Fishburn Sheridan & Associates Ltd.

2018-05-04 FSA Project #: 18058CO

Municipality of Mississippi Mills
14 Bridge Street
P.O. Box 400
Almonte ON K0A 1A0

Attention: Mr. Robert Kennedy, FMP

Subject: **Thermographic Investigation**
Almonte Public Library
155 High Street, Almonte

Dear Sir,

Following your request, Fishburn Sheridan & Associates Ltd. (FSA) conducted a thermographic survey to assess the condition of the existing exterior wall assembly and general roof/wall connections at the subject building. This report summarizes our observations.

Background

The Library was originally constructed in approximately 1980/81 and displays a relative square footprint. In roughly 1995/96, an expansion occurred that resulted in a small addition to the north and a much larger addition to the east. Both conjoined structures are one storey in height and consist of reinforced concrete strip footings, foundation walls and a slab-on-grade floor assembly. The building is of standard wood frame construction and exhibits pitched roof surfaces. The exterior walls are predominantly clad with brick unit masonry in a cavity wall configuration and the building is heated by natural gas fired, forced air furnaces that distribute warm air throughout the interior space. The exception is a few rooms located in the northwest of the original building construction that are heated with electric baseboard heaters.

During the 1995 expansion, the roof system of the original building was enveloped by a new roof structure, which extended over the original from the newer addition. As understood, the design intent was to provide a more uniform and consistent roofline aesthetic. That is, to avoid the complexities of two adjacent building roof constructions and to provide the illusion of a single building structure. As further understood, several large openings through the roof deck sheathing of the original building were made prior to being covered over with the new (1995) roof structure to promote attic space ventilation.

This study was prompted by reports of significant ice damming along the perimeter eaveline of both constructions and was also reported to be a more prominent condition surrounding the original building. Previous leak activity (suspected of being associated with ice damming) was indicated to have occurred within the main entrance vestibule. It was also reported that uncomfortable “cold spots” during the heating season occur in the Chief Librarian’s Office, Staff, Storage and Meeting Rooms.

Methodology and Procedure

Thermography consists of scanning a subject with a specialized infrared sensing device (such as an infrared camera) which detects emitted infrared radiation and translates the captured radiation into images called thermograms. In general, the infrared camera translates detected infrared radiation to surface temperatures and displays these surface temperatures as a range of colours (or shades of grey) corresponding to the infrared radiation detected. Thermography is an advanced non-destructive investigation, diagnostic and imaging tool employed in a wide variety of fields, including many fields of engineering, medicine, life safety and security services.

In the building construction and engineering fields, thermography is most commonly used to examine building envelopes and mechanical/electrical systems. All objects in our environment emit infrared radiation and this radiation increases with increased temperature, which is why the camera can translate the data recorded into surface temperatures

For thermography conducted on a building envelope, certain thermal patterns are expected based on the specific construction being examined and variations from expected patterns will occur when thermal, air movement or moisture defects exist. These defects will show up as "anomalies" in the images recorded, providing evidence of potentially defective building systems; or thermal weaknesses in the system. For example, when viewing the exterior of a building in colder weather, surfaces which appear "hotter" can indicate areas of heat loss due to thermal bridging, air leakage or moisture impacted elements. However, surfaces which appear "hotter" may be normal based on the specific construction being examined; therefore, thermographic images of building envelope systems must be interpreted by a Certified Thermographer who is experienced with building envelope construction to determine if thermal patterns are normal or if anomalies exist which represent potential defects.

With respect to exterior wall systems, glazing or roofs, a thermographic scan of new construction can provide proof of satisfactory construction, as a benchmark record of satisfactory building performance upon commissioning of the building. This same scan also can identify defects in original construction which otherwise would not be known until significant performance problems developed. As a result, the builder can ensure correction by sub-trades during the warranty period, instead of dealing with costly repairs and potential litigation after building turnover.

In post-construction applications, thermography is used to investigate building performance problems relating to thermal, air leakage and moisture issues, as well as to determine potential sources for energy savings. Roofing systems can be scanned to identify locations of moisture impacted insulation or other defects below the membrane which otherwise might not be identified without destructive investigation. Overall, thermography is a very useful tool for documenting the integrity and performance of a building envelope, using non-destructive and repeatable assessment methods.

It is important to note that the images produced by thermography merely present infrared representations of the surface temperatures of the subject. As such, observed anomalies in the image can indicate an issue of concern which may provide evidence of a deficiency, but any anomalies in the infrared images do not conclusively indicate a deficiency.

Building envelope thermography generally concentrates on exterior scans of the building, so that most exterior surfaces can be readily viewed without significant obstruction which would occur by furnishings if the scans were performed on the interior. Another major benefit of exterior scans of building envelopes is that buildings are generally pressurized by mechanical equipment, such that air leakage occurs outwards and therefore such air leakage is best detected on the exterior of a building.

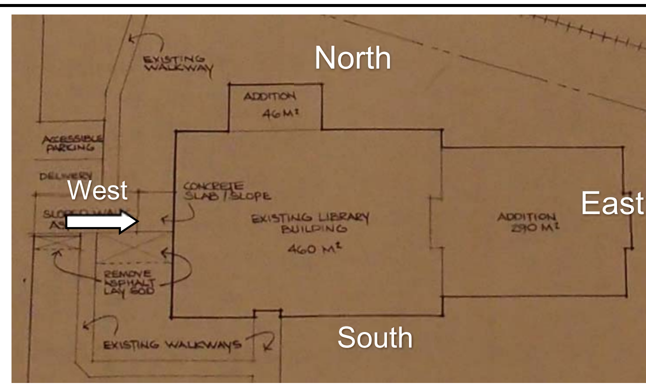
In addition, building envelope thermography is best performed when there is a significant difference between interior and exterior temperatures; with at least 10°C being acceptable in certain circumstances, but with a temperature differential of 15°C or greater being ideal. Since emitted radiation increases with temperature, greater temperature differences create a higher degree of heat flow between "hotter" and "cooler" surfaces; thereby making it easier to detect anomalies.

Observations

The primary objective of this investigation was to conduct a thermographic inspection of the exterior wall surfaces to help define the building envelope performance issues experienced, document encountered anomalies and potential areas of parallel path losses (i.e., heat loss). The following thermographic images or thermograms display temperature signatures that are specific to the subject building at that time; where white and yellow colours are the warmest and purple and blue are the coolest throughout the palette.

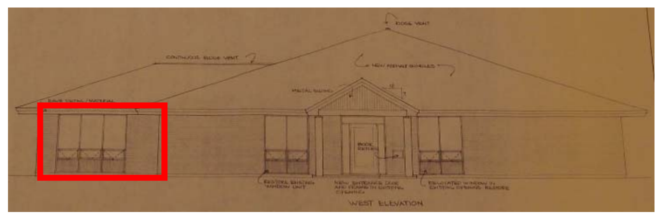
The survey was conducted at roughly 05:30 hours on the morning of April 5, 2018 by FSA. The exterior ambient conditions at that time were clear skies and -11°C with winds from the west at 26 kph (gusting to 39 kph). At least ten hours prior to the scan event, Town staff increased the interior building temperature to approximately 26°C and, by doing so, presumably increased an already positive pressure condition on the interior. This resulted in a temperature differential of 37°C, which is considered optimal to conduct a conducive thermographic scan with meaningful results.

The following commentary summarizes the observations of the thermographic investigation:

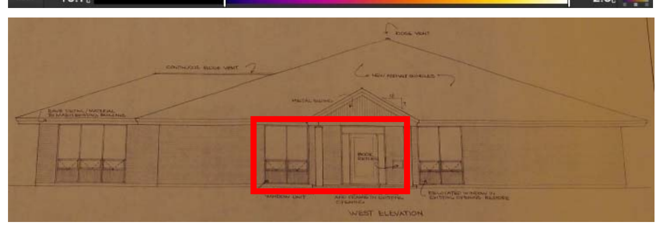
• FSA commenced the thermographic scan on the west elevation (indicated by the write arrow). • We then continued to the south side and subsequent elevations in a counter-clockwise pattern. • FSA scanned the entire building, only images of significance have been highlighted in this reporting.	

West Elevation:

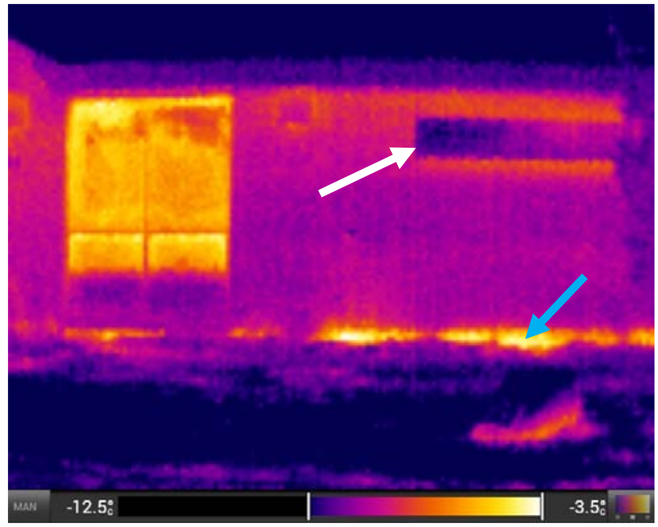
- This image was taken on the northern end of the west elevation, indicated by the red outline.
- The properties of this image are considered to be fairly typical for this building.
- The warmer spots in the window assembly range from -7°C to -3°C. The wall assembly -11°C to -9°C.
- This range was taken as the building's base point and was used as reference for the remainder of scan.

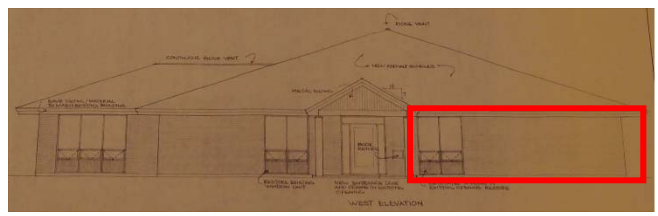


- The wall assembly in this image was found to be within the normal range.
- The window assembly to the left is also exhibits a typical range.
- The door way range is from -7.5°C to 2.8°C, indicating heat loss through the door assembly.



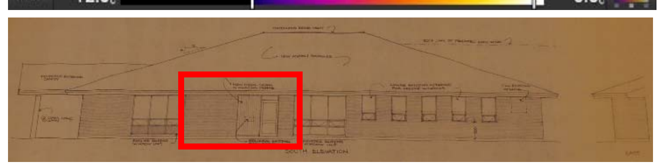
- The window and wall assembly are within the established normal range.
- The exposed portion of the foundation wall (indicated by the blue arrow) is within a range of -6.7°C to -4.2°C.
- This range will be used as reference for the remainder of the report.
- The inconsistent pattern indicated by the white arrow is caused by a wall-mounted sign.

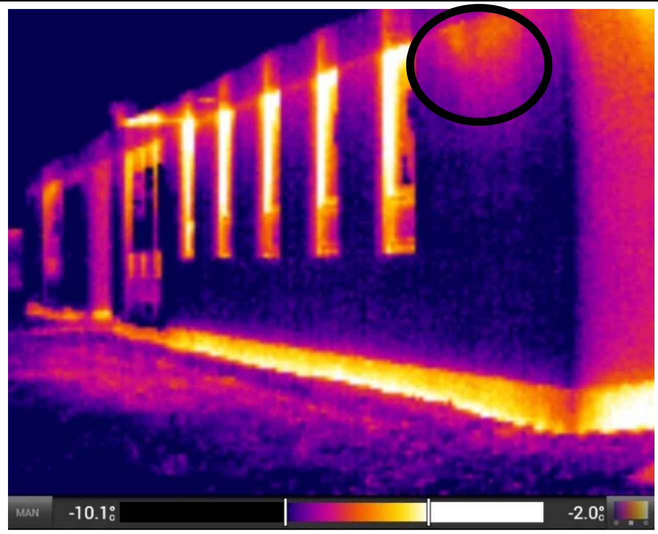
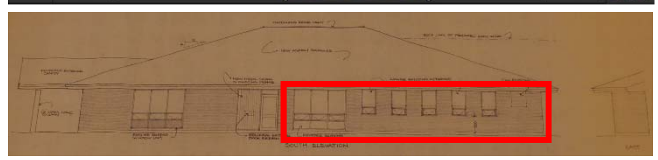
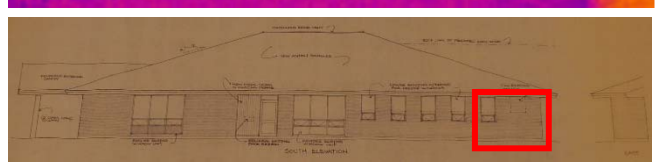




South Elevation:

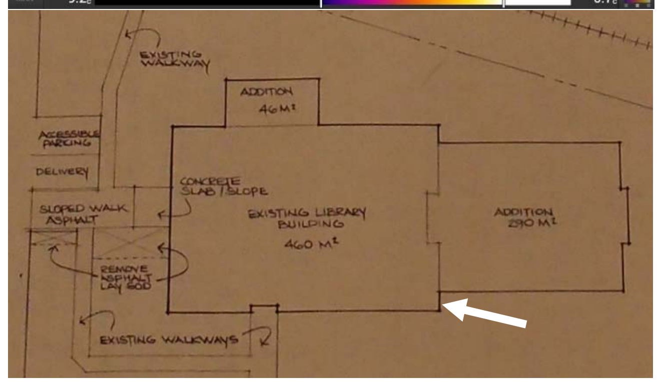
- The wall assembly is within the established range.
- The foundation wall gets as warm as -2.2°C.
- Similar to above, the door assembly exhibited readings as warm as 4°C.



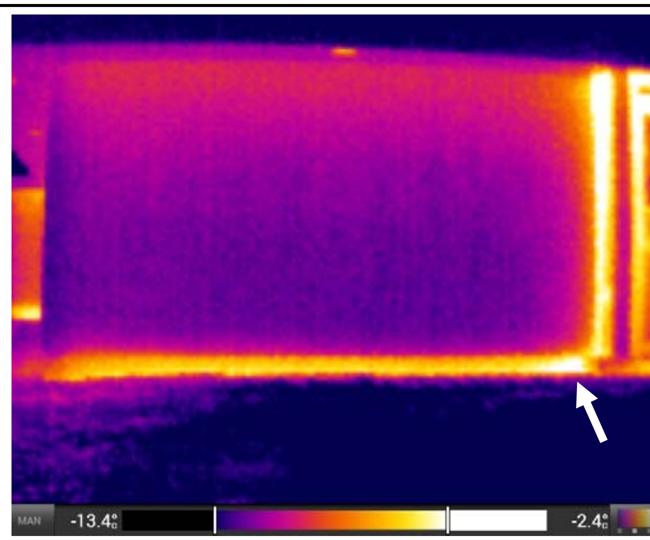
• The top portion of the window assembly has readings as warm as 3.3°C, this is an indication of heat loss. • The upper portion of the wall assembly has an inconsistent thermographic pattern, indicated by the circle. See next section for comments. • The foundation wall has readings as warm as -1.5°C.	 
• This image is a close-up of the previous item and occurs right at the southeast corner. • The lower portion of the wall assembly is within the typical range. • The upper portion of the wall assembly has readings as warm as -4°C (white arrow). • This anomaly is characteristic of extraneous air leakage at the wall/roof interface which may be due to a breach in the air barrier membrane or conduction of heat from displaced/absent insulation at this location.	 

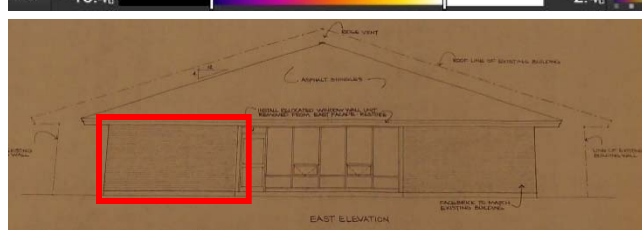
East Elevation:

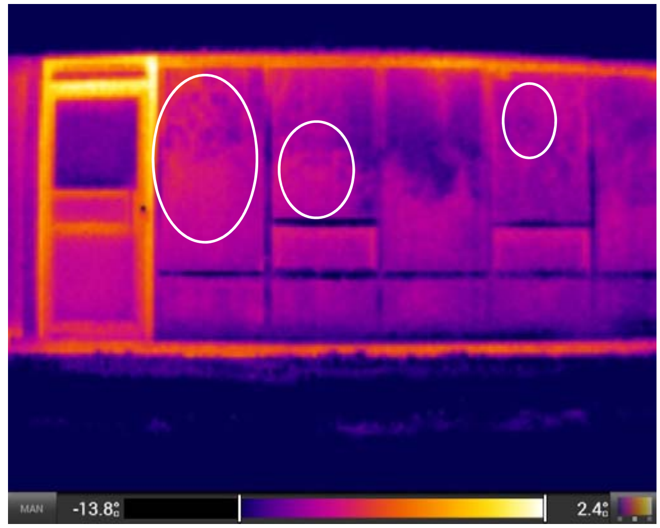
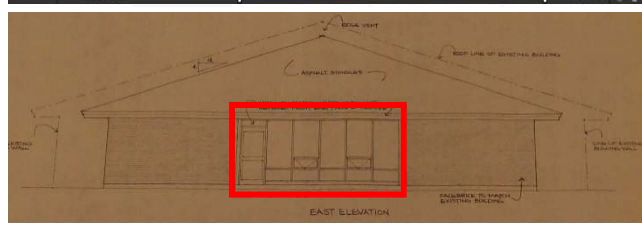
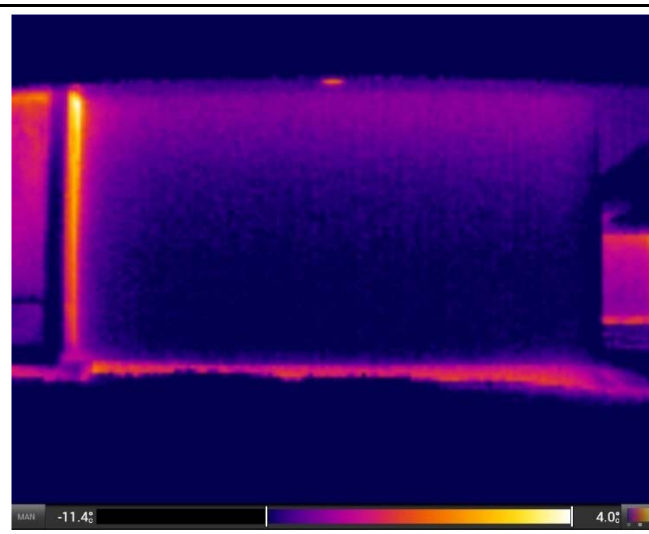
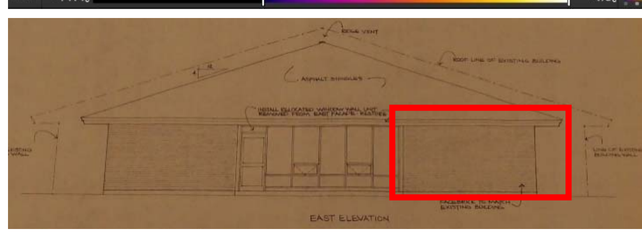
- This image shows the southernmost partial east elevation of the building, where the addition and original building connect (arrow).
- Like the thermographic image above in the previous item, there is a warmer anomaly in the upper portion of the wall assembly (circle). This anomaly gets as warm as -3.2°C.
- As noted above, this anomaly is also characteristic of extraneous air leakage at the wall/roof interface which may be due to a breach in the air barrier membrane or conduction of heat from displaced/absent insulation at this location.
- The warm area at the inside corner of the slab-on-grade is considered typical for this type of configuration and construction method.



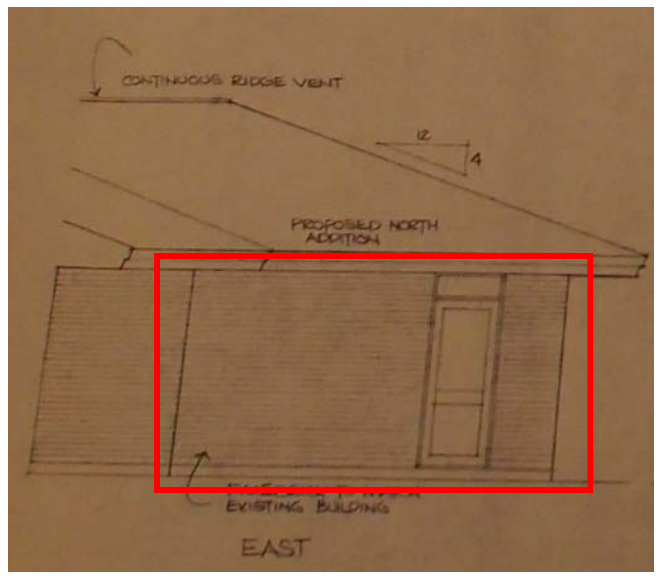
- This portion of wall is situated on the predominant east elevation.
- The wall assembly in this image is within the established range.
- The foundation wall is within the established range; however, started to increase in temperature as you approach the door assembly (arrow).
- The door assembly gets as warm as 2.4°C. This is an indication of heat loss.





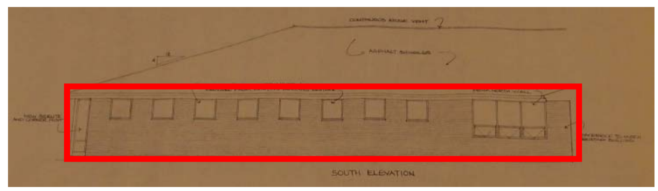
• The window assembly and exposed portion of the foundation wall are within the established range. • The door assembly is typical for this building, with readings as warm as 2.8°C. • Very faint warmer areas noted on the glazing (circles) may be an indication that the hermetic seals of the insulated glass units are beginning to fail.	 
• Similar to above, the wall assembly and exposed portion of the foundation wall are within the established range. • The door assembly is typical for this building, with readings as warm as 3.4°C.	 

- This image shows the northernmost partial east elevation of the building (i.e., the east elevation of the north addition).
- The foundation wall has readings as warm as -1°C.
- The wall assembly is within the established range, except for the upper left corner with a reading as warm as -1.8°C (arrow).
- This is where the addition and original building connect. There could be a lack of insulation or inconsistent air/vapour barrier tie-in at time of construction.
- The door assembly shown in this image has major heat loss, readings as warm as 10°C.



North Elevation:

- FSA noted that the original drawing is mislabeled, as labeled South elevation clearly depicts the North elevation.
- Like the elevation on the south side, the upper portions of the windows have readings as warm as 0°C.



- Overall, wall surfaces in this image are within the established range.
- However, an anomaly was observed and is indicated by the arrow, further investigation is required to determine the cause of this. As there are a few mechanical units in this location, the noted anomaly could simply be a through-wall service penetration that is inappropriately sealed.

Conclusions and Recommendations

Although the examined exterior facades are in an overall good condition, all building facades reviewed on the Almonte Public Library building displayed some degree of thermographic disparity, but it should be understood that buildings of this vintage will undoubtedly display moderate energy losses in comparison to modern construction. Furthermore, older buildings which have not been updated will suffer significant energy losses simply due to poor thermal performance of building envelope element construction which occurred at that time.

In spite of the observed energy loss issues that were documented at the Library, the vast majority of such energy losses are typical of the era and type of construction. Therefore, it is generally concluded that the vast majority of thermographic anomalies are minor and they are principally due to varying severities of air leakage and thermal bridging at transitional detailing. All facades throughout the complex displayed thermal profiles as per the expectations for the era and type of construction, with only isolated anomalies beyond those that would be expected for the building's construction.

The above observation indicates that building, regardless of age or construction, neither has serious nor widespread concerns regarding significant air leakage, thermal bridging or moisture impacted elements; with the exception of noted thermal patterns and isolated anomalies which are common for the era and type of construction for this building. Note: an old building with little to no insulation will provide poor thermal performance but it may not display any significant thermal bridging; because all of the exterior walls could have poor thermal performance to the approximately the same degree. (By definition, thermal "bridging" is increased heat transfer through areas which are more conductive than the normal conductivity of the adjoining general area.)

We draw the following primary conclusions:

- It can be concluded that the building is generally well designed and constructed in relation to its era and the building has been well maintained with respect to issues identifiable by thermal imaging.
- Thermal bridging commonly occurs at the foundation/ground floor slab level of buildings, likely due to foundation walls receiving less thermal insulation attention than above grade levels of buildings.
- All types of glazing display fairly significant thermal bridging at glazing frames and mullions, due to inferior thermal performance of glazing systems as compared to modern glazing systems. However, all such thermal glazing is as per expectations for the era of construction of each system.
- Glass and aluminum entry systems and doorways typically display major air leakage, especially double door glass/aluminum entries, because these systems do not have a good door to frame seal to minimize air leakage.
- In addition, isolated areas displayed occasional anomalies which may be due to construction defects caused by air sealing deficiencies and/or voids in construction.

Based on the above general findings, the recommendations which generally apply to the facades of this building are as follows:

- Thermal bridging and resultant energy losses should be addressed on a case by case basis, because the difficulty and costs to repair, and the comparative benefits of repair, will vary. In general, if remedial efforts are relatively simple and inexpensive, then directed repairs are recommended in the short term (i.e. within the next few years). However, if directed repairs are cost prohibitive, then repairing the issue should be deferred until major cladding renewal is performed on the building.

- While most building glazing and door systems displayed significant thermal bridging, due to the vintage of framing systems, it is usually not cost effective to replace glazing systems solely for the purpose of energy improvements. Therefore, in most cases, replacement of glazing for energy improvement is not recommended. However, the glazing has frame systems which are approaching 38 years in age, so replacement of these systems is recommended within the next five years.
- When glazing replacement is performed on any building, only high-performance glazing systems should be installed. Furthermore, modern building envelope design should be applied to the transition/juncture details, to ensure that the opening surrounding the glazing also receives up-to-date insulation and air sealing design and construction procedures.
- For brick masonry cavity cladding assemblies, no directed repair of these conditions is recommended; as the work would be cost prohibitive in comparison to the energy efficiency benefits to be enjoyed. However, older brick masonry claddings are part of exterior wall systems which have significantly less insulation than today's standards. In those cases, increased insulation levels should be implemented during any building modernization that is performed. Depending on the building and the work being performed, such improvement can consist of new insulated exterior walls on the interior side of the envelope or installing an insulated cladding over the precast concrete cladding.

Taking the above into account, the following represent the available repair scenarios:

<u>Option 1</u> – Status Quo (i.e., do nothing)

- Allow the building to continue to function and operate "as is" in perpetuity with no prescriptive improvement. Not recommended.

<u>Option 2</u> – Minor Roof Perimeter Improvements and General Wall Repairs

- Remove the bottom 600 mm (2') of existing shingle roofing along the entire perimeter of the roof, apply a self-adhesive eave protection membrane and a prefinished metal apron flashing to promote ice/snow evacuation, and complete with a heat tracer cable system around the perimeter and up applicable valleys.
- Review window and door systems to determine if any corrective measures, such as replacement of weatherstripping, gaskets, seals, shim space insulation will improve the situation and correct as required. Apply insulation and parge coating over observed "hot spots" on exterior foundation wall/slab edge.

<u>Option 3</u> – Moderate Roof Perimeter Improvements and General Wall Repairs

- Remove the bottom 1200 mm (4') of existing shingle roofing along the entire perimeter of the roof, remove the existing roof deck sheathing and adjust/augment the existing thermal insulation in the attic space at the roof/wall intersection to reduce possible thermal bridging and promote more effective soffit ventilation. Along the perimeter of the existing building construction, the existing roof deck sheathing should be removed and discarded before the insulation is readjusted. Reinstate perimeter sheathing, apply a self-adhesive eave protection membrane and a prefinished metal apron flashing to promote ice/snow evacuation, and complete with a heat tracer cable system around the perimeter and up applicable valleys.
- Review window and door systems to determine if any corrective measures, such as replacement of weatherstripping, gaskets, seals, shim space insulation will improve the situation and correct as required. Apply insulation and parge coating over observed "hot spots" on exterior foundation wall/slab edge.

Option 4 – Major Roof Improvement and General Wall Repairs

- All of Option 3 plus, perform a detailed ventilation analysis and implement determined additional ventilation required for the subject roof.

It is the opinion of FSA that, given the current condition and age of the building, the most feasible improvement option is **Option 2** - Minor Roof Perimeter Improvements and General Wall Repairs. This recommended repair work can be accomplished by a qualified roofing/window contractor for an estimated Class "D" order of magnitude cost of $45,000, plus applicable taxes.

We trust this report satisfies your immediate requirements. If you have any questions, or if we may be of further assistance, please do not hesitate to contact the undersigned.

Yours truly,

Fishburn Sheridan
& Associates Ltd.

Nate Robb
Project Coordinator

John B. McIntyre, A.Sc.T.
Principal & Senior Project Manager