87	5.05
	1988								0	0	88	5.1
	1989								0	0	89	5.15
	1990								0	0	90	5.2
	1991								0	0	91	5.25
	1992								0	0	92	5.3
	1993								0	0	93	5.35
	1994								0	0	94	5.4
	1995								0	0	95	5.45
	1996								0	0	96	5.5
	1997								0	0	97	5.55
	1998								0	0	98	5.6
	1999								0	0	99	5.65
	2000								0	0	100	5.7
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
	2007								0	0	107	6.05
	2008								0	0	108	6.1
	2009								0	0	109	6.15
	2010								0	0	110	6.2
	2011								0	0	111	6.25
	2012								0	0	112	6.3
	2013								0	0	113	6.35
	2014								0	0	114	6.4
	2015								0	0	115	6.45
	2016								0	0	116	6.5
	2017								0	0	117	6.55
Original Installation	2018	0.2	$ 208.65	2018	0.2	$152.36	$56.29	x	1	1	118	6.6
	2019	1	$ 1,043.23	2019	1	$761.78	$281.45	x	2	2	119	6.65
	2020	1.02	$ 1,064.09	2020	1.02	$777.02	$287.07	x	3	3	120	6.7
	2021	1.05	$ 1,095.39	2021	1.05	$799.87	$295.52	x	4	4	121	6.75
	2022	1.06	$ 1,105.82	2022	1.06	$807.49	$298.33	x	5	5	122	6.8
	2023	1.07	$ 1,116.25	2023	1.07	$815.10	$301.15	x	6	6	123	6.85
	2024	1.08	$ 1,126.68	2024	1.08	$822.72	$303.96	x	7	7	124	6.9
	2025	1.1	$ 1,147.55	2025	1.1	$837.96	$309.59	x	8	8	125	6.95

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
2026	1.15	$ 1,199.71	2026	1.15	$876.05	$323.66	x	9	9	126	7
2027	1.2	$ 1,251.87	2027	1.2	$914.14	$337.74	x	10	10	127	7.05
2028	1.25	$ 1,304.03	2028	1.25	$952.23	$351.81	x	11	11	128	7.1
2029	1.3	$ 1,356.19	2029	1.3	$990.31	$365.88	x	12	12	129	7.15
2030	1.35	$ 1,408.36	2030	1.35	$1,028.40	$379.95	x	13	13	130	7.2
2031	1.4	$ 1,460.52	2031	1.4	$1,066.49	$394.02	x	14	14	131	7.25
2032	1.45	$ 1,512.68	2032	1.45	$1,104.58	$408.10	x	15	15	132	7.3
2033								0	0	133	7.35
2034								0	0	134	7.4
2035								0	0	135	7.45
2036								0	0	136	7.5
2037								0	0	137	7.55
2038								0	0	138	7.6
2039								0	0	139	7.65
2040								0	0	140	7.7
2041								0	0	141	7.75
2042								0	0	142	7.8
2043								0	0	143	7.85
2044								0	0	144	7.9
2045								0	0	145	7.95
2046								0	0	146	8
2047								0	0	147	8.05
2048								0	0	148	8.1
2049								0	0	149	8.15
2050								0	0	150	8.2
2051								0	0	151	8.25
2052								0	0	152	8.3
2053								0	0	153	8.35
2054								0	0	154	8.4
2055								0	0	155	8.45
2056								0	0	156	8.5
2057								0	0	157	8.55
2058								0	0	158	8.6
2059								0	0	159	8.65
2060								0	0	160	8.7
2061								0	0	161	8.75
2062								0	0	162	8.8
2063								0	0	163	8.85
2064								0	0	164	8.9
2065								0	0	165	8.95
2066								0	0	166	9
2067								0	0	167	9.05
2068								0	0	168	9.1
2069								0	0	169	9.15
2070								0	0	170	9.2
2071								0	0	171	9.25
2072								0	0	172	9.3
2073								0	0	173	9.35
2074								0	0	174	9.4
2075								0	0	175	9.45
2076								0	0	176	9.5

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2077								0	0	177	9.55
	2078								0	0	178	9.6
	2079								0	0	179	9.65
	2080								0	0	180	9.7
	2081								0	0	181	9.75
	2082								0	0	182	9.8
	2083								0	0	183	9.85
	2084								0	0	184	9.9
	2085								0	0	185	9.95
	2086								0	0	186	10
	2087								0	0	187	10.05
	2088								0	0	188	10.1
	2089								0	0	189	10.15
	2090								0	0	190	10.2
	2091								0	0	191	10.25
	2092								0	0	192	10.3
	2093								0	0	193	10.35
	2094								0	0	194	10.4
	2095								0	0	195	10.45
	2096								0	0	196	10.5
	2097								0	0	197	10.55
	2098								0	0	198	10.6
	2099								0	0	199	10.65
	2100								0	0	200	10.7
Totals	15	16.68	$ 17,401.01	15	16.68	$12,706.49	$4,694.52					

City of Gladstone EPC	Project		
Gladstone, MO	Location		
Rooftop Unit 3T	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Proposed Old Hrs	Proposed New Hours		
Repair RTU	Repair RTU	Repair Type #1	
10	13.6	Repair Frequency (Years)	
☑		Include Repair Labor?	
27.64	27.64	Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$140.26	$140.26	Repair Labor Rate ($/hour)	HVAC Technician
$2,180.34	$2,180.34	Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace RTU	Replace RTU	Repair Type #2	
15	20.4	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
39.0	39.0	Replacement Labor Required (Hours)	
$114.43	$114.43	Replacement Labor Rate ($/hour)	HVAC Technician
$4,569.64	$4,569.64	Replacement Material Cost	
2018	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$1,251.25	$921.35	Average Annual Repair Cost in 2016 Dollars	
$329.91		**Annual O&M Savings per unit**	
$2,639.26		**Total Savings**	No. of Units: 8

	1st floor		ground floor	average
Old Hours	5292.5	hrs	8760	7026.25
New Hours	3337.1		5683.6	4510.4
	37%	reduction	35%	36%

	Existing		**Proposed**								
Year	**Increase Factor**	**Annual Repair Cost**	**Year**	**Increase Factor**	**Annual Repair Cost**	**Savings**	**Include Year?**	**Original Life**	**New Life**	**Increase Factor Year**	**Increase Factor**
1900								0	0	0	
1901								0	0	1	0.2
1902								0	0	2	1
1903								0	0	3	1.02
1904								0	0	4	1.05
1905								0	0	5	1.06
1906								0	0	6	1.07
1907								0	0	7	1.08
1908								0	0	8	1.1
1909								0	0	9	1.15
1910								0	0	10	1.2
1911								0	0	11	1.25
1912								0	0	12	1.3
1913								0	0	13	1.35
1914								0	0	14	1.4
1915								0	0	15	1.45
1916								0	0	16	1.5
1917								0	0	17	1.55
1918								0	0	18	1.6
1919								0	0	19	1.65
1920								0	0	20	1.7
1921								0	0	21	1.75
1922								0	0	22	1.8
1923								0	0	23	1.85

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1924								0	0	24	1.9
1925								0	0	25	1.95
1926								0	0	26	2
1927								0	0	27	2.05
1928								0	0	28	2.1
1929								0	0	29	2.15
1930								0	0	30	2.2
1931								0	0	31	2.25
1932								0	0	32	2.3
1933								0	0	33	2.35
1934								0	0	34	2.4
1935								0	0	35	2.45
1936								0	0	36	2.5
1937								0	0	37	2.55
1938								0	0	38	2.6
1939								0	0	39	2.65
1940								0	0	40	2.7
1941								0	0	41	2.75
1942								0	0	42	2.8
1943								0	0	43	2.85
1944								0	0	44	2.9
1945								0	0	45	2.95
1946								0	0	46	3
1947								0	0	47	3.05
1948								0	0	48	3.1
1949								0	0	49	3.15
1950								0	0	50	3.2
1951								0	0	51	3.25
1952								0	0	52	3.3
1953								0	0	53	3.35
1954								0	0	54	3.4
1955								0	0	55	3.45
1956								0	0	56	3.5
1957								0	0	57	3.55
1958								0	0	58	3.6
1959								0	0	59	3.65
1960								0	0	60	3.7
1961								0	0	61	3.75
1962								0	0	62	3.8
1963								0	0	63	3.85
1964								0	0	64	3.9
1965								0	0	65	3.95
1966								0	0	66	4
1967								0	0	67	4.05
1968								0	0	68	4.1
1969								0	0	69	4.15
1970								0	0	70	4.2
1971								0	0	71	4.25
1972								0	0	72	4.3
1973								0	0	73	4.35
1974								0	0	74	4.4

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	1975								0	0	75	4.45
	1976								0	0	76	4.5
	1977								0	0	77	4.55
	1978								0	0	78	4.6
	1979								0	0	79	4.65
	1980								0	0	80	4.7
	1981								0	0	81	4.75
	1982								0	0	82	4.8
	1983								0	0	83	4.85
	1984								0	0	84	4.9
	1985								0	0	85	4.95
	1986								0	0	86	5
	1987								0	0	87	5.05
	1988								0	0	88	5.1
	1989								0	0	89	5.15
	1990								0	0	90	5.2
	1991								0	0	91	5.25
	1992								0	0	92	5.3
	1993								0	0	93	5.35
	1994								0	0	94	5.4
	1995								0	0	95	5.45
	1996								0	0	96	5.5
	1997								0	0	97	5.55
	1998								0	0	98	5.6
	1999								0	0	99	5.65
	2000								0	0	100	5.7
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
	2007								0	0	107	6.05
	2008								0	0	108	6.1
	2009								0	0	109	6.15
	2010								0	0	110	6.2
	2011								0	0	111	6.25
	2012								0	0	112	6.3
	2013								0	0	113	6.35
	2014								0	0	114	6.4
	2015								0	0	115	6.45
	2016								0	0	116	6.5
	2017								0	0	117	6.55
Original Installation	2018	0.2	$ 225.05	2018	0.2	$165.71	$59.34	x	1	1	118	6.6
	2019	1	$ 1,125.23	2019	1	$828.55	$296.68	x	2	2	119	6.65
	2020	1.02	$ 1,147.73	2020	1.02	$845.12	$302.61	x	3	3	120	6.7
	2021	1.05	$ 1,181.49	2021	1.05	$869.98	$311.51	x	4	4	121	6.75
	2022	1.06	$ 1,192.74	2022	1.06	$878.26	$314.48	x	5	5	122	6.8
	2023	1.07	$ 1,203.99	2023	1.07	$886.55	$317.45	x	6	6	123	6.85
	2024	1.08	$ 1,215.25	2024	1.08	$894.83	$320.41	x	7	7	124	6.9
	2025	1.1	$ 1,237.75	2025	1.1	$911.40	$326.35	x	8	8	125	6.95

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
2026	1.15	$ 1,294.01	2026	1.15	$952.83	$341.18	x	9	9	126	7
2027	1.2	$ 1,350.27	2027	1.2	$994.26	$356.01	x	10	10	127	7.05
2028	1.25	$ 1,406.54	2028	1.25	$1,035.69	$370.85	x	11	11	128	7.1
2029	1.3	$ 1,462.80	2029	1.3	$1,077.11	$385.68	x	12	12	129	7.15
2030	1.35	$ 1,519.06	2030	1.35	$1,118.54	$400.52	x	13	13	130	7.2
2031	1.4	$ 1,575.32	2031	1.4	$1,159.97	$415.35	x	14	14	131	7.25
2032	1.45	$ 1,631.58	2032	1.45	$1,201.40	$430.18	x	15	15	132	7.3
2033								0	0	133	7.35
2034								0	0	134	7.4
2035								0	0	135	7.45
2036								0	0	136	7.5
2037								0	0	137	7.55
2038								0	0	138	7.6
2039								0	0	139	7.65
2040								0	0	140	7.7
2041								0	0	141	7.75
2042								0	0	142	7.8
2043								0	0	143	7.85
2044								0	0	144	7.9
2045								0	0	145	7.95
2046								0	0	146	8
2047								0	0	147	8.05
2048								0	0	148	8.1
2049								0	0	149	8.15
2050								0	0	150	8.2
2051								0	0	151	8.25
2052								0	0	152	8.3
2053								0	0	153	8.35
2054								0	0	154	8.4
2055								0	0	155	8.45
2056								0	0	156	8.5
2057								0	0	157	8.55
2058								0	0	158	8.6
2059								0	0	159	8.65
2060								0	0	160	8.7
2061								0	0	161	8.75
2062								0	0	162	8.8
2063								0	0	163	8.85
2064								0	0	164	8.9
2065								0	0	165	8.95
2066								0	0	166	9
2067								0	0	167	9.05
2068								0	0	168	9.1
2069								0	0	169	9.15
2070								0	0	170	9.2
2071								0	0	171	9.25
2072								0	0	172	9.3
2073								0	0	173	9.35
2074								0	0	174	9.4
2075								0	0	175	9.45
2076								0	0	176	9.5

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2077								0	0	177	9.55
	2078								0	0	178	9.6
	2079								0	0	179	9.65
	2080								0	0	180	9.7
	2081								0	0	181	9.75
	2082								0	0	182	9.8
	2083								0	0	183	9.85
	2084								0	0	184	9.9
	2085								0	0	185	9.95
	2086								0	0	186	10
	2087								0	0	187	10.05
	2088								0	0	188	10.1
	2089								0	0	189	10.15
	2090								0	0	190	10.2
	2091								0	0	191	10.25
	2092								0	0	192	10.3
	2093								0	0	193	10.35
	2094								0	0	194	10.4
	2095								0	0	195	10.45
	2096								0	0	196	10.5
	2097								0	0	197	10.55
	2098								0	0	198	10.6
	2099								0	0	199	10.65
	2100								0	0	200	10.7
Totals	15	16.68	$ 18,768.81	15	16.68	$13,820.20	$4,948.61					

Calculation Parameters

INPUTS

Kansas City, MO

260	Maximum Heating Load (MBtu/h)
0.00929	Humidity Ratio Setpoint (lb_{wat}/lb_{air})
15	Maximum Cooling Load (tons)
1.20	Cooling Equipment Eff (kW/Ton)
0.8	Heating Equipment Eff (COP)
600	Affected Occupied Outside Air CFM

Heating Source
- ○ Gas Heat-MCF
- ● Gas Heat-Therms
- ○ Electric Heat

OA Temp	% of Max Heating Load
-2.5 & Below	100%
2.5	93%
7.5	86%
12.5	79%
17.5	72%
22.5	65%
27.5	58%
32.5	51%
37.5	44%
42.5	37%
47.5	30%

OA Temp	% of Max Cooling Load
55	0%
60	0%
65	5%
70	19%
75	32%
80	46%
85	59%
90	73%
95	86%
100 & Above	100%

Existing Conditions

74	Cooling Occupied Setpoint (°F)
80	Cooling Un-Occupied Setpoint (°F)
68	Heating Occupied Setpoint (°F)
62	Heating Unoccupied Setpoint (°F)
Yes	Is OA Shut Off When Not Occupied?

Controls Schedule

	Monday through Friday:
6	Hour of day system is turned ON
20	Hour of day system is turned OFF
	Saturday:
6	Hour of day system is turned ON
20	Hour of day system is turned OFF
	Sunday:
6	Hour of day system is turned ON
20	Hour of day system is turned OFF

New Conditions

74	Cooling Occupied Setpoint (°F)
85	Cooling Un-Occupied Setpoint (°F)
68	Heating Occupied Setpoint (°F)
55	Heating Unoccupied Setpoint (°F)

Controls Schedule

	Monday through Friday:
6	Hour of day system is turned ON
18	Hour of day system is turned OFF
	Saturday:
0	Hour of day system is turned ON
0	Hour of day system is turned OFF
	Sunday:
0	Hour of day system is turned ON
0	Hour of day system is turned OFF

Notes/Comments:

This calculation was calibrated for a 50,000 sq ft single story building in Kansas City. The building use type in the calibration was an elementary school and met, but did not exceed, ASHRAE 90.1. System types were single zone RTUs with gas heat and constant volume air distribution. No economizer was included. Windows were 20% of wall area. Lights were 32 W T8. Occupancy was 15 persons/1000 square feet.

Calculation will be reasonably accurate for preliminary calcs and CEA type calcs where M&V is IPMVP Option D (Calibrated Simulation). If IPMVP option C (Utility Bill Guarantee) is used, Engineer is advised to consider modeling with Carrier HAP or similar.

Do not confuse Maximum Heating Load and Maximum Cooling Load with installed equipment capacities. Often (heating systems in particular) are oversized and maximum load is considerably less than installed capacity. Conservative estimates of sq.ft./ton and Btu/hr/sf can be used to estimate load if calculations are not performed or actual historical operating data is not available.

This calc is for the non-Natatorium part of the building

Savings Realized from Schedule Change

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total Usage Savings	
0	0	0	0	856	2,082	3,280	2,315	1,139	562	0	0	**10,234**	**Cooling kWh**
79	68	58	23	0	0	0	0	0	0	60	74	**362**	**Heating Therms**

Calibration of pre-retrofit energy use to match utility analysis baseline.

Cooling Energy Use from Utility Analysis	27,802	kWh
Pre-Retrofit Cooling Energy Use in this calc.	27,800	kWh
Adjustment Factor	2.075	
Heating Energy Use from Utility Analysis	1,717	therms
Pre-Retrofit Heating Energy Use in this calc.	1,717	therms
Adjustment Factor	0.354	

City of Gladstone EPC	Project			
Gladstone, MO	Location			
Rooftop Unit 3T	Equipment			
108.3%	Location Cost Index		Kansas City, MO	
Proposed Old Hrs	Proposed New Hours			
Repair RTU	Repair RTU	Repair Type #1		
10	13.9	Repair Frequency (Years)		
☑		Include Repair Labor?		
18.3	18.3	Repair Labor Required (Hours)		
In-House		Select In-House or Contract Labor		
$140.26	$140.26	Repair Labor Rate ($/hour)	HVAC Technician	
$1,222.00	$1,222.00	Repair Material Cost		
☑		Include End-of-Life Replacement Cost in Analysis?		
Replace RTU	Replace RTU	Repair Type #2		
15	20.8	Replacement Frequency (Years)		
☑		Include Replacement Labor?		
56.6	56.6	Replacement Labor Required (Hours)		
$114.43	$114.43	Replacement Labor Rate ($/hour)	HVAC Technician	
$4,699.00	$4,699.00	Replacement Material Cost		
2018	Year Equipment Originally Installed			
2018	Year New Equipment to be Installed			
15	Length of Performance Contract (Years)			
$1,160.07	$835.93	Average Annual Repair Cost in 2016 Dollars		
$324.14		**Annual O&M Savings per unit**		
$648.27		**Total Savings**	No. of Units:	2

Old Hours	5110	hrs
New Hours	3128.6	
	39%	reduction

	Existing		Proposed								
Year	**Increase Factor**	**Annual Repair Cost**	**Year**	**Increase Factor**	**Annual Repair Cost**	**Savings**	**Include Year?**	**Original Life**	**New Life**	**Increase Factor Year**	**Increase Factor**
1900								0	0	0	
1901								0	0	1	0.2
1902								0	0	2	1
1903								0	0	3	1.02
1904								0	0	4	1.05
1905								0	0	5	1.06
1906								0	0	6	1.07
1907								0	0	7	1.08
1908								0	0	8	1.1
1909								0	0	9	1.15
1910								0	0	10	1.2
1911								0	0	11	1.25
1912								0	0	12	1.3
1913								0	0	13	1.35
1914								0	0	14	1.4
1915								0	0	15	1.45
1916								0	0	16	1.5
1917								0	0	17	1.55
1918								0	0	18	1.6
1919								0	0	19	1.65
1920								0	0	20	1.7
1921								0	0	21	1.75
1922								0	0	22	1.8
1923								0	0	23	1.85

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1924								0	0	24	1.9
1925								0	0	25	1.95
1926								0	0	26	2
1927								0	0	27	2.05
1928								0	0	28	2.1
1929								0	0	29	2.15
1930								0	0	30	2.2
1931								0	0	31	2.25
1932								0	0	32	2.3
1933								0	0	33	2.35
1934								0	0	34	2.4
1935								0	0	35	2.45
1936								0	0	36	2.5
1937								0	0	37	2.55
1938								0	0	38	2.6
1939								0	0	39	2.65
1940								0	0	40	2.7
1941								0	0	41	2.75
1942								0	0	42	2.8
1943								0	0	43	2.85
1944								0	0	44	2.9
1945								0	0	45	2.95
1946								0	0	46	3
1947								0	0	47	3.05
1948								0	0	48	3.1
1949								0	0	49	3.15
1950								0	0	50	3.2
1951								0	0	51	3.25
1952								0	0	52	3.3
1953								0	0	53	3.35
1954								0	0	54	3.4
1955								0	0	55	3.45
1956								0	0	56	3.5
1957								0	0	57	3.55
1958								0	0	58	3.6
1959								0	0	59	3.65
1960								0	0	60	3.7
1961								0	0	61	3.75
1962								0	0	62	3.8
1963								0	0	63	3.85
1964								0	0	64	3.9
1965								0	0	65	3.95
1966								0	0	66	4
1967								0	0	67	4.05
1968								0	0	68	4.1
1969								0	0	69	4.15
1970								0	0	70	4.2
1971								0	0	71	4.25
1972								0	0	72	4.3
1973								0	0	73	4.35
1974								0	0	74	4.4

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	1975								0	0	75	4.45
	1976								0	0	76	4.5
	1977								0	0	77	4.55
	1978								0	0	78	4.6
	1979								0	0	79	4.65
	1980								0	0	80	4.7
	1981								0	0	81	4.75
	1982								0	0	82	4.8
	1983								0	0	83	4.85
	1984								0	0	84	4.9
	1985								0	0	85	4.95
	1986								0	0	86	5
	1987								0	0	87	5.05
	1988								0	0	88	5.1
	1989								0	0	89	5.15
	1990								0	0	90	5.2
	1991								0	0	91	5.25
	1992								0	0	92	5.3
	1993								0	0	93	5.35
	1994								0	0	94	5.4
	1995								0	0	95	5.45
	1996								0	0	96	5.5
	1997								0	0	97	5.55
	1998								0	0	98	5.6
	1999								0	0	99	5.65
	2000								0	0	100	5.7
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
	2007								0	0	107	6.05
	2008								0	0	108	6.1
	2009								0	0	109	6.15
	2010								0	0	110	6.2
	2011								0	0	111	6.25
	2012								0	0	112	6.3
	2013								0	0	113	6.35
	2014								0	0	114	6.4
	2015								0	0	115	6.45
	2016								0	0	116	6.5
	2017								0	0	117	6.55
Original Installation	2018	0.2	$ 208.65	2018	0.2	$150.35	$58.30	x	1	1	118	6.6
	2019	1	$ 1,043.23	2019	1	$751.74	$291.49	x	2	2	119	6.65
	2020	1.02	$ 1,064.09	2020	1.02	$766.77	$297.32	x	3	3	120	6.7
	2021	1.05	$ 1,095.39	2021	1.05	$789.32	$306.06	x	4	4	121	6.75
	2022	1.06	$ 1,105.82	2022	1.06	$796.84	$308.98	x	5	5	122	6.8
	2023	1.07	$ 1,116.25	2023	1.07	$804.36	$311.89	x	6	6	123	6.85
	2024	1.08	$ 1,126.68	2024	1.08	$811.88	$314.81	x	7	7	124	6.9
	2025	1.1	$ 1,147.55	2025	1.1	$826.91	$320.64	x	8	8	125	6.95

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
2026	1.15	$ 1,199.71	2026	1.15	$864.50	$335.21	x	9	9	126	7
2027	1.2	$ 1,251.87	2027	1.2	$902.08	$349.79	x	10	10	127	7.05
2028	1.25	$ 1,304.03	2028	1.25	$939.67	$364.36	x	11	11	128	7.1
2029	1.3	$ 1,356.19	2029	1.3	$977.26	$378.94	x	12	12	129	7.15
2030	1.35	$ 1,408.36	2030	1.35	$1,014.84	$393.51	x	13	13	130	7.2
2031	1.4	$ 1,460.52	2031	1.4	$1,052.43	$408.09	x	14	14	131	7.25
2032	1.45	$ 1,512.68	2032	1.45	$1,090.02	$422.66	x	15	15	132	7.3
2033								0	0	133	7.35
2034								0	0	134	7.4
2035								0	0	135	7.45
2036								0	0	136	7.5
2037								0	0	137	7.55
2038								0	0	138	7.6
2039								0	0	139	7.65
2040								0	0	140	7.7
2041								0	0	141	7.75
2042								0	0	142	7.8
2043								0	0	143	7.85
2044								0	0	144	7.9
2045								0	0	145	7.95
2046								0	0	146	8
2047								0	0	147	8.05
2048								0	0	148	8.1
2049								0	0	149	8.15
2050								0	0	150	8.2
2051								0	0	151	8.25
2052								0	0	152	8.3
2053								0	0	153	8.35
2054								0	0	154	8.4
2055								0	0	155	8.45
2056								0	0	156	8.5
2057								0	0	157	8.55
2058								0	0	158	8.6
2059								0	0	159	8.65
2060								0	0	160	8.7
2061								0	0	161	8.75
2062								0	0	162	8.8
2063								0	0	163	8.85
2064								0	0	164	8.9
2065								0	0	165	8.95
2066								0	0	166	9
2067								0	0	167	9.05
2068								0	0	168	9.1
2069								0	0	169	9.15
2070								0	0	170	9.2
2071								0	0	171	9.25
2072								0	0	172	9.3
2073								0	0	173	9.35
2074								0	0	174	9.4
2075								0	0	175	9.45
2076								0	0	176	9.5

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2077								0	0	177	9.55
	2078								0	0	178	9.6
	2079								0	0	179	9.65
	2080								0	0	180	9.7
	2081								0	0	181	9.75
	2082								0	0	182	9.8
	2083								0	0	183	9.85
	2084								0	0	184	9.9
	2085								0	0	185	9.95
	2086								0	0	186	10
	2087								0	0	187	10.05
	2088								0	0	188	10.1
	2089								0	0	189	10.15
	2090								0	0	190	10.2
	2091								0	0	191	10.25
	2092								0	0	192	10.3
	2093								0	0	193	10.35
	2094								0	0	194	10.4
	2095								0	0	195	10.45
	2096								0	0	196	10.5
	2097								0	0	197	10.55
	2098								0	0	198	10.6
	2099								0	0	199	10.65
	2100								0	0	200	10.7
Totals	15	16.68	$ 17,401.01	15	16.68	$12,538.96	$4,862.05					

Calculation Parameters **INPUTS**

Kansas City, MO

80	Maximum Heating Load (MBtu/h)
0.00929	Humidity Ratio Setpoint (lb_{wat}/lb_{air})
10	Maximum Cooling Load (tons)
1.00	Cooling Equipment Eff (kW/Ton)
0.8	Heating Equipment Eff (COP)
1,000	Affected Occupied Outside Air CFM

Heating Source
Gas Heat-MCF
Gas Heat-Therms
Electric Heat

OA Temp	% of Max Heating Load
-2.5 & Below	100%
2.5	93%
7.5	86%
12.5	79%
17.5	72%
22.5	65%
27.5	58%
32.5	51%
37.5	44%
42.5	37%
47.5	30%

OA Temp	% of Max Cooling Load
55	0%
60	0%
65	5%
70	19%
75	32%
80	46%
85	59%
90	73%
95	86%
100 & Above	100%

Calibration of pre-retrofit energy use to match utility analysis baseline.

Cooling Energy Use from Utility Analysis	10,706	kWh
Pre-Retrofit Cooling Energy Use in this calc.	10,706	kWh
Adjustment Factor	1.127	
Heating Energy Use from Utility Analysis	2,289	therms
Pre-Retrofit Heating Energy Use in this calc	2,289	therms
Adjustment Factor	1.248	

Existing Conditions

74.0	Cooling Occupied Setpoint (°F)
74.0	Cooling Un-Occupied Setpoint (°F)
70.0	Heating Occupied Setpoint (°F)
70.0	Heating Unoccupied Setpoint (°F)
No	Is OA Shut Off When Not Occupied?
Controls Schedule	
	Monday through Friday:
0	Hour of day system is turned ON
24	Hour of day system is turned OFF
	Saturday:
0	Hour of day system is turned ON
24	Hour of day system is turned OFF
	Sunday:
0	Hour of day system is turned ON
24	Hour of day system is turned OFF

New Conditions

74	Cooling Occupied Setpoint (°F)
80	Cooling Un-Occupied Setpoint (°F)
70	Heating Occupied Setpoint (°F)
60	Heating Unoccupied Setpoint (°F)
Controls Schedule	
	Monday through Friday:
12	Hour of day system is turned ON
17	Hour of day system is turned OFF
	Saturday:
12	Hour of day system is turned ON
17	Hour of day system is turned OFF
	Sunday:
12	Hour of day system is turned ON
17	Hour of day system is turned OFF

Notes/Comments:

This calculation was calibrated for a 50,000 sq ft single story building in Kansas City. The building use type in the calibration was an elementary school and met, but did not exceed, ASHRAE 90.1. System types were single zone RTUs with gas heat and constant volume air distribution. No economizer was included. Windows were 20% of wall area. Lights were 32 W T8. Occupancy was 15 persons/1000 square feet.

Calculation will be reasonably accurate for preliminary calcs and CEA type calcs where M&V is IPMVP Option D (Calibrated Simulation). If IPMVP option C (Utility Bill Guarantee) is used, Engineer is advised to consider modeling with Carrier HAP or similar.

Do not confuse Maximum Heating Load and Maximum Cooling Load with installed equipment capacities. Often (heating systems in particular) are oversized and maximum load is considerably less than installed capacity. Conservative estimates of sq.ft./ton and Btu/hr/sf can be used to estimate load if calculations are not performed or actual historical operating data is not available.

Savings Realized from Schedule Change

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total Usage Savings	
0	0	0	0	356	1,318	2,294	1,553	582	289	0	0	**6,391**	**Cooling kWh**
416	336	289	136	0	0	0	0	0	0	266	361	**1,804**	**Heating Therms**

Yes
No

City of Gladstone EPC	Project		
Gladstone, MO	Location		
Rooftop Unit 3T	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Proposed Old Hrs	Proposed New Hours		
Repair RTU	Repair RTU	Repair Type #1	
10	17.9	Repair Frequency (Years)	
☑		Include Repair Labor?	
12	12	Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$140.26	$140.26	Repair Labor Rate ($/hour)	HVAC Technician
$597.03	$597.03	Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace RTU	Replace RTU	Repair Type #2	
15	26.9	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
24.1	24.1	Replacement Labor Required (Hours)	
$114.43	$114.43	Replacement Labor Rate ($/hour)	HVAC Technician
$813.43	$813.43	Replacement Material Cost	
2018	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$475.55	$265.42	Average Annual Repair Cost in 2016 Dollars	
$210.13		**Annual O&M Savings per unit**	
$210.13		**Total Savings**	No. of Units: 1

Old Hours	8760	hrs
New Hours	1825.0	
	79%	reduction

Year	Existing Increase Factor	Existing Annual Repair Cost	Year	Proposed Increase Factor	Proposed Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1900								0	0	0	
1901								0	0	1	0.2
1902								0	0	2	1
1903								0	0	3	1.02
1904								0	0	4	1.05
1905								0	0	5	1.06
1906								0	0	6	1.07
1907								0	0	7	1.08
1908								0	0	8	1.1
1909								0	0	9	1.15
1910								0	0	10	1.2
1911								0	0	11	1.25
1912								0	0	12	1.3
1913								0	0	13	1.35
1914								0	0	14	1.4
1915								0	0	15	1.45
1916								0	0	16	1.5
1917								0	0	17	1.55
1918								0	0	18	1.6
1919								0	0	19	1.65
1920								0	0	20	1.7
1921								0	0	21	1.75
1922								0	0	22	1.8
1923								0	0	23	1.85

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1924								0	0	24	1.9
1925								0	0	25	1.95
1926								0	0	26	2
1927								0	0	27	2.05
1928								0	0	28	2.1
1929								0	0	29	2.15
1930								0	0	30	2.2
1931								0	0	31	2.25
1932								0	0	32	2.3
1933								0	0	33	2.35
1934								0	0	34	2.4
1935								0	0	35	2.45
1936								0	0	36	2.5
1937								0	0	37	2.55
1938								0	0	38	2.6
1939								0	0	39	2.65
1940								0	0	40	2.7
1941								0	0	41	2.75
1942								0	0	42	2.8
1943								0	0	43	2.85
1944								0	0	44	2.9
1945								0	0	45	2.95
1946								0	0	46	3
1947								0	0	47	3.05
1948								0	0	48	3.1
1949								0	0	49	3.15
1950								0	0	50	3.2
1951								0	0	51	3.25
1952								0	0	52	3.3
1953								0	0	53	3.35
1954								0	0	54	3.4
1955								0	0	55	3.45
1956								0	0	56	3.5
1957								0	0	57	3.55
1958								0	0	58	3.6
1959								0	0	59	3.65
1960								0	0	60	3.7
1961								0	0	61	3.75
1962								0	0	62	3.8
1963								0	0	63	3.85
1964								0	0	64	3.9
1965								0	0	65	3.95
1966								0	0	66	4
1967								0	0	67	4.05
1968								0	0	68	4.1
1969								0	0	69	4.15
1970								0	0	70	4.2
1971								0	0	71	4.25
1972								0	0	72	4.3
1973								0	0	73	4.35
1974								0	0	74	4.4

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	1975								0	0	75	4.45
	1976								0	0	76	4.5
	1977								0	0	77	4.55
	1978								0	0	78	4.6
	1979								0	0	79	4.65
	1980								0	0	80	4.7
	1981								0	0	81	4.75
	1982								0	0	82	4.8
	1983								0	0	83	4.85
	1984								0	0	84	4.9
	1985								0	0	85	4.95
	1986								0	0	86	5
	1987								0	0	87	5.05
	1988								0	0	88	5.1
	1989								0	0	89	5.15
	1990								0	0	90	5.2
	1991								0	0	91	5.25
	1992								0	0	92	5.3
	1993								0	0	93	5.35
	1994								0	0	94	5.4
	1995								0	0	95	5.45
	1996								0	0	96	5.5
	1997								0	0	97	5.55
	1998								0	0	98	5.6
	1999								0	0	99	5.65
	2000								0	0	100	5.7
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
	2007								0	0	107	6.05
	2008								0	0	108	6.1
	2009								0	0	109	6.15
	2010								0	0	110	6.2
	2011								0	0	111	6.25
	2012								0	0	112	6.3
	2013								0	0	113	6.35
	2014								0	0	114	6.4
	2015								0	0	115	6.45
	2016								0	0	116	6.5
	2017								0	0	117	6.55
Original Installation	2018	0.2	$ 85.53	2018	0.2	$47.74	$37.79	x	1	1	118	6.6
	2019	1	$ 427.65	2019	1	$238.69	$188.96	x	2	2	119	6.65
	2020	1.02	$ 436.21	2020	1.02	$243.46	$192.74	x	3	3	120	6.7
	2021	1.05	$ 449.04	2021	1.05	$250.62	$198.41	x	4	4	121	6.75
	2022	1.06	$ 453.31	2022	1.06	$253.01	$200.30	x	5	5	122	6.8
	2023	1.07	$ 457.59	2023	1.07	$255.40	$202.19	x	6	6	123	6.85
	2024	1.08	$ 461.87	2024	1.08	$257.79	$204.08	x	7	7	124	6.9
	2025	1.1	$ 470.42	2025	1.1	$262.56	$207.86	x	8	8	125	6.95

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
2026	1.15	$ 491.80	2026	1.15	$274.49	$217.31	x	9	9	126	7
2027	1.2	$ 513.18	2027	1.2	$286.43	$226.76	x	10	10	127	7.05
2028	1.25	$ 534.57	2028	1.25	$298.36	$236.20	x	11	11	128	7.1
2029	1.3	$ 555.95	2029	1.3	$310.30	$245.65	x	12	12	129	7.15
2030	1.35	$ 577.33	2030	1.35	$322.23	$255.10	x	13	13	130	7.2
2031	1.4	$ 598.71	2031	1.4	$334.17	$264.55	x	14	14	131	7.25
2032	1.45	$ 620.10	2032	1.45	$346.10	$274.00	x	15	15	132	7.3
2033								0	0	133	7.35
2034								0	0	134	7.4
2035								0	0	135	7.45
2036								0	0	136	7.5
2037								0	0	137	7.55
2038								0	0	138	7.6
2039								0	0	139	7.65
2040								0	0	140	7.7
2041								0	0	141	7.75
2042								0	0	142	7.8
2043								0	0	143	7.85
2044								0	0	144	7.9
2045								0	0	145	7.95
2046								0	0	146	8
2047								0	0	147	8.05
2048								0	0	148	8.1
2049								0	0	149	8.15
2050								0	0	150	8.2
2051								0	0	151	8.25
2052								0	0	152	8.3
2053								0	0	153	8.35
2054								0	0	154	8.4
2055								0	0	155	8.45
2056								0	0	156	8.5
2057								0	0	157	8.55
2058								0	0	158	8.6
2059								0	0	159	8.65
2060								0	0	160	8.7
2061								0	0	161	8.75
2062								0	0	162	8.8
2063								0	0	163	8.85
2064								0	0	164	8.9
2065								0	0	165	8.95
2066								0	0	166	9
2067								0	0	167	9.05
2068								0	0	168	9.1
2069								0	0	169	9.15
2070								0	0	170	9.2
2071								0	0	171	9.25
2072								0	0	172	9.3
2073								0	0	173	9.35
2074								0	0	174	9.4
2075								0	0	175	9.45
2076								0	0	176	9.5

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2077								0	0	177	9.55
	2078								0	0	178	9.6
	2079								0	0	179	9.65
	2080								0	0	180	9.7
	2081								0	0	181	9.75
	2082								0	0	182	9.8
	2083								0	0	183	9.85
	2084								0	0	184	9.9
	2085								0	0	185	9.95
	2086								0	0	186	10
	2087								0	0	187	10.05
	2088								0	0	188	10.1
	2089								0	0	189	10.15
	2090								0	0	190	10.2
	2091								0	0	191	10.25
	2092								0	0	192	10.3
	2093								0	0	193	10.35
	2094								0	0	194	10.4
	2095								0	0	195	10.45
	2096								0	0	196	10.5
	2097								0	0	197	10.55
	2098								0	0	198	10.6
	2099								0	0	199	10.65
	2100								0	0	200	10.7
Totals	15	16.68	$ 7,133.25	15	16.68	$3,981.35	$3,151.90					

City of Gladstone EPC	Project	
Gladstone, MO	Location	
Rooftop Unit 3T	Equipment	
108.3%	Location Cost Index	Kansas City, MO
Proposed Old Hrs	Proposed New Hours	
Repair RTU	Repair RTU	Repair Type #1
10	17.9	Repair Frequency (Years)
☑		Include Repair Labor?
18.3	18.3	Repair Labor Required (Hours)
In-House		Select In-House or Contract Labor
$140.26	$140.26	Repair Labor Rate ($/hour) HVAC Technician
$1,222.00	$1,222.00	Repair Material Cost
☑		Include End-of-Life Replacement Cost in Analysis?
Replace RTU	Replace RTU	Repair Type #2
15	26.9	Replacement Frequency (Years)
☑		Include Replacement Labor?
56.6	56.6	Replacement Labor Required (Hours)
$114.43	$114.43	Replacement Labor Rate ($/hour) HVAC Technician
$4,699.00	$4,699.00	Replacement Material Cost
2018	Year Equipment Originally Installed	
2018	Year New Equipment to be Installed	
15	Length of Performance Contract (Years)	
$1,160.07	$647.48	Average Annual Repair Cost in 2016 Dollars
$512.59		**Annual O&M Savings per unit**
$512.59		**Total Savings** No. of Units: 1

Old Hours	8760	hrs
New Hours	1825.0	
	79%	reduction

	Existing			Proposed							
Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1900								0	0	0	
1901								0	0	1	0.2
1902								0	0	2	1
1903								0	0	3	1.02
1904								0	0	4	1.05
1905								0	0	5	1.06
1906								0	0	6	1.07
1907								0	0	7	1.08
1908								0	0	8	1.1
1909								0	0	9	1.15
1910								0	0	10	1.2
1911								0	0	11	1.25
1912								0	0	12	1.3
1913								0	0	13	1.35
1914								0	0	14	1.4
1915								0	0	15	1.45
1916								0	0	16	1.5
1917								0	0	17	1.55
1918								0	0	18	1.6
1919								0	0	19	1.65
1920								0	0	20	1.7
1921								0	0	21	1.75
1922								0	0	22	1.8
1923								0	0	23	1.85

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1924								0	0	24	1.9
1925								0	0	25	1.95
1926								0	0	26	2
1927								0	0	27	2.05
1928								0	0	28	2.1
1929								0	0	29	2.15
1930								0	0	30	2.2
1931								0	0	31	2.25
1932								0	0	32	2.3
1933								0	0	33	2.35
1934								0	0	34	2.4
1935								0	0	35	2.45
1936								0	0	36	2.5
1937								0	0	37	2.55
1938								0	0	38	2.6
1939								0	0	39	2.65
1940								0	0	40	2.7
1941								0	0	41	2.75
1942								0	0	42	2.8
1943								0	0	43	2.85
1944								0	0	44	2.9
1945								0	0	45	2.95
1946								0	0	46	3
1947								0	0	47	3.05
1948								0	0	48	3.1
1949								0	0	49	3.15
1950								0	0	50	3.2
1951								0	0	51	3.25
1952								0	0	52	3.3
1953								0	0	53	3.35
1954								0	0	54	3.4
1955								0	0	55	3.45
1956								0	0	56	3.5
1957								0	0	57	3.55
1958								0	0	58	3.6
1959								0	0	59	3.65
1960								0	0	60	3.7
1961								0	0	61	3.75
1962								0	0	62	3.8
1963								0	0	63	3.85
1964								0	0	64	3.9
1965								0	0	65	3.95
1966								0	0	66	4
1967								0	0	67	4.05
1968								0	0	68	4.1
1969								0	0	69	4.15
1970								0	0	70	4.2
1971								0	0	71	4.25
1972								0	0	72	4.3
1973								0	0	73	4.35
1974								0	0	74	4.4

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	1975								0	0	75	4.45
	1976								0	0	76	4.5
	1977								0	0	77	4.55
	1978								0	0	78	4.6
	1979								0	0	79	4.65
	1980								0	0	80	4.7
	1981								0	0	81	4.75
	1982								0	0	82	4.8
	1983								0	0	83	4.85
	1984								0	0	84	4.9
	1985								0	0	85	4.95
	1986								0	0	86	5
	1987								0	0	87	5.05
	1988								0	0	88	5.1
	1989								0	0	89	5.15
	1990								0	0	90	5.2
	1991								0	0	91	5.25
	1992								0	0	92	5.3
	1993								0	0	93	5.35
	1994								0	0	94	5.4
	1995								0	0	95	5.45
	1996								0	0	96	5.5
	1997								0	0	97	5.55
	1998								0	0	98	5.6
	1999								0	0	99	5.65
	2000								0	0	100	5.7
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
	2007								0	0	107	6.05
	2008								0	0	108	6.1
	2009								0	0	109	6.15
	2010								0	0	110	6.2
	2011								0	0	111	6.25
	2012								0	0	112	6.3
	2013								0	0	113	6.35
	2014								0	0	114	6.4
	2015								0	0	115	6.45
	2016								0	0	116	6.5
	2017								0	0	117	6.55
Original Installation	2018	0.2	$ 208.65	2018	0.2	$116.45	$92.19	x	1	1	118	6.6
	2019	1	$ 1,043.23	2019	1	$582.27	$460.96	x	2	2	119	6.65
	2020	1.02	$ 1,064.09	2020	1.02	$593.91	$470.18	x	3	3	120	6.7
	2021	1.05	$ 1,095.39	2021	1.05	$611.38	$484.01	x	4	4	121	6.75
	2022	1.06	$ 1,105.82	2022	1.06	$617.20	$488.62	x	5	5	122	6.8
	2023	1.07	$ 1,116.25	2023	1.07	$623.02	$493.23	x	6	6	123	6.85
	2024	1.08	$ 1,126.68	2024	1.08	$628.85	$497.84	x	7	7	124	6.9
	2025	1.1	$ 1,147.55	2025	1.1	$640.49	$507.06	x	8	8	125	6.95

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
2026	1.15	$ 1,199.71	2026	1.15	$669.61	$530.10	x	9	9	126	7
2027	1.2	$ 1,251.87	2027	1.2	$698.72	$553.15	x	10	10	127	7.05
2028	1.25	$ 1,304.03	2028	1.25	$727.83	$576.20	x	11	11	128	7.1
2029	1.3	$ 1,356.19	2029	1.3	$756.95	$599.25	x	12	12	129	7.15
2030	1.35	$ 1,408.36	2030	1.35	$786.06	$622.30	x	13	13	130	7.2
2031	1.4	$ 1,460.52	2031	1.4	$815.17	$645.34	x	14	14	131	7.25
2032	1.45	$ 1,512.68	2032	1.45	$844.29	$668.39	x	15	15	132	7.3
2033								0	0	133	7.35
2034								0	0	134	7.4
2035								0	0	135	7.45
2036								0	0	136	7.5
2037								0	0	137	7.55
2038								0	0	138	7.6
2039								0	0	139	7.65
2040								0	0	140	7.7
2041								0	0	141	7.75
2042								0	0	142	7.8
2043								0	0	143	7.85
2044								0	0	144	7.9
2045								0	0	145	7.95
2046								0	0	146	8
2047								0	0	147	8.05
2048								0	0	148	8.1
2049								0	0	149	8.15
2050								0	0	150	8.2
2051								0	0	151	8.25
2052								0	0	152	8.3
2053								0	0	153	8.35
2054								0	0	154	8.4
2055								0	0	155	8.45
2056								0	0	156	8.5
2057								0	0	157	8.55
2058								0	0	158	8.6
2059								0	0	159	8.65
2060								0	0	160	8.7
2061								0	0	161	8.75
2062								0	0	162	8.8
2063								0	0	163	8.85
2064								0	0	164	8.9
2065								0	0	165	8.95
2066								0	0	166	9
2067								0	0	167	9.05
2068								0	0	168	9.1
2069								0	0	169	9.15
2070								0	0	170	9.2
2071								0	0	171	9.25
2072								0	0	172	9.3
2073								0	0	173	9.35
2074								0	0	174	9.4
2075								0	0	175	9.45
2076								0	0	176	9.5

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2077								0	0	177	9.55
	2078								0	0	178	9.6
	2079								0	0	179	9.65
	2080								0	0	180	9.7
	2081								0	0	181	9.75
	2082								0	0	182	9.8
	2083								0	0	183	9.85
	2084								0	0	184	9.9
	2085								0	0	185	9.95
	2086								0	0	186	10
	2087								0	0	187	10.05
	2088								0	0	188	10.1
	2089								0	0	189	10.15
	2090								0	0	190	10.2
	2091								0	0	191	10.25
	2092								0	0	192	10.3
	2093								0	0	193	10.35
	2094								0	0	194	10.4
	2095								0	0	195	10.45
	2096								0	0	196	10.5
	2097								0	0	197	10.55
	2098								0	0	198	10.6
	2099								0	0	199	10.65
	2100								0	0	200	10.7
Totals	15	16.68	$ 17,401.01	15	16.68	$9,712.19	$7,688.82					

Calculation Parameters

INPUTS

Kansas City, MO

140	Maximum Heating Load (MBtu/h)
0.00929	Humidity Ratio Setpoint (lb_{wat}/lb_{air})
10	Maximum Cooling Load (tons)
1.30	Cooling Equipment Eff (kW/Ton)
0.8	Heating Equipment Eff (COP)
0	Affected Occupied Outside Air CFM

Heating Source

- ○ Gas Heat-MCF
- ◉ Gas Heat-Therms
- ○ Electric Heat

OA Temp	% of Max Heating Load
-2.5 & Below	**100%**
2.5	**93%**
7.5	**86%**
12.5	**79%**
17.5	**72%**
22.5	**65%**
27.5	**58%**
32.5	**51%**
37.5	**44%**
42.5	**37%**
47.5	**30%**

OA Temp	% of Max Cooling Load
55	**0%**
60	**0%**
65	**5%**
70	**19%**
75	**32%**
80	**46%**
85	**59%**
90	**73%**
95	**86%**
100 & Above	**100%**

Existing Conditions

74	Cooling Occupied Setpoint (°F)
74	Cooling Un-Occupied Setpoint (°F)
70	Heating Occupied Setpoint (°F)
70	Heating Unoccupied Setpoint (°F)
Yes	Is OA Shut Off When Not Occupied?
Controls Schedule	
	Monday through Friday:
1	Hour of day system is turned ON
24	Hour of day system is turned OFF
	Saturday:
1	Hour of day system is turned ON
24	Hour of day system is turned OFF
	Sunday:
1	Hour of day system is turned ON
24	Hour of day system is turned OFF

New Conditions

74	Cooling Occupied Setpoint (°F)
85	Cooling Un-Occupied Setpoint (°F)
70	Heating Occupied Setpoint (°F)
55	Heating Unoccupied Setpoint (°F)
Controls Schedule	
	Monday through Friday:
7	Hour of day system is turned ON
20	Hour of day system is turned OFF
	Saturday:
7	Hour of day system is turned ON
20	Hour of day system is turned OFF
	Sunday:
7	Hour of day system is turned ON
20	Hour of day system is turned OFF

Notes/Comments:

This calculation was calibrated for a 50,000 sq ft single story building in Kansas City. The building use type in the calibration was an elementary school and met, but did not exceed, ASHRAE 90.1. System types were single zone RTUs with gas heat and constant volume air distribution. No economizer was included. Windows were 20% of wall area. Lights were 32 W T8. Occupancy was 15 persons/1000 square feet.

Calculation will be reasonably accurate for preliminary calcs and CEA type calcs where M&V is IPMVP Option D (Calibrated Simulation). If IPMVP option C (Utility Bill Guarantee) is used, Engineer is advised to consider modeling with Carrier HAP or similar.

Do not confuse Maximum Heating Load and Maximum Cooling Load with installed equipment capacities. Often (heating systems in particular) are oversized and maximum load is considerably less than installed capacity. Conservative estimates of sq.ft./ton and Btu/hr/sf can be used to estimate load if calculations are not performed or actual historical operating data is not available.

This calc is for the non-Natatorium part of the building

Savings Realized from Schedule Change

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total Usage Savings	
0	0	0	0	120	495	1,312	703	205	134	0	0	**2,968**	**Cooling kWh**
111	100	94	45	0	0	0	0	0	0	92	108	**549**	**Heating Therms**

Calibration of pre-retrofit energy use to match utility analysis baseline.

Cooling Energy Use from Utility Analysis		kWh
Pre-Retrofit Cooling Energy Use in this calc.	12,391	kWh
Adjustment Factor	1.000	
Heating Energy Use from Utility Analysis		therms
Pre-Retrofit Heating Energy Use in this calc.	2,983	therms
Adjustment Factor	1.000	

City of Gladstone EPC		Project
Gladstone, MO		Location
Rooftop Unit 3T		Equipment
108.3%		Location Cost Index — Kansas City, MO
Proposed Old Hrs	Proposed New Hours	
Repair RTU	Repair RTU	Repair Type #1
10	14.3	Repair Frequency (Years)
☑		Include Repair Labor?
18.3	18.3	Repair Labor Required (Hours)
In-House		Select In-House or Contract Labor
$140.26	$140.26	Repair Labor Rate ($/hour) — HVAC Technician
$1,222.00	$1,222.00	Repair Material Cost
☑		Include End-of-Life Replacement Cost in Analysis?
Replace RTU	Replace RTU	Repair Type #2
15	21.5	Replacement Frequency (Years)
☑		Include Replacement Labor?
56.6	56.6	Replacement Labor Required (Hours)
$114.43	$114.43	Replacement Labor Rate ($/hour) — HVAC Technician
$4,699.00	$4,699.00	Replacement Material Cost
2018		Year Equipment Originally Installed
2018		Year New Equipment to be Installed
15		Length of Performance Contract (Years)
$1,160.07	$808.53	Average Annual Repair Cost in 2016 Dollars
$351.54		**Annual O&M Savings per unit**
$351.54		**Total Savings** — No. of Units: 1

Old Hours	8395	hrs
New Hours	4745.0	
	43%	reduction

	Existing			Proposed							
Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1900								0	0	0	
1901								0	0	1	0.2
1902								0	0	2	1
1903								0	0	3	1.02
1904								0	0	4	1.05
1905								0	0	5	1.06
1906								0	0	6	1.07
1907								0	0	7	1.08
1908								0	0	8	1.1
1909								0	0	9	1.15
1910								0	0	10	1.2
1911								0	0	11	1.25
1912								0	0	12	1.3
1913								0	0	13	1.35
1914								0	0	14	1.4
1915								0	0	15	1.45
1916								0	0	16	1.5
1917								0	0	17	1.55
1918								0	0	18	1.6
1919								0	0	19	1.65
1920								0	0	20	1.7
1921								0	0	21	1.75
1922								0	0	22	1.8
1923								0	0	23	1.85

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1924								0	0	24	1.9
1925								0	0	25	1.95
1926								0	0	26	2
1927								0	0	27	2.05
1928								0	0	28	2.1
1929								0	0	29	2.15
1930								0	0	30	2.2
1931								0	0	31	2.25
1932								0	0	32	2.3
1933								0	0	33	2.35
1934								0	0	34	2.4
1935								0	0	35	2.45
1936								0	0	36	2.5
1937								0	0	37	2.55
1938								0	0	38	2.6
1939								0	0	39	2.65
1940								0	0	40	2.7
1941								0	0	41	2.75
1942								0	0	42	2.8
1943								0	0	43	2.85
1944								0	0	44	2.9
1945								0	0	45	2.95
1946								0	0	46	3
1947								0	0	47	3.05
1948								0	0	48	3.1
1949								0	0	49	3.15
1950								0	0	50	3.2
1951								0	0	51	3.25
1952								0	0	52	3.3
1953								0	0	53	3.35
1954								0	0	54	3.4
1955								0	0	55	3.45
1956								0	0	56	3.5
1957								0	0	57	3.55
1958								0	0	58	3.6
1959								0	0	59	3.65
1960								0	0	60	3.7
1961								0	0	61	3.75
1962								0	0	62	3.8
1963								0	0	63	3.85
1964								0	0	64	3.9
1965								0	0	65	3.95
1966								0	0	66	4
1967								0	0	67	4.05
1968								0	0	68	4.1
1969								0	0	69	4.15
1970								0	0	70	4.2
1971								0	0	71	4.25
1972								0	0	72	4.3
1973								0	0	73	4.35
1974								0	0	74	4.4

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	1975								0	0	75	4.45
	1976								0	0	76	4.5
	1977								0	0	77	4.55
	1978								0	0	78	4.6
	1979								0	0	79	4.65
	1980								0	0	80	4.7
	1981								0	0	81	4.75
	1982								0	0	82	4.8
	1983								0	0	83	4.85
	1984								0	0	84	4.9
	1985								0	0	85	4.95
	1986								0	0	86	5
	1987								0	0	87	5.05
	1988								0	0	88	5.1
	1989								0	0	89	5.15
	1990								0	0	90	5.2
	1991								0	0	91	5.25
	1992								0	0	92	5.3
	1993								0	0	93	5.35
	1994								0	0	94	5.4
	1995								0	0	95	5.45
	1996								0	0	96	5.5
	1997								0	0	97	5.55
	1998								0	0	98	5.6
	1999								0	0	99	5.65
	2000								0	0	100	5.7
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
	2007								0	0	107	6.05
	2008								0	0	108	6.1
	2009								0	0	109	6.15
	2010								0	0	110	6.2
	2011								0	0	111	6.25
	2012								0	0	112	6.3
	2013								0	0	113	6.35
	2014								0	0	114	6.4
	2015								0	0	115	6.45
	2016								0	0	116	6.5
	2017								0	0	117	6.55
Original Installation	2018	0.2	$ 208.65	2018	0.2	$145.42	$63.23	x	1	1	118	6.6
	2019	1	$ 1,043.23	2019	1	$727.10	$316.13	x	2	2	119	6.65
	2020	1.02	$ 1,064.09	2020	1.02	$741.64	$322.45	x	3	3	120	6.7
	2021	1.05	$ 1,095.39	2021	1.05	$763.45	$331.94	x	4	4	121	6.75
	2022	1.06	$ 1,105.82	2022	1.06	$770.72	$335.10	x	5	5	122	6.8
	2023	1.07	$ 1,116.25	2023	1.07	$777.99	$338.26	x	6	6	123	6.85
	2024	1.08	$ 1,126.68	2024	1.08	$785.26	$341.42	x	7	7	124	6.9
	2025	1.1	$ 1,147.55	2025	1.1	$799.81	$347.74	x	8	8	125	6.95

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
2026	1.15	$ 1,199.71	2026	1.15	$836.16	$363.55	x	9	9	126	7
2027	1.2	$ 1,251.87	2027	1.2	$872.52	$379.35	x	10	10	127	7.05
2028	1.25	$ 1,304.03	2028	1.25	$908.87	$395.16	x	11	11	128	7.1
2029	1.3	$ 1,356.19	2029	1.3	$945.23	$410.97	x	12	12	129	7.15
2030	1.35	$ 1,408.36	2030	1.35	$981.58	$426.77	x	13	13	130	7.2
2031	1.4	$ 1,460.52	2031	1.4	$1,017.94	$442.58	x	14	14	131	7.25
2032	1.45	$ 1,512.68	2032	1.45	$1,054.29	$458.39	x	15	15	132	7.3
2033								0	0	133	7.35
2034								0	0	134	7.4
2035								0	0	135	7.45
2036								0	0	136	7.5
2037								0	0	137	7.55
2038								0	0	138	7.6
2039								0	0	139	7.65
2040								0	0	140	7.7
2041								0	0	141	7.75
2042								0	0	142	7.8
2043								0	0	143	7.85
2044								0	0	144	7.9
2045								0	0	145	7.95
2046								0	0	146	8
2047								0	0	147	8.05
2048								0	0	148	8.1
2049								0	0	149	8.15
2050								0	0	150	8.2
2051								0	0	151	8.25
2052								0	0	152	8.3
2053								0	0	153	8.35
2054								0	0	154	8.4
2055								0	0	155	8.45
2056								0	0	156	8.5
2057								0	0	157	8.55
2058								0	0	158	8.6
2059								0	0	159	8.65
2060								0	0	160	8.7
2061								0	0	161	8.75
2062								0	0	162	8.8
2063								0	0	163	8.85
2064								0	0	164	8.9
2065								0	0	165	8.95
2066								0	0	166	9
2067								0	0	167	9.05
2068								0	0	168	9.1
2069								0	0	169	9.15
2070								0	0	170	9.2
2071								0	0	171	9.25
2072								0	0	172	9.3
2073								0	0	173	9.35
2074								0	0	174	9.4
2075								0	0	175	9.45
2076								0	0	176	9.5

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2077								0	0	177	9.55
	2078								0	0	178	9.6
	2079								0	0	179	9.65
	2080								0	0	180	9.7
	2081								0	0	181	9.75
	2082								0	0	182	9.8
	2083								0	0	183	9.85
	2084								0	0	184	9.9
	2085								0	0	185	9.95
	2086								0	0	186	10
	2087								0	0	187	10.05
	2088								0	0	188	10.1
	2089								0	0	189	10.15
	2090								0	0	190	10.2
	2091								0	0	191	10.25
	2092								0	0	192	10.3
	2093								0	0	193	10.35
	2094								0	0	194	10.4
	2095								0	0	195	10.45
	2096								0	0	196	10.5
	2097								0	0	197	10.55
	2098								0	0	198	10.6
	2099								0	0	199	10.65
	2100								0	0	200	10.7
Totals	15	16.68	$ 17,401.01	15	16.68	$12,127.98	$5,273.03					

City of Gladstone EPC	Project		
Gladstone, MO	Location		
Rooftop Unit 3T	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Proposed Old Hrs	Proposed New Hours		
Repair RTU	Repair RTU	Repair Type #1	
10	14.3	Repair Frequency (Years)	
☑		Include Repair Labor?	
27.64	27.64	Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$140.26	$140.26	Repair Labor Rate ($/hour)	HVAC Technician
$2,180.34	$2,180.34	Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace RTU	Replace RTU	Repair Type #2	
15	21.5	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
39.0	39.0	Replacement Labor Required (Hours)	
$114.43	$114.43	Replacement Labor Rate ($/hour)	HVAC Technician
$4,569.64	$4,569.64	Replacement Material Cost	
2018	Year Equipment Originally Installed		
2018	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$1,251.25	$872.09	Average Annual Repair Cost in 2016 Dollars	
$379.17		**Annual O&M Savings per unit**	
$758.34		**Total Savings**	No. of Units: 2

	1st floor	
Old Hours	8395	hrs
New Hours	4745.0	
	43%	reduction

	Existing			Proposed							
Year	**Increase Factor**	**Annual Repair Cost**	**Year**	**Increase Factor**	**Annual Repair Cost**	**Savings**	**Include Year?**	**Original Life**	**New Life**	**Increase Factor Year**	**Increase Factor**
1900								0	0	0	
1901								0	0	1	0.2
1902								0	0	2	1
1903								0	0	3	1.02
1904								0	0	4	1.05
1905								0	0	5	1.06
1906								0	0	6	1.07
1907								0	0	7	1.08
1908								0	0	8	1.1
1909								0	0	9	1.15
1910								0	0	10	1.2
1911								0	0	11	1.25
1912								0	0	12	1.3
1913								0	0	13	1.35
1914								0	0	14	1.4
1915								0	0	15	1.45
1916								0	0	16	1.5
1917								0	0	17	1.55
1918								0	0	18	1.6
1919								0	0	19	1.65
1920								0	0	20	1.7
1921								0	0	21	1.75
1922								0	0	22	1.8
1923								0	0	23	1.85

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1924								0	0	24	1.9
1925								0	0	25	1.95
1926								0	0	26	2
1927								0	0	27	2.05
1928								0	0	28	2.1
1929								0	0	29	2.15
1930								0	0	30	2.2
1931								0	0	31	2.25
1932								0	0	32	2.3
1933								0	0	33	2.35
1934								0	0	34	2.4
1935								0	0	35	2.45
1936								0	0	36	2.5
1937								0	0	37	2.55
1938								0	0	38	2.6
1939								0	0	39	2.65
1940								0	0	40	2.7
1941								0	0	41	2.75
1942								0	0	42	2.8
1943								0	0	43	2.85
1944								0	0	44	2.9
1945								0	0	45	2.95
1946								0	0	46	3
1947								0	0	47	3.05
1948								0	0	48	3.1
1949								0	0	49	3.15
1950								0	0	50	3.2
1951								0	0	51	3.25
1952								0	0	52	3.3
1953								0	0	53	3.35
1954								0	0	54	3.4
1955								0	0	55	3.45
1956								0	0	56	3.5
1957								0	0	57	3.55
1958								0	0	58	3.6
1959								0	0	59	3.65
1960								0	0	60	3.7
1961								0	0	61	3.75
1962								0	0	62	3.8
1963								0	0	63	3.85
1964								0	0	64	3.9
1965								0	0	65	3.95
1966								0	0	66	4
1967								0	0	67	4.05
1968								0	0	68	4.1
1969								0	0	69	4.15
1970								0	0	70	4.2
1971								0	0	71	4.25
1972								0	0	72	4.3
1973								0	0	73	4.35
1974								0	0	74	4.4

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	1975								0	0	75	4.45
	1976								0	0	76	4.5
	1977								0	0	77	4.55
	1978								0	0	78	4.6
	1979								0	0	79	4.65
	1980								0	0	80	4.7
	1981								0	0	81	4.75
	1982								0	0	82	4.8
	1983								0	0	83	4.85
	1984								0	0	84	4.9
	1985								0	0	85	4.95
	1986								0	0	86	5
	1987								0	0	87	5.05
	1988								0	0	88	5.1
	1989								0	0	89	5.15
	1990								0	0	90	5.2
	1991								0	0	91	5.25
	1992								0	0	92	5.3
	1993								0	0	93	5.35
	1994								0	0	94	5.4
	1995								0	0	95	5.45
	1996								0	0	96	5.5
	1997								0	0	97	5.55
	1998								0	0	98	5.6
	1999								0	0	99	5.65
	2000								0	0	100	5.7
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
	2004								0	0	104	5.9
	2005								0	0	105	5.95
	2006								0	0	106	6
	2007								0	0	107	6.05
	2008								0	0	108	6.1
	2009								0	0	109	6.15
	2010								0	0	110	6.2
	2011								0	0	111	6.25
	2012								0	0	112	6.3
	2013								0	0	113	6.35
	2014								0	0	114	6.4
	2015								0	0	115	6.45
	2016								0	0	116	6.5
	2017								0	0	117	6.55
Original Installation	2018	0.2	$ 225.05	2018	0.2	$156.85	$68.20	x	1	1	118	6.6
	2019	1	$ 1,125.23	2019	1	$784.25	$340.98	x	2	2	119	6.65
	2020	1.02	$ 1,147.73	2020	1.02	$799.93	$347.80	x	3	3	120	6.7
	2021	1.05	$ 1,181.49	2021	1.05	$823.46	$358.03	x	4	4	121	6.75
	2022	1.06	$ 1,192.74	2022	1.06	$831.30	$361.44	x	5	5	122	6.8
	2023	1.07	$ 1,203.99	2023	1.07	$839.15	$364.85	x	6	6	123	6.85
	2024	1.08	$ 1,215.25	2024	1.08	$846.99	$368.26	x	7	7	124	6.9
	2025	1.1	$ 1,237.75	2025	1.1	$862.67	$375.08	x	8	8	125	6.95

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
2026	1.15	$ 1,294.01	2026	1.15	$901.89	$392.12	x	9	9	126	7
2027	1.2	$ 1,350.27	2027	1.2	$941.10	$409.17	x	10	10	127	7.05
2028	1.25	$ 1,406.54	2028	1.25	$980.31	$426.22	x	11	11	128	7.1
2029	1.3	$ 1,462.80	2029	1.3	$1,019.52	$443.27	x	12	12	129	7.15
2030	1.35	$ 1,519.06	2030	1.35	$1,058.74	$460.32	x	13	13	130	7.2
2031	1.4	$ 1,575.32	2031	1.4	$1,097.95	$477.37	x	14	14	131	7.25
2032	1.45	$ 1,631.58	2032	1.45	$1,137.16	$494.42	x	15	15	132	7.3
2033								0	0	133	7.35
2034								0	0	134	7.4
2035								0	0	135	7.45
2036								0	0	136	7.5
2037								0	0	137	7.55
2038								0	0	138	7.6
2039								0	0	139	7.65
2040								0	0	140	7.7
2041								0	0	141	7.75
2042								0	0	142	7.8
2043								0	0	143	7.85
2044								0	0	144	7.9
2045								0	0	145	7.95
2046								0	0	146	8
2047								0	0	147	8.05
2048								0	0	148	8.1
2049								0	0	149	8.15
2050								0	0	150	8.2
2051								0	0	151	8.25
2052								0	0	152	8.3
2053								0	0	153	8.35
2054								0	0	154	8.4
2055								0	0	155	8.45
2056								0	0	156	8.5
2057								0	0	157	8.55
2058								0	0	158	8.6
2059								0	0	159	8.65
2060								0	0	160	8.7
2061								0	0	161	8.75
2062								0	0	162	8.8
2063								0	0	163	8.85
2064								0	0	164	8.9
2065								0	0	165	8.95
2066								0	0	166	9
2067								0	0	167	9.05
2068								0	0	168	9.1
2069								0	0	169	9.15
2070								0	0	170	9.2
2071								0	0	171	9.25
2072								0	0	172	9.3
2073								0	0	173	9.35
2074								0	0	174	9.4
2075								0	0	175	9.45
2076								0	0	176	9.5

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2077								0	0	177	9.55
	2078								0	0	178	9.6
	2079								0	0	179	9.65
	2080								0	0	180	9.7
	2081								0	0	181	9.75
	2082								0	0	182	9.8
	2083								0	0	183	9.85
	2084								0	0	184	9.9
	2085								0	0	185	9.95
	2086								0	0	186	10
	2087								0	0	187	10.05
	2088								0	0	188	10.1
	2089								0	0	189	10.15
	2090								0	0	190	10.2
	2091								0	0	191	10.25
	2092								0	0	192	10.3
	2093								0	0	193	10.35
	2094								0	0	194	10.4
	2095								0	0	195	10.45
	2096								0	0	196	10.5
	2097								0	0	197	10.55
	2098								0	0	198	10.6
	2099								0	0	199	10.65
	2100								0	0	200	10.7
Totals	15	16.68	$ 18,768.81	15	16.68	$13,081.29	$5,687.52					

Calculation Parameters

INPUTS

Kansas City, MO

102	Maximum Heating Load (MBtu/h)
0.00929	Humidity Ratio Setpoint (lb_{wat}/lb_{air})
6	Maximum Cooling Load (tons)
1.20	Cooling Equipment Eff (kW/Ton)
1	Heating Equipment Eff (COP)
0	Affected Occupied Outside Air CFM

Heating Source

- ○ Gas Heat-MCF
- ○ Gas Heat-Therms
- ● Electric Heat

Existing Conditions

74.0	Cooling Occupied Setpoint (°F)
74.0	Cooling Un-Occupied Setpoint (°F)
70.0	Heating Occupied Setpoint (°F)
70.0	Heating Unoccupied Setpoint (°F)
No	Is OA Shut Off When Not Occupied?

Controls Schedule

	Monday through Friday:
0	Hour of day system is turned ON
24	Hour of day system is turned OFF
	Saturday:
0	Hour of day system is turned ON
24	Hour of day system is turned OFF
	Sunday:
0	Hour of day system is turned ON
24	Hour of day system is turned OFF

New Conditions

74	Cooling Occupied Setpoint (°F)
85	Cooling Un-Occupied Setpoint (°F)
70	Heating Occupied Setpoint (°F)
55	Heating Unoccupied Setpoint (°F)

Controls Schedule

	Monday through Friday:
11	Hour of day system is turned ON
15	Hour of day system is turned OFF
	Saturday:
0	Hour of day system is turned ON
0	Hour of day system is turned OFF
	Sunday:
0	Hour of day system is turned ON
0	Hour of day system is turned OFF

OA Temp	% of Max Heating Load
-2.5 & Below	100%
2.5	93%
7.5	86%
12.5	79%
17.5	72%
22.5	65%
27.5	58%
32.5	51%
37.5	44%
42.5	37%
47.5	30%

OA Temp	% of Max Cooling Load
55	0%
60	0%
65	5%
70	19%
75	32%
80	46%
85	59%
90	73%
95	86%
100 & Above	100%

Notes/Comments:

This calculation was calibrated for a 50,000 sq ft single story building in Kansas City. The building use type in the calibration was an elementary school and met, but did not exceed, ASHRAE 90.1. System types were single zone RTUs with gas heat and constant volume air distribution. No economizer was included. Windows were 20% of wall area. Lights were 32 W T8. Occupancy was 15 persons/1000 square feet.

Calculation will be reasonably accurate for preliminary calcs and CEA type calcs where M&V is IPMVP Option D (Calibrated Simulation). If IPMVP option C (Utility Bill Guarantee) is used, Engineer is advised to consider modeling with Carrier HAP or similar.

Do not confuse Maximum Heating Load and Maximum Cooling Load with installed equipment capacities. Often (heating systems in particular) are oversized and maximum load is considerably less than installed capacity. Conservative estimates of sq.ft./ton and Btu/hr/sf can be used to estimate load if calculations are not performed or actual historical operating data is not available.

Savings Realized from Schedule Change

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total Usage Savings	
0	0	0	0	723	1,968	3,500	2,287	980	522	0	0	**9,979**	**Cooling kWh**
3,509	3,105	2,791	1,127	0	0	0	0	0	0	2,904	3,432	**16,869**	**Heating kWh**

Calibration of pre-retrofit energy use to match utility analysis baseline.

Cooling Energy Use from Utility Analysis	13,613	kWh
Pre-Retrofit Cooling Energy Use in this calc.	13,613	kWh
Adjustment Factor	1.984	
Heating Energy Use from Utility Analysis	49,910	kWh
Pre-Retrofit Heating Energy Use in this calc.	49,910	therms
Adjustment Factor	0.977	

City of Gladstone EPC	Project		
Gladstone, MO	Location		
Rooftop Unit 3T	Equipment		
108.3%	Location Cost Index		Kansas City, MO
Proposed Old Hrs	Proposed New Hours		
Repair RTU	Repair RTU	Repair Type #1	
10	18.3	Repair Frequency (Years)	
☑		Include Repair Labor?	
27.64	27.64	Repair Labor Required (Hours)	
In-House		Select In-House or Contract Labor	
$140.26	$140.26	Repair Labor Rate ($/hour)	HVAC Technician
$2,180.34	$2,180.34	Repair Material Cost	
☑		Include End-of-Life Replacement Cost in Analysis?	
Replace RTU	Replace RTU	Repair Type #2	
15	27.5	Replacement Frequency (Years)	
☑		Include Replacement Labor?	
39.0	39.0	Replacement Labor Required (Hours)	
$114.43	$114.43	Replacement Labor Rate ($/hour)	HVAC Technician
$4,569.64	$4,569.64	Replacement Material Cost	
2004	Year Equipment Originally Installed		
2004	Year New Equipment to be Installed		
15	Length of Performance Contract (Years)		
$1,251.25	$682.50	Average Annual Repair Cost in 2016 Dollars	
$568.75		**Annual O&M Savings per unit**	
$568.75		**Total Savings**	No. of Units: 1

	1st floor	
Old Hours	8760	hrs
New Hours	1460.0	
	83%	reduction

	Existing			Proposed							
Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1900								0	0	0	
1901								0	0	1	0.2
1902								0	0	2	1
1903								0	0	3	1.02
1904								0	0	4	1.05
1905								0	0	5	1.06
1906								0	0	6	1.07
1907								0	0	7	1.08
1908								0	0	8	1.1
1909								0	0	9	1.15
1910								0	0	10	1.2
1911								0	0	11	1.25
1912								0	0	12	1.3
1913								0	0	13	1.35
1914								0	0	14	1.4
1915								0	0	15	1.45
1916								0	0	16	1.5
1917								0	0	17	1.55
1918								0	0	18	1.6
1919								0	0	19	1.65
1920								0	0	20	1.7
1921								0	0	21	1.75
1922								0	0	22	1.8
1923								0	0	23	1.85

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
1924								0	0	24	1.9
1925								0	0	25	1.95
1926								0	0	26	2
1927								0	0	27	2.05
1928								0	0	28	2.1
1929								0	0	29	2.15
1930								0	0	30	2.2
1931								0	0	31	2.25
1932								0	0	32	2.3
1933								0	0	33	2.35
1934								0	0	34	2.4
1935								0	0	35	2.45
1936								0	0	36	2.5
1937								0	0	37	2.55
1938								0	0	38	2.6
1939								0	0	39	2.65
1940								0	0	40	2.7
1941								0	0	41	2.75
1942								0	0	42	2.8
1943								0	0	43	2.85
1944								0	0	44	2.9
1945								0	0	45	2.95
1946								0	0	46	3
1947								0	0	47	3.05
1948								0	0	48	3.1
1949								0	0	49	3.15
1950								0	0	50	3.2
1951								0	0	51	3.25
1952								0	0	52	3.3
1953								0	0	53	3.35
1954								0	0	54	3.4
1955								0	0	55	3.45
1956								0	0	56	3.5
1957								0	0	57	3.55
1958								0	0	58	3.6
1959								0	0	59	3.65
1960								0	0	60	3.7
1961								0	0	61	3.75
1962								0	0	62	3.8
1963								0	0	63	3.85
1964								0	0	64	3.9
1965								0	0	65	3.95
1966								0	0	66	4
1967								0	0	67	4.05
1968								0	0	68	4.1
1969								0	0	69	4.15
1970								0	0	70	4.2
1971								0	0	71	4.25
1972								0	0	72	4.3
1973								0	0	73	4.35
1974								0	0	74	4.4

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	**Savings**	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	1975								0	0	75	4.45
	1976								0	0	76	4.5
	1977								0	0	77	4.55
	1978								0	0	78	4.6
	1979								0	0	79	4.65
	1980								0	0	80	4.7
	1981								0	0	81	4.75
	1982								0	0	82	4.8
	1983								0	0	83	4.85
	1984								0	0	84	4.9
	1985								0	0	85	4.95
	1986								0	0	86	5
	1987								0	0	87	5.05
	1988								0	0	88	5.1
	1989								0	0	89	5.15
	1990								0	0	90	5.2
	1991								0	0	91	5.25
	1992								0	0	92	5.3
	1993								0	0	93	5.35
	1994								0	0	94	5.4
	1995								0	0	95	5.45
	1996								0	0	96	5.5
	1997								0	0	97	5.55
	1998								0	0	98	5.6
	1999								0	0	99	5.65
	2000								0	0	100	5.7
	2001								0	0	101	5.75
	2002								0	0	102	5.8
	2003								0	0	103	5.85
Original Installation	2004	0.2	$ 225.05	2004	0.2	$122.75	$102.29	x	1	1	104	5.9
	2005	1	$ 1,125.23	2005	1	$613.76	$511.47	x	2	2	105	5.95
	2006	1.02	$ 1,147.73	2006	1.02	$626.04	$521.70	x	3	3	106	6
	2007	1.05	$ 1,181.49	2007	1.05	$644.45	$537.04	x	4	4	107	6.05
	2008	1.06	$ 1,192.74	2008	1.06	$650.59	$542.16	x	5	5	108	6.1
	2009	1.07	$ 1,203.99	2009	1.07	$656.72	$547.27	x	6	6	109	6.15
	2010	1.08	$ 1,215.25	2010	1.08	$662.86	$552.38	x	7	7	110	6.2
	2011	1.1	$ 1,237.75	2011	1.1	$675.14	$562.61	x	8	8	111	6.25
	2012	1.15	$ 1,294.01	2012	1.15	$705.82	$588.19	x	9	9	112	6.3
	2013	1.2	$ 1,350.27	2013	1.2	$736.51	$613.76	x	10	10	113	6.35
	2014	1.25	$ 1,406.54	2014	1.25	$767.20	$639.33	x	11	11	114	6.4
	2015	1.3	$ 1,462.80	2015	1.3	$797.89	$664.91	x	12	12	115	6.45
	2016	1.35	$ 1,519.06	2016	1.35	$828.58	$690.48	x	13	13	116	6.5
	2017	1.4	$ 1,575.32	2017	1.4	$859.27	$716.05	x	14	14	117	6.55
	2018	1.45	$ 1,631.58	2018	1.45	$889.95	$741.63	x	15	15	118	6.6
	2019								0	0	119	6.65
	2020								0	0	120	6.7
	2021								0	0	121	6.75
	2022								0	0	122	6.8
	2023								0	0	123	6.85
	2024								0	0	124	6.9
	2025								0	0	125	6.95

Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
2026								0	0	126	7
2027								0	0	127	7.05
2028								0	0	128	7.1
2029								0	0	129	7.15
2030								0	0	130	7.2
2031								0	0	131	7.25
2032								0	0	132	7.3
2033								0	0	133	7.35
2034								0	0	134	7.4
2035								0	0	135	7.45
2036								0	0	136	7.5
2037								0	0	137	7.55
2038								0	0	138	7.6
2039								0	0	139	7.65
2040								0	0	140	7.7
2041								0	0	141	7.75
2042								0	0	142	7.8
2043								0	0	143	7.85
2044								0	0	144	7.9
2045								0	0	145	7.95
2046								0	0	146	8
2047								0	0	147	8.05
2048								0	0	148	8.1
2049								0	0	149	8.15
2050								0	0	150	8.2
2051								0	0	151	8.25
2052								0	0	152	8.3
2053								0	0	153	8.35
2054								0	0	154	8.4
2055								0	0	155	8.45
2056								0	0	156	8.5
2057								0	0	157	8.55
2058								0	0	158	8.6
2059								0	0	159	8.65
2060								0	0	160	8.7
2061								0	0	161	8.75
2062								0	0	162	8.8
2063								0	0	163	8.85
2064								0	0	164	8.9
2065								0	0	165	8.95
2066								0	0	166	9
2067								0	0	167	9.05
2068								0	0	168	9.1
2069								0	0	169	9.15
2070								0	0	170	9.2
2071								0	0	171	9.25
2072								0	0	172	9.3
2073								0	0	173	9.35
2074								0	0	174	9.4
2075								0	0	175	9.45
2076								0	0	176	9.5

	Year	Increase Factor	Annual Repair Cost	Year	Increase Factor	Annual Repair Cost	Savings	Include Year?	Original Life	New Life	Increase Factor Year	Increase Factor
	2077								0	0	177	9.55
	2078								0	0	178	9.6
	2079								0	0	179	9.65
	2080								0	0	180	9.7
	2081								0	0	181	9.75
	2082								0	0	182	9.8
	2083								0	0	183	9.85
	2084								0	0	184	9.9
	2085								0	0	185	9.95
	2086								0	0	186	10
	2087								0	0	187	10.05
	2088								0	0	188	10.1
	2089								0	0	189	10.15
	2090								0	0	190	10.2
	2091								0	0	191	10.25
	2092								0	0	192	10.3
	2093								0	0	193	10.35
	2094								0	0	194	10.4
	2095								0	0	195	10.45
	2096								0	0	196	10.5
	2097								0	0	197	10.55
	2098								0	0	198	10.6
	2099								0	0	199	10.65
	2100								0	0	200	10.7
Totals	15	16.68	$ 18,768.81	15	16.68	$10,237.53	$8,531.28					

WEATHERIZATION
ECM 67 - 79

The savings calculations for building weatherization (ECM 67 – 79) are included in the documentation located in **Schedule J (Equipment to be Installed by ESCO)** under the Weatherization tab.

Design 1 Gladstone Community Center, 6901 N Holmes St, Gladstone, MO 64118

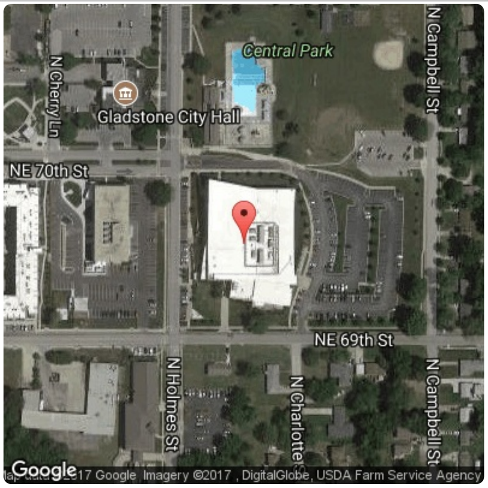
Report

Project Name	Gladstone Community Center
Project Address	6901 N Holmes St, Gladstone, MO 64118
Prepared By	Andrew Stancati astancati@biostarrenewables.com

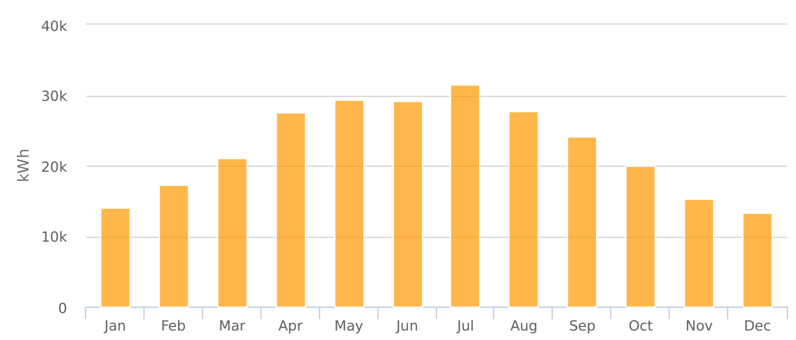
System Metrics

Design	Design 1
Module DC Nameplate	199.9 kW
Inverter AC Nameplate	150.0 kW Load Ratio: 1.33
Annual Production	270.8 MWh
Performance Ratio	81.3%
kWh/kWp	1,355.0
Weather Dataset	TMY, 10km grid (39.25,-94.55), NREL (prospector)
Simulator Version	88e2687ead-a0447e1bad-60a45df119-acaddf2c26

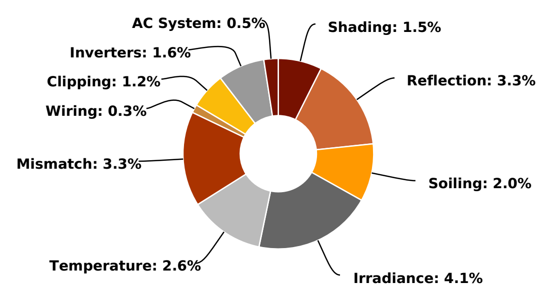
Project Location



Monthly Production



Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m²)	Annual Global Horizontal Irradiance	1,538.1	
	Adjusted Global Horizontal Irradiance	1,538.1	0.0%
	POA Irradiance	1,666.5	8.3%
	Shaded Irradiance	1,641.2	-1.5%
	Irradiance after Reflection	1,587.7	-3.3%
	Irradiance after Soiling	1,556.0	-2.0%
	Total Collector Irradiance	**1,556.0**	**0.0%**
Energy (kWh)	Nameplate	311,118.6	
	Output at Irradiance Levels	298,312.6	-4.1%
	Output at Cell Temperature Derate	290,517.9	-2.6%
	Output After Mismatch	280,946.9	-3.3%
	Optimal DC Output	280,150.3	-0.3%
	Constrained DC Output	276,672.5	-1.2%
	Inverter Output	272,183.0	-1.7%
	Energy to Grid	**270,822.0**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		15.0 °C
	Avg. Operating Cell Temp		22.7 °C
Simulation Metrics			
	Operating Hours		4655
	Solved Hours		4655

Condition Set

Description	Condition Set 1
Weather Dataset	TMY, 10km grid (39.25,-94.55), NREL (prospector)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.075	3°C
Flush Mount	-2.81	-0.0455	0°C

Soiling (%)

J	F	M	A	M	J	J	A	S	O	N	D
2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5%
Cell Temperature Spread	4° C
Module Binning Range	-2.5% to 2.5%
AC System Derate	0.50%

Module Characterizations

Module	Characterization
BVM6612P-325 (Boviet)	Default Characterization, PAN

Component Characterizations

Device	Characterization
CPS SCA50KTL-DO/US-480 V2.0 (Chint Power Systems)	Default Characterization

Components

Component	Name	Count
Inverters	CPS SCA50KTL-DO/US-480 V2.0 (Chint Power Systems)	3 (150.0 kW)
Strings	10 AWG (Copper)	33 (4,806.9 ft)
Modules	Boviet, BVM6612P-325 (325W)	615 (199.9 kW)

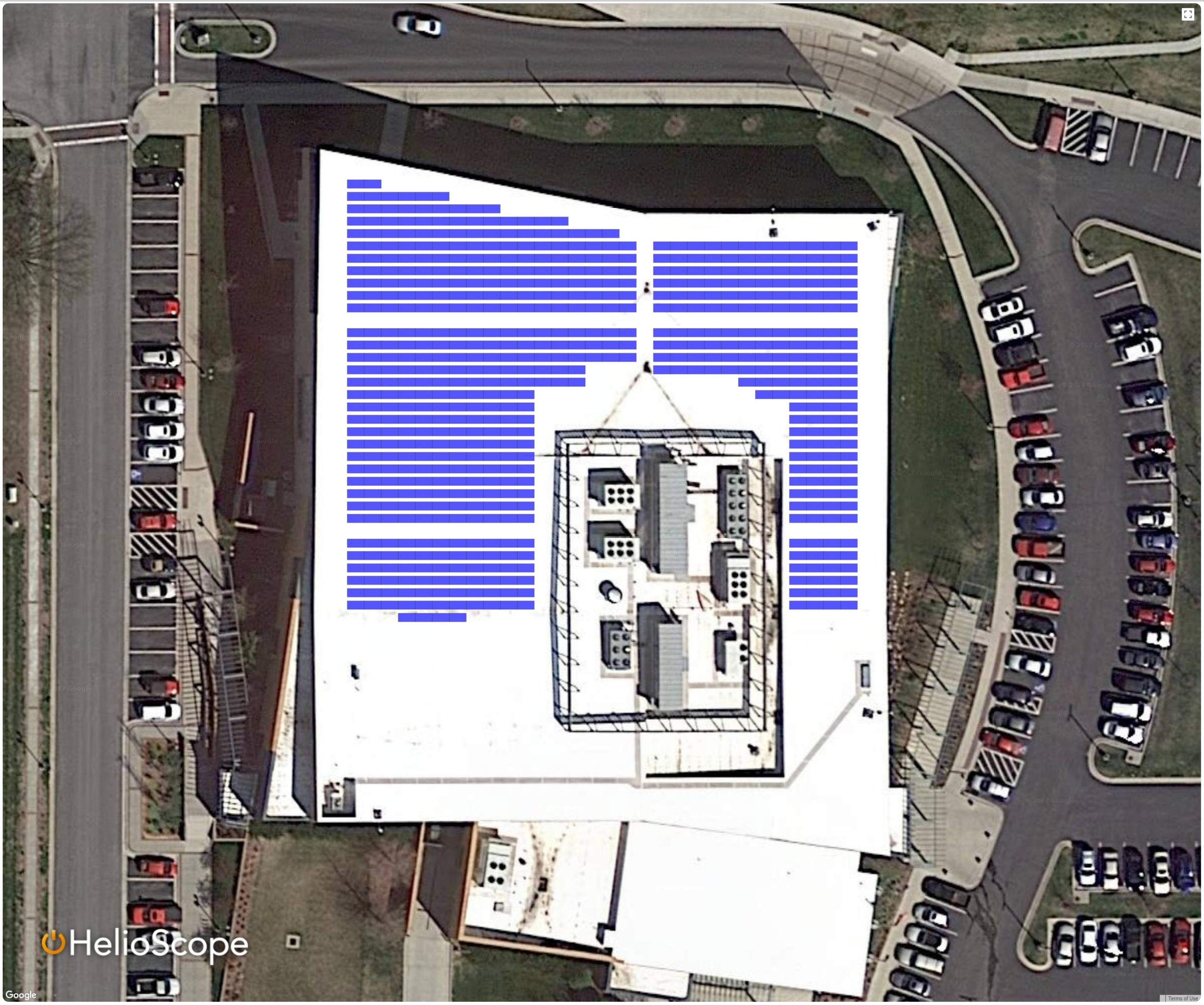
Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	6-19	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Fixed Tilt	Horizontal (Landscape)	10°	180°	1.5 ft	1x1	615	615	199.9 kW

Detailed Layout



Exploring Demand Charge Savings from Commercial Solar

Naïm Darghouth, Galen Barbose, Andrew Mills, and Ryan Wiser, Lawrence Berkeley National Laboratory
Pieter Gagnon and Lori Bird, National Renewable Energy Laboratory

Overview

Commercial retail electricity rates commonly include a demand charge component, based on some measure of the customer's peak demand. Customer-sited solar PV can potentially reduce demand charges, but the magnitude of these savings can be difficult to predict, given variations in demand charge designs, customer loads, and PV generation profiles. Moreover, depending on the circumstances, demand charges from solar may or may not align well with associated utility cost savings.

Lawrence Berkeley National Laboratory (Berkeley Lab) and the National Renewable Energy Laboratory (NREL) are collaborating in a series of studies to understand how solar PV can reduce demand charge levels for a variety of customer types and demand charges designs. Previous work focused on residential customers with solar. This study, instead, focuses on commercial customers and seeks to understand the extent and conditions under which rooftop can solar reduce commercial demand charges. To answer these questions, we simulate demand charge savings for a broad range of commercial customer types, demand charge designs, locations, and PV system characteristics. This particular analysis does not include storage, but a subsequent analysis in this series will evaluate demand charge savings for commercial customers with solar and storage.

Data and Methods

The analysis is based on 30-minute weather data spanning a 17-year historical period (1998-2014), sourced from the National Solar Radiation Database. Using those data, we simulate building loads for fifteen commercial customer groups using the Department of Energy's Energy+ Commercial Reference Building Models. The simulations are performed across 15 U.S. cities. Using the same weather data, we simulate rooftop PV generation using NREL's System Advisor Model. These simulations are performed for the same set of U.S. cities and across multiple PV system sizes (ranging from 10% to 100% of each customer's annual energy consumption) and orientations (south, southwest, west, and flat). This set of simulations yields 9,000 pairs of building load and PV generation data, with each pair based on the same location and time period.

For each pair of load/PV data, we estimate monthly demand charge savings from solar, by comparing demand charges with and without solar, under numerous demand charge designs. Under the "basic" non-coincident demand charge, the customer is charged for its maximum demand during any 30-minute interval over the course of each month. We also estimate demand charge savings under designs with seasonally varying demand charges; with ratchets; with averaging intervals ranging from 30 minutes to 2 hours; and with charges based on the customer's maximum demand during various specified peak period windows, beginning and ending at various times between 8 am and 8 pm.

This executive summary is based on a more-detailed, slide-deck briefing: Darghouth et al. 2017. *Exploring Demand Charge Savings from Commercial Solar*. Berkeley, CA: Lawrence Berkeley National Laboratory. This work was funded by the Solar Energy Technologies Office, Office of Energy Efficiency and Renewable Energy of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.

Key Findings

We compare demand charge savings across the various permutations of load/PV data and demand charge designs in terms of the average reduction in monthly demand charges over the entire 17-year analysis period. The principal metric used in the analysis is the percentage reduction in average billing demand, relative to the customer's billing demand without PV. Though not included in this executive summary, we also present a subset of the results using a second metric in the full briefing's appendix. This metric is termed the *demand charge capacity credit*, and serves as a point of comparison to the capacity credit used to estimate avoided utility system costs. In addition to comparing average demand charge reductions, we also compare *variability* in monthly demand charge savings across demand charge designs, though those results are included only in the full briefing.

Under a basic, non-coincident demand charge design, commercial customers generally achieve low reductions in demand charges from solar. As shown in Figure 1 (the left-most bar segment), rooftop solar reduces demand charges by just 7% in the median case and by less than 15% in about 90% of all cases when based on a basic non-coincident demand charge, for customers with PV systems that generate 50% of their annual load. Demand charge savings for many customers are relatively low under this design, because most commercial customers load profiles that do not align well with PV generation. That said, some commercial customers may be able to generate more-significant savings under a non-coincident demand charge design (e.g., a 20% reduction in demand charges or more). This contrasts with the findings from our earlier analysis of demand charge savings from residential solar, which found lower savings overall and much less variability across customers, when based on a non-coincident design.

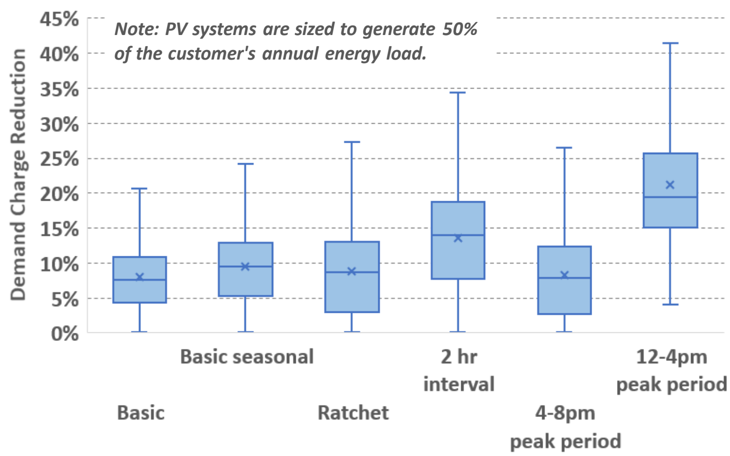


Figure 1. Distribution in average billing demand reduction for various illustrative demand charge designs, over all combinations of commercial customers included in the analysis

Notes: Each box-and-whiskers plot shows the distribution in the average monthly reduction in billing demand, across 900 combinations of simulated load generation and PV generation profiles for customers with PV systems that generate 50% of their annual load. 'x' = mean; shaded box = 25th-75th percentile range; middle line = median; whiskers are maximum and minimum excluding outliers.

Demand charge savings may be significantly greater when based on pre-defined peak periods and on longer time averaging intervals. For example, if based on the customer's maximum demand during a 12-4 pm peak period, commercial solar reduces demand charges by 19% in the median case, and by 40% or more in some cases, as illustrated in Figure 1. Under demand charge designs with peak periods that end later in the day, for example a 4-8 pm peak period, demand charge savings from solar are significantly lower. This is because many customers' peak demand tends to occur at the end of the peak period window, at which point solar output is lower. Demand charge savings from commercial solar are also sensitive to the length of the averaging interval used to compute billing demand. Averaging load over longer periods of time (such as 2 hours, shown in Figure 1) can smooth out variability in PV generation due to intermittent cloud cover, as well as better align load and PV generation when peak load occurs later in the daytime; both of these dynamics can lead to higher demand charge savings. The impacts of averaging interval length on demand charge savings are particularly salient under demand charge designs based on afternoon peak periods (see p. 29 of the full briefing).

Other demand charge design elements generally have less significance for bill savings from solar. As shown in Figure 1, seasonally varying demand charges and ratchets do not significantly impact demand charge reductions from solar, when applied to a basic non-coincident peak demand charge. Seasonal demand charges, where demand charges are higher in summer months, tend to provide a small boost in demand charge reductions from solar. Though not shown here, the relative effect of the seasonal element on the demand charge is similar for the basic demand charge design and that with a 12-4 pm peak (see p. 30 of the full briefing). Ratchets, which create a minimum billing demand based on peak demand in the past year, have a small positive or negative effect on demand charge savings, depending on the commercial customer type and the underlying demand charge design (i.e. see p. 31 of the full briefing).

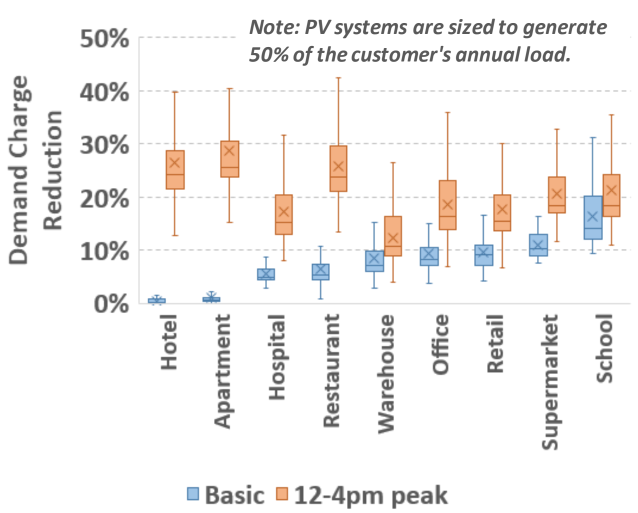


Figure 2. Distribution in average billing demand reduction for various commercial customer groups for the non-coincident and the 12-4 pm peak demand charge designs

Demand charge reductions from solar are heavily dependent on building type. As observed in Figure 2, demand charge reductions can vary significantly from one commercial building group to another, though those comparisons differ depending on demand charge design. For the basic, non-coincident demand charge (blue bars), demand reductions from solar are generally highest for schools and supermarkets, whose load profiles better correspond to PV generation and achieve a mean non-coincident demand charge reduction of 18% for customers with PV systems that generate 50% of their annual load. At the other end of the distribution are apartments and hotels, whose loads tend to peak in the late afternoon and evening, and therefore achieve zero demand charge savings in almost all cases under a non-coincident demand charge design. For most building types, non-coincident demand reductions are low (i.e., 5-10% for PV systems that generate 50% of annual customer load). The ability for PV to reduce non-coincident demand is limited by poor coincidence between load and PV generation profiles for most commercial customers, as well as by cloudiness, which may coincide with peak load. For the 12-4 pm peak period demand charge design, there are also differences in demand charge reductions by commercial building type, but these are less significant than for the non-coincident demand reductions, given the lower variability in load profiles during the 12-4 pm window.

Daily load variability and load factors can help a potential solar customer understand the general magnitude of demand charge savings, particularly if their load shapes do not conform to the general commercial customer types considered in this analysis. Our findings show that customers with higher load factors are more likely to have lower demand charge savings from solar as do customers with more variable daily peak loads.

Demand charge savings increase with PV system size, but with diminishing returns. In contrast to volumetric energy charges, demand charge savings do not scale directly in proportion to PV system size. For example, under a basic, non-coincident demand charge design, a school in Phoenix with a PV system sized to meet just 20% of its annual energy needs reduces demand charges by 16% in the median case, but if sized to meet 100% of its annual energy needs reduces demand charges by only 29%. This occurs for several reasons: larger systems push peak demand to later in the day; larger systems push peak demand to cloudy days; and, under peak period demand charge designs, demand charges in some months can be eliminated, in which case further increases in system size yield no additional savings. For the basic, non-coincident demand charge design, the degree to which there are diminishing returns with increasing PV system size depends on the commercial customer type. Restaurants, for example, quickly reach their maximum non-coincident demand charge reductions with relatively small PV systems, whereas demand charge reductions continue to increase with increasing PV system sizes for schools, as shown for Phoenix in Figure 3.

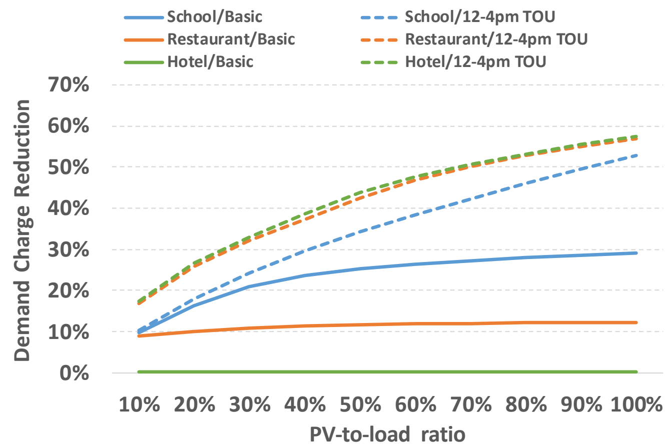


Figure 3. Demand charge reductions with increasing PV system size for the basic and the 12-4 pm peak demand charge designs for three commercial building types in Phoenix

Orienting PV panels westward yields, at most, only slight increases in demand charge savings. Southwest- and west-facing panels peak later in the day, coinciding better with load than flat or south-facing panels. The increase in the demand charge savings occur across commercial customer types and demand charge designs but are generally quite modest, as shown in Figure 4. For example, for a school in Phoenix, the average demand charge reduction under a 12-4 pm peak demand charge rises from 31% for a south-facing system to 34% for a southwest and west-facing system. The increase in the demand charge reduction moving from flat to southwest and west-facing PV panels is roughly similar across customer types and never more than a few percentage points.

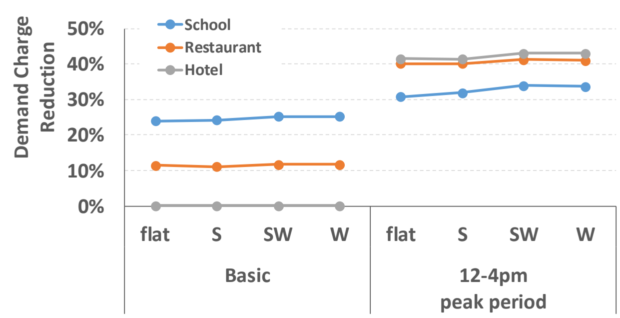


Figure 4. Change in demand charge reduction across PV panel orientations

Note: The figure shows the mean demand charge reductions for PV customers in Phoenix for a single PV system size kept constant for all orientations (50% PV-to-load ratio for a South facing system), to eliminate variability due to PV system size.

Conclusions

This analysis focuses on demand charge savings from solar for commercial customers. Previous work considered residential customers, and upcoming work will consider the synergies between PV and storage in reducing demand charges.

There are a few limitations in the methodology and scope of this work. First, it is based on 30-minute interval data, whereas existing demand charges are often based on 15-minute averaging intervals; as our results show, longer averaging intervals generally result in larger demand charge savings. Second, the simulated building loads used in this analysis do not capture all sources of variability in customer loads—e.g., variations in occupancy patterns or all possible variations in end-use equipment—nor do they account for possible load shifting behavior that might occur as a result of demand charges. Our analysis considers PV-to-load ratios up to 100% (i.e. PV systems that generate 100% of annual load), though available roof-space for many commercial buildings will tend to limit PV system size to much smaller PV-to-load ratios. Finally, although the analysis encompasses a wide variety of demand charge designs, not all possible demand charge rate structures are considered; for example, we did not evaluate tiered demand charge rates, or demand charges based on peak demand averaged over multiple days.

Notwithstanding the limitations above, the findings presented here support several conclusions, with implications for ongoing rate reform efforts:

- **The widespread use of demand charges for commercial customers may tend to direct solar deployment towards particular business types and likely constrains overall growth.** In particular, non-coincident demand charges could have a limiting effect on commercial deployment overall, given that most commercial customers can generally expect small demand charge reductions from PV systems. The customer economics of PV are the least attractive for commercial customers with zero demand charge reductions, such as hotels or apartment buildings. The higher demand charge reductions for other customer types are likely to direct commercial PV deployment to those, whether it be schools, offices, or other customers with late afternoon- or evening-peaking loads. Deployment patterns could be spread more evenly across commercial customer types with peak window demand charges, which tends to reduce differences in demand charge reductions among customer types.
- **Some demand charge designs are clearly better than others for commercial customers with solar.** Although a few customer types, such as schools or offices, can have more significant demand charge savings from solar under the basic, non-coincident demand charge design, *all* customers have higher demand charge savings from solar under other designs such as the 12-4 pm peak window demand charge design. Such demand charge designs make demand charge savings more predictable for commercial customers as the savings do not deviate as much from one customer type to the next. This also has implications for commercial customers who do not have regular load shapes from one month to the next, as afternoon peak demand charge designs lead to less variable demand charge savings.
- **Demand charges incentivize commercial customers to install smaller PV systems.** Our findings show that larger PV systems do not generate proportionally larger demand charge reductions, indicating diminishing returns to scale. This effect is starkest with the basic, non-coincident demand charge, but is also observed with peak window demand charge designs. This suggests that smaller PV systems can be more effective at reducing demand charges in terms of bill savings per kW of solar installed.

- **Demand charges may not always align well with utility cost savings from solar.** Demand charges are often advanced on the basis that they better align customer bills with cost causation. Although this study does not directly compare demand charge savings to utility cost savings, and therefore cannot comprehensively assess their alignment, the findings shown here suggest several specific situations where demand charges are not likely to correspond well to utility cost savings from commercial solar. First, given that the system-wide value of a PV system is largely constant regardless of its host building, the wide variation in demand charge reductions from solar suggests that demand charges may not be effective at communicating the capacity value of PV to commercial customers. Second, at the bulk power system level, solar is generally recognized to provide some capacity value; for example, for electric systems with relatively low overall solar penetration, solar may have a capacity credit of 30-70%. As the preceding results show, the demand charge capacity credit received by commercial solar customers under a basic, non-coincident demand charge design is generally much less than that amount, in most cases under 10% and in some cases zero. Demand charges that are intended to recover bulk power system capital costs would therefore tend to under-compensate solar customers for the utility cost savings they provide, at least at low system-level solar penetrations. Finally, as the results presented here show, demand charge savings from solar exhibit diminishing returns to scale. There is little economic rationale for this relationship: though utility cost savings would be expected to decline with overall bulk power system and distribution system penetrations of solar, that relationship would not be expected to hold for individual PV systems. Instead, to the extent that individual commercial rooftop solar provides capacity value to the utility, that value would be expected to scale with the size of the system, and a well-aligned compensation mechanism would mirror that structure.
- **In other scenarios demand charge savings from commercial solar may better align with utility cost savings.** With the basic, non-coincident demand charge design, alignment may be good for a *subset* of commercial customers with peak loads that correspond to the bulk power system or distribution system peak times, depending on which costs the demand charge is designed to recover. Alternatively, there would be good alignment for demand charges defined with a peak period that mirrors that of the bulk power system, if the demand charge is designed to recover costs at the bulk power system level, or that of the distribution system peak, if the demand charge is instead meant to recover distribution capacity costs.

For More Information

Download the full briefing, published in slide-deck form

Darghouth N., G. Barbose, A. Mills, R. Wiser, P. Gagnon, and L. Bird. 2017. *Exploring Demand Charge Savings from Commercial Solar*. Berkeley, CA: Lawrence Berkeley National Laboratory. https://emp.lbl.gov/publications/exploring-demand-charge-savings-0

Contact the authors

Naïm Darghouth: (510) 486-4570, ndargouth@lbl.gov
Galen Barbose: (510) 495-2593, glbarbose@lbl.gov

Sign up for our email list

https://emp.lbl.gov/join-our-mailing-list

Follow us on Twitter

@BerkeleyLabEMP

Acknowledgments

We thank Elaine Ulrich, Odette Mucha, Daniel Boff, and Ammar Qusaibaty of the U.S. Department of Energy's Solar Energy Technologies Office for their support of this work. We would like to thank members of our advisory group: Ryan Hledik (Brattle Group), Jim Lazar (Regulatory Assistance Project), Tom Stanton (National Regulatory Research Institute), Jeff Bailey (Duke Energy), Robert Levin (California Public Utilities Commission), James Sherwood (Rocky Mountain Institute), Chris Villareal (Minnesota Public Utilities Commission), and Casimir Bielski (Edison Electric Institute). Of course, the authors are solely responsible for any omissions or errors.

Disclaimer

For more information on the Electricity Markets & Policy Group, visit us at www.emp.lbl.gov
For all of our downloadable publications, visit http://emp.lbl.gov/reports

BERKELEY LAB Bringing Science Solutions to the World
ELECTRICITY MARKETS & POLICY GROUP
ENVIRONMENTAL ENERGY TECHNOLOGIES DIVISION

smith&boucher ENGINEERS
25501 W. Valley Parkway, Suite 200
Olathe, Kansas 66061
(913) 345-2127
Fax (913) 345-0617

Job # Gladstone

Date 9/19/17

Community Center Demand Reduction

System Size - 150 kW AC

annual production

270.8 MWh

Bldg baseline consumption

4,246 mWh

PV-to-Load Ratio

$$\frac{270.8}{4246} = 6\%$$

extrapolating for school/basic

Save 7% of bldg demand.

adjust for bldg type

School - 15%

Office/Retail - 9% - later peak in PM early evening.

$$\frac{9}{15}(7\%) = 4.2\%$$

Annual demand = 9741 kW

Saved $(0.042)(9741) = 409$ kW.

groundmount Gladstone Water Treatment Facility Solar, 913 NW 44th Terrace, Kansas City, MO 64116

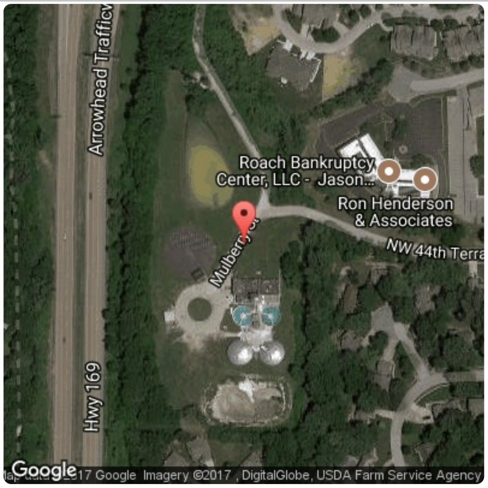
Report

Project Name	Gladstone Water Treatment Facility Solar
Project Address	913 NW 44th Terrace, Kansas City, MO 64116
Prepared By	Andrew Stancati astancati@biostarrenewables.com

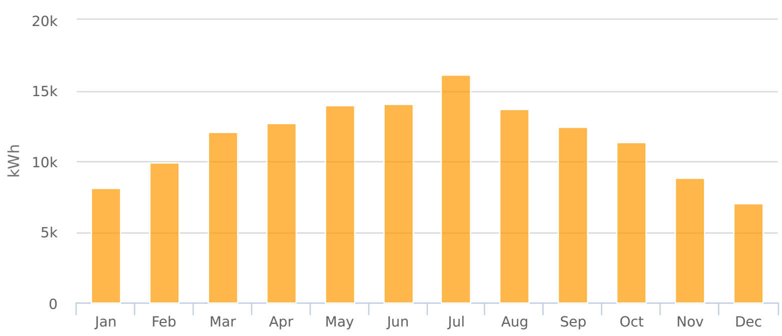
System Metrics

Design	groundmount
Module DC Nameplate	99.5 kW
Inverter AC Nameplate	72.0 kW Load Ratio: 1.38
Annual Production	140.2 MWh
Performance Ratio	79.8%
kWh/kWp	1,410.1
Weather Dataset	TMY, 10km grid (39.15,-94.55), NREL (prospector)
Simulator Version	88e2687ead-a0447e1bad-60a45df119-acaddf2c26

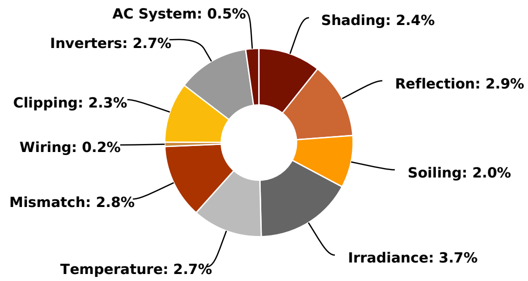
Project Location



Monthly Production



Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m²)	Annual Global Horizontal Irradiance	1,549.2	
	POA Irradiance	1,767.0	14.1%
	Shaded Irradiance	1,724.8	-2.4%
	Irradiance after Reflection	1,674.4	-2.9%
	Irradiance after Soiling	1,640.9	-2.0%
	Total Collector Irradiance	**1,640.9**	**0.0%**
Energy (kWh)	Nameplate	163,252.3	
	Output at Irradiance Levels	157,134.3	-3.7%
	Output at Cell Temperature Derate	152,923.8	-2.7%
	Output After Mismatch	148,592.1	-2.8%
	Optimal DC Output	148,342.3	-0.2%
	Constrained DC Output	144,924.9	-2.3%
	Inverter Output	140,943.0	-2.7%
	Energy to Grid	**140,238.0**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		15.0 °C
	Avg. Operating Cell Temp		23.0 °C
Simulation Metrics			
		Operating Hours	4659
		Solved Hours	4659

Condition Set

Description	Condition Set 1
Weather Dataset	TMY, 10km grid (39.15,-94.55), NREL (prospector)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model
Irradiation Variance	5%
Cell Temperature Spread	4° C
Module Binning Range	-2.5% to 2.5%
AC System Derate	0.50%

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.075	3°C
Flush Mount	-2.81	-0.0455	0°C

Soiling (%)

J	F	M	A	M	J	J	A	S	O	N	D
2	2	2	2	2	2	2	2	2	2	2	2

Module Characterizations

Module	Characterization
BVM6612P-325 (Boviet)	Default Characterization, PAN

Component Characterizations

Device	Characterization
CPS SCA 36KTL-DO (US) (Chint)	Manufacturer

City of Gladstone *Energy Performance Contract*

Components

Component	Name	Count
Inverters	CPS SCA 36KTL-DO (US) (Chint)	2 (72.0 kW)
Strings	10 AWG (Copper)	18 (1,686.9 ft)
Modules	Boviet, BVM6612P-325 (325W)	306 (99.5 kW)

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	16-19	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Fixed Tilt	Vertical (Portrait)	20°	180°	10.0 ft	2x1	153	306	99.5 kW

Detailed Layout

smith&boucher ENGINEERS
25501 W. Valley Parkway, Suite 200
Olathe, Kansas 66061
(913) 345-2127
Fax (913) 345-0617

Job # Gladstone
Date 9/19/17

Water Treatment Demand Reduction

System Size = 72 kw

annual production

140.2 mwh

Plant base line consumption

1015 mwh (wells not included)

PV - to - load ratio

$$\frac{140.2}{1015} = 13.8\%$$

From Figure. 3 in Berkeley Paper.

Save. 12% of demand.

adjust for bldg type

School - 15%

hosp. 6% - more of a 24 hr profile.

$$\left(\frac{6}{15}\right)(12\%) = 4.8\% \text{ Saved.}$$

annual demand = 2632

Saved. $(0.048)(2632) = 126$ kw.

ECM93 - Public Works Used Motor Oil-Fired Heater

12,271.29	therm baseline
11,752.09	therm adjusted baseline after weatherization
6,541	sf total area for PW
3618	sf shop area
6500.390916	therm baseline for shop area
800	gallon/year of oil available
125,000	Btu/gallon heating value
1,000	therms input available from oil
15%	amount of heating needs satisfied

ECM94 - Public Works Engine Block Heater Control

(Temperature Profile for NKC)

		Temperature	On	Off	Day/Night H	Runtime w/o Controller (hours)	Runtime w/ Controller (hours)	Runtime w/ Controllers and Scheduling (hours)		
November	Day	53.4	15%	85%	10.1	63.0	9.5	8.1	99.8	
	Night	36.1	60%	40%	13.9	177.0	106.2	91.7		
December	Day	41.9	15%	85%	9.5	45.0	6.8	5.8	116.5	
	Night	25.2	82%	18%	14.5	195.0	159.5	110.7		
January	Day	37.8	15%	85%	9.8	52.5	7.9	6.7	110.8	
	Night	20.7	85%	15%	14.3	187.5	159.4	104.1		
February	Day	44.1	15%	85%	10.8	82.5	12.4	10.6	80.6	
	Night	26.3	80%	20%	13.3	157.5	126.0	70.0		
March	Day	55.8	15%	85%	11.9	115.5	17.3	14.8	63.1	
	Night	36	67%	33%	12.2	124.5	83.0	48.3		
					Hours	1,200	688	471		
Assumptions:					Hours w/ SF	960	550	377		
Hours Off/Day:	8				# of Trucks	9	9	9		
# of Trucks:	9				Total Hours	8,640	4,953	3,390		
Safety Factor:	20.0%				Reduction in Hours from Baseline Per Heater	-	410	583		
Block Heater Power (kW):	1				Reduction in Hours from Baseline Total	-	3,687	5,250		
					Effective kWh	8,640	4,953	3,390	5,250	kWh Saved
					kWh for heaters per UA	18,396			61%	

ADDITIONAL INSULATION
ECM 95

The savings calculations for additional insulation (ECM 95) are included in the documentation located in **Schedule J (Equipment to be Installed by ESCO)** under the Insulation tab.

ECM 96 Water Treatment Plant - Reconfigure Metering

CITY OF GLADESTONE
PUMP LOG

Meter #1 Pumps 1,2,3
Meter #2 Pump 6
Meter #3 Pumps 4,5

Hours of Operation
WELLS

Large General Service Charges Effective after September 29 2015

Rates:		Summer	Winter
Facilities Charge		$3.272	
	Demand	$ 6.534	$ 3.516
Energy	1st 180 hrs	$0.09596	$0.08818
	Next 180	$0.06615	$0.05085
	Over 360	$0.04260	$0.03580

Medium General Service Charges Effective after September 29 2015

Rates:		Summer	Winter
Facilities Charge		$3.092	
	Demand	$ 4.045	$ 2.058
Energy	1st 180 hrs	$0.11057	$0.09136
	Next 180	$0.07232	$0.05468
	Over 360	$0.06099	$0.04586

Pump Rating 98 kW

Date	1	2	3	4	5	6	Pumps Running Meter #1	Pumps Running Meter #3	Pumps Running Meter #2
1/1/2015	18	18					2	0	0
1/2/2015	13	13					2	0	0
1/3/2015	15	15					2	0	0
1/4/2015	15	15					2	0	0
1/5/2015	15	15					2	0	0
1/6/2015	13	13					2	0	0
1/7/2015		13	13				2	0	0
1/8/2015		15	15				2	0	0
1/9/2015		15.5	15.5				2	0	0
1/10/2015		13	13				2	0	0
1/11/2015		15	15				2	0	0
1/12/2015		15.75	15.75				2	0	0
1/13/2015		15	15				2	0	0
1/14/2015		15		15			1	1	0
1/15/2015		15		15			1	1	0
1/16/2015		17		17			1	1	0
1/17/2015		15		15			1	1	0
1/18/2015		17		17			1	1	0
1/19/2015		15		15			1	1	0
1/20/2015		14.5		14.5			1	1	0
1/21/2015		7		7			1	1	0
1/22/2015		13		13			1	1	0
1/23/2015		13		13			1	1	0
1/24/2015		15		15			1	1	0
1/25/2015		13		13			1	1	0
1/26/2015		13		13			1	1	0
1/27/2015		13		13			1	1	0
1/28/2015		11				11	1	0	1
1/29/2015		15				15	1	0	1
1/30/2015		14.75				14.75	1	0	1
1/31/2015		15				15	1	0	1
2/1/2015		15				15	1	0	1
2/2/2015		15				15	1	0	1
2/3/2015		13				13	1	0	1
2/4/2015		13				13	1	0	1
2/5/2015		15				15	1	0	1
2/6/2015		15				15	1	0	1
2/7/2015		15				15	1	0	1
2/8/2015		17				17	1	0	1
2/9/2015		15				15	1	0	1
2/10/2015		15				15	1	0	1
2/11/2015				10		10	0	1	1
2/12/2015				17		17	0	1	1
2/13/2015				15		15	0	1	1
2/14/2015				17		17	0	1	1
2/15/2015				15		15	0	1	1
2/16/2015				15		15	0	1	1
2/17/2015				13		13	0	1	1
4/13/2017		11				11	1	0	1
4/14/2017		12.5				12.5	1	0	1
4/15/2017		15				15	1	0	1
4/16/2017		15				15	1	0	1
4/17/2017		9				9	1	0	1
4/18/2017		15				15	1	0	1
4/19/2017		16.5				16.5	1	0	1
4/20/2017	11	11					2	0	0
4/21/2017	13	13					2	0	0
4/22/2017	13	13					2	0	0
4/23/2017	11	11					2	0	0
4/24/2017	15	15					2	0	0
4/25/2017	15	15					2	0	0
4/26/2017	11	11					2	0	0
4/27/2017	13			13			1	1	0
4/28/2017	13			13			1	1	0
4/29/2017	10.5			10.5			1	1	0
4/30/2017	12.5			12.5			1	1	0
5/1/2017	10.5			10.5			1	1	0
5/2/2017	13			13			1	1	0
5/3/2017	9					9	1	0	1
5/4/2017	13					13	1	0	1
5/5/2017	15					15	1	0	1
5/6/2017	15					15	1	0	1
5/7/2017	16					16	1	0	1
5/8/2017	13					13	1	0	1
5/9/2017	15					15	1	0	1
5/10/2017	15					15	1	0	1
5/11/2017	13					13	1	0	1
5/12/2017	13					13	1	0	1
5/13/2017	17					17	1	0	1
5/14/2017	15					15	1	0	1
5/15/2017		17		17			1	1	0
5/16/2017		17		17			1	1	0
							2	1	1

Meter #1 LGSE

Date	Number of pumps running at one time	Actually total hours pumps ran	kWh expected	Max Demand	Billing Demand	Facilities Demand	Demand Charge	Facilities Charge	kWh/Dmd, hrs	Energy Charge	Dmd+Fac+Energy Charge
2/16/2015	1	352.25	34520.5	98	200	200	$ 703.20	$654.40	172.6025	$3,044.02	$4,401.62
4/16/2017	2	385.5	37779	196	200	200	$ 703.20	$654.40	188.895	$3,264.94	$4,622.54
5/16/2017	2	494	48412	196	200	200	$ 703.20	$654.40	242.06	$3,805.63	$5,163.23
									331.7		

Meter #2 MGSE

Date	Number of pumps running at one time	Actually total hours pumps ran	kWh expected	Max Demand	Billing Demand	Facilities Demand	Demand Charge	Facilities Charge	kWh/Dmd, hrs	Energy Charge	Dmd+Fac+Energy Charge
2/16/2015	1	292.75	28689.5	98	100	100	$ 205.80	$309.20	286.895	$2,228.98	$2,743.98
4/16/2017	1	129	12642	98	100	100	$ 205.80	$309.20	126.42	$1,154.97	$1,669.97
5/16/2017	1	209.5	20531	98	100	100	$ 205.80	$309.20	205.31	$1,782.88	$2,297.88
									322.4		

Meter #3 MGSE

Date	Number of pumps running at one time	Actually total hours pumps ran	kWh expected	Max Demand	Billing Demand	Facilities Demand	Demand Charge	Facilities Charge	kWh/Dmd, hrs	Energy Charge	Dmd+Fac+Energy Charge	Total of all 3 bills
2/16/2015	1	237.5	23275	98	100	100	$ 205.80	$309.20	232.75	$1,932.92	$2,447.92	$9,593.52
4/16/2017	1	233.5	22883	98	100	100	$ 205.80	$309.20	228.83	$1,911.48	$2,426.48	$8,719.00
5/16/2017	1	106.5	10437	98	100	100	$ 205.80	$309.20	104.37	$953.52	$1,468.52	$8,929.63

374.4 ıl from 1/17/15-5/16/17	$ 272,350.10
Total If Changed to all MGSE	$ 238,649.38
Amount Saved	$ 33,700.73
for most recent year	$123,059.11
	$ 107,977.87
Saved	$15,081.23
for 6/16/15 - 5/16/16	$114,405.11
	$ 100,111.82
saved	$14,293.28
average	$14,687.26

ECM 97 Water Treatment Resolve Billing Errors on Well Pump 1 Account

CITY OF GLADSTONE
PUMP LOG

Large General Service Charges Effective after September 29 2015

Rates:		Summer	Winter
Facilities Charge		$3.272	
Demand		$ 6.534	$ 3.516
Energy	1st 180 hrs	$0.09596	$0.08818
	Next 180	$0.06615	$0.05085
	Over 360	$0.04260	$0.03580

Pump Rating	98	kW
Min. Billing Demand	200	kW

Hours of Operation
WELLS

Date	1	2	3	4	5	6	Pumps Running
1/1/2015	18	18					2
1/2/2015	13	13					2
1/3/2015	15	15					2
1/4/2015	15	15					2
1/5/2015	15	15					2
1/6/2015	13	13					2
7/5/2015				13		13	0
7/6/2015				12.5		12.5	0
7/7/2015				12.5		12.5	0
7/8/2015				8.5		8.5	0
7/9/2015				14.5		14.5	0
7/10/2015				13		13	0
7/11/2015				11		11	0
7/12/2015				13		13	0
7/13/2015				13.5		13.5	0
7/14/2015				17		17	0
7/15/2015			12			12	1
7/16/2015			15			15	1
7/17/2015			17			17	1
7/18/2015			17			17	1
7/19/2015			13			13	1
7/20/2015			13			13	1
5/15/2017		17		17			1
5/16/2017		17		17			1
5/17/2017		17		17			1
5/18/2017		14		14			1
5/19/2017		14		14			1
5/20/2017		12.5		12.5			1
5/21/2017		12.5		12.5			1
5/22/2017		7		7			1
5/23/2017		13.5		13.5			1
5/24/2017		12		12			1
5/25/2017		14.5		14.5			1
5/26/2017	13		13				2
5/27/2017	14.5		14.5				2
5/28/2017	9		9				2
5/29/2017	13		13				2
5/30/2017	15		15				2
5/31/2017		13	13				2
6/1/2017							0
6/2/2017							0
6/3/2017							0
6/4/2017							0
6/5/2017							0
6/6/2017							0
6/7/2017							0
6/8/2017							0
6/9/2017							0
6/10/2017							0
6/11/2017							0
6/12/2017							0
6/13/2017							0
6/14/2017							0
6/15/2017							0
6/16/2017							0
6/17/2017							0

Billing Information

Date	Monthly Max. Demand	Billing Demand	Facilities Demand	kWh Used	Season	Demand Charge	Facilities Charge	kWh/Dmd, hrs	Energy Charge	Dmd+Fac+Energy Charge
7/17/2015	202	202	287	53920	Summer	$ 1,319.87	$939.06	266.9	$4,650.70	$ 6,909.63
5/17/2017	294.4	294.4	296	65120	Winter	$ 1,035.11	$968.51	221.2	$5,289.54	$ 7,293.17
6/17/2017						$ -	$0.00	#DIV/0!	#DIV/0!	#DIV/0!

Expected Billing based on # of Pumps running at rated kW (100% load factor)

Date	Max no of pumps running during period	Actually total hours pumps ran	kWh expected	Max Demand	Billing Demand	Facilities Demand	Demand Charge	Facilities Charge	kWh/Dmd, hrs	Energy Charge	Dmd+Fac+Energy Charge	Amount overcharge	kWh Used/kWh expected	Meter Multiplier/ kWh ratio
7/17/2015	2	221	21658	196	200	200	$ 1,306.80	$654.40	108.29	$2,505.84	$ 4,467.04	$ 2,442.59		
5/17/2017	2	487	47726	196	200	200	$ 703.20	$654.40	238.63	$5,165.92	$ 6,523.52	$ 769.64	1.3644554	58.63145

$ 11,219.26	June, 2016 - May, 2017	$ 934.94	per month
$ 5,397.43	July, 2015 - May, 2016	$ 490.68	per month
	Average	$ 712.81	per month
	Average	$ 8,553.69	per year

SCHEDULE N
STANDARDS OF COMFORT

The ESCO has not proposed or taken any energy savings for this project from the alteration of comfort levels within any space while it is being occupied.

The performance standards herein shall be established to provide sufficient and comfortable conditions for the facility consistent the energy management plan adopted by Customer under the energy savings performance contract. The Customer shall take due diligence to ensure that these standards are maintained.

A. Replacements of all major equipment have been sized to meet or exceed existing demand.

B. Energy savings at the buildings are calculated based upon the temperature set points, as shown below, in all spaces that are impacted by energy retrofit project. Variations from these set points will affect the energy consumption of the systems.

1. The occupied heating season set point will be 70°F.
2. The occupied cooling season set point will be 74°F.
3. The unoccupied heating season set point will be 60°F.
4. The unoccupied cooling season set point will be 85°F except for the Animal Shelter, which will have an unoccupied cooling season set point of 80°F.

C. Energy savings at the buildings are calculated based upon the operating schedule, as shown in Figure N.1, in all spaces that are impacted by energy retrofit project. Variations from these operating schedules will affect the energy consumption of the systems.

Figure N.1 Operating Schedule

Building	Mon through Fri	Weekends/Holiday
Community Center	5:00 am – 9:00 pm	7:00 am – 7:00 pm (Saturdays) 9:00 am – 6:00 pm (Sundays)
City Hall (First Floor)	6:00 am – 6:00 pm	4 hrs per day (Saturdays) Off (Sundays)
Public Safety (Ground Floor)[1]	17 hours per day (avg.)	12 hours per day (avg.)
Fire Station #1[2]	16 hours per day (avg.)	16 hours per day (avg.)
Fire Station #2[2]	16 hours per day (avg.)	16 hours per day (avg.)
Public Works	6:00 am – 6:00 pm	Off
Animal Shelter	12:00 pm – 5:00 pm	12:00 pm – 5:00 pm
Water Treatment	7:00 am – 8:00 pm	7:00 am – 8:00 pm
Atkins-Johnson Museum	11:00 am – 3:00 pm	off

[1] Based on setting 50% of zones at occupied set point 24/7 and remaining 50% of zones occupied 7:00 AM to 5:00 PM during weekdays only.
[2] Based on setting back 33% of zones (sleeping dorm) at occupied set point 24/7 and remaining 67% of zones occupied 7:00 AM to 10:00 PM.

SCHEDULE O
ESCO’S TRAINING RESPONSIBILITIES

ESCO’s training responsibilities have been defined in **Schedule J (Equipment to be Installed by ESCO)** of this Contract, those responsibilities are incorporated by reference as fully set forth herein.

SCHEDULE P
ESCO'S MAINTENANCE RESPONSIBILITIES

The ESCO has no maintenance or operation responsibilities under this Contract.

SCHEDULE Q
CUSTOMER'S MAINTENANCE RESPONSIBILITIES

The equipment has manufacturers' recommended periodic maintenance that must be performed by Customer as part of this Contract. The required maintenance will be described in the individual manufacturers' installation, operation, and maintenance manuals. ESCO will submit the installation, operation, and maintenance manuals prior to final completion and acceptance of work. The manuals will also contain equipment cut sheets, warranty information, and submittals for the major systems and components installed. Performance period responsibilities are identified in the Table Q.1.

Table Q.1 Performance Period Responsibilities

ECM Description	Performance Period Responsibilities		
	Operation	**Maintenance**	**Repair/Replacement**
Lighting Upgrades	Customer	Customer	Customer After Warranty
Building Automation System	Customer	Customer	Customer After Warranty
Weatherization	Customer	Customer	Customer After Warranty
Rooftop Units	Customer	Customer	Customer After Warranty
Pool Heating Boiler	Customer	Customer	Customer After Warranty

It is understood that Customer will perform the maintenance as required by manufacturers' documentation. ESCO will provide copies of installation, operation, & maintenance manuals as outlined in **Schedule J (Equipment to be Installed by ESCO)** for all equipment provided. These manuals will show all maintenance items or activities for the equipment provided as defined in **Schedule J (Equipment to be Installed by ESCO)** of this Contract.

If Customer does not perform the maintenance in accordance with the manufacturer's guidelines, the energy savings may be materially affected.

SCHEDULE R
FACILITY MAINTENANCE CHECKLIST

The maintenance requirements for major equipment will be provided within the operations and maintenance manuals upon completion of construction.

SCHEDULE S
ASSUMPTIONS

ESCO has based our proposal on the following general conditions, assumptions, exclusions and information:

A. **Vehicle Parking**: There will be a designated parking area for construction personnel at facility. Adjustments will be made as needed for loading and un-loading equipment.

B. **Construction Manager Office**: Customer has agreed to provide an office location for the onsite construction manager, which shall consist of a dedicated workspace.

C. **Location of Scope of Work**: The work for this project will be at the location as identified in **Schedule I (Description of Premises)** of this Contract.

D. **Pre-Notification Request for Access**: Each contractor, subcontractor, and/or vendor must agree to provide ESCO at least 48-hour notice prior to accessing the project for the first time.

E. **Valid Driver's License**: Any employee that will drive a company vehicle must have a current and valid driver's license, without any restrictions or suspension etc. It is the responsibility of the employer to keep up with the records of each of their employees.

F. **Restricted Equipment**: Customer-owned equipment will not be available for use for outside contractors.

G. **System Shut Down Schedule**: All power, utility, or system shutdowns need to be scheduled at least one week in advance.

H. **Contingency**: This contract includes contingency for unforeseen conditions, $170,000 in contingency has been budgeted and is carried by ESCO.

I. **Aggregate Liabilities**: In no event shall ESCO's aggregate liability for damages of any kind arising out of or in connection with this contract exceed the Contract Sum set forth in **Schedule E (Final Project Cost & Project Cash Flow Analysis)** of this Contract.

J. **Background Checks**: ESCO, and any subcontractors, suppliers, or lower level trades performing work for the ESCO at the Project site, shall perform background checks on all employees, and provide the Customer with an affidavit verifying and proving that all of its employees working on the Contract have passed all applicable criminal background checks required by the Customer before entering the Customer's premises.

K. **One-Time Repayment for Billing Overcharges**: Reimbursement for identified overcharges from KCPL on account for deep well pumps P-1, P-2, and P-3 have been finalized and agreed upon by KCPL at the time of contract signature. This one-time correction of $51,324 for the period from 2011 through September, 2017 has been included in the financials.

L. **The Risk, Responsibility, and Performance Matrix**: This matrix provides an overview of the allocation of responsibility for key items related to project performance.

RISK, RESPONSIBILITY AND PERFORMANCE MATRIX

	RESPONSIBILITY/DESCRIPTION	ESCO PROPOSED APPROACH
1.	Financial	
a.	Interest Rates: Neither ESCO nor Customer has significant control over prevailing interest rates. Higher interest rates will increase project cost, financing/project term, or both. The timing of the contract signing may impact the available interest rate and project cost.	Customer has chosen to finance the project and will pay entirely with this financing source. Finance rates have already been agreed to by Customer and Springsted.
b.	Construction Costs: ESCO is responsible for determining construction costs and defining a budget. ESCO has provided the design team to provide design services for the project. The design team has done the best they can, but have not identified all unforeseen circumstances.	We have determined the cost for construction and have competitively bid major scopes of work for fixed pricing. We will implement the scope of work in the contract under Schedule J (Equipment to be Installed by ESCO) for the price provided in the contract under Schedule E (Final Project Cost & Project Cash Flow Analysis). ESCO is carrying a contingency budget to support unforeseen circumstances.
c.	Energy Prices: Neither ESCO nor Customer have significant control over actual energy prices. For calculating savings, the value of the saved energy may either be constant, change at a fixed inflation rate, or float with the market conditions. If the value changes with the market, falling energy prices place ESCO at risk of failing to meet the cost savings guarantees. If energy prices rise, there is a small risk to Customer that energy savings goals might not be met while the financial goals are met.	For calculating savings, the value of the energy rates vary with market conditions. They will be escalated according to historical increases at one and one half percent (1.5%) annually or at actual market increases, whichever is greater.
d.	M&V Confidence: Customer assumes the responsibility to determine the confidence that it desires to have in the M&V program and energy savings determinations. The desired confidence will be reflected in the resources required for the M&V program, and ESCO must consider the requirement prior to submittal of the final proposal.	We will provide a verification process that includes a ninety percent (90%) guarantee. The guarantee will be based from the equipment end use measurements.
e.	Energy Related Cost Savings: Customer and ESCO may agree that the project will include savings from recurring and/or one-time costs. This may include one-time savings from avoided expenditures for projects that were appropriated but will no longer be necessary. Including one-time cost savings before the money has been appropriated may involve some risk to Customer. Recurring savings generally result from reduced utility and O&M expenses.	The savings identified for Customer cash flow are recurring. There is a one-time capital cost avoidance savings to replace equipment that is past its useful life that we have included in the contract. This amount has not been used in Customer internal cash flow discussions and analysis.
f.	Delays: Both ESCO and the Contractor can cause delays. Failure to implement a viable project in a timely manner costs Customer in the form of lost savings, and can add cost to the project (e.g., construction interest, re-mobilization).	We will work with Customer to implement the construction schedule as planned. It is in ESCO's and subcontractors best interest to finish the construction on schedule because of the cost of delay in cash flow and erosion of profits. We will work to address concerns and issues as they arise.
g.	Major Changes in Facility: Customer controls major changes in facility use, including closure, loss of funding or other major changes.	We will work with Customer to help identify concerns and issues with any major change. We will try to work with Customer to minimize its impact to their overall operation. In some cases, contract modifications may be necessary.
h.	Estimated Billing Error Corrections: Final agreement of errors and agreed-upon value of correction have not been determined with utility. Value in the cash flow pro forma is ESCO's calculated estimate. Owner is at risk that utility may not provide corrections for previous years.	Two cash flow pro forma are provide in the contract for the Customer to assess risk reward and to establish whether to include the reimbursement in the finances or not. The value of this risk is $51,324.

RESPONSIBILITY/DESCRIPTION		ESCO PROPOSED APPROACH
2.	Operational	
a.	Operating Hours: Customer generally has control over operating hours. Increases and decreases in operating hours can show up as increases or decreases in "savings" depending on the M&V method (e.g., operating hours multiplied by improved efficiency of equipment vs. whole-building/utility bill analysis). If the operating hours are stipulated, the baseline and proposed schedules should be carefully documented and agreed to by both parties.	Operating hours are up to Customer to determine what is needed to properly operate your facility and meet your business needs. As most of the savings are from equipment efficiency improvements we plan to verify the savings by measuring those efficiency improvements. Increased operating hours will increase your utility bills, but also increase the savings achieved from the efficiency improvement. The energy management system is the only upgrade that relies on reduced operating hours and those operating hours are included in Schedule N (Standards of Comfort) of this Contract.
b.	Load: Equipment loads can change over time. Customer generally has control over hours of operation, conditioned floor area, intensity of use (e.g., changes in occupancy, additions, or level of automation). Changes in load can show up as increases or decreases in "savings" depending on the M&V method. If the equipment loads are stipulated, the baseline should be carefully documented and agreed to by both parties.	The load of the systems measured will not change over the period of measurement. This is not a concern for the guarantee due to the method of verification. An increase in load may impact overall utility bills.
c.	Weather: A number of energy efficiency measures are affected by weather. Neither ESCO nor Customer has control over the weather.	End use measurements are not significantly affected by weather and that is one of the benefits of this type of verification for the guarantee. The monitoring of utility bills will be affected by weather and we expect to see some differences over multiple years of monitoring.
d.	User Participation: Many energy conservation measures require user participation to generate savings (e.g., control settings). The savings can be variable and ESCO may be unwilling to invest in these measures. If performance is stipulated, document and review assumptions carefully and consider M&V to confirm the capacity to save (e.g., confirm that the controls are functioning properly).	The energy management system is the upgrade most impacted by this. The Customer with direction and requirements set by ESCO's Energy Manager will manage the operation of this system to achieve savings. As part of the verification plan outlined in Schedule C (Savings Measurement and Verification Plan) of this Contract, we review the set points in this system to verify proper use and operation.
3.	Performance	
a.	Equipment Performance: ESCO has control over the selection of equipment and is responsible for its proper installation, commissioning, and performance. ESCO has responsibility to demonstrate that the new improvements meet expected performance levels including specified equipment capacity, standards of service, and efficiency.	We are responsible to make sure these systems are implemented properly and help make sure Customer knows how to maintain them. The commissioning and verification measurements will verify the equipment is performing as intended. The long-term performance will be affected by the proper maintenance.
b.	Operations: Performance of the day-to-day operations activities is negotiable and can impact performance. Clarify responsibility for operations and implication of equipment control.	Customer will be responsible for proper operation of the installed systems. The long-term performance will be affected by the proper operation.
c.	Preventive Maintenance: Performance of day-to-day maintenance activities is negotiable and can impact performance. Clarify responsibility for maintenance and its implications.	Customer will be responsible for proper maintenance of the installed systems as set forth in the Schedules. The long-term performance will be affected by the proper maintenance.
d.	Equipment Repair and Replacement: Performance of day-to-day repair and replacement of ESCO-installed equipment is negotiable; however it often affects project performance.	Replacement of failed components will be handled by ESCO for the first year, the Manufacturer will be responsible for any extended warranties, and then the responsibility will be Customers.

FELONY CONVICTION NOTIFICATION

The person or business entity that enters into an agreement with CUSTOMER NAME must give advance notice to the CITY OF GLADSTONE if the person or an owner or operator of the business entity has been convicted of a felony. The notice must include a general description of the conduct resulting in the conviction of a felony.

The CITY OF GLADSTONE may terminate this agreement with a person or business entity if the CITY OF GLADSTONE determines that the person or business entity failed to give notice by the next preceding subsection, or misrepresented the conduct resulting in the conviction.

By submitting this offer and signing this certificate, the firm submitting this proposal:

- Certifies that the owner/operator has not been convicted of a felony, except as indicated on a separate attachment to this offer, and

- Certifies that no employee who will enter city buildings or potentially have contact with patrons has been convicted of any felony or a misdemeanor involving violence or sexual contact or sexual abuse. It shall be the duty of the vendor to conduct the appropriate background checks on its employees and vendor agrees to share this information with the CITY OF GLADSTONE upon request.

Vendor Name: ____

Vendor Address: ____

Vendor E-mail Address: ____

Vendor Telephone: ______________________________ Fax Number: ___________________________

Authorized Company Official's Name: ____
(Printed)

Signature of Company Official: ____

Date: ___________________________________

FEDERAL WORK AUTHORIZATION PROGRAM AFFIDAVIT

I, ______________________________, being of legal age and having been duly sworn upon my oath, state the following facts are true:

1. I am more than twenty-one years of age; and have first-hand knowledge of the matters set forth herein.

2. I am employed by ___________________________________ (hereinafter "Company") and have authority to issue this affidavit on its behalf.

3. Company is enrolled in and participating in the United States E-Verify federal work authorization program with respect to Company's employees working in connection with the services Company is providing to, or will provide to, the CITY OF GLADSTONE, to the extent allowed by E-Verify.

4. Company does not knowingly employ any person who is an unauthorized alien in connection with the services the Company is providing to, or will provide to, the CITY OF GLADSTONE.

FURTHER AFFIANT SAYETH NOT.

By: ____
(Individual Signature)

Title: ____

For ____
(Company Name)

Subscribed and sworn to before me on this _________ day of __________________, 20___.

Notary Public:____

My commission expires: _____________________

SCHEDULE T
DETAILED POLLUTION CREDIT CALCULATIONS

The emission reductions produced from implementing this project are equivalent to saving:

- 7,100,990 Total Pounds of CO2 Reduction (Carbon Dioxide)
- -56.4 Total Pounds of CH4 Reduction (Methane)
- 108.2 Total Pounds of N2O Reduction (Nitrous Oxide)
- 21,788 Total Pounds of SO2 Reduction (Sulfur Dioxide)
- 5,723 Total Pounds of NOx Reduction (Nitrogen Oxide)
- -197.9 Total Ounces of PM10 Reduction (Particles of 10 micrometers or less)
- -574.7 Total Ounces of VOC Reduction (Volatile Organic Compounds)
- -8,768.9 Total Ounces of CO Reduction (Carbon Monoxide)

This is equivalent to:

- Removing 618.7 cars from the road each year
- Conserving 363,967 gallons of gasoline each year
- Conserving 43.2 tanker trucks of gasoline each year
- Conserving 6,827 barrels of oil each year
- Conserving 420.2 households worth of electricity each year
- Allowing 74,420 tree seedlings to grow for 10 years each year
- Preserving 23.9 acres of forest from deforestation
- Conserving 14.9 railcars of coal each year
- Recycling 1,089 tons of waste rather than landfilling each year
- Conserving 59,919 propane cylinders used for home barbeques each year

SCHEDULE U
DISPUTE RESOLUTION

A. Claims and Disputes

1. Definition

   A claim is a demand or assertion by one of the parties seeking, as a matter of right, adjustment, or interpretation of contract terms, payment of money, and extension of time, or other relief with respect to the terms of the contract or other disputes arising out of or relating to the Contract. Claims must be initiated by written notice. The responsibility to substantiate claims shall rest with the party making the claim.

2. Time Limits on Claims

   Claims by either party must be initiated within fourteen (14) days after occurrence of the event giving rise to such claim or within fourteen (14) days after the claimant first recognizes the condition giving rise to the claim, whichever is later. Claims must be initiated by written notice to the other party.

3. Claims for Concealed or Unknown Conditions

   If conditions are encountered at the site that are:

   a. subsurface or otherwise concealed physical conditions which differ materially from those indicated in the Scopes of Work outlined in **Schedule J (Equipment to be Installed by ESCO)** or

   b. unknown physical conditions of an unusual nature, which differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the scopes of work,

   then notice by the party seeking adjustment shall be reasonably given to the other party promptly before conditions are disturbed and in no event later than ten (10) days after first observance of the conditions. The Customer will promptly investigate such conditions and, if they differ materially and cause a reasonable increase or decrease in the ESCO's cost of, or time required for, performance of any part of the work, will make an equitable adjustment in the contract sum or contract time, or both. If the Customer determines that the conditions at the site are not materially different from those indicated in the scopes of work outlined in **Schedule J (Equipment to be Installed by ESCO)** and that no change in the terms of the contract is justified, the Customer shall so notify the ESCO in writing, stating the reasons. Claims by the ESCO in opposition to such determination must be made within twenty-one (21) days after the Customer has given notice of the decision. If the conditions encountered are materially different, the contract sum and contract time shall be equitably adjusted.

4. Claims for Additional Cost

   If the ESCO wishes to make claim for an increase in the contract sum, written notice as provided herein shall be given before proceeding to execute the work. ESCO will not proceed with any work subject to the claim for additional cost without first receiving written approval from

Customer to proceed with said work. Prior notice is not required for claims relating to an emergency endangering life or property.

5. Reasonable Cost

   If the ESCO believes additional cost is involved for reasons including but not limited to:

   a. a written interpretation from the Customer,

   b. an order by the Customer to stop the Work where the ESCO was not at fault,

   c. a written order for a minor change in the Work issued by the Customer,

   d. failure of payment by the Customer,

   e. termination of the Contract by the Customer,

   f. Customer's suspension or

   g. other reasonable grounds,

   Claim shall be filed in accordance with this Section.

6. Claims for Additional Time

   If the ESCO wishes to make claim for an increase in the contract time, written notice as provided herein shall be given. The ESCO's claim shall include an estimate of cost and of probable effect of delay on progress of the work. In the case of a continuing delay only one (1) claim is necessary.

   If adverse weather conditions are the basis for a claim for additional time, such claim shall be documented by data substantiating that weather conditions were abnormal for the period of time; could not have been reasonably anticipated; and had an adverse effect on the scheduled construction.

   ESCO shall not commence with any such work without first obtaining written approval from the Customer.

7. Indemnity and Defense

   ESCO shall also indemnify Customer to the fullest extent permitted by laws and regulations, ESCO shall indemnify, defend, and hold harmless Customer, and the board members, officers, directors, partners, employees, agents, consultants of each and any of them from and against all claims, costs, losses and damages (including but not limited to all fees and charges of engineers, architects, attorneys and other professionals in all courts or other dispute resolution costs) arising out of or relating to the performance of the work or in any way related to or arising out of this Contract and Contract Schedules, provided that any such claim , cost, loss or damage is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property, including the loss of use resulting therefrom but only to the extent caused by any act or omission of ESCO, any Sub-Contractor of ESCO, any supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the work or anyone for whose acts any of them may be liable. ESCO will indemnify, defend, and hold customer harmless for any procurement issues associated with the Contract and the Contract Schedules. ESCO guarantees and warrants that

a. the Work constitutes the acquisition or installation of "energy cost savings measures" as defined in Sections 8.231 et seq. of the Revised Statutes of Missouri, as amended (collectively herein the "Act"),

b. this Energy Contract is a "guaranteed energy cost savings contract" as defined in the Act,

c. the Work constitutes an "energy conservation measure" as referenced in Section 165.011.4 of the Revised Statutes of Missouri, and

d. ESCO is a "qualified provider" of energy cost savings measures, as defined by the Act.

ESCO agrees to indemnify, defend, and hold the Customer harmless for any delays, costs, or liability associated with any violation of 8.231, et seq. RSMo, or determination by a court or governmental body that the Contract or ESCO do not meet the aforementioned definitions as guaranteed by ESCO.

No provisions of this Article, or any other provision of this Contract, shall be construed as a waiver of Customer's sovereign immunity.

8. Claims for Consequential Damages

The ESCO and Customer waive claims against each other for consequential damages arising out of or relating to this contract. This mutual waiver includes damages incurred by either party for principal office expenses including the compensation of personnel stationed there, for losses of financing, business, and reputation, and for loss of profit except anticipated profit arising directly from the work. This mutual waiver is applicable, without limitation, to all consequential damages due to either party's termination.

9. Equitable Adjustment

If the enactment or revision of codes, laws or regulations or official interpretations which govern the project cause an increase or decrease of the ESCO's cost of, or time required for, performance of the work, the ESCO shall be entitled to an equitable adjustment in contract sum or contract time. If the Customer and ESCO cannot agree upon an adjustment in the contract sum or contract time, the ESCO shall submit a claim pursuant to this Section.

B. Resolution of Claims and Disputes

1. Decision by Customer

An initial decision by the Customer shall be required as a condition precedent to mediation of all claims between the Customer and ESCO arising prior to the date final payment is due, unless thirty (30) days have passed after the claim has been referred to the Customer with no decision having been rendered by the Customer.

2. Reasons

The initial decision shall be in writing, shall generally state the reasons therefore, and shall notify the parties of any change in the contract sum or contract time or both. The initial decision shall be final and binding on the parties but subject first to mediation and thereafter to such other dispute resolution methods as provided in Section 21 of the contract.

3. Surety Notification

In the event of a claim against the ESCO, the Customer may, but is not obligated to, notify the surety, if any, of the nature and amount of the claim. If the claim relates to a possibility of an ESCO's default, the Customer may, but is not obligated to, notify the surety and request the surety's assistance in resolving the controversy.

4. Mechanic's Lien

If a claim relates to or is the subject of a mechanic's lien, the party asserting such claim may proceed in accordance with applicable law to comply with the lien notice or filing deadlines prior to initial resolution of the claim.

C. Mediation

1. Claims to Mediation

Any claim arising out of or related to the contract shall, after initial decision of the claim or thirty (30) days after submission of the claim for initial decision, be subject to mediation as a condition precedent to the institution of legal or equitable or other binding dispute resolution proceedings by either party.

2. Requests for Mediation

The parties shall endeavor to resolve their claims by mediation which, unless the parties mutually agree otherwise, shall be in accordance with the construction industry mediation rules of the American Arbitration Association currently in effect at the time of the mediation. Request for mediation shall be filed in writing with the other party to the contract and with the American Arbitration Association, or an individual mediator unaffiliated with the American Arbitration Association.

3. Mediator's Fee

The parties shall share the mediator's fee and any filing fees equally. The mediation shall be held in the place where the project is located, unless another location is mutually agreed upon. Agreements reached in mediation shall be enforceable as settlement agreements in any court having jurisdiction thereof.

4. Litigation

If disputes are not resolved through the initial decision or mediation efforts, the parties agree to that the resolution of any remaining issues will be litigated in the Circuit Court of Clay County, Missouri. This Contract and the construction and enforceability thereof shall be interpreted under the laws of the State of Missouri. Customer and ESCO agree that any dispute, including any and all disputes arising from, out of, or related to this agreement, shall be resolved in the Circuit Court of Clay County, Missouri, and each party consents to the exclusive in personam jurisdiction and exclusive venue of that Court.

EXHIBIT I
PERFORMANCE BOND

This sheet serves as the placeholder where the Performance Bond for the construction portion of the project only shall be placed in the executed agreement.

Within ten (10) days of executing Contract, ESCO will provide Customer a performance bond and statutory/public works payment bond, each in the sum of 100% of the cost of construction. The guarantees extended via these bonds are limited to ESCO's construction obligations only, and to a one (1) year warranty against defective materials and workmanship on the construction work performed. These bonds specifically exclude any guarantee of the performance or payment obligations of those sections of the contract related to extended maintenance services, annual reviews and/or guaranteed energy savings.

The parties agree that upon final completion of the construction portion of this Contract that the bond shall be surrendered.

EXHIBIT II
LABOR AND MATERIAL PAYMENT BOND

This sheet serves as the placeholder where the Labor and Material Payment Bond, for the construction portion of the project only, shall be placed in the executed Contract. The parties agree that upon final completion of the construction portion of this agreement that the Bond shall be surrendered.

EXHIBIT III(i)
CERTIFICATE OF ACCEPTANCE – INVESTMENT GRADE AUDIT

PROJECT NO. ______________________________

PROJECT TITLE City of Gladstone

CUSTOMER City of Gladstone

LOCATION Gladstone, Missouri

ESCO Navitas, LLC.

This is to certify that the **Investment Grade Audit** of the premises including all energy conservation measures agreed upon by the parties, and is hereby incorporated by reference as fully set forth herein. Signature below indicates that the **Investment Grade Audit** has been approved and accepted by Customer in accordance with the terms and conditions outlined within the **Investment Grade Audit Agreement**.

NAVITAS, LLC
(ESCO)

________________	________________	________________
Name	Title	Date

CITY OF GLADSTONE
(Customer)

________________	________________	________________
Name	Title	Date

EXHIBIT III(ii)
CERTIFICATE OF ACCEPTANCE – INSTALLED EQUIPMENT

Facility	Scope Description	Warranty Start Dates	ESCO Initials	Customer Initials

The undersigned Customer having entered into an energy performance contract dated _______________________, with the ESCO, does hereby certify that the scope of work listed above has been substantially completed as defined in this agreement on the date shown below for substantial completion acceptance. Please note that the commencement of the equipment warranty will adhere to the dates initialed in the table above.

The Customer also acknowledges that the energy conservation measures have been designed to perform according to the operating schedules and set points agreed upon and defined in **Schedule N (Standards of Comfort)** of this Contract. A final punch list is hereby attached, with fulfillment of this punch list a requirement for acceptance of final completion.

Equipment is of a size, design, capacity and manufacturer as submitted to Customer by the ESCO and its authorized agents and representatives, is in good condition and has been satisfactorily delivered and installed;

SUBSTANTIAL COMPLETION ACCEPTANCE

CITY OF GLADSTONE	NAVITAS, LLC
Signed: ________________________________	Signed: _______________________________________
Name: ________________________________	Name: _______________________________________
Title: ________________________________	Title: _______________________________________
Date: ________________________________	Date: _______________________________________

EXHIBIT III(iii)
CERTIFICATE OF PROJECT COMPLETION

PROJECT NO. ____

PROJECT TITLE ____

CUSTOMER ____

LOCATION ____

ESCO ____

This is to certify that a final inspection of the above Project has been conducted jointly by the ESCO and Customer's designated inspector, and that the parties have determined that the project has been fully completed in accordance with the Contract documents as of ______________________.

All guarantees and warranties that have not commenced by the date on the certificate of partial occupancy, if applicable, shall commence as of the above completion date.

The Customer accepts the project as being fully completed and assumes the responsibility for maintenance, custodial care, and utilities for the premises.

The ESCO remains responsible to correct errors and omissions discovered subsequent to the execution of this document and to respond to claims made under applicable warranties.

NAVITAS, LLC
(ESCO)

______________________	______________________	____________
Name	Title	Date

CITY OF GLADSTONE
(Customer)

______________________	______________________	____________
Name	Title	Date

EXHIBIT IV
EQUIPMENT WARRANTIES

A. General Note.

ESCO will provide a one-year warranty through the equipment manufacturer for all equipment listed in **Schedule J (Equipment to be Installed by ESCO)** of this Contract. The warranty period of one-year (1 year) starts after substantial completion of the energy conservation measures and beneficial use by Customer is achieved on an energy conservation measure by energy conservation measure basis. Notwithstanding any other provisions of the Contract to the contrary, after the one-year period is complete, Customer will assume all warranty responsibilities for the extended warranty term and will be guided as described below. The one-year warranty does not include any maintenance or repair outside of the warranty scope.

B. Detailed Listing of Equipment.

As part of the project closeout documents, ESCO will provide a detailed listing of the equipment installed and its associated warranty or extended warranty if applicable. This information will also include the manufacturer's warranty start and end dates for each piece of equipment.

C. Lighting Warranty.

Lighting warranty is fulfilled by ESCO providing spare components to Customer at substantial completion of that scope. Customer shall be responsible for replacing failed parts using these replacement parts. Customer shall ship failed parts to the appropriate local parts distributor. The distributor will provide replacement parts. No failed parts of the lighting scope have a warranty labor allowance associated with them.

D. One-Year Warranty.

ESCO shall provide coordination for the fulfillment of the one-year warranty only.

E. Warranty Matrix.

ECM Description	Standard Warranty	Extended Warranty
Interior lighting upgrades	1 year parts and labor	5 years on lighting fixtures
Exterior lighting upgrades	1 year parts and labor	5 years on LED fixtures
Water fixtures	1 year parts and labor	N/A
Building automation system	1 year parts and labor	N/A
Weatherization	1 year parts and labor	N/A
Makeup Air Units	1 year parts and labor	N/A
Trane Rooftop units	1 year parts and labor	5 year parts and labor on entire units; 10 year parts warranty on heat exchanger
MAU/EF	1 year parts and labor	N/A
Non-Trane Rooftop units (Multi-zone rooftop unit)	1 year parts and labor	5 year parts on compressor and heat exchanger

F. Manufacturer's Warranties.

ESCO agrees to provide, assign, and deliver all manufacturer's warranties to Customer in the closeout documents