



Engineering Investigation

Parking Garage Condition Assessment

NWS1389

The Willows

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Cover Letter

Absolute Building Science
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#234 – 5589 Byrne Road
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April 2, 2019

Strata Plan NWS1389
The Willows
1121 & 1103 Howie Avenue,
Coquitlam, BC V3J 1T9

Attention: Martin Carey

RE: Parking Garage Condition Assessment for the Strata Plan NWS1389

Dear Mr. Carey,

The subject of this report is regarding the conditions of the underground parking garages and their waterproofing membranes at the “The Willows”, a 90-unit, low-rise residential complex consisting of two buildings, constructed Circa 1979. Active water ingress was reported at the parking garages’ ceilings and walls. Our on-site investigation was aimed to identify the sources of the reported water ingress and other deficiencies within the underground parking garages.

In this report we are describing our observations and conclusions regarding the condition of the parking garages and repair strategies.

Respectfully yours,

Absolute Building Science
Strata Engineering Inc.

Per:

Written By:


Tyson Bolderston, Dipl.T.

Project Technologist

Reviewed By:


David Shi, P.Eng.

Project Engineer

APR 11 / 2 / 2019



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1.0 Terms of Reference

1.1 Objectives

Our on-site investigation was aimed to identify the sources of the reported water ingress and other deficiencies within the underground parking garages.

2.0 Methodology

2.1 Design Review

The following design documentation was made available for our review:

- Garage Drainage Field reviews (1-6) prepared by CSA Building Sciences Western Ltd., dated (December 2016 - March 2017).
- Garage Waterproofing Project Manual prepared by CSA Building Sciences Western Ltd., dated August 15th, 2016.

2.2 Field Review

Tyson Bolderston, Dipl.T. of Strata Engineering has performed the inspection on March 19th, 2019.

The scope of our study does not include a specific review for compliance with the British Columbia Building Code. We relied on design professionals to have prepared designs that comply with Code. However, as professional engineers, we are obligated to report any readily discoverable code violations noted during our site work.

2.2.1 Areas visually surveyed

During the inspection, we visually reviewed the overall accessible areas of the underground parking garages, including utility and storage rooms, and the exterior areas above the underground parking garages. In addition, we excavated landscaping above the parking garages in several locations to review the condition of the underlying waterproofing membranes of the parking garages. The investigation was primarily focused on the east building (1121 Howie Avenue), where the majority of the water ingress was reported.



3.0 Results


3.1 Building Information

Table 1: Building information.

The Willows	
Municipal Address	1121 & 1103 Howie Avenue, Coquitlam
Strata Plan	NWS1389
Real Property Type	Four-storey residential low-rise apartment buildings (Two Buildings)
Units	90
Year of Construction	Circa 1979

3.2 Design Review

Table 2: Building composition.

Composition	Photo
<ul style="list-style-type: none">• Wood-framed superstructure on a cast-in-place reinforced concrete parking garage substructure (beams, columns, and suspended slabs).• Primarily hot-rubberized parking garage waterproofing membranes.	



3.3 Observed Defects

Table 3: Observations.




Photo	Observations
	<p><u>Location:</u> East building garage – Around an exhaust penetration.</p> <p><u>Defect:</u> Widespread moisture staining and efflorescence.</p> <p><u>Remarks:</u> The waterproofing around the penetration has failed.</p>
	<p><u>Location:</u> East building garage - East wall near the entrance.</p> <p><u>Defect:</u> Efflorescence and elevated moisture readings around a hairline crack.</p> <p><u>Remarks:</u> The waterproofing for the foundation wall has failed.</p>
	<p><u>Location:</u> East building garage - East wall near the entrance.</p> <p><u>Defect:</u> Efflorescence and staining around hairline cracks.</p> <p><u>Remarks:</u> The waterproofing for the foundation wall has failed.</p>



Figure 4

Location: East building garage - Electrical utility boxes at parking stall 19.

Defect: Efflorescence.

Remarks: The waterproofing for the foundation wall has failed.



Figure 5

Location: East building garage – Wall by the parking stall #26.

Defect: Efflorescence and moisture staining.

Remarks: The waterproofing around the fresh air intake may have failed.



Figure 6

Location: East building garage - Storm drain penetration.

Defect: Moisture staining surrounding a storm drain penetration through the slab.

Remarks: The waterproofing has failed around the exterior of the drain.



Figure 7

Location: East building garage - Suspended ceiling slab.

Defect: Widespread moisture staining on the ceiling.

Remarks: The moisture ingress is likely occurring at the exterior (non-insulated side) and migrating to the interior (insulated side) due to various waterproofing defects.



Figure 8

Location: See above.

Defect: See above.

Remarks: See above.



Figure 9

Location: East building garage – ceiling by the parking stall #5.

Defect: Efflorescence and moisture staining.

Remarks: The water ingress is originating at the ceiling slab.



Figure 10

Location: See above.

Defect: See above.

Remarks: See above.



Figure 11

Location: West building garage - Wall beside the west exit stairwell.

Defect: Evidence of water ingress.

Remarks: Based on the pattern of the staining, the waterproofing for the concrete stairs has likely failed.



Figure 12

Location: West building garage - Parking stall 8.

Defect: High moisture reading and rusty moisture staining around a hairline crack.

Remarks: The waterproofing for the foundation wall has failed.



Figure 13

Location: West building garage - Parking stall 7.

Defect: High moisture reading and rusty moisture staining around a hairline crack.

Remarks: The waterproofing for the foundation wall has failed.



Figure 14

Location: East building garage - Ceiling at parking stall 22.

Defect: Widespread efflorescence in the ceiling slab.

Remarks: The waterproofing membrane has failed.

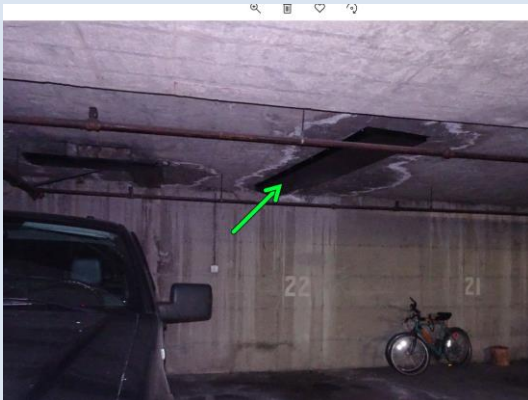


Figure 15

Location: See above.

Defect: See above.

Remarks: See above.



Figure 16

Location: East building garage - South west parking area.

Defect: Exposed, corroding rebar, and spalling concrete.

Remarks: The exposed rebar is resulting in spalling damage to the surrounding concrete.



Figure 17

Location: East building garage - South west parking area.

Defect: Exposed, corroding rebar, and spalling concrete.

Remarks: The exposed rebar is resulting in spalling damage to the surrounding concrete.



Figure 18

Location: East building garage - South west parking area.

Defect: Exposed, corroding rebar, and spalling concrete.

Remarks: The exposed rebar is resulting in damage to the surrounding concrete.



Figure 19

Location: East building garage - South west parking area.

Defect: Exposed, corroding rebar, and spalling concrete.

Remarks: The exposed rebar is resulting in damage to the surrounding concrete.



Figure 20

Location: East building garage - Storm drain penetration through the ceiling slab.

Defect: Efflorescence around the penetration.

Remarks: Waterproofing around the exterior drain has failed.



Figure 21

Location: East building garage - drain penetration through the ceiling slab.

Defect: Efflorescence around the penetration.

Remarks: This drain appears to be under the building's footprint, further investigation is required to determine the source of this leak.



Figure 22

Location: West building garage - Storm drain penetration.

Defect: None.

Remarks: Some of the drains in the west building have been retrofitted; they appear to be performing adequately.



Figure 23

Location: West building garage - Bulkhead for the fresh air intake.

Defect: Efflorescence and moisture staining surrounding the bulkhead.

Remarks: Rainwater may be leaking into the ductwork, further investigation is required.



Figure 24

Location: West building garage - Bulkhead for the fresh air intake.

Defect: Efflorescence and moisture staining surrounding the bulkhead.

Remarks: Rainwater may be leaking into the ductwork, further investigation is required.



Figure 25

Location: East building garage - Drain from mechanical room.

Defect: Efflorescence in the slab on grade.

Remarks: A leak in the mechanical room has resulted in this condition. (Unrelated to parkade waterproofing)

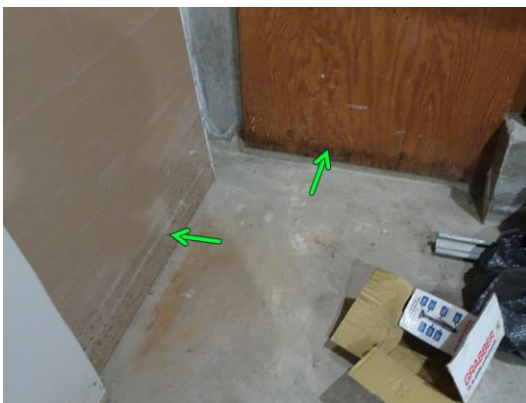


Figure 26

Location: East building garage - Electrical room.

Defect: Mildew on the drywall and plywood.

Remarks: Reportedly, there is flooding in this room during heavy rainfall. This is most likely related to a failed foundation waterproofing or deficient foundation drainage system.



Figure 27

Location: East building exterior - Exhaust penetration waterproofing.

Defect: Previous waterproofing repairs were observed. However, the adjacent damp-proofing is weathered.

Remarks: Waterproofing for this area is inconsistent.



Figure 28

Location: See above.

Defect: See above.

Remarks: See above.



Figure 29

Location: East building exterior -
Throughout.

Defect: Weathered and inconsistent
waterproofing.

Remarks: The waterproofing is in poor
condition.



Figure 30

Location: East building exterior -
Throughout.

Defect: Weathered waterproofing.

Remarks: The waterproofing is in poor
condition.



Figure 31

Location: East building exterior - North elevation perimeter.

Defect: Exposed concrete slab.

Remarks: Poor coverage of waterproofing.

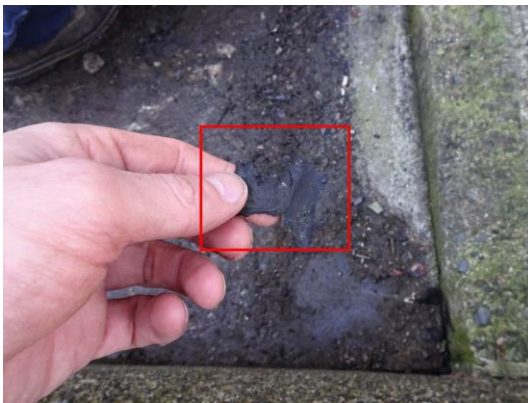


Figure 32

Location: East building exterior - North elevation perimeter.

Defect: The membrane is easily removed.

Remarks: The waterproofing membrane has exceeded its expected service life.



Figure 33

Location: East building exterior - North elevation perimeter.

Defect: Exposed concrete slab.

Remarks: Poor coverage of waterproofing.



Figure 34

Location: East building exterior - North elevation perimeter.

Defect: Exposed concrete slab and marginal sloping.

Remarks: Poor coverage of waterproofing.



Figure 35

Location: East building exterior - North elevation perimeter.

Defect: Various water filled blisters.

Remarks: The waterproofing membrane has failed.



Figure 36

Location: East building exterior - North elevation perimeter.

Defect: Various water filled blisters.

Remarks: The waterproofing membrane has failed.



Figure 37

Location: East building exterior - North elevation perimeter.

Defect: The waterproofing membrane is removed with little effort.

Remarks: The waterproofing membrane has failed.



Figure 38

Location: East building exterior - North elevation perimeter.

Defect: Water filled blister.

Remarks: The waterproofing membrane has failed.



Figure 39

Location: East building exterior - North elevation perimeter.

Defect: Inconsistent layering of the waterproofing.

Remarks: Poor coverage of the waterproofing membrane.



Figure 40

Location: East building exterior - Throughout.

Defect: The waterproofing is removed with little effort.

Remarks: The waterproofing has failed.



Figure 41

Location: East building exterior - Throughout.

Defect: Weathered waterproofing membrane.

Remarks: The waterproofing membrane has failed.



Figure 42

Location: East building exterior - Various concrete curb areas.

Defect: Minimal waterproofing upturn and cracking in the concrete curb.

Remarks: This area is at a high risk for water ingress.



Figure 43

Location: See above.

Defect: See above.

Remarks: See above.



Figure 44

Location: East building exterior - Various concrete curb areas.

Defect: Weathered waterproofing and cracking in the concrete curb.

Remarks: This area is at a high risk for water ingress.



Figure 45

Location: East building exterior - Various concrete curb areas.

Defect: Weathered waterproofing and cracking in the concrete curb.

Remarks: This area is at a high risk for water ingress.

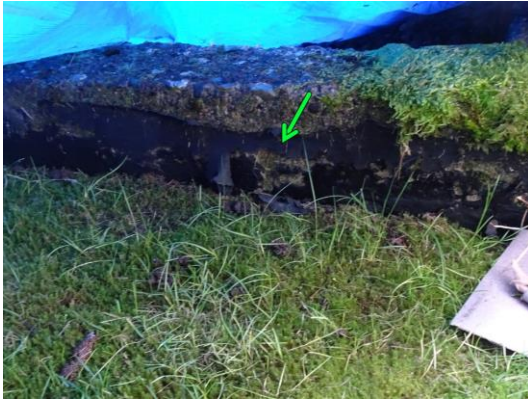


Figure 46

Location: East building exterior - Various concrete curb areas.

Defect: Weathered waterproofing.

Remarks: This area is at a high risk for water ingress.



Figure 47

Location: East building exterior - North elevation perimeter.

Defect: Weathered waterproofing.

Remarks: This area is at a high risk for water ingress.



Figure 48

Location: East building exterior - North elevation perimeter.

Defect: Weathered waterproofing.

Remarks: This area is at a high risk for water ingress.

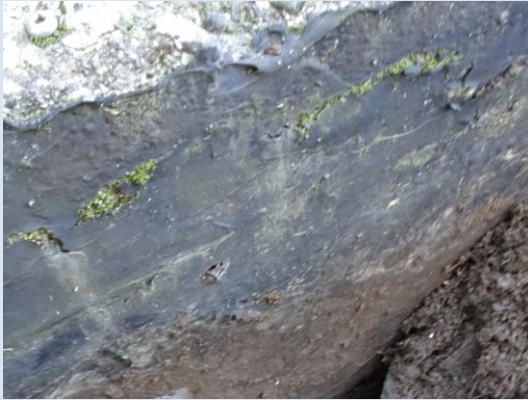


Figure 49

Location: East building exterior - North elevation perimeter.

Defect: Weathered waterproofing.

Remarks: This area is at a high risk for water ingress.



Figure 50

Location: East building - East parking garage wall (exterior).

Defect: Widespread failure of the waterproofing membrane.

Remarks: Replacements are required.



Figure 51

Location: East building - East parking garage wall (exterior).

Defect: Widespread failure of the waterproofing membrane.

Remarks: Replacements are required.



Figure 52

Location: East building - East parking garage wall (exterior).

Defect: Widespread failure of the waterproofing membrane.

Remarks: Replacements are required.



Figure 53

Location: East building exterior - North elevation.

Defect: Various areas are tarped in an attempt to stop water ponding.

Remarks: Drainage will need to be revised for a permanent solution.



Figure 54

Location: East building exterior - North elevation.

Defect: Various areas are tarped in an attempt to stop water ponding.

Remarks: Drainage will need to be revised for a permanent solution.



Figure 55

Location: East building exterior - North elevation.

Defect: Roughly two inches of standing water at areas around the building perimeter.

Remarks: Drainage will need to be revised.



Figure 56

Location: East building exterior - North elevation.

Defect: Standing water.

Remarks: Drainage will need to be revised.



Figure 57

Location: East building exterior - North elevation.

Defect: Standing water.

Remarks: Drainage will need to be revised.



Figure 58

Location: East building exterior - North elevation.

Defect: Standing water.

Remarks: Drainage will need to be revised.



Figure 59

Location: Throughout both buildings.

Defect: Downspouts for the balconies are draining directly into areas surrounding the building perimeter.

Remarks: This condition is contributing to the standing water. Improved storm water management is required.



Figure 60

Location: Throughout both buildings.

Defect: Downspouts for the balconies are draining directly into areas surrounding the building perimeter.

Remarks: This condition is contributing to the standing water. Improved storm water management is required.



Figure 61

Location: Throughout both buildings.

Defect: Downspouts for the balconies are draining directly into areas surrounding the building perimeter.

Remarks: This condition is contributing to the standing water. Improved storm water management is required.



Figure 62

Location: Throughout both buildings.

Defect: Downspouts for the balconies are draining directly into areas surrounding the building perimeter.

Remarks: This condition is contributing to the standing water. Improved storm water management is required.

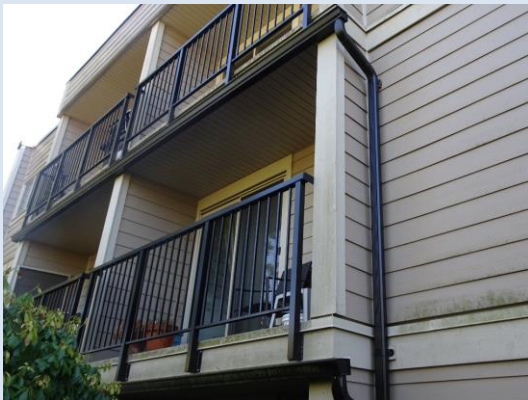


Figure 63

Location: Throughout both buildings.

Defect: Downspouts for the balconies are draining directly into areas surrounding the building perimeter.

Remarks: This condition is contributing to the standing water. Improved storm water management is required.



Figure 64

Location: East building exterior - North elevation.

Defect: N/A.

Remarks: The downspout has been temporarily redirected. Improved storm water management is required for a long term solution.



Figure 65

Location: East building exterior - Patio drain.

Defect: The drain is completely clogged with debris.

Remarks: Improved storm water management and maintenance is required.



Figure 66

Location: East building exterior - East elevation.

Defect: Missing drain cap and debris in drain.

Remarks: Improved storm water management and maintenance is required.



Figure 67

Location: East building exterior - North elevation.

Defect: Poorly protected drainage pipe.

Remarks: The pipe should be fully enclosed in a filter fabric. The perimeter drainage may be clogged with debris.



Figure 68

Location: East building exterior - North elevation.

Defect: Poorly protected drainage pipe and missing drain rock.

Remarks: The pipe should be fully enclosed in a filter fabric. The perimeter drainage may be clogged with debris.



Figure 69

Location: East building exterior - North elevation.

Defect: Various large trees may have potentially damaging roots.

Remarks: The larger trees' roots may be damaging the waterproofing membrane.



Figure 70

Location: East building exterior - North elevation.

Defect: Various large trees may have potentially damaging roots.

Remarks: The larger trees' roots may be damaging the waterproofing membrane.



Figure 71

Location: East building exterior - North elevation.

Defect: Various large trees may have potentially damaging roots.

Remarks: The larger trees' roots may be damaging the waterproofing membrane.



Figure 72

Location: East building exterior - North elevation.

Defect: Various large trees may have potentially damaging roots.

Remarks: The larger trees' roots may be damaging the waterproofing membrane.



4.0 Discussion and Conclusion

During the inspection, we accessed the interior of the parking garage to assess the nature and locations of the reported leaks. The following list is a brief summary of the observed defects found during the interior walkthrough:

- **Widespread efflorescence and moisture staining surrounding an exhaust shaft penetration through the ceiling slab.** Previous repairs were noted around some of the parking garage exhaust shaft penetrations. However, some of the repairs were unsuccessful, this is likely due to a combination of water migrating around the membrane seams, and poor drainage provisions.
- **Widespread moisture staining on the ceiling slab around the footprint of the building.** This condition appears to be a result of failed waterproofing membranes beneath the river-rock planter boxes around the perimeter of the building.
- **Various areas with efflorescence and moisture staining surrounding hairline cracks in foundation walls and ceiling slabs.** Hairline cracks provide avenues for water ingress, providing the waterproofing membranes have failed.
- **Exposed and corroding rebar in the ceiling slab.** This is a casting defect which has worsened over time due to insufficient concrete cover and environmental conditions in the parking garage. This condition will result in continued structural deterioration and weakening of the concrete structure.

Following the interior inspection we investigated the podium area (exterior locations above the parking garage). We performed a general visual review, and carried out several exploratory excavations in localized areas to review drainage, waterproofing membrane conditions, and sloping above the parking garage. The following list is a brief summary of the observed defects found throughout the exterior walkthrough:

- **Severely deteriorated and aged liquid applied hot-rubber membranes.** Aside from previous targeted repairs, the waterproofing membranes are roughly 40 years old. Various deteriorated (failed) areas were observed which provide a means for water ingress into the parking garage.
- **Poorly installed liquid applied hot rubber membranes in planter box areas around the building perimeter.** According to the provided documentation, previous targeted membrane repairs were performed at these locations in conjunction with the exterior cladding work. We found various deficiencies in these membranes, including blisters filled with water, poor membrane adhesion, and poor coverage of the membrane (exposed concrete).



- **Pooling water in planter box areas around the building perimeter.** In addition to the waterproofing membrane defects, water is also pooling in these areas due to poor drainage provisions. Furthermore, the balcony downspouts are worsening the drainage by discharging storm water directly into these locations. In one location, roughly two inches of standing water was measured in the planter box. The extent of standing water noted indicates deficient drainage, since our inspection took place following several days of dry weather conditions.
- **Marginal sloping and poor drainage provisions.** The perimeter planter boxes were observed to be sloped towards a perforated perimeter drain pipe, this pipe is not performing properly and may be clogged with debris. In addition, marginal sloping was measured towards the drain, which is also a contributing factor to the ponding conditions.
- **Marginal membrane upturns at concrete curbs.** Membrane upturns at the concrete curbs were observed to be roughly two inches high in some locations, pooling water exceeding this upturn height can migrate into the concrete ceiling slab of the parking garage.
- **Various large cracks in concrete curbs.** Exposed cracks in the curbs are providing avenues for water ingress into the ceiling slab of the parking garage.
- **Widespread failure of the waterproofing for the east foundation wall.** The waterproofing for the parking garage wall was observed to be deteriorated throughout.
- **Large trees with potentially invasive root systems.** The large trees planted on the north side of the building typically have large structural roots which extend several feet below grade. The roots may be damaging the waterproofing membrane for the ceiling slab or the building's foundation drains. It was reported to us that after removal of similar trees at the west building, leaks became less severe.

Podium areas are exposed to water via rain and irrigation, the water is then managed through two methods, drainage and waterproofing. Drainage directs bulk water above to mechanical drains throughout the podium structure, provisions are typically implemented to facilitate proper drainage, such as sloping surfaces towards drains, and using a layer of drain-rock (gravel). Waterproofing resists water being absorbed through the concrete from hydrostatic pressure, while the bulk of the water is drained. In this case the waterproofing for the podium is a hot-applied asphalt rubberized membrane.

Typically, liquid applied rubber waterproofing membranes have a life expectancy of approximately 30 to 40 years, depending on the quality of installation and service conditions. The podium waterproofing is roughly 40 years old. The conditions observed throughout the site indicate the waterproofing membranes for the parking garage have exceeded their expected service life. In addition, the storm water management for the site was observed to be performing poorly.



There was minimal sloping towards drains, clogged and damaged drains, and the balconies' downspouts are discharging directly into podium areas. These conditions are resulting in water accumulation and ponding in localized areas, such as the river-rock planter boxes around the buildings' perimeters. The ponding, combined with the failed waterproofing membranes are resulting in widespread water ingress into the parking garage. Other factors including large trees with potentially invasive root systems are likely contributing to these conditions.

Leaking through the podium can result in damage to electrical and mechanical services, personal property, and continual structural deterioration.

Based on the age of the building and observed conditions on site, we recommend comprehensive replacement of the parking garage and podium waterproofing membranes in the near term. Site drainage should also be included within the scope of work. If full replacement of the membrane is cost prohibitive, a combination of the following can be performed as temporary measures to reduce water ingress and deterioration of the parking garage:

- Removal of the large trees with potentially invasive root systems (consult arborist for confirmation regarding the impacts of this measure).
- Improved site drainage provisions.
- Targeted excavation and membrane repairs.
- Kryton Krystol Internal Membrane (KIM) leak repairs from the interior of the parking garage.
- Install cap flashings on concrete curbs.

Although temporary repairs will slow the deterioration of the parking garage, they are not long term solutions and are still relatively expensive. Various repairs were already observed during the inspection, such as crack injections, drip pans, and isolated membrane repairs. Some of these repairs have already failed. When the issues with the waterproofing are more than localized, targeted repairs will have limited success. In this case, the cost-to-benefit of repairing leaks may be at a disadvantage in comparison to full waterproofing replacement.