SERVING WESTERN CANADA

DOMESTIC WATER SYSTEM CONDITION ASSESSMENT

STRATA PLAN LMS 712

Beach Tower (Tower A)	**888 Beach Avenue, Vancouver, BC**
Ocean Tower (Tower B)	**1501 Howe Street, Vancouver, BC**
Garden Tower (Tower C)	**1500 Hornby Street, Vancouver, BC**

Presented to: Mr. John Boschert
FirstService Residential
#700 – 200 Granville Street
Vancouver, BC. V6C 1S4

Proponent/ Prepared By: McCuaig & Associates Engineering Ltd.
Suite 200 - 3999 Henning Drive
Burnaby, BC V5C 6P9

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EGBC 1002833

200 - 3999 Henning Drive
Burnaby, BC, V5C 6P9

Phone: 604-255-0992
Fax: 604-255-1054

www.mccuaig.net
info@mccuaig.net

April 19, 2023

FirstService Residential
#700 – 200 Granville Street
Vancouver, BC
V6C 1S4

Attention: John Boschert

RE: Domestic Water Distribution System Assessment at LMS 712 Apartments – 888 Beach Avenue, 1501 Howe Street, 1500 Hornby Street, Vancouver, BC

Dear Mr. Boschert,

Following our investigation of the domestic water systems at Strata Plan LMS 712, we are pleased to present the following report. Our investigation involved testing of water samples and destructive testing of a limited number of pipe samples and a visual review of the domestic piping system and its associated components.

LMS 712 apartments were constructed in 1993 and it is our understanding that the domestic water piping is original to the building with some patch work over the years and has been experiencing leaks at a regular interval. The areas investigated in the three buildings are displayed in Table 1.

Table 1 – Areas Investigated in Three Buildings

Tower	Units
Tower A – Beach Tower	• Penthouse and parkade mechanical rooms • Water entry room • Commercial units C1 (Mini Market grocery store) and C3/C4 (One Clinic Medical Office) • Residential units 505, 809, 1010, 1308, 1606, 1809, 2104, 2501, 2704, and 3202
Tower B – Ocean Tower	• Penthouse and parkade mechanical rooms • Water entry room • Residential units TH-15, 503, 702, 901, 1303, and 1502
Tower C – Garden Tower	• Penthouse mechanical room • Residential units TH-24, 514, and 616

This report consists of a description of the building's plumbing system, a description of typical corrosion in a copper pipe system, discussions of water samples, and destructive testing, followed by our assessment and recommendation.

Description of the Domestic Plumbing Distribution System at LMS 712

For Ocean (Tower B) and Garden (Tower C) Towers, the water from the city enters the building at the water entry room located on the parkade level, P2 in Tower B through a DCVA (Double Check Valve Assembly) and PRV (Pressure Reducing Valve), and a duplex booster pump system to supply domestic cold water (DCW) to upper floors and penthouse mechanical rooms. Similarly, Beach (Tower A) Tower has its own water entry room on the parkade level, P1 along with DCVA, PRV, and booster pump systems.

Unlike the DCW supply system, domestic hot water (DHW) lines are connected to recirculation lines, which run back to the storage tanks. Typically, a pump allows a constant circulation of unused DHW back through the return lines. This frequent circulation is necessary to maintain the temperature of the water in the supply pipes and to meet the hot water demand. Without re-circulation of the hot water supply lines, it could take up to five minutes of running a faucet to get hot water. All hot and cold supply pipes and hot water re-circulation pipes at all three buildings are made of copper.

For buildings over 12-storeys, separate pressure zones are usually required to provide adequate pressure for the entire system. LMS 712 apartments are comprised of various pressure zones as shown in the following table.

Table 2 – Pressure Zones Summary

Tower	Units
Tower A – Beach Tower	36-storey (4 domestic water zones) • Zone 1: 1st – 8th floor • Zone 2: 9th – 16th floor • Zone 3: 17th – 25th floor • Zone 4: 26th – 33rd floor
Tower B – Ocean Tower	19-storey (2 domestic water zones) • Zone 1: 1st floor – 8th floor • Zone 2: 9th floor – 19th floor
Tower C – Garden Tower	10-storey (1 domestic water zone)

Corrosion in a Typical Copper Pipe Distribution System

Copper pipe corrosion of a water distribution system is a common phenomenon with many possible causes. Four major factors affecting the internal corrosion of copper pipes are:

1. The chemical composition of the water
2. The temperature of the water
3. The velocity that the water travels inside the pipe, and
4. The presence of any electrolytic effects.

The chemical composition of the water is determined by the acidity (PH) and the presence of corrosives (oxygen and chlorine). The optimal pH level falls between 6.5 to 8.5 as established by the US EPA (number commonly used worldwide), though the *Guidelines for Canadian Drinking Water Quality* (2022) published by the government of Canada outline that a PH level of 7.0 – 10.5 is ideal for limiting corrosion. The rate of copper corrosion is dependent on the level of PH; the rate increases significantly as the PH level falls below 6.

The temperature of the water also plays an important role in corrosion reaction rates. The higher the temperature of the medium, the faster the rate of corrosion. Thus, hot water pipes tend to corrode faster than cold water pipes.

The velocity of the water corrodes pipes in two ways: increasing erosion due to friction and the creation of pressure shocks caused by cavitation. The increased friction inside a pipe due to high-velocity water results in scouring of the pipe wall by any undissolved solids. Another consideration is that differences in pressure are created around bends and discontinuities in the pipe as high-velocity water travels throughout the system. A large enough change in pressure will cause cavitation (water vapor bubbles forming in the pipe), which in turn will produce noise and more importantly, an increase in the rate of pitting of the pipe wall. Cavitation will occur at lower velocities in hot water than in cold water. The velocity of the water can be reduced by increasing the pipe sizes.

A final consideration is that of electrolytic effects. If two dissimilar metals are in contact with each other in a water solution, a "wet-cell" battery is created and an electric current flows, while deposits form on one of the metals, the other metal dissolves. Unfortunately, the electric potential of iron and copper is such that if iron (or steel) is in contact with copper piping, the copper will dissolve. Steel contacts the copper pipe at pumps, hangers, wall studs, or wiring conduits. Contact between dissimilar metals can be avoided by using plastic or copper pipe hangers or by insulating non-copper pipe hangers and wires from direct contact with copper pipes. Installing dielectric unions to isolate steel fittings from the copper system will also mitigate corrosion caused by contact with dissimilar metals. During the time of the site visit, no hanger with dissimilar metals was observed. However, we recommend a total review of all hangers and replacing them with plastic or similar metals.

General corrosion, such as uniform corrosion, which thins out the inner surface of the pipe at the same rate, is not suspected to cause a rapid failure of the distribution system. However, it can cause significant thinning of the pipe walls and reduced service life. A proper design can minimize the factors contributing to the corrosion.

Water Quality of Metro Vancouver's Reservoirs

Most of the drinking water supplied to the City of Vancouver comes from a network of reservoirs operated by Metro Vancouver. The glacial water from the Metro Vancouver reservoirs is regarded as soft water, which is slightly acidic. Soft water is low in dissolved calcium and magnesium and tends to dissolve minerals, especially copper. The average copper content is less than 0.0005 mg/L and pH is between 7.2 and 7.7 as shown in the 2021 Water Quality Control Annual Report by Metro Vancouver. The reason for the acidic water is the source of water, which comes mainly from natural precipitation. Acidic soft water has a propensity to cause corrosion in copper pipes that produce blue-green stains.

For pH and copper content of the source water, we referenced two reports: Vancouver Water Utility Annual Report issued by the City of Vancouver in 2021 and Greater Vancouver Water District 2021 Quality Annual Report Volume 1 by Metro Vancouver. The average copper content and pH before and after treatment at Seymour, Capilano, and Coquitlam Water Systems are summarized in the table below.

Table 3 – pH and Copper Content in Greater Vancouver Water District

Parameter	Seymour Water System		Capilano Water System		Coquitlam Water System		Canadian Guideline Limit
	Untreated	Treated	Untreated	Treated	Untreated	Treated	
Copper (mg/L)	0.0294	< 0.0006	0.0021	< 0.0005	0.0047	< 0.0005	≤ 1.0
pH	6.5	7.7	6.5	7.7	6.3	7.9	7.0 – 10.5

As the source water from the reservoir passes through filtration and chemical treatment processes, the pH and copper content can change adversely. As shown in the table above, the pH of the source water is increased, and copper content is decreased after the treatment. Metro Vancouver increases the pH of the source water before distribution, so it is less aggressive to plumbing systems.

Water Testing Data at Tower A (Beach Tower)

Our investigation in Beach Tower involved collecting water samples from two commercial units including C1 (Mini Market grocery store), and C3/C4 (A single unit for a Dental Clinic) as well as residential units 505, 809, 1010, 1308, 1606, 1809, 2104, 2501, 2704, and 3202. Four types of water samples were collected: unflushed cold water, unflushed hot water, flushed cold water, and flushed hot water. A total of forty-eight (48) samples were collected and tested for pH level and copper content. The results are displayed from Table 4 to Table 16.

Table 4 – pH and Copper Content in Water from Unit C1 Lavatory

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	0.05	7.80
"Direct" Cold Water (flushed)	<0.05	7.69
"Standing" Hot Water (unflushed)	0.05	7.98
"Direct" Hot Water (flushed)	0.05	8.03

The average pH of the above samples was 7.88. The average Copper Content of the above samples was 0.05 mg/L.

Table 5 – pH and Copper Content in Water from Unit C3/C4 Lavatory/Sink

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	0.05	7.54
"Direct" Cold Water (flushed)	0.70	7.77
"Standing" Hot Water (unflushed)	0.15	7.75
"Direct" Hot Water (flushed)	<0.05	8.40

The average pH of the above samples was 7.87. The average Copper Content of the above samples was 0.24 mg/L

Table 6 – pH and Copper Content in Water from Unit 505 Bathtub

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	0.15	7.93
"Direct" Cold Water (flushed)	0.05	7.91
"Standing" Hot Water (unflushed)	0.10	7.90

"Direct" Hot Water (flushed)	0.05	7.88

The average pH of the above samples was 7.91. The average Copper Content of the above samples was 0.09 mg/L.

Table 7 – pH and Copper Content in Water from Unit 809 Kitchen Sink

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	0.10	7.45
"Direct" Cold Water (flushed)	0.15	7.67
"Standing" Hot Water (unflushed)	0.15	7.20
"Direct" Hot Water (flushed)	0.10	7.65

The average pH of the above samples was 7.49. The average Copper Content of the above samples was 0.13 mg/L.

Table 8 – pH and Copper Content in Water from Unit 1010 Kitchen Sink

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	0.10	7.55
"Direct" Cold Water (flushed)	0.05	7.55
"Standing" Hot Water (unflushed)	0.05	7.22
"Direct" Hot Water (flushed)	0.10	7.26

The average pH of the above samples was 7.40. The average Copper Content of the above samples was 0.08 mg/L.

Table 9 – pH and Copper Content in Water from Unit 1308 Lavatory

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	0.05	7.88
"Direct" Cold Water (flushed)	0.05	7.83
"Standing" Hot Water (unflushed)	<0.05	7.86
"Direct" Hot Water (flushed)	0.05	7.86

The average pH of the above samples was 7.86. The average Copper Content of the above samples was 0.05 mg/L.

Table 10 – pH and Copper Content in Water from Unit 1606 Bathtub

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	0.15	7.78
"Direct" Cold Water (flushed)	0.05	7.59
"Standing" Hot Water (unflushed)	0.10	7.83
"Direct" Hot Water (flushed)	0.05	7.59

The average pH of the above samples was 7.70. The average Copper Content of the above samples was 0.09 mg/L.

Table 11 – pH and Copper Content in Water from Unit 1809 Bathroom Sink

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	0.20	7.65
"Direct" Cold Water (flushed)	0.05	7.71
"Standing" Hot Water (unflushed)	0.15	7.62
"Direct" Hot Water (flushed)	0.10	7.76

The average pH of the above samples was 7.69. The average Copper Content of the above samples was 0.13 mg/L.

Table 12 – pH and Copper Content in Water from Unit 2104 Lavatory

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	<0.05	7.84
"Direct" Cold Water (flushed)	0.05	7.85
"Standing" Hot Water (unflushed)	0.05	7.85
"Direct" Hot Water (flushed)	0.05	7.88

The average pH of the above samples was 7.86. The average Copper Content of the above samples was 0.05 mg/L.

Table 13 – pH and Copper Content in Water from Unit 2501 Kitchen Sink

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	0.10	7.57
"Direct" Cold Water (flushed)	0.10	7.57
"Standing" Hot Water (unflushed)	0.10	7.66
"Direct" Hot Water (flushed)	0.10	9.00

The average pH of the above samples was 7.95. The average Copper Content of the above samples was 0.10 mg/L.

Table 14 – pH and Copper Content in Water from Unit 2704 Lavatory

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	<0.05	7.85
"Direct" Cold Water (flushed)	0.05	7.71
"Standing" Hot Water (unflushed)	0.10	7.84
"Direct" Hot Water (flushed)	0.05	7.94

The average pH of the above samples was 7.84. The average Copper Content of the above samples was 0.06 mg/L.

Table 15 – pH and Copper Content in Water from Unit 3202 Lavatory

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	0.05	7.74
"Direct" Cold Water (flushed)	0.05	7.74
"Standing" Hot Water (unflushed)	<0.05	7.81
"Direct" Hot Water (flushed)	0.05	7.74

The average pH of the above samples was 7.76. The average Copper Content of the above samples was 0.05 mg/L.

Water Testing Data at Tower B (Ocean Tower)

Our investigation of Ocean Tower involved collecting water samples from Units TH-15, 503, 702, 901, 1303, and 1502. Four types of water samples were collected: unflushed cold water, unflushed hot water, flushed cold water, and flushed hot water. A total of twenty-four (24) samples were collected and tested for pH level and copper content. The results are displayed in Table 16 to Table 21.

Table 16 – pH and Copper Content in Water from Unit TH-15

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	0.05	7.82
"Direct" Cold Water (flushed)	0.05	7.92
"Standing" Hot Water (unflushed)	0.05	7.95
"Direct" Hot Water (flushed)	0.05	7.76

The average pH of the above samples was 7.86. The average Copper Content of the above samples was 0.05 mg/L.

Table 17 – pH and Copper Content in Water from Unit 503 Lavatory

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	0.05	7.80
"Direct" Cold Water (flushed)	0.05	7.81
"Standing" Hot Water (unflushed)	0.05	7.98
"Direct" Hot Water (flushed)	0.05	7.89

The average pH of the above samples was 7.87. The average Copper Content of the above samples was 0.05 mg/L.

Table 18 – pH and Copper Content in Water from Unit 702

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	0.05	7.50
"Direct" Cold Water (flushed)	0.05	7.42
"Standing" Hot Water (unflushed)	0.05	7.33

"Direct" Hot Water (flushed)	0.05	7.55

The average pH of the above samples was 7.45. The average Copper Content of the above samples was 0.05 mg/L.

Table 19 – pH and Copper Content in Water from Unit 901 Bathroom Sink

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	0.05	7.74
"Direct" Cold Water (flushed)	0.05	7.88
"Standing" Hot Water (unflushed)	0.05	7.69
"Direct" Hot Water (flushed)	0.05	7.80

The average pH of the above samples was 7.78. The average Copper Content of the above samples was 0.05 mg/L.

Table 20 – pH and Copper Content in Water from Unit 1303 Kitchen Sink

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	0.05	7.30
"Direct" Cold Water (flushed)	0.05	7.56
"Standing" Hot Water (unflushed)	<0.05	7.68
"Direct" Hot Water (flushed)	0.05	7.83

The average pH of the above samples was 7.59. The average Copper Content of the above samples was 0.05 mg/L.

Table 21 – pH and Copper Content in Water from Unit 1502

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	0.05	7.24
"Direct" Cold Water (flushed)	0.05	7.77
"Standing" Hot Water (unflushed)	0.05	7.33
"Direct" Hot Water (flushed)	0.05	7.74

The average pH of the above samples was 7.52. The average Copper Content of the above samples was 0.05 mg/L.

Water Testing Data at Tower C (Garden Tower)

Our investigation of Garden Tower involved collecting water samples from Units TH-24, 514, 616. Four types of water samples were collected: unflushed cold water, unflushed hot water, flushed cold water, and flushed hot water. A total of twelve (12) samples were collected and tested for pH level and copper content. The results are displayed in Table 22 to Table 24.

Table 22 – pH and Copper Content in Water from Unit TH-24 Lavatory

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	0.05	7.85
"Direct" Cold Water (flushed)	0.05	7.71
"Standing" Hot Water (unflushed)	0.15	7.86
"Direct" Hot Water (flushed)	0.10	7.76

The average pH of the above samples was 7.80. The average Copper Content of the above samples was 0.09 mg/L.

Table 23 – pH and Copper Content in Water from Unit 514 Kitchen Sink

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	0.10	7.88
"Direct" Cold Water (flushed)	0.05	7.92
"Standing" Hot Water (unflushed)	0.10	7.95
"Direct" Hot Water (flushed)	0.05	8.14

The average pH of the above samples was 7.97. The average Copper Content of the above samples was 0.08 mg/L.

Table 24 – pH and Copper Content in Water from Unit 616 Bathroom Sink

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	0.15	7.67
"Direct" Cold Water (flushed)	0.05	7.47

"Standing" Hot Water (unflushed)	0.15	7.50
"Direct" Hot Water (flushed)	0.10	7.67

The average pH of the above samples was 7.58. The average Copper Content of the above samples was 0.11 mg/L.

Water Testing Summary for LMS 712

The average pH and copper content of all samples for all three towers were found to be 7.74 and 0.08 mg/L in which the pH level is within the "reasonable" pH range (6.5 to 8.5) for drinking water and is not a health concern at its current level based on the safe levels established in the "Guidelines for Canadian Drinking Water Quality" (pH between 7.0 to 10.5).

The copper content of 0.08 mg/L is found to be lower than the aesthetic objective amount of 1.0 mg/L in the "Guidelines for Canadian Drinking Water Quality" published in 2022. Adverse health effects occur at levels much higher than the aesthetic objective. This lower value may be as a result of the tenant usage of the water supply prior to sampling, which would lower the overall copper content measured.

Table 25 – Summary of Water Testing at LMS 712

	Copper Content (mg/L)	pH
Tower A – Beach Tower	0.09	7.76
Tower B – Ocean Tower	0.05	7.68
Tower C – Garden Tower	0.09	7.78
Strata Summary	0.08	7.74

High levels of dissolved copper often indicate an accelerated rate of corrosion, typically involving thinning of the pipe walls throughout rather than simply localized pitting. As previously noted, the concentration of copper is less than 0.0005 mg/L and pH is between 7.2 and 7.7 as shown in the 2021 Water Quality Control Annual Report by Metro Vancouver. This means virtually all the dissolved copper is originating from the corrosion of the copper pipes throughout this building, and the fact that all the un-flushed water samples had higher copper content than flushed samples also support this observation.

Destructive Testing of Pipe Samples at Tower A (Beach Tower)

Twenty-one (21) pipe samples and two (2) manifolds samples were obtained for destructive testing. Most samples were found to be Type L or Type K copper with one (1) Type M pipe, as indicated on the pipe samples. A description of these samples is provided in Table 26.

Table 26 – Description of Samples at Tower A

Sample	Description/ Location	Pipe Type	Hot/Cold Pipe	Pipe Diameter (inches)
A	P2 Mechanical	K	Hot	2.5
B	P2 Mechanical	L	Cold	2.5
C	P2 Mechanical	L	Cold	2.5
D	P2 Mechanical	K	Hot	2.5
E	P2 Mechanical	L	Cold	2.5
F	Roof Mechanical	L	Cold	2.0
G	Roof Mechanical	K	Hot	2.0
H	Roof Mechanical	K	Hot	2.0
I	Roof Mechanical	L	Cold	2.0
J	Roof Mechanical	K	Cold	2.0
K	3301	L	Hot	0.75
L	P2 Mechanical	L	Hot Return	1.0
M	1809	K	Hot	1.0
N	Roof Mechanical	K	Hot Return	1.0

Sample	Description/ Location	Pipe Type	Hot/Cold Pipe	Pipe Diameter (inches)
O	Roof Mechanical	K	Hot Return	1.0
P	1707	L	Cold	1.0
Q	1010	K	Hot	1.0
R	P2 Mechanical	M	Hot Return	1.0
S	1809	L	Hot Return	0.75
T	1707	L	Hot	0.75
U	3301	L	Cold	0.75
V	809	L	Hot	1.00
W	809	L	Cold	1.00

Destructive testing involves both microscopic and macroscopic reviews. Microscopic review of the samples determines the nature of the pitting. For example, velocity related pitting due to undersized pipes leaves a specific signature or type of pit-shape.

Macroscopic review involves a visual review of pipe samples such as measuring the wall thickness, observing different types of failures, checking for corrosion or scouring patterns, and determining the number of pinholes in the samples. The results are shown in Table 27 with photos to follow.

Table 27 – Summary of Results from Pipe Sample Examination at Tower A

Sample	Hot/ Cold	Original Thickness (mm)	Wall Loss (%)	Condition
A	Hot	2.41	2.25	Blackened surface with moderate pitting

Sample	Hot/ Cold	Original Thickness (mm)	Wall Loss (%)	Condition
B	Cold	2.03	5.01	Uniform corrosion with moderate pitting
C	Cold	2.03	5.58	Uniform corrosion with velocity wear
D	Hot	2.41	2.56	Blackened surface with minor pitting
E	Cold	2.03	0.53	Uniform corrosion with velocity wear
F	Cold	1.78	7.21	Uniform corrosion with velocity wear
G	Hot	2.11	1.30	Blackened surface with moderate pitting
H	Hot	2.11	5.21	Blackened surface with moderate pitting
I	Cold	1.78	3.47	Velocity wear and minor pitting
J	Cold	2.11	1.50	Uniform corrosion with moderately severe pitting
K	Hot	1.65	1.46	Blackened surface with mild corrosion
L	Hot Return	1.27	18.18	Blackened surface with moderate velocity wear and pitting
M	Hot	1.65	2.02	Blackened surface with minor pitting

Sample	Hot/ Cold	Original Thickness (mm)	Wall Loss (%)	Condition
N	Hot Return	1.65	0.71	Blackened surface with moderate pitting
O	Hot Return	1.65	1.57	Moderate pitting with velocity wear corrosion
P	Cold	1.27	13.78	Moderate pitting and corrosion
Q	Hot	1.65	0.96	Blackened surface with minor pitting
R	Hot Return	.89	0.47	Moderate pitting
S	Hot Return	1.14	1.46	Corrosion with moderate pitting
T	Hot	1.14	0.44	Blackened surface with moderate corrosion
U	Cold	1.14	3.36	Uniform corrosion with minor pitting
V	Hot	N/A	N/A	Blackened surface with moderate pitting
W	Cold	N/A	N/A	Uniform corrosion with moderate pitting

Note: Results shown in above table are based on the analysis of half-pipe segments from each sample. Wall loss shown has an experimental error of +/- 5%.

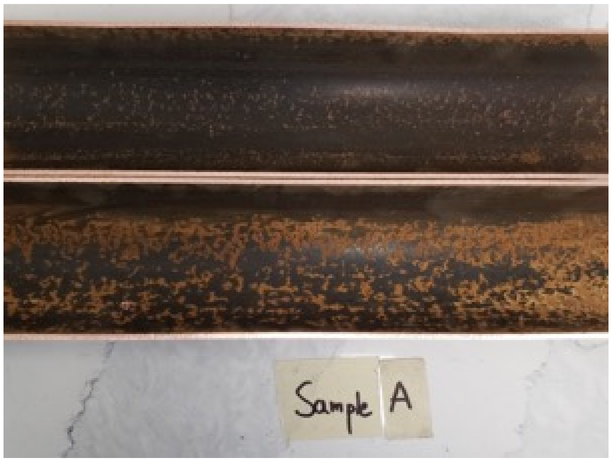

Photo 1. Sample A – P2 Mechanical DHW

Photo 2. Sample A – Blackened surface with moderate pitting

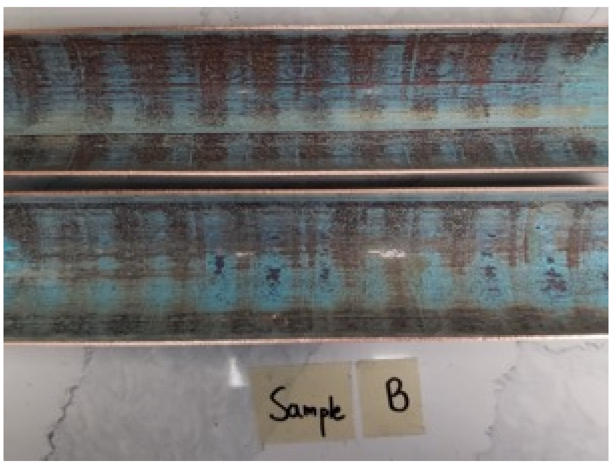

Photo 3. Sample B – P2 Mechanical DCW

Photo 4. Sample B – Uniform corrosion with moderate pitting

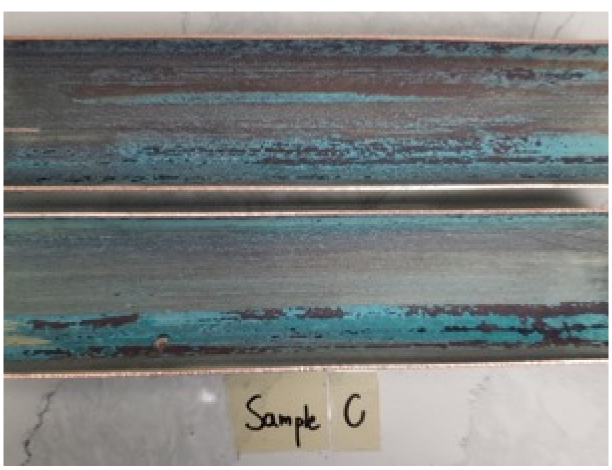

Photo 5. Sample C - P2 Mechanical DCW

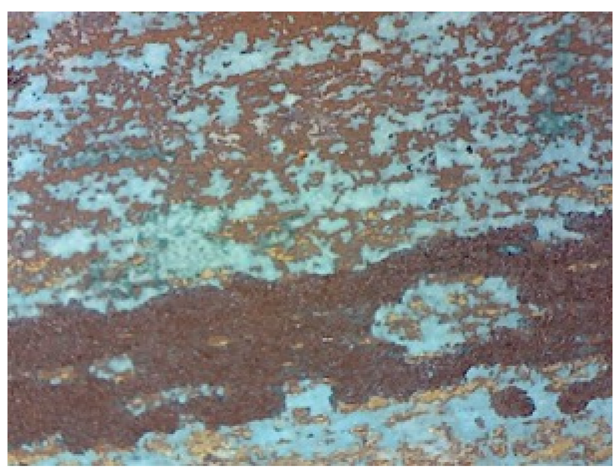

Photo 6. Sample C – Uniform corrosion with velocity wear

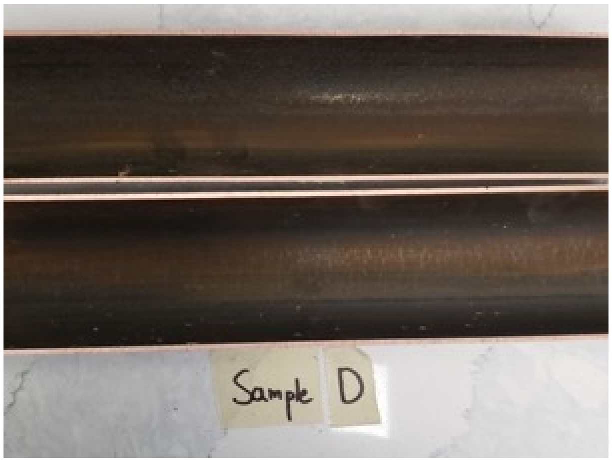

Photo 7. Sample D - P2 Mechanical DHW

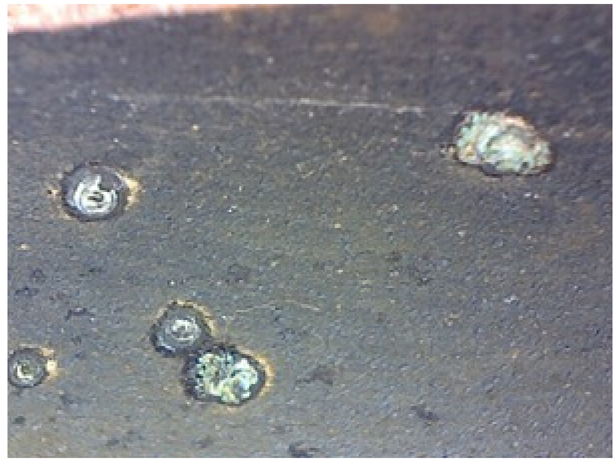

Photo 8. Sample D – Blackened surface with minor pitting

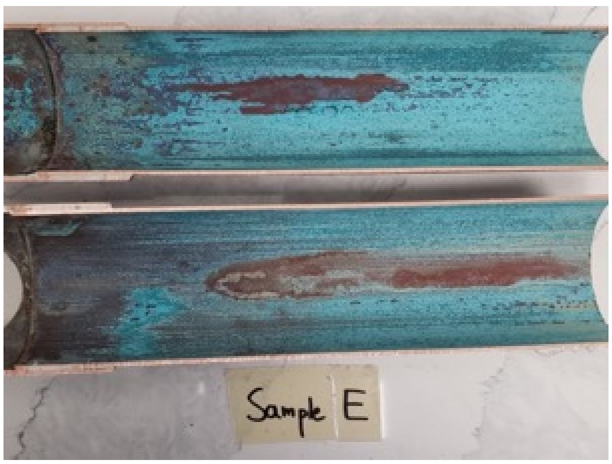

Photo 9. Sample E - P2 Mechanical DCW

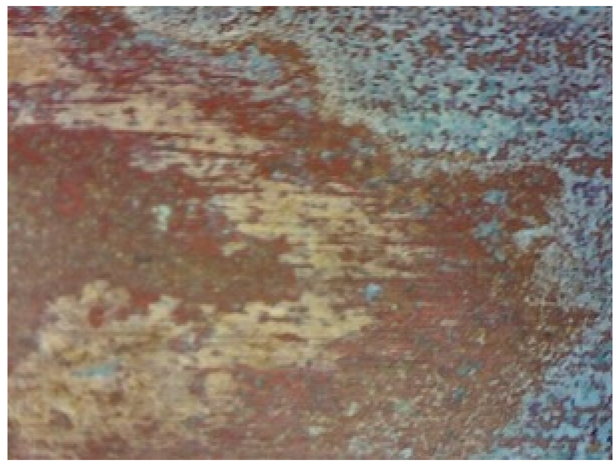

Photo 10. Sample E – Uniform corrosion with velocity wear

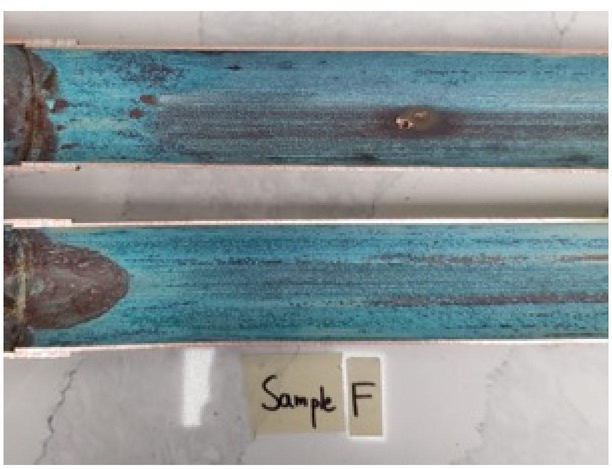

Photo 11. Sample F – Roof Mechanical DCW

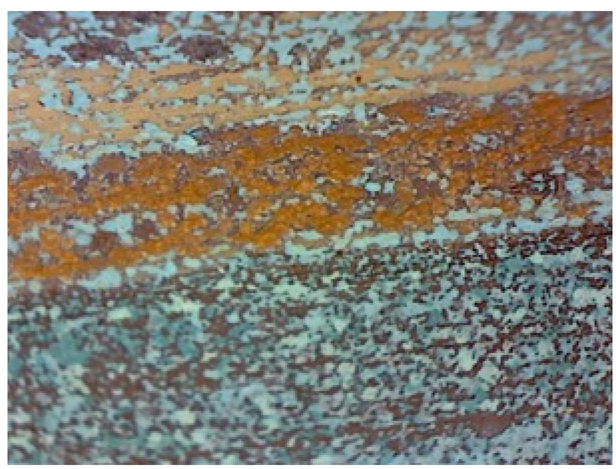

Photo 12. Sample F – Uniform corrosion with velocity wear

Photo 13. Sample G – Roof Mechanical DHW

Photo 14. Sample G – Blackened surface with moderate pitting

Photo 15. Sample H – Roof Mechanical DHW

Photo 16. Sample H – Blackened surface with moderate pitting

Photo 17. Sample I – Roof Mechanical DCW

Photo 18. Sample I – Velocity wear and minor pitting

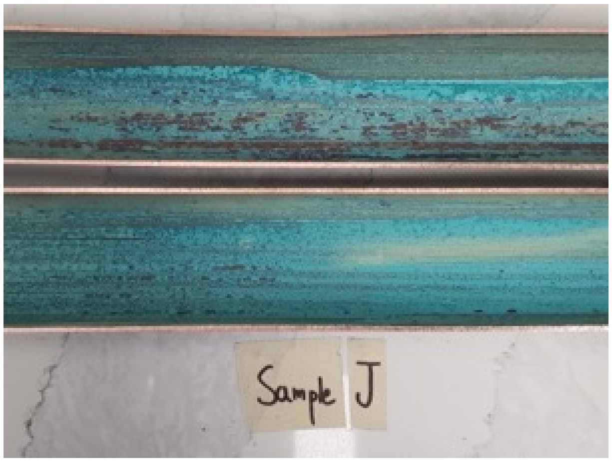

Photo 19. Sample J – Roof Mechanical DCW

Photo 20. Sample J – Uniform corrosion with moderately severe pitting

Photo 21. Sample K – Unit 3301 DHW

Photo 22. Sample K – Blackened surface with mild corrosion

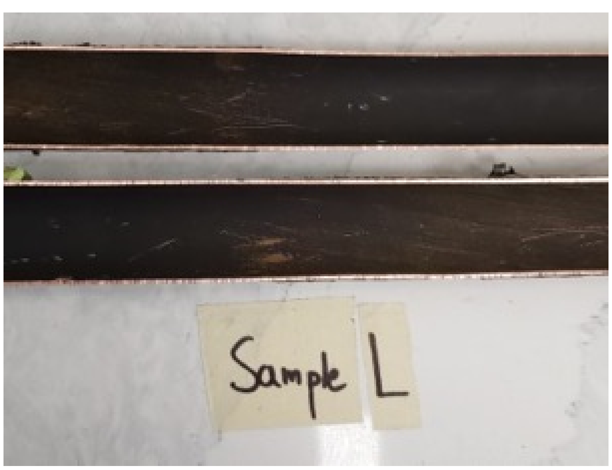

Photo 23. Sample L – P2 Mechanical DHW Return

Photo 24. Sample L – Blackened surface with moderate velocity wear and pitting

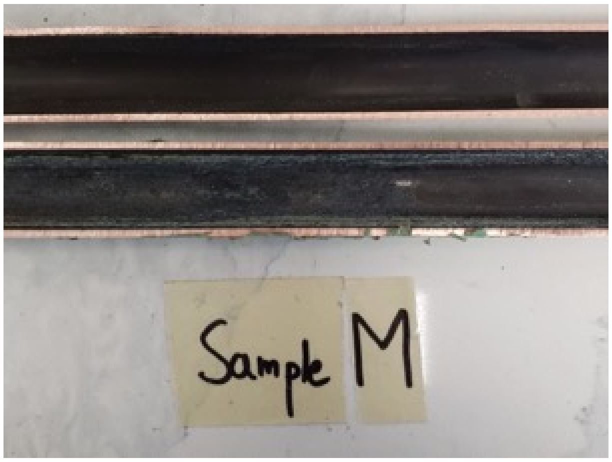

Photo 25. Sample M – Unit 1809 DHW

Photo 26. Sample M – Blackened surface with minor pitting

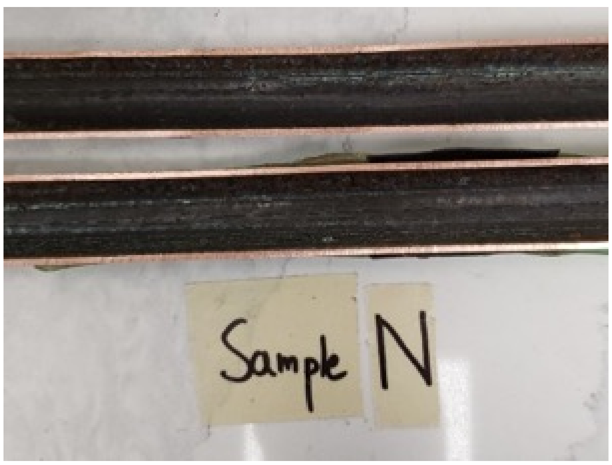

Photo 27. Sample N – Roof Mechanical DHW Return

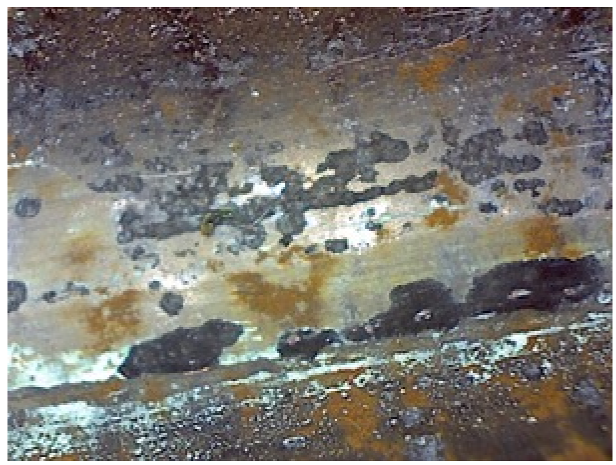

Photo 28. Sample N – Blackened surface with moderate pitting

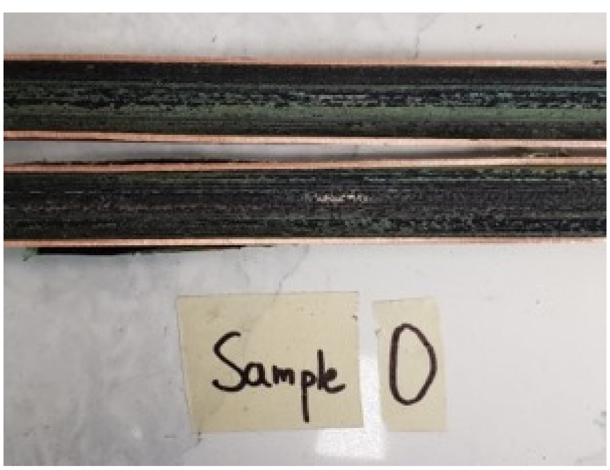

Photo 29. Sample O – Roof Mechanical DHW Return

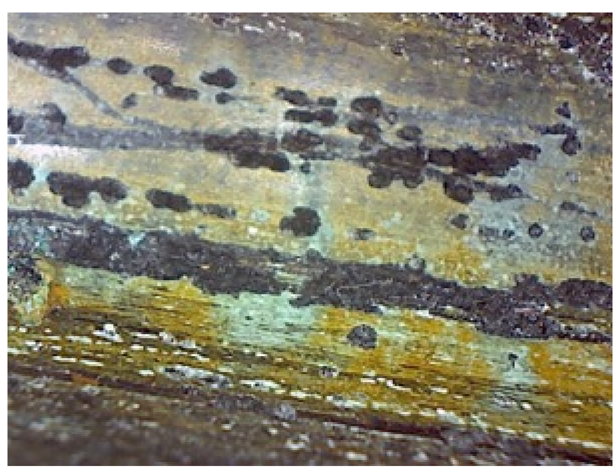

Photo 30. Sample O – Moderate pitting with velocity wear corrosion

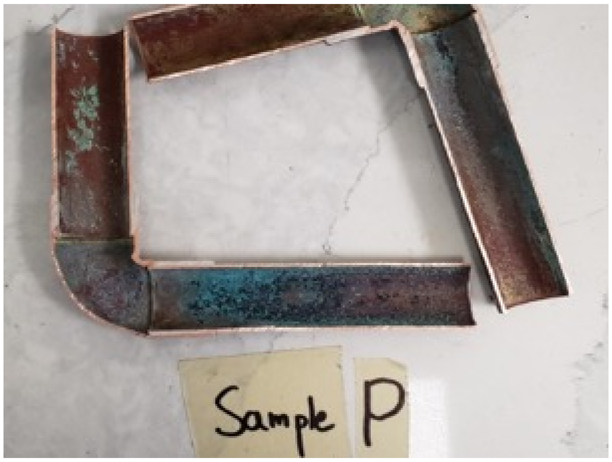

Photo 31. Sample P – Unit 1707 DCW

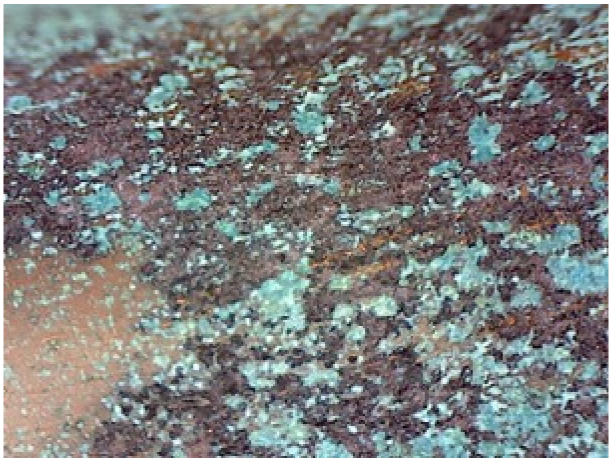

Photo 32. Sample P – Moderate pitting and corrosion

Photo 33. Sample Q – Unit 1010 DHW

Photo 34. Sample Q – Blackened surface with minor pitting

Photo 35. Sample R – P2 Mechanical DHW Return

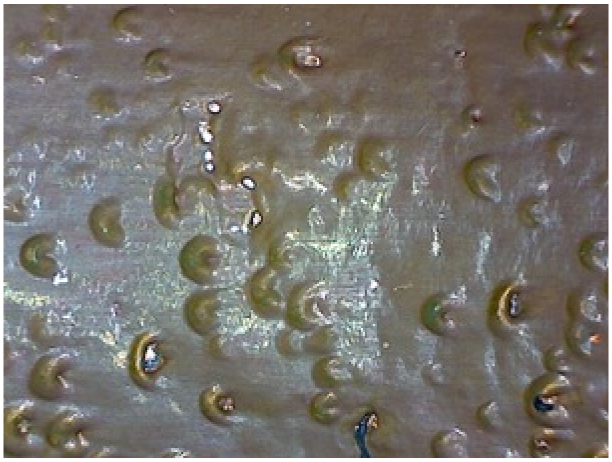

Photo 36. Sample R – Moderate pitting

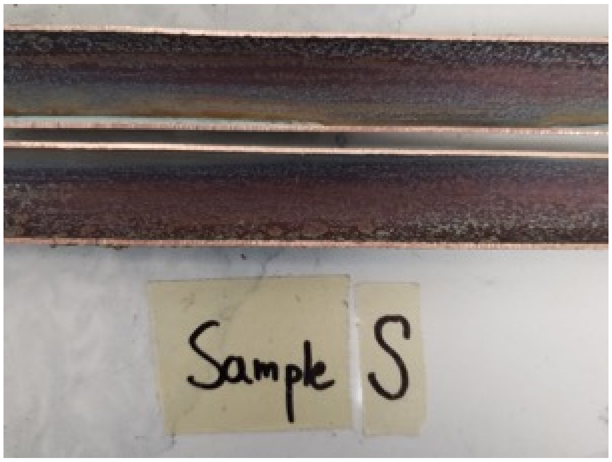

Photo 37. Sample S – Unit 1809 DHW Return

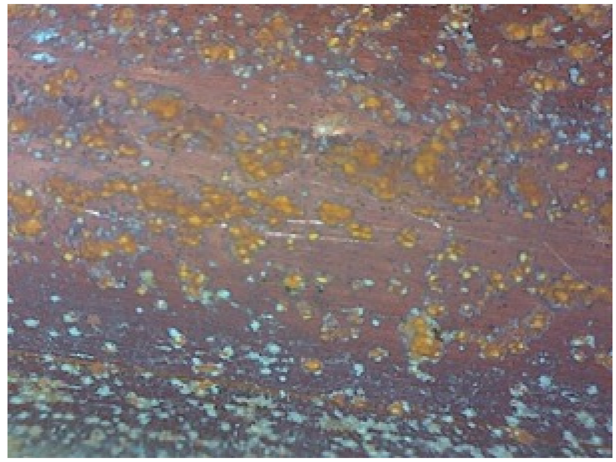

Photo 38. Sample S – Corrosion with moderate pitting

Photo 39. Sample T – Unit 1707 DHW

Photo 40. Sample T – Blackened surface with moderate corrosion

Photo 41. Sample U – Unit 3301 DCW

Photo 42. Sample U – Uniform corrosion with minor pitting

Photo 43. Sample V – Unit 809 DHW

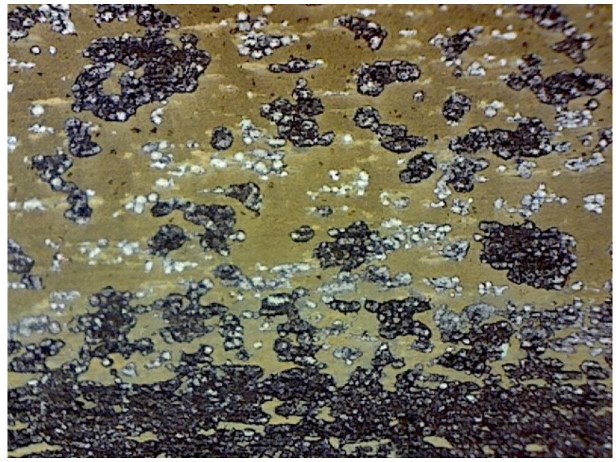

Photo 44. Sample V – Blackened surface with moderate pitting

Photo 45. Sample W – Unit 809 DCW

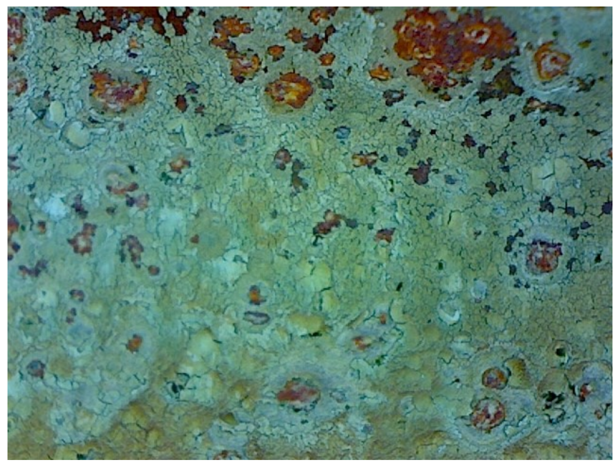

Photo 46. Sample W – Uniform corrosion with moderate pitting

Summary of Destructive Testing at Tower A (Beach Tower)

In general, the pipe samples displayed moderate amounts of thinning. The wall loss in the samples varied from 0.44% to 18.18% with an average of 3.76%. The wall loss within the samples varies, but the average wall thickness generally gives a good indication of the pipe wall condition. Samples A and B exteriors were corroded showing greenish-blue color (refer to Photos 91 and 92). Exterior corrosion due to pinhole leaks are usually localized, however, Samples A, and B showed uniform corrosion on the exterior. Hence, it is most likely that corrosion had occurred due to moisture forming on the pipe exterior.

An example of uniform corrosion is seen in Sample B, C, E, and F (refer to Photos 3, 4, 5, 6, 9, 10, 11, and 12). Uniform corrosion is a general form of corrosion where the entire surface of the pipe wall is thinning at a uniform rate. Tarnished copper surface and shallow narrow pits characterize uniform corrosion and cold water pitting respectively.

Hot water pipes represent typical uniform velocity scouring and hot water pitting. Such deteriorations are characterized by deep pits of small cross sections that are capped by greenish-black mounds and water-swept marks, seen in Sample I and L (refer to Photo 17, 18, 23, and 24). The causes of this kind of corrosion are usually high velocity water and high temperature (over 60 °C).

Manifolds Samples V and W showed moderate pitting on pipe interior (refer to Photo 43, 44, 45, and 46). However, both Samples did not show any signs of pinhole leaks on pipe exterior. Connection of the plastic pipes to manifolds were also observed to be in fair condition without any signs of leaks, and no discoloration was observed.

Photo 47. Sample A – Corrosion on Exterior

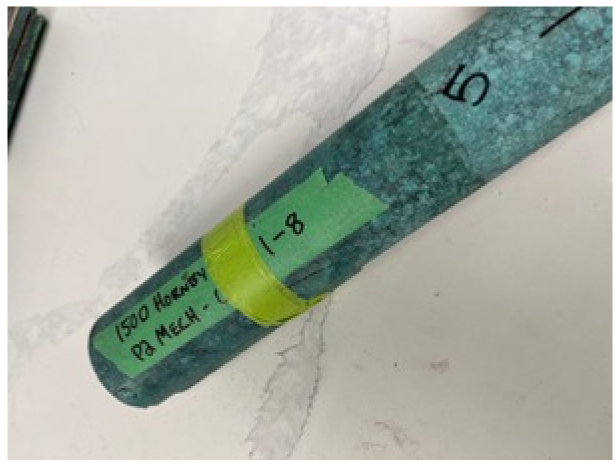

Photo 48. Sample B – Corrosion on Exterior

Destructive Testing of Pipe Samples at Tower B (Ocean Tower)

Eleven (11) pipe samples and two (2) manifolds samples were obtained for destructive testing. The samples were found to be a combination of Type L copper and Type K copperas shown in Table 28.

Table 28 – Description of Samples at Tower B

Sample	Description/ Location	Pipe Type	Hot/Cold Pipe	Pipe Diameter (inches)
A	P4- Mechanical Room	K	Hot	2.5
B	Old Sample Pipe	K	Unknown	2.5
C	Unknown	L	Unknown	2.5
D	P2- Mechanical Room	L	Cold	3.0
E	Roof Mechanical	K	Hot Return	0.75
F	Roof Mechanical	L	Cold	2.5
G	P4- Mechanical Room	L	Cold	2.5
H	Roof Mechanical	K	Hot	2.0
I	Unknown	L	Unknown	3.0
J	901	K	Hot	0.75
K	901	L	Cold	0.75
L	503	M	Cold	1.00
M	503	M	Hot	1.00

Destructive testing involves both microscopic and macroscopic reviews. Microscopic review of the samples determines the nature of the pitting. For example, velocity related pitting due to undersized pipes leaves a specific signature or type of pit-shape.

Macroscopic review involves a visual review of pipe samples such as measuring the wall thickness, observing different types of failures, checking for corrosion or scouring patterns, and determining the number of pinholes in the samples. The results are shown in Table 29.

Table 29 – Summary of Results from Pipe Sample Examination at Tower B

Sample	Hot/ Cold	Original Thickness (mm)	Wall Loss (%)	Condition
A	Hot	2.41	3.49	Blackened surface with moderate pitting
B	Unknown	2.41	3.42	Blackened surface with moderate pitting
C	Unknown	2.03	1.07	Uniform corrosion with velocity wear
D	Cold	2.29	9.06	Uniform corrosion with moderately severe pitting
E	Hot Recirc.	1.65	4.55	Moderately severe pitting
F	Cold	2.03	1.35	Uniform corrosion with moderate pitting and velocity wear
G	Cold	2.03	0.49	Uniform corrosion with moderate pitting and velocity wear
H	Hot	2.11	1.03	Blackened surface with moderate pitting
I	Unknown	2.29	6.55	Uniform corrosion with velocity wear
J	Hot	1.65	1.52	Blackened surface with moderately severe pitting

Sample	Hot/ Cold	Original Thickness (mm)	Wall Loss (%)	Condition
K	Cold	1.14	0.88	Uniform corrosion with moderate pitting
L	Cold	N/A	N/A	Uniform corrosion with moderate pitting
M	Hot	N/A	N/A	Uniform corrosion with moderate pitting

Note: Results shown in above table are based on the analysis of half-pipe segments from each sample. Wall loss shown has an experimental error of +/- 5%.

Photo 49. Sample A – P4 Mechanical DHW

Photo 50. Sample A – Blackened surface with moderate pitting

Photo 51. Sample B – Old Sample Pipe

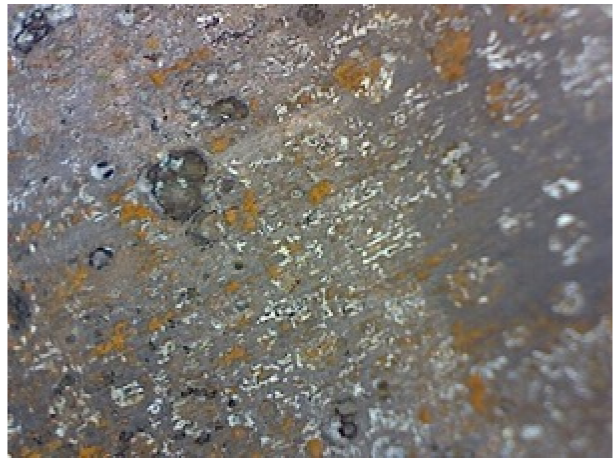

Photo 52. Sample B – Blackened surface with moderate pitting

Photo 53. Sample C – Unknown Sample Pipe

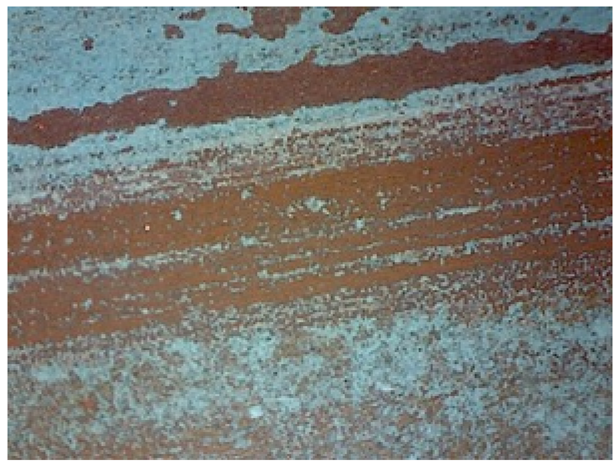

Photo 54. Sample C – Uniform corrosion with velocity wear

Photo 55. Sample D – P2 Mechanical DCW

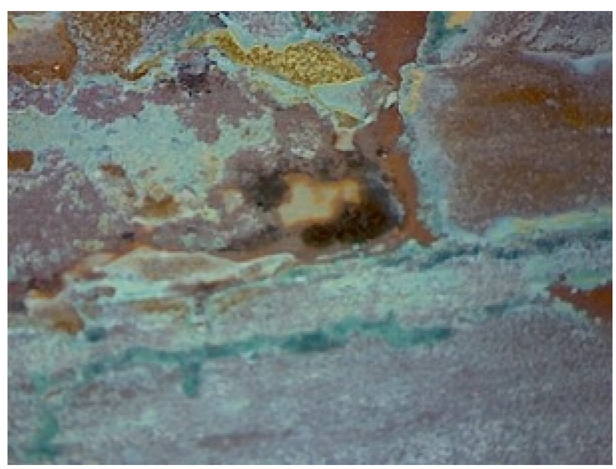

Photo 56. Sample D – Uniform corrosion with moderately severe pitting

Photo 57. Sample E – Roof Mechanical DHW Return

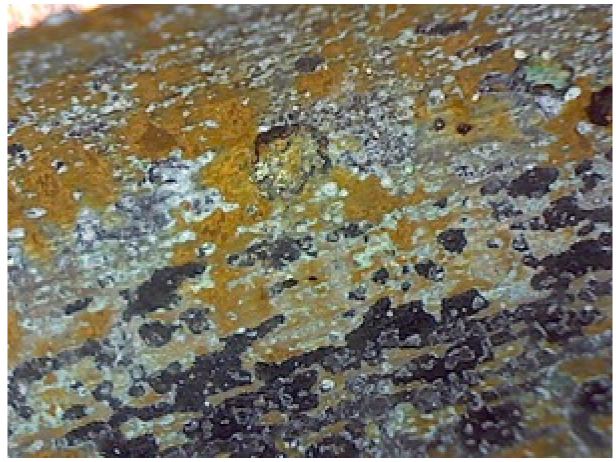

Photo 58. Sample E – Moderately severe pitting

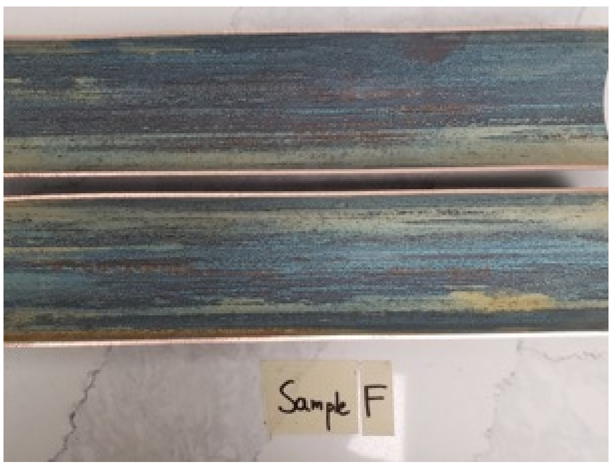

Photo 59. Sample F – Roof Mechanical DCW

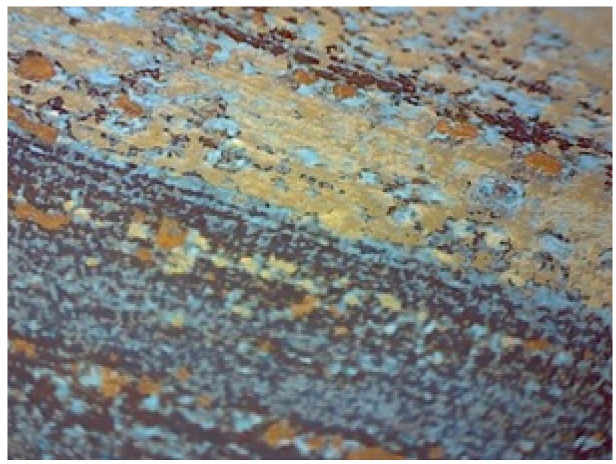

Photo 60. Sample F – Uniform corrosion with moderate pitting and velocity wear

Photo 61. Sample G – P4 Mechanical DCW

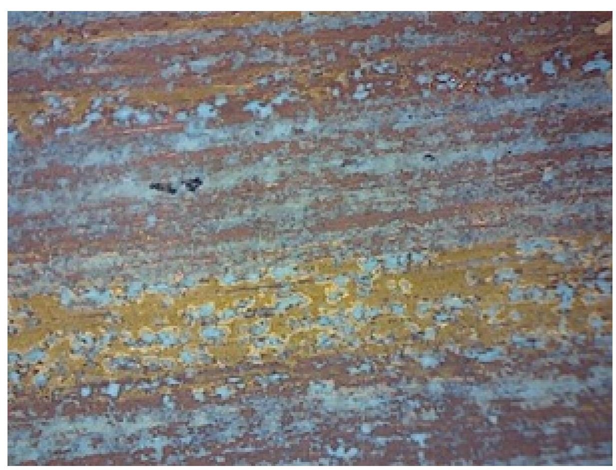

Photo 62. Sample G – Uniform corrosion with moderate pitting and velocity wear

Photo 63. Sample H – Roof Mechanical DHW

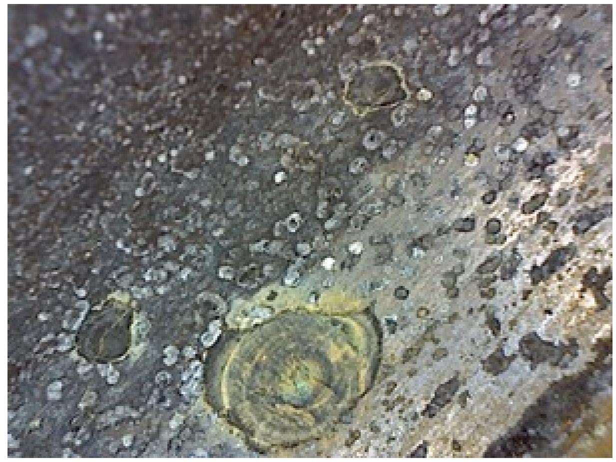

Photo 64. Sample H – Blackened surface with moderate pitting

Photo 65. Sample I – Unknown Sample Pipe

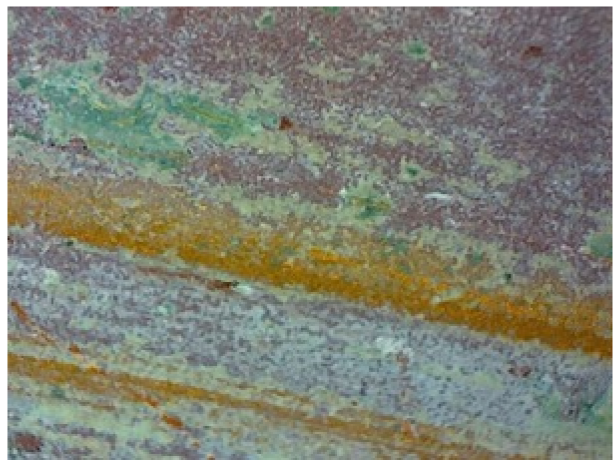

Photo 66. Sample I – Uniform corrosion with velocity wear

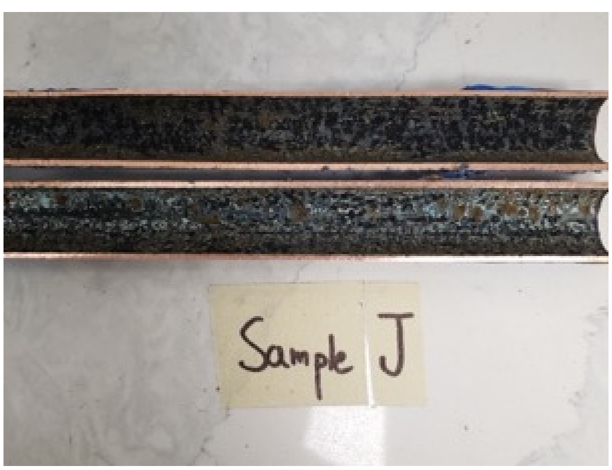

Photo 67. Sample J – Unit 901 DHW

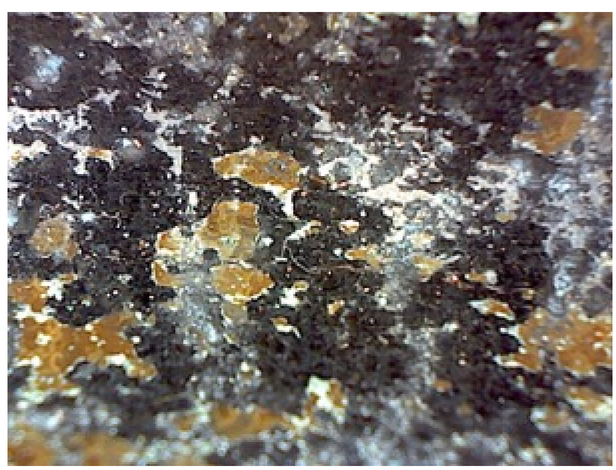

Photo 68. Sample J – Blackened surface with moderately severe pitting

Photo 69. Sample K – Unit 901 DCW

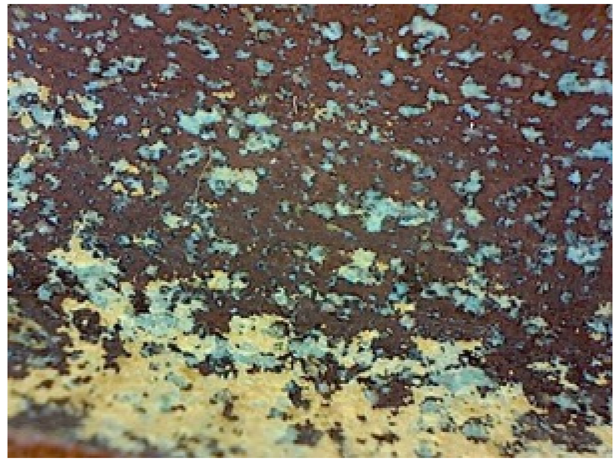

Photo 70. Sample K – Uniform corrosion with moderate pitting

Photo 71. Sample L – Unit 503 DCW

Photo 72. Sample L – Uniform corrosion with moderate pitting

Photo 73. Sample M – Unit 503 DHW

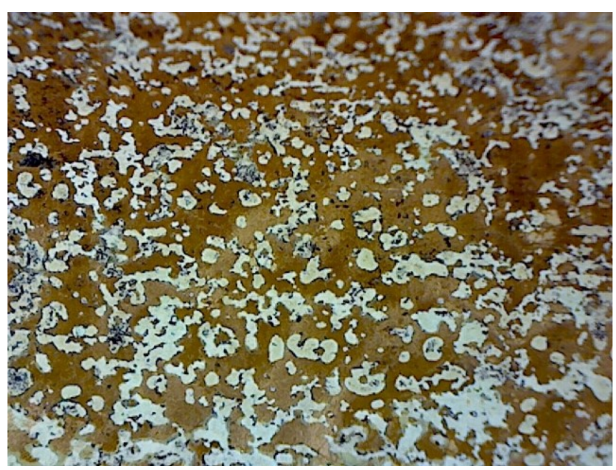

Photo 74. Sample M – Uniform corrosion with moderate pitting

Summary of Destructive Testing at Tower B (Ocean Tower)

In general, the pipe samples displayed moderate thinning. The wall loss in the samples varied from 0.49% to 9.06% with an average of 3.06%. The wall loss within the samples varies, but the average wall thickness generally gives a good indication of the pipe wall condition. In general, the pipe samples displayed moderately severe pitting, and Samples C, D, G, and I exteriors were corroded showing greenish-blue color (refer to Photos 54, 56, 62, and 66). Exterior corrosion due to pinhole leaks are usually localized, however, Samples C, D, G, and I showed uniform corrosion on the exterior. Hence, it is most likely that corrosion had occurred due to moisture forming on the pipe exterior.

An example of uniform corrosion and cold water pitting is seen in Samples D, F, G, and K (refer to Photos 55, 56, 59, 60, 61, 62, 69, and 70). Uniform corrosion is a general form of corrosion where the entire surface of the pipe wall is thinning at a uniform rate. Tarnished copper surface and shallow narrow pits characterize uniform corrosion and cold water pitting respectively.

Hot water pipes represent typical uniform velocity scouring and hot water pitting. Such deteriorations are characterized by deep pits of small cross sections that are capped by greenish-black mounds and water-swept marks (refer to Photos 48, 49, 62, 63, 67, and 68). The causes of this kind of corrosion are usually high velocity water and high temperature (over 60°C).

Manifolds Sample L and M both showed uniform corrosion with moderate pitting on the pipe interior (refer to Photos 71, 72, 73, and 74). Sample M did not show any signs of pinhole leaks on the pipe exterior. Connections of the plastic pipes to manifolds were in fair condition without any signs of leaks, and no discoloration was observed. Sample L on the other hand, showed localized corrosion in greenish color on pipe exterior. Also, black discoloration of the pipe exterior was observed, and this may be an indication that the pipe is in contact with other non-compatible metals such as galvanized steel.

Photo 75. Sample C – Corrosion on Exterior

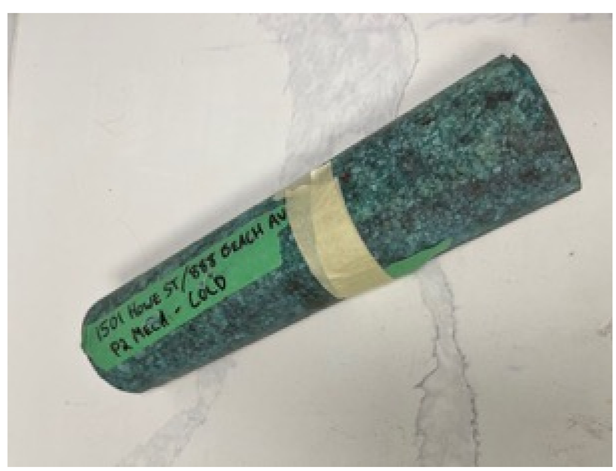

Photo 76. Sample D – Corrosion on Exterior

Photo 77. Sample G – Corrosion on Exterior

Photo 78. Sample I – Corrosion on Exterior

Destructive Testing of Pipe Samples at Tower C (Garden Tower)

Seven (7) pipe samples in total were obtained for destructive testing. Five (5) pipe samples were found to be Type K copper and two (2) Type L copper for cold pipes as shown in Table 30.

Table 30 – Description of Samples at Tower C

Sample	Description/ Location	Pipe Type	Hot/Cold Pipe	Pipe Diameter (inches)
A	Roof Mechanical	K	Hot	2.0
B	Roof Mechanical	K	Cold	2.0
C	Roof Mechanical	K	Hot Return	0.75
D	Easy Day Store	L	Cold	0.5
E	Easy Day Store	K	Hot	0.5
F	TH24	L	Cold	0.75
G	TH24	K	Hot	0.75

Destructive testing involves both microscopic and macroscopic reviews. Microscopic review of the samples determines the nature of the pitting. For example, velocity related pitting due to undersized pipes leaves a specific signature or type of pit-shape.

Macroscopic review involves a visual review of pipe samples such as measuring the wall thickness, observing different types of failures, checking for corrosion or scouring patterns, and determining the number of pinholes in the samples. The results are shown in Table 31 with photos following.

Table 31 – Summary of Results from Pipe Sample Examination at Tower C

Sample	Hot/ Cold	Original Thickness (mm)	Wall Loss (%)	Condition
A	Hot	2.11	0.51	Blackened surface with moderate pitting and uniform corrosion
B	Cold	2.11	1.66	Moderate pitting with uniform corrosion
C	Hot Recirc.	1.65	0.81	Blackened surface with moderate velocity wear
D	Cold	1.02	0.00	Blackened surface with velocity wear and minor pitting
E	Hot	1.24	1.88	Minor pitting with uniform corrosion
F	Cold	1.14	0.66	Moderate pitting with uniform corrosion
G	Hot	1.65	0.00	Velocity wear and moderate pitting

Note: Results shown in above table are based on the analysis of half-pipe segments from each sample. Wall loss shown has an experimental error of +/- 5%.

Photo 79. Sample A – Roof Mechanical DHW

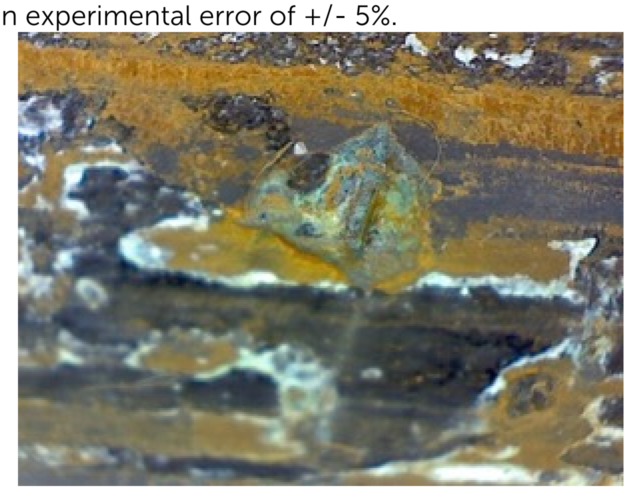

Photo 80. Sample A – Blackened surface with moderate pitting and uniform corrosion

Photo 81. Sample B – Roof Mechanical DCW

Photo 82. Sample B – Moderate pitting with uniform corrosion

Photo 83. Sample C – Roof Mechanical DHW Return

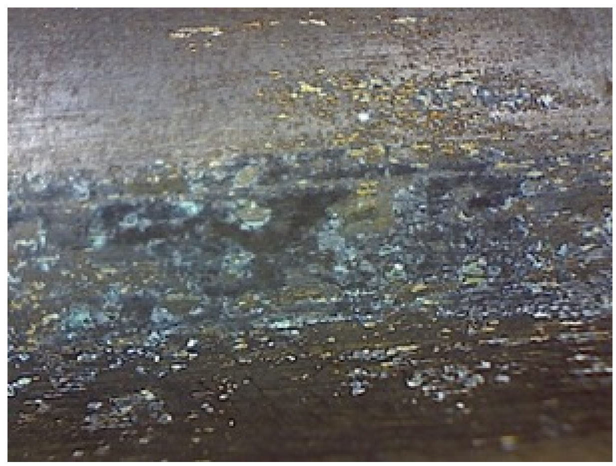

Photo 84. Sample C – Blackened surface with moderate velocity wear

Photo 85. Sample D – Easy Day Store DCW

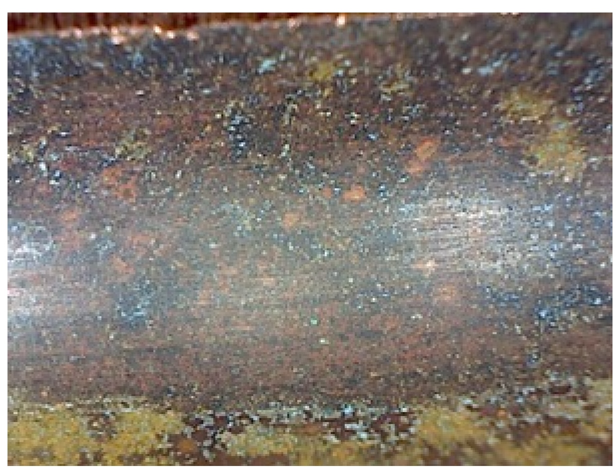

Photo 86. Sample D – Blackened surface with velocity wear and minor pitting

Photo 87. Sample E – Easy Day Store DHW

Photo 88. Sample E – Minor pitting with uniform corrosion

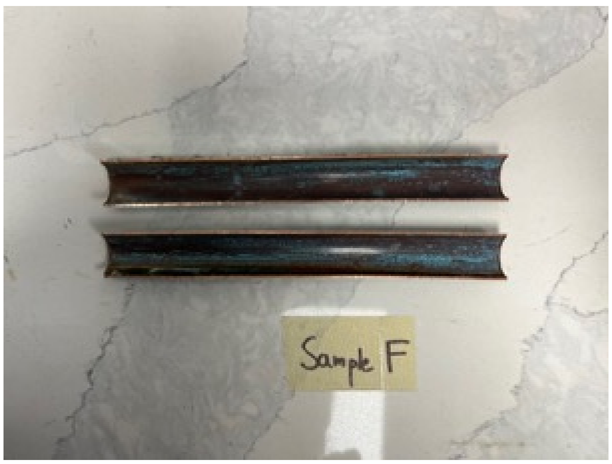

Photo 89. Sample F – TH24 DCW

Photo 90. Sample F - Moderate pitting with uniform corrosion

Photo 91. Sample G – TH24 DHW

Photo 92. Sample G – Velocity wear and moderate pitting

Summary of Destructive Testing at Tower C (Garden Tower)

In general, the pipe samples displayed mild thinning. The wall loss in the samples varied from 0.00% to 1.88% with an average of 0.79%. The wall loss within the samples varies, but the average wall thickness generally gives a good indication of the pipe wall condition. The highest degree of wall loss was found in the hot water recirculation, Sample C (refer to Photos 83 and 84). This was expected as the water continuously running at high temperatures tends to wear the pipe fastest.

An example of uniform corrosion and cold water pitting is seen in Samples B and F (refer to Photos 81, 82, 89, and 90). Uniform corrosion is a general form of corrosion where the entire surface of the pipe wall is thinning at a uniform rate. Tarnished copper surface and shallow narrow pits characterize uniform corrosion and cold water pitting respectively.

Hot water pipes represent typical uniform velocity scouring and hot water pitting. Such deteriorations are characterized by deep pits of small cross sections that are capped by greenish-black mounds and water-swept marks (refer to Photo 79 and 80). The causes of this kind of corrosion are usually high velocity water and high temperature (over 60°C).

Mechanical Room Equipment – Tower A (Beach Tower)

There are two mechanical rooms at Beach Tower, one located on the 34th floor, equipped with four gas boilers supplying five hot water heaters. The other one is located on parkade, P2 equipped with three gas boilers supplying four hot water storage tanks. Additional circulating pump is used to feed the hydronic make-up air unit in the same room. It has been observed that steel hangers were in direct contact with copper piping, which may lead to galvanic corrosion. As well, there is water entry room on the parkade level, P1 equipped with various DCVA's, PRV, and booster pump assembly. Booster pumps are feeding penthouse mechanical room, zones 3 and 4 as described in Table 2.

Refer to the following tables and photos for the mechanical equipment summary.

Table 32 - Summary of Penthouse Mechanical Room Equipment (Tower A)

Description	Manufacturer	Model	Serial	Capacity	Manufactured Date	Zone
Boiler 3	LAARS	VW0325C N12KBDPX	C11229 508	325 MBH input, 263 MBH output	Jan 25, 2011	17th to 25th Floor
Boiler 4	LAARS	VW0325C N12KBDPX	C11229 507	325 MBH input, 263 MBH output	Jan 25, 2011	
DHW Storage Tank 1	Lochinvar	RJA175	110924 096	175 gal	2011	
DHW Storage Tank 2	Lochinvar	RJA175	110685 449	175 gal	2011	
DHW Storage Tank 3	Lochinvar	RJA175	110924 099	175 gal	2011	
DHW Circulation Pump 1	Armstrong	E17.2B	182212 -664	2/5 hp, max 65 gpm, max 27 ft head	Sep 2019	
Expansion Tank 1	AMTROL	N/A	N/A	N/A	N/A	
Boiler 1	LAARS	VW0325C N12KBDPX	C11229 432	325 MBH input, 263 MBH output	Jan 25, 2011	26th to 33rd Floor
Boiler 2	LAARS	VW0325C N12KBDPX	N/A	325 MBH input, 263 MBH output	Jan 25, 2011	
DHW Storage Tank 4	Lochinvar	RJA175	110685 447	175 gal	2011	
DHW Storage Tank 5	Lochinvar	RJA175	110685 446	175 gal	2011	
DHW Circulation Pump	Armstrong	E17.2B	180210 -664	2/5 hp, max 65 gpm, max 27 ft head	Sep 2019	


Photo 93 – Boilers


Photo 94 - DHW Storage Tanks

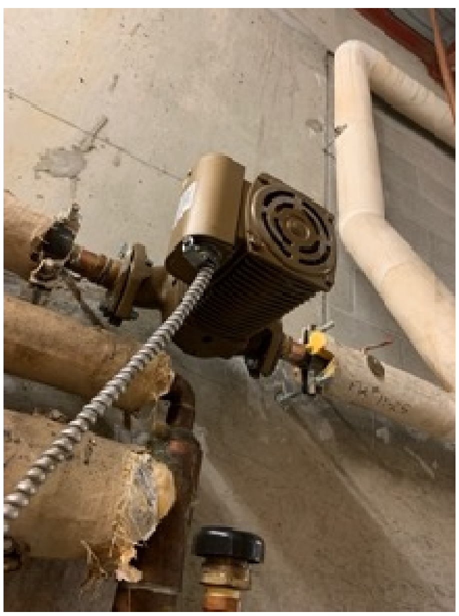
Photo 95 - DHW Circulation Pump


Photo 96 - Expansion Tank


Photo 97 – Boilers

Photo 98 - DHW Storage Tanks


Photo 99 - DHW Circulation Pump

Table 33 - Summary of Level P2 Mechanical Room Equipment (Tower A)

Description	Manufacturer	Model	Serial	Capacity	Manufactured Date	Zone
Boiler 1	IBC	SL40-399G3	SL40-399G3-03862	399 MBH input max, 383 MBH output max	Sep 2015	1st to 16th Floor
Boiler 2	IBC	SL40-399G3	SL40-399G3-03861	399 MBH input max, 383 MBH output max	Sep 2015	
Boiler 3	IBC	SL40-399G3	SL40-399G3-04076	399 MBH input max, 383 MBH output max	Sep 2015	
Expansion Tank 1	Wellrite	NTA180	N/A	90 US Gal, 125 psi max allowable pressure	2014	
Heat Exchanger 1	Kelvion	GBH-DW 400H-60	5100447119-0001	N/A	2016	1st to 8th Floor, Townhomes 1- 4
DHW Storage Tank 1	Lochinvar	RJA200	110924119	200 gal	2011	
DHW Storage Tank 2	Lochinvar	RJA200	110776180	200 gal	2011	
DHW Circulation Pump 1	Armstrong	E10B	180200-650	1/6 hp, max 43 gpm, max 28 ft	N/A	
DHW Circulation Pump 2	Grundfos	UPS26-99SFC	98961763P1	1/5 hp, max 33 gpm, max 29 ft	N/A	
Heat Exchanger 2	WTT	DW460	416942.001	N/A	2002	9th to 16th Floor
DHW Storage Tank 3	Lochinvar	RJA200	110847362	200 gal	2011	
DHW Storage Tank 4	Lochinvar	RJA200	110776180	200 gal	2011	
DHW Circulation Pump 3	Bell & Gossett	M10711	N/A	1/6 hp, max 65 gpm, max 27 ft	N/A	
DHW Circulation Pump 4	Taco	007	N/A	N/A	N/A	

Photo 100 – Typical Boiler

Photo 101 – Expansion Tank

Photo 102 – Plated Heat Exchanger

Photo 103 - DHW Storage Tanks


Photo 104 – DHW Circulation Pump


Photo 105 - Plated Heat Exchanger

Photo 106 - DHW Storage Tanks


Photo 107 – DHW Circulation Pump

Table 34 - Summary of Level P1 Water Entry Room Equipment (Tower A)

Description	Manufacturer	Model	Serial	Capacity	Manufactured Date
Booster Pump 1	Grundfos	CR10-08 A-GJ-A-EHQQE	0001	7.5 hp, 53 gpm, 387 Feet Head	~2019
Booster Pump 2	Grundfos	CR10-08 A-GJ-A-EHQQE	0001	7.5 hp, 53 gpm, 387 Feet Head	~2019
DCVA (Main Water Entry)	Watts	957	OC 5394	N/A	~2019

Photo 108 – Booster Pumps

Photo 109 – Booster Pumps Control Panel

Photo 110 – Main DCVA

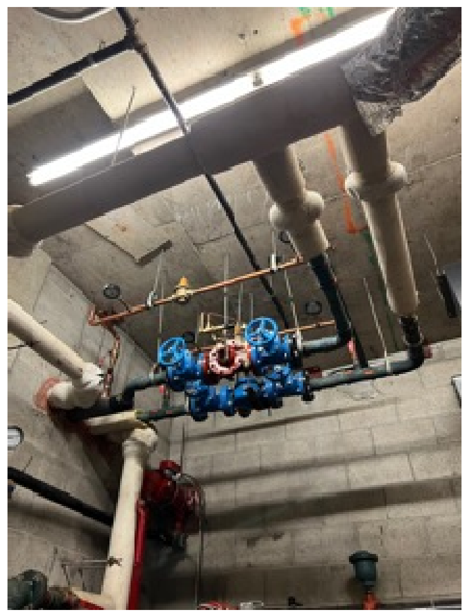

Photo 111 – Various PRVs

Mechanical Room Equipment – Towers B (Ocean Tower)

There are two mechanical rooms at Tower B, one located on the 19th floor, equipped with two gas boilers supplying two hot water storage tanks. The other mechanical room is on parkade level, P4 comprised of two hot water storage fed by the Tower A P2 boiler system. It has been observed that steel hangers were in direct contact with copper piping, which may lead to galvanic corrosion. As well, there is water entry room on the parkade level, P2 equipped with various DCVA's, PRV, and booster pump assembly. Booster pumps are feeding penthouse mechanical room, zone 2 of Tower B as described in Table 2.

Refer to the following tables and photos for mechanical equipment summary.

Table 35 - Summary of Penthouse Mechanical Room Equipment (Tower B)

Description	Manufacturer	Model	Serial	Capacity	Manufactured Date	Zone
Boiler 1	LAARS	VW0325C N12KBDPX	C11229 505	325 MBH input, 263 MPH output	2011	9^{th} to 19^{th} Floor
Boiler 2	LAARS	VW0325C N12KBDPX	C11229 506	325 MBH input, 263 MPH output	2011	
DHW Storage Tank 1	Lochinvar	RJA175	110924 097	175 gal	2011	
DHW Storage Tank 2	Lochinvar	RJA175	110924 100	175 gal	2011	
DHW Recirculation Pump (Return line to tanks)	Armstrong	ARMflo E17B	180210 -664	2/5 HP	-	
DHW Circulation Pump (Tank to Boiler)	Bell & Gosset	PL-30B	1BL013 LF H51	-	-	
DHW Circulation Pump (Tank to Boiler)	Grundfos	-	989517 63P1	-	-	
Expansion Tank	Amtrol	ST20	480471	N/A	2022	

Photo 112 – Boilers

Photo 113 - DHW Storage Tanks

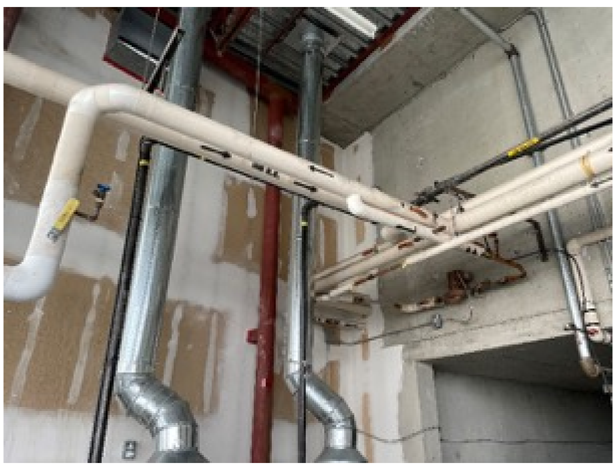

Photo 114 - DHW Circulation Pump

Table 36 - Summary of Level P4 Mechanical Rooms Equipment (Tower B)

DHW Storage Tank 1	Lochinvar	RJA200	110924 113	200 gal	Early 2011	P2 to 8th Floor
DHW Storage Tank 2	Lochinvar	RJA200	110924 110	200 gal	Early 2011	
DHW Circulation Pump 1 (Return Line)	Grundfos	UPS26-99SFC	N/A	1/5 hp, max 33 gpm, max 29 ft	N/A	
DHW Circulation Pump 2 (To HWT)	Bell & Gosset	M80067	1L91	½ HP	-	
DHW Circulation Pump 3 (To HWT)	Grundfos	UPS26-99SFC	989617 63 P1	1/5 hp, max 33 gpm, max 29 ft	N/A	


Photo 115 – DHW Storage Tanks

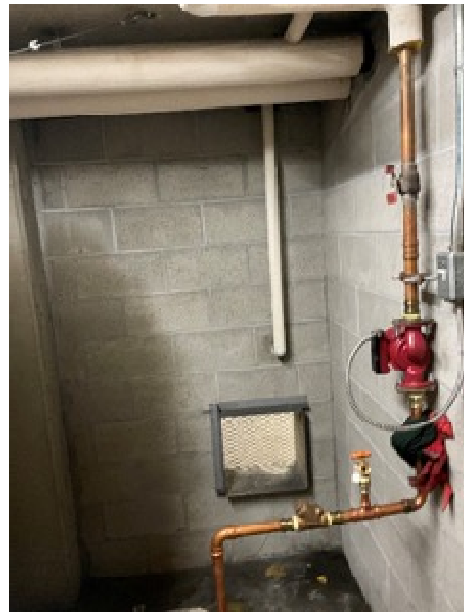
Photo 116- DHW Circulation Pump 1


Photo 117 - DHW Circulation Pump 2

Photo 118 - DHW Circulation Pump 3

Table 37 - Summary of Level P2 Water Entry Room Equipment (Tower B)

Description	Manufacturer	Model	Serial	Capacity	Manufactured Date
Booster Pump 1	Franklin Electric	1303053103	N/A	2.0 hp	N/A
Booster Pump 2	Techtop	JEP0012DP	N/A	1.5 hp	N/A
DCVA (Main Water Entry)	Watts	957	N/A	N/A	~2019


Photo 119 – Booster Pumps


Photo 120 – Booster Pumps Control Panel


Photo 121 – Main DCVA


Photo 122 – Various PRVs

Mechanical Room Equipment – Tower C (Garden Tower)

There Is a mechanical room at Tower C, located on the 10th floor, equipped with two gas boilers supplying two domestic hot water storage tanks. It has been observed that steel hangers were in direct contact with copper piping, which may lead to galvanic corrosion. Refer to the following tables and photos for mechanical equipment summary.

Table 38 - Summary of Mechanical Room Equipment (Tower C – Penthouse)

Description	Manufacturer	Model	Serial	Capacity	Manufactured Year	Zone
Boiler 1	LAARS	VW0325 CN12KB DPX	C 1129431	325MBH max input, 263 max output	2011	1st – 10th Floor
Boiler 2	LAARS	VW0325 CN12KB DPX	C 11229433	325MBH max input, 263 max output	2011	
DHW Storage Tank 1	Lochinvar	RJA175	111031460	175 gal	2011	
DHW Storage Tank 2	Lochinvar	RJA175	110685448	175 gal	2011	
DHW Circulation Pump (between storage tank and boiler)	Armstrong	ARMflo E7.2B	182202-644	1/6 HP	-	
DHW Circulation Pump (between storage tank and boiler)	Grundfos	UPS26-99SFC	98961763 P1	1/5 hp, max 33 gpm, max 29 ft	N/A	
DHW Recirculation Pump (with return line)	TACO	006-B4	-	12 gpm max, 9 ft max	-	
Expansion Tank	AMTROL	Therm-X-Trol	24530313	N/A	-	

Photo 123 - DHW Boilers

Photo 124 - DHW Storage Tanks

Photo 125 - DHW Circulation Pump

Photo 126 - Expansion Tank

General Assessment and Recommendations

A summary of the results of our analysis is as follows:

- The samples obtained from existing piping were found to be mostly Type K and Type L with one (1) Type M copper. Thirty-nine (39) pipe samples were assessed in this report. The amount of pipe thinning varied slightly in each sample. The level of thinning in the samples ranged from 0.00% to 18.18% with average being 2.54%.
    - Copper Corrosion generally follows a pattern of three phases: initial fluctuating leak frequency, followed by steady state (almost predictable) leak frequency, followed by the final stage of exponentially increasing leak frequency.
    - The building is likely within the initial fluctuating leak frequency. There have been 19 leaks in the past 4 years (2019: two, 2020: seven, 2021: eight, 2022: one, 2023: one). There yet has been only one leak in 2023, but given the past record, it is expected that more leaks would occur.
- Eighty-four (84) water samples were tested for this report. The average pH value and copper content were 7.74 and 0.08 mg/L, respectively.
    - Dissolved copper levels show that the level of corrosion is low at this time. Copper content indicates the amount of pipe material being corroded. Due to the age of the piping at Pleasant View, the rate of copper dissolving will increase in the future.
    - Water pH level appears to be within the reasonable limits of 7.0 to 10.5 for safe drinking water.
- A typical copper pipe system lasts 20 to 25 years. MAE has been informed that the domestic water piping is mostly original to the building with some repair work at the time of this report (approximately 30 years). Though the age of piping has well exceeded that of a typical copper piping system where leakages have been encountered, further leakages can be expected as the piping corrosion reaches a steady state.
    - It is our understanding that several locations throughout the building have already been repaired piecemeal due to on-going leaks. Partial repairs generally result in a poorer quality overall system due to inconsistencies of design or workmanship and are also much more expensive than a comprehensive repair strategy.

  - Based on the results of our assessment, a comprehensive re-pipe is necessary in the next 3-5 years. Leakages should be closely monitored given the age of. the pipes.

- A visual review of the mechanical room equipment revealed several outstanding issues and the equipment appeared to be maintained by the contracted provider. The expected service life for the indirect hot water heaters are approximately 15-25 years.

  - The hangers used to hold the copper piping (steel) are in direct contact with the copper piping in many cases. These dissimilar metals may lead to galvanic corrosion through electrolysis, and is recommended that a rubber (or non-conductive) barrier be placed between the piping and hanger.

- Replacement of the domestic water distribution system, including associated valves will likely be in the range of $ 2,000,000 – $ 2,500,000.

- Note that the above prices are considered Class D estimate with +/- 50% accuracy range as defined in guidelines prepared by the association of Engineers and Geoscientists of British Columbia (EGBC). Any relevant engineering consulting fees will depend on the selected firm and the scope of work and are not included in the above estimates. In addition to these costs, the owners should set aside approximately 10% to 15% of the chosen renewal option for any hidden damages.

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

Sincerely,
McCUAIG & ASSOCIATES ENGINEERING LTD.

Prepared by: ***Reviewed by:***

Will Lee, P. Eng Ali Karimi, P. Eng

Noel Lee, EIT

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