REF: 2014-0580

20 April 2015

The Owners – Strata Plan 69259
2 Powell Street
WATERLOO NSW 2017

Attention: John Hutchinson

AJ Whipps Consulting Group

Where ingenuity flows

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Dear John

RE: SP69259 – 2 POWELL STREET, WATERLOO
PRELIMINARY ASSESSMENT ON HOTWATER RECIRCULATION SYSTEM

Purpose: This letter has been prepared to provide a brief assessment for review and consideration by the Owners Corporation. The objective of the letter is to:

- Record installation or performance deficiencies with the hotwater delivery system and in the event of an identified issue nominating what the impact of the issue is on the building or amenity afforded to residents in the short or long term.
- Provide the Owners Corporation with a remediation recommendation to address any identified installation or performance deficiencies with the properties hotwater delivery system.
- Identify the ability and implications associated with staging or delaying implementation of remediation works.
- Provide preliminary cost estimates for staged remediation works for the Owners Corporation to consider with respect to financial budgeting.
- Allow the Owners Corporation to provide further instruction to AJ Whipps on the staging of works for incorporation in the remedial design documentation that will be subject to a competitive tender, with tender costings then being submitted to the Owners Corporation prior to proceeding.

Background: AJ Whipps Consulting Group (AJW) is a hydraulic design firm engaged by the Owners SP69259, to assist in evaluating options available and documenting a suitable remedial methodology to minimise leaks in the hotwater delivery system.

To effectively establish the extent of remediation works required, the causes of the issues affecting the properties hotwater delivery system were identified through onsite inspections, theoretical design analysis based on plumbing industry codes and standards and material testing undertaken by ExcelPlas Polymer Analysis under the direction of AJW. The inspections and design analysis identified the following building attributes pertaining to the property and its hotwater delivery system:

- The property is a multi-residential complex with 137 units.
- The property is supplied with metered potable water from the Sydney Water Authority. The potable water supplied to the property is boosted in pressure by a variable speed pressure pump set located on ground level within a plant room. The pressurised cold water is conveyed to residential units and to the hotwater heating plant. The recorded operating pressure ranged between 560-580kPa on basement level.

- The hotwater heating plant is a centralised heating system comprising of seven individual 275 litre hotwater heaters. The hotwater heaters heat the stored hotwater to a temperature of 65° Celsius. The stored 65° Celsius hot water is then reduced in temperature to 50° Celsius in the plant room by seven individual thermostatic temperature control valves.
- 50° Celsius hotwater is conveyed from the heating plant room to residential units via primary (common service) flow pipework that is located in the basement level carpark, the basement level plant rooms and accessible hydraulic service ducts on residential levels. The common hotwater service pipework is generally constructed from Class 16 polybutylene pipe material manufactured by 'George Fischer' under the 'Instaflex' product brand. The individual unit delivery pipes (private services) between the common service and unit fixtures is constructed from polybutylene pipe material also however is manufactured by 'Dux' under the 'SecuraGold' product brand.
- The common hotwater delivery pipework is a 'dead leg' system. This means the 50° Celsius hotwater is not recirculated back to the heating plant room to boost temperature lost through radiant heat transmission. The 'dead leg' hotwater delivery systems temperature is maintained by 'Thermon' heat trace cable. The heat trace cable uses an electrical current to maintain the 50° Celsius water temperature.
- A treatment system or testing regime is not in place to prevent or monitor bacteria content in the 50° Celsius 'dead leg' water delivery pipework.
- Consistent pipe material failures have occurred over the preceding two years in the polybutylene hotwater pipework where positioned in the basement carpark only (George Fischer pipe material). The hotwater pipe material failures observed were attributable to polybutylene pipe material fatigue at points of pipe support. The pipe subject to failure is the class 16 polybutylene pipe material manufactured by 'George Fischer' under the 'Instaflex' product brand.
- Two George Fischer polybutylene pipe samples were taken from the properties common hotwater delivery system. The samples were of sections of George Fischer polybutylene pipe that had not failed previously and did not display with visual evidence of material failure or imminent material failure. One sample was taken adjacent to carspace 116 in the basement carpark, with the other sample taken from level 2 in building 2.
- The two George Fischer polybutylene pipe samples along with an evaluation brief were provided to Dr John Scheirs representing ExcelPlas Polymer Testing Services, permitting the supply of the Polymer Analysis Report dated 3 March 2015.
- The Dux polybutylene pipe material used in the private hotwater service to individual units is common within the plumbing industry and is not subject to the same material failures experienced with the George Fischer pipe. On this basis the Dux polybutylene pipe material has not been evaluated.

Installation or Performance Deficiencies Identified with the Existing Hotwater Delivery System: The onsite investigation, pipe material analysis and design verification identified installation defects and performance deficiencies with the properties hotwater delivery system. The installation issues relate to materials and the performance issues related to hotwater delivery capacity and occupant health and safety. Each identified issue is considered to either adversely affect the hotwater system with the resultant impact being premature material failure attributable to oxidative stress cracking or present as a risk to resident health and safety with water delivery temperature. The following installation defects and performance faults were identified. The defects and performance faults have been categorised based on the service location and resultant impact to the building or residents.

ITEM NUMBER	**Item 1**
Property Location:	Basement level carpark and hydraulic service ducts located on all residential levels.
Impact To The Property:	The common property hotwater delivery pipes and risers (riser is a vertical pipe serving more than one unit) are constructed from a polybutylene material. The polybutylene material has been subject to consistent pipe material failures where installed horizontally within the basement carpark. Polybutylene pipe material failures have not occurred to date in the hotwater delivery risers.

Identified Installation Defect or Performance Deficiency	Assessment of Installation Defect or Performance Deficiency	Preliminary Remedial Recommendation (for Development into a Tender Scope of Works)	Remediation Work Priority Categorisation
The polybutylene pipe material incorporated into the properties hotwater delivery system is subject to consistent material failure. The failure occurs at locations where the pipe has been supported by a fixed pipe clamp. The type of fixed pipe clamp used does not facilitate polybutylene pipe material expansion and contraction. This has resulted in distortion to the polybutylenes pipes circumferential shape ultimately causing failure.	The attribution of the oxidative stress cracking material failures are considered to be roughly 80% due to installation and 20% due to pipe material factors. Refer to the ExelPlas Polymer Analysis Report prepared by Dr John Scheirs dated 3 March 2015.	With the hotwater delivery systems existing polybutylene material reaching its material life end in approximately 3-7 years a material renewal will need to be undertaken. The material renewal will need to be undertaken on all primary flow hotwater pipework located in the basement carpark and in hydraulic service ducts on residential levels.	Work Priority Categorisation - TYPE C: Remedial works are required as part of ongoing services life cycle maintenance.

ITEM NUMBER	**Item Two**		
Property Location:	Centralised Hotwater Plant room Located on the Basement Level		
Impact To The Property:	The health and safety of residents is potentially affected due to water delivery temperature		
Identified Installation Defect or Performance Deficiency	**Assessment of Installation Defect or Performance Deficiency**	**Preliminary Remedial Recommendation (for Development into a Tender Scope of Works)**	**Remediation Work Priority Categorisation**
Hotwater is potentially being delivered to sanitary fixtures being basins, showers and baths at a temperature of 59° Celsius.	The inability to test the thermostatic temperature control valves at the valves outlet has resulted in incorrect valve commissioning with an outlet temperature of 59° Celsius instead of 50° Celsius. Water above 50° Celsius is not permitted by the governing Australian Standards at ablution fixtures to minimise the probability of scalding.	As part of the basement carpark pipe material renewal works the provision to effectively test and commission the thermostatic temperature control valves will be provided. The temperature control valves will then be serviced and commissioned ensuring an outlet temperature not exceeding 50° Celsius is achieved.	Work Priority Categorisation - TYPE D: Remedial works are required to meet Australian standards, manufacturer's requirements and or authorities' requirements.
The thermostatic temperature control valves installed to modulate hotwater delivery temperature to 50° Celsius are deficient in theoretical hydraulic capacity.	The industry design guidelines nominate a theoretical diversified hotwater usage for 137 residential units at a flow rate of approximately 10 litres per second. For the seven thermostatic temperature control valves to satisfy this water flow rate, a system pressure loss of approximately 300kPa or 30 metres head will be experienced. This pressure loss will not be simulated in the coldwater delivery system which will result in a pressure imbalance at pressure balanced sanitary fixtures. A pressure imbalance at pressure balanced fixtures such as showers will result in variation in the water delivery temperature.	As part of the basement carpark pipe material renewal works the performance capabilities of the thermostatic temperature control valves will be supplemented with the inclusion of three additional valves. The additional valves will ensure the hotwater demand imposed by residents during peak usage does not result in excessive pressure loss within the hotwater delivery system.	Work Priority Categorisation - TYPE B: Remedial works are required to satisfy dysfunctional workings of the building.

The hotwater delivery system stores water in the pipework at a temperature of 50° Celsius. The water temperature is maintained at 50° Celsius by the 'Thermon' heat trace. There was no means of bacterial treatment for the water stored in the pipework at 50° Celsius.	Hotwater stored at a temperature lower than 60° may permit the growth of legionella bacteria which can affect the health and wellbeing of residents preventing an unsafe design and installation. The Australian Standard AS/NZS3500.4 governing hotwater installations in Australia does not permit hotwater to be stored at a temperature less than 60degrees to prevent bacterial growth. This requirement to prevent bacterial growth is also endorsed under NSW health legislation.	As part of the basement carpark and hydraulic riser pipe material renewal works the designed function will be altered to a recirculating flow and return hotwater delivery system with UV sterilisation to minimise the probability of bacterial growth.	Work Priority Categorisation - TYPE A: Remedial works are required as tenants health may be immediately at risk.

Installation or Design Evaluation Notes:

1. Work Priority Categorisation: Indicates the items relevance to the established issues, the type of issue identified, and the impact to the property or person for rectification prioritisation as follows;
   TYPE A: Remedial works are required urgently as tenants health may be immediately at risk.
   TYPE B: Remedial works are required to satisfy dysfunctional workings of the building.
   TYPE C: Remedial works are required as part of ongoing services life cycle maintenance.
   TYPE D: Remedial works are required to meet current Australian Standards, manufactures requirements and or authorities' requirements.
2. The design or performance evaluation is theoretical only and is based on the recommendations or requirements as nominated within plumbing industry standards or manufacturers design manuals. Theoretical implies that the assessment is calculated based on industry accepted design standards not from onsite system flow monitoring during periods of peak usage.

Assessment: The properties hotwater delivery system has been constructed primarily from polybutylene pipe. It is my professional opinion based upon industry experience and the findings in the ExcelPlas Polymer Analysis Report that the existing George Fischer polybutylene material incorporated in the properties hotwater delivery system will need to be renewed in copper tube or stainless tube. Any alternative option other than service renewal would in my opinion be considered as a temporary measure only and would not effectively minimise future material failures. Any hotwater delivery system renewal works should be undertaken with consideration to altering the current systems designed performance to instead incorporate means to effectively control water temperature and minimise the probability of bacterial growth within the water. This would create a conventional hotwater delivery system maintaining a constant hotwater delivery temperature. It would be preferable to complete the hotwater service renewal works as one stage to minimise costs associated with job management and the inclusion of inert tube materials (stainless steel).

Additionally, the Owners Corporation may wish to undertake further investigations on the George Fischer polybutylene pipe material and obtain legal advice regarding the manufacturer's responsibility given the ExcelPlas Polymer Analysis findings indicate the attribution of the oxidative stress cracking material failures to be roughly 80% due to installation and 20% due to pipe material factors.

Best Practice Options for Remediation Works: Based on the findings contained within the ExcelPlas Polymer Analysis Report prepared by Dr John Scheirs on George Fischer polybutylene material samples from the property that were without any evident material failure it has been established that:

- The existing George Fischer polybutylene pipe material incorporated in the properties hotwater delivery system in the basement carpark and hydraulic service risers on residential levels may exceed its material life cycle in 3-5yrs and will require replacement.
- This anticipated material life cycle could only be increased by up to 50% through pipe bracket renewal.

With the hotwater delivery systems existing George Fischer polybutylene material reaching its material life end in approximately 3-7 years a material renewal will need to be undertaken. The material renewal will need to be undertaken on all primary flow hotwater pipework located in the basement carpark and in hydraulic service ducts on residential levels. The material renewal will permit the incorporation of an alternative copper product in a conventional flow and return designed hotwater recirculation system. In addition, our industry knowledge with residential buildings and the issues that can occur with all hotwater delivery systems, will permit design measures to be implemented with the objective of maximising the life cycle of the renewed material, minimising the probability of any future system failures. The methodology for the service renewal would duplicate the hotwater delivery system to permit commissioning and testing of the new pipework with minimised hotwater service interruption to residents. This methodology could be staged, with the basement carpark works completed initially and hydraulic risers on residential levels completed progressively. The objectives of the remediation works would be to:

- Remove all polybutylene pipes that are incorporated in the properties primary or secondary hotwater delivery system. The removed polybutylene pipes would be replaced with an Australian manufactured copper tube. The jointing system adopted in the new copper tube installation would be a press fit system that has a manufacturer's warranty and does not impact the copper materials durability. The existing individual unit hotwater pipe material will be retained.
- Remove all heat trace cabling and heat trace control modules that currently maintain the polybutylene materials hotwater delivery temperature at approximately 50°. The heat trace system would be replaced with hotwater recirculation return loops. The return loops in the 50° Celsius hotwater are constantly circulating permitting bacterial treatment through UV sterilisation. This will reduce the health risks associated with a hotwater delivery system having a temperature less than 60° Celsius.
- Increase the number of 50° Celsius temperature control valves in the hotwater plant room to ensure warm water demand imposed by residential unit usage does not create excessive pressure loss in the hotwater system which currently results in a pressure imbalance causing temperature fluctuation at faucets.
- Provide means in the hotwater plant room to test and commission the 50° Celsius temperature control valves to ensure that residents are not exposed to hotwater delivery at faucets at a temperature that may result in injury.
- Provide hotwater heating plant recirculation pumps that are sized appropriately to the systems performance requirements maximising output and system efficiency. This will create a consistent hotwater temperature delivery increasing the end users experience.
- Provide hotwater filtration to remove suspended solids from the new recirculating hotwater pipework to minimise pitting of the new copper tube maximising the new materials life cycle.
- Provision of additional strategically placed isolation valves to facilitate hotwater system isolation in segments minimising impact to residents during the new piping systems installation and during future maintenance.
- Provide means to facilitate material expansion in the new copper hotwater pipework to maximise the new materials life cycle.
- Provide means of pipe material support to the new copper hotwater pipework that will facilitate material expansion without creating isolated material strain to maximise the new materials life cycle.
- Provide suitable thermal treatment to all hotwater reticulation pipework to minimise heat loss and create a stable recirculation temperature to minimise thermal induced pipe material expansion and delivery temperature variation at faucets. This will create a consistent hotwater temperature delivery increasing the end users experience.
- Facilitate a staged implementation of the remediation works.

Preliminary Budget Estimate for Remediation Options: Based on industry experience, we have calculated estimated costs for a licensed plumbing contractor to carry out the remedial works outlined above. We note that the estimates do not include common ancillary costs associated with the preparation of tender documentation and project management fees to supervise contractors onsite. These costs will vary depending on the extent of the scope once finalised in the tender documentation.

Remediation Works Proposed	Estimated Remediation Costs
The following plant room and basement carpark works (referenced as **Stage 1** works below) will involve and have allowance for the following in brief: ▪ Replacement of all polybutylene hotwater delivery pipework in the hotwater plant room and basement carpark. ▪ Installation of a recirculating hotwater delivery system instead of the current 'dead leg' delivery system to minimise variation in water delivery temperature. ▪ Plant upgrades addressing under sized warm water thermostatic mixing valves to optimise system performance and facilitate thermostatic mixing valve testing. ▪ Plant upgrades to accommodate a warm water recirculation system with bacterial treatment to prevent legionella. ▪ Isolation valve installation to permit isolation of individual risers and to facilitate a staged installation methodology with minimised impact to residents. ▪ Hotwater filtration to maximise the life cycle of new hotwater pipe materials. ▪ Balancing of new hotwater recirculation pipework to minimise temperature variation and maximise new pipe material life cycle. ▪ Installation of thermal lagging to minimise heat loss. ▪ Installation of expansion provision and pipe support systems to control the effects of thermal induced material expansion to maximise pipe material life cycle.	$95,000 - $105,000 + GST
The following Hydraulic Service Duct Works (referenced as **Stage 2** works below) will involve and have allowance for the following in brief: ▪ Replacement of all polybutylene primary (common) hotwater delivery pipework in the accessible hydraulic service ducts in each building on each respective level. ▪ Installation of a recirculating hotwater delivery system instead of the current 'dead leg' delivery system to minimise variation in water delivery temperature. ▪ Renewal of hotwater metering manifolds and installation of new individual isolation valves to facilitate a staged installation methodology with minimised impact to residents. ▪ Installation of thermal lagging to minimise heat loss. ▪ Installation of expansion provision and pipe support systems to control the effects of thermal induced material expansion to maximise pipe material life cycle.	$115,000 - $130,000 + GST
Temporary works involving the replacement of all existing hotwater pipe brackets with an alternative pipe bracketing system to minimise the progression of polybutylene material oxidative degradation. The temporary works would intend to increase the polybutylene materials life cycle by up to 50% based on findings detailed in the ExcelPlas Polymer Analysis Report prepared by Dr John Scheirs. These temporary works may afford the existing polybutylene material a life cycle ranging between approximately 4 years and 7 years. The bracket works are required on both the risers and the basement pipe as material deterioration is present in both locations although complete failure has only been experienced in the carpark.	$8,500 - $9,500 + GST

Budget Estimate Limitations:

1. The hydraulic service duct works do not make allowance to replace existing individual unit hot supply pipework or individual unit pipework where located other than in the accessible common property service ducts as this would constitute a 'complete' service renewal.
2. We have not included costs to upgrade the existing hotwater heaters or storage cylinders unless noted specifically.
3. Our cost assessment is preliminary in nature as it is based on the remediation works that have yet to be finalised in full. We advise that further investigation and design works will be undertaken prior to finalisation of an accurate estimate.

Owners Corporation Input: AJ Whipps has established the presence of installation, performance and material life cycle issues in the hotwater plant room, the basement carpark and within common service hydraulic ducts on each respective level. To afford the property reliability with the hotwater delivery system and minimise ongoing maintenance costs the existing George Fischer polybutylene hotwater pipe material needs to be replaced. AJ Whipps requires verification from the Owners Corporation on how they

would prefer the proposed remediation and upgrade works to be undertaken. The works can either be completed as a whole or staged. If the works were staged, the plant room and basement carpark works would be undertaken initially as stage one with the service duct works following as stage two. All works proposed are recommended for implementation within a 3 year period based on the findings contained within the ExcelPlas Polymer Analysis Report prepared by Dr John Scheirs. The Owners Corporation must be aware that in the event the works proposed are staged then the total remediation costs will be increased and the performance of the hotwater system will be impacted with an estimated hotwater delivery delay of 5 minutes at the most disadvantaged hotwater fixture, when both stages one & two are completed the hotwater delivery delay to the most disadvantaged fixture will be approximately 45 seconds (being the same or better than what is currently experienced). In the event the Owners Corporation intend on delaying implementation of the works for a period greater than three years then temporary works in the form of existing pipe bracket replacement will need to be undertaken as a matter of urgency.

Further Actions Required: AJ Whipps has established the hotwater systems configuration with respect to piping layout and the extent of any major deficiencies that impact on hotwater delivery performance or material life cycles. These deficiencies will need to be addressed through onsite upgrade works to the existing hotwater heating plant and the installation of a new recirculating hotwater piping network. The deficiencies need to be addressed to maximise performance and provide reliability currently not afforded with the hotwater piping system due to the existing George Fischer polybutylene material reaching its material life end in approximately 3-7 years. To facilitate the implementation of remediation or upgrade works, remediation documentation will now need to be compiled by AJ Whipps so that the work objectives and requirements are clearly defined in a manner that will permit a competitive tender. To undertake the remediation design documentation and manage the tender process, AJ Whipps will require instruction from the Owners Corporation to complete any outstanding investigations and proceed with compilation of the tender documentation as nominated within the current fee agreement dated 13 November 2014. Once instruction to proceed has been provided by the Owners Corporation to AJ Whipps via email, the scheduling or works would require 3 weeks to complete the tender documentation and 3 weeks to complete the tender process. We will be awaiting the Owners approval in moving forward with the onsite investigation and preparation of remediation tender documentation. If there are any questions or concerns please do not hesitate to contact the undersigned.

Yours faithfully
AJ Whipps Consulting Group

Haimish McGill
Senior Associate