Structural Review of Balconies
At 3740/3760 Albert Street, Burnaby, BC



Prepared for:

Strata Plan NW 2099
C/O Dorset Realty Group Canada
200 – 8211 Ackroyd Road
Richmond, BC V6X 3J9

Prepared by:

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November 15th, 2004

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15th November, 2004

Strata Plan NW 2099
C/o Dorset Realty Group Canada
200 – 8211 Ackroyd Road
Richmond, BC V6X 3J9

Attention: Mr. Brian Spencer

Re: Structural Review of Balconies at 3740/3760 Albert Street, Burnaby, BC

Dear Mr. Spencer,

The enclosed report documents the structural components of the balcony review which was completed by McCuaig and Associates Engineering Ltd. for the buildings that are located at 3740 and 3760 Albert Street in Burnaby, B.C. McCuaig and Associates Engineering Ltd. has completed a series of surveys, inspections, and analyses of this property. The results of our study are presented in the attached report.

If you have any questions or require further information please contact our office.

Yours truly,
McCUAIG & ASSOCIATES ENGINEERING LTD.

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
P. A. GOOD

Paul Good, P.Eng.

TABLE OF CONTENTS

Index of Tables i

Index of Appendices i

1.0 EXECUTIVE SUMMARY 1

2.0 INTRODUCTION 2

3.0 METHODOLOGY 4

4.0 GENERAL DISCUSSION OF THE BEHAVIOUR OF REINFORCED CONCRETE STRUCTURES 9

5.0 OBSERVATIONS AND RESULTS 11

6.0 CONCLUSIONS 14

7.0 RECOMMENDATIONS 15

8.0 PRELIMINARY BUDGETS 16

9.0 LIMITATION OF LIABILITY 17

INDEX OF TABLES

Table 1 – Available Construction Drawings 3

Table 2 – Explanation of Risk Factors 7

Table 3 – Correlation Between Risk Factors and Balcony Types 8

Table 4 – Order of Magnitude Budget 16

INDEX OF APPENDICES

Appendix A

Appendix B

Appendix C

1.0 EXECUTIVE SUMMARY

Boundaryview consists of two strata titled high-rise residential apartment buildings which are located at 3740 and 3760 Albert Street, Burnaby, BC. There are a total of 220 suites in the two buildings. The buildings' structural components have been constructed from reinforced concrete. McCuaig and Associates was contacted by Mr. Brian Spencer in June 2004 to investigate cracks which have appeared on the surface of several balcony floors. Our investigation was comprised of the following components:

- Visual inspections of 28 balconies were carried by McCuaig and Associates;
- A balcony condition assessment survey was distributed to the building occupants. One hundred seven properly completed surveys were returned and analysed;
- The structural engineer of record for these two buildings was interviewed by telephone;
- A detailed structural analysis on selected balcony floor areas was completed.

Four types of balconies were identified based on their orientation within the buildings. Excessive cracking and unusually large deflections were noted at Types 1, 2 3 balconies, mostly at 3760 Albert Street. The structural analysis was completed on the Type 1, 2 and 3 balconies. Based on the results of our structural analysis we are of the opinion that the structural design that we analyzed is adequate. The structural engineer of record indicated that all slabs were inspected prior to casting, therefore, we have made the assumption that, in general, the required reinforcing steel was properly placed. A hypothesis, which suggests that shoring may have been prematurely removed during construction, is presented as a possible cause for the behavior exhibited by the balcony floors.

In order to ensure that the balconies remain serviceable, the following recommendations have been presented in the report:

- Delaminating or otherwise damaged concrete should be removed;
- Exposed reinforcing steel should be refurbished or replaced as required;
- Where delaminated or otherwise damaged concrete has been removed, it should be replaced;
- A waterproofing membrane should be applied to affected balcony floors;

We estimate that it will cost approximately $287,000 to implement the above recommendations.

2.0 INTRODUCTION

Boundaryview consists of two strata titled high-rise residential apartment buildings which are located at 3740 and 3760 Albert Street, Burnaby BC. The two buildings, which will henceforth be referred to as Buildings 3740 and 3760, are collectively owned by Strata Plan NW 2099. Building 3740 has 12 residential floors and Building 3760 has 14 residential floors. The buildings sit on top of a shared parkade, which is partially underground. The buildings' load bearing (structural) components have been constructed from concrete which has been reinforced with embedded steel rods (reinforcing steel). Typical floor plans for both buildings are identical, and thus, the structural design for each typical floor in both buildings is identical. Available documentation suggests that the buildings were constructed around 1980/1981.

In June, 2004, McCuaig and Associates Engineering Ltd. (henceforth referred to as MA) was contacted by Mr. Brian Spencer of Dorsett Realty Group, Richmond, BC, to assess the condition of the cantilevered balconies which extend from the building perimeters. Building occupants became concerned about the condition of the balconies when cracks in the balcony floors became noticeable. At some crack locations small pieces of concrete have fallen off thereby exposing noticeably corroded reinforcing steel. For the purpose of this investigation, cracks can be divided into two categories. Category 1 cracks occur on the top or possibly bottom of the balcony floors, mostly in the vicinity of structural supports. Category 1 cracks may be indicative of structural overstress. Category 2 cracks occur mostly at the concrete curbs (top, bottom or vertical surfaces) which have been constructed at the perimeter of the balcony floors. Category 2 cracks are generally related to deterioration of the concrete due to non-structural reasons. Only Category 1 cracks will be addressed in this report. At the strata's request, Category 2 cracks will be addressed in a subsequent report. For the remainder of this report, references to concrete cracks shall imply Category 1 cracks unless noted otherwise.

In order to facilitate this investigation, the strata provided MA with the buildings' architectural and structural drawings. A complete list of the construction drawings which were available for this investigation is presented in Table 1.

Table 1 – Available Construction Drawings

	Architectural Drawings	Structural Drawings
Prepared By:	Ronald Howard Architect/Barclay McCloud Architect	W. A. Walrond & Associates Ltd.
Drawing Numbers:	1 to 25, 28	S1 to S15
Drawing Date:	May, 1980	The original drawings appear to have been produced August, 1980. Various revisions to the drawings were made, presumably during construction. The revision dates varied from July, 1980 to July, 1981.
Comments:	The drawings indicate that the complete set contains 28 drawings. Note that Drawings 26 and 27 were not available for this investigation. The architectural drawings were perused for reference only. There was no attempt to review the architectural drawings for completeness or adequacy of design.	The drawings which pertain to the typical floors were carefully reviewed as required for this investigation. It was found that the drawings which pertain to the typical floors provided sufficient information for this investigation. Other structural drawings were reviewed for reference only. Except where specifically noted in this report, there was no attempt to verify the completeness or adequacy of structural designs.

3.0 METHODOLOGY

MA conducted visual inspections of selected balconies on June 17 and June 28, 2004. Balconies which were inspected during the first visit were selected by the buildings' resident manager, Mr. Ray Borcolli. Balconies which were inspected during the second visit were selected by MA. Mr. Borcolli's selections were intended to point out the balconies which exhibited the highest degree of deterioration. MA's selections were intended to provide a wider sampling of balcony Types with various structural supports, from both buildings.

Where possible, the following data was recorded at each of the balconies that was inspected:

- The location and orientation of top (and bottom if structurally significant) cracks;
- The concrete surface was "sounded" in the vicinity of the most severe cracks. Sounding was achieved by dragging a heavy metal hammer head across the surface of the concrete. Delaminating concrete often produces a hollow sound when sounded. Locations of apparently delaminating concrete were recorded.
- The slope of the top surface of the balcony floor was established with the use of a two foot carpenter's level.

A list of the balconies that were visually inspected by MA, along with the observations that were recorded at each balcony is presented in Appendix A - Table A1.

In order to further broaden the sampling of the condition of balcony surfaces, a survey was sent to all of the occupants in both buildings. A sample survey is provided in Appendix B. The combined results of MA's visual inspections and the completed occupant surveys are presented in Appendix A - Table A2.

Subsequent to our initial perusal of the structural drawings, balconies were divided into four Types corresponding to their orientation within the building. Balcony types are shown in Figure 1 which depicts a typical floor plan. Each balcony that was visually inspected or was the subject of a completed survey was assigned a risk factor, based on the results of visual observations. Risk factors range from 1 to 5, with a risk factor of 1 indicating the highest likelihood of structural distress. Risk factors are fully described in Table 2. Risk factors have been correlated against balcony types. The correlation between risk factors and balcony types is presented in Table 3.

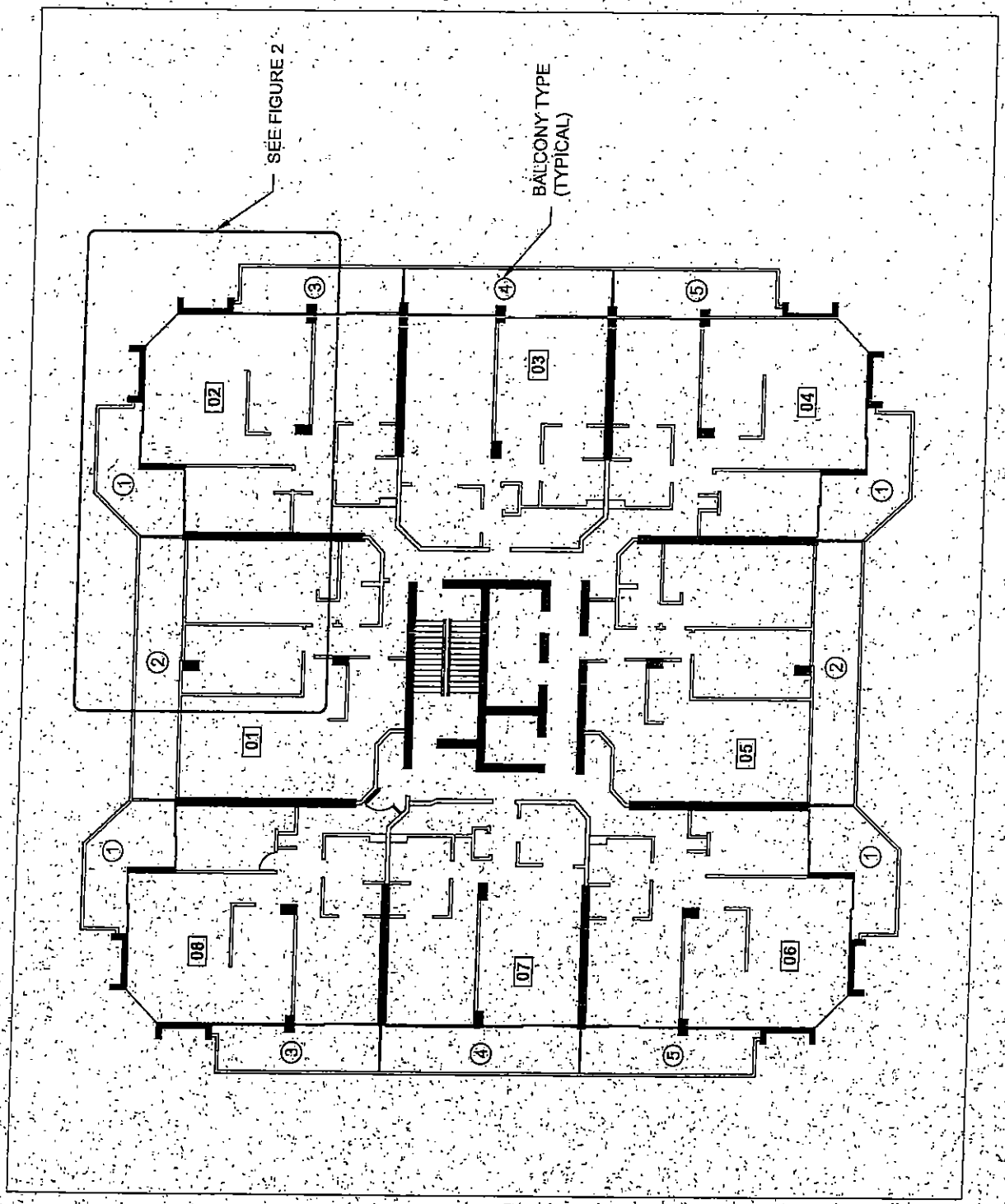


Figure 1 – Typical Floor Plan

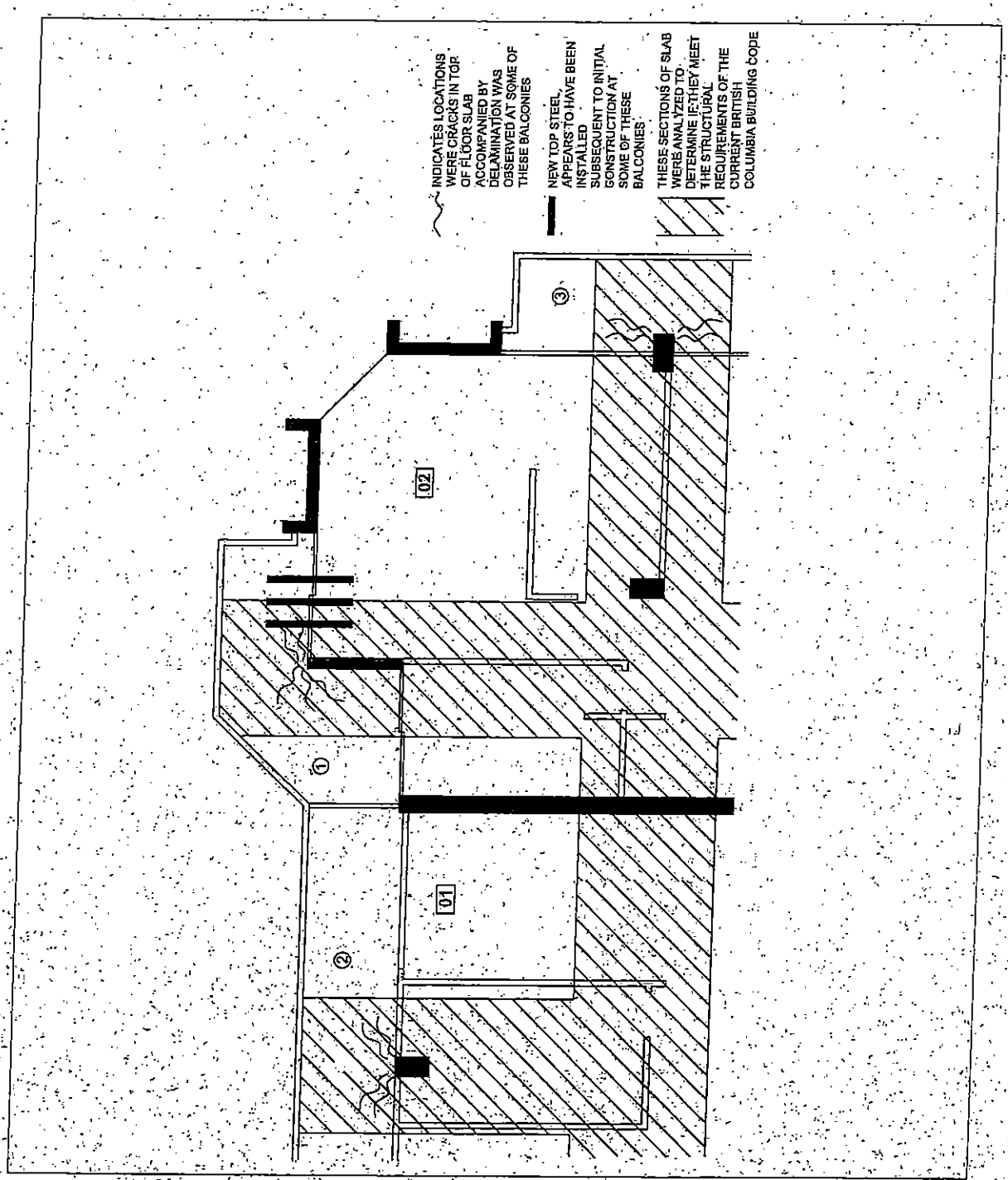


Figure 2 – Type 1, 2 and 3 Balconies

Table 2 – Explanation of Risk Factors

Risk Factor	Explanation
1	The balcony was physically inspected by McCuaig and Associates – crack orientation, crack width or hammer tests indicate that there is a high probability of structural distress
2	The balcony was physically inspected by the suite's owner or occupant who completed a balcony inspection survey report. The results of the completed survey report were analysed by McCuaig and Associates. McCuaig and Associates' interpretation of the completed survey report indicates that there is a high probability of structural distress.
3	The balcony was physically inspected by the suite's owner or occupant who completed a balcony inspection survey report. The results of the completed survey report were analysed by McCuaig and Associates. McCuaig and Associates' interpretation of the completed survey report indicates that there *may* be significant structural distress.
4	The balcony was physically inspected by the suite's owner or occupant who completed a balcony inspection survey report. The results of the completed survey report were analysed by McCuaig and Associates. McCuaig and Associates' interpretation of the completed survey report indicates that the probability of structural distress is low.
5	The balcony was physically inspected by McCuaig and Associates – crack orientation, crack width or hammer tests indicate that there is a low probability of structural distress.

Table 3 – Correlation Between Risk Factors and Balcony Types

Building	Balcony Type	Number Of Balconies With A Risk Factor Of:		Total Number Of Balconies Inspected Or Surveyed
		1	2	
3740 Albert	1	1	-	13
	2	-	1	11
	3	-	-	11
	4	-	-	10
3760 Albert	1	4	1	24
	2	1	1	13
	3	1	-	23
	4	-	-	12

A review of Table 3 suggests that most of the potential structural problems are located at balcony Types 1, 2 and 3, especially at Building 3760; therefore, an analysis of the structural capacity of the sections of the floor slabs in the vicinity of balcony types 1, 2 and 3 was carried out. The structural capacity of the slabs in the vicinity of the suspicious behavior was then compared to loading that is specified by the British Columbia Building Code (BCBC). In addition to a strength analysis, theoretical long term deflections were calculated in order to compare theoretical deflections to observed deflections.

Mr. Wilbur Walrond, P. Eng, who is the Structural Engineer of Record for Boundaryview was contacted to see if he could offer any opinions as to why the balcony slabs were cracking and why the cracking was mainly confined to one building. Mr. Walrond could not offer an explanation, but he did indicate that the reinforcing steel in all slabs was inspected by a representative of his firm. The primary purpose of Mr. Walrond's (or his representative's) inspections was to ensure that reinforcing steel was placed in accordance with the structural drawings.

4.0 GENERAL DISCUSSION OF THE BEHAVIOUR OF REINFORCED CONCRETE STRUCTURES

Prior to presenting the results of our field observations and structural analysis, a short discussion on the behavior of steel reinforced concrete is presented so that the reader may better understand our observations, results and recommendations.

Structural stresses can be broadly divided into two categories: compressive stresses and tensile stresses. Compressive stresses tend to squeeze a structural element together and tensile stresses tend to pull a structural element apart. Un-reinforced concrete can resist much higher compressive stresses than tensile stresses. Concrete's inherent lack of tensile strength requires that concrete structures be reinforced with steel rods in order to resist tensile stresses. In order to obtain the maximum benefit from the steel's tensile strength, the rods must be placed either near the top or bottom surface of slabs. Generally, the steel is placed near the slab's top surface in the vicinity of columns or walls and it is placed near the slab's bottom surface at locations where the slab is between columns or walls. Steel rods have been used to reinforce all of the structural elements at Boundaryview Towers.

In order for tensile stresses to be transferred from the (weak in tension) concrete to the steel, hairline cracks must develop in the concrete. Hairline cracks can also form in concrete while it is curing (hardening and gaining strength). The preceding discussion indicates that cracks in the concrete are not generally an indication of structural distress, and, in fact, should be expected. Of course, there are exceptions to this explanation.

Cracks in the concrete surface can have a detrimental effect on structural performance if water is allowed to pass through the cracks for a long period of time. Water which passes through concrete cracks can accelerate corrosion of the reinforcing steel. As the corrosion level of the reinforcing steel increases, the steel expands, which may cause chunks of surrounding concrete to spall off or to delaminate. Also, as the steel corrosion continues, the strength of the bar decreases. This process can be ongoing for many years before structural integrity becomes appreciably compromised. Indications that this process is occurring may include:

- Rust stains on the outer surface of the concrete;

- Small chunks of concrete are easily pulled off the main surface;
- A hollow sound is heard when the concrete is sounded. The hollow sound indicates that the concrete is delaminating.

The strength of concrete is often expressed as the amount of compressive stress that can be exerted on a standard sized concrete cylinder before the cylinder crushes. The crushing stress is referred to as the concrete's compressive strength. When fresh concrete is cast, its compressive strength is much lower than its specified compressive strength. As the fresh concrete cures its compressive strength steadily increases. It is generally accepted that concrete will reach its specified compressive strength about 28 days after it has been cast. When fresh concrete is cast as a horizontal surface (a floor slab) the fresh concrete must be supported, usually by wood shoring, until the concrete is strong enough to support it's own weight and construction loading. If the shoring is removed before the concrete attains sufficient strength, higher than expected deflections may occur. Excessive deflections may cause or increase cracking on the top surface of the slab in the vicinity of its supports (walls or columns).

When weight is placed on a concrete slab, the slab will deflect downwards. In general, the amount of deflection is proportional to the amount of weight that is supported. If the weight is removed quickly, most of the deflection will be reversed. If a constant weight is supported by a slab for a long time, the slab will continue to deflect. It is generally accepted that the long term deflection under the influence of a constant load is approximately three times the immediate deflection. Although theoretically slab deflection would continue to increase indefinitely under the influence of a sustained load, practically all of the long term deflection occurs after approximately five years.

5.0 OBSERVATIONS AND RESULTS

Observations and the results of our analysis which are pertinent to this investigation are listed below:

1. Top surface cracks were observed at many balcony floors. In most cases the cracks were shallow, hairline width, and not accompanied by delamination. We do not consider this Type of cracking to be a cause for concern. An example of this Type of crack is shown in Photo 1.

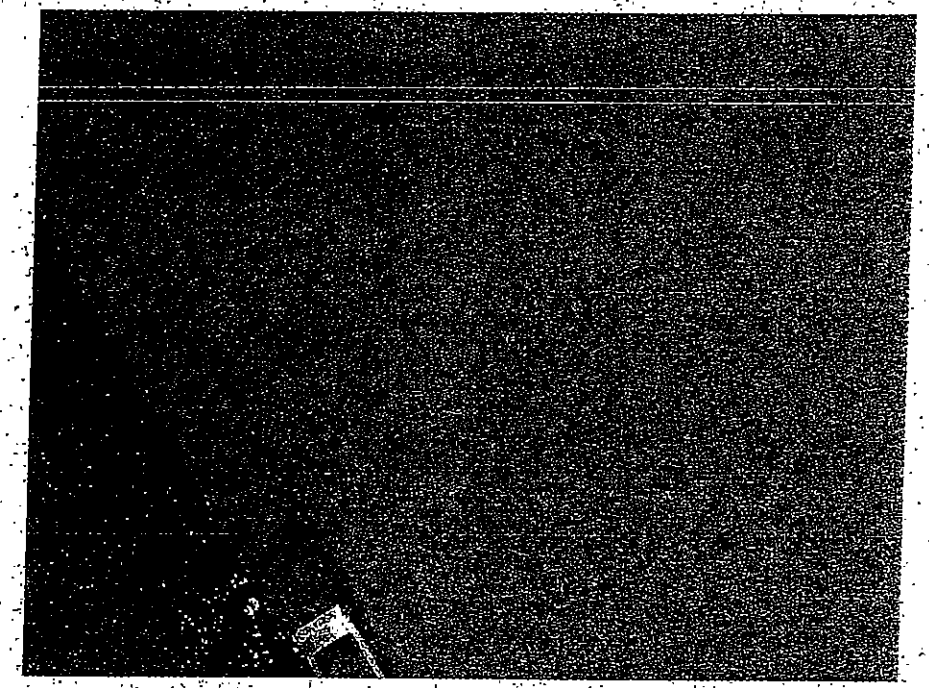


Photo 1 – Non Structural Cracking

2. Larger surface cracks, which radiated out from structural supports were observed at some Type 1, 2 and 3 balconies. The majority of the larger cracks were found in Building 3760, however, we did note some larger cracks at Type 1 and Type 2 balconies at Building 3740. When sounded, the concrete in the vicinity of many of these cracks was found to be delaminating. There were no observances of exposed top reinforcing steel at these locations. An example of one of the larger cracks is shown in Photo 2. Figure 2 indicates typical locations where such cracks were observed. The observations that were recorded at each of the balconies that were inspected by MA are described in Table A1 in Appendix A.

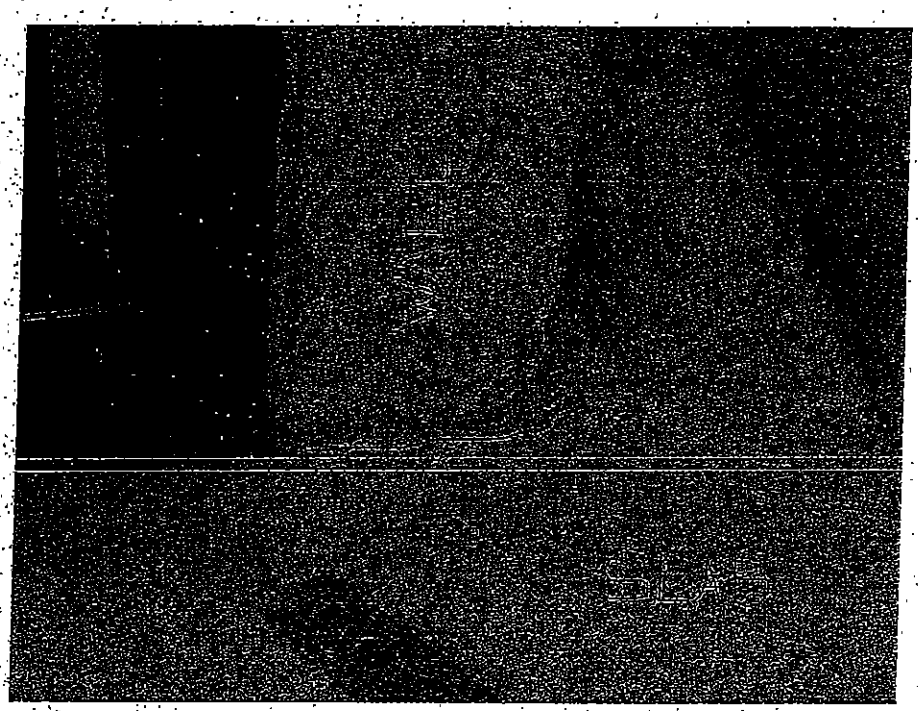


Photo 2 – Structural Cracking

3. All of the balconies that were visually inspected by MA were sloped towards their leading edge. We noted that the measured slope ranged from 2.1 percent to 5.2 percent. All of the floor slopes at Building 3760 – Type 1 balconies exceed 4 percent. None of the floor slopes at Building 3740 – Type 1 balconies exceeded 3.1 percent.

   It is common practice for balcony surfaces to be sloped towards their leading edge in order to promote drainage. Our perusal of available construction drawings did not indicate any requirements for balcony floor sloping, however this information may be contained on the architectural drawings that are missing from our set. It is common practice to specify a balcony floor slope of 2 percent. If the balcony floors were originally constructed with a 2 percent slope, the remaining 3.2 percent (5.2 – 2 = 3.2) slope may be attributable to long term deflection under the influence of the balcony floors' self weight. At Type 1, 2 and 3 balconies, the distance between the most exterior support and the balconies' leading edge is 1,600 mm, thus with a 3.2 percent slope, the deflection at the edge would be 51 mm.

4. Patches on the top surface of three of the Building 3760 – Type 1 balcony floors were observed by MA or reported by occupants. A typical patch is shown in Photo 3. The orientation of the patches suggests that additional top steel was placed in the slabs over the support – See Figure 2. We understand that the additional steel was placed 1993. The orientation of the patches is consistent with an attempt to strengthen the balcony floor slabs.

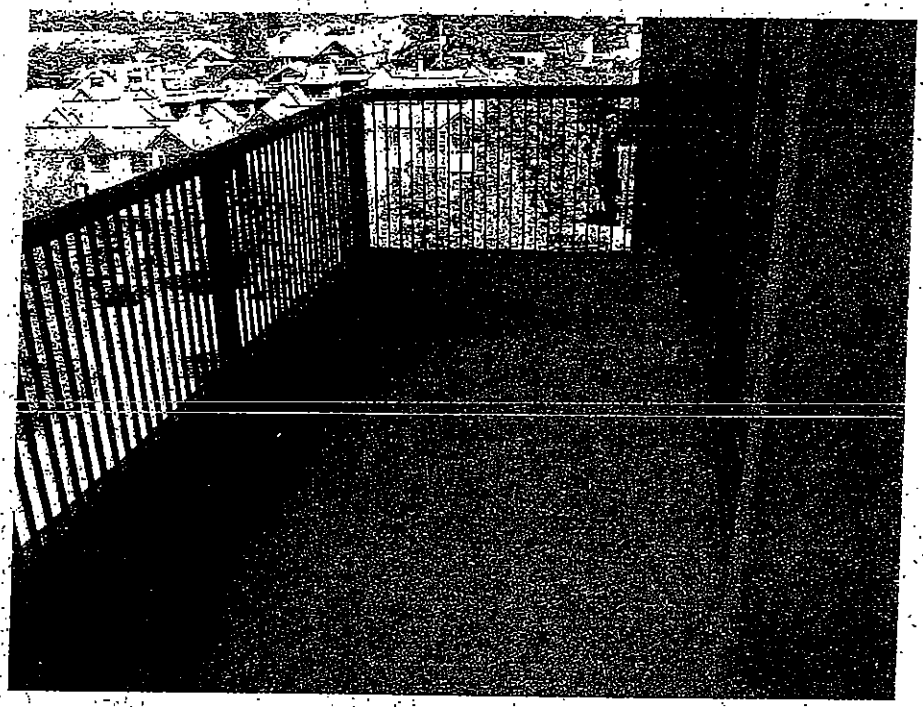


Photo 3 – Previous Repairs

5. The above observations suggest that the slab at Type 1, 2 and 3 balconies may have been either under designed or the reinforcing steel was not installed in accordance with the structural drawings. A detailed structural analysis was conducted to determine if the slabs in the vicinity of the cracks which were observed at Type 1, 2 and 3 balconies have been adequately designed. The design loading that was used for our analysis consisted of the slab self weight plus an occupant load of either 4.8 kPa (100 pounds per square foot) for balconies or 1.9 kPa (40 PSF) for interior spaces. The design occupant loads have been obtained from the latest edition of the British Columbia Building Code (BCBC). Material properties, steel strength, steel spacing and steel orientation were obtained from the structural drawings. There has been no attempt to verify material properties or steel placement.

Our analysis indicates that the slab design in the vicinity of the Type 1, 2 and 3 balconies as indicated on the structural drawings conforms to the structural requirements in latest edition of the BCBC. In other words, we did not find the design to be deficient.

6. Our analysis also indicates that the theoretical long-term deflection at the leading edge of the Type 1, 2 and 3 balconies is approximately 2.5 mm. This is significantly less than the 51 mm that has been observed at some balconies.

6.0 CONCLUSIONS

During our discussions with the Building's Structural Engineer of Record, he indicated that all of the slabs were inspected before they were cast. This suggests that it is unlikely that significant amounts of reinforcing steel were omitted from the slabs. In view of the facts that the structural design appears to be adequate and there is a high likelihood that the reinforcing steel was properly placed, we offer the following hypothesis to explain the behavior of the Type 1, 2 and 3 balcony slabs:

- During the course of construction, the contractor removed the shoring which supported the freshly cast slabs before the concrete strength was sufficient to adequately support self weight and construction loads without undergoing excessive deflection.

- The cantilevered ends of the Type 1, 2 and 3 slabs deflected under the influence of self weight and construction loads. The end deflection caused the slabs to rotate about their supports (walls or columns).

- The slab rotation caused tension cracks to appear on the top surface of the slabs near the supports.

- Over time, water has been allowed to infiltrate the cracks which may have caused the embedded reinforcing steel to rust. As the steel rusted, it expanded causing an outward pressure on the surrounding concrete, which in turn caused the concrete to spall and delaminate.

- If this process is allowed to continue, the steel may continue to corrode. Excessive steel corrosion can significantly reduce the strength of the structural system.

Note that the above sequence of events is only one possibility to explain the behavior of the Type 1, 2 and 3 balconies. It would be practically impossible to verify for certain that the above sequence of events has occurred as described.

7.0 RECOMMENDATIONS

In order to ensure that reinforcing steel has not corroded beyond acceptable limits and to reduce the likelihood that it will corrode beyond acceptable limits in the future, we recommend a repair program which will:

- Allow for direct observation of reinforcing steel that is considered to be the most susceptible to corrosion;
- Replace or refurbish excessively corroded reinforcing steel;
- Replace obviously delaminating concrete;
- Protect reinforcing steel from future exposure to moisture.

We propose to achieve the above noted objectives as follows:

1. Arrange to have the top surface of every balcony floor inspected so that deteriorated areas can be recorded and marked.
2. Remove and dispose of delaminated concrete.
3. Inspect exposed reinforcing steel at areas where delaminated concrete has been removed. Replace or clean the steel as required.
4. Patch areas where delaminated concrete has been removed. Where necessary, patch other excessively large cracks as well.
5. Apply a waterproofing membrane to the top surface of the balcony floors. The waterproofing membrane could be expected to remain effective for approximately fifteen to twenty years, after which time it will likely require replacement.

If the Strata is considering implementing the above recommendations in phases, priority should be given to the Type 1, 2 and 3 balconies at Building 3760.

Until all of the balconies have been inspected and repaired, it is recommended that loading on Type 1, 2 and 3 balconies be restricted to light patio furniture and no more than two people at a time.

8.0 PRELIMINARY BUDGETS

It is extremely difficult to provide an accurate cost estimate without some preliminary design work and a clearly defined scope of work. The actual cost of the work cannot be known until material quantities have been reliably estimated, project drawings and specifications have been produced, contractors have bid on the project and the extent of hidden damage is known. Based on cost figures from similar projects, and discussions with contractors who are familiar with this Type of work, we have presented an order of magnitude budget in Table 4.

Table 4 – Order of Magnitude Budget

Ref	Item	Unit	Unit Cost	Estimated # of Units	Total Cost	Comments
1	Engineering - Prepare specifications and drawings, tender project, review contractor's progress.	Allowance	$15,000	1	$15,000	
2	Engineering - Detailed inspection of all balconies; mark areas for repairs.	Allowance	$10,000	1	$10,000	
3	Swing Stage Rental	Allowance	$17,000	1	$17,000	See Note 1
4	Demolition and repair	Balcony	$600	100	$60,000	See Note 2
5	Apply Membrane	Balcony	$1,200	100	$120,000	See Note 2
6	Contingency	Allowance	15%	1	$29,550	See Note 3
7	GST and PST	Allowance		1	$35,217	See Note 4
8	GRAND TOTAL:				$286,767	

Notes to Table 4:

The cost of the swing stage is based on the amount of time that it will be required and on how many times it will have to be moved. For the purpose of this budget, it has been assumed that the project will take approximately three months to complete and the swing stage will have to be moved twelve times at each building for a total of 24 moves.

We have estimated that approximately 97 balconies will require structural repairs which has been rounded up to 100 balconies. The estimate for the number of balconies that may require structural repairs was based on a statistical analysis of the results of our visual inspection and completed survey results. We have assumed that balconies with a risk factor of 1, 2 or 3 will require repairs. A description of the analysis that was used to estimate the number of balconies that may require repairs is presented in Table C1- Appendix C

The contingency amount, which is 15 percent of the estimated contractor's fees may account for unforeseen items that come to light during the course of the project.

PST may not be applicable to all items; however, we have added to all items in order to simplify the budget.

9.0 LIMITATION OF LIABILITY

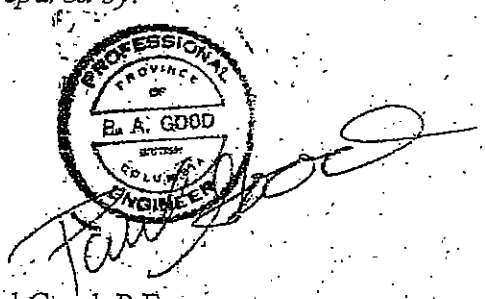
It should be noted that this report is based on a visual inspection of the existing structural systems which are described in the body of this report. Except where specifically noted in this report, no testing or dismantling of any assemblies was performed and inspections were made on a random basis with no attempt to review or inspect every element or portion of the building. The intent of the inspection was to determine balcony areas of visually obvious deterioration and to generally determine the overall quality and sufficiency of the work, but not to ascertain the quality or sufficiency of all balconies. Our comments are not a guarantee or warranty of any aspect of the condition of the building whatsoever.

This report was prepared by McCuaig and Associates Engineering Ltd. for the account of Strata Plan NW 2099. The material in it reflects McCuaig and Associates Engineering Ltd.'s best judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. McCuaig and Associates Engineering Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

This report is intended for the sole use of Strata Plan NW 2099 who further agrees that it will indemnify and hold harmless McCuaig and Associates Engineering Ltd. from any and all liability which Strata NW 2099 may incur from the his use or misuse, of this report.

Yours truly,
McCUAIG & ASSOCIATES ENGINEERING LTD.

Prepared by:



Paul Good, P.Eng.

Ref. No 20040601-RPT-Final

APPENDIX A

Table A-1 - Visual Inspection Results

Building	Suite	Balcony Type	Inspection Method	Vertical drop per 24 inches	Floor Slope	Comments
3740	1101	2	Physical and visual	0.5	2.08%	Hairline cracks were observed in the top of the slab, but there was no indication of structural distress.
	1108	1	Visual only	0	Not Measured	Hairline cracks, running parallel to the exterior wall and originating from the support column, were observed on the top surface of the slab.
	402	1	Physical and visual	0.75	3.13%	Cracks were observed in the top of the slab, originating from the support column. Some delamination of the top surface of the slab was observed in the vicinity of the support column.
	402	3	Physical and visual	1	4.17%	Small hairline cracks were observed in the top of the slab, but there was no indication of structural distress.
	705	2	Physical and visual	0.5	2.08%	Hairline cracks were observed in the top of the slab, but there was no indication of structural distress.
	704	3	Visual only	0	Not Measured	No indication of structural distress
	706	3	Visual only	0	Not Measured	No indication of structural distress
	704	1	Physical and visual	0.75	3.13%	No indication of structural distress.
	703	4	Physical and visual	1	4.17%	Hairline cracks in the top of the slab, originating from the support column were observed, but no obvious indication of structural distress
	305	2	Physical and visual	0.625	2.60%	Hairline cracks in the top of the slab, originating from the support column were observed, with some delamination of the top surface of the slab.
	304	1	Visual only	0	Not Measured	Hairline cracks were observed in the top of the slab, originating from the support column.
	306	1	Visual only	0	Not Measured	Hairline cracks were observed in the top of the slab, originating from the support column.
3760	1402	3	Limited - due to carpet on deck	1.25	5.21%	
	1403	4	Visual only	0	Not Measured	Hairline cracks were observed in the top of the slab, originating from the support column.
	1402	1	Limited - due to carpet on deck	1.375	5.73%	The current occupant has indicated that top steel reinforcement was added to this slab several years ago, but after original construction. At the time of our inspection the balcony floor slab was covered with carpeting, and therefore the orientation of additional reinforcement could not be verified.
	1201	2	Physical and visual	1.5	6.25%	No indication of structural distress

Building	Suite	Balcony Type	Inspection Method	Vertical drop per 24 inches	Floor Slope	Comments
3760	1208	1	Visual only	0	Not Measured	Hairline cracks, running parallel to the exterior wall and originating from the support column, were observed on the top surface of the slab.
	208	1	Physical and visual	1.25	5.21%	Cracks were observed in the top of the slab, originating from the support column. Some delamination of the top surface of the slab was observed in the vicinity of the support column.
	208	3	Physical and visual	1.125	4.69%	Hairline cracks in the top of the slab, originating from the support column were observed, but no obvious indication of structural distress
	201	2	Visual only	0	Not Measured	No indication of structural distress
	1007	4	Physical and visual	1	4.17%	Hairline cracks were observed in the top of the slab, originating from the support column, but no obvious indication of structural distress.
	1006	3	Visual only	0	Not Measured	Hairline cracks were observed in the top of the slab, originating from the support column.
	1506	3	Physical and visual	1	4.17%	Small hairline cracks were observed in the top of the slab, but there was no indication of structural distress.
	1506	1	Physical and visual	1.25	5.21%	Hairline cracks in the top of the slab, originating from the support column were observed; with some delamination of the top surface of the slab.
	806	3	Physical and visual	0	Not Measured	Small hairline cracks were observed in the top of the slab, but there was no indication of structural distress.
	806	1	Physical and visual	1.5	6.25%	Some cracks were observed in the top of the slab, originating from the support column. The top surface of the slab is delaminating in the vicinity of the support column. There is evidence to suggest that additional top steel was placed in the slab after original construction.
	1208	1	Physical and visual	1	4.17%	Hairline cracks in the top of the slab, originating from the support column were observed; with some delamination of the top surface of the slab.
	1208	3	Physical and visual	0	Not Measured	Hairline cracks in the top of the slab, originating from the support column were observed, with some delamination of the top surface of the slab.

Table A2 - Combined Survey and Inspection Results

41 Balcony Survey Responses - 3740 Albert Street				
Counter	Suite	Balcony Type	Risk Factor	Additional top steel added (no unless noted otherwise)
1	402	3	5	-
2	705	2	5	
3	1101	2	5	
4	704	1	5	
5	207	4	4	
6	403	4	4	
7	407	4	4	
8	603	4	4	
9	803	4	4	
10	903	4	4	
11	1003	4	4	
12	1103	4	4	
13	302	3	4	
14	404	3	4	
15	408	3	4	
16	806	3	4	
17	906	3	4	
18	1008	3	4	
19	1106	3	4	
20	1108	3	4	
21	301	2	4	
22	601	2	4	
23	605	2	4	
24	701	2	4	
25	801	2	4	
26	901	2	4	
27	1005	2	4	
28	302	1	4	
29	304	1	4	
30	404	1	4	
31	408	1	4	

Counter	Suite	Balcony Type	Risk Factor	Additional top steel added (no unless noted otherwise)
32	806	1	4	
33	906	1	4	
34	1008	1	4	
35	1106	1	4	
36	1108	1	4	
37	203	4	3	
38	503	4	3	
39	206	3	3	
40	304	3	3	
41	905	2	3	
42	206	1	3	
43	306	1	3	
44	201	2	2	
45	402	1	1	
69 Balcony Survey Responses - 3760 Albert Street				
1	1208	3	1	
2	305	2	1	
3	208	1	1	
4	806	1	1	YES
5	1208	1	1	
6	1506	1	1	
7	805	2	2	
8	1104	1	2	
9	203	4	3	
10	303	4	3	
11	707	4	3	
12	1203	4	3	
13	306	3	3	
14	502	3	3	
15	508	3	3	
16	802A	3	3	
17	902A	3	3	
18	1006	3	3	

Counter	Suite	Balcony Type	Risk Factor	Additional top steel added (no unless noted otherwise)
19	1508	3	3	
20	301	2	3	
21	1205	2	3	
22	1405	2	3	
23	502	1	3	
24	508	1	3	
25	606	1	3	
26	708	1	3	
27	802A	1	3	
28	902A	1	3	
29	1006	1	3	YES
30	1206	1	3	
31	1204	1	3	
32	1508	1	3	YES
33	207	4	4	
34	307	4	4	
35	607	4	4	
36	807	4	4	
37	1503	4	4	
38	1507	4	4	
39	206	3	4	
40	402	3	4	
41	504	3	4	
42	604	3	4	
43	606	3	4	
44	704	3	4	
45	706	3	4	
46	708	3	4	
47	1102	3	4	
48	1104	3	4	
49	1108	3	4	
50	1206	3	4	
51	205	2	4	

Counter	Suite	Balcony Type	Risk Factor	Additional top steel added (no unless noted otherwise)
52	501	2	4	
53	505	2	4	
54	605	2	4	
55	801	2	4	
56	901	2	4	
57	1101	2	4	
58	206	1	4	
59	306	1	4	
60	402	1	4	
61	504	1	4	
62	604	1	4	
63	704	1	4	
64	706	1	4	
65	1102	1	4	
66	1108	1	4	
67	703	4	3	
68	1007	4	5	
69	208	3	5	
70	806	3	5	
71	1506	3	5	
72	1201	2	3	

APPENDIX B

MCCUAIG & ASSOCIATES ENGINEERING LTD

439 McLean Drive, Vancouver, BC V5L 3M5
Tel: (604) 255-0992 Fax: (604) 255-1054
Info@mccuaig.net www.mccuaig.net

DEAR RESIDENTS OF BOUNDARY VIEW 3740 AND 3760 ALBERT STREET

McCuaig & Associates is conducting a survey of the balcony floors in your buildings. Please fill out and return the form below to the Strata Council's mail box which is located in the lobby **by Monday July 12, 2004.** Please note, all of the questions below relate to balcony floors only. At this time we are not collecting data on balcony curbs.

IF YOU HAVE ANY QUESTIONS, PLEASE FEEL FREE TO CONTACT PAUL GOOD AT OUR OFFICE AT 604-467-0644.

NAME:	PHONE:
BUILDING: 3740 or 3760 (Please circle one)	SUITE:

	The balcony is on the N S E W side of the building.	The balcony is on the N S E W side of the building.
Are there significant cracks on the top surface of the balcony floor? A significant crack is wide enough to fit a credit card in.		
Do the cracks appear to originate from walls or columns which support the balcony floor?		
What is the orientation of the cracks? Are they generally parallel to the balcony sliding doors or are they perpendicular to the balcony sliding doors?		
Are there cracks in the exterior columns or walls which support the balcony floor?		

MCCUAIG & ASSOCIATES ENGINEERING LTD

439 McLean Drive, Vancouver, BC V5L 3M5
Tel: (604) 255-0992 Fax: (604) 255-1054
Info@mccuaig.net www.mccuaig.net

If possible, please hit a cracked area with a hammer or other hard object. Please hit a non-cracked area with the same instrument. Please drag the hammer over the non cracked area and then over the cracked area. Is there a difference in sounds between the cracked and non cracked areas. Does the cracked area produce a hollow sound? Note: please protect your eyes and just hit hard enough to hear the difference.		
Does it appear that the floor of your balcony has been patched? Do the patches generally run parallel or perpendicular to the balcony sliding glass doors?		

If possible, on the back of this page, please provide a simple drawing showing the location and orientation of the significant (wider than a credit card) cracks in relation to the balcony sliding glass doors and exterior walls.

Thank you for your help.

Paul Good, P.Eng.

McCuaig and Associates Engineering Ltd.

APPENDIX C

TABLE C1 – STATISTICAL ANALYSIS TO ESTIMATE THE NUMBER OF BALCONIES WHICH MAY REQUIRE STRUCTURAL REPAIRS

Building	3760 Albert Street				3760 Albert Street			
Balcony Type	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Number of Balconies Inspected	13	11	11	10	24	13	23	12
Number of Balconies with Risk Factor 1, 2 or 3	3	2	2	2	15	5	8	4
Percentage Of Balconies with Risk Factor 1, 2 or 3	23	18	18	20	63	38	35	33
Total number of balconies	40	20	40	20	52	26	52	26
Estimated Number of Balconies Requiring Structural Repairs	10	4	8	4	33	10	19	9
Estimated Number of Balconies Requiring Structural Repairs – Each Building	26				71			

Ref. No.: 20040601-TBL-C1

McCuaig & Associates Engineering Ltd.
439 McLean Drive, Vancouver, B.C., V5L 3M5 255-0992 • 255-1054

LETTER OF TRANSMITTAL

DATE: 11/22/2004

TO:
Dorset Realty Group Canada Limited
200 - 8211 Ackroyd Road
Richmond, B.C.
V6X 3J9

Attention: Mr. Brian Spencer

RE:
Strata Plan NW 2099 – 3740/3760 Albert Street, Burnaby, B.C.

☐ HAND DELIVERED ☒ COURIER
☐ FAXED ☐ PICK-UP

☒ FOR INFORMATION ☐ FOR APPROVAL ☐ Return _____ corrected prints
☐ FOR COMMENT ☒ FOR YOUR RECORDS ☐ RETURNED ____/____/____

ITEM NO.	NUMBER OF COPIES	REFERENCE NUMBER	REVISION NUMBER	DESCRIPTION
1	3	20040601-RPT02-Final		Balcony Condition Assessment at 3740/3760 Albert Street, Burnaby, BC

NOTES:

Brian,

As requested, please find enclosed three copies of our report for the Balcony Condition Assessment at 3740/3760 Albert Street in Burnaby. Please call with any questions.

Sincerely,

Corey

COPY TO: _____

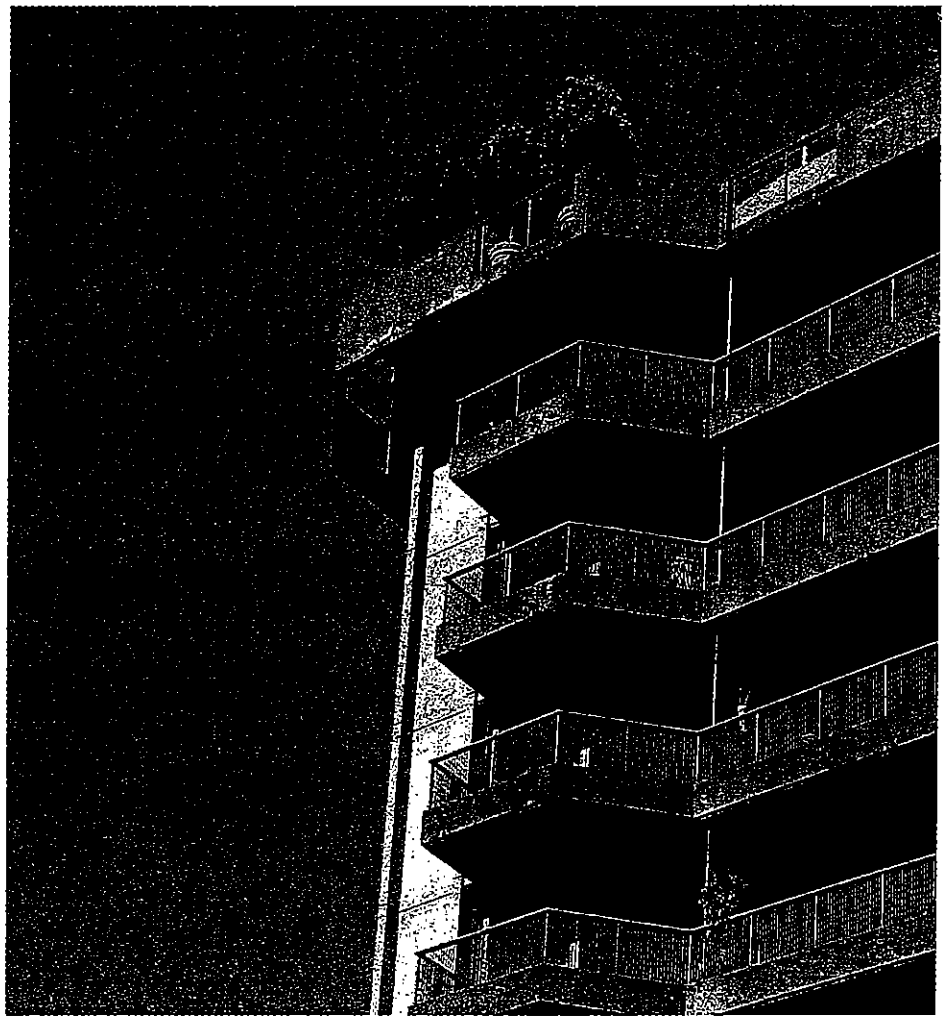
FILE NO: 20040601

SIGNED: Adams
Corey Adams, Office Manager

If enclosures are not as noted, kindly notify us at once.

Ref. No. **20040601**-GD-TR-02

BALCONY CONDITION ASSESSMENT
At 3740/3760 Albert Street, Burnaby, BC



Prepared for:

Strata Plan NW 2099
C/O Dorset Realty Group Canada
200 – 8211 Ackroyd Road
Richmond, BC V6X 3J9

Prepared by:

McCuaig and Associates Engineering Ltd.
November 19th, 2004

McCuaig & Associates Engineering Ltd.

Vancouver
439 McLean Drive
Vancouver, BC V5L 3M5
Phone: 604-255-0992
Fax: 604-255-1054

Victoria
127- 425 Simcoe Street
Victoria, BC V8V 4T3
Phone: 250-384-1085
Fax: 250-384-1081

19th November, 2004

Strata Plan NW 2099
C/o Dorset Realty Group Canada
200 – 8211 Ackroyd Road
Richmond, BC V6X 3J9

Attention: Mr. Brian Spencer

Re: Review of Damaged Balconies at 3740/3760 Albert Street, Burnaby, BC

Dear Mr. Spencer,

The enclosed report documents the results of our balcony condition survey which was completed by McCuaig and Associates Engineering Ltd. for the buildings that are located at 3740 and 3760 Albert Street in Burnaby, B.C. McCuaig and Associates Engineering Ltd. has completed a series of inspections, and analyses of this property. The results of our study are presented in the attached report.

If you have any questions or require further information please contact our office.

Yours truly,
McCUAIG & ASSOCIATES ENGINEERING LTD.

Paul Good, P.Eng.

TABLE OF CONTENTS

Index of Tables i

1.0 EXECUTIVE SUMMARY 1

2.0 INTRODUCTION 2

3.0 METHODOLOGY 3

4.0 GENERAL DISCUSSION OF THE BEHAVIOUR OF REINFORCED CONCRETE AS IT PERTAINS TO THIS REPORT 5

5.0 OBSERVATIONS AND CONCLUSIONS 6

6.0 RECOMMENDATIONS 12

7.0 ORDER OF MAGNITUDE BUDGET 14

8.0 LIMITATION OF LIABILITY 16

INDEX OF TABLES

Table 1 – Available Construction Drawings 3

Table 2 – Balconies That Were Visually Inspected By MA 4

Table 3 – Order of Magnitude Budget 15

1.0 EXECUTIVE SUMMARY

Boundaryview consists of two strata titled high-rise residential apartment buildings which are located at 3740 and 3760 Albert Street, Burnaby, BC. In the two buildings there are a total of 220 suites and 285 suspended balconies. In addition to the balconies, there are eight decks located at the penthouse levels. The buildings' structural components have been constructed from reinforced concrete. McCuaig and Associates was contacted by Mr. Brian Spencer in June 2004 to investigate cracks, spalling concrete and exposed reinforcing steel which have appeared on the surface of several balcony floors and the upstand curbs which surround the balconies.

Our investigation consisted of visual, close up inspections of 19 balconies, plus general inspections from the ground with binoculars.

The problems which are described above appear to be due to corrosion of embedded reinforcing steel. The corrosion has been caused by allowing the steel to be in contact with excessive amounts of moisture due to:

- Poor balcony drainage;
- Lack of waterproofing membrane on the balcony floors;
- Insufficient concrete cover around the reinforcing steel.

McCuaig and Associates is of the opinion that a danger to public safety exists from the potential for small pieces of concrete to break off from suspended slabs and fall to the ground. In order to mitigate the potential danger to the public, and to ensure that the balconies remain serviceable, the following repair program is recommended:

- Implement a thorough inspection of all balconies so that all deteriorated areas can be identified;
- Remove all delaminating concrete;
- Clean, treat or replace exposed reinforcing steel as required;
- Patch or replace damaged concrete as required;
- Improve balcony drainage;
- Apply a waterproofing membrane to all balcony floors.

We estimate that it will cost approximately $1,763,000 to implement the above recommendations. Our estimate is based on a worse case scenario in which all balconies require some repair work. Our estimate includes the cost of structural repairs which are described in our report entitled "Structural Review of Balconies At 3740/3760 Albert Street, Burnaby, BC", dated November 15, 2004.

2.0 INTRODUCTION

Boundaryview consists of two strata titled high-rise residential apartment buildings which are located at 3740 and 3760 Albert Street, Burnaby BC. The two buildings, which will henceforth be referred to as Buildings 3740 and 3760, are collectively owned by Strata Plan NW 2099. Building 3740 has twelve residential floors and Building 3760 has fourteen residential floors. The buildings sit on top of a shared parkade, which is partially underground. The buildings' load bearing (structural) components have been constructed from concrete which has been reinforced with embedded steel rods (reinforcing steel). Typical floor plans for both buildings are identical. Available documentation suggests that the buildings were constructed around 1980/1981.

In June, 2004, McCuaig and Associates Engineering Ltd. (henceforth referred to as MA) was contacted by Mr. Brian Spencer of Dorsett Realty Group, Richmond, BC, to assess the condition of the cantilevered balconies which extend from the building perimeters. Building occupants became concerned about the condition of the balconies when cracks in the balcony floors became noticeable. At some crack locations small pieces of concrete have delaminated or fallen away thereby exposing noticeably corroded reinforcing steel. For the purpose of this investigation, cracks can be divided into two categories. Category 1 cracks occur on the top or possibly bottom of the balcony floors, mostly in the vicinity of structural supports. Category 1 cracks may be indicative of structural overstress. Category 2 cracks occur mostly at, but are not restricted to, the concrete curbs (top, bottom or vertical surfaces) which have been constructed at the perimeter of the balcony floors. Category 2 cracks are generally related to deterioration of the concrete due to non-structural reasons. Only Category 2 cracks will be addressed in this report. At the strata's request, Category 1 cracks were addressed in a previous report entitled "Structural Review of Balconies At 3740/3760 Albert Street, Burnaby, BC", dated November 15, 2004. Our report dated November 15, 2004 will henceforth be referred to as The Structural Report. For the remainder of this report, references to concrete cracks shall imply Category 2 cracks unless noted otherwise.

In order to facilitate this investigation, the strata provided MA with the buildings' architectural and structural drawings. A complete list of the construction drawings which were available for this investigation is presented in Table 1.

Table 1 – Available Construction Drawings

	Architectural Drawings	Structural Drawings
Prepared By:	Ronald Howard Architect/Barclay McCloud Architect	W. A. Walrond & Associates Ltd.
Drawing Numbers:	1 to 25, 28	S1 to S15
Drawing Date:	May, 1980	The original drawings appear to have been produced August, 1980. Various revisions to the drawings were made, presumably during construction. The revision dates varied from July, 1980 to July, 1981.
Comments:	The drawings indicate that the complete set contains 28 drawings. Note that Drawings 26 and 27 were not available for this investigation. The architectural drawings were perused for reference only. There was no attempt to review the architectural drawings for completeness or adequacy of design.	The drawings which pertain to the typical floors were reviewed as required for this investigation. It was found that the drawings provided sufficient information for this investigation. Dimensions which are indicated on the drawings were used to estimate material quantities for preliminary budget purposes. There was no attempt to verify dimensions on site.

3.0 METHODOLOGY

MA conducted visual inspections of selected balconies on June 17 and June 28, 2004. Balconies which were inspected during the first visit were selected by the buildings' resident manager, Mr. Ray Broccoli. Balconies which were inspected during the second visit were selected by MA. Mr. Broccoli's selections were intended to point out the balconies which exhibited the highest degree of deterioration. MA's selections were intended to provide a wider sampling of balconies.

Where possible, the following data was recorded at each of the balconies that was inspected:

- The location and orientation of cracks;
- The location, orientation and general condition of exposed reinforcing steel;
- The slope of the top surface of the balcony floor was established with the use of a two foot carpenter's level;
- Balcony floor drainage conditions.

A list of the balconies that were visually inspected by MA is provided in Table 2.

In addition to inspection individual balconies, elevations of the buildings were visually inspected from the ground with binoculars.

Table 2 – Balconies That Were Visually Inspected By MA

Building	Suite	Balcony Location
3740	402	North
		West
	704	North
	705	East
	1101	West
3760	208	East
		North
	305	West
	703	South
	806	North
		West
	1007	North
	1201	East
	1208	East
		North
	1402	East
		South
	1506	North
		West

4.0 GENERAL DISCUSSION OF THE BEHAVIOUR OF REINFORCED CONCRETE AS IT PERTAINS TO THIS REPORT

Prior to presenting the results of our field observations, a short discussion on the behavior of steel reinforced concrete is presented so that the reader may better understand our observations and recommendations.

Structural stresses can be broadly divided into two categories: compressive stresses and tensile stresses. Compressive stresses tend to squeeze a structural element together and tensile stresses tend to pull a structural element apart. Un-reinforced concrete can resist much higher compressive stresses than tensile stresses. Concrete's inherent lack of tensile strength requires that concrete structures be reinforced with steel rods in order to resist tensile stresses. In order to obtain the maximum benefit from the steel's tensile strength, the rods must be placed either near the top or bottom surface of slabs. Generally, the steel is placed near the slab's top surface in the vicinity of columns or walls and it is placed near the slab's bottom surface at locations where the slab is between columns or walls. Steel rods have been used to reinforce all of the structural elements at Boundaryview.

In order for tensile stresses to be transferred from the (weak in tension) concrete to the steel, hairline cracks must develop in the concrete. Hairline cracks can also form in concrete while it is curing (hardening and gaining strength) or when it is under the influence of stresses due to changes in volume. Changes in volume occur as the concrete ages or as a result of changes to ambient temperatures. The preceding discussion indicates that cracks in the concrete are not generally an indication of structural distress, and, in fact, should be expected.

Cracks in the concrete surface can have a detrimental effect on structural performance if water is allowed to pass through the cracks for a long period of time. Water which passes through concrete cracks can accelerate corrosion of the reinforcing steel. As the corrosion level of the reinforcing steel increases, the steel expands, which may cause chunks of surrounding concrete to spall off or to delaminate. Also, as the steel corrosion continues, the strength of the bar decreases. This process can be ongoing for many years before structural integrity becomes appreciably compromised. Indications that this process is occurring may include:

- Rust stains on the outer surface of the concrete;
- Small chunks of concrete that are easily pulled off the main surface;
- A hollow sound being heard when the concrete is sounded. The hollow sound indicates that the concrete is delaminating.

One method of protecting reinforcing steel from the effects of continuous exposure to water is to ensure that there is an adequate amount of concrete cover around the bars. The current edition of the CSA Concrete Design Standard specifies that reinforcing steel in concrete slabs which are exposed to exterior conditions shall be protected with at least 30 mm of concrete cover. Our review of the building's original structural drawings indicates that the specified concrete cover for all slab reinforcing was 25 mm.

5.0 OBSERVATIONS AND CONCLUSIONS

There is a continuous 12 inch high by 6 inch wide concrete curb which surrounds the exterior edges of all balcony floors. Fall protection for each balcony is provided by aluminum picket guards which have been fastened to the tops of the curbs.

All of the balconies that were inspected were adequately sloped away from the building to promote good drainage. Most of the balconies that were inspected have been provided with two small scupper drains which are intended to drain water - which may accumulate on the balcony floor - through the underside of the curb to the exterior side of the curb. At the time of our inspection, many of the scupper drains were clogged or were sloped towards the building. Some occupants have reported that water pools against the inside face of the curb at locations which are not near the scupper drains. This indicates that some scupper drains are not located at low points.

The top surface of the balcony floors are not protected by a waterproofing membrane.

Some level of deterioration was observed at most of the balconies that were inspected by MA. The level of deterioration ranged from small hairline cracks, to delaminating concrete to rust stained surfaces to exposed and corroded reinforcing steel. The majority of the deterioration was found on or in the vicinity of the concrete curbs, although some balcony soffits also exhibited less severe indications of deterioration. The corner balconies on the east and west sides of the building appeared to be in the worst condition, although there was deterioration noted at all balcony types. The balconies at Building 3760 appear to be in worse condition than the balconies at Building 3740. It appears that at many of the locations where reinforcing steel has been exposed, the original concrete cover was less than the specified cover of 25 mm.

Where inspected, aluminum guards were in good condition.

Some of our observations are illustrated in the following photos:

Photo 1: This photo shows the front elevation of a typical balcony curb. Note the exposed and corroded reinforcing steel at the balcony soffit. Also note the white mineral build-up on the balcony soffit. This build-up is referred to as efflorescence and usually indicates that water is passing through the slab.

Photo 2: This is a close-up view of the soffit which is shown in Photo 1.

Photo 3: This photo shows the inside elevation of a typical concrete curb. Note the exposed and corroded reinforcing steel both near the top of the curb and where the curb interfaces with the floor slab.

Photo 4: This is a close-up view of the exposed and corroded reinforcing bar which is shown In Photo 3.

Photo 5: This photo shows a balcony soffit. Note the exposed and corroded reinforcing steel around the perimeter of the slab. Also note the smaller sections of exposed reinforcing steel near the building's exterior wall and the "ghosting" of the bottom steel near the light.

Photo 6: This photo shows the condition of a balcony soffit in the vicinity of an exhaust grill. Note the exposed reinforcing steel in the vicinity of the grill.

Photo 7: This photo shows the conditions at a penthouse deck. Note the full height concrete parapet wall which provides fall protection for the penthouse balconies.

Photo 8: This is a close-up of a penthouse balcony floor slab soffit.

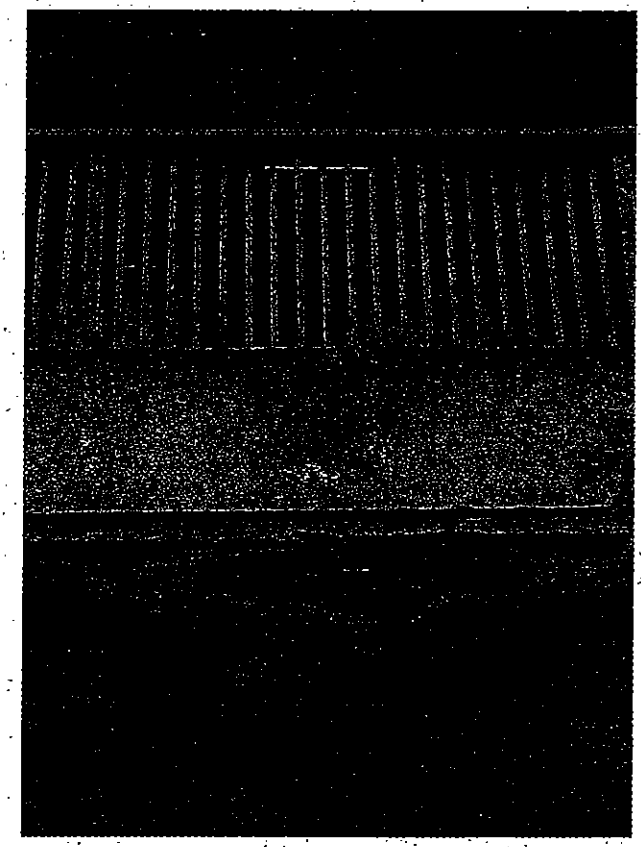


Photo 1

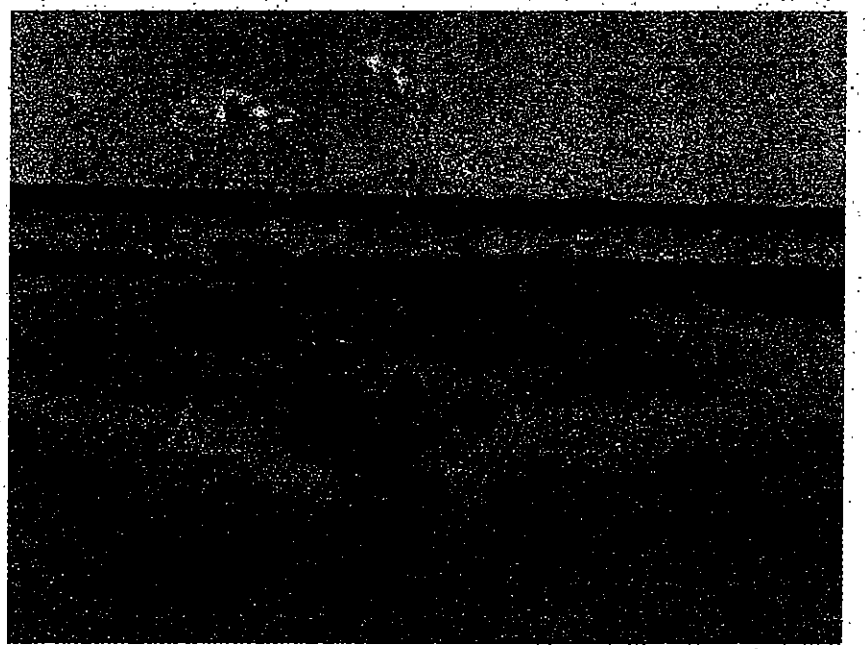


Photo 2

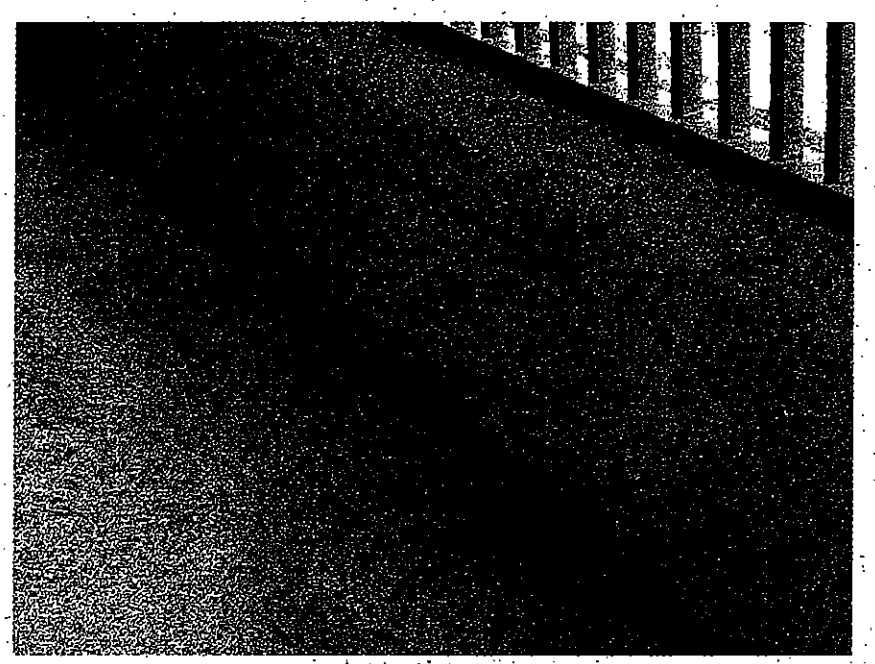


Photo 3

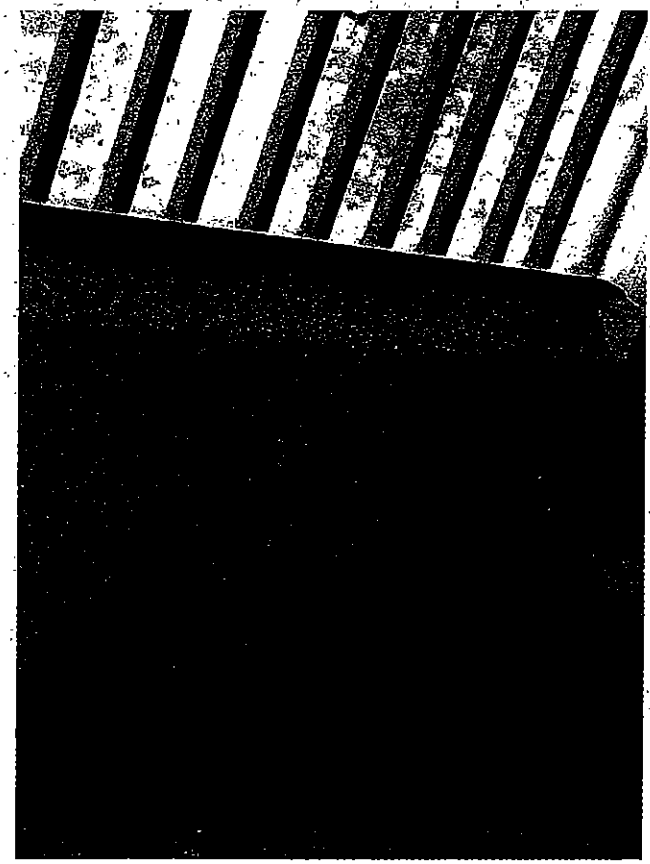


Photo 4

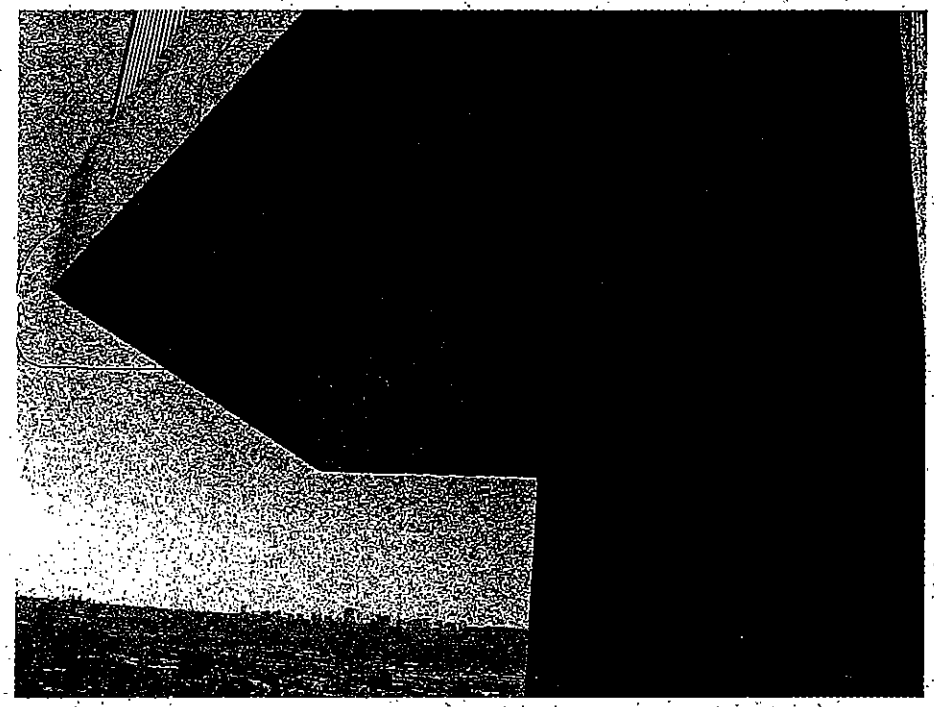


Photo 5



Photo 6



Photo 7

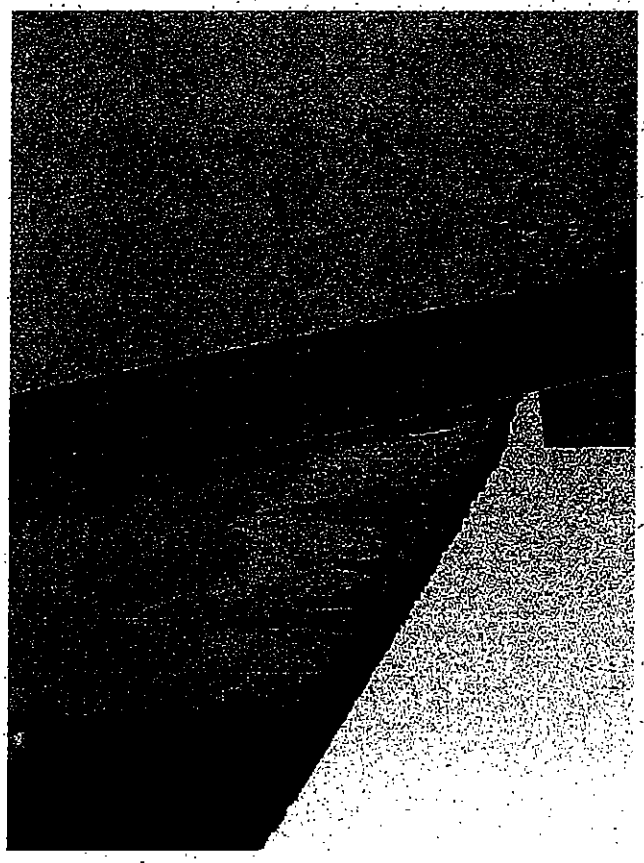


Photo 8

A review of the above noted photos and our field observations suggest that the majority of the deterioration that has been observed can be associated with poor balcony drainage and inadequate protection of the reinforcing steel from moisture.

Having now completed both the structural analysis of the balconies (Refer to The Structural Report) and our investigation of the deteriorated concrete we are of the opinion that the deteriorated concrete which is the subject of this report represents a greater danger to the public than the potential structural deficiencies which are the subject of The Structural Report. The Strata should be aware that the potential exists for small pieces of concrete to break loose from some balcony slabs and fall to the ground which could cause property damage, or personal injury. It is our opinion that steps should be taken as soon as practical to eliminate the above noted potential danger to the public and/or other residents.

6.0 RECOMMENDATIONS

In order to ensure that reinforcing steel has not corroded beyond acceptable limits, to increase the likelihood that reinforcing steel will not corrode beyond acceptable limits in the future, and to significantly reduce the likelihood of pieces of concrete falling to the ground from suspended balconies, we recommend a repair program which will:

- Allow for direct observation of reinforcing steel that is considered to be the most susceptible to corrosion;
- Replace or refurbish excessively corroded reinforcing steel;
- Replace obviously delaminating concrete;
- Protect reinforcing steel from future exposure to moisture;
- Reduce future maintenance requirements;
- Improve public safety.

We propose to achieve the above noted objectives by:

- Inspecting every balcony floor so that deteriorated areas can be recorded and marked;
- Inspecting exposed reinforcing steel at areas where delaminated concrete has been removed and then replace or clean the steel as required;
- Either completely removing and reconstructing existing curbs or patching areas where delaminated concrete has been removed. The decision whether to rehabilitate or completely replace existing curbs would be made pending a thorough inspection and evaluation of each curb. If the extent of required patching is too great, it would be more economical to simply remove the curb and then reconstruct it. When compared to complete replacement, there are several disadvantages to patching existing curbs:
- It may not be possible to achieve the recommended concrete cover of 30 mm around the existing reinforcing bars;
- Existing reinforcing bars which do not become visible during the patching process may be significantly corroded. As the moisture which has already entered the curb assembly makes its way through the assembly, corrosion of existing (hidden) bars may continue, even though there are no new sources of moisture. The potential for continued corrosion of existing bars may necessitate additional patching in the future;
- Cleaning and patching other areas balcony areas as required;
- Improving balcony drainage by ensuring scupper drains are located at low points. This may require either relocating some existing drains or re-sloping some existing balcony floors;
- Applying a waterproofing membrane to the top surface of the balcony floors and curbs. The waterproofing membrane could be expected to remain effective for approximately 15 to 20 years, after which time it will likely require replacement.

During the course of the repairs, it will likely be necessary to temporarily remove existing aluminum guard rails. Once the guard rails have been removed, it may be difficult to re-install them and ensure that they remain reliable and safe, thus it may become necessary to replace some of all of the guard rails.

We understand that some of the balcony floors have ceramic tiles permanently affixed to them. It is our opinion that the ceramic tile assembly does not provide reliable waterproof protection to underlying reinforcing steel and therefore, if the strata elects to allow the tiles to remain, effective repairs to tiled balconies may not be possible.

7.0 ORDER OF MAGNITUDE BUDGET

It is extremely difficult to provide an accurate cost estimate without more extensive testing, some preliminary design work and a clearly defined scope of work. The actual cost of the work cannot be known until material quantities have been reliably estimated, project drawings and specifications have been produced, contractors have bid on the project and the extent of all damages (hidden and exposed) are known. Based on cost figures from similar projects, and discussions with contractors who are familiar with this type of work, we have presented an order of magnitude budget in Table 3.

The budget which is presented in Table 3 has been prepared based on the following assumptions:

The intent of this Order Of Magnitude budget is to present a worse case scenario, therefore it has been assumed that all of the 285 suspended balconies and the four penthouse decks will require some demolition and repair work even though we estimate that only 50 percent to 75 percent of the balconies will require work.

The Structural Report provides an estimated budget of $287 000 to implement recommended structural repairs. Many of the costs which would be associated with the structural repair budget would also be incurred to implement the recommendations which are contained in this report, therefore, the Order of Magnitude Budget which is presented in Table 3 assumes that the recommendations which are presented The Structural Report will be implemented at the same time as the recommendations which are presented in this report.

Table 3 – Order of Magnitude Budget

Ref	Item	Unit	Unit Cost	Estimated # of Units	Total Cost	Comments
1	Engineering - Prepare specifications and drawings, tender project, review contractor's progress	Allowance	$40,000	1	$40,000	
2	Engineering - Detailed inspection of all balconies; mark areas for repairs.	Allowance	$13,000	1	$13,000	
3	Swing Stage Rental	Allowance	$24,000	1	$24,000	
4	Demolition and repair	Balcony	$2,000	285	$570,000	
5	Apply Membrane	Balcony	$1,200	285	$342,000	
6	Remove Existing Balcony Guardrail and Replace With New	Balcony	$1,100	285	$313,500	
7	Allowance For Penthouse Decks	Allowance	4%	1	$49,020	
8	Contingency	Allowance	15%	1	$194,778	See Note 1.
9	GST and PST	Allowance	14%	1	$216,482	See Note 2.
10	**GRAND TOTAL:**				**$1,762,780**	

Notes to Table 3:

1. The contingency amount, which is 15 percent of the estimated contractor's fees may account for unforeseen items that come to light during the course of the project.

2. PST may not be applicable to all items, however, we have added PST to all items in order to simplify the budget.

3. The strata may wish to consider implementing the proposed repair program in phases, for example, one building elevation at a time. The strata should be aware that the sum of the costs of each phase would be more than the cost of implementing the entire repair program at one time. Additional engineering costs associated with multiple tendering processes, and additional contractor mobilization and demobilization costs should be expected. An estimate of the cost of each phase may be determined as follows:

    - Divide the total cost which is indicated in Table 3 (Line 10) by the number of phases contemplated. For example, if the strata wishes to repair one building elevation at a time, divide the total in Line 10 by 8 (eight elevations).

    - Increase the value obtained above by 15 percent. This is the approximate value of the considered phase.

8.0 LIMITATION OF LIABILITY

It should be noted that this report is based on a visual inspection of the existing structural systems which are described in the body of this report. No testing or dismantling of any assemblies was performed and inspections were made on a random basis with no attempt to review or inspect every element or portion of the building. The intent of the inspection was to determine balcony areas of visually obvious deterioration and to generally determine the overall quality and sufficiency of the work, but not to ascertain the quality or sufficiency of all balconies. Our comments are not a guarantee or warranty of any aspect of the condition of the building whatsoever.

This report was prepared by McCuaig and Associates Engineering Ltd. for the account of Strata Plan NW 2099. The material in it reflects McCuaig and Associates Engineering Ltd.'s best judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. McCuaig and Associates Engineering Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

This report is intended for the sole use of Strata Plan NW 2099 who further agrees that it will indemnify and hold harmless McCuaig and Associates Engineering Ltd. from any and all liability which Strata NW 2099 may incur from its use or misuse, of this report.

Yours truly,

McCUAIG & ASSOCIATES ENGINEERING LTD.

Prepared by:

Paul Good, P.Eng.

Reviewed by:

J. J. McCuaig, P.Eng.

Ref. No **20040601**-RPT02-Final

McCuaig & Associates
Engineering Ltd.
439 McLean Dr., Vancouver, B.C. V5L 3M5 Phone: 255-0992 Fax: 255-1054

RECEIVED
MAR 0 1 2001

22 February, 2001

Dorset Realty Group Canada Ltd.
200 - 8211 Ackroyd Road
Richmond, BC
V6X-3J9

MAR 0 5 2001

ATTN: Brian Spencer

RE: Roof Condensation - 3740/3760 Albert Street, Burnaby, BC

Dear Sir,

As requested, we have visited the buildings located at 3740 and 3760 Albert Street in Burnaby and reviewed the water ingress concerns. Our inspection was completed with the assistance of the Resident Manager and a representative of a contracting company who recently completed work at these buildings related to water ingress problems.

There are two residential concrete high rise buildings. There are balconies located at each floor above grade. The roofs are a combination of inverted roofing and sloping metal clad hip roof around the perimeter. An inverted roof is a roof that has the waterproofing membrane loose laid directly over the roof deck and the insulation is placed on the exterior side of the roof membrane. The insulation is typically covered with a scrim sheet and held in place by gravel ballast. The metal roof extends down to provide vaulted ceilings and eaves for the penthouse level suites. At the corners of the building the metal roofing extends down to floor level creating storage rooms for the penthouse level suites.

McCuaig and Associates Engineering was asked to review water ingress related concerns in three areas: at the vaulted ceiling of a penthouse unit in the east building; at the storage rooms at the penthouse level; and excessive condensation inside the metal roofing in both buildings.

The water ingress problem in the East facing penthouse suite involved water running down the valence-box for the fireplace chimney vent. The fireplace is located in the corner of the first level of the suite. The box out runs from the ceiling above the fireplace to the upper corner of the ceiling at the loft level. Evidence of water running down the box and dripping onto the floor of suite was noted. The resident reported similar water related problems on one previous occasion. Leaking has typically occurred during or immediately following and very heavy

rainfall with accompanying high winds. The exterior side of the valence is metal clad roofing. A review of the roofing directly above the water ingress areas revealed no obvious weaknesses in the roofing assembly. Previous attempts to caulk fastener locations and seal around the chimney vent housing have not prevented the most recent report of water ingress. The condition of the flat roof is difficult to assess since it is an inverted roof system. This system protects the membrane via a layer of insulation, fabric sheet and ballast *on top* of the membrane. Thus the integrity of the membrane can not be easily assessed, moreover, leaks in this type of roof system are difficult to source because water may travel along the deck surface once it penetrates the membrane. There was no significant ponding of water on the roof deck at the time of our inspection. The design and slope of the metal roofing system makes it an improbable candidate for leaking of any significance at the upper section of the roof as was occurring in this unit.

Given the roof style and design, it is our opinion that the source of the leaking is at the flat roof level. The outside edge of the flat roof is covered by the metal roof assembly and would rarely be exposed to significant amounts of water. The frequency of the leaking and the accompanying climatic conditions suggest the leak problems only happen during extreme rainfall conditions. It is probable that the roof is incapable of draining the water fast enough during heavy rainfalls. As a result, the water level on the flat roof would exceed the normally expected levels. The water may spill over the edge of the flat roof and find a hole in the membrane or run down the enclosed vaulted ceiling thereby creating leaks inside the suite.

During our inspection we were told that during the same rain storm, water was observed flowing out of an "overflow" scupper in the other building. This would indicate a very intense rainfall causing accumulation faster than the drains can eliminate the water.

Following our review of the roof conditions and related information it is our opinion that the water ingress occurrences are limited to extremely heavy rainfall conditions. Since there have been limited incidence of this nature, we feel that it would be advisable to monitor the leak area for future leaks prior to undertaking a major roof rehabilitation program. While it is possible to complete a roof upgrade program, the cost to complete this work would be quite extensive and may not be warranted at this time.

The second area reviewed were the storage rooms at the penthouse level. The storage rooms are equipped with two access doors, one at either end of the room. These doors are hinged wooden doors designed to swing into the room. The doors and jambs at the time of our inspection were weathered and rotting in areas. The interiors of the rooms are bare concrete floors with a concrete curb wall at the perimeter of the room. There is no membrane or coating on the floors and the cold joints at the curb walls are not sealed and there are no floor drains. Any water in these rooms would easily flow into the underlying suites.

Water could enter the rooms from two possible areas: the entrance doors and the roof. The access doors would be the primary source of water ingress given the design and condition of the doors. The roof may contribute incidental water/moisture inside the room, however, it is our opinion that amount of water ingress from the roof assembly would be minimal and inconsequential.

The access door should be replaced with new doors mounted at the exterior side of the jamb and designed to swing out. The new doors and jambs should include proper flashing and weather stripping to prevent water ingress. The interiors of the storage rooms should have the cold joints in the concrete caulked and have a proper deck membrane installed over the floor and six inches up the walls. This will prevent any incidental moisture that enters the rooms from migrating through the concrete joints and into the suites below.

The estimated cost to have a contractor complete this work is in the range of $1,000.00 to $1,500.00 per storage room.

The final area of our investigation was the condensation accumulating on the underside of metal roof cladding. At the time of our inspection at section of metal roofing was opened to allow an inspection of the inside conditions. There was limited condensation at the time our inspection, however, the contractor reported significant amounts of condensation on previous occasions. The amount of condensation resulted in water dripping out the bottom areas of the metal roofing. The design and construction of the metal roofing assembly is such that it is an integral part of the vaulted ceilings inside the penthouse suites. As such removing sections of roofing removes the structural support for the gypsum on the ceilings.

Having reviewed the roofing assembly and the water concerns, we feel that in general terms there are two options available to address these concerns. Efforts can be made to limit the amount of condensation occurring in these areas or the assembly can be redesigned and replaced. Clearly, the first option is more financially feasible and less disruptive to the residents of the penthouse units.

There are several ways of mitigating the amount of condensation occurring in this area. Condensation accumulates due to a variety of conditions and our office has not completed any detailed analysis of the conditions in this building. However, based on the conditions we noted in this situation, it is possible that the metal roof cavity is adequately to sealed to create a temperature differential in the cavity resulting in the dew point being established inside the cavity and resulting in condensation. Our office can complete a detailed analysis of these conditions if the owners require it. The owners may also wish to attempt increasing the cavity ventilation and attempting to move the dew point outside the cavity. This could be achieved by

having a contractor install ventilation around the inside vertical wall of the metal roof assembly. A relatively simple design that would include perforating the upstand walls and covering them with ventilated soffit material.

The estimated cost to complete this type of work would be in the range of $5,000.00 for both buildings.

McCuaig and Associates would be pleased to provide any technical assistance necessary to complete this work. If requested a representative from our firm is available to meet with council to review this report and answer questions that may exist.

We trust this meets your requirements at this time, and should you have any questions or concerns please contact our office.

Yours truly,
McCUAIG & ASSOCIATES ENGINEERING LTD.

Andrew Leonard, B.Sc.Eng.

J.J. McCuaig, P.Eng., B.E.P.

Ref. No 00794**B10105**

REPORT ON DOMESTIC HOT AND COLD WATER PIPING

AT:

BOUNDARYVIEW
3740 - 3760 ALBERT STREET
BURNABY, BC

PREPARED FOR:

THE OWNERS STRATA PLAN NW2099

PREPARED BY:

MECHANICAL ENGINEERS:

QUADRA PACIFIC CONSULTANTS
#400 - 1550 ALBERNI STREET
VANCOUVER, B.C.
V6G 1A5
TELEPHONE: 688-8671
FASCIMILE: 688-9760
internet: http://www.quadrapacific.com
e-mail: qpc@quadrapacific.com

REFERENCE NO.: 388-079

JUNE 1999

QUADRA

1.0 INTRODUCTION

.1 Quadra Pacific Consultants were retained by the Property Management company for Boundaryview, Dorset Realty Group Canada Ltd., to report on:

a) "Evaluation of copper samples" conducted by Levelton Engineering Ltd. in March 1999, and

b) Provide a budget cost for replacement of the domestic water piping should we consider it necessary.

.2 Quadra pacific Consultants were given a brief tour of the common areas of each tower and the mechanical room and took possession of three (3) 1/2" diameter sections of copper piping, removed as a result of failures.

2.0 SYSTEM DESCRIPTION

.1 The complex is served by one water service from the street then splits into two distribution systems serving each tower.

.2 The domestic hot and cold water distribution is by City mains pressure, the water supply to each tower is controlled by pressure reducing valve stations that create three pressure zones in each tower according to the record drawings.

.3 Each tower has its own domestic hot water generating equipment in the lower level mechanical room. The equipment comprises a gas fired boiler coupled with two 115-gallon storage tanks.

A recirculation pump circulates the domestic hot water between the suites and the equipment.

3.0 PIPE MATERIALS

.1 The existing domestic water piping system is type 'L' copper tubing.

4.0 OBSERVATIONS

.1 The three (3) pipe samples inspected visually by Quadra Pacific Consultants were from suite #607 in tower 'A'. Two of the pipe samples failed from transverse cracking. It appears that the piping was fixed in such a way that constant movement due to expansion and contraction created corrosion fatigue or "weak points" in the system.

.2 The third section of pipe failed due to pinholes. The 3 ft long section had approximately 20 visible pinholes. This number would be double if the piping was acid etched and placed under more scrutiny.

5.0 LEVELTON'S EVALUATION

.1 The six (6) samples evaluated by Levelton do not identify which tower or location the pipe samples were removed from. However, the samples were from the hot water supply, cold water supply and the hot water recirculation piping and so give a good cross section of each distribution system.

.2 Tables 2, 3 and 4 give Levelton's observations of the pipe samples in various stages:

- Table 2 - Uncleaned
- Table 3 - After washing and scrubbing
- Table 4 - After acid cleaning

.3 The most common thread running through all three tables is pitting or pinholes and this will be the most common cause of pipe failures.

Thinning of the pipe is general and, as indicated in Table 5, is not the major source of concern.

The other source of leaks and concern is corrosion fatigue or cracking either due to where the piping has been bent or the method in which the piping was fixed at the initial installation.

.4 We traditionally expect to see in a complex of this age, pinholes and cracking in the smaller diameter piping (1/2" through 1-1/4"), particularly in the domestic hot water piping. In table 4, we note that the 2-1/2" cold water piping is also showing signs of pitting.

6.0 CONCLUSIONS AND RECOMMENDATIONS

.1 From our review of Levelton's evaluation and the pipe samples gathered from the site, we are of the opinion that the Owners will continue to experience pipe failures due to pinholing and cracking as the piping continues to age and fatigue.

.2 The one pipe sample we removed from the complex that has approximately 20 pinholes (we expect is part of the hot water system), had failed at only one pinhole. The remaining pinholes had not yet failed but are a good indication of the general condition of the remainder of the domestic hot water piping distribution.

.3 We assume that the samples examined by Levelton are not failed samples and so are also indicative of the general condition of the overall piping condition.

.4 Our recommendation is that the Owners develop a long term plan and/or budgeting program to replace all of the domestic hot and cold copper water piping from where it enters the lower mechanical room to each plumbing fixture in the complex to avoid further leaks and water damage.. We have seen instances where the cost of the water damage had insurance companies demanding these situations be rectified.

7.0 COST ESTIMATES

.1 The following cost estimate is a "ballpark" estimate that will give the Owners a feel for the magnitude of cost involved to retrofit both towers at the same time.

.2 It certainly is possible to retrofit one building at a time. It is also possible to retrofit a building one pressure zone at a time. The downside of this type of procedure is that at the "end of the day" the Owners will pay a higher cost than having the work carried out as one contract.

.3 Cost estimate (both buildings - one contract)
Approximately 6 month duration $800,000.00

In the estimate, we have made an allowance for engineering fees, GST and a contingency for unknowns. It should be noted that this a ballpark estimate. Market conditions, i.e., workload of the contractors at the time of bidding will impact on the tenders.

8.0 RETROFIT METHODOLOGY - RISER REPLACEMENT OR LATERAL REPLACEMENT

.1 Several factors need to be taken into account in determining which is the best method, the main factors being the physical layout of the suites, e.g. location of bathrooms, kitchens relative to corridors and architectural finishes of common area corridors and the suites.

.2 The following advantages/disadvantages are the result of discussions with owners and contractors involved in the piping retrofit business and are representative of the considerations that are taken into account.

.3 Each building requires its own evaluation, although in the minority, some buildings have been retrofitted with a combination of lateral and vertical systems.

.4 In a valence or lateral installation, the piping within the suites is completed on a one floor per day basis. On this day, the occupants of the floor being worked on will be out of water for the entire day. The remainder of the building will be without water for approximately 1 hour each morning.

.5 In a vertical replacement system, the disruption affects the "stacked" kitchens or "stacked" bathrooms, e.g. the water supply will be shutoff to 5 stacked" bathrooms or kitchens at a time while the piping is replaced.

LATERAL SYSTEM

ADVANTAGES	DISADVANTAGES
• Less noise and disruption to tenants • One set of shutoffs to each suite • Minimizes potential of leaks in existing piping during replacement • Shutoffs to each floor	• Requires valences in suites and corridors on each floor to conceal piping • May require relocation of corridor lights and alarms • Requires opening of washroom ceilings • Cost is $750 per suite more than the vertical system • Longer run of piping from hallways result in hot water not being as instant as the existing installation

VERTICAL SYSTEM

ADVANTAGES	DISADVANTAGES
• Does not require additional valences • Lights and alarms not affected • Less painting and drywall finishes • Less heat loss in piping • Better availability of hot water • Separate shutoffs to each bathroom and each kitchen are possible. Cost is approximately $200 per suite	• Shutoffs on each riser will affect say 5 kitchens or 5 bathrooms • individual suite shut-offs are not possible • Larger size piping (than original) may require enlargement of existing holes through floors in each suite • Suites are without water for a greater number of days compared to the valence system during the retrofit process

9.0 PIPE MATERIALS (For Retrofit)

.1 We recommend that two pipe materials be considered for the retrofit work:

a) Type 'K' copper for all risers and horizontal distribution. Type 'K' copper has a wall thickness that is approximately 30% greater than type 'L' copper tubing.

b) CPVC plastic piping (chlorinated polyvinyl chloride) and fittings for the smaller branch piping to fixtures. The manufacturers recommendations for installation need to be monitored.

END OF REPORT

Graham P. Aspinall, Partner
Manager, Plumbing and Fire Protection
GPA:jms

Latham's

ommercial/industrial heating, air conditioning & plumbing

DEPENDABILITY

March 30, 1999

Dorset Realty Group Canada Limited
#200 - 8211 Ackroyd Road
Richmond, BC V6X 3J9

Attention: **Mr. Brian Spencer**

Dear Sirs:

Reference: **Boundaryview Apartments - Levelton Engineering Ltd.**
Report #299-0150 Dated March 24, 1999

We recently removed several representative piping samples from Boundaryview Apartments and submitted them to Levelton Engineering Ltd. whom completed a detailed analysis and report of the condition of this piping. Please see the attached report.

We wish to draw your attention to table 4, specifically, item #2 the main domestic hot water supply piping - Levelton has noted that the pipe wall has deep pitting which in these areas is in excess of 50% of the pipe wall thickness. This condition indicates that leaks from piping failure can be expected in the future.

The other item that is of concern with this report is table 4, specifically, item #6 the domestic hot water recirculation supply piping - Levelton has noted that the pipe wall has several deep pitting which in these areas is in excess of 50% of the pipe wall thickness. Again this condition indicates that leaks from piping failure can be expected in the future.

In the case of a building's domestic water piping deteriorating to the point of 50% of the original pipe wall thickness, it is recommended that the complete domestic water piping systems be replaced as continuing failure of this piping can now be expected.

If you require any further information please contact myself at 683-2321 or 836-4704.

Sincerely yours,

GORDON LATHAM LIMITED

Ken Allison

Ken Allison, C.Tech.
Sales Representative

KA/ap
Encl.

⊗

allison/dorbound.let

LEVELTON
Engineering Solutions

March 24, 1999

File: 299-0150

Levelton Engineering Ltd.

150-12791 Clarke Place
Richmond, B.C.
Canada V6V 2H9

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Construction Materials
Building Science
Geotechnical
Metallurgy and Corrosion
Environmental
Analytical Chemistry
Physical Testing

Gordon Latham Ltd.
1141 Richards Street
Vancouver, British Columbia
V6B 3E8

Attention: Mr. Ken Allison, C.Tech.

Dear Mr. Allison:

Re: Copper Pipe Condition Evaluation – Boundary View Apartments – Dorset Realty

As requested, Levelton Engineering Ltd. have examined the six samples of copper pipes submitted. It is our understanding that the samples were removed from Boundary View Apartments, 3760 Albert Street, Burnaby, B.C., an approximate 17 year old building.

The six samples submitted were as follows (see also Figure 1):

Table 1 – Summary of Copper Samples

SAMPLE NO.	NOMINAL PIPE SIZE, inches	SERVICE	LOCATION	DESCRIPTION
1	2 1/2	Cold	11th floor	12" straight length
2	2	Hot	11th floor	12"straight length
3	1	Recirculation	11th floor	10" straight length
4	1/2	Hot	607	10 1/2" straight length
5	1/2	Cold	607	9 1/2" straight length
6	1/2	Hot	1202	Approximately 8" long bend section

VISUAL OBSERVATIONS

A summary of our visual observations aided by low power stereomacroscopy of the internal surfaces of the pipe samples: as received; after washing and scrubbing in hot water; and after acid cleaning, is shown in Tables 2 to 4.

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Engineering Solutions

Table 2 – Summary of Visual Observations As Received

SAMPLE NO.	NOMINAL PIPE SIZE, inches	SERVICE	OBSERVATIONS	REFERENCE FIGURE
1	2 1/2	Cold	Surface covered with a reddish chocolate brown deposit. Possibly some flux deposits. No apparent deterioration.	2
2	2	Hot	Relatively thick chocolate brown deposit. Numerous fine pits in areas where deposit has flaked off. Surface light greenish underneath brown deposit.	3
3	1	Recirculation	Thick soft dark brown deposit with light greenish film underneath. Extensive fine deep pits.	4 to 6
4	1/2	Hot	Very thick brownish crystalline deposit that was easily dislodged. Relatively thin greenish grey deposit underneath brown deposit.	7 and 8
5	1/2	Cold	Similar to Sample 4 but significantly less deposit.	7
6	1/2	Hot	Heavy beige brown deposit. Bend was severely cracked on both sides at mid radius.	9 and 10

Table 3 – Summary of After Washing and Scrubbing in Hot Water with Soft Bristle Brush

SAMPLE NO.	NOMINAL PIPE SIZE, inches	SERVICE	OBSERVATIONS	REFERENCE FIGURE
1	2 1/2	Cold	Thin chocolate brown film. Some residual flux spots. No apparent pitting.	11
2	2	Hot	Thin black film which was covered in areas with light brown deposit. Numerous fine pits. Some light greenish deposit in pits, especially elongated pits.	12
3	1	Recirculation	Light greenish deposit over thin black film. Extensive fine to fairly broad isolated pits with some fairly deep. Some general attack at one end of sample.	13 and 14
4	1/2	Hot	Thin light greenish film over brown deposit. Some localized attack in the deformed area.	15 and 16
5	1/2	Cold	Thin patchy grey to light greenish deposit. Relatively thick brown scale on metal surface.	15
6	1/2	Hot	Dark shiny brown scale. Numerous fine pits. Extensive mid radius cracking on both sides of bend.	17 and 18

LEVELTON
Engineering Solutions

Table 4 – Summary After Acid Cleaning

SAMPLE NO.	NOMINAL PIPE SIZE, inches	SERVICE	OBSERVATIONS	REFERENCE FIGURE
1	2 1/2	Cold	General light surface etching. A few small pits.	19
2	2	Hot	Heavy general surface etching. Numerous shallow small diameter pits. A few isolated deep pits in excess of 50% of the wall thickness.	20
3	1	Recirculation	General attack with extensive non-uniform attack areas.	21
4	1/2	Hot	General thinning. Some fine pitting.	-
5	1/2	Cold	General thinning with localized areas of deeper attack. Fine cracks in deformed areas.	22
6	1/2	Hot	Extensive fine relatively shallow pitting ranging from isolated to general attack. Pit depths up to approximately 50% of wall thickness.	-

WALL THICKNESS MEASUREMENTS

Wall thickness measurements for the six samples are compared with the specified thickness for ASTM B 88 Type L copper pipe in Table 5.

Table 5 – Specified Wall Thickness vs. Measured Wall Thickness for ASTM B 88 Type L

SAMPLE NO.	NOMINAL PIPE SIZE inch	SERVICE	WALL THICKNESS, inch			
			SPECIFIED (1)		MEASURED	
			MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
1	2 1/2	Cold	0.072	0.088	0.070	0.075
2	2	Hot	0.063	0.077	0.058	0.065
3	1	Recirculation	0.045	0.055	0.035	0.045
4	1/2	Hot	0.036	0.044	0.032	0.035
5	1/2	Cold	0.036	0.044	0.032	0.037
6	1/2	Hot	0.036	0.044	0.034	0.038

Note (1) – ASTM B 88 Type L.

LEVELTON
Engineering Solutions

CONCLUSIONS AND COMMENTS

The thickness measurements indicate all piping was likely originally ASTM B 88 Type L.

The most severe corrosion was on the 1" hot water recirculation line (Sample 3), as would be expected, with a corrosion thickness loss of approximately 30% from nominal wall thickness. The 2" hot water riser (Sample 2) and 1/2" hot water branch lines (Samples 4 and 6) also show some thinning but a more significant problem was the deep isolated pitting on the 2" riser piping which could result in leaks. The 1/2" cold water line (Sample 5) also shows significant thinning for a cold water line.

The centreline radius cracking on the bend Sample 6 is typical of corrosion fatigue of hot water lines that are subjected to heating and cooling cycles due to intermittent usage.

I hope this information is satisfactory for your requirements. If you have any questions or comments, please contact me.

Yours truly,

LEVELTON ENGINEERING LTD.

R.S. Charlton, P.Eng.
Manager, Materials and Corrosion Engineering

Direct Line: 207-5112

RSC:nvl

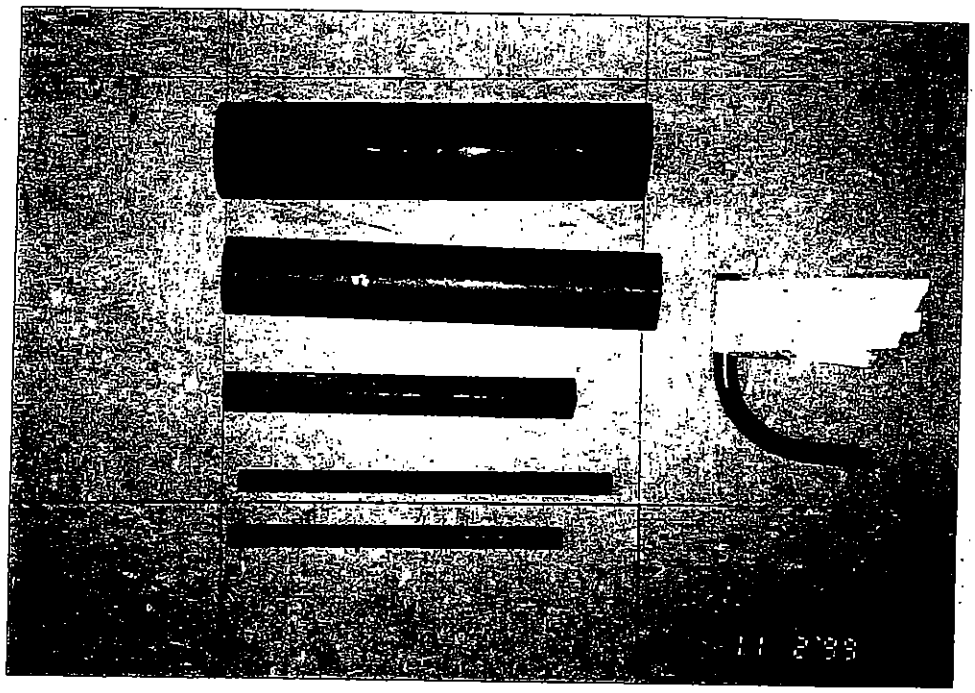


Figure 1: View showing Boundary View Apartment copper pipe samples. Straight lengths are Samples 1 to 5 (from top to bottom) and the long radius bend is Sample 6.

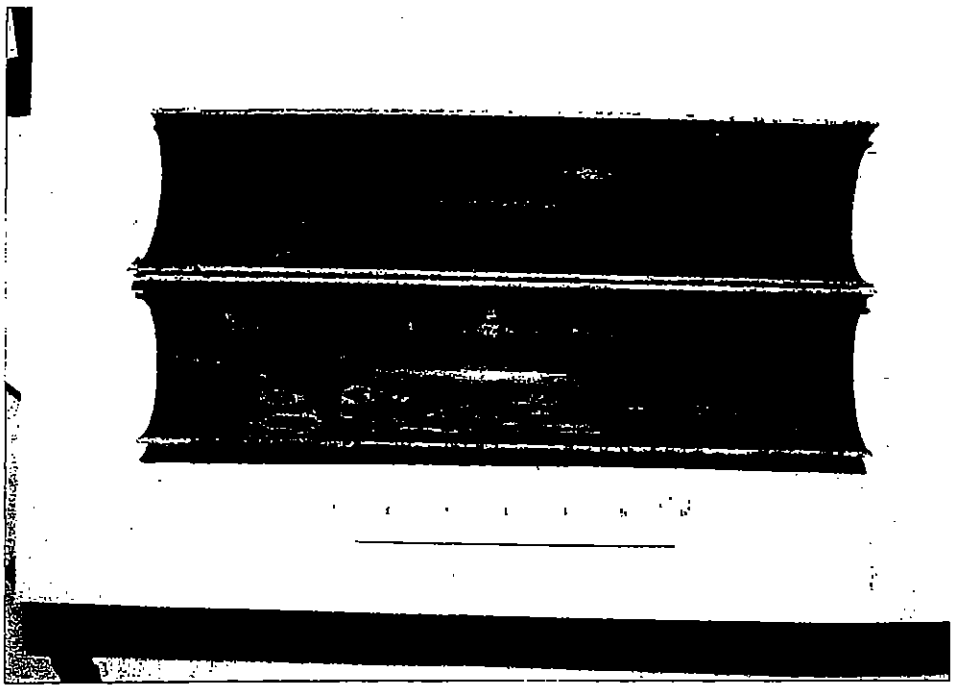


Figure 2: View of pipe Sample 1 in as-received condition after splitting in half lengthwise. Note spots of residual flux (isolated patches) which are especially noticeable in lower half section.

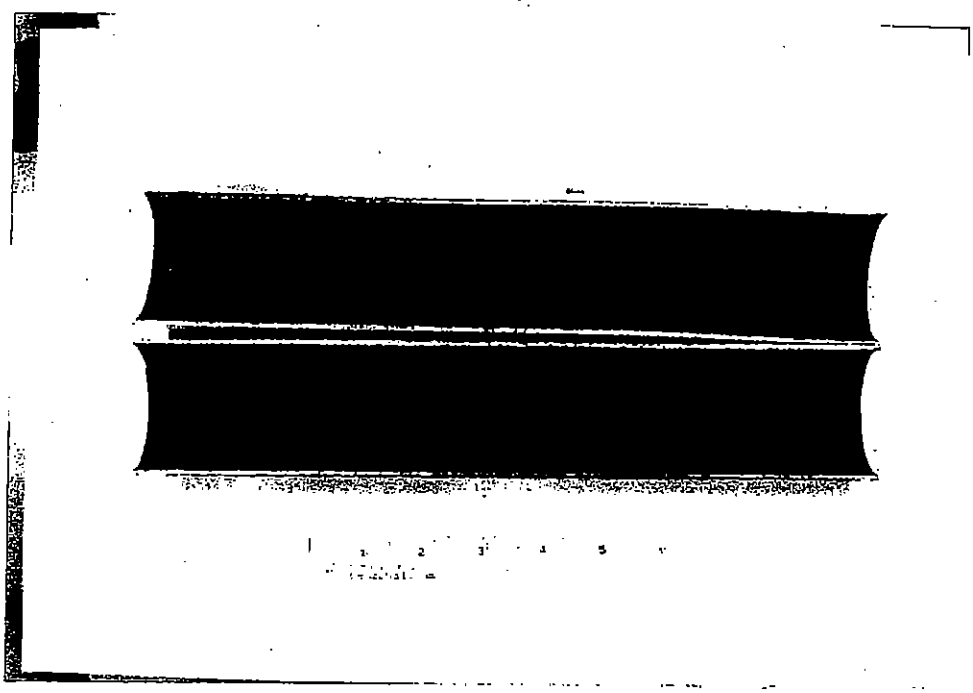


Figure 3: View of pipe Sample 2 in as-received condition after splitting in half lengthwise. Note light greenish deposit under chocolate brown surface deposit especially towards left hand end of upper cross-section.

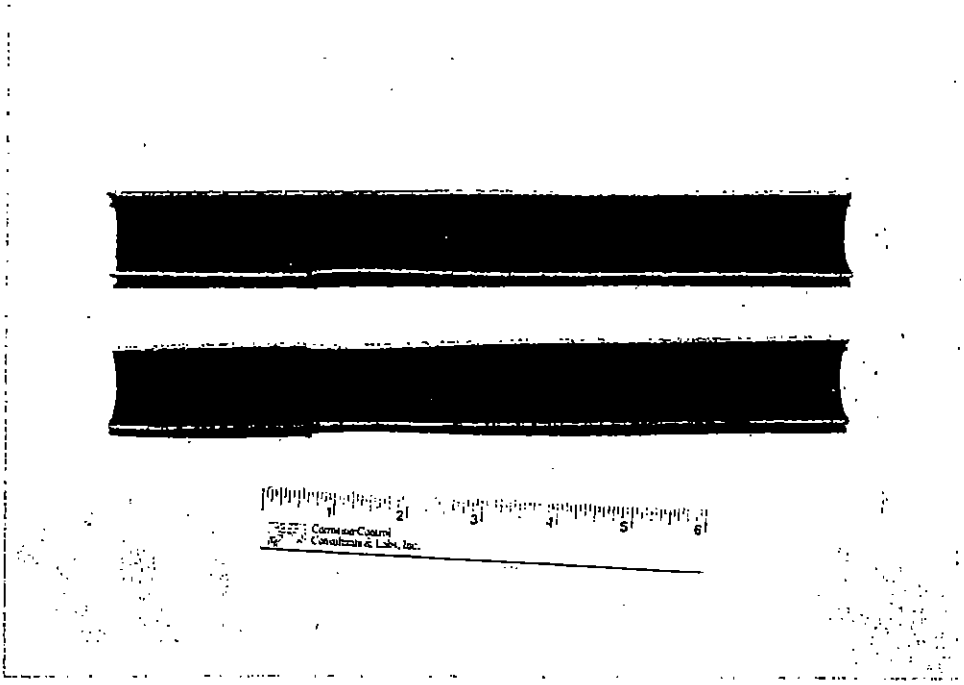


Figure 4: View of pipe Sample 3 in as-received condition after splitting in half lengthwise.



Figure 5: Close-up view of Figure 4 showing left hand end of lower half section. Note extensive fine pitting.

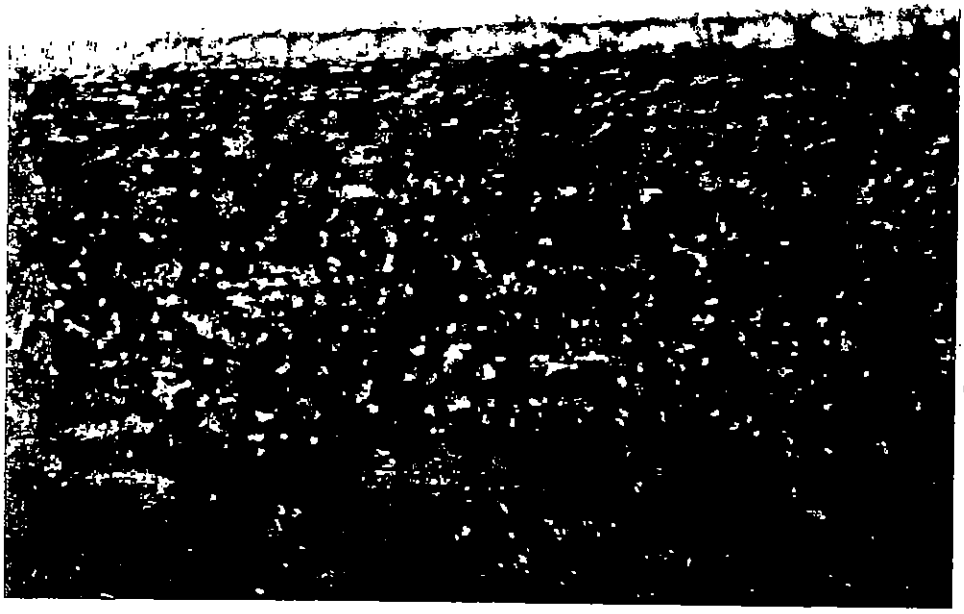


Figure 6: Close-up view of Figure 5. Note extensive fine pitting and light greenish film under brown surface scale. Magnification approximately 3.6 X.

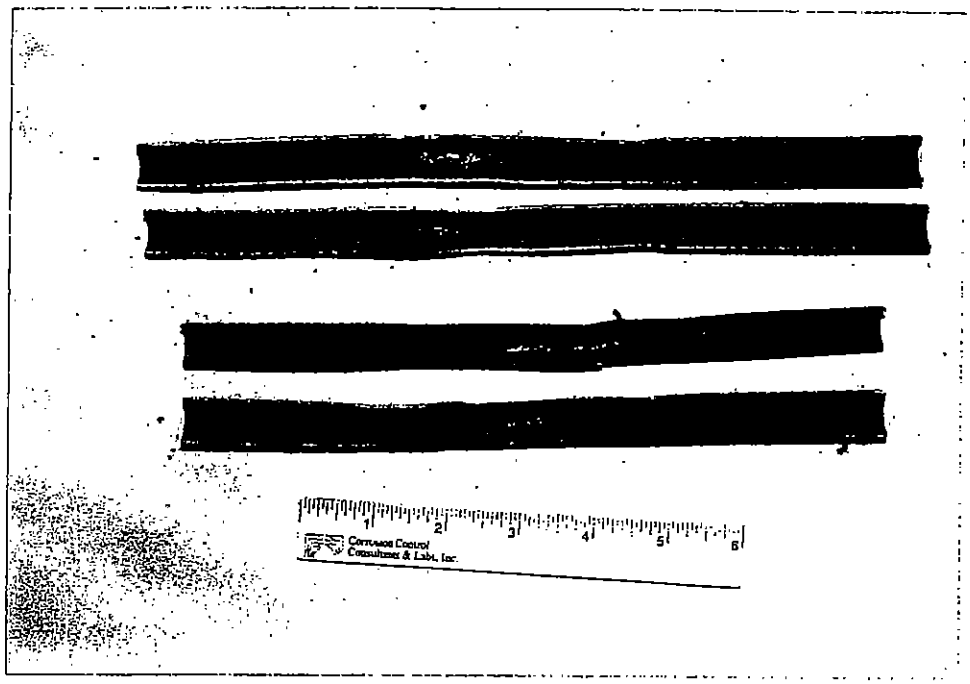


Figure 7: View of pipe Samples 4 (upper) and 5 (lower) in as-received condition after splitting in half lengthwise.

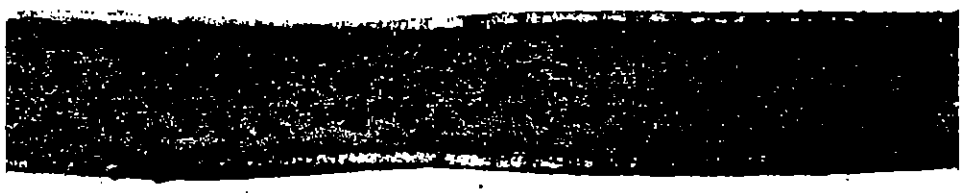


Figure 8: Close-up view of lower section of Sample 4. Outer scale has formed into discrete particles after drying and has exposed the underlying light greenish film.

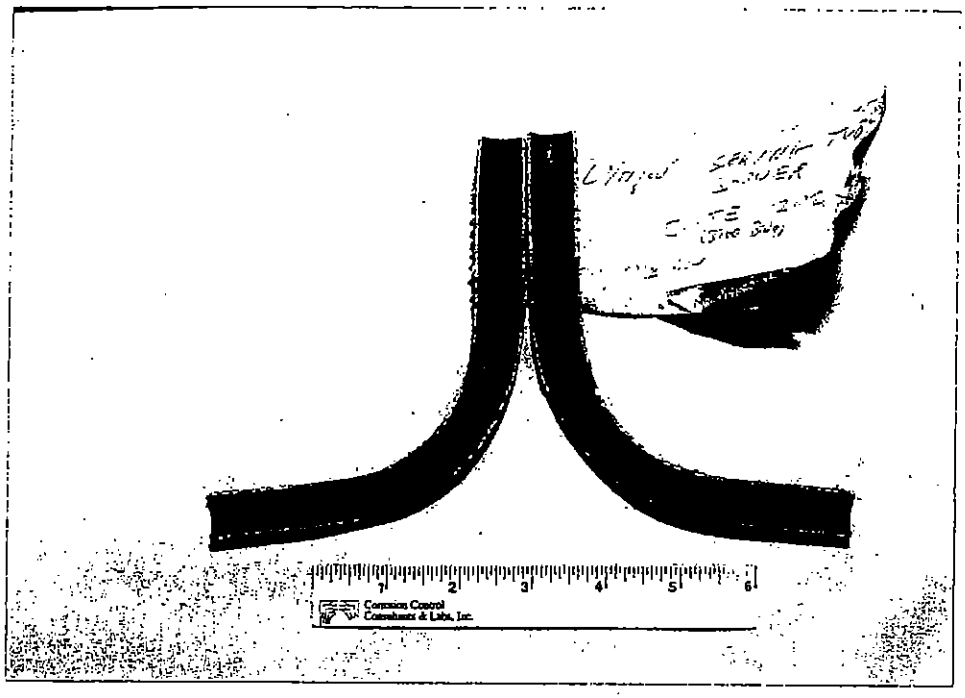


Figure 9: View of pipe Sample 6 in as-received condition after splitting in half lengthwise. Note extensive cracking at mid radius in both halves of bend.



Figure 10: Enlarged view of right hand section shown in Figure 9. Note mid line cracking.

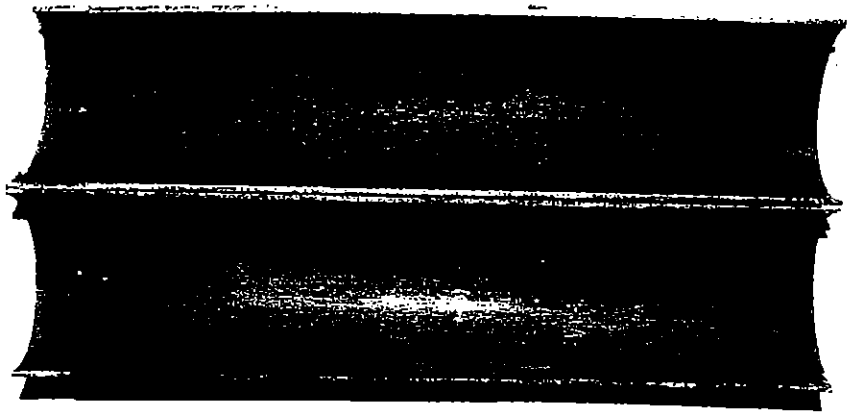


Figure 11: View of pipe Sample 1 after washing and scrubbing in hot water with soft bristle brush. Residual flux patches are still visible especially in lower half section.



Figure 12: View of pipe Sample 2 after washing and scrubbing in hot water with soft bristle brush.

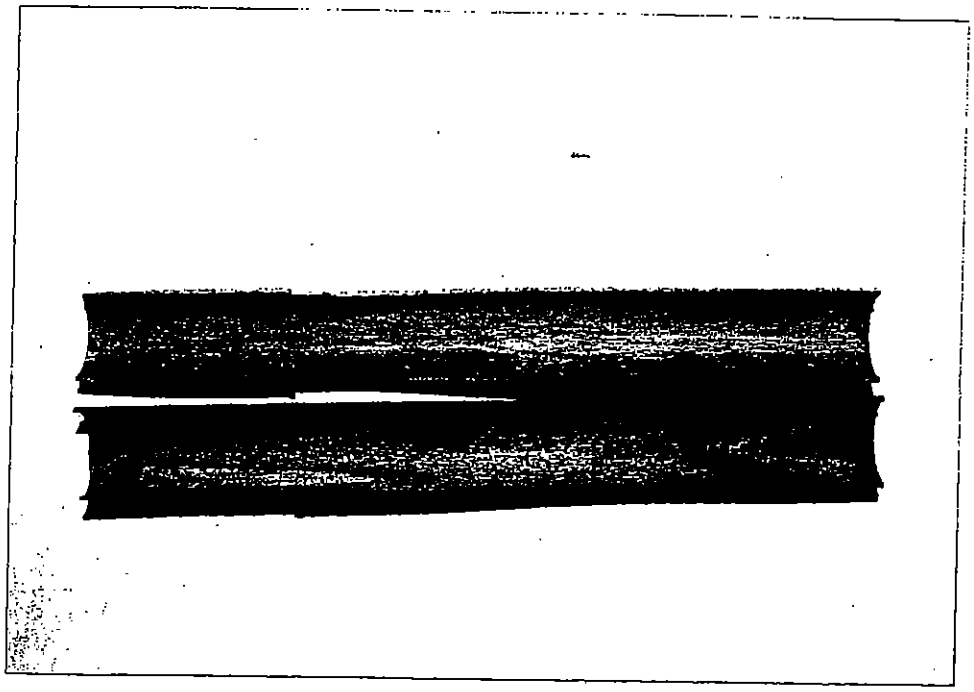


Figure 13: View of pipe Sample 3 after washing and scrubbing in hot water with soft bristle brush.

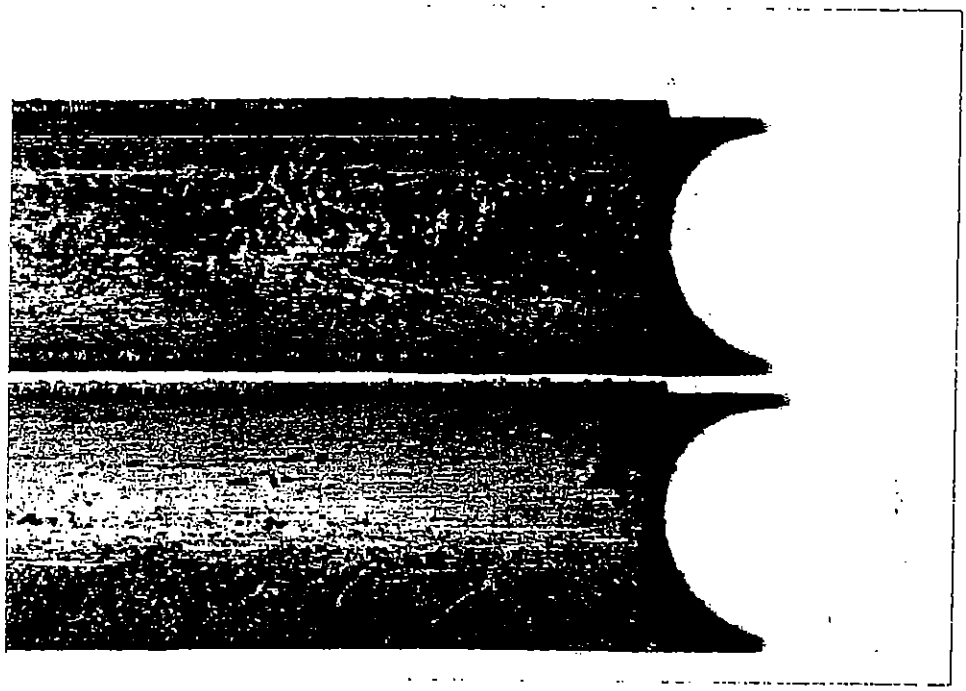


Figure 14: Close-up view of right-hand end shown in Figure 13. Positions of ends have been inverted from Figure 13.

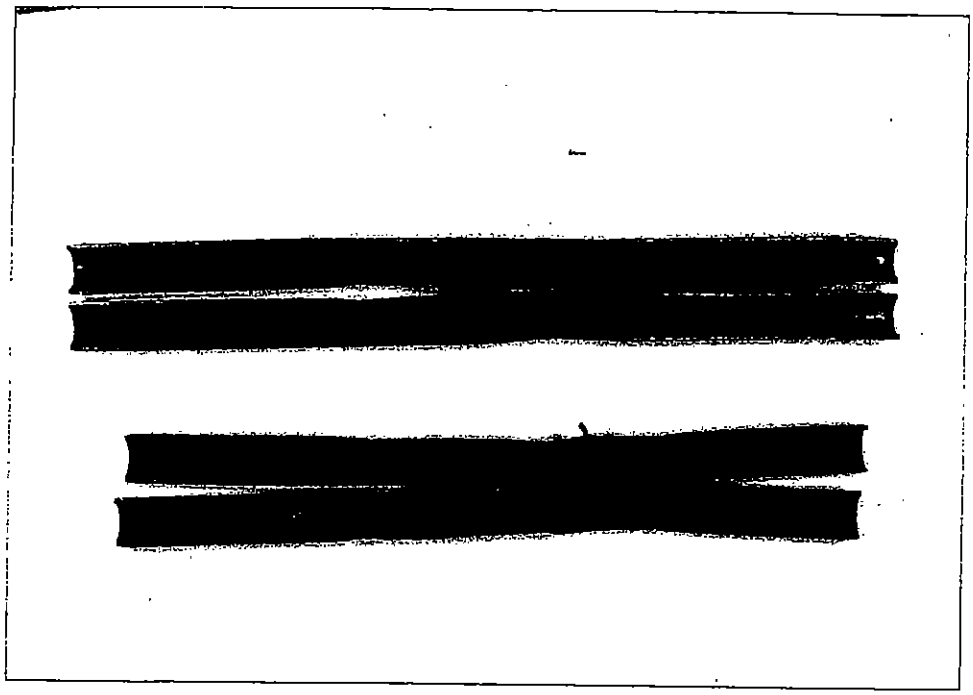


Figure 15: Views of pipe Sample 4 (upper) and 5 (lower) after washing and scrubbing in hot water with soft bristle brush.

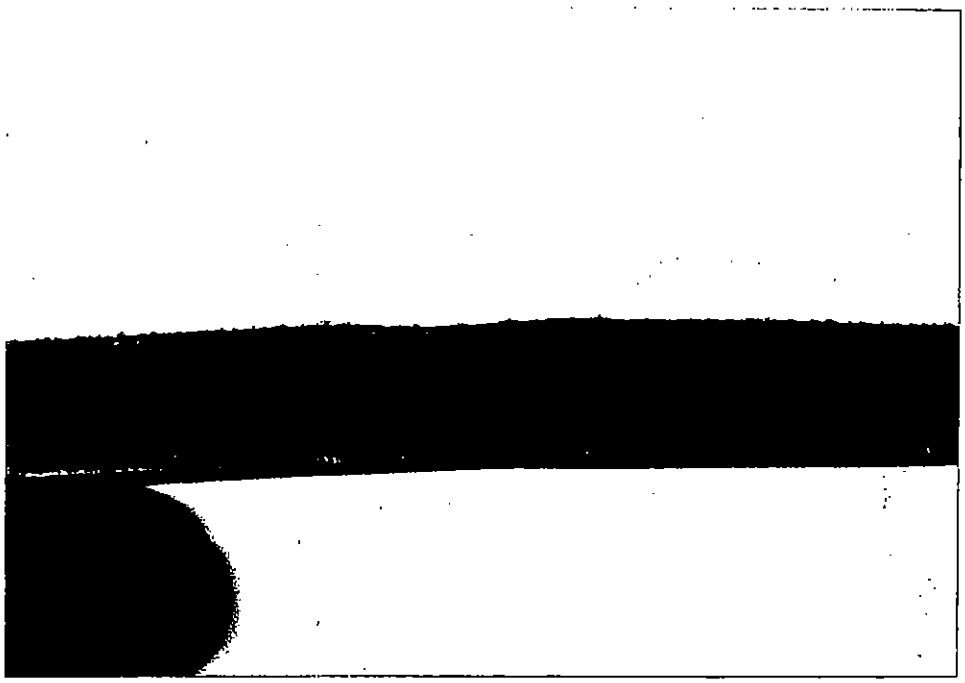


Figure 16: Close-up view of pipe Sample 4 showing area of localized attack after washing and scrubbing in hot water with soft bristle brush.



Figure 17: Close-up view of one half of pipe Sample 6 after washing and scrubbing in hot water with soft bristle brush. Note: centreline radius cracking.



Figure 18: Close-up view of Figure 17 showing mid-radius cracking. Magnification approximately 3.6 X.



Figure 19: View of pipe Sample 1 after acid cleaning. Light coloured areas near centreline of pipe section are uncorroded areas of pipe that resulted from residual flux on the surface.

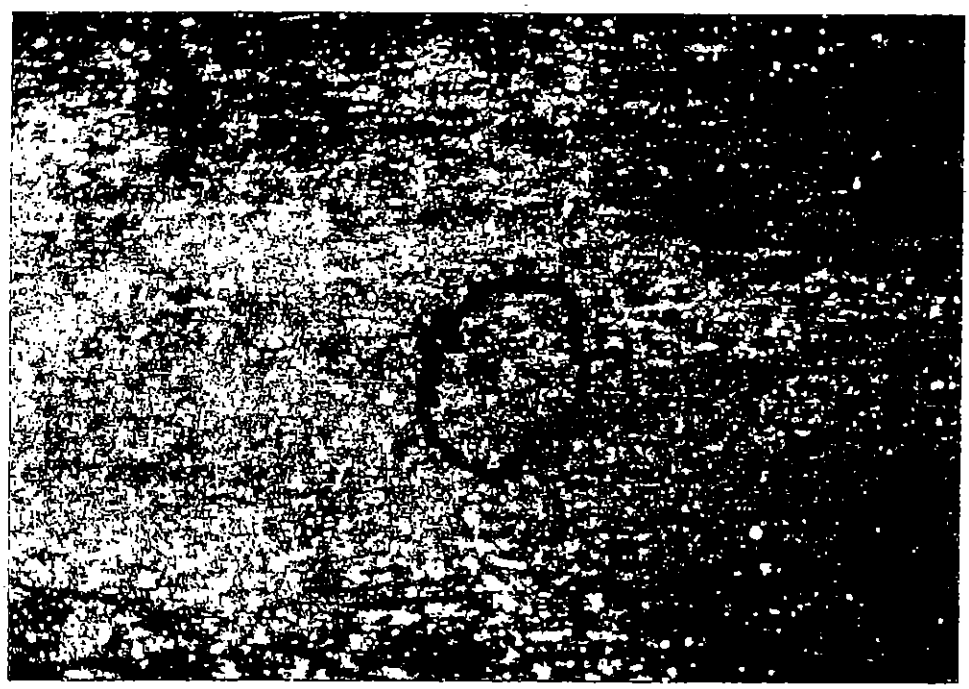


Figure 20: View of pipe Sample 2 after acid cleaning showing isolated deep pit. Magnification approximately 3.6 X.



Figure 21: View of pipe Sample 3 after acid cleaning showing typical non-uniform attack. Magnification approximately 3.6 X.



Figure 22: View of pipe Sample 5 after acid cleaning showing typical areas of deep attack. Magnification approximately 3.6 X.

Brian Spencer

From: Paul Good

Sent: June 28, 2004 2:02 PM

To: brianspencer@dorsetrealty.com

Cc: Andrew Leonard; Bob Legget

Subject: Re: Andrew, I Do not know who to send these questions too. Need for Monday. June 28, 2004]

Hi Brian;

In regards to your recent email, I am the engineer who is looking after items 1 & 2.

Item 1:
As discussed during our telephone conversation of June 21, 2004, I have now inspected (I've just completed my inspections this morning) more balconies to increase my data base. To date, I have now inspected 30 balconies, which cover a variety of framing schemes. Based on my preliminary review of the data that I have collected and my preliminary review of the available structural drawings, I offer the following comments:

The structural drawings indicate that the typical floors in both buildings have been identically constructed, yet there appears to be a problem with the corner balconies at 3760 only. **For the corner balconies at 3760 only,** larger than expected deflections and delaminating top concrete suggests that the balcony structures may be overstressed. It is possible that the balconies are strong enough (they will not break), but not stiff enough (they deflect too much). To date, we have not completed a structural analysis and so cannot confirm if the balcony structures, as indicated on the drawings, meet strength requirements. It appears that some - but not all - of the 3760 corner balconies have had additional reinforcing steel placed after original construction. Some of the occupants have indicated that this occurred just before the building became a condominium. Some of the building's long-time occupants may be able to shed some light as to who upgraded the balcony reinforcement. The middle balconies at both buildings and the corner balconies at 3740 appear to be functioning as expected.

As discussed in our telephone conversation of June 21/04, once I have collated my data, I will attempt to contact the buildings' structural engineer of record to see what information he has. If, after discussing the site conditions with him, he is unable to shed any new light on the problem, we will perform a structural analysis on the corner balconies, based on the information that we have available.

To date, I have spent approximately 10 hours on this investigation (10 hours @ $135/hour = $1350). At this point, it is not possible to estimate how much time it will take to complete the investigation and provide meaningful recommendations. If we get good cooperation from the buildings' original structural engineer of record, the investigation will proceed more quickly.

Until we have had a chance to talk to the structural engineer of record or complete our own analysis, I offer the following recommendations:

> Do not allow 3760 corner balconies to support heavy loading. Lawn furniture and one or two people would be acceptable - heavy objects and/or more than three

people at a time should be avoided;

Occupants of 3760 corner balconies should be aware of existing conditions (crack patterns, existing floor slope) and report any unusual changes;

The strata should attempt to determine who authorized the post-construction balcony reinforcements;

A survey should be issued to all occupants in order to determine exactly how many balconies are cracked and delaminating and how many appear to have been post construction reinforced. If you wish, I could design a survey questionnaire which would provide us with data that will be useful to evaluate the pervasiveness of the problem and design a repair strategy. Please let me know if you want me to produce a survey questionnaire.

Item 2:
I will also be addressing the issue of spalling concrete from balcony curbs, however, I have been concentrating on the cracked balcony slabs, and therefore have not had a chance to prepare a proposal to evaluate and report on this issue. I will prepare and issue a proposal to address your concerns next week.

If you have any questions on the above items, pleases do not hesitate to contact me.

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