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1.0 EXECUTIVE SUMMARY

CVM documented reported and observed leak activity at various locations around the perimeter of James Hall as part of a preliminary leak assessment. Localized probes and diagnostic water testing were employed to recreate leaks, observe water paths through the window and wall assemblies, and identify deficient building components.

The chronic leaks around the north elevations windows were determined to be attributable to a combination of dysfunctional flashings above the window heads in the brick façade areas and deteriorated sealant joints in the metal wall panel system. Water infiltration into the northeast mechanical room space was traced back to improper sill flashing below the louver vents. Leakage around the elevator shafts was determined to be the result of dysfunctional roof and wall flashings at the ends of the low walls at the roof level. Other significant findings included an improper roofing termination along the south elevation canopy roof, dysfunctional wall flashings at the east and west stairwells, and improper sill flashing at the southeast corner windows. Other observations included maintenance items such as deteriorated sealants and dislodged gaskets within the metal panel façade areas.

Each identified leak location is described in the body of this report along with our preliminary conclusions and repair recommendations. For planning purposes, the following is a prioritized summary of recommended repairs associated with each location and estimated repair costs. For a more detailed breakdown of the costs below, please refer to last section of the report.

REPAIR PROGRAM BUDGET

<table>
<thead>
<tr>
<th>LOCATION / COMPONENT</th>
<th>REPAIR RECOMMENDATION</th>
<th>SCENARIO 1: (INCLUDES RETROFIT REPAIRS NOTED)</th>
<th>SCENARIO 2: (INCLUDES ENHANCED REPAIRS NOTED)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 North Elevation Windows</td>
<td>Repair flashing above window heads in brick façade area</td>
<td>$256,000</td>
<td>$256,000</td>
</tr>
<tr>
<td>2 East Elevation Louver</td>
<td>(Retrofit Repair) Repair flashing with louver in place</td>
<td>$5,000</td>
<td>-</td>
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<tr>
<td></td>
<td>(Enhanced Repair) Replace flashing below louver sill</td>
<td>-</td>
<td>$52,400</td>
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<tr>
<td>3 Roof Level - East &amp; West Elevators</td>
<td>Locally repair roof and wall flashings</td>
<td>$74,000</td>
<td>$74,000</td>
</tr>
<tr>
<td>4 East Elevation Stair Tower</td>
<td>Install new end dam flashing at third floor line</td>
<td>$3,500</td>
<td>$3,500</td>
</tr>
<tr>
<td>5 South Elevation Canopy Roof</td>
<td>Repair roofing termination at roof/wall interface</td>
<td>$16,000</td>
<td>$16,000</td>
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<tr>
<td>6 Southeast Corner Windows</td>
<td>(Retrofit Repair) Re-seal interface between sill flashing and southeast corner windows</td>
<td>$300</td>
<td>-</td>
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<td></td>
<td>(Enhanced Repair) Replace and reslope sill flashing</td>
<td>-</td>
<td>$22,000</td>
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<td>7 Northeast Corner Louvers</td>
<td>Repair gap between wall panels</td>
<td>$3,600</td>
<td>$3,600</td>
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<tr>
<td>8 Roof Level- Roofing Termination</td>
<td>Repair failed roof termination</td>
<td>$800</td>
<td>$800</td>
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<tr>
<td>TYP Metal Panels - Gasketed (Type 1)</td>
<td>Assess gasket seals in metal panel wall system and repair as necessary</td>
<td>$9,600</td>
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<tr>
<td>TYP Metal Panels - Sealed (Type 2)</td>
<td>Replace all sealant joints in metal panel façade area</td>
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TOTAL REPAIR PROGRAM COST$1 $416,800 $485,900

1The above budgets represent total program costs and include allowances for contractor general conditions (access, temporary controls, site logistics) and soft costs (design, construction management, contingency).
2.0 INTRODUCTION

CVM was retained by Rowan University to perform a preliminary leak assessment of the façade at James Hall. Services were performed in accordance with our Proposal Memorandum for Engineering Services, P2015-06dr, dated December 7, 2015.

Originally constructed in 2005, James Hall is a relatively recent addition to the Rowan campus. The building façade is comprised of alternating regions of brick cavity wall construction, insulated metal panels, and aluminum framed windows.

CVM’s investigation was prompted by reports of widespread leak activity and related water damage at various locations around the perimeter of the building, with concentrations along the lower levels of the north elevation. Those areas are addressed in this report along with observations at other locations. The goal of the preliminary leak assessment is to catalogue the areas of known leak activity, to draw preliminary conclusion as appropriate, and to provide repair recommendations along with estimates of probable cost.

Figure 1: Campus map with James Hall circled in red.
3.0 METHODOLOGY & PROCEDURES

CVM conducted site visits on March 14, 15, and 16th, 2016 in order to perform a targeted evaluation of envelope components in the areas of reported leak activity.

In advance of the site visits, Rowan provided a log of reported leaks, identifying the date(s) of occurrence and locations throughout the building. In addition, the original 2005 construction drawings were provided for review. The archive drawings contained floor plans with the corresponding office numbers, building elevations, as well as typical wall sections and flashing details.

The investigation consisted of the following activities:

- **Interviews**: Interviews with building occupants and maintenance personnel were conducted to gather additional information on the leak locations and history.

- **Visual Inspection**: Visual surveys were conducted from the interior of the building in order to document locations of apparent water damage and active leaks. From the exterior, a high-reach lift was used for up-close tactile and visual observation of façade conditions and to facilitate probing and water testing.

- **Probing**: Select façade components were removed with assistance from a specialty restoration contractor, Dan Lepore & Sons, in order to document the as-built wall construction and expose concealed flashings. Probe locations included:
  1. Removal of select brick masonry and sealant from above a first floor window head along the north elevation.
  2. Removal of sealant from between insulated metal panels above a first floor window head along the north elevation.
  3. Removal of sealant from around the upper louver vent along the east elevation.
  4. Removal of a coping stone from the east low wall at roof level to expose through-wall flashing.
  5. Removal of select brick masonry from east low wall at roof level to expose concealed wall flashing.

- **Diagnostic Water Testing**: Based on the document review and initial visual surveys, specific components were identified for targeted leak testing in order to recreate leaks and evaluate avenues for water ingress into the building.
4.0 DOCUMENTED LEAK LOCATIONS

Approximate locations of reported and observed leaks are illustrated in Figures 1 through 5.

Figure 1: North elevation of James Hall denoting leak locations (in blue highlight)

Figure 1a (left): Standing water and towels along sills of first floor office along north elevation.

Figure 1b (right): Water damaged finishes in corner office 1032.
Figure 2: East elevation of James Hall denoting leak locations (in blue highlight)

Figure 2a (left): Water infiltration at third floor line of East Stair. Water staining along inside wall face.
Figure 2b (right): Standing water along east wall of mechanical room.
Figure 3: South elevation of James Hall denoting leak locations (in blue highlight)

Figure 3a (left): Water damage along underside of South Elevation Canopy.
Figure 3b (right): Water damaged finishes at Southwest Corner Windows.
Figure 4: Roof area above east elevator denoting leak locations (circled in blue)

Figure 4a (left): Water damaged finishes at southwest corner of East Elevator.
Figure 4b (right): Water damaged finishes at northeast corner of East Elevator.
Figure 5: Roof plan above west elevator and west stair denoting leak locations (circled in blue) (GBQC Architects, 2003)

Figure 5a (left): Water damaged finishes at northeast corner of West Elevator. Figure 5b (right): Standing water in northwest corner of West Stair.
5.0 OBSERVATIONS & RECOMMENDATIONS

The following is a summary of observations and recommendations for each leak location:

Location #1: North Elevation Windows

- **Observations**: CVM observed active leakage and interior finish damage at all three levels of aluminum windows along the north elevation of the building (Figure 1). From the interior, the leakage appears to originate at seams in the frames and/or the glazing gaskets, rolling down the glass and mullions and collecting on the sill (Figures 1a & 1b). It is our understanding that a remedial effort to seal the interior joints of the windows was performed post-construction.

CVM conducted two exterior probes above first floor windows. The first was located at a brick-to-metal panel façade interface in order to document the as-built condition of both wall types and to observe the concealed flashings above the windows (Figure 6). The second was in the metal panel façade region and involved select removal of sealant (Figure 8). Diagnostic water testing was employed in both locations to recreate leaks and identify paths of water ingress into the building. Significant observations include:

**Brick-to-Metal Panel Interface:**

1. The brick cavity wall system appears to consist of an outer wythe of masonry separated from the metal stud wall framing and exterior gypsum sheathing by a 3 inch air gap. This type of wall system is designed to account for some moisture penetration through the exterior masonry, where the air space allows the moisture to flow down the cavity. Flashings and weeps are provided to divert this moisture back to the exterior of the building. This type of system relies on continuous and functional flashings and weeps to avoid trapping moisture in the wall or inadvertently diverting it to adjacent assemblies.
2. There is copper fabric flashing along the steel shelf angle above the window heads in the brick cavity wall area; however, the flashing does not “daylight”, or extend to the outside wall face.
3. Looking inside the wall cavity, there does not appear to be a water resistive barrier (WRB) on the face of the exterior gypsum sheathing. WRBs are intended to provide a barrier to control moisture penetration to the interior of the wall assembly and, in this application, would be mandated by code. It is unclear to what degree (if any) this condition contributes to the leakage at the windows, but based on our assessment it does not appear to be a primary factor.
4. The joint between the outer brick and window head has been sealed, preventing water in the wall cavity from discharging to the outside.
5. There is no end dam at the brick-to-metal panel interface. Consequently, the flashing is discontinuous at this location.
6. The discontinuity in the flashing provides a direct path for water to enter the window frames.
7. Once inside the window frame, water is able to enter the interior spaces through openings in the glazing gaskets and seams of the frames. Any remaining water in the window assembly is directed to the sub-sill flashing.
8. The sub-sill flashing is sealed to the window frames. Weeps have been drilled in the frames to allow for trapped water to escape. The weeps appear to be functioning.

It is worth noting that the south elevation facade, which is primarily comprised of brick cavity wall construction, does not have reported leak issues like the north elevation. CVM noted that the
flashing details on the south elevation differ from the north in that they are more consistent with the original design drawings and general industry practice (i.e. the flashings at the floor lines and window heads are daylighted) (Figure 7).

**Metal Wall Panels:**

9. The metal wall panel system appears to be intended to function as a surface sealed barrier, meaning that there is no secondary means to control ancillary moisture that may penetrate the system. This type of system relies heavily on the integrity of the panel sealant joints to manage water and must be maintained in near perfect condition as there is no flashing above the windows in the metal panel façade region to discharge water that may penetrate the system to the exterior.

10. CVM noted a number of adhesion failures in the vicinity of the probe and several sealant joints that appeared to be deteriorated. Breaches in the sealant joints provide paths for water into the metal panel system and ultimately to the window frames (See items 7 & 8 above).

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**Figure 6: Brick-to-Metal Panel Interface: View of concealed flashing above first floor window head illustrating water path into window frame**
Figure 7: Brick Cavity Wall: Original flashing detail above window head (GBQC Architects, 2003). Note that brick was not intended to be sealed to window frame.

Water is able to get into metal wall panel system through breaches and adhesion failures in the sealant joints.

Once behind the sealant joints, water can flow along horizontal joints in the wall panels until reaching a vertical joint where it can flow directly into the window frames.

Water inside the window frame can enter the interior space through openings in the glazing gaskets and seams of the frames.

Figure 8 (left): Metal Wall Panel: View of probe illustrating water path into window frame.
**Recommendation:**

1. **Repair Flashing Detail above Window Heads in Brick Façade Areas:** In order to cut off the flow of water into the window frames, the window head flashings must be addressed. This would involve the following:
   a. Remove sealant between brick and window frame;
   b. Remove brick as required to access flashings;
   c. Provide new flashing, weeps, and end dams at all floor lines;
   d. Reconstruct brick.
2. **Replace Deteriorated Sealants in Metal Panel Façade Area:** The existing sealant joints in the metal panel wall system are deteriorated and have reached the end of their useful life. Replace all sealant joints.
3. **Investigate Water Resistive Barrier System in Brick Façade Area:** Based on the apparent absence of a water resistive barrier system within the brick cavity wall construction, it is recommended that a more detailed investigation be conducted to determine whether this condition is widespread throughout the building and, if so, what the long-term implications may be on the performance of the façade going forward.

**Location #2: East Elevation Louver in Mechanical Room**

**Observations:** CVM observed standing water and active leakage along the east wall of the mechanical room located in the northeast corner of the building (Figures 2 & 2b). It is our understanding that this area has been problematic for some time and that during at least one severe rain event, water was able to accumulate around duct penetrations and penetrate through the floor to initiate substantial leaks in the finished gym space below.

CVM utilized diagnostic water testing to isolate various components of the east wall and louver system in order to recreate the observed leak activity and identify deficient component(s) of the system. Significant observations include:

1. The metal panel wall system along the east elevation appears to be intended to function as a surface sealed barrier, utilizing compression sealed rubber gaskets at vertical panel joints to prevent water entry into the system. The system also has integrated flashings, which provide a secondary means to control small amounts of moisture that may penetrate the system.
2. CVM noted isolated locations where the gaskets had dislodged. Upon closer inspection, some of the gaskets appeared to be undersized and incapable of being compressed between panels. These locations were water tested, but did not initiate leaks to the interior space due to the head flashing above the louver opening which appeared to be effective in evacuating water that breached the gaskets.
3. The louver blades also appear to be performing as intended, preventing bulk water from entering the mechanical room and diverting runoff down the face of the blades (Figure 9).
4. The bottom of the louver frame has a shallow lip along its front edge which allows water to accumulate in the bottom of the frame (Figure 10).
5. There are open butt joints in the louver frame by design, which provide avenues for water to reach the sill flashing below the louver frame (Figure 11). The sill flashing is intended to collect this water and drain it to the exterior.
6. The sill flashing is sealed to the bottom of the louver frame. Consequently, water that reaches the sill flashing through the joints in the frame is trapped, being forced laterally or to the interior, eventually flowing down the metal studs and inside face of the wall panels (Figure 12).
7. Targeted water testing revealed a correlation between the locations of observed leakage and joints in the sill flashing and louver frame.

![Figure 9: Overview of water testing along sill of louver opening.](image)

![Figure 10 (left): Close up of water patterns at sill. Note lip along bottom frame and sealant between frame and sill flashing](image)

![Figure 11 (right): Close up view of water accumulation in bottom frame of louver at joint location.](image)
Figure 12: Sketch of section through louver sill illustrating water path into mechanical room

• **Recommendations:**

1. **Repair Flashing Detail at Louver Sill:** In order to divert water from the sill flashing to the façade, the existing sill flashing must be repaired. This would involve the following:
   a. Temporarily remove the louvers;
   b. Install new sloped sill flashing with upturned rear and end dams.
   c. Provide weeps to evacuate water to outside.

   A less invasive repair option would be to attempt a retrofit repair to the existing sill flashing with the louver in place. This, however, may or may not prove effective and would need to be validated via testing.

2. **Assess Gasket Seals in Metal Panel Wall System:** It is recommended that all gasket seals be assessed and that any necessary repairs be conducted (i.e. replace ill-fitting gaskets or reseal as needed).
**Location #3: East and West Elevators**

- **Observations:** CVM observed interior water damage on multiple floors around the east and west elevators (Figures 4a, 4b, & 5a). The source of the water entry appears to originate at the roof level. The roof directly above the elevators projects above the surrounding roof between two lines of low walls (Figure 13). CVM conducted two probes at the south wall of the east elevator to document concealed wall flashings in the vicinity of observed water damage. Significant observations include:

1. Typical leaks occur at the inside corners of the elevator shafts, which align with the ends of the low walls at the roof level.
2. In general, the height of the roof flashing around the ends of the walls is inadequate, as low as 1 inch in some locations. There is also evidence of past attempts to mitigate leakage with sealant (Figure 14).
3. The low walls appear to be intended to function as cavity walls with through-wall flashings to discharge any water from inside the cavity onto the roof.
4. There is copper fabric through wall flashing that is lapped on top of the roof counterflashing. Upon removal of the veneer masonry for closer inspection, CVM observed a fairly large hole in the lap of the flashing at the southwest corner wall. As a result, water is able to bypass the flashing and enter the interior finish space below (Figure 15).
5. There is also copper fabric flashing below the coping stones, which is undersized and not daylighted. CVM observed that the underside of the flashing as well as the interior face of the CMU were wet, suggesting that water is able to migrate around the flashing (Figure 16). This is a deviation from the original construction detail which indicated custom stainless steel flashings with a daylighted drip edge (Figure 17).

![Figure 13: Section though elevator shaft at roof level illustrating water paths into interior space (GBQC Architects, 2003)](image)
Figure 14: Inadequate roof flashing height at end of low walls above elevators.

Figure 15 (left): Hole in wall flashing at base of low wall above elevator provides avenue for water entry.
Figure 16 (right): Through-wall flashing below coping stone does not daylight and allows for excess water entry into cavity.
Figure 16: Original coping stone detail indicates custom stainless steel flashing with daylighted drip edge (GBQC Architects, 2003).

- **Recommendation:**
  1. **Replace Damaged Through-Wall Flashing:** Remove brick to access through-wall flashings along length of low walls. Remove and replace existing through-wall flashings with new continuous flashings. Step flashing height along roof slope. Coordinate height with roof counterflashings.
  2. **Repair Roofing Flashing Height at Ends of Low Walls:** Install new roof flashings at least 8” above roof level. Step flashing height along roof slope. Install new reglet and counterflashings.
  3. **Replace Through-Wall Flashing Below Coping Stones:** Temporarily remove coping stones. Install new through-wall flashing with drip edge that daylighted to outside face of wall. Re-seal coping stone cross joints.

Another option is to overclad the walls with a rainscreen and coping cap, negating the need to repair the wall flashings. This option will still require repairs to the base flashings that do not have adequate height.
Location #4: East and West Stair Towers

- **Observations**: CVM observed active leakage in the corners of both the east and west stairwells of the building (Figures 2a & 5b, respectively). Water appeared to originate at the third floor line at the east stairwell and from the roof level of the west stairwell. Significant observations include:

  **East Stair**

  1. CVM observed water entry along the third floor line where the through-wall flashing intersects the storefront window of the east stair tower.
  2. It is suspected that the flashing in this location lacks end dams, allowing water in the wall cavity to travel laterally along the flashing line and into the interior space (Figure 17).

  **West Stair**

  3. CVM observed water dripping from the exposed steel framing at the roof level of the west stairwell.
  4. Similar to the elevators shafts, the outside corners of the stairwell align with the corners of the low walls at the roof level.
  5. CVM observed that the coping stone cross joints along the low walls are deteriorated (open), providing an avenue for water entry.
  6. As discussed in the prior section, the through-wall flashing below the coping stones is dysfunctional, allowing water to bypass the flashing and continue down the wall cavity.
  7. At the end of the low wall above the leak location, there is no additional through wall flashing or roof counter flashing. Instead the roofing is lapped onto the face of the cast stone.
  8. Consequently, once water is inside the wall cavity at this location, it bypasses the roof assembly and is diverted by the intersecting steel framing into the stairwell (Figure 18).

![Figure 17: East Stair: View of leak location at southeast corner, illustrating water path into interior space.](image-url)
Figure 18: West Stair: View of low wall above northwest corner of west stairwell, illustrating water path into interior space.

- **Recommendation:**

  **East Stair:**
  1. **Install New End Dam Flashing at Third Floor Line:** Remove brick masonry to expose through-wall flashings at northeast and southeast corners of east stairwell. Provide new flashings with end dams to prevent water entry into stairwell. Reconstruct masonry.

  **West Stair:**
  1. **Repair Flashing at Roof-to Wall Interface**
  2. **Replace Through-Wall Flashing Below Coping Stones**
  3. **Replace Coping Stone Sealant Joints**

As discussed in the prior section of this report, it may prove more efficient and cost effective to address the west stair repairs described above by reconstruction the low walls in their entirety or re-cladding.
Location #5: South Elevation Canopy

- **Observations:** CVM observed evidence of water damage along the underside of the south elevation canopy structure (Figure 3a). Inspection of the roofing revealed an improper roofing termination that does not conform to the original design drawings nor good industry practice (Figures 19 & 20). In its current state, the edge of the roofing membrane has been left loose and is not properly integrated with the wall flashing. As a result, water in the wall cavity appears to be able to penetrate behind the roofing termination and to the underlying construction below, causing damage to the finished ceiling.

It is worth noting that the original construction detail called for reglet counterflashing, which was not installed (Figure 21).

![Figure 19: Improper roofing termination along south canopy roof-wall interface. Note that termination bar has been installed backwards and without waterstop mastic.](image)

![Figure 20: Close-up view of roof-wall interface. Note that the wall flashing diverts water behind the roofing membrane.](image)
Figure 21: Original flashing detail indicates metal reglet and counterflashing, which was not installed (GBQC Architects, 2003)

- **Recommendation:**
  
  1. **Repair Roof Termination along South Elevation Canopy:** Install new metal reglet counterflashing and seal to underside of steel shelf angle.
Location #6: Southeast Corner Windows

- **Observations**: CVM observed water damaged finishes along the sill of the southeast corner windows (Figure 3b). Diagnostic water testing quickly revealed that the sill flashing is backpitched towards the window, allowing water to pond along the seal between the flashing and window frame (Figure 22). Breaches in the sealant interface readily allow water under the window frame and into the interior space.

![Figure 22: Sill flashing is inadequately sloped to deter water away from window frame.](image)

- **Recommendation**:
  1. **Short Term**: Re-seal and maintain joint between sill flashing and frame.
  2. **Long Term**: In order to properly fix the sill flashing and deter water entry, the window would need to be removed in order to install new sloped sill flashing with rear return and end dams.
Observations: CVM observed active water leakage through the north and east walls of the northeast corner gym space. Above the first floor windows, the north and east walls are comprised of mechanical louvers with blank-off panels along the inside, serving as the primary drainage plane for the wall. From the interior, CVM could see daylight between seams in the panels. It is suspected that water is able to enter the interior space through this gap (Figure 23).

Figure 23: View of interior of north wall from first floor gym space. Gap (and daylight) between blank-off panels provides avenue for water entry into space.

Recommendation:
1. Repair Gap between Panels: Provide mending plate to deter water entry between panels. Verify that sill flashing is present and functioning.
Location #8: Vertical Roofing Termination

- **Observations**: Evidence of water damage within the third floor conference room along the north elevation of the building prompted a review of conditions at the roof level. CVM observed a failed vertical roofing termination in the vicinity of the leak. The roofing membrane, which had been sealed to the metal wall panel, has pulled away, exposing the underlying wood sheathing (Figure 24). This breach in the roofing system provides direct access for water into the finished spaces below.

![Failed roofing termination above third floor conference room on north elevation.](image)

**Figure 24: Failed roofing termination above third floor conference room on north elevation.**

- **Recommendation**:
  1. **Repair Roof Termination**: Provide new sealed roof termination along vertical edge of metal panel.
6.0 COST ESTIMATES

The following is a summary of the costs associated with CVM’s recommended repairs to address ongoing leakage around the perimeter of James Hall. As discussed in the body of the report, several deficiencies warrant repairs that would be very disruptive and invasive to properly execute (i.e. east elevation louver sill flashing replacement). For such locations, CVM has estimated two repair approaches – an “enhanced repair”, which is considered a long term repair to permanently fix the deficient condition, and a “retrofit repair”, which is a repair intended to work around adjacent assemblies to minimize disruption and cost, but which may require some degree of testing to verify effectiveness and will require ongoing maintenance.

Prioritized Repair Program Budget

<table>
<thead>
<tr>
<th>LOCATION / COMPONENT</th>
<th>Cost Basis</th>
<th>SCENARIO 1: (INCLUDES RETROFIT REPAIRS NOTED)</th>
<th>SCENARIO 2: (INCLUDES ENHANCED REPAIRS NOTED)</th>
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<tbody>
<tr>
<td></td>
<td>Base Cost</td>
<td>General Conditions</td>
<td>Access</td>
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<tr>
<td>1 North Elevation Windows Window Head Flashing Repair</td>
<td>$131,100</td>
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<td>2 East Elevation Mechanical Louver Sill Flashing Repair</td>
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<td>3 East &amp; West Elevators- Roof Level Elevator Parapet Flashing Repair</td>
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<td>8 Roof Level Roofing Termination Repair</td>
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TOTAL REPAIR PROGRAM COST $416,106 $484,310

Notes:
1. An 18% markup on the base construction cost has been added as contractors general conditions for.
2. Budget is based on anticipated access needs for various repairs (fixed scaffolding, high reach access, etc.)
3. A markup for softs costs has been applied to the program (10% contingency, 10% professional fees, 5% CM fee).
4. All budgets are presented in current (2016) dollars.
5. Budget does not include any interior finish repairs.
6. Budget does not include any abatement or hazmat removal costs.