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Carleton Condominium Corporation No. 145
% Condominium Management Group
434 Queen Street,
Ottawa, Ontario, K1R 7V7

Attn: Ms. Eileen Boles

CCC 145 - DOMESTIC HOT AND COLD WATER RISER PIPE CONDITION ASSESSMENT

Dear Ms. Boles:

At your request, Keller Engineering coordinated with Glencor Engineering to conduct a domestic hot and cold-water riser piping condition assessment at the Carleton Condominium Corporation No. 145 (CCC 145), located at 151 Bay St., in Ottawa, Ontario. Our mandate was to review the condition of the existing domestic hot and cold-water riser piping and provide recommendations on remedial repairs or required replacements.

INTRODUCTION

Carleton Condominium Corporation No. 145 (CCC 145) is a 13-storey high rise condominium containing 142 residential suites, located at 151 Bay Street, Ottawa Ontario. The building was constructed in 1975 and uses copper riser and branch piping for the domestic hot and cold-water distribution in the building.

CCC 145 is currently in the design phase of a building-wide full sanitary drain stack replacement project. As part of this project, there will be significant costs placed on the owners for the removal and reinstatement of the kitchen and washroom sinks, bathtubs, toilets, counters, cupboards, tiles, finishes, and any other items that obstruct access to the mechanical pipe chase inside the walls. In addition to the costs involved, there will be significant occupant disruption caused by this project, as the majority of the work needs to be performed from within the Suites.

During the sanitary drain stack replacement inspections, it was observed that the domestic water risers are also located within the same mechanical walls, adjacent to the sanitary drain stack piping. Sections of the domestic water riser piping were observed to be Type-M copper piping, which has a pipe wall thickness that is approximately 30% to 50% thinner, depending on the pipe diameter, than the Type-L copper piping which is typically used in domestic water riser piping applications for high-rise buildings. Due to the location of the riser piping, and the thinner wall piping used, Keller Engineering recommended having the domestic riser pipe condition tested as it could be beneficial to schedule this piping replacement to coincide with the sanitary drain replacement project.

To investigate the remaining service life of the domestic riser piping, an ultrasonic thickness testing study was performed on a sample of piping at 162 locations. The testing locations were concentrated on the bottom of the system risers, but also included locations at the top of the main hot, cold, and recirculation

water pipes, and locations in straight sections of riser in the washrooms of Suites 403 and 1008. The bottom of the risers is the location with the highest expected wear, so these locations are expected to represent a worst-case scenario, and the other locations were included to get a better picture of the current piping condition in the building.

FINDINGS

The following is a summary of the results of pipe thickness testing performed by Glencor Engineering on the domestic hot and cold-water riser piping serving the building.

Domestic hot water piping:

- 38% maximum pipe wall thickness loss was detected on pipe elbows
- 25% maximum pipe wall thickness loss was detected on straight sections of pipe
- 0-11% maximum pipe wall thickness loss was detected in 49% of the locations tested
- 12%-25% maximum pipe wall thickness loss was detected in 42% of the locations tested
- 26% or greater maximum pipe wall thickness loss was detected in 9% of the locations tested

Domestic cold-water piping:

- 32% maximum pipe wall thickness loss measured on pipe elbow
- 28% maximum pipe wall thickness loss measured on straight section of pipe
- 77% of locations tested included a maximum pipe wall thickness loss of 0-11%
- 16% of locations tested included a maximum pipe wall thickness loss of 12-25%
- 6% of locations tested included a maximum pipe wall thickness loss of greater than 25%

DISCUSSION

The ultrasonic probe measures the average thickness of the pipe wall over a small area. This means that a pipe wall thickness loss measurement of 50% can represent an area of 25% pipe wall loss, that contains localized pitting or wear with 90% thickness loss. Since pipe failure is determined by any point of the pipe which has 100% thickness loss, the actual point of failure will occur well before 100% thickness loss is registered on the ultrasonic thickness measurements. As the piping ages, the rate of wear accelerates due to increased surface roughness and additional localized turbulence. Any pipe that measures 25% pipe wall thickness loss has significant thinning and can be expected to develop leaks within the next 2-5 years, and any pipe reading 50% pipe wall thickness loss is considered to be at risk of imminent failure and needs to be replaced immediately.

Loss of pipe wall thickness occurs in copper piping due to a combination of erosion, erosion corrosion, and localized pitting. Erosion is mechanical wear in the pipes caused by water and debris flowing through them. This type of wear leads to general thinning of the pipes and is most prominent in locations where the pipe changes direction and the flowing water can be concentrated at a point of high turbulence. Erosion corrosion occurs when high velocity or turbulent water flow erodes the protective copper oxide layer off the inside of the pipe, which allows new corrosion to form and over time leads to cumulative corrosion of the piping material. Localized pitting can be caused by various conditions, and it leads to material deterioration in a small, localized area that can lead to pinhole leaks.

Domestic hot water recirculation system's typically see the highest degree of wear due to the elevated temperatures and the constant flow in this system. At the bottom of the risers the hot water recirculation piping is at its smallest diameter, so the recirculating water is at its highest velocity, a condition which results in the maximum wear. Another location in this system which can be susceptible to more advanced wear is the hot water return riser pipe, which combines all of the hot water risers into one pipe to recirculate it back to the hot water system in the mechanical penthouse.

The results of the pipe thickness testing performed by Glencor Engineering indicates significant thinning on many of the elbows, and some straight sections of piping, on both the hot and cold-water systems. The level of thinning that was measured would indicate that leaks may occur in some elbows in the next 2-5 years. Due to the concentration of thinning on elbows Glencor recommends removing some of the elbows showing the most wear for further analysis into the cause of the localized thinning. However, since most of the riser piping at this building is located in the same pipe chases inside the walls that will be removed as part of the upcoming stack replacement project, this also needs to be taken into consideration.

The existing level of pipe deterioration has occurred over roughly the past 50 years of operation and since pipe wear rates tend to accelerate over time, it can be expected that the level of pipe deterioration within the next 50 years will be more than double that currently found. With the current level of general thinning, it is likely that pin hole leaks and pipe failures will begin developing in the system before the next scheduled stack replacement. In discussing this matter further with Glencor, they advised that while they cannot precisely predict the remaining service life of the overall pipe system they expect that a more realistic estimate of the overall domestic water pipes remaining service life would be 10-20 years.

To avoid the cost and occupant impact of additional major construction projects, the domestic water riser replacement should ideally be scheduled to coincide with a sanitary stack replacement cycle. It is expected that the next sanitary drain stack replacement in the building will be required in 50 years, however, based on the current level of deterioration, it is unlikely that the domestic water risers will last another 50 years before their replacement is required.

RECOMMENDATIONS & BUDGET PRICING

Due to the significant cost and occupant impact involved in accessing the pipe chases throughout much of this building, we recommend replacing the domestic hot and cold-water riser piping within the pipe chases as part of the ongoing sanitary drain piping replacement project. This will minimize overall replacement cost and occupant impact since the pipe chases will be made accessible through the course of construction, and it will ensure the domestic water riser piping is able to remain in service for the entire life of the new sanitary drain stack piping.

Class D (+/- 25%) budget pricing to include replacement of the domestic hot and cold-water riser piping as part of the sanitary stack replacement is $575,000.

We trust that the above satisfies your current requirements. Please feel free to contact us if you have any questions regarding the above.

Sincerely,

Chris O'Brien, P.Eng.

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Inspection Report 2310174

Ultrasonic Thickness Survey of
Domestic Water Piping
at
151 Bay Street
Keller Engineering,
Ottawa, Ontario

date: November 3, 2023

prepared by:

J.E. Martin
CGSB 48.9712 UT-1
& ASNT-TC-1A UT-2

&

D.M.M. Twigg
CGSB 48.9712 UT-2
& ASNT-TC-1A UT-2

Subject: Ultrasonic Thickness Survey of Domestic Water Piping at 151 Bay Street, Keller Engineering, Ottawa, Ontario

1.0 INTRODUCTION

On October 16th and 23rd, 2023 visits were made to 151 Bay Street in Ottawa, Ontario to perform an ultrasonic thickness survey of the Domestic Water Piping. The intention of the survey is to help determine the overall condition of the piping throughout the building.

2.0 TEST

An Olympus 36DL plus ultrasonic thickness gauge, with a ¼" 7.5 MHz dual transducer probe and Sonotech Soundsafe gel as couplant were used to take thickness readings at selected locations on the domestic water risers throughout the parking garage, two occupied units (403 & 1008) and the penthouse fan room.

3.0 RESULTS OF THE TESTING

Thickness measurements were taken all around the circumference of the piping at areas of known high probable wear. Readings at each location start on the top/front of the pipe and proceed counter-clockwise around the pipe when facing the direction of flow. Readings on the backs of tee s and elbows start upstream and proceed in the direction of flow. All readings are in inches. Any readings of concern are in bold while readings of immediate concern are also underlined for ease of identification.

3.1 Table of Readings

Reading Number	Locations									
	In Front of Garage Door Level 1						Side of Garage Door			
	DCW			DHW			DCW			DHW
	2" Cu Type M			$^3/_4$" Cu Type L			2" Cu Type M			$^3/_4$" Cu Type L
	1	2 elbow	3	4	5 elbow	6	7	8 elbow	9	10
1	0.057	0.061	0.063	0.039	0.036	0.036	0.054	0.060	0.060	0.039
2	0.055	0.060	0.064	0.042	0.034	0.036	0.056	0.058	0.060	0.038
3	0.055	0.061	0.064	0.043	**0.033**	0.039	0.059	0.058	0.058	0.036
4	0.054	0.061	0.058	0.044	**0.033**	0.038	0.058	0.051	0.063	0.039

Reading Number	Locations									
	Side of Garage Door		Spot 6						Spot 9	
	DHW		DCW			DHW			DCW	
	$^3/_4$" Cu Type L		2" Cu Type M			$^3/_4$" Cu Type L			$1^1/_2$" Cu Type M	
	11 elbow	12	13	14 elbow	15	16	17 elbow	18	19	20 elbow
1	0.035	0.040	0.049	0.058	0.048	0.038	0.038	0.038	0.054	0.064
2	0.036	0.039	**0.043**	0.055	0.055	0.040	0.040	0.038	0.053	0.057
3	0.037	0.038	0.056	0.052	0.058	0.037	0.037	0.038	0.050	0.058
4	0.036	0.039	0.056	0.052	0.057	0.036	0.036	0.039	0.051	0.059

Reading Number	Locations									
	Spot 9				Middle of Garage by Spot 9					
	DCW	DHW						DCW		
	$1\frac{1}{2}$" Cu Type L	$\frac{1}{2}$" Cu Type L						$\frac{3}{4}$" Cu Type M		
	21	22	23	24	25	26 elbow	27	28	29 cast elbow	30 elbow
1	0.053	0.033	-	0.039	0.033	0.035	0.036	0.033	0.047	0.031
2	0.053	0.031	-	0.040	0.031	0.033	0.037	0.035	0.046	0.031
3	0.061	**0.030**	-	0.037	0.031	0.033	0.035	0.035	0.046	0.032
4	0.059	0.031	-	0.035	0.032	0.031	0.033	0.037	0.051	0.029

- no access due to fitting

Reading Number	Locations									
	Middle of Garage									
	DHW			DCW						DHW
	$\frac{1}{2}$" Cu Type M			$\frac{3}{4}$" Cu Type M			$\frac{1}{2}$" Cu Type L			
	31	32 elbow	33	34	35 elbow	36	37	38 elbow	39	40
1	0.032	0.032	0.031	0.038	0.031	0.038	0.036	0.043	-	0.032
2	0.033	0.033	0.030	0.037	0.032	0.037	0.036	0.039	-	0.033
3	0.034	0.031	0.031	0.039	0.032	0.038	0.037	0.038	-	0.033
4	0.030	0.029	0.029	0.038	0.031	0.039	0.039	0.039	-	0.033

-no access

Reading Number	Locations									
	Middle of Garage		Middle by Spot 15			Generator Room				
	DHW					DCW			DHW	
	1/2" Type M Cu		1" Cu Type L			2" Type M Cu			3/4" Cu Type M	
	41 elbow	42	43	44 elbow	45	46	47 elbow	48	49	50 cast elbow
1	0.028	0.030	0.050	0.042	0.048	0.058	0.058	0.059	0.035	0.048
2	0.026	0.033	0.048	0.043	0.041	0.059	0.057	0.058	0.036	0.045
3	0.026	0.031	0.047	0.044	0.041	0.056	0.059	**0.042**	0.037	0.046
4	0.025	0.032	0.050	0.041	0.050	0.058	0.058	**0.043**	0.034	0.043

Reading Number	Locations									
	Generator Room	Outside Generator Room						By Building Entrance to Garage		
	DHW				DCW					
	3/4" Cu Type M	3/4" Cu Type L			2" Cu Type M					
	51	52	53 elbow	54	55	56 elbow	57	58	59 elbow	60
1	0.038	0.039	0.040	0.039	0.052	0.059	0.052	-	0.059	0.063
2	0.039	0.038	0.040	0.040	0.056	0.058	0.049	-	0.058	0.061
3	0.037	0.039	0.041	0.042	0.059	0.057	0.058	-	0.049	0.058
4	0.038	0.039	0.042	0.041	0.057	0.058	0.057	-	0.052	0.061

-no access

Reading Number	Locations									
	By Building Entrance to Garage			Near Building Entrance by Spot 33						By Spot 16
	DHW			DCW			DHW			DCW
	$^3/_4$" Cu Type L			2" Cu Type M			$^3/_4$" Cu Type L			2" Cu Type M
	61	62 elbow	63	64	65 elbow	66	67	68 elbow	69	70
1	0.044	0.043	0.040	0.058	0.067	0.068	0.039	0.038	0.041	0.058
2	0.041	0.044	0.041	0.057	0.065	0.063	0.040	0.037	0.042	0.057
3	0.043	0.042	0.041	0.060	0.063	0.064	0.041	0.035	0.038	0.060
4	0.040	0.044	0.042	0.059	0.062	0.062	0.040	0.036	0.040	0.059

Reading Number	Locations									
	By Spot 16					Spot 17				
	DCW		DHW			DCW			DHW	
	2" Cu Type M		$^3/_4$" Cu Type L			$1^1/_2$" Cu Type L			½" Cu Type L	
	71 elbow	72	73	74 elbow	75	76	77 elbow	78	79	80 elbow
1	0.050	0.063	-	0.045	0.040	0.057	0.046	0.056	0.036	0.034
2	0.051	0.063	-	0.046	0.038	0.056	**0.042**	0.055	0.036	0.036
3	0.049	0.060	-	0.044	0.038	0.054	**0.041**	0.053	0.037	0.034
4	0.052	0.061	-	0.043	0.039	0.059	**0.041**	0.061	0.036	0.036

- no access

Reading Number	Locations									
	Spot 19							By Spot 20		
	DHW	DCW			DHW			DCW		
	$^1/_2$" Cu Type L	3" Cu Type M			$1^1/_4$" Cu Type M			$1^1/_2$" Cu Type M		
	81	82	83 cast elbow	84	85	86 elbow	87	88	89 elbow	90
1	0.038	0.076	0.087	-	0.047	0.041	0.047	0.053	**0.036**	0.044
2	0.037	0.075	0.096	-	0.046	0.041	0.046	0.045	0.037	0.046
3	0.037	0.074	0.087	-	0.045	0.039	0.045	0.044	**0.035**	0.051
4	0.038	0.073	0.081	-	0.046	0.038	0.045	0.046	**0.036**	0.044

-no access

Reading Number	Locations									
	Spot 20	Spot 21						Middle by Ramp		
	DHW	DCW			DHW			DCW		
	$^1/_2$" Cu Type L	2" Cu Type M			$^3/_4$" Cu Type L			2" Cu Type M		
	91	92	93 elbow	94	95	96 elbow	97	98	99 tee	100
1	0.041	0.059	0.052	0.061	0.040	0.042	0.041	0.060	0.145	0.064
2	0.042	0.060	0.053	0.059	0.043	0.039	0.040	0.059	0.141	0.066
3	0.041	0.059	0.054	0.058	0.041	0.040	0.043	0.060	0.147	0.064
4	0.041	0.060	0.052	0.060	0.043	0.039	0.045	0.059	0.144	0.062

Reading Number	Locations									
	Middle by Ramp			Spot 24						
	DHW			DCW			DHW			DCW
	$^{3}/_{4}$" Cu Type L			$1^{1}/_{2}$" Cu Type L			$^{1}/_{2}$" Cu Type L			2" Type M
	101	102 elbow	103	104	105 elbow	106	107	108 elbow	109	110
1	-	0.040	0.040	0.056	0.049	0.060	0.036	**0.028**	0.040	0.059
2	-	0.039	0.041	0.053	0.048	0.058	0.039	**0.029**	0.038	0.060
3	-	0.041	0.042	0.056	0.050	0.055	0.038	**0.029**	0.037	0.057
4	-	0.040	0.043	0.055	0.049	0.059	0.037	0.030	0.035	0.059

-No access

Reading Number	Locations									
	Spot 2 on Level 1A									
	DCW		DHW			DCW			DHW	
	2" Cu Type M		$^{3}/_{4}$" Cu Type L			$1^{1}/_{2}$" Cu Type L			½" Cu Type L	
	111 elbow	112	113	114 elbow	115	116	117 elbow	118	119	120 elbow
1	0.049	0.061	0.043	**0.030**	0.041	0.053	0.051	0.069	0.035	**0.027**
2	0.048	0.061	0.045	**0.028**	0.042	0.053	0.050	0.068	0.036	**0.026**
3	0.047	0.058	0.046	**0.028**	0.040	0.054	0.049	0.071	0.038	**0.029**
4	0.047	0.062	0.043	**0.029**	0.038	0.055	0.047	0.072	0.035	**0.028**

Reading Number	Locations									
	At Wall Across From Spot 2 Level 1A							1A Storage Area		
	DHW	DCW			DHW			DCW		
	½" Cu Type L	2" Cu Type M			¾" Cu Type M			2" Cu Type M		
	121	122	123 elbow	124 tee	125	126 elbow	127	128	129 elbow	130
1	0.038	0.056	0.061	0.062	0.038	0.038	0.039	0.060	0.066	0.058
2	0.037	0.057	0.060	0.061	0.032	0.039	0.038	0.059	0.069	0.057
3	0.035	0.057	0.063	0.060	0.041	0.038	0.037	0.057	0.063	0.060
4	0.037	0.059	0.061	0.058	0.042	0.035	0.038	0.060	0.064	0.061

Reading Number	Locations									
	Level 1 A Storage Area			Spot 1						
	DHW			DCW			DHW		DCW	
	¾" Cu Type L			2" Cu Type M			¾" Cu Type L		2" Cu Type M	
	131	132 elbow	133	134	135 elbow	136	137 elbow	138	139	140 elbow
1	-	0.043	0.041	0.061	0.061	0.061	0.040	0.040	0.059	0.070
2	-	0.044	0.041	0.059	0.053	0.059	0.039	0.037	0.059	0.065
3	-	0.040	0.041	0.058	0.058	0.061	0.038	0.038	0.057	0.063
4	-	0.039	0.039	0.059	0.059	0.064	0.037	0.040	0.058	0.063

-no access

Reading Number	Locations									
	Spot 1								Spot 25	
	DCW	DHW		DCW			DHW		DCW	
	$^{3}/_{4}$" Cu Type L						$^{1}/_{2}$" Cu Type L		$1^{1}/_{2}$" Cu Type L	
	141	142 elbow	143	144	145 elbow	146	147 elbow	148	149	150 elbow
1	0.059	0.038	0.045	0.058	0.044	0.061	0.032	0.040	0.057	0.047
2	0.060	0.039	0.046	0.059	0.045	0.060	**0.030**	0.038	0.053	0.046
3	0.057	0.037	0.047	0.057	0.043	0.059	**0.027**	0.036	0.053	0.045
4	0.058	0.036	0.043	0.059	0.046	0.062	**0.028**	0.040	0.055	**0.044**

Reading Number	Locations									
	Spot 25				Unit 403		Unit 1008		Penthouse Fan Room	
	DCW	DHW			DCW		DHW	DCW		
	$1^{1}/_{2}$" Cu Type L	$^{1}/_{2}$" Cu Type L			$1^{1}/_{4}$" Type M Cu		$1^{1}/_{2}$" Type M Cu	$1^{1}/_{4}$" Type M Cu	3" Type M Cu	
	151	152	153 elbow	154	155	156	157	158	159	160 elbow
1	0.052	0.036	0.033	0.043	0.049	0.047	0.051	0.045	0.075	0.077
2	0.054	0.035	0.032	0.038	0.049	0.048	0.052	0.043	0.074	0.070
3	0.054	0.037	0.031	0.040	0.048	0.046	0.051	0.044	0.074	0.075
4	0.056	0.035	**0.028**	0.039	0.046	0.048	0.050	0.044	0.073	0.083
5									0.072	0.074
6									0.073	0.073

Reading Number	Locations									
	Penthouse Fan Room						In Front of Spot 75			
	DCW	DHW					DCW		DHW	
	3" Type M Cu	$1^1/_4$" Type M Cu		3" Type M Cu			2" Type M Cu		$^3/_4$" Type M Cu	
	161 elbow	162	163 elbow	164	165	166	167	168 elbow	169	170 elbow
1	0.079	0.042	0.039	0.073	-	0.073	0.057	0.060	0.039	0.028
2	0.077	0.046	0.039	0.075	-	0.072	0.056	0.067	0.040	0.027
3	0.076	0.044	0.039	0.076	-	0.073	0.057	0.068	0.033	0.028
4	0.071	0.042	0.039	0.073	-	0.071	0.056	0.067	0.039	0.031
5	0.072			0.071	-	0.074				
6	0.069			0.072	-	0.073				

-no access

3.2 Calculations

3.2.1 Domestic Cold Water

Thickness measurements on the $^1/_2$" Type L copper piping range from 0.036 inches to 0.043 inches. This suggests a nominal thickness of 0.040 inches for $^1/_2$" Type L copper piping. Maximum wall loss detected would be 0.004 inches or ~10.0%.

Thickness measurements on the $^3/_4$" Type M copper piping range from 0.029 inches to 0.051 inches. This suggests a nominal thickness of 0.032 inches for $^3/_4$" Type M copper piping. Maximum wall loss detected would be 0.003 inches or ~9.4%.

Thickness measurements on the $^3/_4$" Type L copper piping range from 0.043 inches to 0.062 inches. This suggests a nominal thickness of 0.045 inches for $^3/_4$" Type L copper piping. Maximum wall loss detected would be 0.002 inches or ~4.4%.

Thickness measurements on the $1^1/_4$" Type M copper piping range from 0.043 inches to 0.048 inches. This suggests a nominal thickness of 0.042 inches for $1^1/_4$" Type M copper piping. Little to no wall loss was detected.

Thickness measurements on the $1^1/_2$" Type M copper piping range from 0.035 inches to 0.064 inches. This suggests a nominal thickness of 0.049 inches for $1^1/_2$" Type M copper piping. Maximum wall loss detected would be 0.014 inches or ~28.6%.

Thickness measurements on the $1^1/_2$" Type L copper piping range from 0.041 inches to 0.072 inches. This suggests a nominal thickness of 0.060 inches for $1^1/_2$" Type L copper piping. Maximum wall loss detected would be 0.019 inches or ~31.7%.

Thickness measurements on the 2" Type M copper piping range from 0.042 inches to 0.147 inches with thicker readings being on a tee. This suggests a nominal thickness of 0.058 inches for 2" Type M copper piping. Maximum wall loss detected would be 0.016 inches or ~27.5%.

Thickness measurements on the 3" Type M copper piping range from 0.069 inches to 0.096 inches. This suggests a nominal thickness of 0.072 inches for 3" Type M copper piping. Maximum wall loss detected would be 0.003 inches or ~4.2%.

3.2.2 Domestic Hot Water

Thickness measurements on the $^1/_2$" Type L copper piping range from 0.026 inches to 0.043 inches. This suggests a nominal thickness of 0.040 inches for $^1/_2$" Type L copper piping. Maximum wall loss detected would be 0.014 inches or ~35.0%.

Thickness measurements on the $^1/_2$" Type M copper piping range from 0.025 inches to 0.034 inches. This suggests a nominal thickness of 0.028 inches for $^1/_2$" Type M copper piping. Maximum wall loss detected would be 0.003 inches or ~10.7%.

Thickness measurements on the $^3/_4$" Type M copper piping range from 0.027 inches to 0.048 inches. This suggests a nominal thickness of 0.032 inches for $^3/_4$" Type M copper piping. Maximum wall loss detected would be 0.005 inches or ~15.6%.

Thickness measurements on the $^3/_4$" Type L copper piping range from 0.028 inches to 0.047 inches. This suggests a nominal thickness of 0.045 inches for $^3/_4$" Type L copper piping. Maximum wall loss detected would be 0.017 inches or ~37.8%.

Thickness measurements on the 1" Type L copper piping range from 0.041 inches to 0.050 inches. This suggests a nominal thickness of 0.050 inches for 1" Type L copper piping. Maximum wall loss detected would be 0.009 inches or ~18.0%.

Thickness measurements on the $1^1/_4$" Type M copper piping range from 0.038 inches to 0.049 inches. This suggests a nominal thickness of 0.042 inches for $1^1/_4$" Type M copper piping. Maximum wall loss detected would be 0.004 inches or ~9.5%.

Thickness measurements on the $1^1/_2$" Type M copper piping range from 0.050 inches to 0.052 inches. This suggests a nominal thickness of 0.049 inches for $1^1/_2$" Type M copper piping. Little to no wall loss was detected.

4.0 DISCUSSION

Thickness measurements on the domestic water piping show wall losses ranging from ~0 - 37.8%. Deterioration appears to be from the internal surface and mainly in the form of erosion/erosion-corrosion and pitting corrosion.

The $^{3}/_{4}$" Type L domestic hot water, ½" Type L domestic hot water, $1^{1}/_{2}$" Type L copper domestic cold water, $1^{1}/_{2}$" Type M copper domestic cold water and 2" Type M copper domestic cold water piping all show wall losses of greater than 25% of the assumed nominal at ~37.8%, 35.0%, 31.7%, 28.6% and 27.5%, respectively. Based on the rules of thumb established for the interpretation of ultrasonic thickness survey results on pressure piping, leaks could be expected to develop within the next 2 - 5 years. However, much of the thinning appears to be located at the elbows of the piping. This would seem to suggest that the straight lengths of piping are in better condition. However, copper elbows can also be thinner due to forming operations as well. It may be advisable to remove a few elbows that show significant thinning to examine internally so that it can be determined the extent of the deterioration before wholesale replacement is considered.

The remainder of the piping is in good condition with wall losses ranging from ~0 - 18.0%.

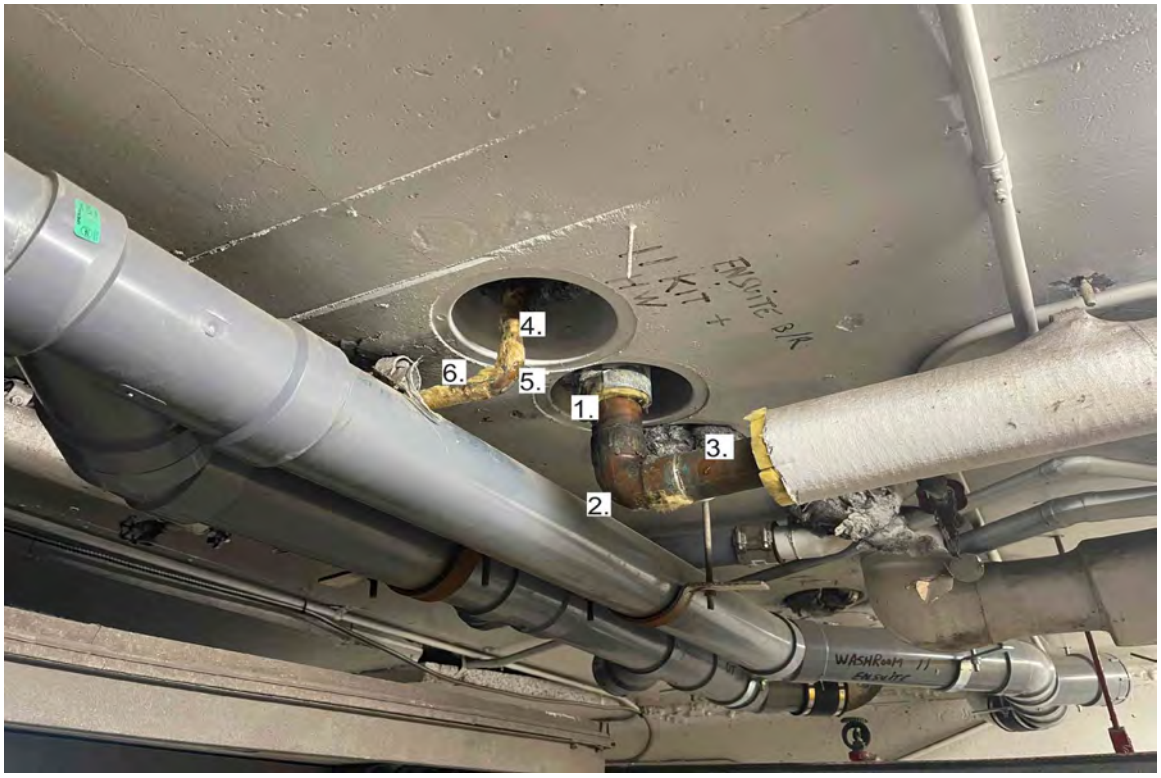
5.0 CONCLUSIONS

The domestic water piping at 151 Bay Street has experienced some deterioration and thinning from the internal surface in the form of erosion/erosion-corrosion and pitting corrosion. Maximum detected wall losses range from ~0-37.8%.

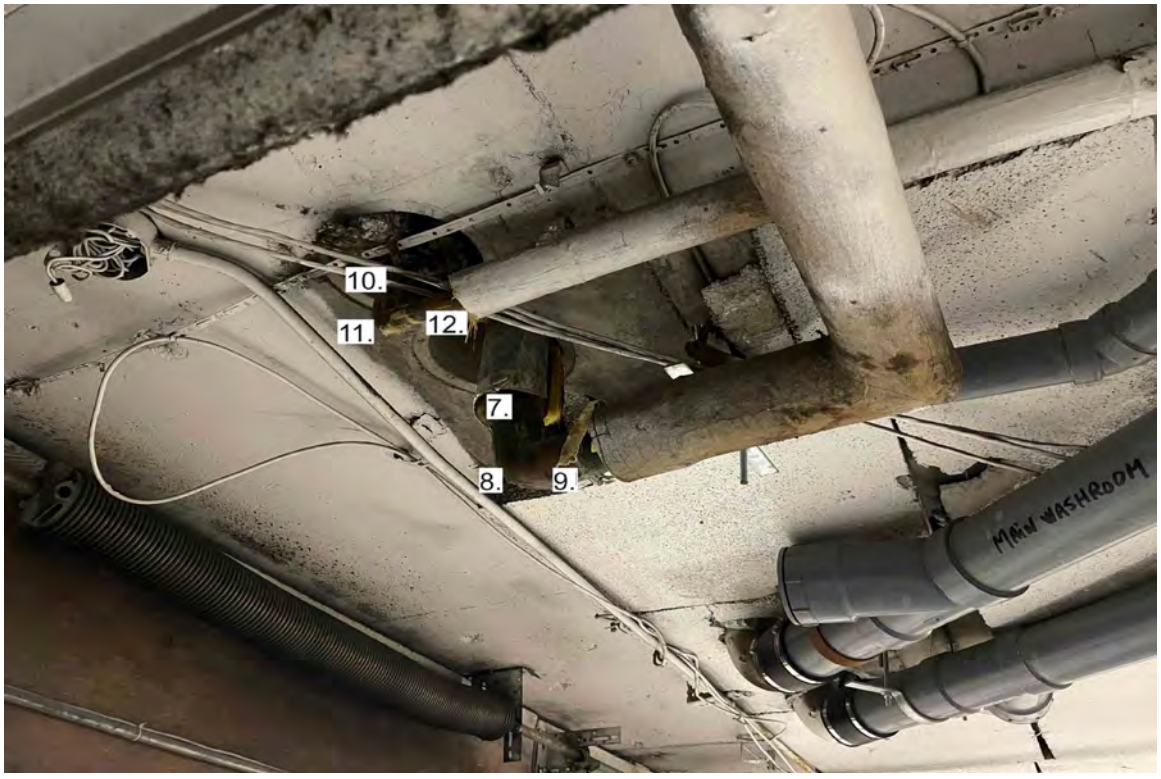
The $^{3}/_{4}$" Type L domestic hot water, ½" Type L domestic hot water, $1^{1}/_{2}$" Type L copper domestic cold water, $1^{1}/_{2}$" Type M copper domestic cold water and 2" Type M copper domestic cold water piping all have wall losses of greater than 25% of the assumed nominals. At these levels of thinning, leaks could be expected in the next 2 - 5 years. However majority of the thinning is occurring on elbows and may represent a combination of elbows that were originally thin due to forming operations and deterioration.

It may be advisable to remove some elbows that show evidence of thinning so that they can be examined internal to try and determine the extent of the attack.

The remainder of the piping is in good condition with wall losses ranging from ~0 - 18.0%, leaks would not be expected at this time.

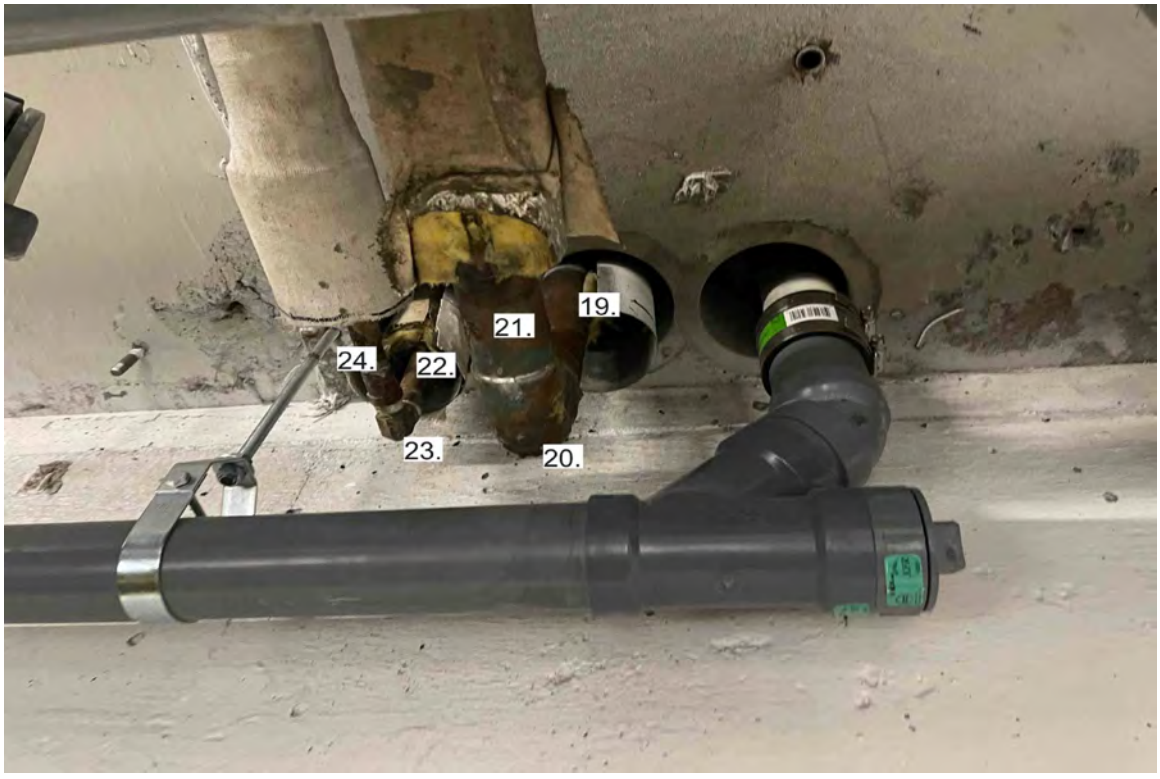


Photograph 1: In Front of garage door on level 1.

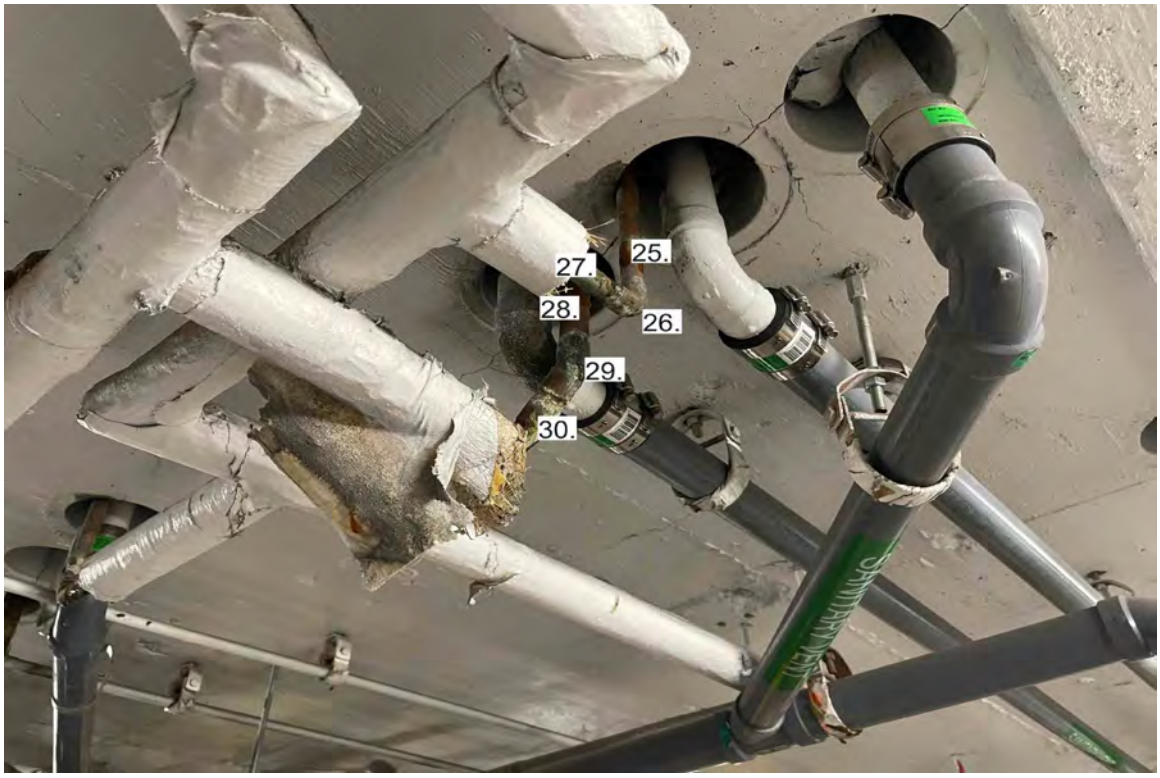


Photograph 2: Side of Garage Door.

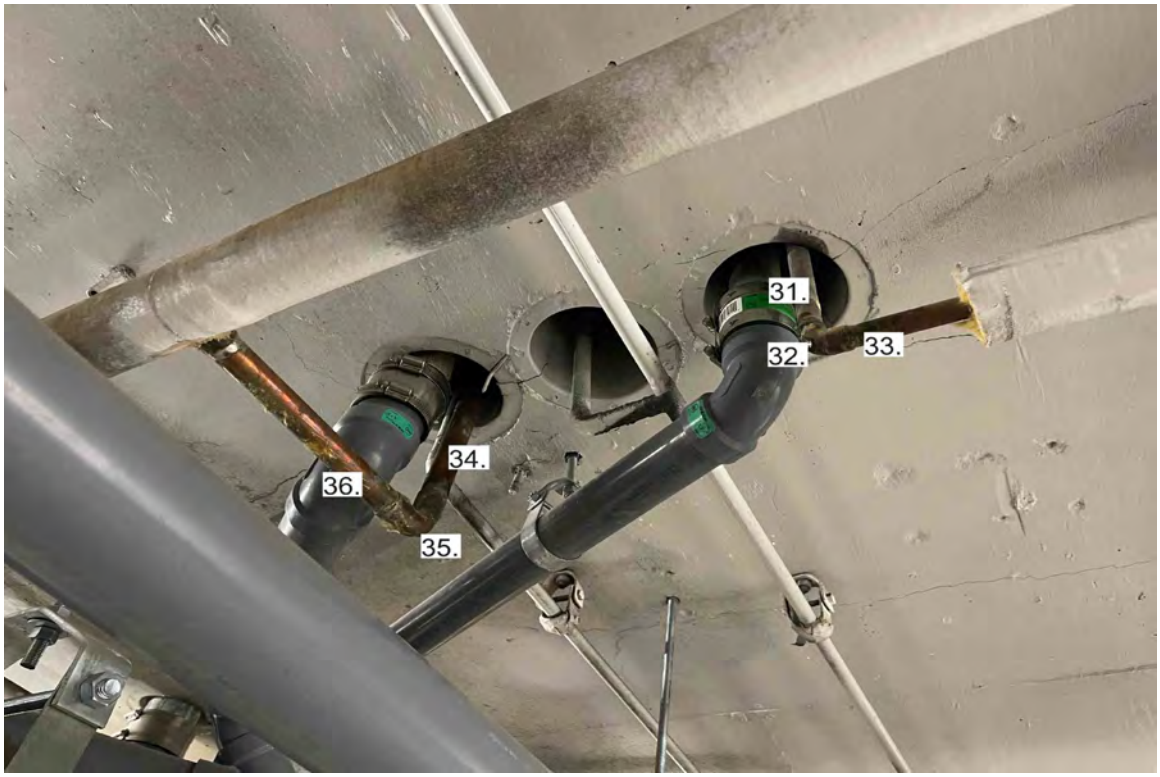
Photograph 3: Parking Garage Spot #6.



Photograph 4: Parking Garage Spot #9.

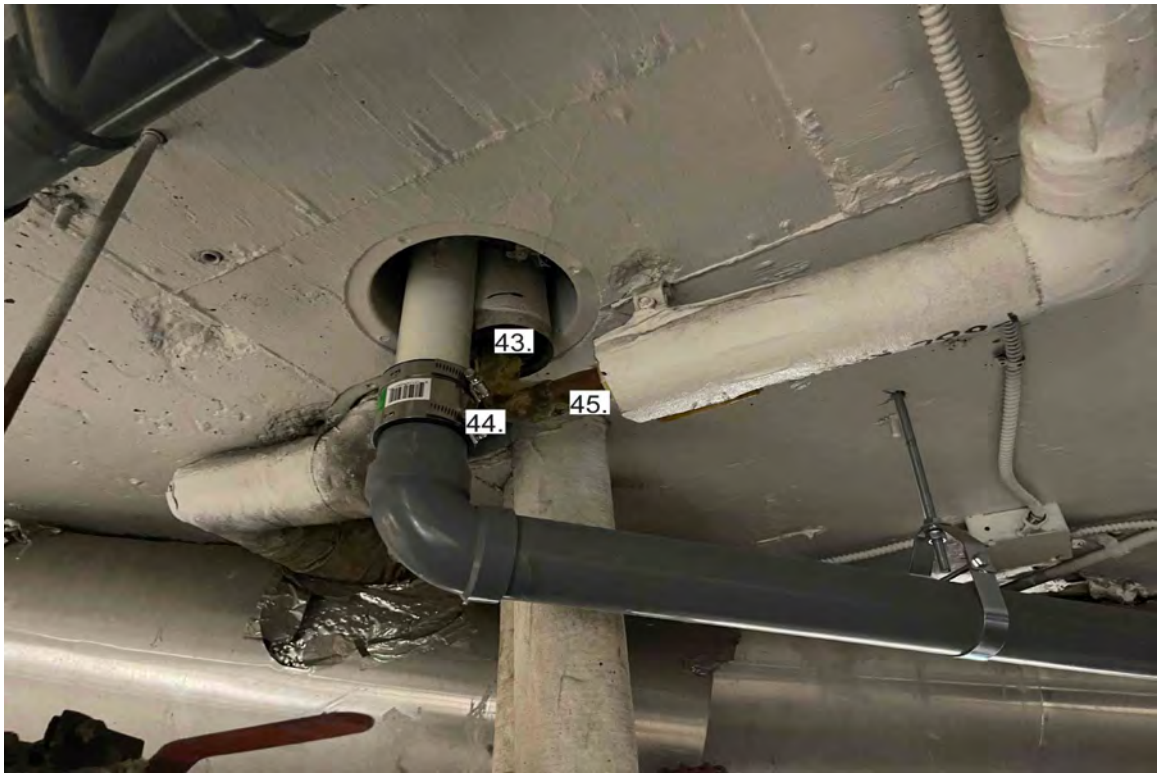


Photograph 5: Middle of Parking Garage by Spot #9.

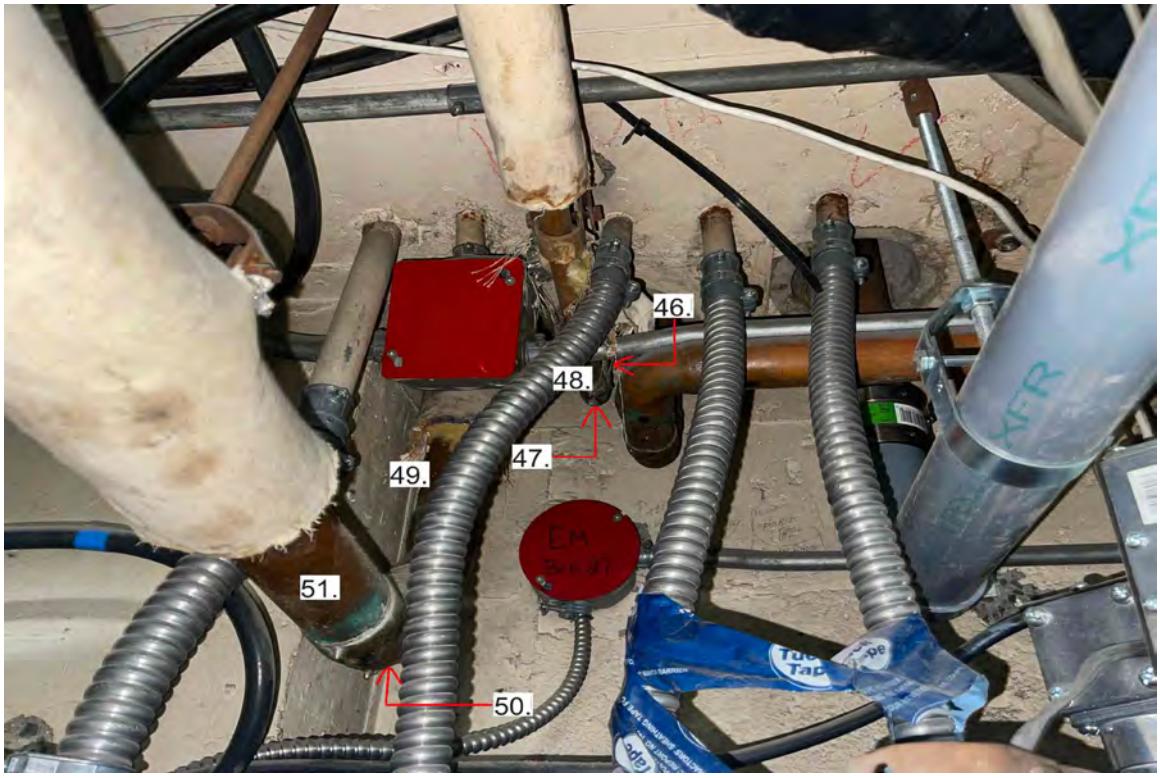


Photograph 6: Middle of Garage Level 1.

Photograph 7: Middle of Garage Level 1.

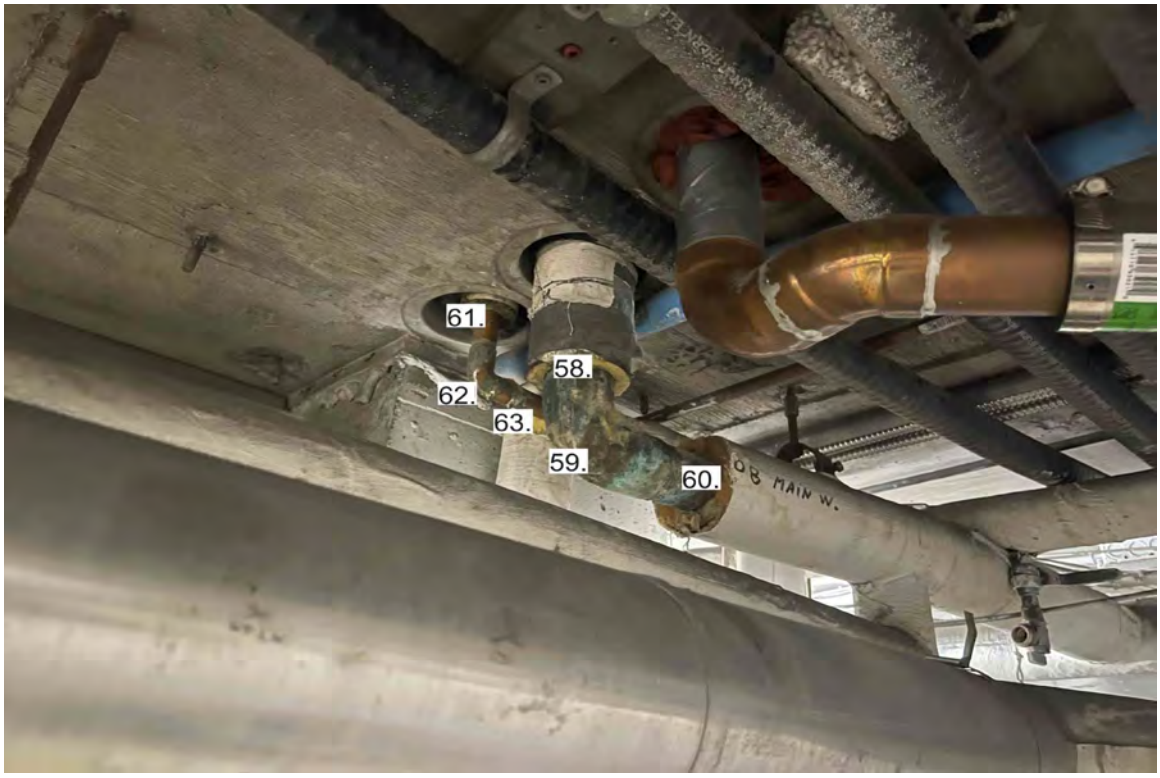


Photograph 8: Level 1 Middle of Garage by Spot #15.

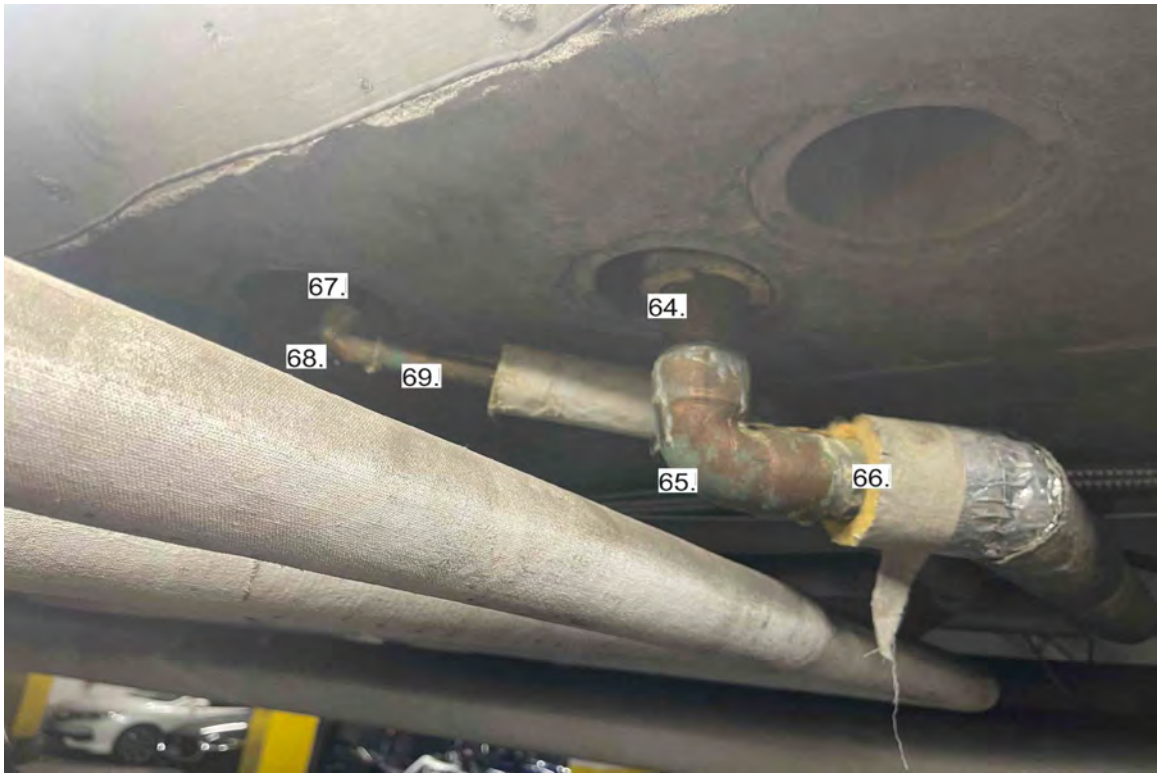


Photograph 9: Parking Garage Level 1 Generator Room.

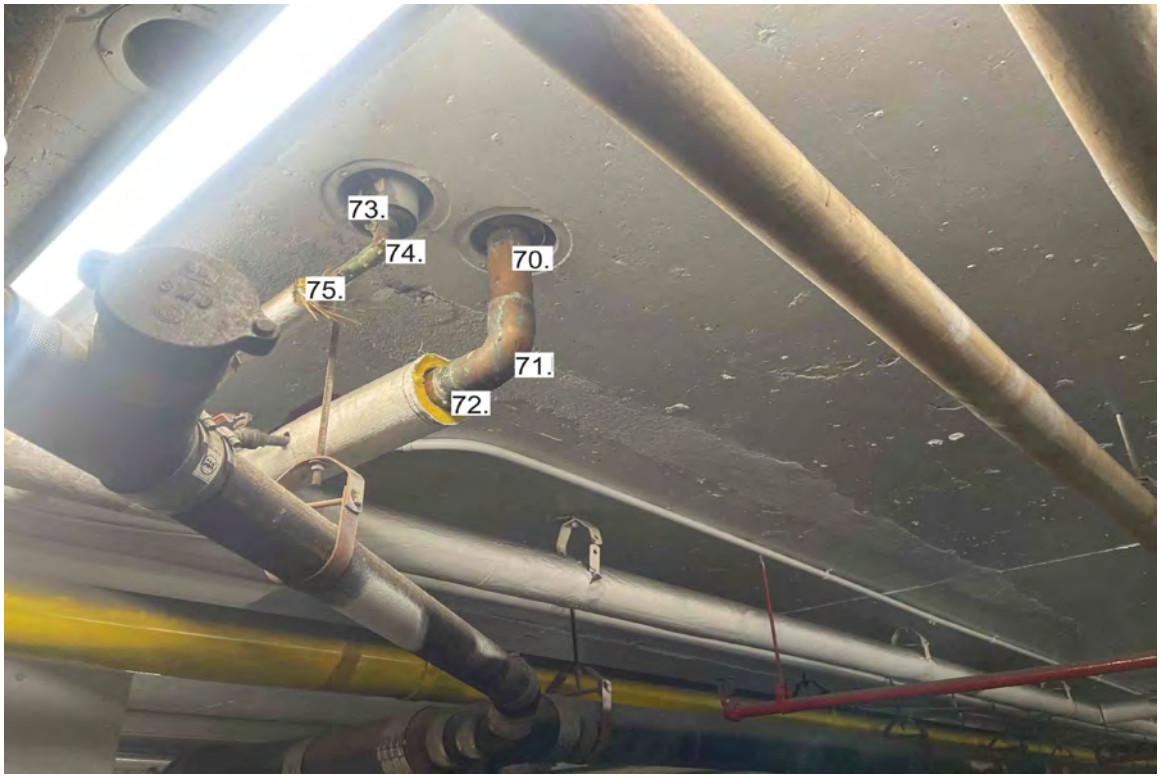
Photograph 10: Outside Generator Room.



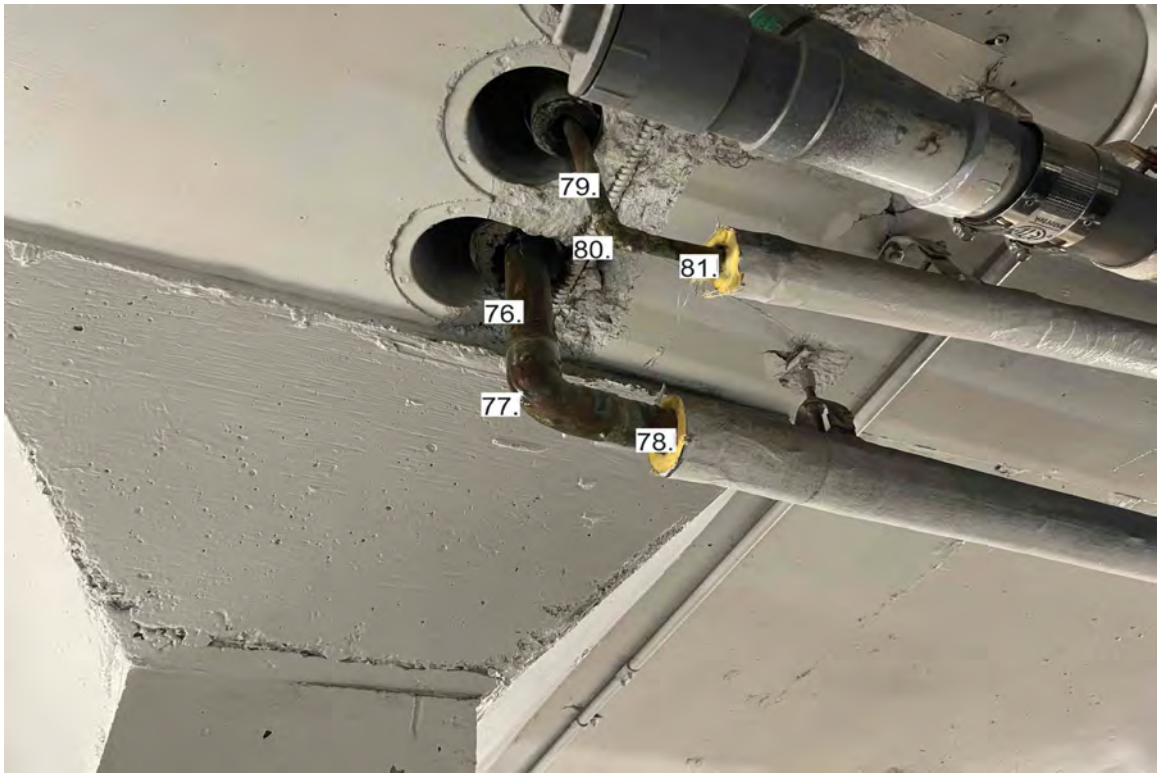
Photograph 11: By building entrance to garage.



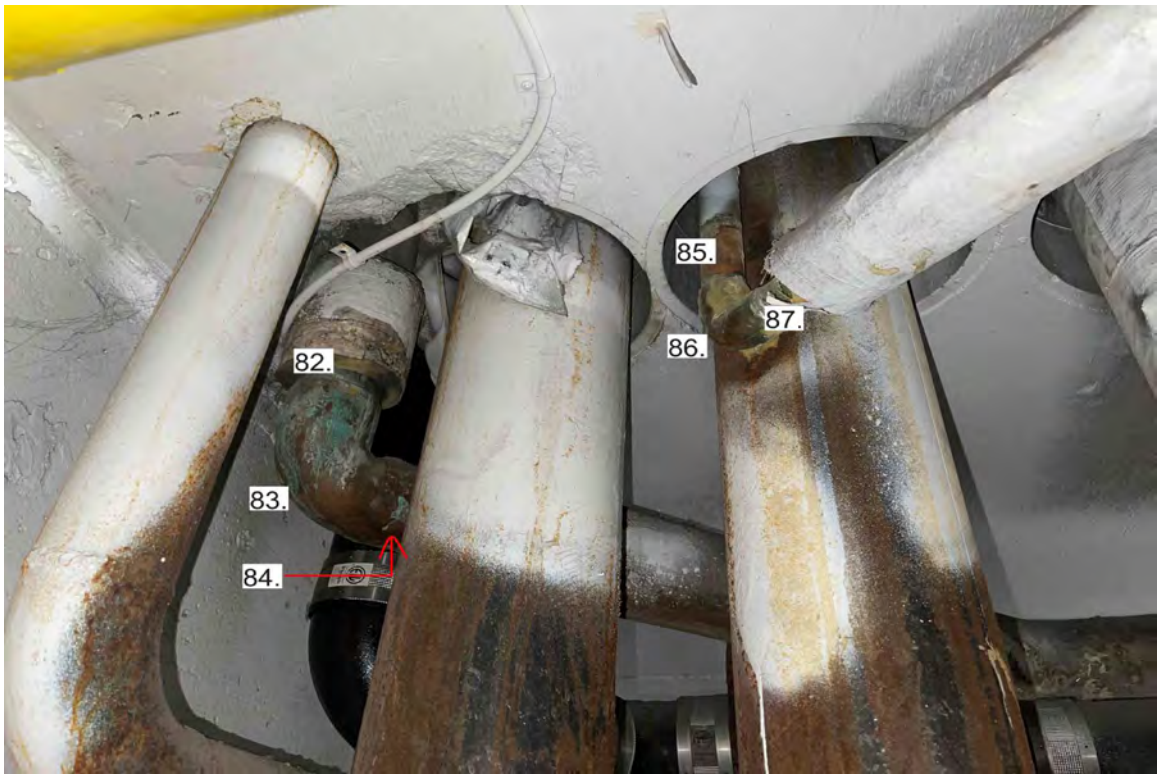
Photograph 12: Near building entrance by spot 33.



Photograph 13: By Spot #16.



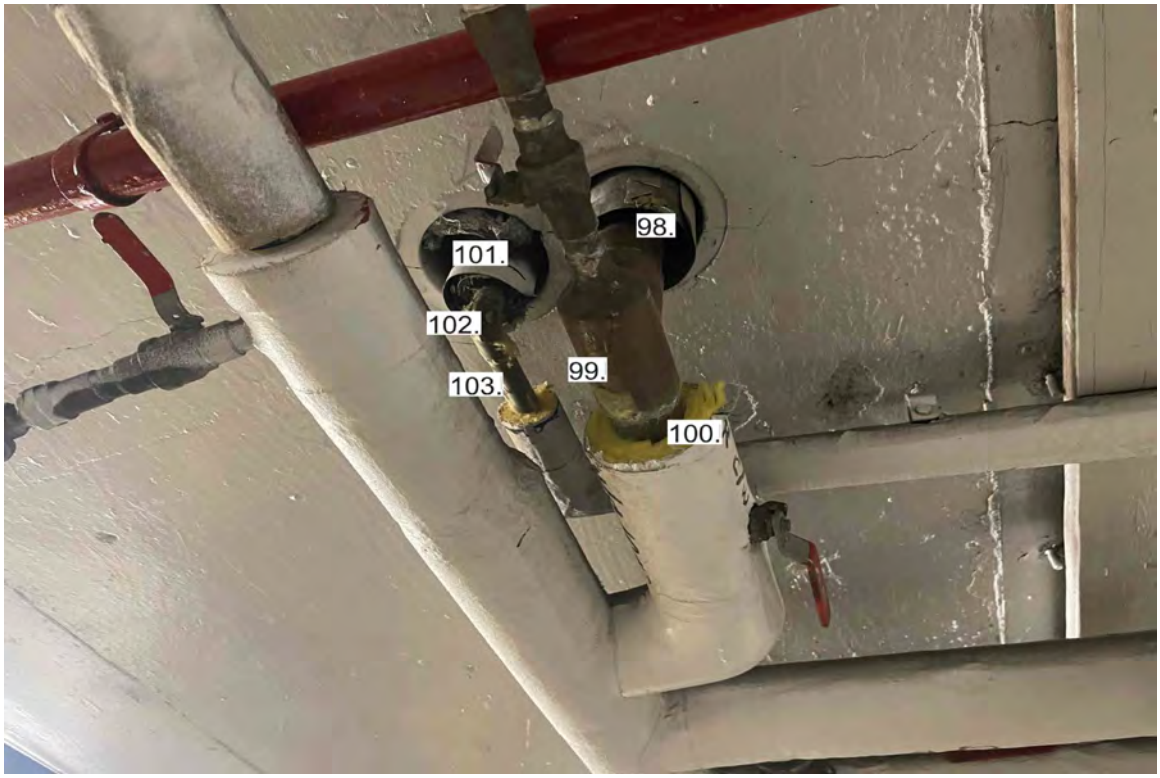
Photograph 14: Parking Garage Spot #17.



Photograph 15: Parking Garage Spot #19.

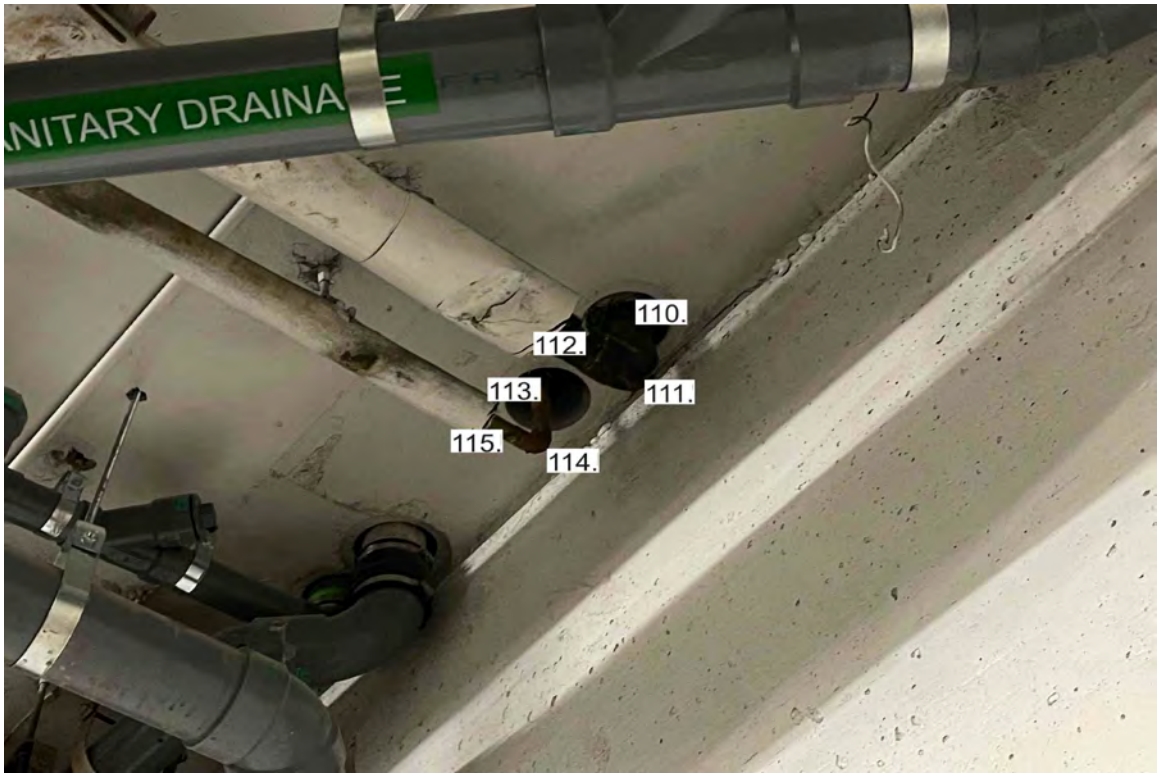
Photograph 16: Parking Garage Spot #20.

Photograph 17: Parking Garage Spot #21.

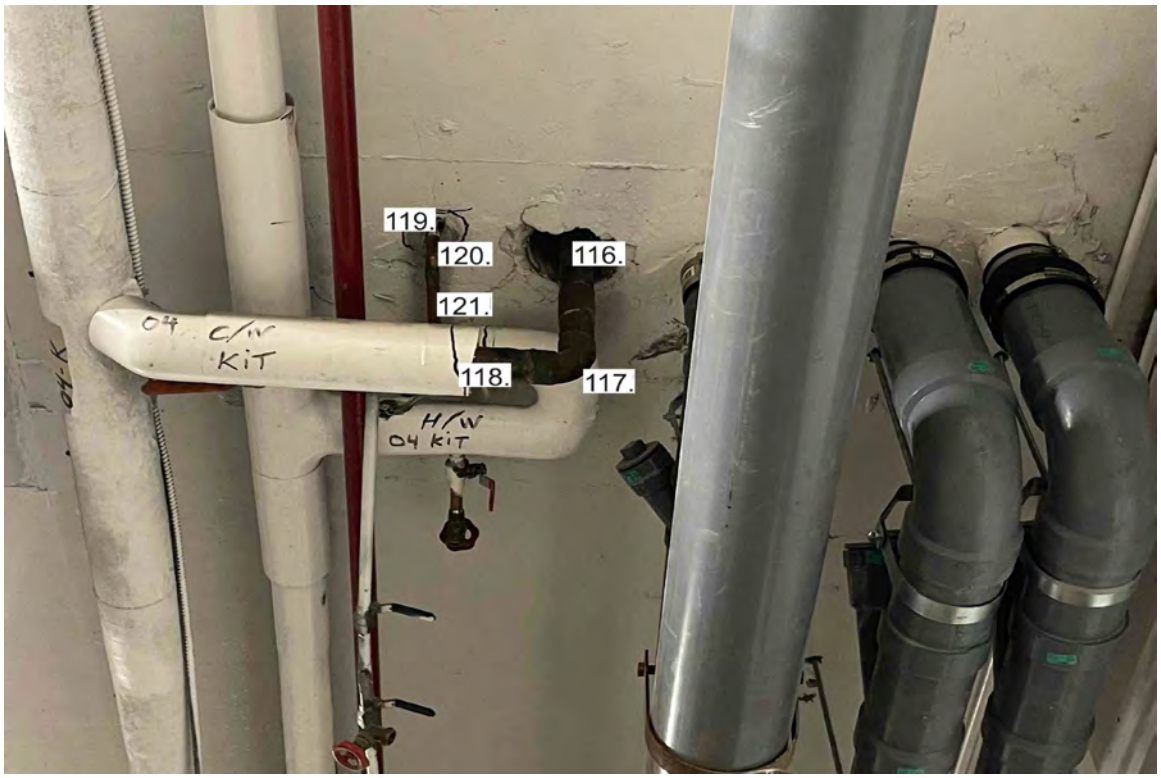


Photograph 18: Parking Garage Middle by Ramp.

Photograph 19: Parking Garage Spot #24.



Photograph 20: Parking Garage Spot #2 Level 1A.

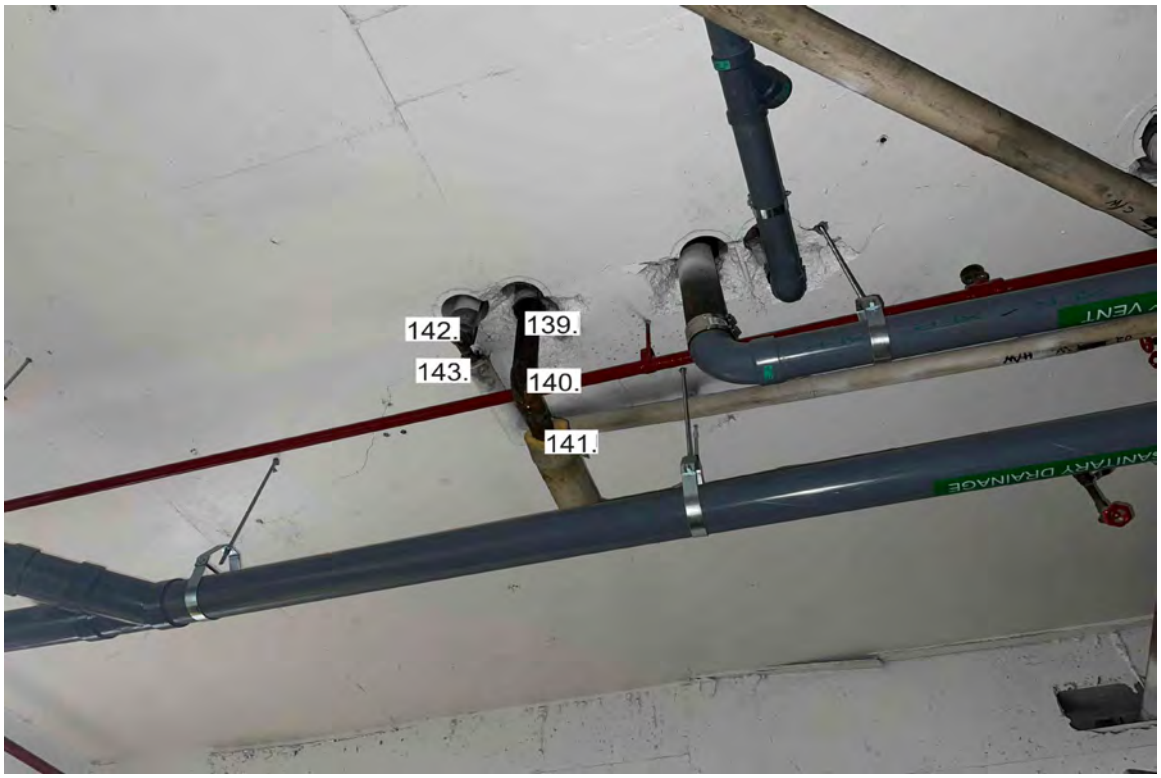


Photograph 21: Parking Garage Spot #2 Level 1A.

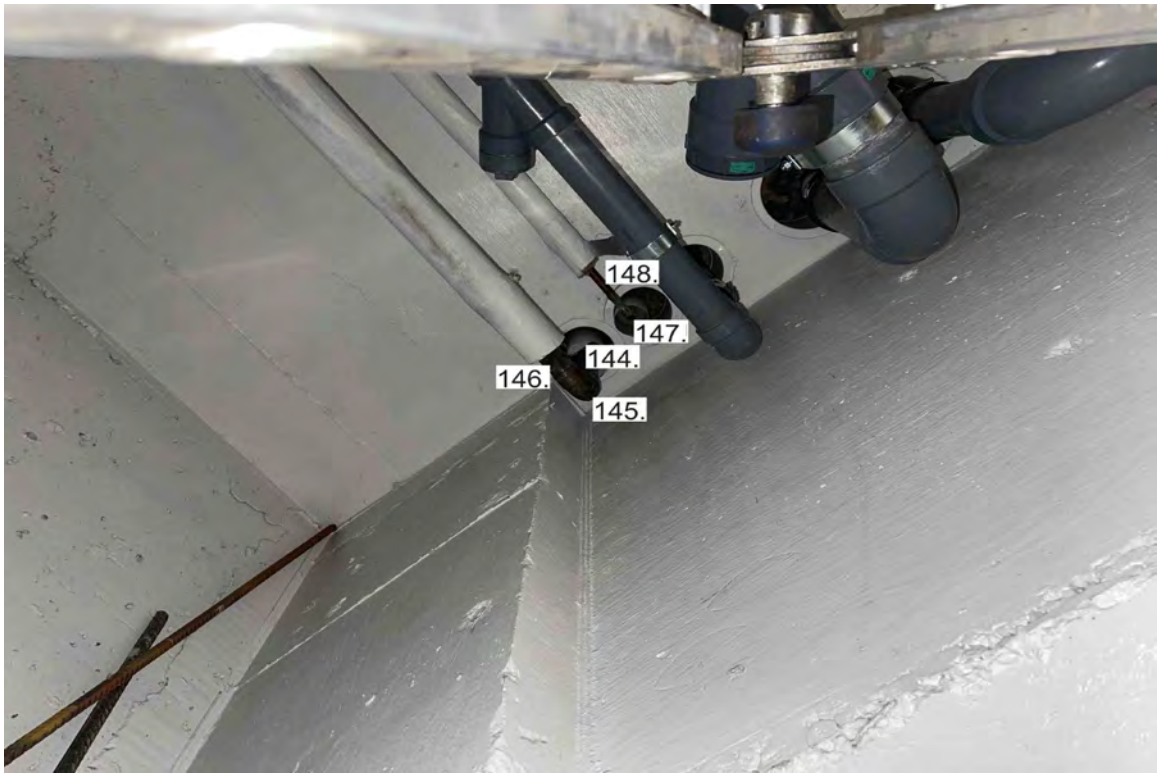
Photograph 22: Parking Garage at Wall across from spot #2 Level 1A.

Photograph 23: Parking Garage Level 1A Storage Area.

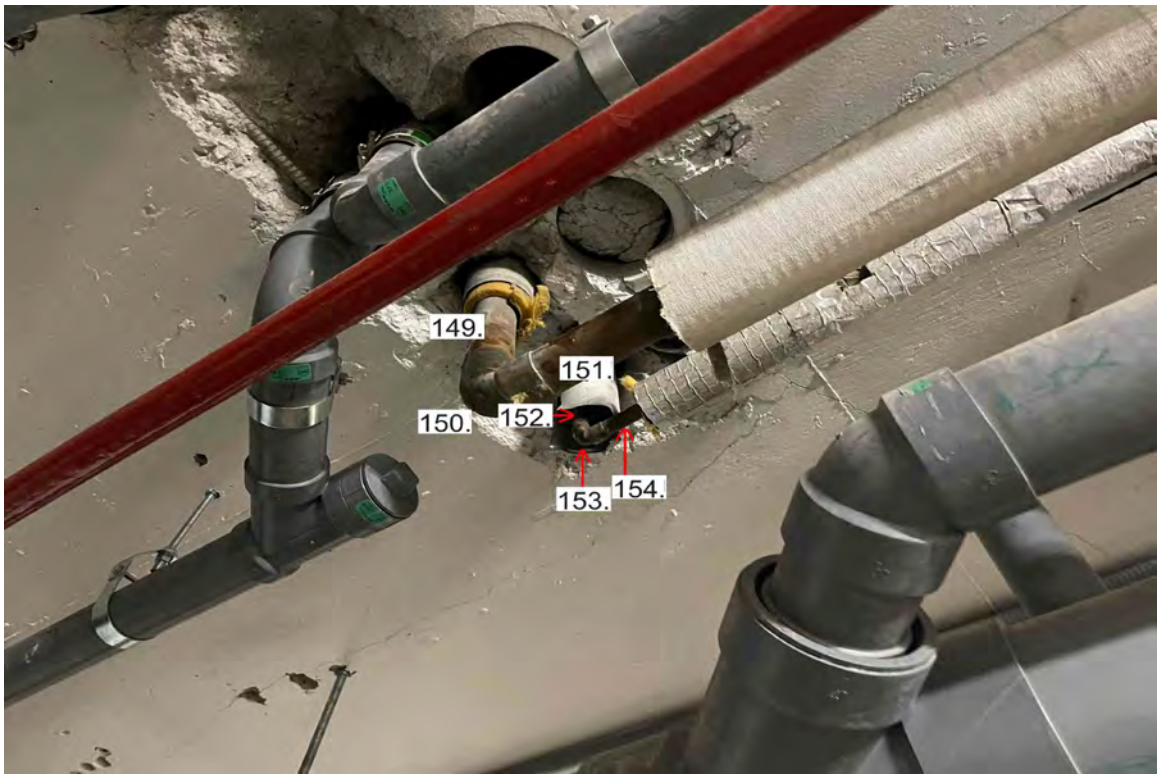
Photograph 24: Parking Garage Spot #1.



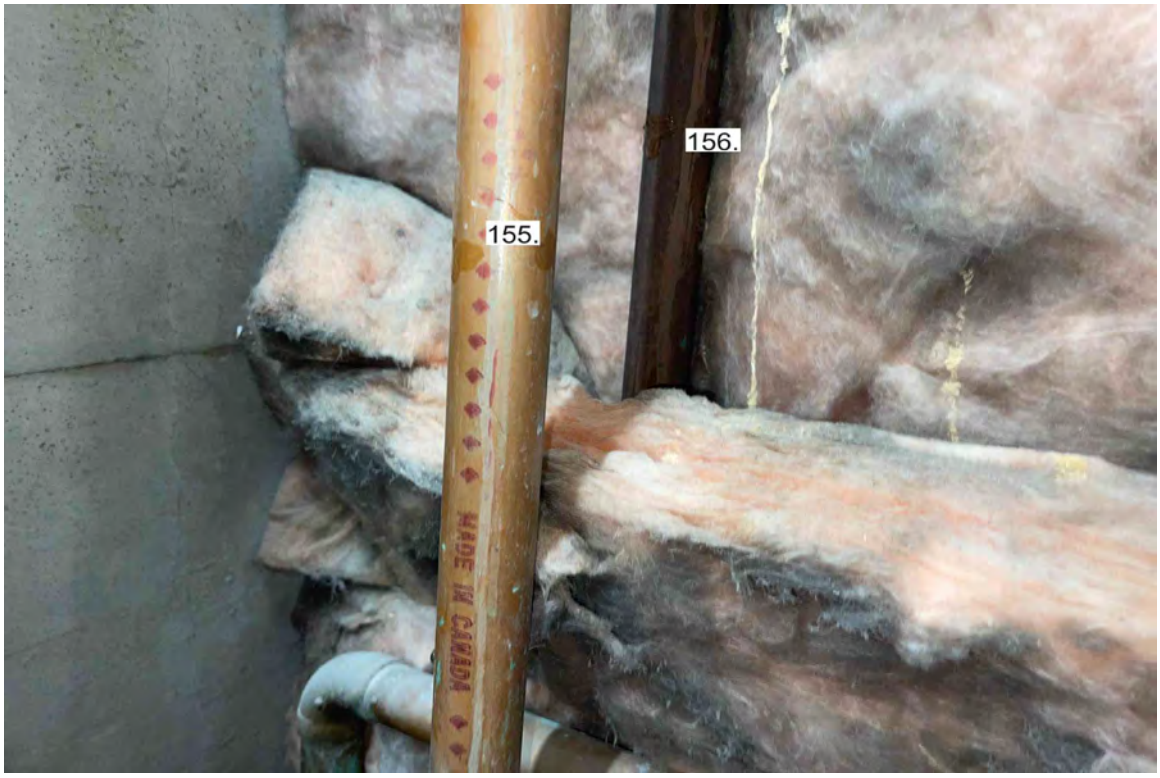
Photograph 25: Parking Garage Spot #1.



Photograph 26: Parking Garage Spot #1.

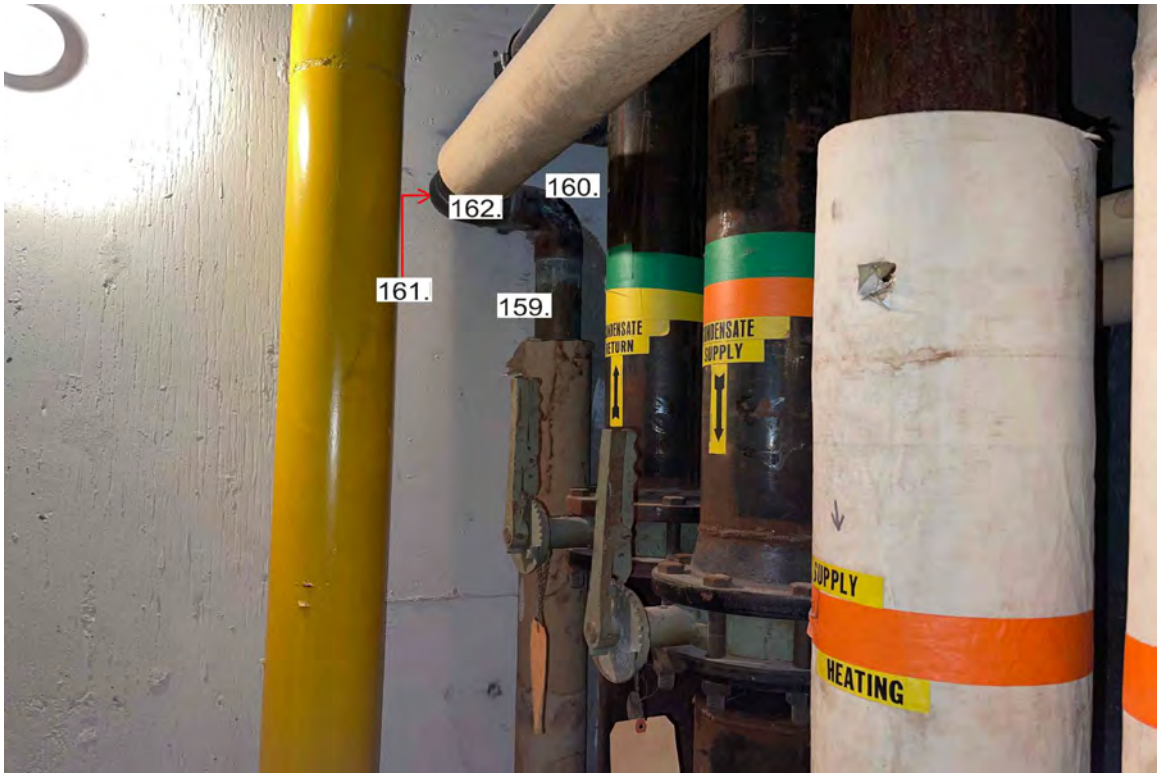


Photograph 27: Parking Garage Spot #25.



Photograph 28: Unit 403.

Photograph 29: Unit 1008.



Photograph 30: Penthouse.

Photograph 31: Penthouse.

Photograph 32: Parking Garage in front of spot #25.