Solebury Township HVAC System Assessment

Solebury Township Building
3092 Sugan Road
Solebury, PA 18963

Prepared For:
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INTRODUCTION

BSEG, LLC has been commissioned by Solebury Township to review the existing HVAC system serving the township building at 3092 Sugan Road, Solebury, PA. The purpose of the review is to determine the condition of the existing system, identify opportunities to improve the existing system, and introduce alternative systems. The main portion of the building is the focus of this report. There is an addition to the main building with an HVAC system consisting of split-system air conditioners with gas furnaces, that will be excluded from this study. The following report is the result of our assessment and recommendations. Our review of the existing building system is based on observations made during our site visit on May 11, 2022. Our site visit consisted of a visual observation of the building and as such not all components and conditions may have been observed. Please note no testing or sampling was performed.

EXISTING HVAC SYSTEM

The HVAC system serving the main building is a 4-pipe fan coil unit (FCU) system. The 4-pipe FCU system is comprised of a chilled water system and a hot water system. The ventilation needs for the building are aided by three energy recovery ventilators (ERVs), which precondition the outside air being delivered to the return side of the FCUs that serve high-occupancy spaces.

Chilled Water System

The chilled water system consists of a 40-ton air-cooled chiller with scroll compressors and two integral variable speed chilled water pumps. The chiller has been replaced recently, and the replacement chiller was manufactured by Trane in 2021. At the time of the site visit, the chiller was not operating properly, and the township was awaiting HVAC technicians to repair it.

Air-Cooled Chiller

Hot Water System

The hot water system is comprised of gas-fired boiler and two constant speed hot water pumps. The boiler was manufactured by Lochnivar in 2014 and has an output capacity 653,000 btu/hr. The two hot water system pumps were manufactured by Bell and Gossett, one of which appeared to be a replacement as it was manufactured in 2020. The other pump's serial number was unreadable, and it is assumed that it was manufactured around 2004. The boiler also has a circulation pump, manufactured by Grundfos. A serial number could not be located for this pump, but it appeared to be in good condition.

Hot Water Boiler **Hot Water System Pumps**

Fan Coil Units

The chilled and hot water piping networks feed the cooling and hot water coils of the 4-pipe FCUs. There are 18 ducted FCUs that provide conditioned air to the building. The FCUs were manufactured around 2004. The condition of the FCUs varied depending on their location – some appeared to be in good condition, but some that were located above ceilings or in an attic space near a window are in poor condition. Based on our observation and the existing MEP drawings from when the system was designed in 2004, all the chilled and hot water valves associated with these coils are two-way valves. There are two locations (one in each mechanical attic area) at which there are differential pressure bypasses in the chilled and hot water systems that diverts the chilled and hot water supply back to the return side during non-peak cooling/heating conditions.

Fan Coil Unit FC-15

Ventilation

Outside air ductwork is connected to the return air ductwork for each of the eighteen FCUs. Motorized dampers are installed so the outside air is only introduced to the system when the FCUs are operating. For 12 of the 18 FCUs, the outside air is brought directly from louvers on the exterior of the building. For the other six FCUs, those that serve high-occupancy spaces such as the township meeting room, main lobby, and conference rooms, the outside air is preconditioned by three ERVs. The two larger ERVs located in the attic spaces were manufactured by Greenheck in 2005, while the smaller ERV located in the ground floor water service room was manufactured by Lennox around 2005. The ERVs are also utilized to exhaust various bathrooms and other spaces that require to be exhausted in the building.

Energy Recovery Ventilator ERV-2

Existing System Recommendations and Opinion Of Probable Construction Cost

Based on the observations made during the site visit, the review of the 2004 HVAC design drawings, and the cooling and heating load calculations performed by BSEG, the following upgrades and revisions to the existing HVAC are recommended:

- There are various pieces of equipment that exceed or are approaching their estimated life expectancy. The township should start accounting as such for the replacement of the following:

  - Fan coil units – The American Society of Heating, Refrigeration, and Air-conditioning Engineers (ASHRAE) estimates the life expectancy of fan coil units to be 20 years. The FCUs serving the township building are approximately 18 years old.

  - Hot water system pump – ASHRAE estimates the life expectancy of base-mounted pumps to be 20 years. One of the hot water system pumps is assumed to be 18 years old.

  - Energy Recovery Ventilators – ASHRAE estimates the life expectancy of ERVs to be 20 years. The ERVs serving the township building are 17 years old.

- According to the 2004 HVAC design drawings, the amount of outside air being introduced to the majority of the FCUs far exceeds the code requirements. It appears the FCUs were sized to accommodate the additional load associated with a higher percentage of outside air. FCUs are typically only meant to accommodate 15-20% outside air as a percentage of total supply air. Whereas many of the installed FCUs were designed with as much as 35% outside air. It is assumed that the system was balanced to the design. As testing was beyond the scope of the study, we could not verify if that was the case.

  Since FCUs are not intended to handle such a high percentage of outside air, the resultant may be elevated humidity conditions. Furthermore, as the FCUs' coils become fouled up over time, their performance will degrade. As such the heat transfer characteristics may be impacted, and this may further dimension the ability of the units to remove moisture. Hence the noted indoor environment comfort issues such as excessive humidity are a likely result of this.

  Furthermore, though providing a higher percentage of outside air may result in better indoor air quality, it also leads to higher energy usage on both the cooling and heating systems. By decreasing the amount of outside air to code minimums, the replacement FCUs and ERVs may be selected for a lower capacity, when compared to their existing counterparts. To further reduce the required capacity of FCUs serving the high-occupancy spaces and better control building humidity, the replacement ERVs can be provided with heating/cooling coils, so the outside air introduced to these FCUs is fully conditioned.

- According the 2004 HVAC design drawings, the pumps were originally designed to be constant speed. Though some of the pumps have since been replaced with those that have the capability to be variable speed, the chilled and hot water systems are not designed to accommodate variable speed operation. It is recommended that variable frequency drives

(VFDs) be provided for the hot water pumps. The differential pressure sensors in the system can be interlocked with these VFDs and the VFDs installed on the chiller pumps so that the pumps operate at a lower speed during non-peak load conditions. This is more efficient than the pumps turning on and off to meet the loads of the systems.

- The insulation on the chilled and hot water piping was observed to be in poor condition in various areas of the building. There were also instances in which the insulation was not continuous or where a different type of insulation was provided. This was especially apparent on the valves throughout the chilled and hot water piping systems. It is recommended that the insulation be repaired as necessary and new insulation be provided so that continuity is maintained throughout the piping systems.

Insulation on Chilled and Hot Water Valves

The below is a breakdown of an opinion of probable construction cost for the upgrade of these systems:

Item	Quantity	**Probable Cost** (Material and Labor)	Total
FAN COIL UNIT	18	$3,800	$68,400
ENERGY RECOVERY VENTILATOR W/ COOLING AND HEATING	3	$13,000	$39,000
3 HP HOT WATER END SUCTION PUMP	1	$15,000	$15,000
3 HP VARIABLE FREQUENCY DRIVE	2	$3,000	$6,000
HYDRONIC PIPE INSULATION	LS	$5,000	$5,000
MISCELLANEOUS DUCTWORK	LS	$5,000	$5,000
DEMOLITION	LS	$10,000	$10,000
MISCELLANEOUS ARCHITECTURAL	LS	$1,000	$1,000
CONTROLS	LS	$8,000	$8,000
BALANCING	LS	$10,000	$10,000
MISCELLANEOUS ELECTRICAL	LS	$5,000	$5,000
SUBTOTAL			$172,400
Contingency	25%		$43,100
SUBTOTAL			$215,500
General Conditions	10%		$21,550
Overhead & Profit	15%		$32,325
TOTAL			**$269,375**

HVAC System Alternatives

A 4-pipe chilled/hot water HVAC system is an appropriate and efficient way of conditioning a building of this size and usage. Typically, the cost prohibitors for this type of system are the chiller, boiler and piping network. Since the boiler and chiller are relatively new, those infrastructure costs are already borne. Nevertheless, if alternate system, which are efficient to operate and capable of handling the building loads are to be pursued, Variable Refrigerant Flow (VRF) system and a ground-source heat pump system are two feasible systems. The installation of either of these systems would involve the complete removal of the existing system.

Variable Refrigerant Flow

VRF systems are comprised of large condensing units located outside that are tied to multiple indoor units with a fan and direct expansion (DX) coil. The indoor units are offered in various styles such ducted air-handler, slim-ducted, ceiling cassette, and wall-mounted ductless. The condensing units are interconnected to the indoor units via refrigerant piping and branch controllers, which utilize heat recovery such that indoor units can either be in cooling or heating mode simultaneously. This system is entirely electric and would only be feasible if the reductions to the outside air percentages are implemented. It is estimated that a 26-ton VRF condensing unit would be required, tied to 18-20 indoor units.

The below is a breakdown of an opinion of probable construction cost for the replacement of the existing system with a VRF system:

Item	**Quantity**	**Probable Cost** (Material and Labor)	**Total**
13-ton VRF CONDENSING UNIT	2	$50,000	$100,000
INDOOR VRF FAN COIL UNIT	20	$3,500	$70,000
VRF SYSTEM BRANCH CONTROLLER	3	$2,000	$6,000
VRF SYSTEM REFRIGERANT PIPING	LS	$10,000	$10,000
ENERGY RECOVERY VENTILATOR WITH HEATING/COOLING	3	$20,000	$60,000
MISCELLANEOUS	LS	$10,000	$10,000
DEMOLITION	LS	$50,000	$50,000
MISCELLANEOUS ARCHITECTURAL	LS	$10,000	$10,000
CONTROLS	LS	$10,000	$10,000
BALANCING	LS	$10,000	$10,000
MISCELLANEOUS ELECTRICAL	LS	$15,000	$15,000
SUBTOTAL			$351,000
Contingency	25%		$87,750
SUBTOTAL			$438,750
General Conditions	10%		$43,875
Overhead & Profit	15%		$65,813
TOTAL			**$548,438**

Ground Source (Geothermal) Heat Pump

A ground source, or geothermal, heat pump system is comprised of geothermal wells, water-source heat pumps, and interconnecting ground water piping and pumps. The water source heat pumps would be ducted units located inside the building, similar to the existing FCUs. However, they will be larger than the FCUs because they utilize an integral refrigerant loop with a compressor. Given the limited space above the ceilings where many of the FCUs are located, finding sufficient space to install the water-source heat pumps may prove to be challenging. The refrigerant in the water source heat pumps rejects or absorbs heat from the ground water loop, which is connected to a series of wells. In order to determine the well depth a geothermal thermal test will be required. Nevertheless, assuming conditions are good the wells will be roughly 400-500 feet deep and are utilized as a heat sink for the water loop during the summer and a heat source during the winter. This system is very efficient with a low operating cost but has a high initial cost. For the township building, it is anticipated that approximately fifteen wells would be required, with each well being spaced about 20 feet apart. Therefore, approximately 3000 square feet of land would be required to accommodate the wells. It will also need to be determined if the ground around the township building is conducive to the drilling of the wells.

The below is a breakdown of an opinion of probable construction cost for the replacement of the existing system with a geothermal system. This cost does not include the cost of the wells, and assumes that the indoor heat pumps can be installed in locations similar to the current FCU locations:

Item	**Quantity**	**Probable Cost** (Material and Labor)	**Total**
GEOTHERMAL WELL*	15	TBD ($6,000-$16,000)	TBD
WATER SOURCE HEAT PUMPS	18	$5,500	$99,000
5 HP GROUND WATER PUMPS	2	$15,000	$30,000
APPURTENANCES	LS	$10,000	$10,000
GROUND WATER PIPING (200FT)	LS	$35,000	$35,000
ENERGY RECOVERY VENTILATOR WITH HEATING/COOLING	3	$20,000	$60,000
MISCELLANEOUS	LS	$10,000	$10,000
DEMOLITION	LS	$50,000	$50,000
MISCELLANEOUS ARCHITECTURAL	LS	$15,000	$15,000
CONTROLS	LS	$15,000	$15,000
BALANCING	LS	$10,000	$10,000
MISCELLANEOUS ELECTRICAL	LS	$20,000	$20,000

SUBTOTAL			$354,000
Contingency	25%		$88,500
SUBTOTAL			$442,500
General Conditions	10%		$44,250
Overhead & Profit	15%		$66,375
TOTAL*			**$553,125**

* The cost of the wells is not included in the total cost

CONCLUSION

After analyzing the existing HVAC system and considering alternate systems, it is BSEG's opinion that the most cost-effective path forward for Solebury Township is the modification of the existing HVAC system. Our opinion of probable construction cost of performing these modifications is approximately $270,000, while the opinion of probable construction cost for new VRF system is approximately $550,000. A ground source heat pump system's opinion of probable construction cost is highly dependent on the cost of the geothermal wells; but even without the wells the opinion of probable construction cost is approximately $553,000. By implementing the recommended upgrades and replacements, it is anticipated that the existing system will experience a noticeable improvement in performance and energy usage.