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PROFESSIONAL BUILDING ENVELOPE DESIGN, CONSULTING, & INSPECTION SERVICES

BUILDING ENVELOPE EVALUATION REPORT

STRATA PLAN VAS 2876
980 WEST 21ST AVENUE,
VANCOUVER, B.C.

PREPARED FOR:
Strata Plan VAS 2876
c/o R. Jang & Associates Ltd.
1010 West Broadway,
Vancouver, B.C.
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October 12, 2001

EXECUTIVE SUMMARY

As requested by the Council for Strata Plan VAS 2876, BC BUILDING SCIENCE & ENGINEERING LTD. have carried out a building envelope evaluation at 980 West 21st Avenue, Vancouver, B.C.

The intent of this evaluation was to:

- Investigate the condition and performance of the exterior wall, balcony, deck, and roof assemblies,
- Determine the extent of moisture ingress and resultant damage to the underlying structural assemblies,
- Discuss the main factors and processes that influence the performance of the building envelope, and
- Recommend a scope of remedial repairs to meet current building envelope requirements for the long-term performance of the building envelope.

The scope of this evaluation involved the:

- Issue and review of homeowner surveys,
- Review of previous reports addressing building envelope performance by other consultants,
- Cursory review of the original Architectural drawings for building envelope aspects,
- Review of selected units from the interior and interviews with selected occupants,
- Visual review of building envelope assemblies and components,
- Select moisture probes and investigative openings through the assemblies, and
- Issue of a detailed report.

Based on this evaluation, the main conclusions are as follows:

- Significant structural decay has been found on all elevations. Although the majority of the moisture contents were within adequate levels, the investigative openings have revealed structural decay of the wood framing.
- The windows and sliding doors are adequately performing, as expected for their type and service life. However, some problems with their assembly, installation, and performance are apparent.
- The membrane at the balconies and decks is nearing the end of its service life. Problems with their installation and performance are apparent
- The recently installed roofing system is performing as expected for its type and service life.
- Water ingress at the parking garage is apparent but is not a major structural concern.

Based on these conclusions, the recommendations are as follows:

- The only effective means of providing a long-term remedial solution is to replace the existing wall systems with an upgraded "rainscreen" system. There are no apparent effective short term targeted repairs that can prolong the life of the existing system and assure the performance of the building.
- The windows and sliding doors should be considered for replacement, however it is possible that they can be repaired and re-installed but warranty requirements must be considered.
- The balcony and deck membranes should be replaced.
- There are no immediate repair recommendations for the roofing system.
- The most severe leaks in the parking garage should be repaired in a localized manner. Remaining leaks should be monitored for future repair as part of an on-going maintenance program.

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1. INTRODUCTION

As requested by the Council for Strata Plan VAS 2876, BC BUILDING SCIENCE & ENGINEERING LTD. (BCBSE) have carried out a building envelope evaluation at 980 West 21st Avenue, Vancouver, B.C.

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2. BACKGROUND INFORMATION

2.1 BUILDING DESCRIPTION

The building is a four storey, 17 unit, residential condominium (Photos 1-4). The main structure is wood frame over a cast-in-place concrete underground parking garage. The building is oriented north to south on a site of relatively moderate to low exposure. The east elevation is setback from the property line and the west elevation is a firewall at the property line of the adjacent building.

The building is approximately eleven years old as based on the date of the architectural drawings by Gomberoff-Policzer Architects Inc. The design and construction of this building was governed by the requirements of the Vancouver Building By-law 6134 (referred to as the Code hereafter).

The exterior wall cladding is conventional three-coat stucco. The roof system, recently upgraded, is a granulated torch-applied sheet membrane system. The majority of the balconies and decks are covered in a liquid applied urethane membrane. The windows and sliding doors are double glazed, aluminum frame. The building is sprinklered.

2.2 BUILDING HISTORY

Based on the homeowner surveys and verbal correspondence with the occupants, there have been a series of remedial and maintenance actions at this project. Major building envelope repairs have included the installation of a new roof in 1999, the repair of, and re-waterproofing of portions of the east elevation in 1995, the installation of awnings at the east and north elevations, and balcony waterproofing repairs throughout; including the installation of a new vinyl membrane at unit 403 deck in 2000. These repairs and maintenance actions have not addressed the building envelope as a whole, but rather they have addressed localized problem areas.

The Strata retained Gordon Spratt & Associates Ltd. (GSA) in July 1999 to undertake a building envelope survey. (Refer to section 2.5 for our review of the GSA report.) The Strata has now retained BCBSE to conduct a subsequent full evaluation of the building envelope in order to provide a second opinion on the condition and required repairs.

2.3 HOMEOWNER SURVEYS

A brief homeowner survey was issued to each unit in order to gain a broader understanding of the extent of water ingress and other moisture related problems from an occupant's perspective. The survey consisted of ten questions addressing moisture concerns of both the individual units and the entire building. A sample of the survey and summary of the occupants' responses to these surveys is included in Appendix A.

Eight (47%) of the seventeen surveys were returned. Four surveys reported water leakage or moisture problems within their suite. Seven surveys reported water leakage or moisture problems in the building. Responses varied, as problems and repairs were reported at several locations throughout the building.

Although not all of the surveys were returned, it can be assumed, to some extent, that the units not returning the survey have not experienced any indications of extensive moisture related problems. The conclusions

and recommendations of this report do not rely heavily on the survey. Rather, the survey was used a guide for the investigation and to provide confirmation of the report's findings.

2.4 REVIEW OF ARCHITECTURAL DRAWINGS

The original architectural drawings were forwarded to our office by Gomberoff-Bell-Lyon Group of Architects. The set included drawings A-1, A-2, A-2a, and A-3 to A-9, dated November 2, 1990 and labelled "Issued for Construction". The drawings include plans, a section, elevations, and nine detail drawings. Note that the details and drawings may not reflect 'as-built' conditions, as there have been various repairs over the life of the building and changes during the original construction. Our review of the architectural drawings focused solely on the building envelope aspects.

The wall and roof assemblies listed in the drawings appeared to be complete and conform to the standard at the time of construction. However, this assembly schedule was manually crossed out and labelled "obsolete". It is, therefore, unclear of the designer's intent as there may been changes during construction.

The wall system is detailed using the sealed polyethylene approach, where the polyethylene acts as the air and vapour barrier. The exterior cladding was detailed as a "face sealed" or "concealed barrier" system, where the stucco, flashings, and sealants are designed to shed the majority of the water. This type of design and detailing was predominant at the time of construction. (For more information on this exterior wall design refer to section 5.5.)

The architectural details were at a reasonable scale to show layering of the components; however, areas such as window heads and sills require detailing at a larger scale in order to accurately display the designer's intent. Current practice is to provide enhanced detailing, such as isometric and sequencing drawings at a large scale, in order to accurately show drainage paths and continuity of the various components.

These drawings appear to meet the minimum intent of the Code (VBBL 6134) and conform to the general standard at the time of construction. However, the amount of detail shown is not sufficient to clearly show the layering and sequencing of the various components, which affect the drainage and drying of the building envelope.

2.5 REVIEW OF PREVIOUS REPORT

The previous building envelope report was forwarded to our office by the Property Manager. This report, titled "Report on Building Envelope Survey" was prepared by Gordon Spratt & Associates Ltd. and dated July 1999. We were not forwarded any appendices. This report was found to generally include the main components required in a survey of this type. However, our concerns are outlined as follows.

This report did not address all the assemblies and components of the building envelope. The condition of the decks and balconies, windows, parking garage, and roof was not reviewed nor discussed. When addressing the building envelope it is important to consider all components of the system as each are integral in preventing water ingress. The possible sources of the identified decay and water ingress were also not discussed.

Moisture content readings alone may not give an accurate assessment of the buildings condition, as they only identify the moisture content of the wood. As buildings typically dry out in the summer, the wood framing

may decayed even though a low moisture content is recorded. Approximately 75mm (3") diameter core tests were undertaken, however, it is our opinion that these are not sufficient to determine the full extent of damage and the sequencing and layering of the underlying assemblies.

The report recommended that the exterior walls be re-clad with rainscreen stucco. When recommending a rehabilitation program, components other than the walls must also be considered. Repairing the walls, without investigating the sources of water ingress or the condition of all the components, will not assure long-term performance of the entire wall assembly. As well, the budget provided at the end of the report was approximate and it is unclear what was included.

3. METHODS

The methodology used in evaluating the building envelope substantially corresponds to the recommendations of the published in "Building Envelope Rehabilitation" (CMHC 2000). Specifically the investigation includes a visual review, moisture probes, and investigative openings.

These methods are intended to give an overview of the building envelope condition and the typical standard to which it was constructed. Many of the observations are based on these methods and it is assumed that the results generally represent the entire project. However, there may be specific areas of the project that do not conform to the typical situation; thus, it cannot be confirmed that all hidden aspects of the construction were investigated.

3.1 VISUAL REVIEW

The visual review of the project involves the investigation of the major components of the building envelope. This includes the review of the cladding, windows, balconies and decks, roof, and parking garage. As well, this includes selected interior reviews as based on the homeowner surveys. Photographs are included in Appendix D.

3.2 MOISTURE PROBES

The moisture content of the wood frame members was taken at locations and critical details that are typically prone to moisture infiltration. These readings were taken with a Delmhorst moisture meter, which records moisture levels by reading the electrical resistance between two points (probe pins). Moisture probe readings can assist in determining the extent of water ingress and potential for wood decay. All moisture probes are located on the elevations provided in Appendix B.

Generally, moisture contents below 19% are ideal service levels. Moisture contents above this, in the range 20% to 29%, indicate that the wood member is susceptible to decay. Above 30%, due to the physical properties of wood, the member invariably will decay. High moisture levels, combined with limited venting and ideal temperature conditions, will lead to wood decay and loss of structural capacity.

3.3 INVESTIGATIVE OPENINGS

The moisture content readings alone cannot fully determine the performance of a wall assembly; therefore, visual observation of the wood components is necessary. Approximate 300x300mm (12"X12") holes were cut through the stucco with a diamond blade saw to allow for observation of the installation of the various components and the condition of the structural framing assembly. All investigative openings are located on the elevations provided in Appendix B. As well, observations from the investigative openings are included in Appendix C.

4. OBSERVATIONS AND DISCUSSION

The observations and conclusions of this section are based substantially on the investigation. Further discussion of the building envelope can be referenced in section 5.0. All referenced photographs are included in Appendix D.

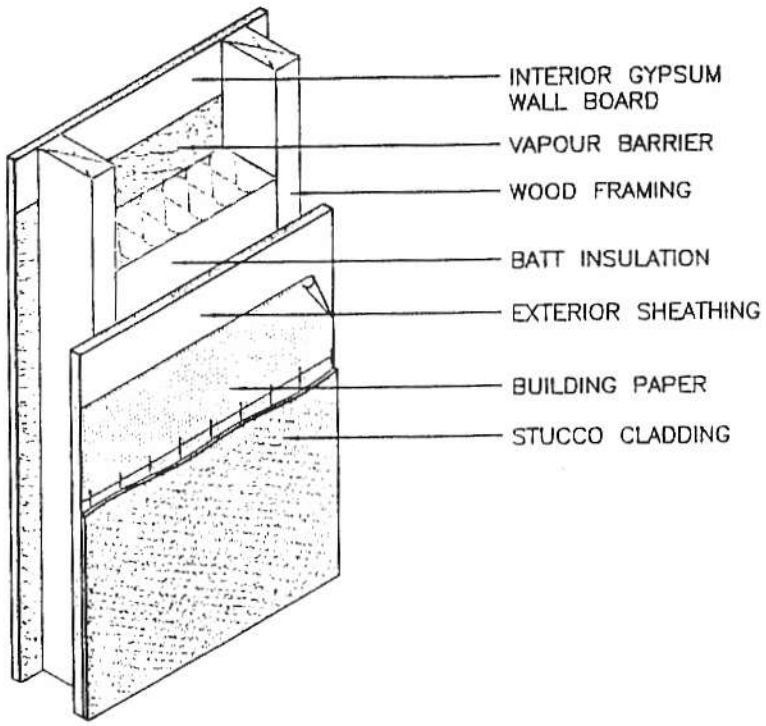
4.1 EXTERIOR WALLS

The main wall assembly (Figure 1) as listed in the architectural drawings was visually confirmed as:

- 3/4" stucco with metal lath
- Building paper (asphalt saturated sheathing paper)
- 3/8" plywood or OSB (Oriented Strand Board) sheathing
- 2X4 wood studs
- Batt insulation (R14)
- Polyethylene sheet vapour barrier (6mil)
- 1/2" Interior gypsum wallboard and interior finishes

This wall assembly was confirmed by the investigative openings; however, at some of the previously repaired areas (T6 and T12), housewrap (Tyvek) was found in place of the building paper.

Figure 1 – Existing Stucco Wall Assembly



As previously discussed this wall assembly is described as "face sealed" system with a concealed moisture barrier. The combined air/vapour barrier utilizes the sealed polyethylene approach. This was typical for residential use at the time of construction. (For more information on this wall design refer to section 5.5.)

Stucco Cladding

The application of the stucco consisted of a traditional 3-coat application. The stucco appeared to have good embedment into the wire lath reinforcing. The density (hardness) of the stucco also appeared to be acceptable; however, the actual density cannot be confirmed from a visual inspection.

The thickness of the stucco at the investigative openings was measured to be in excess of 19mm (3/4"); however, one of the previous GSA core tests was opened and, as reported by GSA, the stucco was verified to be approximately 12mm (1/2"). This variation in stucco thickness is due to its application at different wall locations. For example, around corners and intersections the stucco will generally tend to be thicker, whereas, in the field areas the stucco will be thinner. Even with slight variation at different areas, the thickness should never be less than that prescribed by the Code.

These stucco properties are integral in limiting water penetration through the stucco itself; however, they have not been shown to have a large impact on water penetration of the overall wall system.

Sheathing Paper

The sheathing paper in behind the stucco is considered to be the moisture barrier. The purpose of the moisture barrier in a wall system of this type is to drain incidental moisture that may penetrate through the stucco.

At some of the investigative openings the paper was deteriorated and the staples used as fasteners exhibited signs of corrosion, indicating the presence of continued moisture. This was observed at all elevations. There was also indication of reverse lapping or improper shingling of the sheathing paper at the perimeter of the windows (which is further discussed in section 4.2).

Moisture Content Readings

All moisture probes have been taken in late-summer, which generally will yield lower moisture contents than in the other seasons. Although buildings typically dry out in the summer months as part of the yearly cycle, they should never exceed typical service moisture levels. Refer to Section 5.2 for a discussion of moisture contents.

The distribution of moisture levels is shown in Appendix C. Half of the moisture probes recorded were within typical service levels (i.e. below 20%MC). A little less than one quarter of the moisture probes were above saturated levels (i.e. above 30%MC). The remaining readings were at levels susceptible to decay (i.e. 20-30%MC).

The moisture content readings do not necessarily indicate the condition of the framing. Decayed framing was found at a range of moisture content levels, indicating that areas of the building have been exposed to different drying cycles, depending on each areas exposure to weather conditions. This is apparent as the higher moisture levels were generally around the east side of the building. The majority of the driving rain wind pressures (DRWP) occur from the south and east.

Wall Details and Investigative Openings

The waterproofing at the base of wall was found to have failed at several locations (Photo 21). Further investigation of this detail was undertaken through investigative openings T1 and T3 (Photos 5,7,8). T1 revealed decay of the sheathing and the underlying framing. The decayed framing appears to be only partly due to the failure of the membrane as the decay also extends above the membrane's termination. The membrane terminated at least 200mm (8") from the top of the concrete slab and was reasonably lapped under the sheathing paper and stucco cladding. T3 revealed extensive decay of the wood framing as the membrane was torn where it lapped from the concrete curb onto the sheathing. Moisture contents in this area were close to saturation (30%MC).

Visual observations indicate that the existing membrane is not adequately reinforced or of adequate thickness to resist cracking at the joint between the different substrates. Failure of the waterproofing membrane will typically result in continued moisture ingress and eventual deterioration of the underlying wood structure.

On the east elevation the stucco extended down onto the concrete patio (Photo 22). This is not good practice as moisture is drawn in to the wood assembly through the porous stucco. Current codes require a 50mm (2") clearance between the underside of the stucco and the ground surface.

Investigative openings T5 and T6 (Photos 10,11) were undertaken at a window sill and a window head at different windows on the east elevation. T5 revealed decay of the sheathing and jamb studs at the sill to jamb intersection. It appears that this decay pattern is at least in part a result of a failure of the window mitre, which is further discussed in section 4.2 windows. T6 revealed substantial decay of the sheathing and the window header. Moisture content readings around this window were also high.

Investigative openings T8 and T9 (Photos 14,15) were undertaken at intersections between the parapet flashing at the exterior wall. Typically these types of saddle intersections are prone to water ingress. T8 on the north elevation exhibited slight staining at the sheathing, indicating the presence of moisture. However, the wood framing was generally dry and in satisfactory condition. T9 on the south elevation exhibited structural decay of the sheathing and underlying framing. In both these openings the moisture contents were measured to be within typical service levels. It appears that water has infiltrated into the wall assembly, caused decay, and subsequently dried out.

The Parallam beam below opening T10 exhibited high moisture contents and was very soft when probed at the end face (Photo 24). Although this location was not opened it is highly probable that this beam is extensively decayed. The decay of this beam appears to be due to ingress at the cracks in the stucco and the leaking of the adjacent down-pipe elbows. The sheathing exposed at T10 above was dry, showing minimal signs of water ingress (Photo 16).

Investigative opening T11 (Photos 17,18) at the south elevation exposed the Parallam beam and the saddle connection into the masonry firewall. The beam was significantly decayed and the saddle connection was in poor condition, exhibiting excess amounts of water ingress. This water ingress appears to be due to the large crack in the stucco below the end of the gutter (Photo 24). It is expected that this crack was caused by the differential settlement between the wood structure and masonry firewall. At the other end of the beam, excessive staining and spalling of the stucco, causing the underside of the beam to be exposed, was observed (Photo 25). The beam at this location was substantially decayed.

Investigative opening T12 (Photos 19;20) revealed saturated moisture contents and slight decay of the sheathing. Beyond this, new studs, possibly from a renovation, were exposed. The new studs were dry, however the original framing behind was saturated and decayed. It is not clear whether this decay was present prior to the installation of the new studs.

Overall Condition

Overall, significant structural decay has been found on all elevations. Although the majority of the moisture contents were within acceptable levels, the investigative openings have revealed structural decay of the wood framing. In this decayed state, the wood framing will have lost a significant amount of its strength and stability and needs to be repaired. In addition to the structural damage observed, the current condition and design of the cladding system is not sufficient to ensure the long-term performance of the building envelope.

4.2 WINDOWS AND SLIDING DOORS

The basic window system at this project is a flanged, aluminium frame supporting a sealed, double-glazed, insulating glass unit (IGU). The opening vents in the window systems are casement type (out swinging unit with latch lock). As indicated by the stamp on the IGU, these windows were manufactured by Almetco in 1990. This type of window was typical for residential use and appears to have met minimum Code requirements at the time of construction.

Sliding Doors

The sliding doors are manufactured and installed similar to the windows. They are typically prone to the same problems and concerns as discussed below. However, specific to sliding doors, increased air leakage (through the sliding unit) is a concern and they are typically operated more frequently causing mechanical breakdown of the unit. Most of these doors, however, are well protected with overhangs and awnings thus making them less susceptible to water infiltration. The following discussion focuses mainly on the windows, but also applies to the sliding doors.

Window Details

In many cases the head flashing at the top of the window was poorly or negatively sloped back towards the wall and therefore not properly deflecting water away from the building (Photo 26). This may also cause water to flow laterally towards the side of the window and drain directly into the wall. To prevent this from occurring, current practice is to provide end dams (flashing up-turns at the sides of the windows) to further divert the water away from the wall assembly. However, this was not typical practice at the time of construction. Also, in some locations, the head flashing was also found to poorly sealed at the lap joints (Photo 27).

Investigative openings T5 and T6 (Photos 10, 11) revealed concerns with the building paper lapping and sequencing at the windows. The windows investigated were observed to have a building paper liner at the perimeter of the opening. Providing a paper liner allows a condensation break and sheds incidental moisture behind the window frame to the outside assemblies. At the window head, where flashing is required, the field paper was properly lapped over the flashing. At the window sill the field paper was lapped on to the lower flange and over the paper liner, creating a reverse lap. It is not specifically identified in the Code or the architectural drawings how the paper is to be integrated at the bottoms of the windows. Preferably the building paper should extend behind the paper liner (and consequently, behind the flange) at the sill in order to eliminate any reverse laps and shed moisture to the exterior.

These installation details were typical practice at the time of construction; however, do no provide effective drainage for moisture infiltration through, or around the windows.

Mitred Corners

Another concern with this type of window system is at the mitred corners. In the assembly of the windows, the corners are typically screwed together and sealed with a sealant compound. It is a common occurrence for the mitre corners to separate and the sealant to fail, thus allowing moisture to leak through the frame. As the sheathing paper laps up onto the bottom window flange, any moisture that may leak past the window frame is not drained to the exterior and eventually causes damage to the underlying wall assembly. Warranty provisions for window frames and IGUs are typically five years.

To investigate the quality of the mitres, a test can be performed which involves removing the glazing stop, plugging the weep holes, and filling the bottom track with water. If the water is retained in the track, it can be concluded that the mitres are sealed and performing properly. The window at the location of opening T5 was tested. After approximately ten minutes, water began trickling into the wall assembly on the interior face of the sheathing. This appears to be the source for the decay revealed in the opening T5 at the sill-jamb intersection. It is possible that many other windows are allowing water ingress into the underlying framing due to a poor seal at the mitred corner.

Interior Condensation

As aluminium frame windows are good heat conductors, some condensation will occur at the interior side, especially during periods of colder weather or with elevated interior humidity levels. Any damage due to excessive condensation is usually limited to the interior finishes and is therefore not a major concern. Current Code requirements prescribe the use of a thermal break to minimize condensation. At the time of installation thermal breaks were not required, nor was it typical practice to provide them. Of the homeowner surveys received, condensation was not specifically noted as a major concern. (For more information refer to section 5.3.)

Water Tightness

At this project casement operating vents were used. The use of casement vents allows for improved water penetration resistance as they open outward and are sealed tight with a latch mechanism. These types of windows will typically perform better in terms of water penetration than sliding doors and windows as they inherently allow water penetration at the interlocks.

The requirements for water tightness of the windows, at the time of construction, are significantly lower than current Code requirements. The only means to determine the water tightness of the windows is to perform a test where a DRWP is simulated and water infiltration is measured. Although the water tightness requirements for residential windows have increased and the windows at this project may not conform to current requirements, testing does not appear to be warranted. (Refer to section 5.4 for further discussion of window performance.)

Water tightness of the window itself typically does not contribute to overall failure or damage as much as the detailing and interfacing of the window into the wall system.

Overall Condition

The windows and sliding doors at this project are generally performing as expected for their service life of fifteen to twenty-five years. Although they were detailed to the standards and requirements at the time of construction, problems with their assembly, installation, and performance are apparent. The problems are mostly related to their interface to the exterior wall system and the failure at the mitres. These problems appear to have contributed to a considerable portion of the observed damage to the structure.

4.3 BALCONIES AND DECKS

The balcony assembly, similar to that listed in the architectural drawings, was visually confirmed as:

- Urethane waterproofing membrane
- Exterior plywood subfloor
- Wood joists

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4.3 BALCONIES AND DECKS

The balcony assembly, similar to that listed in the architectural drawings, was visually confirmed as:

- Urethane waterproofing membrane
- Exterior plywood subfloor
- Wood joists

- Exterior gypsum wallboard/Acrylic stucco soffit -OR-
- Perforated metal soffit

There was a 75mm (3") edge flashing overlapping a gutter with sufficient downspout locations. The guardrails were aluminium with glass panel inserts.

The deck assembly is similar to the balcony assembly with the exception that they are installed over a living space. As such, they also contain insulation, a vapour barrier, and interior finishes as opposed to a soffit. The urethane-based membranes used on the decks are not recommended as a roofing membrane. Current code requirements specify that all roof decks be detailed and designed similar to a roof. The original architectural drawings specify a proper roofing assembly for decks over a habitable space; however, this assembly schedule on these drawings are crossed out and labelled "obsolete". It is, therefore, inconclusive why the urethane deck membrane was installed and whether it met the Code requirements in effect at the time of construction.

Balcony and Deck Membranes

The condition of the membrane was poor as there were many locations where it was weak or had failed (Photo 28). Although the urethane membranes are well into their expected service lives, there are some indications that they were poorly installed. The membrane appeared to be thin, as the fasteners used to attach the plywood sheathing and the line of the edge flashing were visible (Photo 29). The finish coat was also observed to be peeling away at some locations, further indicating the susceptibility to water ingress to the underlying assemblies (Photo 28).

The deck membranes were reported by the Homeowner Surveys to be a source of leaks. The original deck membrane at unit 403 was replaced with a vinyl membrane in order to resolve leaks below in unit 305 (Photo 30). The new vinyl membrane appeared to be in good condition. The thickness of this membrane must be determined, as some vinyl membranes are not rated as a roof membrane. In addition, it was observed that the new membrane extended and was sealed to the underside of the stucco thereby inhibiting the drainage of the cladding.

Details and Investigative Openings

Elevated moisture contents were measured through the membranes at some fourth floor decks and at the intersection of the exterior wall and the membrane (Photo 31). This assists in confirming the inadequacy of the balcony/deck membrane.

The general slope of the balconies and decks appeared to be sufficient; however, stains indicating localized ponding were observed (Photo 32). As well, the edge flashing created a dam at some locations resisting the flow of water over the balcony edge and into the gutter (Photo 33).

The condition of the balcony framing was reviewed through investigative opening T2 (Photo 6). Staining and mould growth were observed at the underside of the balcony floor sheathing and the joists. The joists appeared to be dry and in good condition as they returned back towards the building. The staining and decay of the wood members is suspected to be due to the failure of the membrane above.

Stains through the perforated aluminium soffit of a balcony were reviewed through investigative opening T4

(Photo 9). The adjacent dryer vents were plugged up with lint and debris, thus restricting the proper flow of air though the ducts. Since the ducts were not sealed to the vent sleeves the moist air had been vented into the balcony assembly. Stains on the rim joist and adjacent floor joists appear to be a result of these vents. The moisture contents of the framing were at 20-25% but no decay was apparent. At many locations, vents were installed through a perforated soffit. This is a potential problem source, as the warm moist air exhausted from the vents flows back up into the soffit and is exposed to the wood framing. Vents should be installed such that they direct the moist air away from the building and are sealed to limit air leakage.

To investigate the condition of the balcony framing and Parallam beam, investigative opening T7 (Photos 12, 13) through the perforated aluminium soffit of a balcony was undertaken. The Parallam beam was decayed at the rim joist and at the supporting steel column.

Investigative opening T10 (Photo 16) revealed a return of the membrane approximately 100mm (4") up the wall. This is not sufficient to prevent moisture ingress from potential snow build-up nor does it allow for sufficient overlap of the stucco cladding. Current practice is to return the membrane 200mm (8") up the wall. As well, in some locations, the clearance between the stucco cladding and the balcony/deck surface ranged from 0mm to 25mm (1") (Photo 34). As mentioned previously this is poor practice as stucco is a porous material and it is now a Code requirement to provide 50mm (2") clearance.

Overall Condition

Based on the condition of the membrane at the balconies and decks it appears that it is nearing the end of its service life. Typically a urethane membrane will have an expected service life ten to fifteen years but this depends on the quality of application, exposure, and quality of maintenance. Some decay of the underlying assemblies has been identified due to failure of the waterproofing membrane and related details. The current condition of the waterproofing membranes is not sufficient for any type of localized, or short-term maintenance work that will effectively prolong their lives.

4.4 ROOF

The roof assembly was visually confirmed as a SBS torch-on roofing membrane with granulated cap sheet over roof framing (Photo 35). This upgraded roof membrane was installed in 1999 to solve several water ingress problems. There were various penetrations such as pipes, drains, and vents through the membrane. The perimeter of the roof was a 100mm (4") parapet curb capped with metal flashing. The roof was generally sloped from the curb towards the drains.

The roof membrane appears to be in good condition. Several roof drains and penetrations were visually reviewed and appear to be well sealed and functioning properly. At the roof perimeter the membrane was observed to extend up and over the top of the curb with metal cap flashing over. The flashing was properly sloped back towards the roof. The seams and the corners of these flashings were properly detailed with standing seams.

At the mechanical equipment on the west side of the roof, extensive ponding was observed (Photo 36). At this location there was insufficient slope to any drain thereby causing the collection of water. This is not a major issue, however, sustained ponding on the membrane surface may be a potential source of water ingress and may ultimately reduce the expected service life of the membrane.

Overall Condition

The roofing system is performing as expected for its typical service life of twenty to twenty-five years. This service life, however, strongly depends on the quality and quantity of maintenance provisions.

4.5 PARKING GARAGE

Upon visual review of the parking garage, signs of water ingress were noted. Efflorescence and staining was observed at several locations: at the east side at parking stall 15, at the south side at stall 18, and at the southwest corner at the exhaust vent (Photos 38-40). These stains indicate water ingress through the cold joint at the beam and slab to wall intersections. In cast-in-place concrete construction, the beams and walls are poured at different times resulting in a cold joint at the intersection. Cold joints are typically prone to leaks, as the concrete is not continuous at these locations.

There is typically a below grade waterproofing membrane installed on the exterior side of the concrete to protect the concrete structure. It is suspected that this waterproofing either is in poor condition or may not have returned down over the cold joint. This waterproofing, however, was not visually investigated as it is generally embedded under concrete patios or sod and planters.

Overall Condition

Water ingress at the parking garage is apparent but, due to the high durability of the concrete structure, it is not a major concern. However, it should be noted that continued water ingress over a long period of time may lead to potential problems.

4.6 INTERIOR OBSERVATIONS

Selected interior reviews were undertaken. Residents of unit 103 reported to have extensive staining on the carpet at the east wall of the living room (Photo 41). Review of the interior and through investigative opening T13 on the exterior (Photo 42) confirmed that this location is subject to significant fungal growth. Failure of the patio waterproofing at the base of the wall and possibly a failure of the window mitre appear to be allowing continued water ingress into the unit.

Environmental consultants, PHH Environmental (PHHE), were retained to collect and analyse mould samples from both the interior and exterior at the northeast corner of unit 103. The Mould Contamination Investigation Report, prepared by PHHE, includes analysis on the toxicity and inherent risk of the mould and provides recommendations for its treatment. A copy of the PHHE report is included in Appendix E.

Residents of unit 305 reported some previous accounts of water ingress into the suite from the roof deck above. These concerns were addressed when a new vinyl deck membrane was installed at unit 403 above. The interior of unit 305 was reviewed as the residents reported a sag in the ceiling. At this location surface moisture content readings revealed no signs of moisture, however, these readings only apply to the interior finish and not the hidden framing assemblies. It is not apparent whether this sagging is a moisture related problem or is from original construction.

5. BUILDING ENVELOPE DESIGN AND REHABILLITATION

This section, referred to throughout the report, provides supplementary information on building envelope design and rehabilitation. This discussion is important in understanding the necessary repair work that is recommended and required.

5.1 THE BUILDING ENVELOPE AND EXPECTED SERVICE LIFE

The building envelope is typically defined as "the built enclosure that separates the outdoor environment from the indoor environment". This includes walls, roofs, foundations, and, for the purpose of this evaluation, balconies and decks.

The performance of the building envelope and its expected service life is directly affected by the:

- exposure to climatic conditions of the area;
- structural design and installation of the supporting assemblies;
- type, quality, and construction details of the assemblies;
- use, occupancy, and interior environmental conditions;
- quality and quantity of maintenance programs.

The expected service life is the time when the specific component can no longer serve its intended function. For example, a built up tar and gravel roof may have an expected service life of 15 years. The roof may perform beyond the expected years; however, risk of failure is increased and more frequent inspection and repair is required.

The expected service life is based on manufacturers literature, warranties, and theoretical industry standards. All systems and components are subject to a wide variety of factors that affect their life expectancy, including quality of installation, quality of materials, weather conditions, and quantity and quality of maintenance programs. As a result of this variation, systems and components demonstrate wide variations of predictability: some may out live their expected service life, while others may not.

5.2 WOOD FRAME BUILDINGS

Wood frame buildings are prone to both shrinkage and decay. These properties of wood have a large affect on the function, integrity, and aesthetics of the building.

Typically, a building experiences the majority of its settlement and shrinkage in the first year after construction. Adverse effects of differential settlement and shrinkage may include:

- poor or reverse slope on balcony surfaces, leading to ponding water.
- reverse slope on flashings, leading to water collecting at the surface of the wall cladding.
- poor frame alignment at door and windows, leading to improper operation.

As a result, most components may require some adjustment or even repairs after the first year. For example, a fourth floor balcony door may need to be removed and adjusted to ensure proper operation.

Wood framed buildings also have an increased potential to wood decay. This is due to moisture penetration and retention of the underlying wood structure. Wood moisture content above 20% and temperatures above 18°C can allow fungal growth in wood products to expand rapidly, ultimately leading to structural wood decay. Therefore, it is critical that any water ingress problems are addressed as soon as possible.

Generally, moisture contents below 19% are ideal service levels. Moisture contents above this, in the range 20% to 29%, indicate that the wood member is susceptible to decay. Above 30%, due to the physical properties of wood, the member invariably will decay. High moisture levels, combined with limited venting and ideal temperature conditions, will lead to wood decay and loss of structural capacity.

5.3 USE AND OCCUPANCY

Apart from the various factors influencing the building envelope from the exterior, there are many others influencing it from the interior. The most notable being use and occupancy. Some typical uses that impact the performance of the building envelope include: extensive plant growth within the suite, number of occupants within the suite, or daily activities, such as cooking, bathing, or washing and drying clothes.

Although not considered to be as great a factor as exterior moisture penetration, elevated interior moisture levels will ultimately impact on the performance of the building envelope. Typically, high moisture levels show up in the form of condensation on cold surfaces such as windows. Ideal moisture levels for human comfort range from 35% to 55% relative humidity, and any levels above these should be avoided.

Interior humidity levels can be controlled by:

- proper use of the humidistat (this information may be found in the mechanical systems operations manual);
- opening exterior doors or windows;
- proper use of fresh air vents;
- use of kitchen and bathroom exhaust fans.

If interior humidity levels remain consistently high, homeowners may want to consider the use of de-humidifiers. Particularly, the use of humidifiers, extensive plant growth, and daily living activities leading to excessive interior moisture should be avoided.

5.4 WINDOW PERFORMANCE

The performance of window systems is governed by the Canadian standard – CAN/CSA A440 Window Standard. This standard sets performance levels for various aspects of window design, such as air tightness, water tightness, and wind load resistance.

The water tightness performance rating is the most notable with respect to building envelope performance. Windows are required to withstand water leakage at standardized wind pressures. For example, the current Code requires residential windows to meet a minimum B3 water tightness level, that is, perform under a wind pressure of 300 Pa (6.3 lb/sqft).

Even for windows that meet a specific water tightness level, some leakage can occur during high driving rain wind pressure (DRWP) periods. DRWP is the occurrence of wind simultaneous with rain. The reference DRWP for residential windows is based on a one in five year potential recurrence of water leakage failure or a 20% probability that water leakage may occur over a period of one year. According to Environment Canada, exposed locations on the west coast can reach occasional DRWP levels of more than 500 Pa (10.5 lb/sqft).

Typical wood frame doors are not rated for water tightness as per the Window Standard. They can be expected to "leak" at high exposure areas, therefore it is important to provide protection as much as possible

including large overhangs and proper flashings at the perimeter. Even if they are partially protected by overhangs and soffits, some leakage may occur. Water leakage can be expected through the door seal and at the door threshold sweep. Amount of actual leakage will depend upon the exposure, height, and typical weather conditions (rainfall, wind, etc.); which can vary greatly due to local site conditions, as well as severity of the winter season.

It is important to differentiate leakage due to the window (through seals and gaskets) from leakage due to the window installation. Typically leakage through the windows unit itself will cause minimal damage if it is visible as it can be dried or cleaned by each Owner. Leakage at the interface or through the mitres is a more systematic problem and of greater concern, as it is typically hidden within the exterior wall and can cause extensive damage before it is observed or addressed.

5.5 EXTERIOR WALL DESIGN

In a sealed polyethylene approach, the polyethylene sheet acts as both the vapour barrier and air barrier. The main function of a vapour barrier is to resist the movement of vapour from the high interior vapour pressure to the low vapour pressure at the exterior. This movement of vapour is termed diffusion and is the molecular movement of water vapour through a product. Diffusion needs to be controlled in order to prevent warm, humid air from the interior passing through a wall assembly and condensing at the exterior dew point of the wall assembly (typically at the sheathing plane).

The main function of an air barrier is to resist air infiltration and exfiltration through a wall assembly. Among other aspects, this helps to improve both energy efficiency and moisture management of the assembly. From a moisture management perspective, free flowing air needs to be controlled, as it can condense at the exterior dew point of the wall (the sheathing plane) and saturate the wood components. In contrast to diffusion however, air movement has the ability to move far greater amounts of moisture.

For a building of this design, height and exposure, the sealed polyethylene approach has been shown to sufficiently retard movement of air and vapour. It is our opinion and experience that the type of air and vapour barrier system has little effect on water penetration problems in low-rise apartment buildings. This is consistent with the findings of the CMHC study of building envelope failures in the coastal area of British Columbia (CMHC 1998).

The exterior stucco cladding system design may be defined as either a "concealed barrier system" or a "face-sealed system". A concealed barrier system is intended to provide for some drainage (at the building paper) of incidental moisture that may penetrate through the face of the stucco. However, with a building of moderate exposure, minimal overhangs, lack of wall flashings, and poor detailing, there is minimal ability for drainage once moisture has penetrated through the stucco. The wall system should, therefore, more appropriately be defined and treated as a face-sealed system.

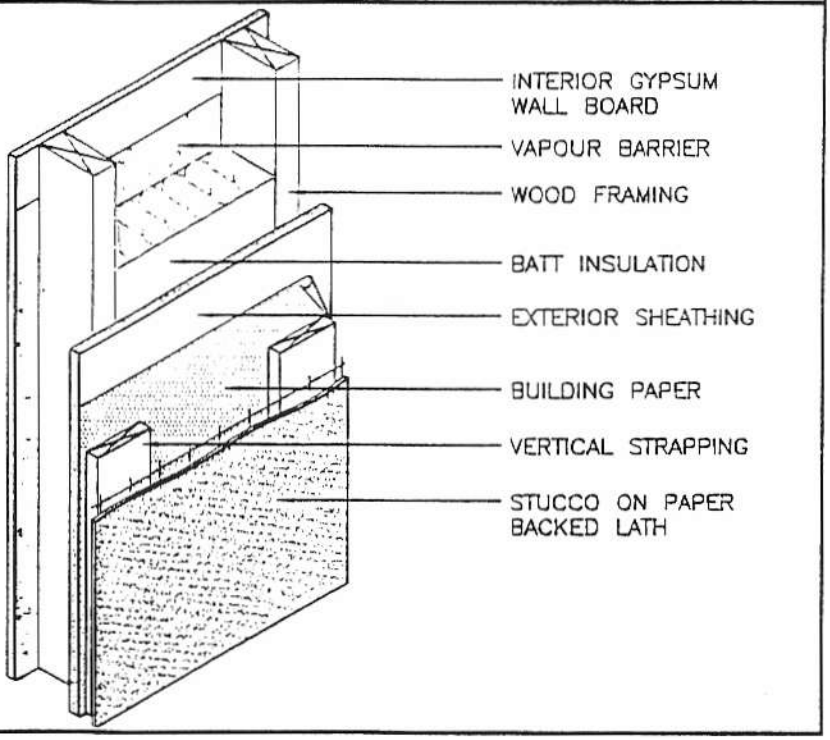
A face-sealed system has total reliance on the outer face to prevent moisture ingress. In a face sealed system any moisture that may penetrate the stucco must dry by diffusion through the exterior cladding. Diffusion only occurs for a limited period of time (during summer months) and only provides limited drying ability for a wall design of this type. As well, the ability of stucco to absorb and store moisture increases the potential for moisture to penetrate the assembly.

The majority of exterior moisture must be deflected at the face of the cladding as sheathing paper or moisture barrier is only intended to withstand incidental moisture penetration and does not provide resistance to other factors, such as differential pressures, or prolonged saturation. It is therefore important with this type of wall system to limit any moisture penetrating past the face of the stucco.

Based on numerous past failures of similarly constructed claddings, it is now understood that face-sealed and concealed barrier cladding systems are not adequate to provide protection against long-term moisture ingress.

It is now the current practice to provide a "rainscreen" wall system (Figure 2) allowing drainage and drying behind the face of the cladding. The rainscreen system provides an air space behind the face of the exterior cladding with the installation of vertical strapping over the moisture barrier, which is properly shingled to provide positive drainage. This system improves both the venting and drainage potential of the wall assembly, thereby reducing the potential for water infiltration and corresponding structural damage. Rainscreen principles have been in use for many years and have proven their effectiveness with many types of claddings, specifically in masonry applications.

Figure 2 – Rainscreen Stucco Wall Assembly



The rainscreen system, with the addition of cross-cavity flashings at floor levels and an upgrade in detailing around windows and other penetrations, is expected to provide enhanced long-term performance for most buildings. The City of Vancouver now requires all wall assemblies to utilise these rain-screen principles.

5.6 BUILDING ENVELOPE MAINTENANCE AND RENEWAL

When selecting an appropriate repair strategy, it is critical to consider the upgrade of the components of the building envelope. Each component has a different expected service life and requires different amounts of maintenance. As well, the amount of maintenance will increase with the components age. With this, each component should be considered to be upgraded or replaced during a major rehabilitation. Factors such as economic impact and long-term re-sale value will be affected by these considerations.

A scheduled maintenance program is important in sustaining the serviceability of the building and maintaining any warranty provisions. Through the maintenance of all individual components, the overall function and integrity of the building envelope is preserved for the expected service life.

In addition to regular maintenance, a renewal plan is equally important in preserving the life of the building. A renewal plan provides a timeline of the expected service life for the main systems and components and allows budgeting for their replacements. Although replacement of an entire system may not be required at the end of the service life, it can be expected that extensive repairs and replacement of some components will be needed in order to maintain the performance. It is also expected that maintenance requirements will become higher as the systems and components age.

Currently, the new Homeowner Protection Act requires all new developments to provide a building envelope maintenance manual for the future Owners (Strata). A building envelope maintenance manual covers all exterior components, and discusses recommended maintenance action, monitoring programs, expected service lives, and preliminary renewal plans.

5.7 WARRANTY REGULATIONS

As of September 2000 the Homeowners' Protection Office (HPO) has enacted new legislation mandating warranty protection for all "building envelope renovations". The intention of the new warranty regulations is to provide more protection for Homeowners who are undergoing major repairs due to a premature building envelope failure. The definition of a building envelope renovation and the mandate of the new HPO regulations are available directly from HPO (www.hpo.bc.ca), however we offer the following comments.

The mandatory warranty consists of two key warranty provisions. The first provision consists of a two-year labour and materials warranty. Once more than 60% of an elevation is repaired, a five-year water penetration warranty becomes mandatory. Based on a full rainscreen repair, a five-year warranty would be required.

The warranty regulations require that all "building envelope renovations" be completed by a "building envelope renovation contractor" licensed by the HPO, and that all renovations are designed and engineered by a "Building Envelope Professional (BEP)". In order to become a licensed building envelope renovator, the Contractor must be backed by one of the participating warranty providers. The warranty company will need to be involved at the planning stages of any major renovation or repair, in order to review the proposed scopes of work and the repair design. A building permit, which is required for all major renovations and repairs, cannot be obtained unless a warranty provider and licensed contractor have been retained.

The new warranty regulations have put increasing requirements onto all parties: the Strata, the consulting engineers, the contractor and the warranty provider. It is important that the Owners are aware of the varying regulations and the increasing demands and requirements. This is necessary to ensure that all parties are able to confirm the appropriateness of the repairs and stand behind their work for the duration of the warranty period and beyond.

6. RECOMMENDATIONS

The following recommendations are based on the findings of the building envelope evaluation. Detailed repair specifications and construction details were not included in the scope of this evaluation.

6.1 EXTERIOR WALLS

The only effective means of providing a long-term remedial solution is to replace the existing wall systems with an upgraded "rainscreen" system. (For more information refer to section 5.5.) This will effectively address the current water ingress and resultant decay. There are no effective short term targeted repairs that can prolong the life of the existing system and assure the performance of the building.

The upgrade should consist of full removal of the outer wall system, including the existing sheathing. This would allow for clear identification and repair of the damaged structural components as well as an opportunity for the wall systems (insulation, wood framing) to dry out. The existing sheathing should be replaced with a higher durability, treated, plywood sheathing, giving the overall system an increased service life. The sheathing paper and stucco cladding should then be installed as per rainscreen details.

The repairs should also include upgrade of all details, including proper saddle flashing connections, cross-cavity flashings at floor levels, and full membrane / flashing details at windows, dryer vents, and other penetrations. As well, the repairs should include the re-waterproofing at the base of the exterior wall at the concrete patios.

The extent of repairs would encompass the three elevations (north, east, and south). It is recommended these repairs be completed as soon as possible as moisture ingress and wood decay leading to structural damage is ongoing.

6.2 WINDOWS AND SLIDING DOORS

As the windows and sliding doors are performing to their expected service lives two options are presented.

- Option 1: Replace all existing windows and doors with new

The preferable option is the full replacement of all windows and sliding doors with new PVC (vinyl) windows. These new windows would be installed as per rainscreen details. This would provide a superior upgrade to the existing window system with improved energy efficiency, reduced condensation potential, and improved overall performance. Also, the window systems' service lives would then correspond to the upgraded wall assembly, thereby reducing the need for short-term maintenance and repairs.

- Option 2: Reuse all existing windows and sliding doors

The other option would be to reuse the existing window systems. As part of the exterior wall upgrade, the windows would be removed and reinstalled as per rainscreen details. While the windows are removed they would be inspected and the re-sealing of all the bottom mitres of the windows would be undertaken as part of the remedial repair. This is a typical maintenance item that needs to be addressed to minimize the potential for future problems. It should be noted that eventually the existing windows could be prone to localized water ingress. This, however, should not significantly impact the performance of the walls due to the upgraded flashings, waterproofing at the window perimeter, and the overall assembly.

In considering these options other factors must be considered. For example, the warranty provider may

require the full upgrade of the windows as part of the repairs. (Refer to section 5.6 and 5.7 for more information.)

As part of the remedial process, all exposed, exterior swing doors should also be replaced with a new PVC (vinyl) frame door unit.

6.3 BALCONIES AND DECKS

All the balcony waterproofing should be removed and properly waterproofed with a new membrane. Two options for the membrane are recommended:

- Option 1: Urethane membrane

The first option is to replace the existing membrane with a new urethane membrane. This is the same type of membrane that is currently installed; however, it would be installed to current manufacturers requirements and building code standards. The main advantage of this option is that it would have the same aesthetic look as what it currently installed.

- Option 2: PVC (vinyl) membrane

The other option is to replace the existing membrane with a new PVC (vinyl) membrane. This sheet-type membrane provides an improved walking surface and is less prone to workmanship defects.

Either of these two balcony membrane options should be detailed with proper rainscreen detailing at the edge flashings and wall intersections. As well, the plywood deck sheathing should be removed and replaced and the framing below should be inspected. All areas should be re-sloped to proved positive drainage.

All of the decks should be waterproofed with a new membrane meeting roofing standards. Two options are recommended:

- Option 1: 2-ply SBS roofing membrane with decking or pavers over.

The first option is to replace the existing membrane with a new 2-ply SBS roofing membrane and install wood decking or concrete / rubber pavers over. This type of membrane is similar to that which is currently protecting the roof. This option would provide a superior upgrade to the existing waterproofing with improved waterproofing ability, durability, and service life. However, with this option, there are additional design considerations to be implemented, which may induce higher design cost.

- Option 2: PVC (vinyl) membrane

The other option is to replace the existing membrane with a new 60mil PVC (vinyl) membrane. This is a more feasible option and will require less design work to integrate it into the existing building. This would also allow the recently replaced deck membrane at Unit 403 to be properly tied into the new wall system, rather than being replaced.

Either of these two options should be detailed with proper rainscreen detailing at the edge flashings and wall intersections. As well, the plywood deck sheathing should be removed and replaced and the framing below should be inspected. All areas should be re-sloped to proved positive drainage. The venting should then be checked and upgraded, if necessary, as part of these repairs.

As well, the guardrails, at both the balconies and decks, should be re-installed with new gaskets and sealants, in addition to any suitable readjustments in order to accommodate the rainscreen wall.

6.4 ROOF

There are no immediate repair recommendations for the roof as it was recently upgraded. However, the flashing at the perimeter may have to be adjusted to accommodate the rainscreen wall. The ponding around the mechanical equipment is not a major concern; however, it should be monitored for possible future repairs.

Proper maintenance must also be undertaken in order to sustain the performance of the roof. Typical maintenance would include a visual inspection and the cleaning of the drains twice a year. A more thorough inspection by a qualified roofing consultant is also recommended at three to five year intervals.

6.5 PARKING GARAGE

The preferred remedial solution to the wide spread suspended slab waterproofing is to remove all the sod, landscaping, and concrete patios in order to allow for the identification of the full extent of repair required. However, based on the amounts of actual water leaks through the underside of the suspended slab, this approach may not be feasible. Immediate recommendations are therefore, to repair the most severe leaks in a localized manner and monitor any remaining leaks. A possible future repair program to replace the entire waterproofing system could then be predicted and budgeted, based on this monitoring program.

As a potential cost savings measure, the Strata may consider using epoxy injection, crystalline concrete patch or other proprietary measures in an attempt to stop the leaks at isolated locations. This method can be effective for small leaks in foundation walls. However for leaks at suspended slabs and large leaks at foundation walls, this process is not highly effective. The leak may dissipate for a short period, but eventually the leak is likely to re-appear, or may simply move to another location.

7. BUDGET

The following section is included in order to make general decisions on suitable repair approaches. It is important to understand that, at this phase in the rehabilitation process, these costs are approximate and should not be used as a basis for assessing for funds to complete the repairs. An accurate cost accounting of repairs may be considered once a specific scope of work is completed. The quantities used to prepare the budged were taken from the original architectural drawings.

The budget costs provided generally includes: new stucco rainscreen wall assembly; new treated plywood wall sheathing; new waterproofing at base of wall; new vinyl windows, sliding doors, and wood doors; new vinyl balcony and deck membranes; new balcony and deck sheathing; new parapet and roof cap flashings; new stucco soffit at north elevation; parking garage crack remediation. The options presented in the recommendations (section 6.0) are included as adjustments to the budget.

BUDGET			
Stucco wall repairs		$	274,500.00
Base of wall repairs		$	8,000.00
Replace existing windows with new		$	10,200.00
Replace existing sliders with new		$	28,500.00
Replace existing wood doors with new		$	3,000.00
Replace balcony membranes		$	12,400.00
Replace deck membranes		$	9,400.00
Replace parapet cap flashings		$	400.00
Replace roof parapet cap flashings		$	1,300.00
Replace stucco soffit		$	2,500.00
Parking garage concrete repairs		$	1,500.00
Subtotal		$	351,700.00
General Conditions	10%	$	35,200.00
Structural Contingency	15%	$	52,800.00
Construction Budget Subtotal		$	439,700.00
Warranty	10%	$	44,000.00
Engineering	12%	$	52,800.00
Full Repair Budget Total (GST Excluded)		**$**	**536,500.00**

TAXES	
GST	7%
PST Rebate (Post Construction)	deduct 7% of 40% of total

OPTIONS		Addition to Subtotal
Repair existing windows/sliders	$	(35,811.00)
Replace balcony membranes with urethane	$	(2,060.00)
Replace deck membranes with SBS and pavers	$	6,240.00

8. CLOSING

When considering repairs to the building envelope, factors relating to each component of the system must be considered, such as, maintenance, renewal, and service lives. Also, other factors must be considered, such as: economic impact, re-sale value, and warranty requirements. (For further information refer to sections 5.6 and 5.7.)

In addition to the specific recommendations, it is also recommended that a maintenance manual and renewal plan be prepared for this building. This would help to ensure the long-term performance of the building envelope beyond the recommended rehabilitation repairs, meet warranty requirements, and plan for future maintenance and contingency fund requirements.

Any future repairs should be designed and reviewed by a qualified building envelope professional.

Respectfully Submitted,

BC BUILDING SCIENCE & ENGINEERING LTD.

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APPENDICES

APPENDIX A – SUMMARY OF HOMEOWNER SURVEYS

- Includes a summary of the responses by each unit.
- Includes a sample of the survey as issued to each unit.

APPENDIX B – MOISTURE PROBE AND INVESTIGATIVE OPENING LOCATIONS

- Includes moisture probe and investigative opening locations labelled on the building elevations.

APPENDIX C – INVESTIGATIVE OPENING OBSERVATIONS

- Includes a list summarizing investigative opening observations. The observations indicate the envelope component removed and findings therein.

APPENDIX D – PHOTOGRAPHS

- Includes photographs of all test locations observed and other significant details. All photographs include a number and a brief description.

APPENDIX E – MOULD CONTAMINATION INVESTIGATION REPORT

- Includes a copy of the Mould Contamination Investigation Report as prepared by PHH Environmental Ltd.

APPENDIX A – SUMMARY OF HOMEOWNER SURVEYS

A sample of the homeowner survey as issued to each unit can be found on the following page. A summary of the responses by each unit is as follows:

UNIT	COMMENTS ON THE UNIT	COMMENTS ON THE BUILDING
101	Not aware of any problems.	Problems and repairs throughout.
103	Problems at northeast corner.	Problems at east wall.
201	Not aware of any problems.	Problems at east wall and at balcony above.
202	Problems at southwest balcony.	Problems and repairs throughout.
203	Not aware of any problems.	Problems and repairs throughout.
305	Problems at north elev. due to deck above.	Problems and repairs throughout.
401	Not aware of any problems.	Not aware of any problems.
403	Problems solved by new roof and deck.	Problems and repairs throughout.

BC BUILDING SCIENCE
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PROFESSIONAL BUILDING ENVELOPE DESIGN, CONSULTING, & INSPECTION SERVICES

HOMEOWNER SURVEY

Strata Plan VAS 2876 – 980 West 21st Avenue, Vancouver

BC Building Science & Engineering Ltd. has been retained to undertake an investigation of the exterior building envelope of the project located at 980 West 21st Avenue, Vancouver, BC. In order to assist with the investigation, please answer, to best of your knowledge, the following questions:

GENERAL INFORMATION

1. Unit Number _____ 2. Homeowner/Occupant Name _____
3. How long have you lived here? _____ 4. Phone Number (not req'd.) _____

INDIVIDUAL UNIT

5. Have you experienced any water leakage or other moisture problems (i.e. condensation) in your Unit? _____

6. If so, what is the nature of the problems, where are they located, what appears to be their source, and when did they begin occurring? _____

7. What actions, if any, were taken to repair the water leakage or solve the moisture problems? When were these repairs completed? _____

THE BUILDING

8. Are you aware of any water leakage or moisture problems in this building? (other than in your unit) _____

9. If so, what is the nature of the problems, where are they located, what appears to be their source, and when did they begin occurring? _____

10. Are you aware of any repairs or maintenance actions that have occurred, relating to the exterior cladding and waterproofing of the building? When were these repairs completed? _____

Thank you for your time and assistance. If you need additional room, or have any other comments, please use the back of this page. Please return this survey to _____ by _____.

APPENDIX B – MOISTURE PROBE AND INVESTIGATIVE OPENING LOCATIONS

- Includes moisture probe and investigative opening locations labelled on the building elevations.
- Legend:

indicates investigative opening

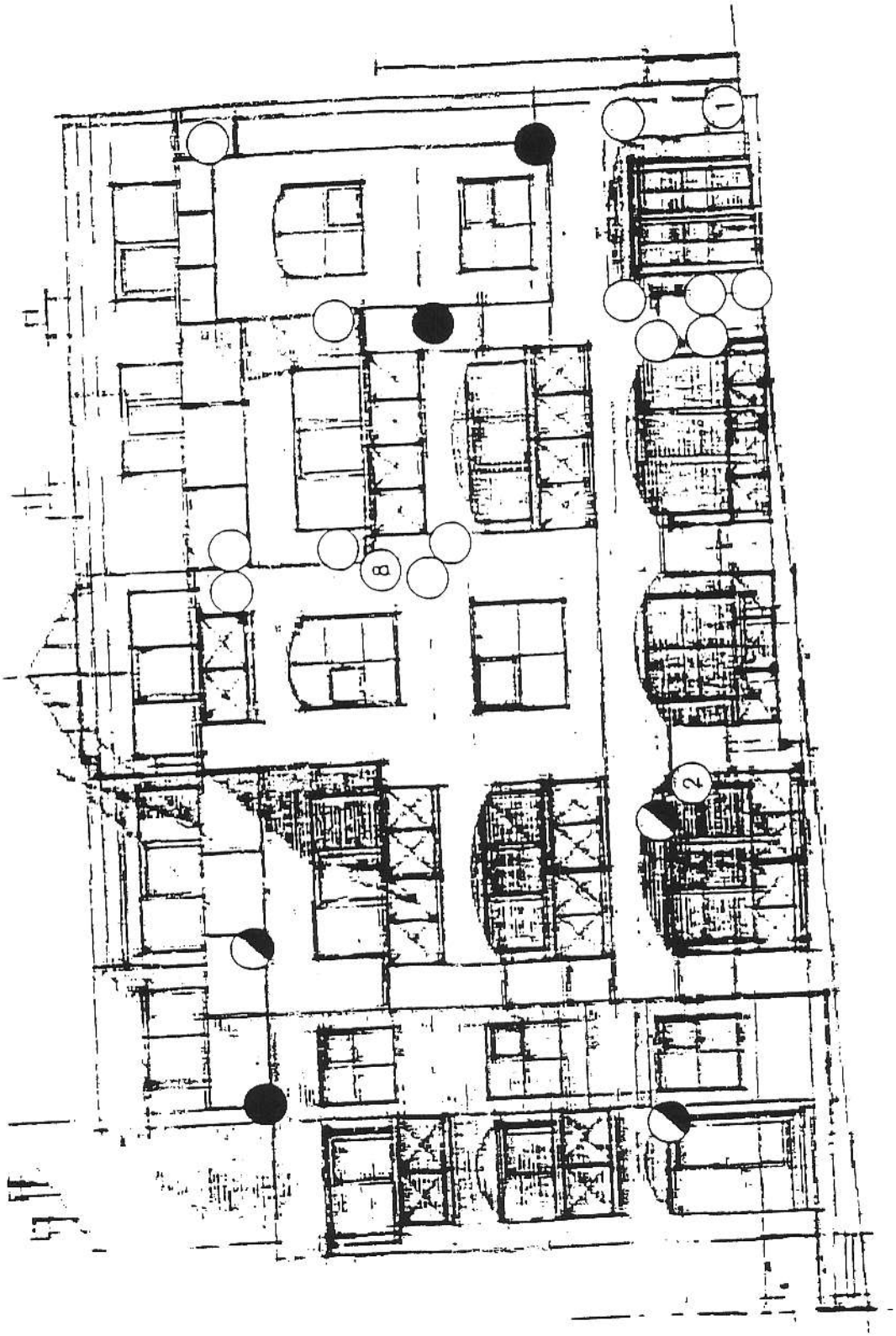
indicates moisture content below 20%

indicates moisture content in range of 20% - 30%

indicates moisture content above 30%

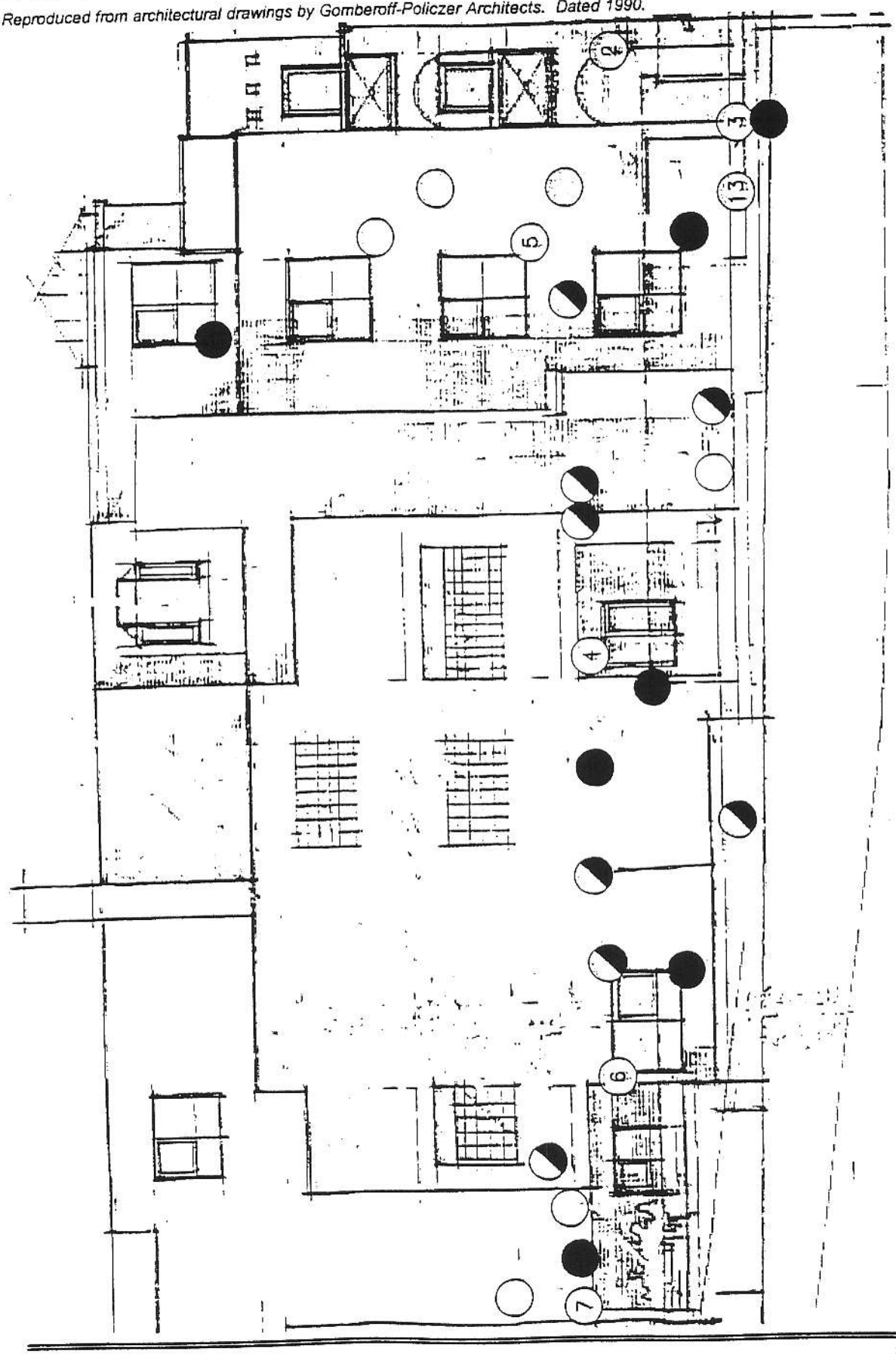
NORTH ELEVATION

Reproduced from architectural drawings by Gomberoff-Policzer Architects. Dated 1990.



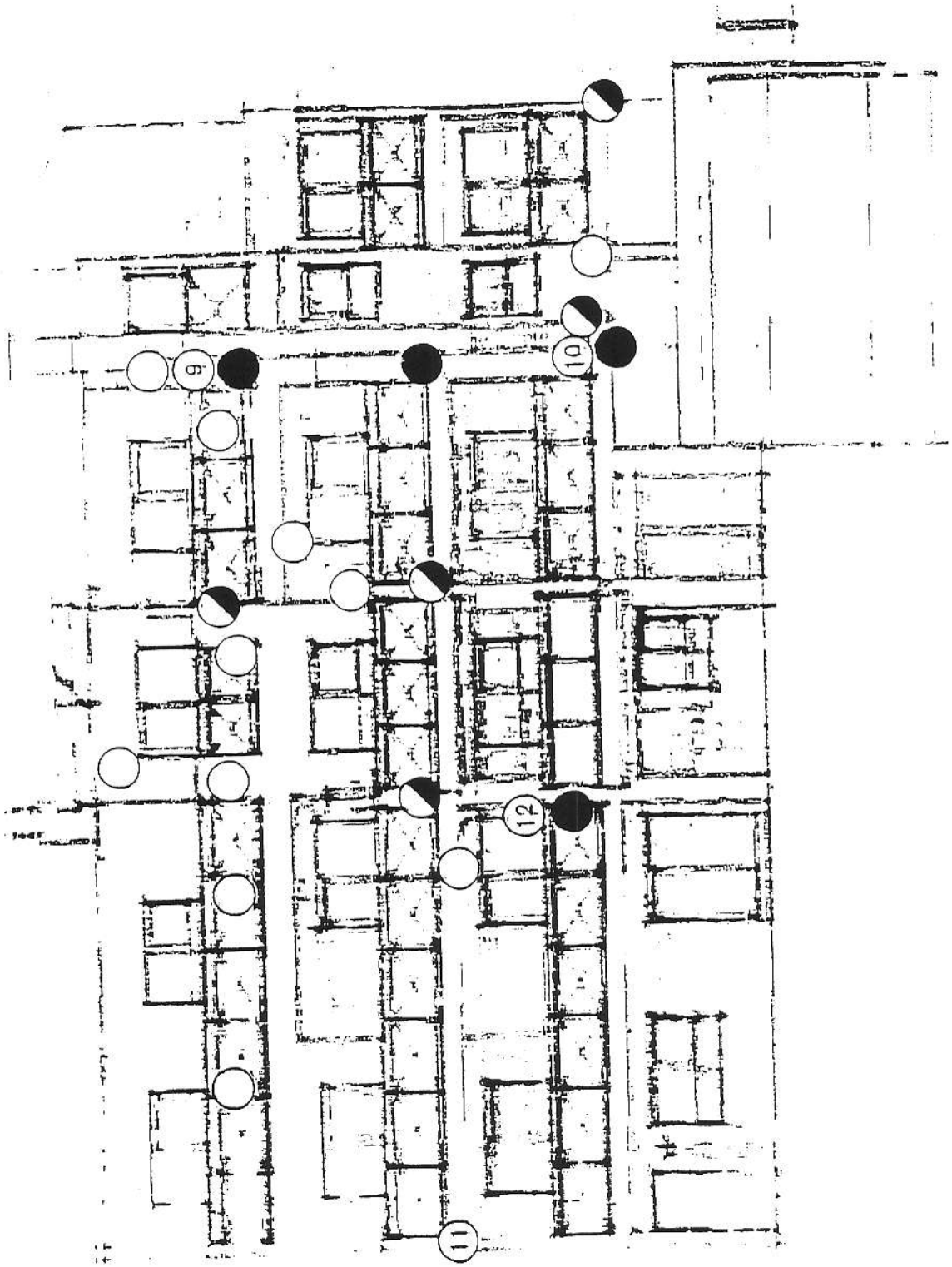
EAST ELEVATION

Reproduced from architectural drawings by Gomberoff-Policzer Architects. Dated 1990.



SOUTH ELEVATION

Reproduced from architectural drawings by Gomberoff-Policzer Architects. Dated 1990.



APPENDIX C – INVESTIGATIVE OPENING OBSERVATIONS

Summary of observations from the investigative openings are as follows (Numbers in brackets indicate photograph number as included in Appendix D):

ID#	LOCATION	OBSERVATIONS
T1 (5)	North Elevation - Entry at base of west false build out	Removed stucco cladding and building paper; waterproofing more than 200mm up from slab; wall sheathing decayed, dry. Removed wall sheathing; framing decayed, dry.
T2 (6)	North Elevation - Unit 204 balcony soffit	Removed gypsum soffit; underside of floor sheathing stained with signs of mould growth; joists stained at ends, otherwise dry.
T3 (7,8)	East Elevation – Unit 103 base of wall at north corner	Removed stucco cladding and building paper; stucco thickness over 19mm; building paper lapped over waterproofing; waterproofing in poor condition. Removed wall sheathing; sill plate and other framing decayed.
T4 (9)	East Elevation – Unit 203 balcony soffit at vents	Removed perforated metal soffit; build up of lint and insects; vent sleeve not attached to duct; vents plugged causing back-up of moist air; stains on face of rim joist; rim joist at 20-25% MC; joists dry.
T5 (10)	East Elevation – Unit 204 living room window sill	Removed stucco cladding and building paper; building paper liners installed at jambs and sill; field paper lapped over sill flange; wall sheathing decayed at sill jamb intersection only. Removed wall sheathing; framing decayed.
T6 (11)	East Elevation – Unit 102 master bedroom window head	Removed stucco cladding and housewrap; building paper liner; stucco thickness over 19mm; housewrap lapped over head flashing (~12mm lap); flashing upturn leg 38mm; window header decayed; wall sheathing at jamb decayed.
T7 (12, 13)	East Elevation – Unit 203 balcony soffit	Removed perforated metal soffit; stains on underside of soffit; staining and slight decay of parallam beam at end and at column connection; joists stained at end.
T8 (14)	North Elevation – Unit 304 unit 305 balcony saddle	Removed stucco cladding and building paper; sheathing dry; slight staining at saddle corner.
T9 (15)	South Elevation – Unit 402 east parapet at roof deck	Removed stucco cladding and building paper; building paper slightly deteriorated with rust at fasteners; wall sheathing decayed. Removed wall sheathing; framing decayed, dry; adjacent wall framing decayed, dry.
T10 (16)	South Elevation – Unit 202 balcony at base of east column built out	Removed stucco cladding and building paper; balcony waterproofing100mm onto wall; stucco stop 50mm from balcony surface; wall sheathing dry.
T11 (17, 18)	South Elevation – Unit 301 balcony beam at firewall	Removed stucco cladding and building paper; stucco lath rusted; building paper slightly deteriorated; wall sheathing decayed; balcony sheathing decayed. Removed wall sheathing; parallam beam and adjacent framing decayed; rust on saddle connection.
T12 (19, 20)	South Elevation – Unit 202 enclosed balcony	Removed stucco cladding and housewrap; wall sheathing decayed, with 25% to saturated MC. Removed wall sheathing; new studs present; framing behind decayed with 30% MC.