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BUILDING ENVELOPE STUDY – BAY SQUARE CONDOMINIUMS

Bay Square Condominiums
950 Massachusetts Avenue
Cambridge, MA 02139

Prepared for:

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As requested by Thayer & Associates, Inc., AMO®, BRS/Building Recon Services (RECON) visited 950 Massachusetts Avenue, Cambridge, MA, on November 28, 2023. The purpose of the visit was to complete a building envelope study to determine the sources of water leaks that are penetrating the interior of the building at the first-floor level, the lower-level pool area, and the parking garage. The intent was to complete visual observations, water penetration resistance testing, and make sample openings in the exterior cladding components as required to determine the causes of the leakage and the condition of the envelope construction at these locations. The areas of focus for this study were limited to the first-floor level and both levels of the parking garage.

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The report is divided into the following sections:

- *Background*
- *Summary of Observations*
- *Water Penetration Testing*
- *Summary of Sample Openings*
- *Summary of Concrete Sampling/Lab Testing*
- *Discussion*
- *Conclusions*
- *Recommendations*
- *Preliminary Budgets*
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BACKGROUND

The building at 950 Massachusetts Avenue in Cambridge, also known as the Bay Square Condominiums, was constructed in 1988/1989 and consists of a seven-story residential condominium building with 109 units. In addition to the seven residential stories above grade, there is a two-story, below grade parking garage beneath the building. At the ground floor level, there are three commercial tenant spaces, a loading dock, and common areas for the residential building (Photos 1-3). The exterior is clad in a brick masonry veneer with cast stone embellishments. The windows and terrace doors at the upper levels are fiberglass with aluminum-framed commercial storefront windows and exterior entry doors at the first-floor level.

We understand that various upgrades to the building envelope have been completed over the past twenty years; however, the building is currently experiencing persistent water leakage at interior spaces including the first floor, the lower-level pool area, and the parking garage.

A building condition assessment study was completed by others in 2022. This study focused on the overall condition of the building envelope, including the exterior walls, roofs, lower-level pool area, and the parking garage. Although this study did include general observations, conclusions, and recommendations, it did not include any water penetration resistance testing of cladding components to recreate leakage, any destructive testing of cladding or structural components, any review of concealed envelope construction at leakage locations, or a budget for repairs.

You asked RECON to complete an additional envelope study to include the items noted above in hopes of determining the cause of the leakage so that a repair strategy, repair budget, and repair documents could be prepared.

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SUMMARY OF OBSERVATIONS

RECON completed general visual observations of the building envelope at the interior and exterior from the ground and from ladders at the first floor and both levels of the parking garage. The following summarizes the conditions and defects that we observed during our study. Refer to the photographic documentation section for additional descriptions.

Exterior Observations:

1. Cracked, deteriorated, open, and missing mortar at the cast stone coping and brick masonry veneer on the east exterior wall of the parking garage (Photos 4 – 5).

2. Efflorescence and widespread ivy covering the two-story brick masonry wall at the east exterior wall of the parking garage (Photo 6).

3. Cracked and spalled cast stone coping on south exterior wall of the parking garage with failing surface-applied sealants (Photo 7).

4. Cracked, deteriorated, open, and missing mortar as well as displaced brick masonry veneer and efflorescence on the south exterior wall of the parking garage (Photos 8 - 9).

5. Failing mastic coatings along the metal counter flashings at the south exterior wall of the parking garage (Photo 10).

6. Cracked and open mortar joints at the cast stone coping and brick masonry veneer as well as efflorescence on the pool headhouse structure (Photos 11 - 12).

7. Failing mastic coatings along the metal counter flashing and damaged/open masonry on the east exterior wall of the building at the terrace on the first-floor level (Photo 13).

8. Failed sealants at concrete-to-concrete wall joints at the Unit 106 terrace on the first-floor level (Photos 14 and 15).

9. Failing surface-applied sealants along the roof membrane termination and termination bar at the Unit 106 terrace on the first-floor level (Photo 16).

10. Deteriorated and spalled concrete structure beneath the loading dock platform at the east side of the building with exposed, deteriorated, and corroded steel reinforcing steel (Photo 17).

11. Open/failing joint between the brick masonry and concrete wall at the east elevation of the parking garage (Photo 18).

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12. Gaps, honeycombs, and cracks in the exterior concrete wall at the east side of the loading dock (Photo 19).

13. Holes in the concrete foundation wall at the front of the loading dock, constructed by others. We were told that water leaked out of these holes, once constructed (Photo 20).

14. Spalls concrete at the loading dock slab and stairs (Photos 21 - 22).

15. Missing through wall flashings along the perimeter of the loading dock and at the side of the loading dock stairs (Photo 22).

16. Failing surface-applied sealants along the loading dock ramp and stairs.

17. Perimeter sealants at the south brick masonry exterior wall of the first-floor common area that have passed their useful service life (Photo 23).

18. Glazing gaskets and sealants at the storefronts on the south elevation of the first-floor common area have passed their useful service life.

19. Perimeter sealants on the storefronts at the south elevation of the first-floor common area that have passed their useful service life.

20. Open mortar and failed surface-applied sealants at the cast stone curbs beneath the storefront windows/doors at the south wall of the first-floor common area (Photo 24).

21. Surface-applied sealants at the planter walls on first floor common terrace that are open and have passed their useful service life.

22. Cracks withing the brick veneer mortar and efflorescence on the brick masonry at the first-floor common terrace (Photo 25).

23. Surface drains at the terrace that have limited drainage due to mortar buildup at the drain opening and have mortar covering the weep holes around the drain bowl preventing water from evacuating from the split-slab construction (Photo 26).

24. Surface-applied sealants at the pool area have failed allowing water to migrate into the split slab construction and possibly into the lower-level pool area through unsealed penetrations in the structural slab (Photo 27).

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Interior Observations:

1. Moisture, corroded studs, and dirt within the exterior wall assembly at the south elevation of the first-floor common area (Photo 28).

2. Calcium carbonate build-up beneath pipe penetrations through the concrete foundation walls beneath the pool (Photos 29 - 30).

3. Calcium carbonate build-up around pipe penetrations through the concrete slab beneath the pool. Also, water/moisture on the concrete slab on grade beneath the pipe penetrations (Photo 31).

4. Ponded water on the slab beneath the pool (Photo 31a).

5. Calcium carbonate build-up around conduit and conduit penetrations beneath the pool terrace (Photo 32).

6. Cracks and previous injection repairs at the east foundation wall in the parking garage (Photo 33).

7. Cracks and previous injection repairs at the underside of the concrete slab/ceiling beneath the east terrace, in the upper-level parking garage (Photo 34).

8. Cracks in concrete beams at ceiling in the garage (Photo 35).

9. Delaminated concrete beams with exposed and corroded rebar at ceiling in the garage (Photo 36).

10. Hairline cracks in the underside of the concrete slab in the parking garage (Photo 37).

11. Cracks in the wearing surface of the parking garage slabs with failing repair sealants and water around drains (Photo 38).

12. Failing traffic coating on the parking garage slabs at many locations with exposed concrete.

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SUMMARY OF WATER PENETRATION TESTING

Water Penetration Resistance Testing

The following table provides a summary of the water penetration resistance testing results and observations at each of the leak locations. The table specifically includes the test number, the location, the condition tested, method, and results and observations. RECON performed a total of five (5) water tests. A table of reference photographs follows the test table and provides additional descriptions of the leak locations and testing procedures.

Test No.	Location/Condition Tested	Method	Results and Observations
1	South elevation, exterior wall from lobby, courtyard, West planter.	AAMA Standard 501.2	The West planter bed was flood tested with water for thirty minutes. No water was observed on the interior as a result of this test.
2	South elevation, exterior wall from lobby, courtyard, West planter, windowsill	AAMA Standard 501.2	Water was applied to the storefront windowsill for thirty minutes. Ten minutes after the test began, water was observed seeping through the brick. Water was also observed building up in the cavity at base of the wall **(Photos 39 - 40)**.
3	South elevation, exterior wall from lobby, courtyard, East planter.	AAMA Standard 501.2	The East planter bed was flood tested with water for thirty minutes. No water was observed on the interior as a result of this test.
4	South elevation, exterior wall from lobby, courtyard, East planter, left corner of windowsill	AAMA Standard 501.2	Water was applied to the storefront windowsill for six minutes. Two minutes after the test began, water was observed seeping through the brick. Water was also observed dripping from the exterior sheathing.
5	South elevation, exterior wall from lobby, courtyard, window & doorsill	AAMA Standard 501.2	Water was applied to the bottom of the entry door for twenty-five minutes. After fifteen minutes, water was observed seeping beneath the carpet and leaking over the threshold, beneath the entry door **(Photos 41 - 42)**.

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SUMMARY OF SAMPLE OPENINGS

In addition to the general visual observations of the existing exterior envelope systems, RECON constructed isolated sample openings in the exterior cladding to determine the causes of water leakage and confirm the condition and detailing of the concealed envelope construction. The following summarizes our observations at these sample openings.

Sample Opening #1:

At the south exterior wall in the first-floor common area, the interior gypsum wallboard was removed (by others) at approximately the middle of the west planter. We observed the following, at this location:

- Corroded steel studs and steel bottom track, wet insulation, deteriorated exterior sheathing, and water within the pea stone in the cavity (Photo 28).

Sample Opening #2:

At the south exterior wall in the first-floor common area, the interior gypsum wallboard was removed (by others) behind the west planter. We observed the following, at this location:

- Corroded steel studs and steel bottom track, wet insulation, deteriorated exterior sheathing, and water within the pea stone in the cavity.

- Steel studs are not in contact with the bottom track due to corrosion.

Sample Opening #3:

At the south exterior wall of the first-floor common area, three bricks were removed above the terrace slab between the west planter and the exterior door (Photos 43 - 44). We observed the following, at this location:

- Corroded steel studs and steel bottom track, wet insulation, deteriorated exterior sheathing, and water within the pea stone in the cavity.

- Steel studs are not in contact with the bottom track due to excessive corrosion (Photo 44).

- Straw vent weeps are installed between the split slab and extend up into the brick cavity wall (Photo 43).

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Sample Opening #4:

At the loading dock, the steel protection plates were removed to review the concealed construction. We observed the following, at this location:

- Traffic coating on the loading dock slab that has failed and debonded from the concrete slab (Photo 45).
- Deteriorated concrete slab with exposed aggregate and moisture within the concrete slab (Photo 46).

Sample Opening #5:

At the upper-level parking garage slab, concrete was removed from a beam on the underside of the slab where there was evidence of corroded reinforcing steel. We observed the following at this location:

- Corroded reinforcing steel (Photo 36).
- Inadequate concrete cover over the reinforcing steel.

Sample Opening #6:

At the upper-level parking garage slab, concrete was removed from a beam on the underside of the slab where there was no evidence of damage or deterioration. We observed the following at this location:

- Reinforcing steel with no evidence of corrosion (Photo 47).
- Proper concrete cover over the reinforcing steel (Photo 48).

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SUMMARY OF CONCRETE SAMPLING / LAB TESTING

Test No.	Location/Condition Tested	Acceptable Limit per ACI 318	Results and Observations
1A	Lower Garage Ceiling Beam (good condition) – Exposed Surface	0.15%	0.004%
1B	Lower Garage Ceiling Beam (good condition) – Embedded Surface	0.15%	0.004%
2A	Lower Garage Ceiling Beam (good condition) – Exposed Surface	0.15%	0.4% (high)
2B	Lower Garage Ceiling Beam (poor condition) – Embedded Surface	0.15%	1.2% (high)
3A	Pool Foundation Wall – Exposed Surface	0.15%	0.006%
3B	Pool Foundation Wall – Embedded Surface	0.15%	0.002%
4A	Pool Foundation Wall – Exposed Surface	0.15%	0.009%
4B	Pool Foundation Wall – Embedded Surface	0.15%	0.020%
5A	Loading Dock Beam – Exposed Surface	0.15%	0.9% (high)
5B	Loading Dock Beam – Embedded Surface	0.15%	0.9% (high)

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DISCUSSION

RECON performed an evaluation of the exterior walls and terraces on the first floor and the exterior walls and slabs at the parking garage. The visual observations were augmented with water testing and sample openings to determine the causes of water leakage and review damage to concealed construction.

The following discussion is intended to provide further description of our analysis of the issues with the exterior walls and terraces. RECON's recommendations for repairs can be found in the recommendations section of this report. Budget estimates for the recommended repairs are included in the Preliminary Budgets section of this report.

South Exterior Wall - First Floor Common Area (Photos 49 – 50):

We understand that there is persistent leakage into the first-floor common area and exterior wall, along the south elevation. Sample openings made at the interior drywall reveal excessive deterioration of concealed construction including exterior sheathing, insulation, and steel stud framing. Sample openings made at the exterior reveal the same deterioration as the interior openings. In addition, they reveal a design and/or construction error that is attributed to the interior leakage.

Brick masonry cavity wall construction is designed to allow water to enter the cavity and drain downward to through-wall flashings where it is evacuated from the assembly through weep vents/holes installed within the brick mortar joints. Typically, in New England through wall flashings and weep vents/tubes are installed approximately 8-inches above grade to prevent snow and ice on grade at the exterior from inhibiting water discharge.

At the exterior walls on first floor level of this building, there are no through wall flashings and/or weep vents above grade. At these areas, we identified 'straw vent' weep tubes installed within the bottom of the drainage cavity. The weep tubes extend from within the masonry cavity downward and turn horizontally into the interstitial space between the terrace topping slab and the structural slab. It appears that the intent was for water in the wall cavity to pass through the tubes and flow into the interstitial space between the two slabs. Once water entered the interstitial space it would flow across the structural slab to the terrace drains. The water would pass through weep holes within drain bodies of the terrace drains and be evacuated through the drain piping that extends along the upper-level parking garage.

Straw vent weep tubes are not a reliable product to discharge water from masonry walls as they easily clog, preventing the passage of water. Once clogged, there is no reasonable way to unclog them or maintain them. In addition, if they are curved or bent as installed at these locations, the issues, and chances of clogs/failure increases. Weep vents/tubes are designed to be installed above grade and should not be installed below grade as a matter of practice.

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Common Terrace Drains:

When properly detailed and designed, split slab construction can be effective at managing water. With these systems, there must be a properly constructed waterproofing membrane and drainage plane/mat on the lower slab to allow water flow and prevent leaks through the lower slab. In addition, bi-level type drains must be used whereby the waterproofing membrane extends into the lower portion of the drain body. Surface water on the terrace from rain events is drained through the upper portion of the drain body. Any water that migrates down to the lower slab from the perimeter conditions flows across the waterproofing membrane to the lower drain body which is perforated and/or has weep holes. Water passes from the lower slab through the perforation/weep holes and is evacuated into the drain and discharge piping.

It is unclear if there is a waterproofing membrane and/or drainage mat between the slabs at these terraces. However, the terrace drains at this building do not allow water to discharge from the lower slab. Mortar was applied around the inside of the terrace drain bodies covering any weep holes or perforation in the drain bodies designed to evacuate the water. In addition, the mortar buildup has closed the opening of the drain piping reducing the discharge capacity of the drains. Therefore, any water that is directed from the cavity wall or from defects in perimeter sealants at the terrace becomes trapped in the interstitial space which becomes overwhelmed with water causing leakage at the interior. Also, standing water causes leaks in the slab through defects/cracks in the concrete that may not otherwise leak if the water could flow freely to the drains.

To minimize the risk of further leakage into the parking garage, the terrace topping slab should be removed and replaced with a paver system over a new waterproofing system with new bi-level drains. However, we understand that this is costly, and a first approach may be to replace the bi-level drains to confirm whether that addresses all leaks.

Cast Stone Copings and Masonry Veneer:

This building uses cast stone copings as an architectural feature at the top of masonry parapets. Coping stones are commonly used to cover the top of both barrier type and cavity type masonry walls. The stones limit the amount of bulk water from entering the masonry cavity and reduce the potential for standing water on the top of the masonry veneer. In doing so, the coping helps increase the service life of the masonry and the mortar below and may limit leakage. Because the copings have a horizontal surface and are exposed to environmental conditions such as UV and rain, the mortar and material itself is prone to faster deterioration than the veneer. However, the joints in the copings must be properly maintained for the copings to be effective at protecting the masonry veneer and the interior. If the coping joints are not properly maintained, water will migrate into the stone causing damage to the stone, mortar, masonry veneer below and may result in water leakage to the interior. In addition, water can migrate through failed joints to the back of the brick masonry cladding causing efflorescence on the exterior surfaces of the brick which is unsightly.

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The coping stones on this building have not been properly maintained resulting in damage and deterioration, efflorescence, and leakage. If maintaining coping stones is an issue, coping covers may be considered to reduce the potential for damage and leakage.

In addition to the importance of coping stone maintenance, mortar at brick masonry veneers must be maintained with routine 'cutting and pointing' to limit bulk water from entering the masonry and the cavity. There are widespread areas where failed mortar joints have led to water ingress, efflorescence, and interior leakage. After selective cutting and pointing is completed to address the current issues, a proactive cutting and pointing maintenance plan should be considered to reduce the risk for these occurrences in the future.

East Unit Terraces @ First Floor:

In addition to failed coping stone mortar joints, roofing membranes and membrane flashings at the unit terraces on the east side are poorly designed, poorly installed, and are failing. Defects in the concrete substrate and defects in the roof membrane terminations allow water to bypass the roofing and flow downward to the slab where it becomes trapped. Over time, this trapped water has migrated through cracks in the slab and leaked into the parking garage. Although injection repairs were completed at the interior side of the slabs, the issue must be addressed on the positive side, at the exterior where the leaks originate.

These terraces use loose-laid, single-ply roof membranes to protect the slab and the interior. Self-adhered waterproofing systems installed and adhered directly to the concrete slab are a better choice than loose-laid roofing type membranes. With loose systems, if there is a breach in the membrane water can migrate anywhere beneath the membrane until it reaches a crack or penetration in the slab where it leaks into the slab or the interior. With a self-adhered waterproofing such as hot fluid-applied rubberized asphalt, if there is defect in the waterproofing water cannot travel to a crack or penetration. The water is confined to the defect, therefore the risk for damage or leakage is greatly reduced.

Loading Dock Area:

Exposed concrete at the loading dock area is susceptible to cracks and damage from environmental conditions, as well as in service loads, equipment, etc. Although there is a traffic coating installed in this area, the coating has not been maintained and has failed at most locations. Cracks, deterioration, and damage in the concrete perimeter walls and slab are widespread allowing water to penetrate the concrete structure causing damage to the structure and leaks into the loading dock chamber, and the parking garage below. A robust, heavy duty traffic coating should be installed and properly maintained to reduce the potential for further damage to the structure and interior leakage.

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Sampling and lab testing of concrete from the loading dock support beams show highly elevated chloride levels of 0.9%. This level is well above the threshold set in ACI 318 which is 0.15%. This chloride level represents a high risk for corrosion of reinforcement.

Parking Garage Slab:

In general, concrete shrinks which causes cracks. Sometimes the cracks are superficial (at the surface) and in some cases they are structural (through the slab or wall). In addition to shrinkage cracks, concrete can also crack from live and/or dead loads imposed on the concrete element from wind, occupants, cars, self-weight, etc.

The slab at the upper-level parking garage has cracks at numerous locations. These cracks can be observed from the underside and in most cases are superficial; however, some are not. This elevated slab does not have a redundant waterproofing membrane. The upper surface of the slab relies upon a traffic coating to keep water from entering the concrete slab and concrete support beams. In some cases, traffic coatings can span across cracks that form after the coating is installed. The extent to which the coating can conceal/protect a crack is determined by the elastomeric quality of the coating, when it was installed, the coating thickness, preparation, and the age of the coating. If a large crack forms after the coating is applied, the crack may telegraph through the coating causing a breach in the waterproofing membrane.

Traffic coatings must be properly maintained to be effective. In some cases, if there is a breach the crack can be routed and sealed. A coating patch may also be required. Due to the wear and tear from vehicles, particularly at turning areas, coatings do not have a long service life and require routine maintenance.

Vehicles that enter the garage produce ‘runoff’ from rainwater, snow, ice, etc. tracked into the garage from the exterior. Water on the slab surface is migrating through the failed traffic coating and concrete cracks at several areas. This moisture has caused localized concrete deterioration, corrosion of reinforcing steel and leakage to the lower level.

Sampling shows that there is insufficient concrete cover over reinforcing steel at some locations. When steel reinforcing corrodes it expands placing tensile strength on the concrete which causes cracks, spalls, and delamination of the concrete. These types of defects are obvious at several locations. The steel corrosion rate is accelerated by chlorides that may be found in some of the winter ‘runoff’ from vehicles. Chlorides can be found in winter deicing salts and may be tracked into the garage from outside, during winter months.

Sampling and lab testing of concrete from the upper-level parking garage deteriorated floor beams show highly elevated chloride levels over 1%. This level is well above the threshold set in ACI 318 which is 0.15%. This chloride level represents a high risk for corrosion of reinforcement.

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CONCLUSIONS

Based on our visual observations and isolated destructive test cuts, we conclude the following:

1. Failing mortar joints at the cast stone coping and brick masonry veneer on the east exterior wall of the parking garage allows water to migrate into the wall assembly causing efflorescence and interior leakage.

2. Failing mortar joints at the cast stone coping and brick masonry veneer on the south exterior wall of the parking garage allows water to migrate into the wall assembly causing efflorescence and interior leakage.

3. Failing mortar joints at the cast stone coping and brick masonry veneer on the south exterior wall of the parking garage allows water ingress creating cracks, spalls, and damage to the cast stone and displaced brick.

4. Failing mastic coatings and sealants along the metal counter flashings and suspect roof membrane terminations at the south exterior wall of the parking garage and along the east terrace (south unit) at the first-floor level allows water to enter the exterior wall and slab assemblies causing damage and resulting in leakage within the exterior walls and the parking garage below.

5. Failing sealants along the roof membrane terminations and termination bars and open mortar joints at concrete intersections and coping caps at the east terrace (north unit) on the first-floor level allows water to enter the exterior wall and slab assemblies causing damage and resulting in leakage within the exterior walls and the parking garage below.

6. Failing mortar joints along the top of wall and at the cast stone coping on the pool headhouse structure is causing efflorescence and may result in damage to wall components and cause interior leakage.

7. Improper concrete cover and exposure to environmental elements has caused corrosion of steel reinforcement beneath the loading dock, causing spalled concrete and local deterioration of the concrete slab structure.

8. Cracks in cast-in-place concrete walls at the perimeter of the loading dock allow water to migrate into the concrete structure causing potential damage to reinforcement steel and water leakage at the interior of the parking garage.

9. Failing traffic coating and surface-applied sealants at the loading dock has allowed water ingress, damage to concrete reinforcing steel, and water leakage within the parking garage as well as accumulated water within the enclosed concrete structure beneath the loading

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dock. Deicing salts has caused elevated chloride levels in concrete which has accelerated corrosion of concrete reinforcing steel.

10. Deicing salts and accumulated moisture at the loading dock stairs has caused the concrete to fail.

11. Lack of through wall flashings along the loading dock ramp, stairs, and louvers allows water to migrate to the parking garage resulting in leakage.

12. Cold joints, honeycombs, cracks, and defects in the exposed concrete foundation wall at the east side of the loading dock allow water into the wall causing further damage and deterioration and leakage into the parking garage.

13. Perimeter sealants at the south brick masonry exterior wall of the first-floor common area have passed their useful service life allowing water into the wall assembly and the interior.

14. Glazing gaskets and sealants on the storefronts at the south elevation of the first-floor common area have passed their useful service life allowing water into the wall assembly and the interior.

15. Perimeter sealants on the storefronts at the south elevation of the first-floor common area have passed their useful service life allowing water into the wall assembly and the interior.

16. Open mortar and failed surface-applied sealants at the cast stone curbs beneath the storefront windows/doors at the south wall of the first-floor common area allow water into the assembly and the interior.

17. Surface-applied sealants at the planter walls on first floor common terrace have passed their useful service life allowing water into the wall assembly.

18. Failing mortar and/or sealants at the common terrace planter copings and brick veneer allows water ingress causing further damage and efflorescence.

19. Mortar build-up in the surface drains at the common terrace has reduced water discharge and drainage capacity. This reduction in capacity can lead to flooding of the terrace and leakage to the interior.

20. Mortar applied over the weep holes in the common terrace drains prevents water from draining from the split slab. The buildup of water within the split slab causes leakage into the common area at the first-floor level and into the upper-level parking garage ceiling.

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21. Straw vent weeps used to drain the exterior wall cavity into the split slab at the common terrace are clogged and are not adequate to properly discharge water from the exterior cavity wall assembly. Water that flows down the wall cavity cannot properly discharge above grade, to the exterior. Instead, water in the cavity flows downward to the base of the wall where it becomes trapped and migrates into the stud wall, past interior finishes and into the first-floor common area.

22. Cracks and failing and/or missing traffic coatings on the upper parking garage wearing slab allow water from vehicle run off to migrate into the concrete slab/beams causing corrosion of reinforcing steel and leaks into the lower-level parking garage.

23. Cracks and spalls in the concrete around drains, failing drain bodies, and failing traffic coatings around the drains at the upper level parking garage allow water to migrate through the slab, around the drains.

24. Deicing salts carried into the parking garage from vehicle runoff has caused elevated chloride levels in cracked concrete, which has accelerated corrosion of concrete reinforcing steel causing cracks and spalls.

25. Inadequate concrete cover over some lower reinforcement steel in the concrete beams at the elevated parking garage slab has caused the beams to spall and delaminate from the tensile stresses placed on the concrete beams as result of the corrosion process.

26. Cracks in the slab on grade, failing slab drains and potentially cracked subsurface drainage piping allow groundwater to penetrate through the slab causing leakage onto the lower-level parking surface.

27. Failed seals at pipe penetrations through the pool walls and floor allow pool water to migrate through the pool structure and the concrete foundation resulting in calcium carbonate buildup on the surfaces of the foundation walls, sub structural slab, and slab on grade below.

28. Failed seals at conduit penetrations through the pool deck allow water that flows between the split slab to migrate between the structural slab and the conduit and leak to into the lower-level pool area.

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RECOMMENDATIONS

Based upon or observation, water penetration resistance testing, sample openings, and conclusions, we recommend the following:

1. Cut and point the coping stones along the parking garage east foundation wall and cover the coping stones with membrane waterproofing and metal coping covers.

2. Remove the ivy from the east foundation wall and cut/point the brick masonry veneer.

3. Replace the damaged cast stone coping elements at the parking garage south foundation wall.

4. Cut and point the coping stones along the parking garage south foundation wall and cover the coping stones with membrane waterproofing and metal coping covers.

5. Cut and point the brick masonry wall at the upper level of the parking garage on the south elevation.

6. Cut and point the coping stones at the pool headhouse and cover the coping stones with membrane waterproofing and metal coping covers.

7. Remove and replace the storefront windows and entrance doors at the common terrace area on the first and second floor levels.

8. Remove the stone curb beneath the storefront windows on the south exterior wall of the first-floor common area, install a new waterproofing membrane and new curb.

9. Remove and replace the perimeter sealants and masonry sealants at the south exterior wall of the first-floor common area.

10. Remove approximately 3ft of the south exterior wall above the terrace along the first-floor common area and the brick masonry above the planters. Install new through wall flashing with end dams, brick masonry with weep vents, new steel stud repairs, exterior sheathing, water barrier, insulation, and interior drywall.
    a. Remove end walls of the planters as required to complete this repair work or remove the planters in their entirety.

11. Sawcut a 3ft x 3ft area of the terrace slab around each of the two exterior terrace drains, remove the existing drains and replace them with new bi-level drains. Apply fluid applied waterproofing membrane on the structural slab that extends into the new drain bodies. Install drainage mat and new concrete patch to match the existing terrace concrete surface.

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12. Sawcut a 2ft x 2ft area of the pool deck topping slab at four locations where conduits penetrate the structural slab. Apply fluid-applied waterproofing at the conduit penetrations. Install new concrete patch to match the existing pool deck surface.

13. Remove loose concrete from concrete beams at the slabs in the parking garage and adjacent concrete, as required to expose sound, non-corroded reinforcement steel. Remove corroded reinforcement steel and replace in kind then patch concrete in kind.

14. Remove concrete at cracks in beams at the elevated slabs in the parking garage and adjacent concrete, as required to expose the reinforcement steel. Remove corroded reinforcement steel and replace in kind then patch concrete in kind.

15. Remove and replace selective drains at the elevated parking garage slab.

16. Remove the existing coating from the loading dock, repair deteriorated concrete, install new heavy duty traffic coating that extends across the loading dock slab and up the two exposed concrete walls at the perimeter. Remove and replace the existing drain body in kind.

17. Saw cut an access door in the side of the concealed chamber beneath the loading dock for inspection and repairs.

18. Remove loose concrete from the exposed concrete beams beneath the loading dock and adjacent concrete, as required to expose sound, non-corroded reinforcement steel. Remove corroded reinforcement steel and replace in kind with epoxy coated steel, then patch concrete. Concrete patches shall provide additional concrete cover over the steel reinforcement.

19. Rout and remove the loose concrete and honeycombs at the east foundation wall of the loading dock. Repair any reinforcing steel that is exposed as part of the concrete removal. Coat the exposed concrete wall with a vapor permeable water resistive coating.

20. Remove the existing pavers and the roof membrane from the east terrace (Unit 106) at the first-floor level. Remove and replace the existing roof drain body. Install a new fully adhered hot fluid-applied waterproofing membrane such as American Hydrotech MM6125 or a cold fluid-applied membrane such as Kemper 2K-PUR. Install self-adhered membrane over the concrete parapet wall and cover with metal panels that tie-in to the new metal coping cover. Install new pavers on pedestals over a drainage mat. Also, install new masonry through wall flashings with weep vents at the exterior wall, above the new waterproofing system.

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21. Install new masonry through wall flashings with weep vents at the exterior wall, above the new waterproofing system at the east terrace (south of Unit 106).

22. Install coating on the concrete slab in the room beneath the pool (including beneath the pool structure) to prevent the passage of water to the green street parking garage.

PRELIMINARY BUDGETS

The following list provides a summary breakdown of the recommended scope of renovations and associated budgetary prices for each work item. Prices include labor, materials, General Conditions (supervision, daily cleanup, etc.), work area access, pedestrian protection, and all permits and associated fees.

1. Repairs at South Exterior Wall of First-Floor Common Area – ***Option 1***:

   - Remove planter walls as required to complete the exterior wall repairs.
   - Demo exterior wall as required to complete the exterior wall repairs.
   - New steel stud repairs, through wall flashing, exterior sheathing, water resistive barrier, insulation, and interior drywall.
   - Reinstall brick masonry wall veneer that was removed.
   - Restore planter walls, waterproofing within the planters, and soil/plantings.

   Subtotal Budget for Repairs @ South Exterior Wall of 1st Floor $97,000

2. Repairs at South Exterior Wall of First-Floor Common Area – ***Option 2***:

   - Remove planter walls in their entirety.
   - Demo exterior wall as required to complete the exterior wall repairs.
   - New steel stud repairs, through wall flashing, exterior sheathing, water resistive barrier, insulation, and interior drywall.
   - Reinstall brick masonry wall veneer that was removed.
   - Pour new concrete slab where planters are removed to match the existing adjacent terrace surface.

   Subtotal Budget for Repairs @ South Exterior Wall of 1st Floor $122,000

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3. Replacement of Storefront Windows and Entry Doors @ 1st floor Common Area Terrace:

   - Remove and dispose of the existing storefront windows and entry doors.
   - Supply and install new pan flashings beneath storefront windows.
   - Supply and install new storefront windows and entry doors.
   - Supply and install new perimeter sealants at storefront windows and entry doors.

   Subtotal Budget for Replacement of Storefront Windows and Entry Doors…... $169,000

4. Replacement of Storefront Windows and Entry Doors @ 2nd floor Common Area Terrace (south common area wall):

   - Remove and dispose of the existing storefront windows and entry doors.
   - Supply and install new pan flashings beneath storefront windows.
   - Supply and install new storefront windows and entry doors.
   - Supply and install new perimeter sealants at storefront windows and entry doors.

   Subtotal Budget for Replacement of Storefront Windows and Entry Doors…... ..$40,000

5. Repairs at Common Terrace Drains:

   - Sawcut 3ft x 3ft area of topping slab at two locations.
   - Remove existing drains and replace them with new bi-level drains.
   - Install fluid-applied waterproofing from the drain bodies onto the structural slab.
   - Install drainage mat and concrete patches to match the surface of the terrace.

   Subtotal Budget for Repairs @ Exterior Common Terrace Drains $13,000

6. Repairs at East Wall of the Parking Garage:

   - Remove and dispose of the ivy on the wall.
   - Cut and point the brick masonry mortar on the entire east wall from the ground to the coping.

   Subtotal Budget for Repairs at East Wall of the Parking Garage $195,000

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7. Metal Coping Cover at East Wall of the Parking Garage – Alternate 1:

   - Supply and install high-temperature, self-adhered membrane on the coping stone.
   - Supply and install new metal coping cover over the existing cast stone coping.

   Subtotal for New Aluminum Coping at East Wall of the Parking Garage……..$17,000
   Subtotal for New Leas Coated Copper Coping at East Wall of the Parking …....$21,000

8. Repairs at South Wall of the Parking Garage:

   - Remove and replace two damaged cast stone coping pieces.
   - Cut and point all brick mortar on the wall from the base to the coping.
   - Supply and install high-temperature, self-adhered membrane on the coping stone.
   - Supply and install new metal coping cover over the existing cast stone coping.

   Subtotal Budget for Repairs at the South Wall of the Parking Garage.....$95,000

9. Repairs at East Terrace (Unit 106):

   - Remove three courses of brick for new through wall flashing.
   - Supply and install lead coated copper through wall flashing.
   - Install three courses of brick with weep vents.
   - Remove and dispose of the pavers.
   - Remove and dispose of the rubber roofing.
   - Supply and install new self-adhered waterproofing membrane on the terrace concrete and up the rising walls.
   - Supply and install lead coated copper panel cladding on the parapet wall to cover the new waterproofing.
   - Supply and install drainage mat and existing pavers on new pedestals.

   Subtotal Budget for Repairs at East Terrace (Unit 106) $146,000

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10. Repairs at East Terrace (Unit south of 106):

- Remove three courses of brick for new through wall flashing.
- Supply and install lead coated copper through wall flashing.
- Install three courses of brick with weep vents.

***Subtotal Budget for Repairs at East Terrace (Unit - 106)*……... 35,000**

11. Repairs at the Loading Dock:

- Sawcut concrete and install access panel for future inspection and repairs of space beneath the loading dock.
- Demo existing loose traffic coating, repair damaged concrete slab, and prep for new traffic coating.
- Remove the existing drain body and install new drain body in kind. Cut and patch concrete, as required.
- Remove/replace sealants on concrete rising walls adjacent to the loading dock.
- Supply and install new heavy duty traffic coating at the dock slab, parapet wall, and wall between dock and terrace.
- Repair concrete beams and reinforcing beneath the loading dock, at the east wall.
- Repair concrete cracks and spalls at east wall.
- Reinstall existing diamond plate protection at same location.

***Subtotal Budget for Repairs at the Loading Dock*.....$76,500**

12. Through Wall Flashing at Loading Dock:

- Remove three courses of brick for new through wall flashing.
- Supply and install lead coated copper through wall flashing.
- Install three courses of brick with weep vents.

***Subtotal Budget for Through Wall Flashing at the Loading Dock*……..…... $30,000**

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13. Repairs at the Pool Terrace Area:

- Sawcut 2ft x 2ft area in the concrete topping slab at four locations.
- Install waterproofing at penetrations through the structural slab.
- Place new concrete to match the existing adjacent surface of the terrace concrete.

Subtotal Budget for Repairs at the Pool Terrace Area **.....$5,000**

14. Repairs at the Pool Scuppers:

- Sawcut pool deck to expose pool scuppers.
- Dig around scuppers as required to expose scupper to piping connections.
- Install waterproofing at pool scupper to piping.
- Place new concrete to match the existing adjacent surface of the terrace concrete.

Subtotal Budget for Scupper Repairs (each) **……$4,000**

15. Repairs at the Pool Head House:

- Cut and point all brick mortar on the structure.
- Supply and install new metal coping cap to cover the cast stone coping.

Subtotal Budget for Repairs at the Pool Head House **.....…….$65,000**

16. Repairs Within the Upper-Level Parking Garage:

- Rout and seal cracks in the surface of the upper-level parking slab.
- Repair damaged concrete beams, including new steel reinforcement (incl. 10lf @ 3" depth).
- Supply and install new heavy duty traffic coating system.
- Paint/stripe parking spots.

Subtotal Budget for Repairs within the Upper-Level Parking Garage **.....$668,000**

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17. Repairs Within the Lower-Level Parking Garage:

- Rout and seal cracks in the surface of the upper-level parking slab.
- Repair damaged concrete beams, including new steel reinforcement (incl. 10lf @ 3" depth).
- Supply and install new heavy duty traffic coating system.
- Paint/stripe parking spots.

Subtotal Budget for Repairs within the Lower-Level Parking Garage**.....$692,000**

18. Replace Elevated Parking Garage Floor Drains:

- Sawcut elevated concrete deck and remove the existing drain body.
- Install new drain body and connect to existing drain piping.
- Form and pour concrete patch to match the existing adjacent surface.
- Apply traffic coating over new concrete patch.

Subtotal Budget for New Elevated Parking Garage Floor Drains (each)**……..…$4,500**

19. Coating on the Concrete Slab beneath the Pool Area:

- Clean and prep concrete slab for new coating.
- Install a new waterproof coating on the slab.

Subtotal Budget for New Coating on Slab Beneath Pool Area**…….....$33,500**

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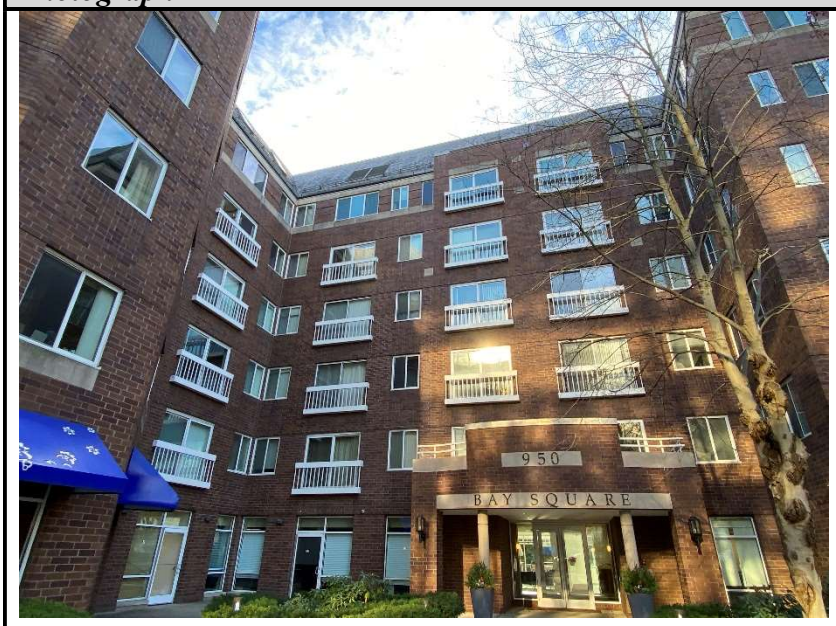
PHOTOGRAPHIC DOCUMENTATION

The following matrices include captioned, representative photographs with summary descriptions of our visual observations.

Photograph	*Description*
	**Photo 1:** Partial overall view looking at the front door on the Massachusetts Avenue elevation. (front of building)
	**Photo 2:** Partial overall view of the elevation along Bay Street. (right side of building when looking at the front of building)

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Photograph	*Description*
	**Photo 3:** Partial overall view of the elevation on Green Street. (back of the building)
	**Photo 4:** Failed mortar joints at east wall coping stone and brick masonry veneer.

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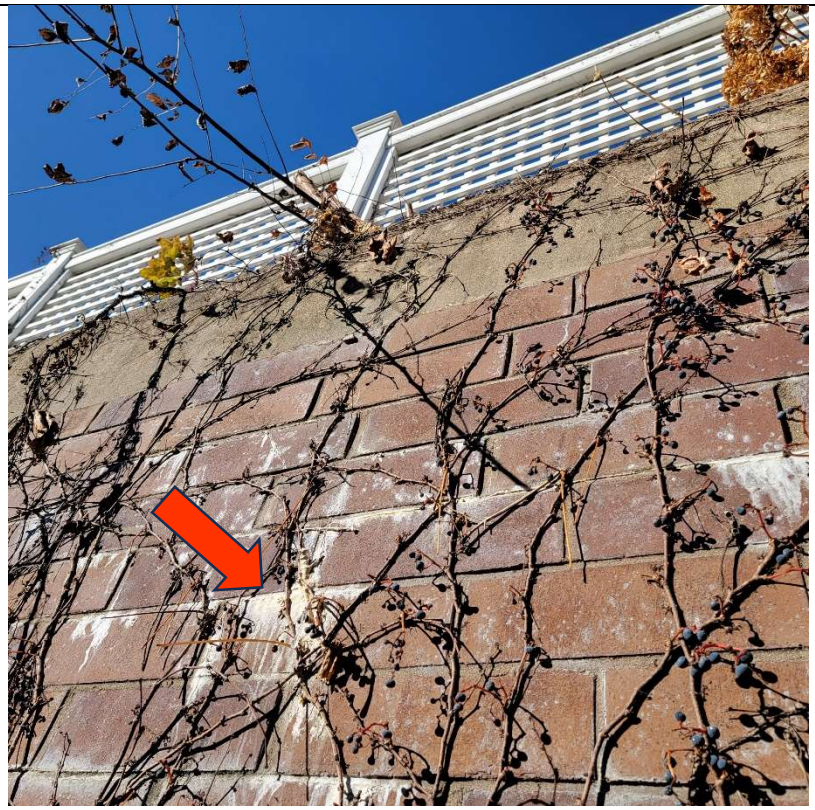
Photograph	*Description*
	**Photo 5:** Failed coping stone mortar joints at east wall.
	**Photo 6:** Ivy and efflorescence on east wall of parking garage.

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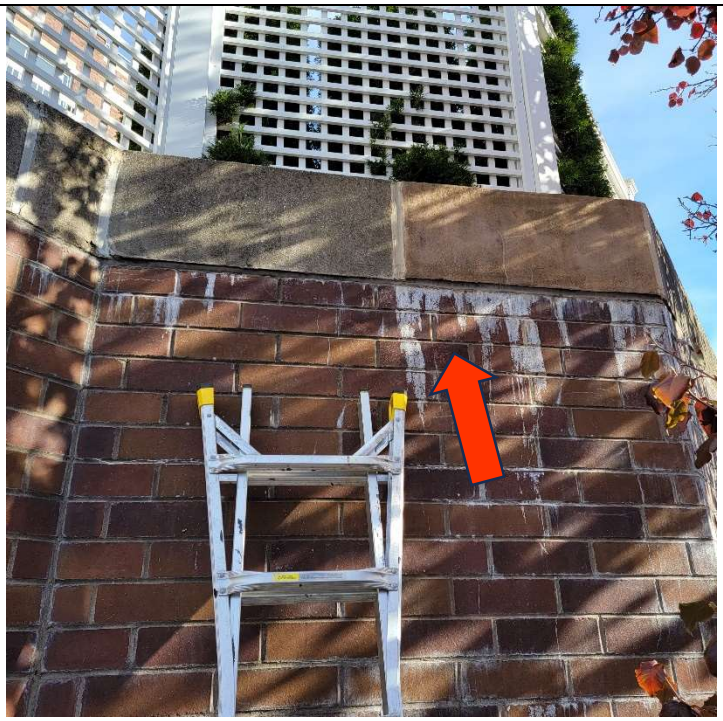
Photograph	*Description*
	**Photo 7:** Spalled/damaged coping stones at south elevation of parking garage.
	**Photo 8:** Cracked, deteriorated, open, and missing mortar and efflorescence on the south exterior wall of the parking garage.

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Photograph	*Description*
	**Photo 9:** Cracked, deteriorated, open, and missing mortar as well as displaced brick masonry veneer and efflorescence on the south exterior wall of the parking garage.
	**Photo 10:** Failing mastic coatings along the metal counter flashings at the south exterior wall of the parking garage

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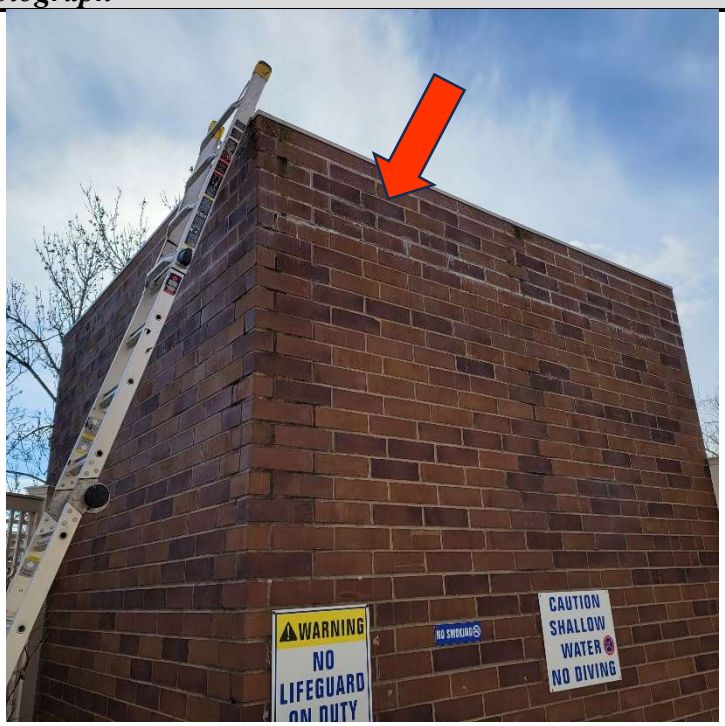
Photograph	*Description*
	**Photo 11:** Cracked and open mortar joints at the cast stone coping and brick masonry veneer as well as efflorescence on the pool headhouse structure
	**Photo 12:** Cracked and open mortar joints at the cast stone coping and brick masonry veneer as well as efflorescence on the pool headhouse structure

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Photograph	*Description*
	**Photo 13:** Failing mastic coatings along the metal counter flashing and damaged/open masonry on the east exterior wall of the building at the terrace on the first-floor level
	**Photo 14:** Failed sealants and open mortar joints at the Unit 106 terrace on the first-floor level.

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Photograph	*Description*
	**Photo 15:** Failed sealants at concrete-to-concrete wall joints at the Unit 106 terrace on the first-floor level.
	**Photo 16:** Failing surface-applied sealants along the roof membrane termination and termination bar at the Unit 106 terrace on the first-floor level

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Photograph	*Description*
	**Photo 17:** Deteriorated and spalled concrete structure beneath the loading dock platform at the east side of the building with exposed, deteriorated, and corroded steel reinforcing steel

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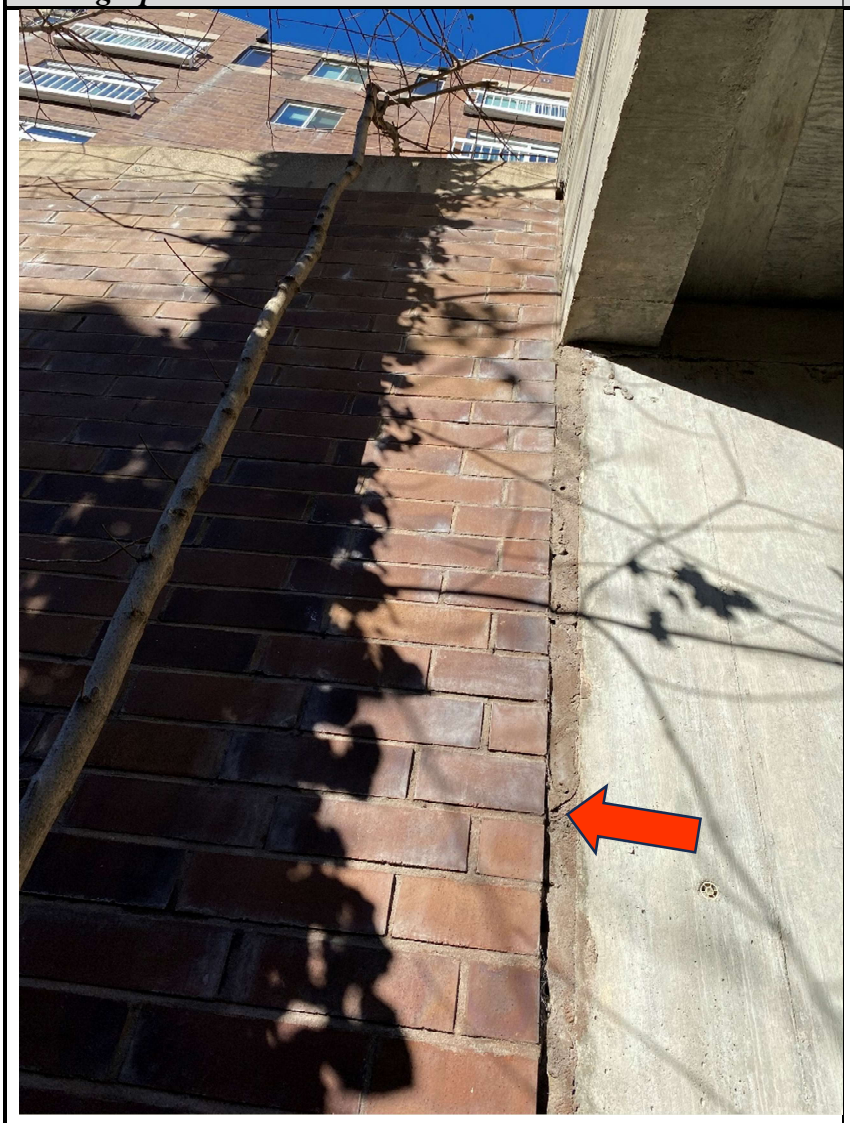
Photograph	*Description*
	**Photo 18:** Open/failing joint between the brick masonry and concrete wall at the east elevation of the parking garage

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Photograph	*Description*
	**Photo 19:** Gaps, honeycombs, and cracks in the exterior concrete wall at the east side of the loading dock
	**Photo 20:** Holes in the concrete foundation wall at the front of the loading dock, constructed by others. We were told that water leaked out of these holes, once constructed.

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Photograph	*Description*
	**Photo 21:** Spalls concrete at the loading dock slab and stairs
	**Photo 22:** Spalls concrete at the loading dock slab and stairs

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Photograph	*Description*
	**Photo 23:** Perimeter sealants at the south brick masonry exterior wall of the first-floor common area that have passed their useful service life

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Photograph	*Description*
	**Photo 24:** Open mortar and failed surface-applied sealants at the cast stone curbs beneath the storefront windows/doors at the south wall of the first-floor common area
	**Photo 25:** Cracks withing the brick veneer mortar and efflorescence on the brick masonry at the first-floor common terrace

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Photograph	*Description*
	**Photo 26:** Surface drains at the terrace that have limited drainage due to mortar buildup at the drain opening and have mortar covering the weep holes around the drain bowl preventing water from evacuating from the split-slab construction
	**Photo 27:** Surface-applied sealants at the pool area have failed allowing water to migrate into the split slab construction and possibly into the lower-level pool area through unsealed penetrations in the structural slab

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Photograph	*Description*
	**Photo 28:** Moisture, corroded studs, and dirt within the exterior wall assembly at the south elevation of the first-floor common area

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Photograph	*Description*
	**Photo 29:** Calcium carbonate build-up beneath pipe penetrations through the concrete foundation walls beneath the pool
	**Photo 30:** Calcium carbonate build-up beneath pipe penetrations through the concrete foundation walls beneath the pool

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Photograph	*Description*
	**Photo 31:** Calcium carbonate build-up around pipe penetrations through the concrete slab beneath the pool. Also, water/moisture on the concrete slab on grade beneath the pipe penetrations
	**Photo 31a:** Ponded water on the slab beneath the pool.

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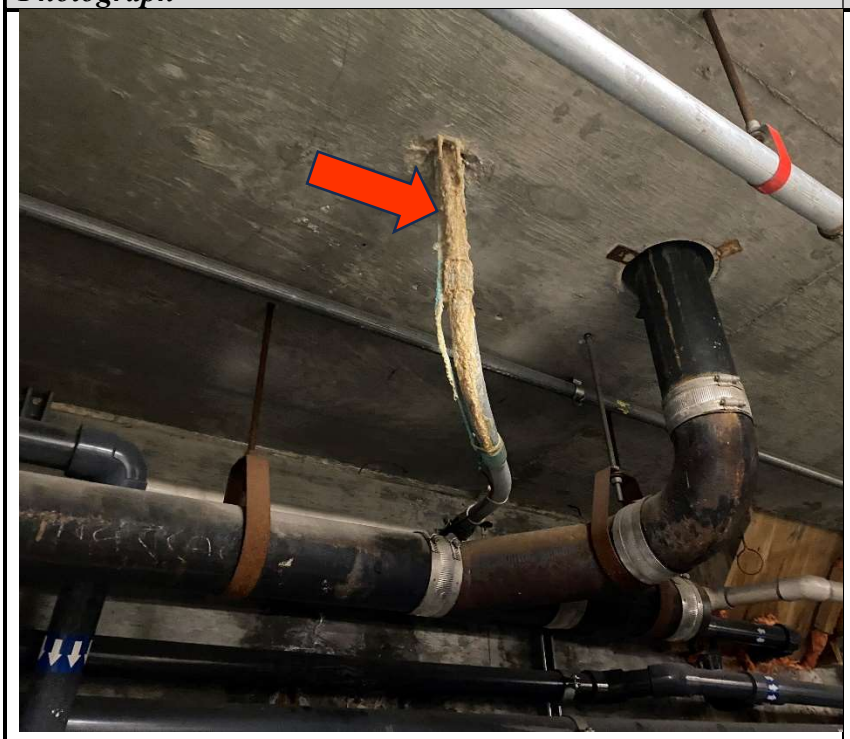
Photograph	*Description*
	**Photo 32:** Calcium carbonate build-up around conduit and conduit penetrations beneath the pool terrace

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Photograph	*Description*
	**Photo 33:** Cracks and previous injection repairs at the east foundation wall in the parking garage
	**Photo 34:** Cracks and previous injection repairs at the underside of the concrete slab/ceiling beneath the east terrace, in the upper-level parking garage

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Photograph	*Description*
	**Photo 35:** Cracks in concrete beams at ceiling in the garage
	**Photo 36:** Delaminated concrete beams with exposed and corroded rebar at ceiling in the garage

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Photograph	*Description*
	**Photo 37:** Hairline cracks in the underside of the concrete slab in the parking garage
	**Photo 38:** Cracks in the wearing surface of the parking garage slabs with failing repair sealants and water around drains

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Photograph	*Description*
	**Photo 39:** Water was applied to the storefront windowsill for thirty minutes. Ten minutes after the test began, water was observed seeping through the brick. Water was also observed building up in the cavity at base of the wall.
	**Photo 40:** Water was applied to the storefront windowsill for thirty minutes. Ten minutes after the test began, water was observed seeping through the brick. Water was also observed building up in the cavity at base of the wall.

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Photograph	*Description*
	**Photo 41:** Water was applied to the bottom of the entry door for twenty-five minutes. After fifteen minutes, water was observed seeping beneath the carpet and leaking over the threshold, beneath the entry door.
	**Photo 42:** Water was applied to the bottom of the entry door for twenty-five minutes. After fifteen minutes, water was observed seeping beneath the carpet and leaking over the threshold, beneath the entry door.

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Photograph	*Description*
	**Photo 43:** Corroded steel studs and steel bottom track, wet insulation, deteriorated exterior sheathing, and water within the pea stone in the cavity. Steel studs are not in contact with the bottom track due to excessive corrosion. Straw vent weeps are installed between the split slab and extend up into the brick cavity wall.
	**Photo 44:** Corroded steel studs and steel bottom track, wet insulation, deteriorated exterior sheathing, and water within the pea stone in the cavity. Steel studs are not in contact with the bottom track due to excessive corrosion.

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Photograph	*Description*
	**Photo 45:** Traffic coating on the loading dock slab that has failed and debonded from the concrete slab.
	**Photo 46:** Deteriorated concrete slab with exposed aggregate and moisture within the concrete slab.

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Photograph	*Description*
	**Photo 47:** Reinforcing steel with no evidence of corrosion at the upper-level parking garage floor beam.
	**Photo 48:** Proper concrete cover over the reinforcing steel at the upper-level parking garage floor beam.

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Photograph	*Description*
	**Photo 49:** Overall view of the south entry wall leading to the common terrace.
	**Photo 50:** Overall view of the west planter at the common terrace on the south side of the lobby.

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We trust this report meets your needs at this time. Feel free to contact us to discuss the report and next steps. We would be happy to prepare repair drawings and specifications that may be used for bidding, permitting, and construction. In the meantime, if there are questions, comments, or concerns, please do not hesitate to contact me directly at 978-877-3447.

Respectfully,
BRS/BUILDING RECON SERVICES

Joshua Kelly, RA
Director/Building RECON Services