Report of the Task Force on Investigation of Excessive Lead Content in Drinking Water

October 2015

Contents

Chapter 1 Introduction

1.1 Due to the lead contents in some drinking water samples taken at Kai Ching Estate (KCE) exceeding the Provisional Guideline Value (PGV) of 10µg/L [1] specified in the "Guidelines for Drinking-water Quality, Fourth Edition" published by the World Health Organization (WHO) in 2011, the inter-departmental meeting chaired by the Chief Secretary for Administration decided on 13 July 2015 to set up a task force to investigate the cause and make recommendations for prevention of similar incidents in future. On 14 July 2015, some drinking water samples taken at Kwai Luen Estate Phase 2 (KLE2) were also found to have lead contents exceeding WHO PGV[2]. In addition, a tenant living in Mun Ching House of KCE was confirmed to have contracted Legionnaires' Disease (LD) on 28 May 2015.

1.2 The Secretary for Development appointed the Chairman and Members of the Task Force on Investigation of Excessive Lead Content in Drinking Water (the Task Force) as follows:

Chairman:	Mr WONG Chung Leung, Deputy Director of Water Supplies
Members:	Dr CHAN Hon Fai, Chairman of Advisory Committee on Water Resources and Quality of Water Supplies
	Dr George GREENE, former Associate Professor, Service Behaviour of Materials, Department of Mechanical Engineering, University of Hong Kong and Consultant to Various Industries
	Prof SHING Kung Ming Tony, Professor, Department of Chemistry, Chinese University of Hong Kong

1 For KCE, a total of 115 water samples taken from 3 July 2015 to 10 July 2015 in four batches were tested, seven water samples did not meet WHO PGV, with readings at 11.1, 14.0, 17.0, 23.0, 10.8, 11.6 and 35.1µg/L respectively.

2 For KLE2, 44 water samples taken on 13 July 2015 were tested, five water samples were found with lead content levels of 10.4, 10.5, 16.8, 19.4 and 23.3µg/L respectively.

Mr CHAN Kin Man, Chief Waterworks Chemist of Water Supplies Department

Mr WONG Mung Wan, Chief Architect of Housing Department

Dr LEE Wai On, Chief Chemist of Government Laboratory

Dr NG Kwok Po Eddy, Principal Medical and Health Officer of Department of Health

Mr LAI Hon Chung Harry, Assistant Director of Electrical and Mechanical Services

Mr KOON Chi Ming, Assistant Director of Buildings

Secretary: Mr LEUNG Chung Lap Michael, Assistant Director of Water Supplies

1.3 The Terms of Reference of the Task Force were as follows:

(a) To carry out investigation to ascertain the causes of the recent incidents leading to presence of lead in water drawn by households;

(b) To recommend measures to prevent recurrence of similar incidents in future; and

(c) To follow up on a recent case of Legionnaires' Disease found at Kai Ching Estate.

1.4 The Task Force held a total of seven meetings. Main deliberations in each meeting were summarised as follows:

(a) At the first meeting held on 17 July 2015, the Task Force decided to dismantle components of pipes and fittings along three water supply chains each serving an individual flat in Hong Ching House and Yuet Ching House of KCE and Luen Yat House of KLE2 respectively for testing.

(b) At the second meeting held on 23 July 2015, the Task Force reviewed the sampling plan of the components dismantled from the three water supply chains in KCE and KLE2 and decided to conduct leaching test for the components in relation to lead and perform stagnation and flushing test in some vacant flats in KCE and KLE2.

(c) At the third meeting held on 3 August 2015, the Task Force decided to test for the contents of cadmium, chromium and nickel in addition to lead in the water samples of the leaching test for the components dismantled from the three water supply chains in KCE and KLE2. Results of the stagnation and flushing tests were also reviewed. Mechanism of lead contamination in the plumbing systems was discussed. Subsequent to the third meeting and through circulation of emails, the Task Force agreed for control purpose, to test components of pipes and fittings of the water supply chain in Hung Hei House of Hung Fuk Estate (HFE) with lead contents in its drinking water samples well below WHO PGV of 10μg/L.

(d) At the fourth meeting held on 13 August 2015, the Task Force reviewed the leaching test results and decided to perform another round of leaching test after cleansing the deposits inside the components. The Task Force also noted that there was high leaching of nickel in some taps. It was also agreed to carry out elemental analysis of some of the components to determine their lead contents. Progress of the disinfection work in Mun Ching House in which a tenant had contracted LD was reported by the secretariat at the meeting. The disinfection work was overseen by the Inter-departmental Working Group on Disinfection of Water Supply Pipework with Legionnaires' Disease (Working Group) formed by the Housing Department (HD)

(e) At the fifth meeting held on 26 August 2015, the Task Force reviewed the latest findings in the various tests and analysis. Isotopic analysis and mathematical modeling for investigating the cause of excess lead in drinking water in KCE and KLE2 were discussed. Progress of the disinfection work in Mun Ching House was reported by the secretariat at the meeting.

(f) At the sixth meeting held on 10 September 2015, the Task Force reviewed the findings of the investigation of the cause of excess lead in drinking water and discussed the recommendations of the Task Force to prevent recurrence of similar incidents in future.

(g) At the seventh meeting held on 23 September 2015, the Task Force confirmed the preliminary findings of the investigation of the cause of excess lead in drinking water, the recommendations to prevent recurrence of similar incidents in future and the points for the public to note for presentation at the press conference.

1.5 The Task Force also conducted site visits to KCE and KLE2 on 21 July 2015 and 5 August 2015 to inspect the inside service of the two estates and the locations for sampling components of pipes and fittings. Besides, the Task Force visited the laboratory at Ngau Tam Mei Water Treatment Works on 8 August 2015 where the leaching tests were conducted.

1.6 The Task Force presented the preliminary findings at a press conference held on 25 September 2015.

1.7 In this Report, the investigation conducted by the Task Force will be presented in Chapter 2 and the identified cause of excess lead in drinking water as well as other findings revealed during the course of investigation will be presented in Chapter 3. The control mechanism on construction of inside service by the Water Authority (WA) and the Housing Authority (HA) will be examined in Chapter 4 together with a review of the local and overseas practices in plumbing works. The recommendations of the Task Force to prevent recurrence of similar incidents in future will be presented in Chapter 5. The Task Force will also report on the case of LD in Mun Ching House of KCE in Chapter 6. In closing, the Task Force presents some points to note for the attention of the public on the subject of lead in drinking water in Chapter 7.

Chapter 2 Investigation

In this Chapter, a detailed account is given on the investigation conducted by the Task Force on the cause of excess lead in drinking water in KCE and KLE2.

2.1 Typical inside service of a housing development

2.1.1 The Water Supplies Department (WSD) provides water supply to the consumers via the government water mains. The government water mains up to the connection point[3] at the lot boundary of a housing development are maintained by WSD. The communal service including the service pipes and fittings from the lot boundary to the individual buildings in the development as well as those pipes and fittings inside the buildings generally up to the individual water meters is maintained by the agent (usually the property management agent or the owners' committee). The pipes and fittings from the water meters up to the taps of individual flats are maintained by the property owners. The communal service and the pipes and fittings inside individual flats are collectively referred to as inside service under the Waterworks Ordinance (WWO) (Cap. 102). **Figure 2.1** illustrates the demarcation of maintenance responsibility of the government waterworks and inside service.

[3] The connection point is the point between the government water mains and inside service.

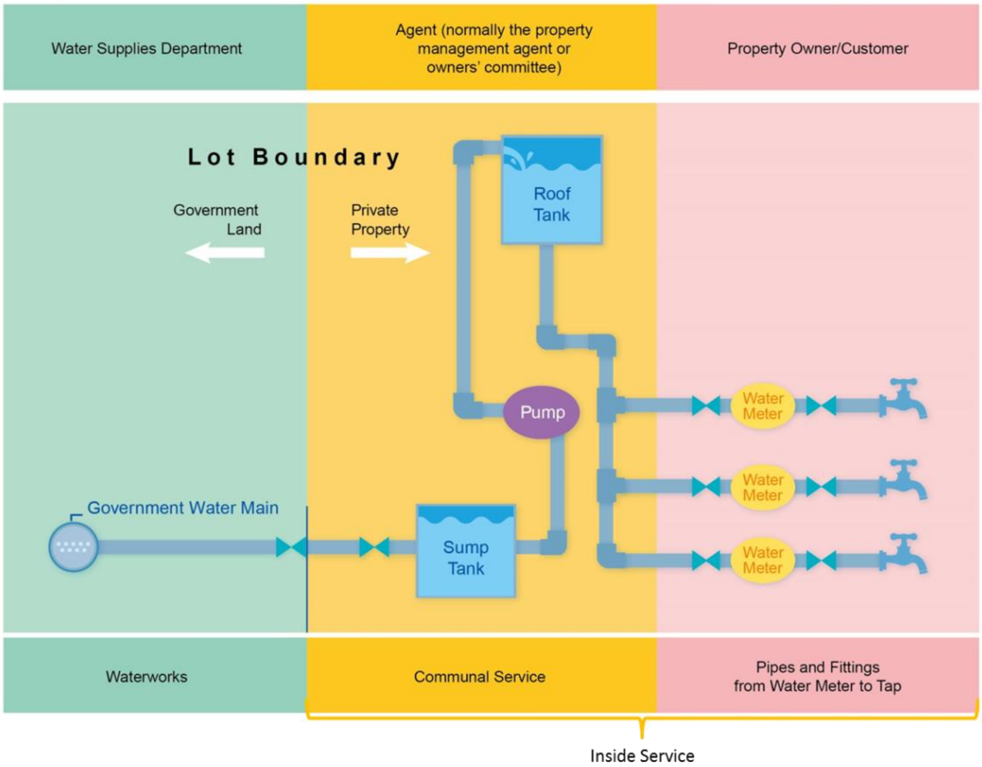


Figure 2.1 Demarcation of maintenance responsibility of government waterworks and inside service

2.1.2 A typical inside service in a housing development is shown in the schematic diagram in **Figure 2.2**. Water entering into the development is first delivered into the sump tank, where it is pumped to the roof tank for temporary storage. Water will then be conveyed to each floor via the down pipes and distributed to individual flats via branch pipes on each floor.

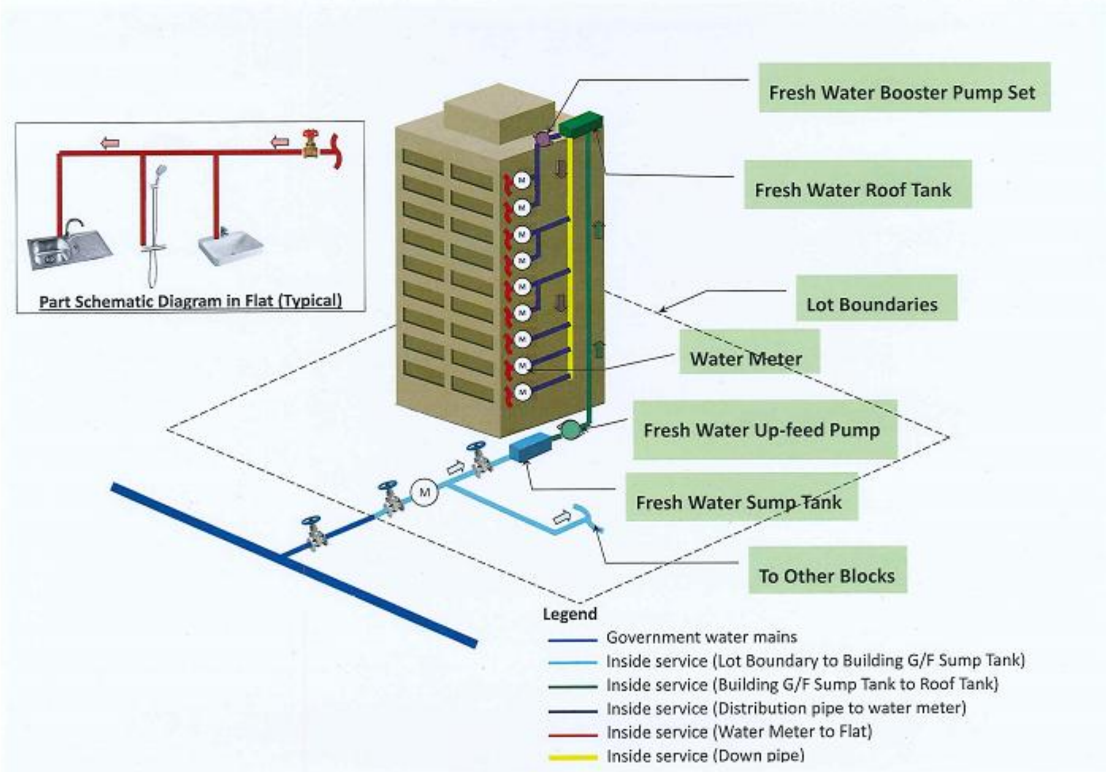


Figure 2.2 Schematic diagram of a typical inside service

2.2 Component sampling plan

2.2.1 For the investigation of the cause of excess lead in drinking water, components of pipes and fittings were dismantled for testing from three water supply chains each of which served an individual flat in Hong Ching House and Yuet Ching House of KCE and Luen Yat House of KLE2 respectively. Five categories of components, namely pipes, valves, water meters, taps and elbows and sockets with joints (hereinafter refer to as joints) were dismantled from the water supply chains.

2.2.2 The water samples taken from the sump tanks and roof tanks in the above three housing blocks had undetectable lead contents as shown from the test results in **Annex 2.1**. Therefore, the presence of lead in the drinking water samples taken from these housing blocks must have come from the inside service after the roof tanks. As such, only components of pipes and fittings along the down pipes (yellow pipeline in **Figure 2.2**) and branch pipes (purple and red pipelines in **Figure 2.2**) downstream of the roof tanks were dismantled for testing.

2.2.3 The numbers of components of pipes and fittings dismantled from the three water supply chains in KCE and KLE2 are shown below:

Estate	House	Copper pipes	Valves	Water meters	Taps	Joints	Total
KCE	Hong Ching	15	8	1	4	17	**45**
KCE	Yuet Ching	13	8	1	4	13	**39**
KLE2	Luen Yat	16	12	1	4	17	**50**
	Total	**44**	**28**	**3**	**12**	**47**	**134**

2.2.4 During investigation, the Task Force considered that it was necessary to test components of pipes and fittings from a water supply chain with undetectable lead contents in its drinking water for control purpose. Components were therefore dismantled for testing from a water supply chain in Hung Hei House of HFE with lead contents in its drinking water samples well below WHO PGV of 10μg/L[4].

2.2.5 The numbers of components of pipes and fittings dismantled from the control supply chain in HFE are shown below:

Estate	House	Copper pipes	Valves	Water meters	Taps	Joints	Total
HFE	Hung Hei	3	11	1	4	3	**22**

2.2.6 Lists of components of pipes and fittings dismantled from KCE, KLE2 and HFE are at **Annexes 2.2(a)-(d)** respectively.

2.3 Protocol for component sampling

2.3.1 To ensure that the components of pipes and fitting would not be disturbed during dismantling and delivery, the protocol listed below and shown in **Figure 2.3** was followed:

(a) Dismantling of components was carried out by workers of the contractors of HD. The whole process was supervised by professional engineers and chemists of WSD, witnessed by Clerks of Works from HD. The whole process was photographed and videoed.

[4] According to the results of the water sample testing programme conducted by HD in conjunction with WSD, 150 water samples taken from HFE on 18 and 19 July 2015 were tested and all were well below WHO PGV for lead.

(b) Before commencement of dismantling work each day, the professional engineers/chemists of WSD would brief the workers regarding the precautionary measures to be taken in dismantling the components. Workers were reminded to completely clean the cutting equipment before dismantling of each component and not to disturb or tamper with the component during the process.

(c) Before dismantling of each component, the direction of water flow was marked on its body.

(d) Components dismantled were properly wrapped by cling wrap and stored inside airtight plastic bags.

(e) Identification label was attached to each of the components. Information on the label included:
   (i) Date of Sampling
   (ii) Sampling Location
   (iii) Sample Description

(f) The dismantled components were stored in a cold box and delivered to WSD laboratory at Ngau Tam Mei Water Treatment Works for testing.

(g) Personnel involved in handling the dismantled components were required to complete and sign a chain-of-custody form for traceability of the current locations of the components.

1. Briefing to worker

2. Cleaning of cutting equipment

3. Marking direction of flow on pipe body before dismantling

4. Sample wrapping

5. Sample labelling

6. Sample storage in cold box

Figure 2.3 Protocol for component sampling

2.4 Leaching test

2.4.1 The leaching test was conducted for all the components of pipes and fittings dismantled from the three water supply chains in KCE and KLE2. The purpose of the leaching test was to investigate which component(s) leached and if so determine the leaching amounts of the four heavy metals, namely lead, chromium, cadmium and nickel during the 24-hour test.

Sampling and testing procedures

2.4.2 Each component, without any treatment or cleansing, was sealed off at one end and placed in an upright position. It was filled up with water. The other end of the component was then sealed off and the component was allowed to stand for 24 hours before the water was taken out for testing.

2.4.3 Water sample was drawn from the centre of the component by a pipette. Scrupulous care had been taken not to draw/disturb the deposits near the component's surface. The water sample was collected in a 250ml acid pretreated polyethylene sampling bottle and preserved by acidifying with high-purity concentrated nitric acid to pH less than two before delivering to the laboratory for testing of the four metals by the Inductively Coupled Plasma-Mass Spectrometer (ICP-MS)[5].

2.4.4 The testing by ICP-MS was based on the United States Environmental Protection Agency Method 200.8. Each water sample was analysed by five measurements in accordance with the instrument setting. Each measurement was performed by repeating the signal measuring procedures for three times. The result of the respective metal content was calculated by taking the average of the five measurements.

2.4.5 The following quality control and calibration samples were included in each batch of 20 water samples or less:

- Method blank
- Spiked blank
- Spiked blank duplicate
- Spiked matrix
- Spiked matrix duplicate
- Certified Reference Material (TM-28.4, Environment Canada)
- Calibration samples

2.4.6 The acceptance criterion for correlation coefficient of the calibration curve was 0.998 or greater. In view of the implementation of a stringent and comprehensive quality control system, each water sample was only subject to one ICP-MS testing. In fact, each water sample had been tested for 15 times (five replicates x three repeated counts).

2.4.7 The estimated measurement uncertainties (MU) of the testing results for lead, chromium, cadmium and nickel were ±7%, ±7%, ±8% and ±8% respectively at 95% confidence level. For example, if the test result of lead content in a water sample was 0.1mg/L, the result would be within the range of 0.1 ± 0.07mg/L after taking into consideration of MU of the test.

[5] ICP-MS is an advanced analytical technique used for the trace level detection of metals and several non-metals. A sample for ICP-MS test is first digested with acid and vaporised/ionised by the inductively coupled plasma. The ions will then be separated by mass spectrometer according to the mass-to-charge ratio. The signal is measured by an electron-multiplier and the concentration of metal is determined by a calibration curve of signal against concentration.

2.4.8 For simulating the actual conditions on site, the water used for the leaching test was taken from the roof tank of the housing block where the component was dismantled. **Figure 2.4** illustrates the procedures of the leaching test.

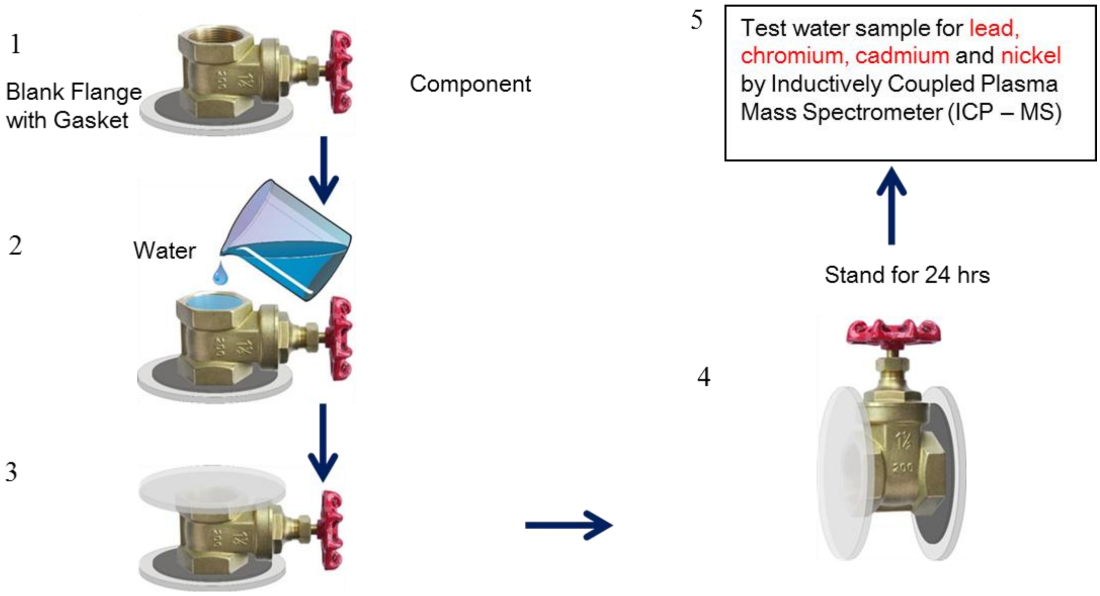


Figure 2.4 Procedures of the leaching test

2.5 Analysis of the leaching test results of the water supply chain in Hong Ching House of KCE

Leaching test results

2.5.1 The lead leaching test results of the components dismantled from the water supply chain in Hong Ching House of KCE are tabulated in **Annex 2.3(a)** and summarised in the table below:

Hong Ching House of KCE	Copper pipes		Valves		Water meters	Taps	Joints[6]	
Total number of components installed in the water supply chain	Numerous		8		1	4	194	
Lead leached (µg) in 24 hours	>76.1 mm	0	Cast iron	0 - 4.5	3.7	0–13.7	>76.1 mm	0
	≤76.1 mm	0 - 16	Copper alloy	10.1 – 43.9			≤76.1 mm	0 - 639.8

2.5.2 The test results showed that no lead leached from copper pipes and joints with diameters greater than 76.1mm (i.e. basically the down pipe from roof tank to the floor of the flat which the water supply chain served). The minimal lead leaching (4.5µg in mass or 1.6µg/L) from the 100mm diameter cast iron valve should be caused by deposits formed from lead ions leached from the copper alloy parts of the adjacent pressure reducing valve (see Section 2.8 below) as cast iron normally would not contain lead. However, the leaching test results showed that lead leached from copper pipes and solder joints with diameters smaller than 76.1mm[7] (i.e. basically the branch pipe along the floor of the flat and within the flat) as well as copper alloy fittings. In light of the above, the Task Force excluded cast iron valves and pipe joints with diameters greater than 76.1mm (which should use silver brazing containing no lead according to HD's specifications) in the subsequent investigation.

2.5.3 On examination, deposits of various amounts were found inside the components of pipes and fittings in the branch pipes as shown in the photos in **Figure 2.5**. It was believed that there were lead containing compounds which might release lead into the drinking water.

[6] According to the specifications of HD, soldering could only be used for copper pipe joints less than or equal to 76.1mm diameter. For copper pipe joints greater than 76.1mm diameter, silver brazing, which would not contain lead, should be used.

[7] There was no lead leached from copper pipes and joints with diameter equal to 76.1 mm.

Figure 2.5 Deposits in copper alloy valve and copper pipe elbows

Leaching test results after cleansing deposits and elemental analysis

2.5.4 In order to determine whether lead leaching was originated from the components themselves or from the foreign deposits, the Task Force cleansed the deposits in some of the components and conducted another round of leaching test. The cleansing procedures are shown below:

(a) A new soft bristle of adequate size was used to brush off as far as possible the deposits inside the components.
(b) A small amount of water of less than 250ml was used to wash out the deposits. The washed-out mixture was collected in a 250ml acid pretreated polyethylene sampling bottle. The volume of the washed-out collected was recorded.
(c) The component was thoroughly flushed with tap water before carrying out the leaching test.

2.5.5 It should be noted that the cleansing could not completely remove all the deposits inside the components. A comparison of the results of leaching test of the components before and after cleansing deposits is shown below:

Hong Ching House of KCE		Copper pipes	Copper alloy valves	Water meters	Taps	Solder Joints[6]
Lead leached in 24 hours (μg)	Before cleansing	1.7-5.5	10.1-14.9	3.7	0-13.7	0.8-17.3
	After cleansing	0.1-1.1	3.3-11.4	1.2	N/A[8]	0.1-10.1

2.5.6 In addition, the lead contents of some representative components of pipes and fittings in the water supply chain were determined by elemental analysis. Chemical methods using either Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES)[9] or Flame Atomic Absorption Spectrometric Method (FAAS)[10] were employed for the analysis.

2.5.7 Results of elemental analysis of the lead contents of the components are tabulated in **Annex 2.4(a)**.

Copper pipes

2.5.8 Before cleansing the deposits, the leaching test results showed that copper pipes leached lead. However, the amounts of lead leached dropped to very low level after cleansing the deposits which indicated that the lead leached should come from the deposits. In addition, the elemental analysis showed that the copper pipes contained only 0.003-0.007% of lead as impurity. The Task Force therefore concluded that copper pipes would not leach lead.

Copper alloy fittings

2.5.9 Copper alloy fittings including valves, water meters and taps still leached lead after cleansing the deposits although the leached

8 An attempt had been made to remove deposits inside the taps but found to be ineffective.

9 ICP-OES is an analytical technique used for the detection of metals. A sample for ICP-OES test is first digested with acid and then vaporised/atomised by the inductively coupled plasma. The excited atoms are brought to a high energy state within the plasma and create a unique emission spectrum specific to each element. The amount of light generated is measured by a photo-multiplier and the concentration of metal is determined by a calibration curve of signal against concentration.

10 FAAS is an analytical technique used for the detection of metals. A sample for FAAS test is first digested with acid and vaporised/atomised by flame. The light absorbed by the vaporised atom is specific to each element. The amount of light absorbed is measured and the concentration of metal is determined by a calibration curve of signal against concentration.

amounts had been reduced. According to the British Standard (BS)[11] requirements for the types of copper alloy used for the fittings, the valves could contain lead ranging from 4-6%; water meters 1.6-2.5%; and taps 0.5-2.5%. The Task Force therefore considered that lead leaching did occur from the copper alloy fittings.

Solder joints

2.5.10 Similarly, solder joints still leached lead after cleansing the deposits although the leached amounts had been reduced. The elemental analysis showed that the lead contents of the solder in most of the joints tested were between 33% and 41% which were well above the limit for lead-free solder stipulated in the BS[12] of 0.07%. The Task Force therefore considered that lead leaching also occurred in the solder joints. A photo of leaded solder joint is shown in **Figure 2.6** below.

Figure 2.6 Cross-section of leaded solder joints

[11] Copper alloy for valves and taps should comply with the requirement of BS EN 1982:2008 and copper alloy for water meters comply with the requirement of BS EN 12165:1998 (later updated to BS EN 12165:2011).

[12] Lead-free solder shall comply with the requirement of BS EN ISO 9453:2014.

2.6 Analysis of leaching test results of the water supply chain in Yuet Ching House of KCE

Leaching test results

2.6.1 The lead leaching test results of the components dismantled from the water supply chain in Yuet Ching House of KCE are tabulated in **<u>Annex 2.3(b)</u>** and summarised in the table below:

Yuet Ching House of KCE	Copper pipes		Valves		Water meters	Taps	Joints[6]	
Total number of components installed in the water supply chain	Numerous		7		1	4	180	
Lead Leached (µg) in 24 hours	>76.1mm	0	Cast iron	0	20.2	0.2–2.1	>76.1mm	0 - 5.4^
	≤76.1mm	0 - 83.8#	Copper alloy	6.5 - 68.9			≤76.1mm	0 - 599#

^ The 159mm diameter joint had minimal lead leaching (5.4µg in mass or 1.8µg/L) which could be due to minor contamination by dust during dismantling as the joint was covered up by panels located on the roof floor. According to HD's specifications, silver brazing joint containing no lead should be used for 159mm diameter joints.

There was no lead leached from copper pipes and solder joints with diameters between 35mm and 76.1mm

2.6.2 The test results showed that no lead leached from copper pipes and joints with diameters greater than 76.1mm and between 35mm and 76.1mm (i.e. basically the down pipe from roof tank to the floor of the flat which the water supply chain served) as well as cast iron valves. However, the leaching test results showed that lead leached from copper pipes and solder joints of 22mm diameter (i.e. basically the branch pipe along the floor of the flat and within the flat) as well as copper alloy fittings. In light of the above, the Task Force excluded cast iron valves and brazing pipe joints with diameters greater than 76.1mm in the subsequent investigation.

Leaching test results after cleansing deposits and elemental analysis

2.6.3 The deposits in some of the components were cleansed and another round of leaching test was conducted. A comparison of the results of leaching test of those components before and after cleansing deposits is shown in the following table:

Yuet Ching House of KCE		Copper pipes	Copper alloy valves	Water meters	Taps	Solder Joints[6]
Lead leached in 24 hours (μg)	Before cleansing	4.5 – 83.8	6.5 – 68.9	20.2	0.2 – 2.1	20.0 – 599.0
	After cleansing	0 – 0.4	1.5 – 37.5	0.3	N/A[8]	2.0 – 28.4

2.6.4 Results of elemental analysis of the lead contents in the representative components in the water supply chain are tabulated in **Annex 2.4(b)**.

Copper pipes

2.6.5 The amounts of lead leached from the copper pipes dropped to very low levels after cleansing the deposits. The elemental analysis also showed that the copper pipes contained only 0.001-0.004% of lead as impurity.

Copper alloy fittings

2.6.6 The copper alloy fittings including valves, water meters and taps still leached lead after efforts to cleanse the deposits from wetted surfaces although the leached amounts had been reduced. Similar to those in Hong Ching House, the copper alloy fittings in Yuet Ching House could contain lead according to the BS: valves ranging from 4-6%; water meters 1.6-2.5%; and taps 0.5-2.5%.

Solder joints

2.6.7 Similarly, solder joints still leached lead after cleansing the deposits although the leached amounts had been reduced. The elemental analysis showed that the lead contents of the solder in most of the joints tested were between 16% and 38%[13] which were above the limit stipulated in the BS of 0.07%.

[13] According to BS EN ISO 9453:2014, leaded solder contains at least 40% lead. The lead content of the leaded solder from the elemental analysis was on the low side as the samples collected might have included copper metal from the pipe joints during sampling.

2.6.8 Similar to Hong Ching House, the Task Force concluded that copper pipes in Yuet Ching House would not leach lead while lead leaching did occur from the copper alloy fittings and the solder joints which contained lead.

2.7 Analysis of leaching test results of the water supply chain in Luen Yat House of KLE2

Leaching test results

2.7.1 The lead leaching test results of the components dismantled from the water supply chain in Luen Yat House of KLE2 are tabulated in **Annex 2.3(c)** and summarised in the table below:

Luen Yat House of KLE2	Copper pipes		Valves		Water meters	Taps	Joints[6]	
Total number of components installed in the water supply chain	Numerous		15		1	4	160	
Lead leached (μg) in 24 hours	>76.1mm	0	Cast iron	0 - 3.4	65.9	1.2 - 5.8	>76.1mm	0
	≤76.1mm	0 - 7.9	Copper alloy	10.5 - 216.4			≤76.1mm	0 - 242.8

2.7.2 The test results showed that no lead leached from copper pipes and joints with diameters greater than 76.1mm (i.e. basically the down pipe from roof tank to the floor of the flat which the water supply chain served). The minimal lead leaching (3.4μg in mass or 2.4μg/L) from the 80mm diameter cast iron valve should be caused by deposits formed from lead ions leached from the copper alloy parts of the adjacent pressure reducing valve (see Section 2.8 below) as cast iron normally would not contain lead. However, the leaching test results showed that lead leached from copper pipes and solder joints with diameters smaller than 76.1mm (i.e. basically the branch pipe along the floor of the flat and within the flat) as well as copper alloy fittings. In light of the above, the Task Force excluded cast iron valves and brazing pipe joints with diameters greater than 76.1mm in the subsequent investigation.

2.7.3 However, the test results showed that lead of various amounts leached from copper pipes and solder joints with diameters ≤

76.1mm (i.e. basically the branch pipe along the floor of the flat and within the flat) as well as copper alloy fittings.

Leaching test results after cleansing deposits and elemental analysis

2.7.4 The results of leaching test of the components (after cleansing deposits) are tabulated below:

Luen Yat House of KLE2		Copper pipes	Valves	Water meters	Taps	Solder Joints[6]
Lead leached in 24 hours (µg)	Before cleansing	1.3 – 7.9	10.5 – 216.4	65.9	1.2 – 5.8	5.5 – 242.8
	After cleansing	0 – 0.8	0.9 – 24.2	2.2	N/A[8]	3.1 – 41.4

2.7.5 Results of elemental analysis of the lead contents in the representative components in the water supply chain are tabulated in **Annex 2.4(c)**.

Copper pipes

2.7.6 The amounts of lead leached from the copper pipes dropped to very low levels after cleansing the deposits. The elemental analysis also showed that the copper pipes contained only 0.003-0.007% of lead as impurity.

Copper alloy fittings

2.7.7 The copper alloy fittings including valves, water meters and taps still leached lead after cleansing the deposits although the leached amounts had been reduced. Similar to those of KCE, the copper alloy fittings in Luen Yat House could contain lead according to the BS: valves ranging from 4-6%; water meters 1.6-2.5%; and taps 0.5-2.5%.

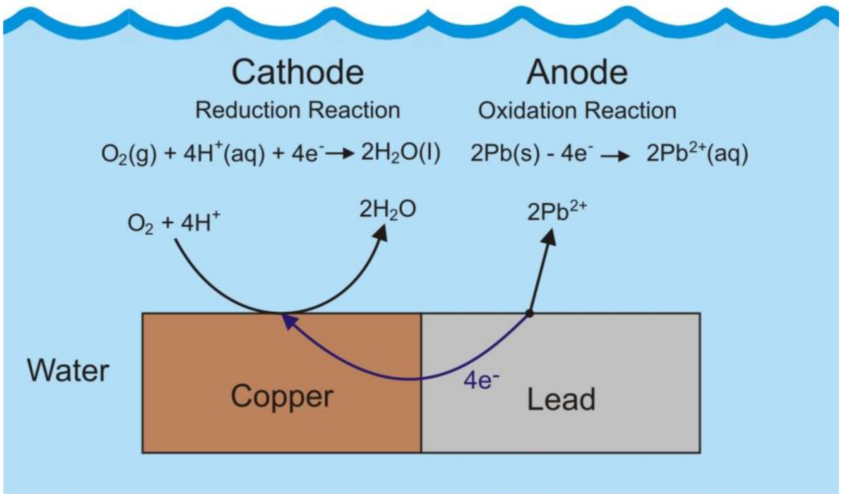
Solder joints

2.7.8 Similarly, solder joints still leached lead after cleansing the deposits although the leached amounts had been reduced. The elemental analysis showed that the lead contents of the solder in all the joints tested were between 27% and 42%, which were well above the limit stipulated in the BS of 0.07%.

2.7.9 Similar to Hong Ching House and Yuet Ching House of KCE, the Task Force concluded that copper pipes in Luen Yat House of KLE2 would not leach lead while lead leaching did occur in the copper alloy fittings and the solder joints which contained lead.

2.8 Lead leaching by galvanic corrosion and formation of lead containing deposits

2.8.1 The mechanism for lead leaching from copper alloy fittings and leaded solder joints in contact with water is the formation of a corrosion cell between the lead and the copper resulting in galvanic corrosion. Under this setting, copper acts as the cathode metal, lead acts as the anode metal and water is the electrolyte medium. As lead has a greater tendency to lose electrons to form positive ions than does copper, lead ions leach into water as a result of galvanic corrosion and the process is shown in **Figure 2.7.**



Galvanic corrosion is an electrochemical process in which one metal has a greater tendency to lose electrons than another. There are three essential components for galvanic corrosion: two dissimilar metals in electrical contact with one metal as an anode and the other as a cathode, and a medium for ions to move around, i.e. an electrolyte medium.

Figure 2.7 Schematic diagram illustrating lead leaching by galvanic corrosion

2.8.2 Reaction of lead ions with carbonate ions and hydroxide ions in water may form insoluble lead carbonates or lead hydroxides at or near the surfaces where lead ions are released due to the low solubilities of the carbonates and hydroxides and the relatively higher concentrations of the lead ions under stagnant conditions. The insoluble compounds may deposit locally or be drifted downstream and deposit on other surfaces in contact as alien matters. The formation of lead compounds was identified by analysis of the deposits cleansed from some of the components of the water supply chains. The test results shown in **Annex 2.5** indicated the presence of lead compounds in the deposits which could also release lead into the drinking water by dissolution as lead ions and by suspension as small particles of lead compounds from the deposits. **Figure 2.8 (a)-(c)** illustrates the process of formation of lead containing deposits and release of lead into drinking water from the deposits.

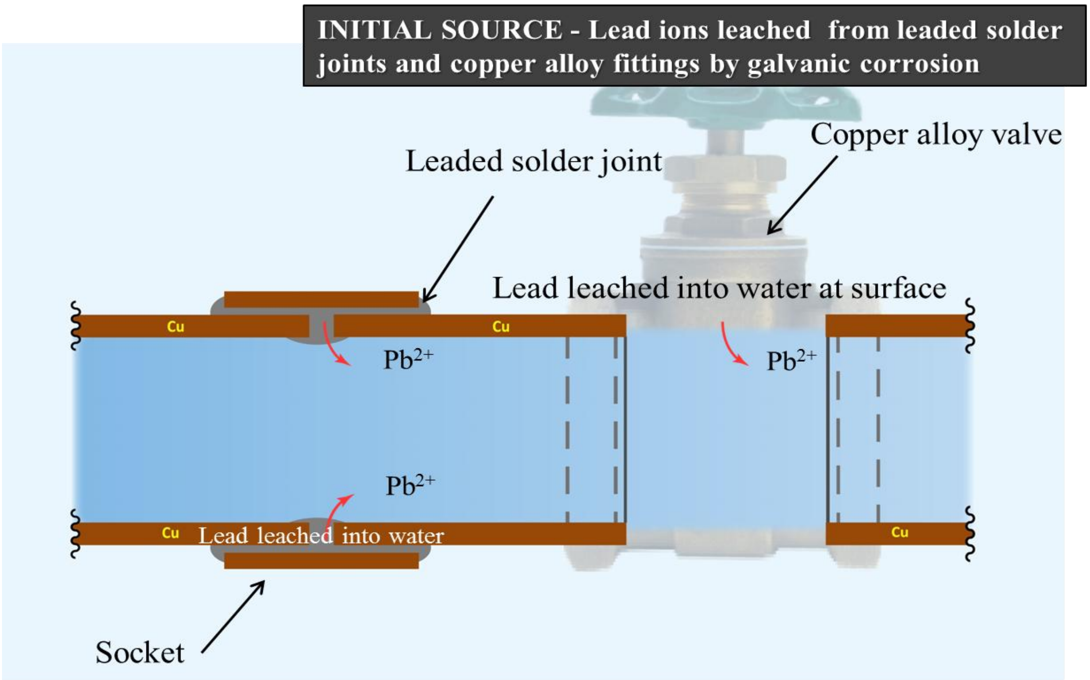


Figure 2.8(a) Leaching of lead from leaded solder joints and copper alloy fittings

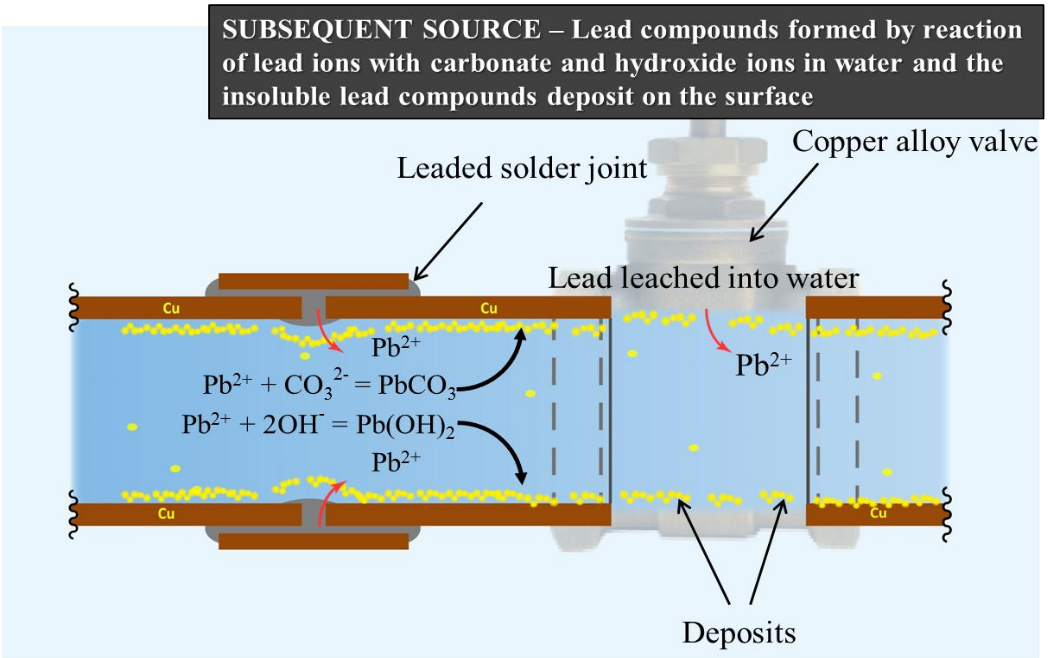


Figure 2.8(b) Formation of lead containing deposits

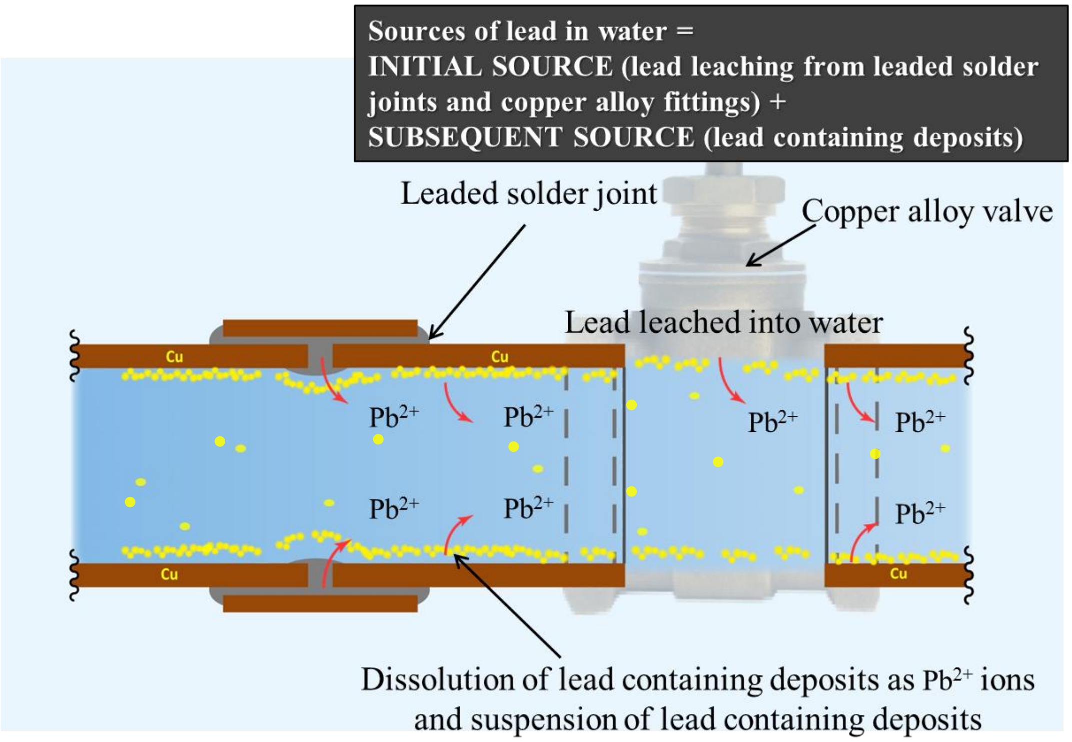


Figure 2.8(c) Release of lead into drinking water from the deposits

2.9 Isotopic Analysis

2.9.1 Lead (Pb) has three major isotopes namely Pb-206, Pb-207 and Pb-208 and lead of different origins may have different ratios of these isotopes. Isotopic analysis was conducted to provide a preliminary deduction of the source of lead in drinking water by comparing the lead isotopic ratio of the water sample with those of the copper alloy fittings and leaded solder joints. One isotopic analysis was carried out for each of the three water supply chains in KCE and KLE2 by using a copper alloy valve and a leaded solder joint in the water supply chain with water sample taken from the respective housing block of the water supply chain.

2.9.2 The Hong Kong Polytechnic University (PolyU) was commissioned to carry out the isotopic analysis using ICP-MS[5] with specific operational setting.

Methodology

2.9.3 In order to avoid the interference of the lead containing deposits to the isotopic analysis, the surface layers of the copper alloy valve and leaded solder joint were removed before the bulk mass was digested with Aqua Regia (A mixture of nitric acid and hydrochloric acid).

2.9.4 The ICP-MS analysed the counts of individual lead isotopes in the sample of copper alloy valve, the sample of leaded solder joint and water sample (the samples) and their lead isotopic ratios would then be calculated. The ICP-MS analysis was repeated 20 times for each of the samples.

2.9.5 Linear Discriminant Analysis (LDA) was carried out to determine the clustering of the 20 lead isotopic ratios of each sample to see if the clusters of the copper alloy valve and the leaded solder joint are significantly different from each other. A Division Line between the clusters of the copper alloy valve and the leaded solder joint was then established to determine if the cluster of the water sample resembled that of the copper alloy valve.

Results of isotopic analysis

2.9.6 Results of the isotopic analysis for the three water supply chains are shown in **Figures 2.9-2.11**. LDA of the lead isotopic ratios of the copper alloy valves and the leaded solder joints showed that they were two separate clusters at 95% confidence level and were significantly different from each other in all three water supply chains.

2.9.7 Further analysis of the isotopic ratios of the lead in the water samples showed that their mean values closely agreed with those of the leaded solder joints at 95% confidence level. It was therefore deduced that the lead in drinking water mainly came from the leaded solder joints.

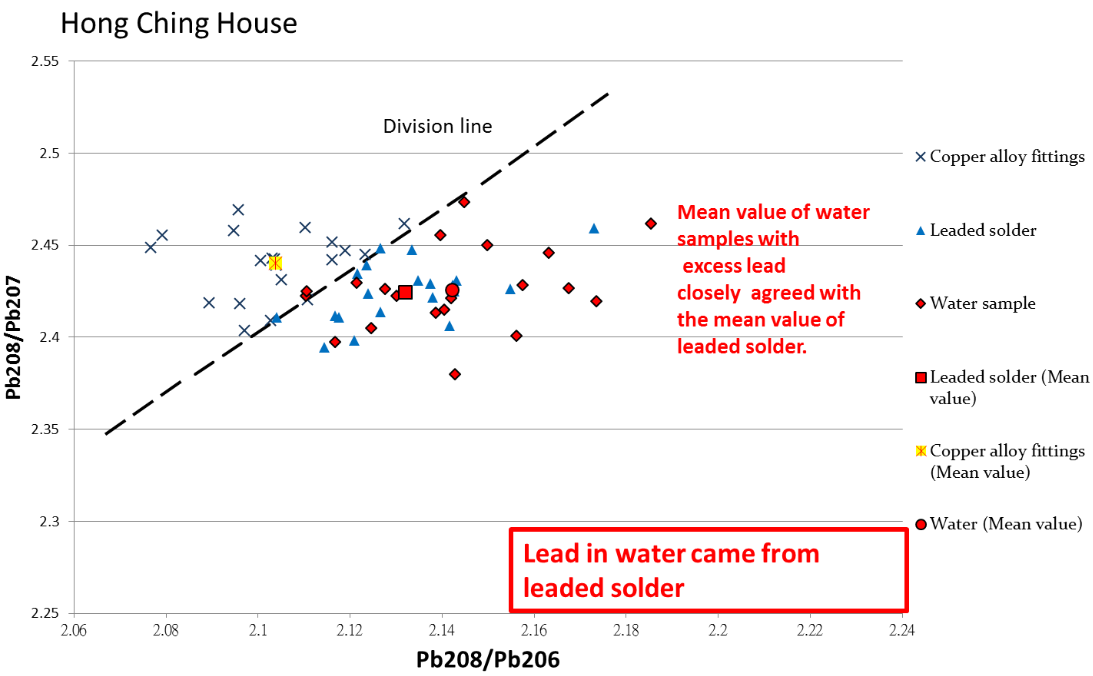


Figure 2.9 Isotopic analysis for the water supply chain in Hong Ching House of KCE

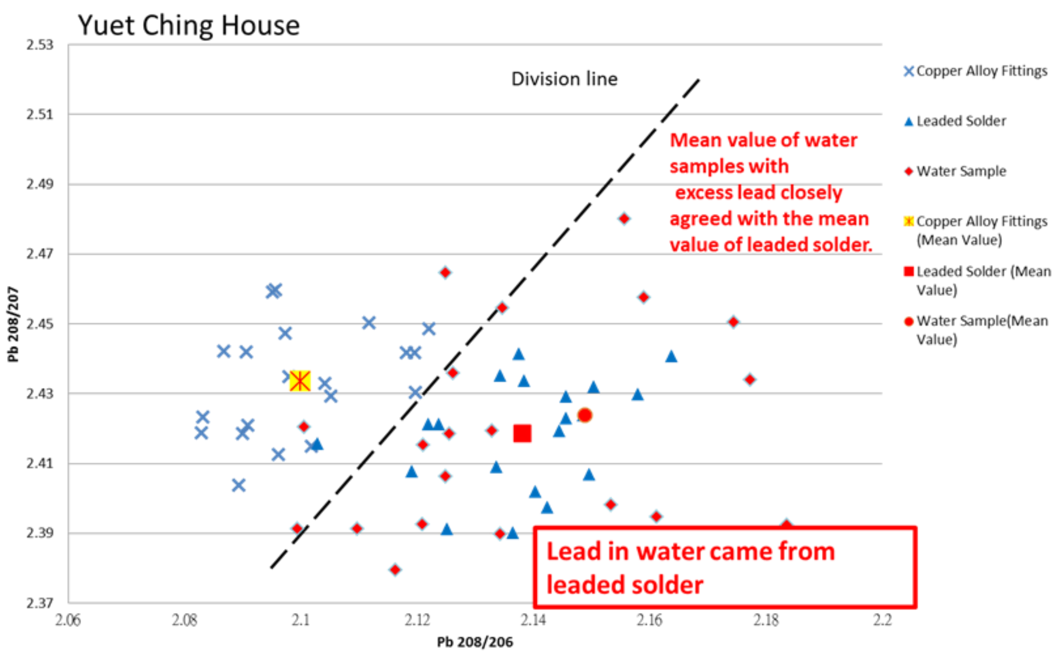


Figure 2.10 Isotopic analysis for the water supply chain in Yuet Ching House of KCE

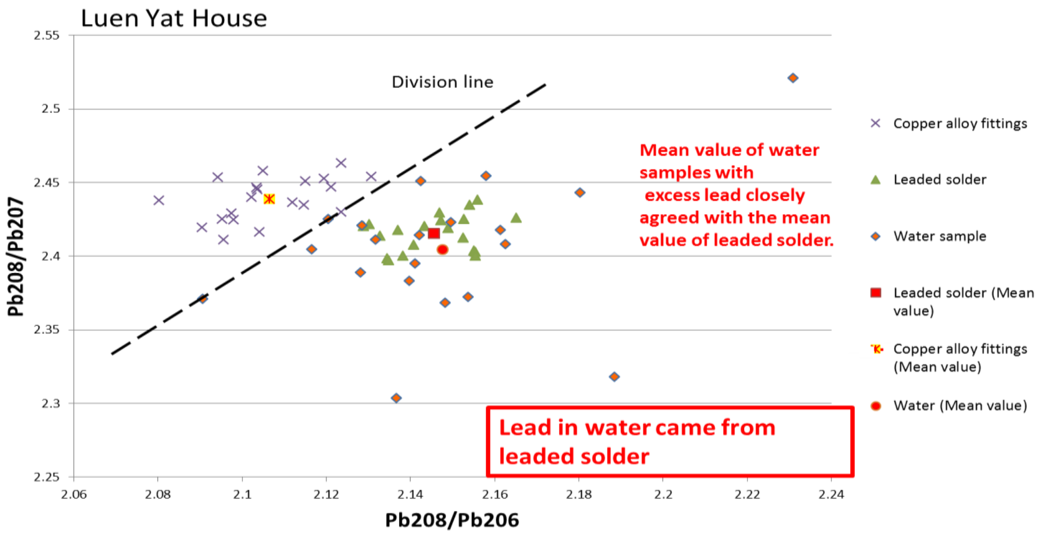


Figure 2.11 Isotopic analysis for the water supply chain in Luen Yat House of KLE2

2.10 Mathematical modeling

2.10.1 The Task Force has made use of mathematical modeling to confirm or otherwise if the source of lead in the drinking water at a kitchen tap mainly came from the leaded solder joints. By using the 24-hour leaching test results of the components, the mathematical model estimated the relative contributions from respective components in the water supply chains to the lead in drinking water at a kitchen tap. Data for mathematical modeling for the three water supply chains are tabulated in **Annex 2.6**.

Methodology

2.10.2 The lead concentration in drinking water in a water supply chain over a given period of time may be estimated from the amounts of lead leached under stagnant condition from each component in the water supply chain during the period of time.

Let

$C(t)$ = average lead concentration at time t in the water supply chain

$C(t_0)$ = average lead concentration at time t_0 in the water supply chain

V = system volume of the water supply chain

L^i = lead leached from i^{th} item in the water supply chain between t and t_0
V^j = volume of water drawn off at point j from the water supply chain between time t and t_0
C^j = lead concentration at draw-off point j

2.10.3 By conservation of mass,:

$$C(t) = C(t_0) + [\ Ó^{\,i}\ (L^i) - Ó^{\,j}\ V^j * C^j\ ] / V \qquad \text{———————} \quad (1)$$

Where
$Ó^{\,i}$ = summation over i of all leaching items in the water supply chain between t_0 and t
$Ó^{\,j}$ = summation over j of all draw-off points in the water supply chain between t_0 and t

In equation (1), the total amount of lead leached, say in 24 hours, by a component may be determined from a leaching test as below:

L^i = [concentration of lead in water from the leaching test (in μg/L) between t and t_0] * [volume of water used in leaching test for item i (in Litre)]

2.10.4 The above equation may be applied to the section of water supply chain between the meter room/cabinet and the kitchen tap to obtain the average lead concentration in the water at draw-off point as below:

$$C(t) = C(t_0) + [\ Ó^{\,i}\ (L^i) – Ó^{\,j}\ V^j * C^j\ ] / V \qquad \text{———————} \quad (2)$$

Where
C(t) = average lead concentration at draw-off point at time t
$C(t_0)$ = incoming lead concentration from the down pipe at t_0
$Ó^{\,i}$ = summation over i of all leaching components in the section between t_0 and t
$Ó^{\,j}$ = summation over j of all draw-off at tap j
V = volume of water supply chain between the meter

room/cabinet and tap

V^j = volume drawn off at point j from the water supply chain between time t and t_0

C^j = lead concentration at draw-off point j

2.10.5 The draw-off patterns in the water supply chain will determine the lead concentration at any draw-off point and at any time. The above model does not take into account the sloughing off of deposits in the components due to shearing force of the flow since the leaching amounts in the model are based on leaching tests under stagnant conditions.

2.10.6 The contribution of each or each group of components in the water supply chain to the average lead concentration between the meter room/cabinet and the kitchen tap in the branch pipe may be estimated as below:

(a) Percentage contribution from k^{th} lead source(s) in the down pipe

= [(V_h /V_d) * ó ^{k} (L^k)]/[(V_h /V_d) * ó ^{i} (L^i) + ó ^{j} (L^j)] * 100%

——— (3)

(b) Percentage contribution from m^{th} lead source(s) in the water supply chain between meter room/cabinet and kitchen tap

=ó ^{m} (L^m)/[(V_h /V_d)*ó ^{i} (L^i) + ó ^{j} (L^j)] *100%

——— (4)

Where

V_h = system volume of the water supply chain between meter room/cabinet and kitchen tap

V_d = system volume of the down pipe

ó ^{i} = summation of all sources in the down pipe

ó ^{k} = summation of k^{th} source(s) in the down pipe

ó ^{j} = summation of all sources in the water supply chain between meter room/cabinet and kitchen tap

ó ^{m} = summation of m^{th} source(s) in thewater supply chain between meter room/cabinet and kitchen tap

2.10.7 The factor (V_h/V_d) in equations (3) and (4) is derived from equation (2) where the lead leached in the down pipe is considered a background source to the lead concentration in the section of the water supply chain between the meter room/cabinet and the kitchen tap, as well as other chains served by the down pipe, i.e.

$$C(t_o) = \Sigma^{i} (L^{i})/V_d \qquad \text{———— (5)}$$

Results of the modeling

2.10.8 The following three scenarios were considered in the mathematical modeling:

(a) Scenario 1 – Lead leached from all components of pipes and fittings – to examine the lead leaching condition in the three water supply chains in KCE and KLE2;

(b) Scenario 2 – Lead leached from leaded solder joints and copper alloy fittings (excluding lead leached from deposits in copper pipes) – to examine the relative contribution of lead leaching from copper alloy fittings and leaded solder joints; and

(c) Scenario 3 – Lead leached solely from copper alloy fittings – to model a water supply chain with lead-free solders joints.

(a) Scenario 1- Lead leached from all components of pipes and fittings

2.10.9 By using the lead leaching test results of components of pipes and fittings before cleansing the deposits, the relative contributions from respective group of components to the lead contents in drinking water were calculated as shown below:

Components	Hong Ching House (KCE)	Yuet Ching House (KCE)	Luen Yat House (KLE2)
Copper pipes with lead containing deposits	84%	68%	35%
Copper alloy fittings (valves, water meters and taps) with lead containing deposits	3%	1%	16%
Leaded solder joints with lead containing deposits	13%	31%	49%

2.10.10 The above results showed that the copper alloy fittings, including valves, water meters and taps, were the least contributor (1% to 16%) to the lead contents in drinking water in the three water supply chains.

2.10.11 Moreover, the results also showed that the major source of lead in drinking water for the water supply chains of Hong Ching House and Yuet Ching House of KCE was the lead containing deposits in copper pipes while the major source of lead in drinking water for Luen Yat House of KLE2 was leaded solder joints. It should be noted that the lead containing deposits in copper pipes should mostly be formed from lead ions corroded from the leaded solder joints as analysed in the scenarios below.

(b) Scenario 2 –Lead leached from leaded solder joints and copper alloy fittings (excluding lead leached from deposits in copper pipes)

2.10.12 Against the analysis of the leaching test results of the three water supply chains in KCE and KLE2 in Sections 2.5 to 2.7 above that copper pipes would not leach lead, the relative contributions from copper alloy fittings and leaded solder joints to the lead contents in drinking water were calculated as shown below using the leaching test results before and after cleansing the deposits:

Before cleansing			
Components	Hong Ching House (KCE)	Yuet Ching House (KCE)	Luen Yat House (KLE2)
Copper alloy fittings (valves, water meters and taps) with lead containing deposits	18%	4%	26%
Leaded solder joints with lead containing deposits	82%	96%	74%

After cleansing			
Components	Hong Ching House (KCE)	Yuet Ching House (KCE)	Luen Yat House (KLE2)
Copper alloy fittings (valves, water meters and taps) with lead containing deposits partially removed	14%	4%	9%
Leaded solder joints with lead containing deposits partially removed	86%	96%	91%

2.10.13 The above results showed that the leaded solder joints were the major contributor to the lead contents in drinking water in the three water supply chains.

(c) Scenario 3 - Lead leached solely from copper alloy fittings

2.10.14 This scenario modeled a supply chain with lead-free solder joints and assumed only the copper alloy fittings leached. By using leaching test results of copper alloy fittings before cleansing the deposits, the lead contents in the drinking water would be:

Before cleansing			
Components	Hong Ching House (KCE)	Yuet Ching House (KCE)	Luen Yat House (KLE2)
Copper alloy fittings (valves, water meters and taps) with lead containing deposits	2.7μg/L	3.5μg/L	8.7μg/L

2.10.15 The mathematical model showed that if only the copper alloy fittings leached lead, the lead contents in the drinking water would range from 2.7μg/L to 8.7μg/L in the three water supply chains which were all below WHO PGV of 10μg/L.

2.10.16 It should be noted that the calculated 2.7μg/L-8.7μg/L were on the high side because (i) they were based on the leaching test results before cleansing the lead containing deposits in the copper alloy fittings and the lead containing deposits would also release lead into the drinking water in addition to the copper alloy fittings; and (ii) they were based on the leaching test results under 24 hours of stagnation and did not simulate the actual operating/flowing condition of the water supply chain under which water flowed through each fitting in short time. The leaching rate under the actual operating / flowing condition could be determined by running the taps at normal flow rate.

2.10.17 Further mathematical modeling was carried out using leaching test results of copper alloy fittings after cleansing partially removing the lead containing deposits and the lead contents in the drinking water would then be:

After cleansing			
Components	Hong Ching House (KCE)	Yuet Ching House (KCE)	Luen Yat House (KLE2)
Copper alloy fittings (Valves, water meters and taps) with lead containing deposits partially removed	1.5μg/L	1.0μg/L	1.5μg/L

2.10.18 The mathematical model showed that if only the copper alloy fittings leached lead and with the effect of lead containing deposits (which should mostly form from lead ions leached from the leaded solder joints) removed, the lead contents in the drinking water would range from 1.0μg/L to 1.5μg/L in the three water supply chains which were well below WHO PGV of 10μg/L.

2.11 Comparison with HFE

2.11.1 Unlike KCE and KLE2, stainless steel pipes with mechanical joints and copper pipes with lead-free solder joints[14] are used in the communal area and inside the flats respectively in HFE. Nevertheless, copper alloy fittings are used in HFE like KCE and KLE2.

2.11.2 As mentioned in paragraph 2.2.4 above, components of pipes and fittings were also dismantled from a control water supply chain in Hung Hei House of HFE. Leaching tests for the dismantled components were conducted and the results are shown in **Annex 2.7** and summarised in the table below**:**

Hung Hei House of HFE	Copper alloy valves	Water meters	Taps (inside flat)
Lead leached in 24 hours (μg)	1.7 – 23.4	0.4	0.1 – 2.6

2.11.3 It was noted that the amounts of lead leached from the copper alloy fittings in Hong Ching House and Yuet Ching House of KCE and Luen Yat House of KLE2 (after cleansing deposits) were comparable with the amounts of lead leached from the copper alloy fittings in Hung Hei House of HFE.

2.11.4 Therefore, by comparing the control water supply chain in HFE (without leaded solder joints) with the three water supply chains in KCE and KLE2 (with leaded solder joints) as shown in **Figure 2.12**, it could be confirmed that leaded solder joints should be the cause of excess lead in drinking water and even

[14] Elemental analysis confirmed that the solder joints of the copper pipes in the control water supply chain in HFE were lead-free.

though the copper alloy fittings leached lead, they would not result in excess lead contents in drinking water.

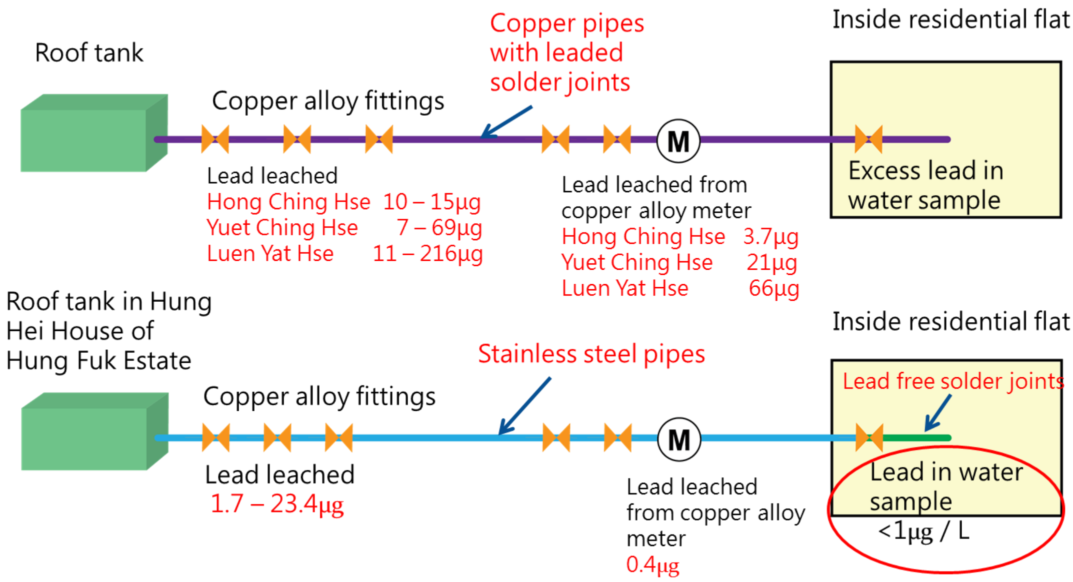


Figure 2.12 Comparison of the control water supply chain in HFE with that of the three water supply chains in KCE and KLE2

2.12 Stagnation and flushing test

2.12.1 To investigate the lead contents in the water supply chains during stagnation and after flushing, the Task Force carried out stagnation and flushing tests in KCE and KLE2. Three vacant flats and one management office in KCE and KLE2 were used for the stagnation and flushing tests.

2.12.2 For the stagnation test, it was conducted by first thoroughly flushing the water supply chain for 15 hours. Water then remained stagnant in the water supply chain and water samples were taken at 0 hour, 1 hour, 2 hours, 3 hours, 4 hours, 6 hours, 8 hours, 24 hours and 48 hours for determining the lead contents.

2.12.3 Immediately after the 48-hour stagnation test, the flushing test was carried out by taking water samples after flushing for 1 minute, 2 minutes, 3 minutes, 4 minutes, 5 minutes, 10 minutes and 30 minutes. The results of the stagnation and flushing tests are summarised in **Annex 2.8**.

2.12.4 The results of the stagnation and flushing tests conducted in the three vacant flats and one management office revealed that the lead contents in water would increase with its stagnation time in the water supply chain if there was lead leaching from its components. In addition, the test results also indicated that the lead contents in the stagnated water could be reduced substantially after flushing for about two minutes. The test results are illustrated in **Figure 2.13** below and a combined graph is presented in **Annex 2.9**.

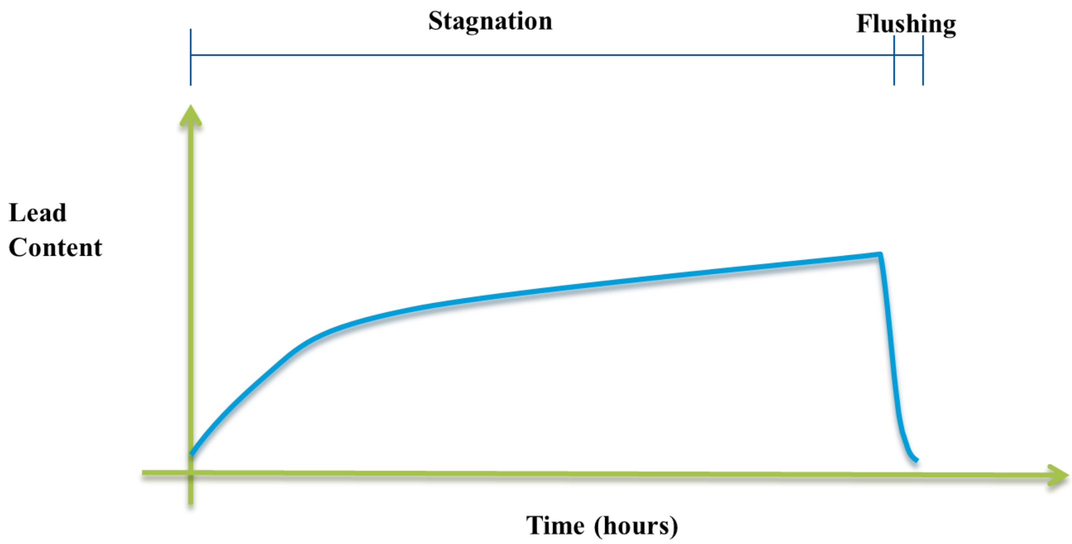


Figure 2.13 Generalised results of stagnation and flushing tests

Chapter 3 Findings

This Chapter summarises the findings of the investigation of the cause of excess lead in drinking water and other findings revealed during the course of investigation.

3.1 Cause of excess lead in drinking water

Analysis of leaching test results

3.1.1 In the leaching test for the copper pipes in the three water supply chains in KCE and KLE2 before cleansing the deposits, the results initially showed that there was lead leaching from them. The amounts of lead leached reduced to very low level after cleansing the deposits which indicated that the lead leached should come from the deposits. Subsequent analysis of the cleansed deposits showed that there were lead compounds which should be formed by reaction of the lead ions leached from the copper alloy fittings and leaded solder joints with the carbonate and hydroxide ions in water. In addition, the elemental analysis showed that the copper pipes contained minimal amounts of lead (0.001%-0.007%) as impurity. The Task Force therefore concluded that copper pipes would not leach lead.

3.1.2 Both copper alloy fittings and solder joints leached lead even after cleansing the lead containing deposits. The copper alloy fittings including valves, water meters and water taps may contain small amounts of lead according to the BS. More significantly, elemental analysis showed that the lead contents of the solder in the joints were high (16%-42%) and were well above the limit stipulated in the BS of 0.07%. The Task Force therefore considered that lead leaching occurred in both the copper alloy fittings and the leaded solder joints. In order to identify which of them was the cause of excess lead in drinking water, the Task Force conducted isotopic analysis and mathematical modeling and made comparison of the three water supply chains in KCE and KLE2 with the control water supply chain in HFE.

Isotopic analysis

3.1.3 Isotopic analysis was carried out for each of the three water supply chains in KCE and KLE2 by using a copper alloy valve, a leaded solder joint, and a water sample taken from the respective housing block of the water supply chain. LDA of the lead isotopic ratios of the copper alloy valves and the leaded solder joints showed that they were two separate clusters at 95% confidence level and were significantly different from each other in all three water supply chains. Further analysis of the isotopic ratios of the lead in the water samples showed that their mean values closely agreed with those of the leaded solder joints at 95% confidence level. It could therefore be deduced that the lead in drinking water mainly came from the leaded solder joints.

Mathematical modeling

3.1.4 Based on the mathematical modeling using the leaching test results, the leaded solder joints were found to be the major source of lead in drinking water in the three water supply chains in KCE and KLE2.

3.1.5 The mathematical modeling also showed that if only the copper alloy fittings leached lead, the lead contents in the drinking water would range from 2.7µg/L to 8.7µg/L (based on leaching test results before cleansing the lead containing deposits) or 1.0µg/L to 1.5µg/L (based on leaching test results after cleansing the lead containing deposits) in the three water supply chains which were below WHO PGV of 10µg/L. It was concluded that although copper alloy fittings leached lead, they would not result in excess lead in drinking water. It followed that the cause of excess lead in drinking water should be the leaded solder joints.

Comparison with HFE

3.1.6 The above findings were further supported by comparing the control water supply chain in HFE, where lead contents in its drinking water samples were well below WHO PGV of 10µg/L, with the three water supply chains in KCE and KLE2. Stainless steel pipes with mechanical joints and copper pipes with lead-free solder joints are used in the communal area and inside the flats respectively in HFE (i.e. without leaded solder joints). Nevertheless, copper alloy fittings are used in HFE just like in KCE and KLE2. Based on the leaching test results, the amounts of lead leached from the copper alloy fittings in Hong Ching House and Yuet Ching House of KCE and Luen Yat House of KLE2 were comparable with the amounts of lead leached from the copper alloy fittings in Hung Hei House of HFE. By making the comparison of the control water supply chain in HFE with the three water supply chains in KCE and KLE2, it could be confirmed that leaded solder joints should be the cause of excess lead in drinking water and even if the copper alloy fittings were leaching lead, they would not result in excess lead in drinking water.

Conclusion

3.1.7 Based on the above investigation, the Task Force has concluded the following findings:

(a) Leaded solder joints were the cause of excess lead in drinking water; and

(b) Copper alloy fittings also leached lead but did not result in excess lead in drinking water.

3.2 Applicability of the findings on other public rental housing developments with excess lead in drinking water

3.2.1 Apart from KCE and KLE2, some drinking water samples taken from nine[15] other public rental housing (PRH) developments were also found to have lead contents exceeding WHO PGV. No components of pipes and fittings have been dismantled from these nine developments. Nevertheless, the design of the inside service and the specifications of the pipes and fittings in these nine PRH developments are similar to those of KCE and KLE2, and the solders in the joints of their copper pipes were also found to have lead contents ranging from 18% to 61% levels which were well above the limit stipulated in the BS of 0.07%. The

[15] The nine PRH developments with some drinking water samples found to have excess lead contents are Wing Chong Estate, Lower Ngau Tau Kok Estate Phase 1, Shek Kip Mei Estate Phase 2, Tung Wui Estate, Hung Hom Estate Phase 2, Yan On Estate, Choi Fook Estate, Un Chau Estate Phase 2 and 4 and Ching Ho Estate Phase 1.

Task Force therefore considered that the above findings should be applicable to these nine PRH developments.

3.2.2 A survey of the inside service of water supply chains in KCE and KLE2 and these nine PRH developments with excess lead in water samples are summarised in **<u>Annex 3.1</u>**.

3.3 Other Findings

Leaching of chromium, cadmium and nickel

3.3.1 The leaching test results for chromium, cadmium and nickel from the various components of pipes and fittings in the three water supply chains in KCE and KLE2 are shown in **<u>Annexes 2.3(a)-(c)</u>**. Based on the leaching test results, the amounts of chromium and cadmium leached from the various components were low. However, there was significant leaching of nickel from some taps in KCE, e.g. the highest leached amount of nickel after standing for 24 hours was 102.0μg or 1,569μg/L in one washing machine tap. Elemental analysis on the cross section of these taps showed that nickel had seeped into the wetted surfaces of the taps during electroplating (**Figure 3.1**). Nevertheless, as the taps hold very small amounts of water (less than 150ml) under stagnant condition, the leached nickel should be flushed away within one to two seconds after turning on the taps.

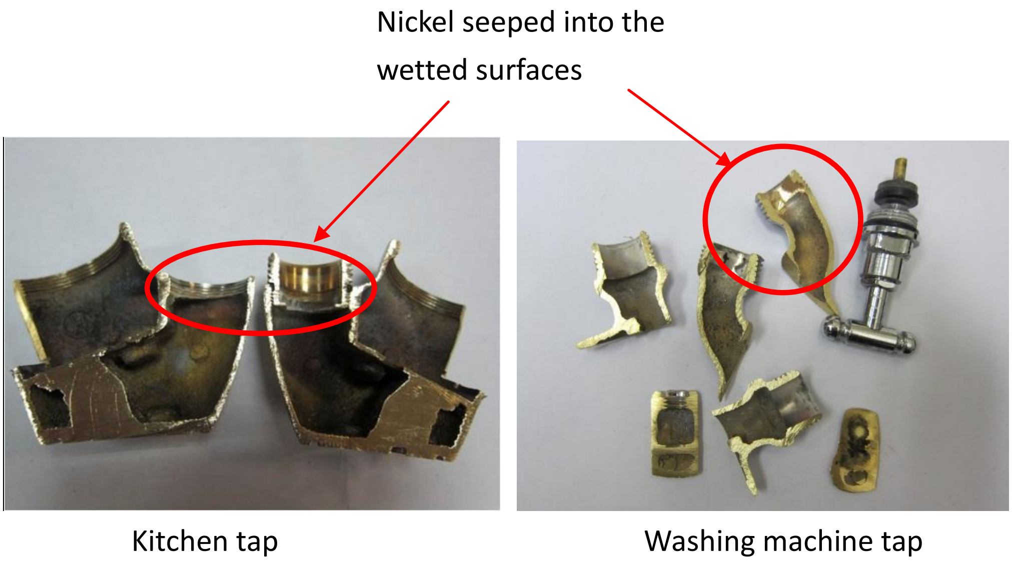


Figure 3.1 Cross-section of taps

Non-compliance with BS

3.3.2 Some valves and taps dismantled from the three water supply chains in KCE and KLE2 were found to be not those brands and models submitted to WA in the Form WWO 46 before commencement of construction of the inside service, although they were on the directory of pipes and fittings accepted by WA[16]. Lists of pipes and fittings installed in the three water supply chains in KCE and KLE2 as compared to those submitted to WA are tabulated at **Annex 3.2**.

3.3.3 In addition, elemental analysis showed that some of the copper alloy valves and taps in the three water supply chains in KCE and KLE2 did not comply with BS requirement in respect of the lead contents of 4-6% for the copper alloy for valves and 0.5-2.5% for the copper alloy for taps as summarised in **Annex 3.2**. Despite non-compliance with BS requirement, it should be noted that the leaching test results of these copper alloy valves and taps were comparable to those complying with BS requirement. In other words, they were not the cause of excess lead in drinking water.

[16] WA has published a directory listing out all water supply pipes and fittings, water heaters and materials which have been accepted by WA (the pre-approved list).

Chapter 4 Control Mechanism on Construction of Inside Service

This Chapter examines the adequacy of the then control mechanism of WA and HA on construction of inside service of KCE and KLE2. It also reviews the local and overseas practices for plumbing works for formulating the recommendations to prevent recurrence of incidents of excess lead in drinking water in future.

4.1 Under WA's regulatory regime

4.1.1 There were a number of measures on the control of the construction of inside service in the regulatory regime of WA as follows:

(a) All pipes and fittings should comply with the relevant BS

Under Regulation 20 of the Waterworks Regulations (WWR), every pipe or fitting should comply with the BS requirement. Suppliers would submit BS Institution Certificates / Water Regulations Advisory Scheme (WRAS) Certificates / test reports issued by accredited laboratories to show compliance with the relevant BS for their pipes and fittings for approval by WA before they could be installed in the inside services. In respect of the use of solder material for jointing copper pipes, it should comply with BS EN 1254:1998 (the latest revised edition of the BS 864) stipulated in the WWR that it should be lead-free. According to the BS EN ISO 9453:2014, the maximum lead contents of lead-free solder is 0.07%.

(b) The Authorised Person (AP)[17] and the Licensed Plumber (LP)[18] needed to submit a list of pipes and terminal fittings to be installed in the inside services to WA before commencement[19] of construction.

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[17] AP means a person whose name is on the authorized persons' register kept under Buildings Ordinance (section 3(1), Cap 123) either (a) as an architect; (b) as an engineer; or (c) as a surveyor.

[18] LP means a person licensed under the WWO (section 2, Cap. 102) to construct, install, maintain, alter, repair or remove inside services.

[19] In WSD Circular Letter No. 3/2000, it made clear that in order to expedite the process of water supply applications, the LP/AP might not be required to seek approval for commencement of the inside service works after approval of the plumbing proposal. However, the LP/AP were required

The AP and LP would apply to WA (in the Form WWO 46 (**Annex 4.1)**) Part I & II for permission to commence the construction of the inside service with details as follows:

- In Part I of Form WWO 46, AP and LP would certify that the pipes and fittings intended to be installed were as prescribed by WWR.
- AP and LP would list out the proposed pipes and terminal fittings intended to be installed in the inside services and standards of compliance in the Annex to Form WWO 46.
- WA would check the submission and give permission to the LP to proceed with the plumbing works (i.e. construction of the inside service) if the submitted information was found to be in order. (Form WWO 46 Part III)

(c) The AP had to confirm that all pipes and fittings were in full compliance with the waterworks standards and requirements upon completion of inside service

Upon completion of the inside service and in the application for certificate regarding water supply connection (in the Form WWO 132 Part II (**Annex 4.2**)), AP would confirm that the pipes and fittings used were in full compliance with waterworks standards and requirements.

(d) Inside service was inspected[20] and approved by WA

(i) During the construction stage, upon application by the LP, WA would carry out interim inspection(s) of completed underground or concealed pipeworks against the approved plumbing proposals[21] and the pipes and

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to submit Form WWO 46 to confirm that the pipes and fittings to be installed were approved by WA. Under no circumstances should pipes and fittings that had not been approved by WA be installed in the plumbing works.

20 WA will inspect pipes and fittings installed before they are covered up and completed inside service before it is connected to the Government mains.

21 In accordance with the WWO, if a new inside service is to be constructed or installed, the applicant shall submit to WA plumbing proposal in respect of the inside service for approval by WA before

fittings listed in the Annex to Form WWO 46 submitted previously by the AP and LP (see paragraph 4.1.1(b) above) before they were covered up.

(ii) After completion of the inside service, the LP and AP would apply to WA for final inspection and approval of the plumbing works (Form WWO 46 Part IV). WA would then carry out site inspection to check the completed works against the approved plumbing proposals and the pipes and fittings listed in the Annex to Form WWO 46 submitted by the AP and LP. The final inspection of WA would primarily focus on communal part of the plumbing system. It would also include some flats selected on a random basis. If no irregularities were found, WA would issue approval of the plumbing works (Form WWO 46 Part V) to the LP.

(e) LP had to arrange testing of water samples taken from the completed inside service to confirm their compliance with the acceptance criteria specified by WA[22].

(i) Prior to August 2012, to guard against possible pollution of the government water mains by the inside service, WA required water samples to be taken near the connection point for compliance testing against parameters (see footnote 22) mainly in connection with the bacteriological concerns. It was to avoid the risk of contamination to the government water supply system by the inside service. If the water sample test results were satisfactory, water supply would be effected to the development and WA would issue the certificate regarding water supply connection to the AP for application of occupation permit for the development.

(ii) In light of the detection of Legionella bacteria at the newly completed Tamar Central Government Offices in late 2011, WA issued a guideline via WSD Circular Letter no. 2/2012 (**Annex 4.3**) in August 2012 on

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seeking permission of WA to construct or install the inside service.

22 The test parameters include turbidity, colour, pH at 25°C, free residual chlorine, conductivity at 25°C, total coliforms, E. coli and heterotrophic plate counts. Testing for the four heavy metals, namely, lead, chromium, cadmium and nickel were not required before July 2015.

cleaning and disinfection of inside service and taking of water samples from other part of the inside service in addition to the connection point for testing. The testing parameters for the additional water samples were the same as those for the water samples taken near the connection point. The main purpose of the guideline was to provide guidance to the LP and AP to arrange for proper cleaning and disinfection of the inside service which was to be confirmed by the water sample test results before the inside service was put into operation. If the water sample test results were not satisfactory, the cleaning and disinfection should be carried out again until the water sample test results were satisfactory. The water sample test results would be submitted to WA when needed.

4.2 Under the control mechanism of the Hong Kong Housing Authority (HA) on construction contracts

4.2.1 HA's contracts specified the use of lead-free solder material for jointing copper pipes, and pipes and fittings should comply with BS requirements. In addition, under the material approval system, HA checked the specifications in the contract against the contractor's submission of documents and samples. The contractor would also submit an undertaking that the materials were in full compliance with HA's and other recognised requirements[23].

4.2.2 HA also checked the materials proposed by main contractors, including catalogues, samples, certificates, test reports and approval documents from respective regulatory authorities, made reference to the performance of the materials in other projects, and checked whether the material had ever been listed in the "Material Quality Alerts"[24], before determining whether to approve the proposed materials for use.

4.2.3 HA conducted checks on whether the documents of origin submitted by the main contractors showing compliance of

[23] For KCE, the Contractor's submission which included the lead-free solder had been checked and approved for use on site.

[24] The list of "Material Quality Alerts" was maintained by the Component and Materials Team of HA. The team conducted surprise checks, selected and sent random samples to an accredited laboratory for thorough examination, and posted regular reports on findings.

standards were complete when the materials were delivered to the site. Visual inspection and verification were carried out on materials against submitted catalogues and certificates. HA also selected samples on site for checking the appearance, construction, dimensions against relevant standards, and whether there were visible defects. HA's Components and Materials Team conducted laboratory tests on major components such as sink faucet, mixer and shower head to ensure compliance with the specified performance standards.

4.2.4 Although HA's developments are exempted from the provisions of the Buildings Ordinance (BO), the Independent Checking Unit (ICU) of HD exercised buildings control on HA's new projects and alteration and addition works in existing buildings by way of administrative arrangement within HD. As parallel to the projects subject to the BO, the main contractor engaged by HA would carry out continuous supervision of the building works, whilst HA's Contract Manager and his/her technical supporting team would conduct periodic inspection by carrying out surveillance checks.

4.2.5 HA monitored the main contractor's works regularly to ensure the inside service was constructed in accordance with the contractual requirements. For instance, HA inspected the alignment of water pipes, position and quantity of brackets and whether they were firmly fixed, adequacy of pipe sleeves and spacing, the connection of pipes, whether the materials used comply with contractual requirements, etc. However, HA did not inspect the joints between pipes (including the soldering materials) for lead contents.

4.2.6 On completion of the inside service, the main contractor would conduct inspection and testing to ascertain compliance with the drawings approved by WSD, statutory requirements and contract specifications, and the LP would apply to WA for inspection and approval of the completed inside service. HA also carried out final inspection and testing, including checking the main contractor's cleaning and disinfection of tanks and pipes, conducting pressure tests and checking for water-tightness. In the final inspection of each flat, HA checked the pipes and fittings for proper fixing and water-tightness, and whether the water supply and drains operated normally. Upon the satisfactory completion of all tests, HA would apply to ICU for Occupation Permit.

4.3 Inadequate awareness of the stakeholders of construction industry

4.3.1 The Task Force observed that notwithstanding the control mechanism of WA and HA as set out above, it did not discover the use of leaded solder materials for jointing copper pipes and the existence of lead in drinking water. It was noted that no checking was conducted on whether the solder joints contain lead and testing of water samples did not include the four heavy metals namely lead, chromium, cadmium and nickel. It reflects the inadequate awareness of the stakeholders in the construction industry on the use of leaded solder material and its consequences on the drinking water quality.

4.3.2 The Task Force therefore recommended formulating measures to prevent recurrence of lead in drinking water incidents in future.

4.4 Consultancy studies on local and overseas practices in plumbing works

4.4.1 For formulating the recommendations to prevent recurrence of incidents of excess lead in drinking water in future, the Task Force has made reference to following two consultancy studies commissioned by WSD.

(a) Study on Good Practice to Ensure Completion of the Plumbing Works involving Copper Pipes and Soldering Pipe Joints in Compliance with the Requirements of Water Authority as well as Contractual Arrangements

(b) Benchmarking Study of Overseas Regulations and Practices on the Management and Control of Inside Plumbing Services

Study on good practice to ensure completion of the plumbing works involving copper pipes and soldering pipe joints in compliance with the requirements of Water Authority as well as contractual arrangements

4.4.2 The study comprises the following objectives:

(a) To conduct an investigation to review the current practices of the private, government and public housing sectors in Hong Kong in supervision of plumbing works in building projects; and

(b) To devise good practice to ensure completion of plumbing works (involving copper pipes and soldering pipe joints) are in compliance with all the requirements of WA as well as the contractual requirements.

4.4.3 The study has recommended the following good practices of implementation of plumbing works:

(a) Pipe materials or jointing methods other than copper pipe with soldering capillary fittings should be used for potable system where practicable. If the use of copper pipe with soldering capillary fitting is unavoidable, more stringent supervision should be adopted such as inclusion of solder material as essential components to be submitted to the Consultant / Project Engineer / Project Officer for approval.

(b) Sampling and testing of materials delivered to site and used in the works shall also be enhanced. These measures include:

(i) verification of materials on site by sampling and testing to confirm compliance with requirement, and a system to record plumbing materials delivered to and removed off site; and

(ii) enhanced verification during construction – random checking on solder material used; non-destructive and destructive testing of completed joints; and creating a register of joint locations against soldering operator.

(c) To improve quality of materials supplied, the contract should specify that supply of essential components of the plumbing works shall be the responsibility of the main contractor, but not any other parties, to clearly define the material supply responsibility to avoid the use of unapproved materials on site.

(d) On completion of works, after cleaning and disinfection, water samples shall be taken at different locations of the building for testing including lead contents to ensure the water quality is suitable for potable use.

(e) It may consider employing qualified person, such as, Building Services Engineer (BSE)/Building Services Inspector (BSI) to carry out adequate supervision for the plumbing works.

Benchmarking study of overseas regulations and practices on the management and control of inside plumbing services

4.4.4 The study comprises the following objectives:

(a) To provide benchmark information on overseas regulations and practices relating to the management and control of inside plumbing services; and
(b) To compare the benchmark information in (a) with the local regulations and practices in Hong Kong.

4.4.5 The study has covered the following countries / cities:

United Kingdom (UK)
United States (US) - New York
San Francisco
Canada - Toronto
Australia
Singapore

4.4.6 The findings of the study relevant to the Task Force are summarised as follows:

(a) Laws/Regulations/Guidelines for LP (or equivalent)[25] to carry out construction of inside service works

[25] The LP in this section means LP or equivalent personnel in the countries / cities covered by the Benchmarking Study of Overseas Regulations and Practices on the Management and Control of Inside Plumbing Services.

There are systems similar to the LP system in Hong Kong in the countries / cities covered by the study. In general, the plumbing works shall be supervised/carried out by LP. In Singapore, when the plumbing works involve design of a pumping system or storage tank, a professional engineer shall also be engaged.

(b) Laws/Regulations/Guidelines for the authority to carry out inspection of the newly completed inside service

Most countries/cities covered by the study allow the LP self-certifying the compliance of the completed inside service. The Authority will then inspect (usually randomly) the completed inside service to verify the quality.

(c) Laws/Regulations/Guidelines for taking water samples from newly completed inside service

In general, there is no mandatory water sample testing requirement for newly completed inside service in the countries / cities covered by the study. In Singapore, all mains and services to be used for domestic purposes shall be sterilised before being put into use and water samples shall be taken for bacteriological (plus residual chlorine and iron) testing by accredited laboratories after sterilisation.

(d) Laws/Regulations/Guidelines for governing pipes and fittings in inside service

(i) Similar to Hong Kong, only pipes and fittings approved under the respective schemes or organisations can be used in inside service in Australia, US and Canada:

- WaterMark Certification Scheme in Australia
- National Sanitation Foundation (NSF) in New York and San Francisco of US
- Canadian Standards Association (CSA) in Toronto of Canada

(ii) Singapore no longer maintains a list of approved products since 2000. Under the new practice, suppliers and installers of pipes and fittings must ensure that all pipes and fittings that are advertised, sold or installed for water service applications meet the relevant standards and codes. Failure to do so can be considered an offence under the legislation.

(e) Control of solder material in respect of lead contents

(i) In UK, according to the Water Supply (Water Fittings) Regulations 1999, no material or substance which causes contamination of water shall be used in the construction, installation, renewal, repair or replacement of any water fitting which conveys or receives water supplied for domestic or food production purposes.

(ii) In US, the Safe Drinking Water Act specifies that solder and flux shall contain no more than 0.2% lead.

(iii) Canada adopts the standard NSF 372 which specifies that solder shall have less than 0.2 % lead.

(iv) In Australia, the Australian Standard AS/NZS 3500.1 – Plumbing and Drainage, Part 1: Water Services specifies that soft solder shall not contain more than 0.1% lead by weight.

(v) In Singapore, typically only welding and brazing are permitted for jointing metallic pipes except for stainless steel pipes in the Code of Practice for Water Services (CP48:2005).

Chapter 5 Recommendations

5.1 Taking note of the findings of the two consultancy studies as detailed in Chapter 4, the Task Force has the following recommendations to prevent recurrence of similar incidents of excess lead in drinking water in the future:

(a) Prevention of the use of leaded solder material and non-conforming pipe fittings:

(i) To enhance site inspection and testing system for plumbing works

- The consultancy study on good local practice has recommended employing a qualified person, such as BSE / BSI to carry out adequate supervision in implementation of plumbing works. It is considered that supervisory staff with relevant professional knowledge and practical skills would help to ensure the quality of the plumbing works. It is therefore recommended that **qualified persons (e.g. BSE or BSI) should be engaged to carry out adequate and regular field inspection.**

- The control mechanism prior to the incident of excess lead in drinking water did not discover the use of leaded solder materials for jointing copper pipes. It was because no checking was conducted on site on whether the solder joints contained lead. **It is recommended that systematic non-destructive tests of solder pipe joints should be conducted during construction (e.g. conducting quick lead test or using portable x-ray fluorescence analyser/spectrometer)** which allows handy and quick check on the lead contents of the solder material.

- The investigation has revealed that some of the fittings used in the three water supply chains in KCE and KLE2 did not comply with the BS in spite of the fact they were on the directory of pipes and fittings accepted by WA. It could be due to the inadequate quality control in the production of the fittings. The consultancy study on good local practice has recommended verification of materials on site by sampling and testing to confirm compliance with requirements. For better quality control of the materials, it is recommended that **random sampling and testing of materials delivered to site should be carried out** before they are used in the works.

(ii) The control mechanism prior to the incident of excess lead in drinking water did not require testing of lead and other heavy metals in water samples as well as the solder pipe joints in newly completed inside services. It is recommended that **testing of four additional heavy metals (lead, chromium, cadmium and nickel) should be stipulated for drinking water samples and testing of the lead content in solder pipe joints in newly installed inside service** which would help to reveal the existence of components with severe lead leaching in particular leaded solder joints in the plumbing system**.** It is noted that WSD has stipulated these testing requirements since mid-July 2015 via Circular Letters 1/2015 and 5/2015.

(b) The investigation of the Task Force concluded that leaded-solder joints were the cause of excess lead in drinking water in KCE and KLE2. It is recommended that **WA should explore the use of pipe materials free from the risk of misuse of leaded solder joints in plumbing works**, e.g. stipulating the use of silver brazing or compression joints for copper pipes, stainless steel pipes or crosslinked polyethylene pipes.

(c) To improve quality of materials supplied, the consultancy study on the good local practice has recommended that contract should specify the supply of essential components of the plumbing works be the responsibility of the main contractor. It is recommended that **HA should consider requiring the adoption of central procurement for solder material** (and other essential components of the plumbing works as appropriate) by the main contractor in order to clearly define the material supply responsibility and to avoid the use of unapproved materials on site.

(d) It is recommended that **WA should consider reviewing relevant legislation** to effect the above recommendations. The WA should also review the WWO and WWR to see if improvement is necessary to further strengthen its regulatory regime on the construction of inside service. Reference could be made to the overseas laws/regulations/guidelines identified under the findings of the benchmarking study of overseas regulations and practices.

Chapter 6 Legionnaires' Disease

6.1 A tenant in Mun Ching House of KCE was confirmed to have contracted LD on 28 May 2015. The Centre for Health Protection (CHP) of the Department of Health (DH) classified it as a "local case" after investigation because the patient had no history of travel outside Hong Kong during the incubation period. The patient was discharged from hospital after treatment on 12 June 2015.

6.2 As part of the epidemiological investigation, water samples and environmental swabs were taken from Mun Ching House for testing by the CHP's Public Health Laboratory Services Branch. Seven water samples taken from water outlets of the patient's residence on 18 June 2015 had been tested positive for *Legionella pneumophila* at a level of 4.2 to 600 colony-forming units per milliliter (cfu/ml) while one of the four environmental swabs taken from the patient's residence had been tested positive for *Legionella pneumophila*. Besides, water sample taken from the roof water tank of Mun Ching House was tested negative for *Legionella pneumophila*.

6.3 Two further water samples were taken from the water pipe supplying the patient's flat and the water pipe supplying a nearby flat on the same floor respectively on 6 July 2015. They had been tested positive for *Legionella pneumophila* at a level of 0.7 to 1.7 cfu/ml. In addition, one water sample taken from the water pipe on the first floor of the building had also been tested positive for *Legionella pneumophila* at a level of 0.3 cfu/ml.

6.4 After the replacement of all the water supply fittings in the patient's residence, seven water samples were taken on 8 July 2015 at the same locations as those taken during the first visit on 18 June 2015. They had been tested positive for *Legionella pneumophila* at a level of 0.4 to 14.3 cfu/ml.

6.5 HD formed an Inter-departmental Working Group on Disinfection of Water Supply Pipework with Legionnaires' Disease in Kai Ching Estate (the Working Group) with representatives from DH, WSD and Electrical and Mechanical Services Department. The Working Group decided at the meeting held on 16 July 2015 to disinfect the whole water supply system of Mun Ching House involving 960 flats by shock hyperchlorination.

6.6 The Task Force maintained regular contact with the Working Group to follow the progress of their disinfection work at Mun Ching House. Three phases of disinfection work were carried out by a specialist contractor from 14 August to 30 August 2015. For some individual flats where the tenants could not be contacted or were not available during the scheduled phases of disinfection work, their water supply was isolated by disconnecting individual water meter and the disinfection work was arranged at a later confirmed date. The disinfection of all the outstanding flats was completed on 2 October 2015.

6.7 After the disinfection work, water samples were taken from the same locations in the patient's residence and Mun Ching House as in the previous water sampling before the disinfection work. The laboratory results of all samples were below action level.

6.8 The test results of water samples taken before and after the disinfection work are tabulated at **Annex 6.1**.

6.9 Based on the epidemiological and microbiological findings so far, CHP indicated that the source of infection of the case could not be determined. It was noted that thorough disinfection had been carried out for the water supply system in Mun Ching House as proposed by the Working Group and the test results of all water samples taken from the patient's residence and Mun Ching House after the disinfection were below action level. There was no dead leg identified in the plumbing plan/design for Mun Ching House of KCE. It was therefore considered that no further follow up action was required for the LD case by the Task Force.

Chapter 7 Points to Note

7.1 The Task Force would like to give the following points to note for the attention of the public:

(a) According to the results of stagnation and flushing tests conducted by the Task Force, the heavy metal contents in water will increase with its stagnation time in the water supply chain if there is leaching of heavy metals from its components. In addition, the test results also indicate that the heavy metal contents in the stagnated water can be reduced substantially after flushing for about two minutes. Therefore, **if water has been standing in pipes for a long time (for instance, after several hours of non-use, overnight, over a weekend or after a holiday), the tap should be run for two minutes or longer before using it for drinking or food preparation in order to avoid high concentration of lead in the stagnated water.** The flushed water could be saved and used for purposes other than drinking and cooking.

(b) Lead leaching will be more severe in hot water. In the leaching test for components dismantled from the three water supply chains in KCE and KLE2, the results of lead leaching from the components in the hot water supply systems are shown in the table below:

Lead leached in 24 hours	Hong Ching House	Yuet Ching House	Luen Yat House
22mm diameter copper elbow at toilet (hot water)	639.8µg	229.3µg	242.8µg
22mm diameter copper elbow at toilet (cold water)	3.5µg	20.0µg	5.5µg

The amounts of lead leached from the components in the hot water systems were much higher than those from the cold water systems as shown in the table above. It was because they contained much more lead containing deposits due to the higher amounts of lead leached from leaded solder joints when they were in contact with hot water. **As hot water increases the amount of lead that may leach from pipes and fittings, only water from a cold water tap should be used for cooking and drinking.**

(c) The investigation of the Task Force has concluded that leaded-solder joints were the cause of excess lead in drinking water in KCE and KLE2. Therefore, **for water supply system using other pipe materials without solder joints such as stainless steel pipes, lined galvanised steel pipes or copper pipes with compression joints, the risk of having excess lead in drinking water should be low**.

(d) The Government has published a brochure titled "Hong Kong's Water Supply – Reducing Lead in Drinking Water" which contains useful information on lead in drinking water. The brochure can be obtained in the Public Enquiry Service Centres in all Home Affairs Department District Offices and all estate management offices of HD. It can also be downloaded from designated website: www.isd.gov.hk/drinkingwater of the Information Services Department.

- End -

List of Annexes

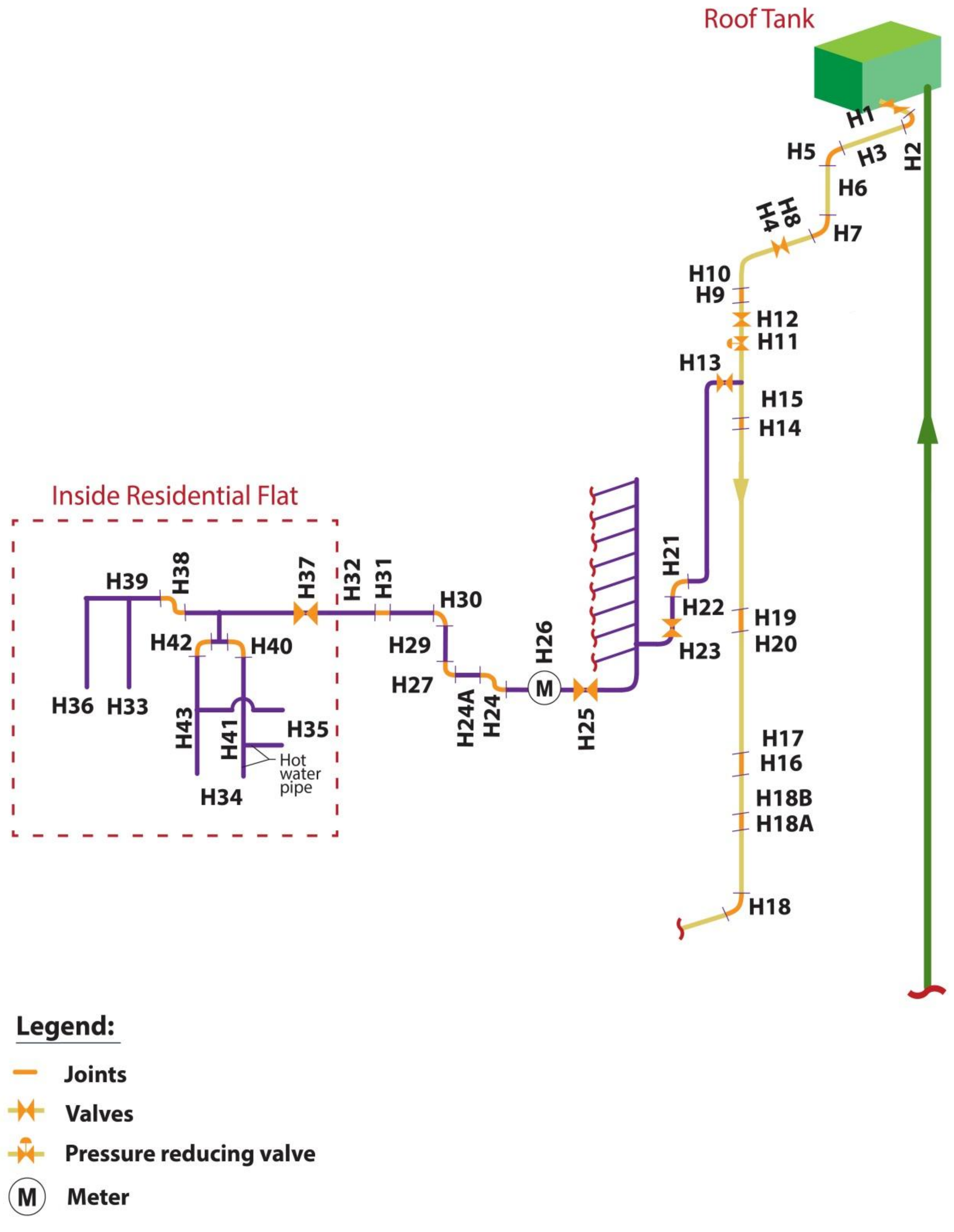
<u>**Annex 2.1**</u>

Results of water samples taken from the sump tank and roof tank of Hong Ching House and Yuet Ching House of KCE and Luen Yat House of KLE2

Estate	House	Location	Lead (μg/L)	Cadmium (μg/L)	Chromium (μg/L)	Nickel* (μg/L)
KCE	Hong Ching House	Roof Tank	<1	<1	<1	12.2
		Sump Tank	<1	<1	<1	13.0
	Yuet Ching House	Roof Tank	<1	<1	<1	12.8
		Sump Tank	<1	<1	<1	13.1
KLE2	Luen Yat House	Roof Tank	<1	<1	<1	5.0
		Sump Tank	<1	<1	<1	5.1
WHO Provisional Guideline Value			≤10	≤3	≤50	≤70

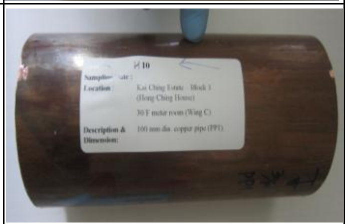
* : According to WSD's water quality monitoring statistics in 2014/2015, nickel content in the treated water in Hong Kong is less than 15 μg/L.

Components of pipes and fittings dismantled from the water supply chain in Hong Ching House of Kai Ching Estate

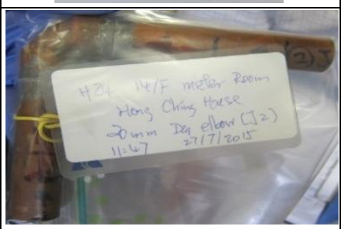


List of the components of pipes and fittings dismantled from the water supply chain in Hong Ching House of Kai Ching Estate

Item No.	Location	Description	Photo
H1	Working platform at lift machine roof	150 mm dia. gate valve (cast iron)	
H2		159 mm dia. elbow (copper)	
H3		159 mm dia. copper pipe	
H4	Main roof floor	150 mm dia. gate valve (cast iron)	
H5		159 mm dia. elbow (copper)	

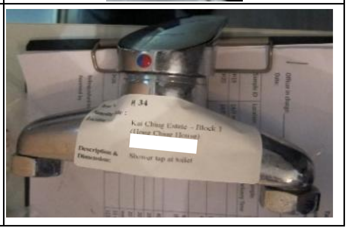
Item No.	Location	Description	Photo
H6	Main roof floor	159 mm dia. copper pipe	
H7		159 mm dia. elbow (copper)	
H8		159 mm dia. copper pipe	
H9	30/F meter room	108 mm dia. socket (copper)	
H10		108 mm dia. copper pipe	
H11	25/F meter room	100 mm dia. pressure reducing valve (copper alloy)	
H12		100 mm dia. gate valve (cast iron)	

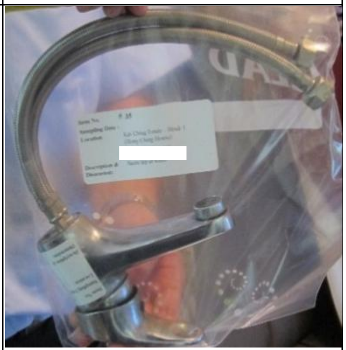
Item No.	Location	Description	Photo
H13	23/F meter room	65 mm dia. gate valve (copper alloy)	
H14	20/F meter room	108 mm dia. socket (copper)	
H15		108 mm dia. copper pipe	
H16	10/F meter room	76.1 mm dia. socket (copper)	
H17		76.1 mm dia. copper pipe	
H18	4/F meter room	54 mm dia. elbow (copper)	
H18A	5/F meter room	54 mm dia. socket (copper)	

Item No.	Location	Description	Photo
H18B	5/F meter room	54 mm dia. copper pipe	
H19	14/F meter room	76.1 mm dia. socket (copper)	
H20		76.1 mm dia. copper pipe	
H21		35 mm dia. elbow (copper)	
H22		35 mm dia. copper pipe	
H23		35 mm dia. gate valve (copper alloy)	
H24		22 mm dia. elbow (copper)	

Item No.	Location	Description	Photo
H24A	14/F meter room	22 mm dia. copper pipe	
H25		20 mm dia. stopcock (copper alloy) before meter	
H26		15 mm dia. meter (copper alloy)	
H27	14/F corridor	22 mm dia. elbow (copper)	
H29		22 mm dia. copper pipe	

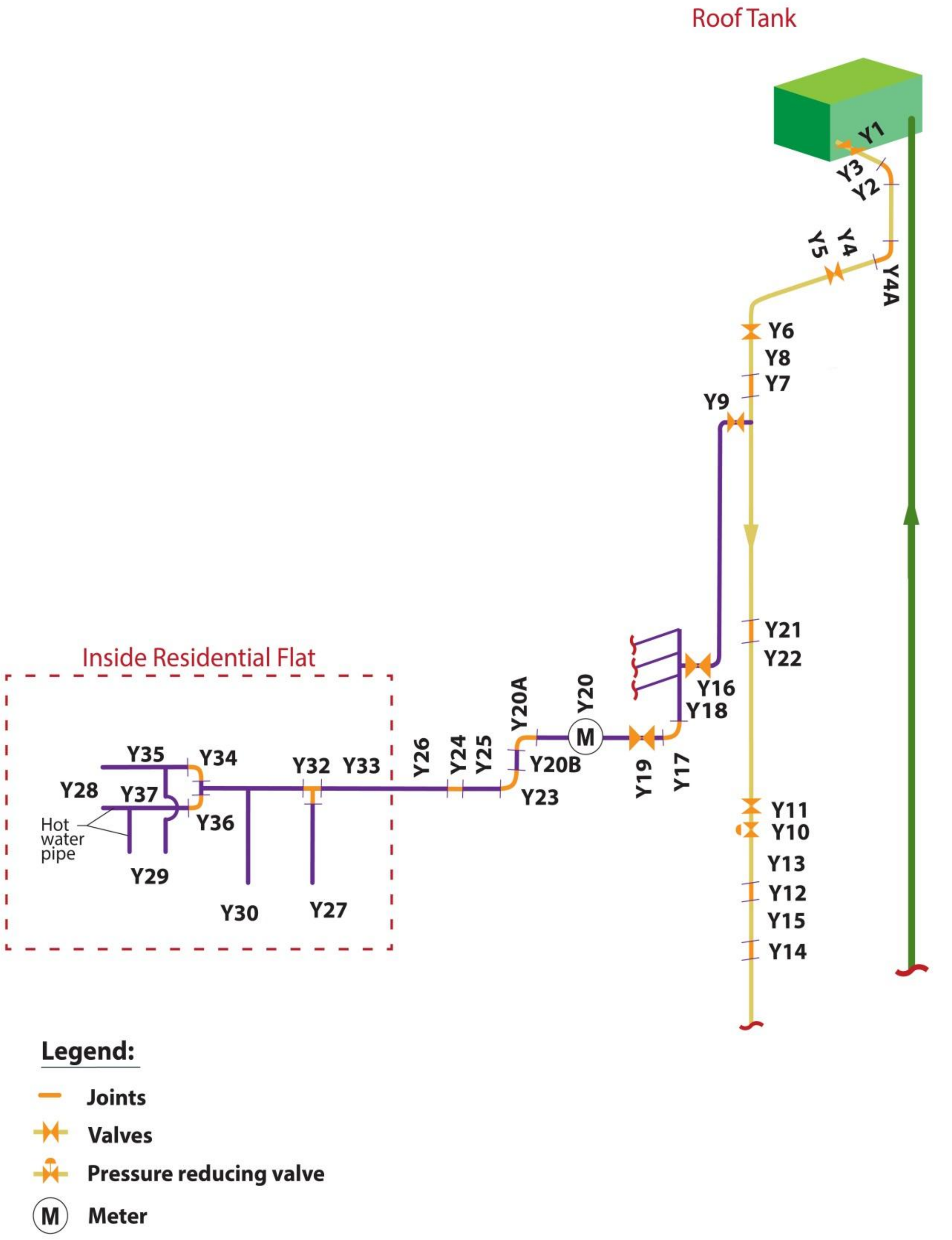
Remark: Item no. H28 not used

Item No.	Location	Description	Photo
H30		22 mm dia. elbow (copper)	
H31	14/F corridor	22 mm dia. socket (copper)	
H32		22 mm dia. copper pipe	
H33	Flat on 14/F	Tap at kitchen (copper alloy)	
H34		Shower tap at toilet (copper alloy)	

Item No.	Location	Description	Photo
H35	Flat on 14/F	Basin tap at toilet (copper alloy)	
H36		Tap for washing machine (copper alloy)	
H37		20 mm dia. gate valve (copper alloy)	
H38		22 mm dia. elbow at kitchen (copper)	

Item No.	Location	Description	Photo
H39	Flat on 14/F	22 mm dia. copper pipe at kitchen	
H40		22 mm dia. elbow (hot water) at toilet (copper)	
H41		22 mm dia. copper pipe (hot water) at toilet	
H42		22 mm dia. elbow (cold water) at toilet (copper)	
H43		22 mm dia. copper pipe (cold water) at toilet	

Components of pipes and fittings dismantled from the water supply chain in Yuet Ching House of Kai Ching Estate



List of the components of pipes and fittings dismantled from the water supply chain in Yuet Ching House of Kai Ching Estate

Item No.	Location	Description	Photo
Y1	Main roof floor	150 mm dia. gate valve (cast iron)	
Y2		159 mm dia. elbow (copper)	
Y3		159 mm dia. copper pipe	
Y4		159 mm dia. copper pipe	
Y4A		159 mm dia. elbow (copper)	

Item No.	Location	Description	Photo
Y5	Main roof floor	100 mm dia. gate valve (cast iron)	
Y6	29/F pipe duct	100 mm dia. gate valve (cast iron)	
Y7		108 mm dia. socket (copper)	
Y8		108 mm dia. copper pipe	
Y9	29/F meter room	65 mm dia. gate valve (copper alloy)	

Item No.	Location	Description	Photo
Y10	18/F pipe duct	65 mm dia. pressure reducing valve (copper alloy)	
Y11		65 mm dia. gate valve (copper alloy)	
Y12	14/F pipe duct	66.7 mm dia. socket (copper)	
Y13		66.7 mm dia. copper pipe	
Y14	6/F pipe duct	54 mm dia. socket (copper)	
Y15		54 mm dia. copper pipe	

Item No.	Location	Description	Photo
Y16	20/F meter room	35 mm dia. gate valve (copper alloy)	
Y17		35 mm dia. elbow (copper)	
Y18		35 mm dia. copper pipe	
Y19		20 mm dia. stopcock (copper alloy) before meter	
Y20		15 mm dia. meter (copper alloy)	
Y20A		22 mm dia. elbow (copper)	

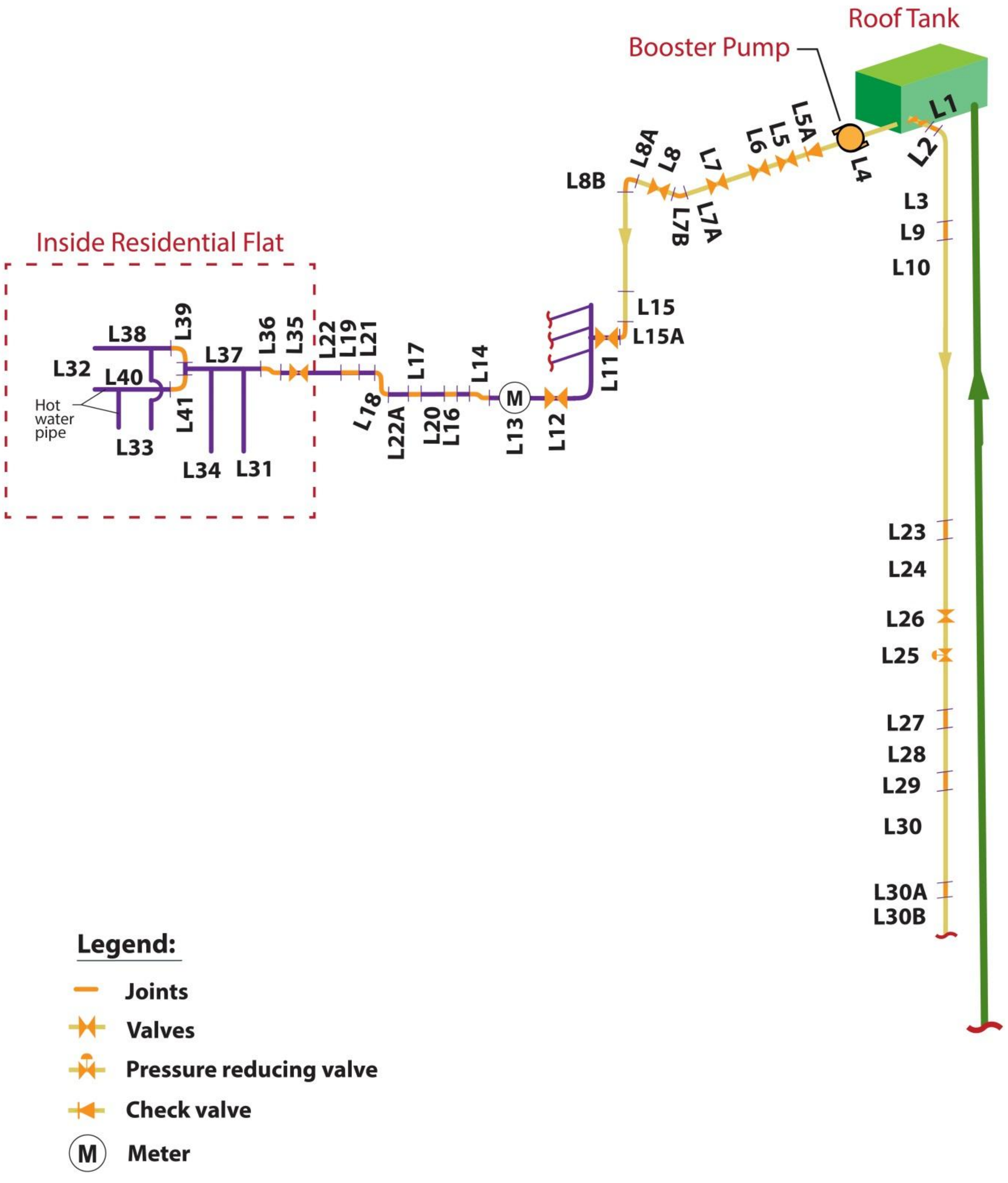
Item No.	Location	Description	Photo
Y20B	20/F meter room	22 mm dia. copper pipe	
Y21	20/F pipe duct	66.7 mm dia. socket (copper)	
Y22		66.7 mm dia. copper pipe	
Y23	20/F corridor	22 mm dia. elbow (copper)	
Y24		22 mm dia. socket (copper)	
Y25		22 mm dia. copper pipe	
Y26		22 mm dia. copper pipe	

Item No.	Location	Description	Photo
Y27	Flat on 20/F	Tap at kitchen (copper alloy)	
Y28		Shower tap at toilet (copper alloy)	
Y29		Basin tap at toilet (copper alloy)	
Y30		Tap for washing machine (copper alloy)	
Y32		22 mm dia. tee at kitchen (copper)	
Y33		22 mm dia. copper pipe at kitchen	

Remark: Item No. Y31 not used

Item No.	Location	Description	Photo
Y34	Flat on 20/F	22 mm dia. elbow (cold water) at toilet (copper)	
Y35		22 mm dia. copper pipe (cold water) at toilet	
Y36		22 mm dia. elbow (hot water) at toilet (copper)	
Y37		22 mm dia. copper pipe (hot water) at toilet	

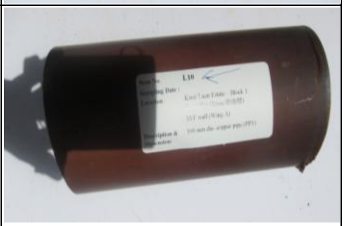
Components of pipes and fittings dismantled from the water supply chain in Luen Yat House of Kwai Luen Estate Phase 2



List of the components of pipes and fittings dismantled from the water supply chain in Luen Yat House of Kwai Luen Estate Phase 2

Item No.	Location	Description	Photo
L1	Upper roof floor	150 mm dia. gate valve (cast iron)	
L2		159 mm dia. socket (copper)	
L3		159 mm dia. copper pipe	
L4	Roof floor	65 mm dia. booster pump (stainless steel)	

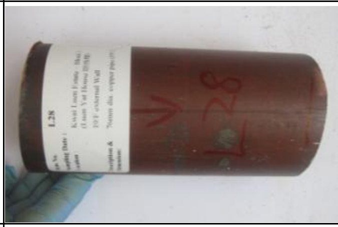
Item No.	Location	Description	Photo
L5		65 mm dia. gate valve (copper alloy)	
L5A		65 mm dia. check valve (cast iron)	
L6	Roof floor	100 mm dia. gate valve (cast iron)	
L7		100 mm dia. gate valve (cast iron)	
L7A		108 mm dia. copper pipe	
L7B		108 mm dia. elbow (copper)	

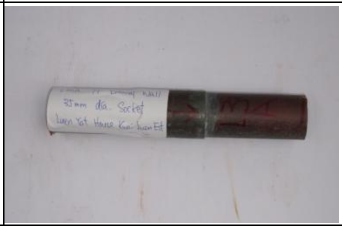
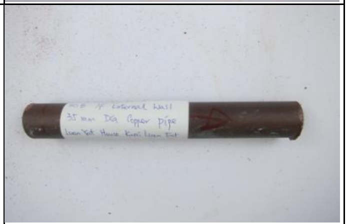
Item No.	Location	Description	Photo
L8	Roof floor	50 mm dia. gate valve (copper alloy)	
L8A		54 mm dia. copper pipe	
L8B		54 mm dia. elbow (copper)	
L9	38/F external wall	108 mm dia. socket (copper)	
L10		108 mm dia. copper pipe	
L11	33/F meter cabinet	35 mm dia. gate valve (copper alloy)	

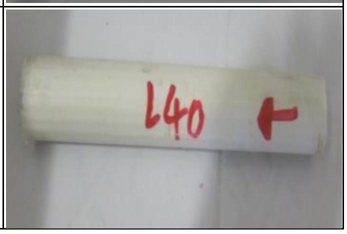
Item No.	Location	Description	Photo
L12	33/F meter cabinet	20 mm dia. stopcock (copper alloy) before meter	
L13		15 mm dia. meter (copper alloy)	
L14		22 mm dia. elbow (copper)	
L15		35 mm dia. copper pipe	
L15A		35 mm dia. elbow (copper)	
L16	33/F corridor	22 mm dia. socket (copper)	
L17		22 mm dia. socket (copper)	

Item No.	Location	Description	Photo
L18	33/F corridor	22 mm dia. elbow (copper)	
L19		22 mm dia. socket (copper)	
L20		22 mm dia. copper pipe	
L21		22 mm dia. copper pipe	
L22		22 mm dia. copper pipe	
L22A		22 mm dia. copper pipe	
L23	27/F external wall	76.1 mm dia. socket (copper)	

Annex 2.2(c)

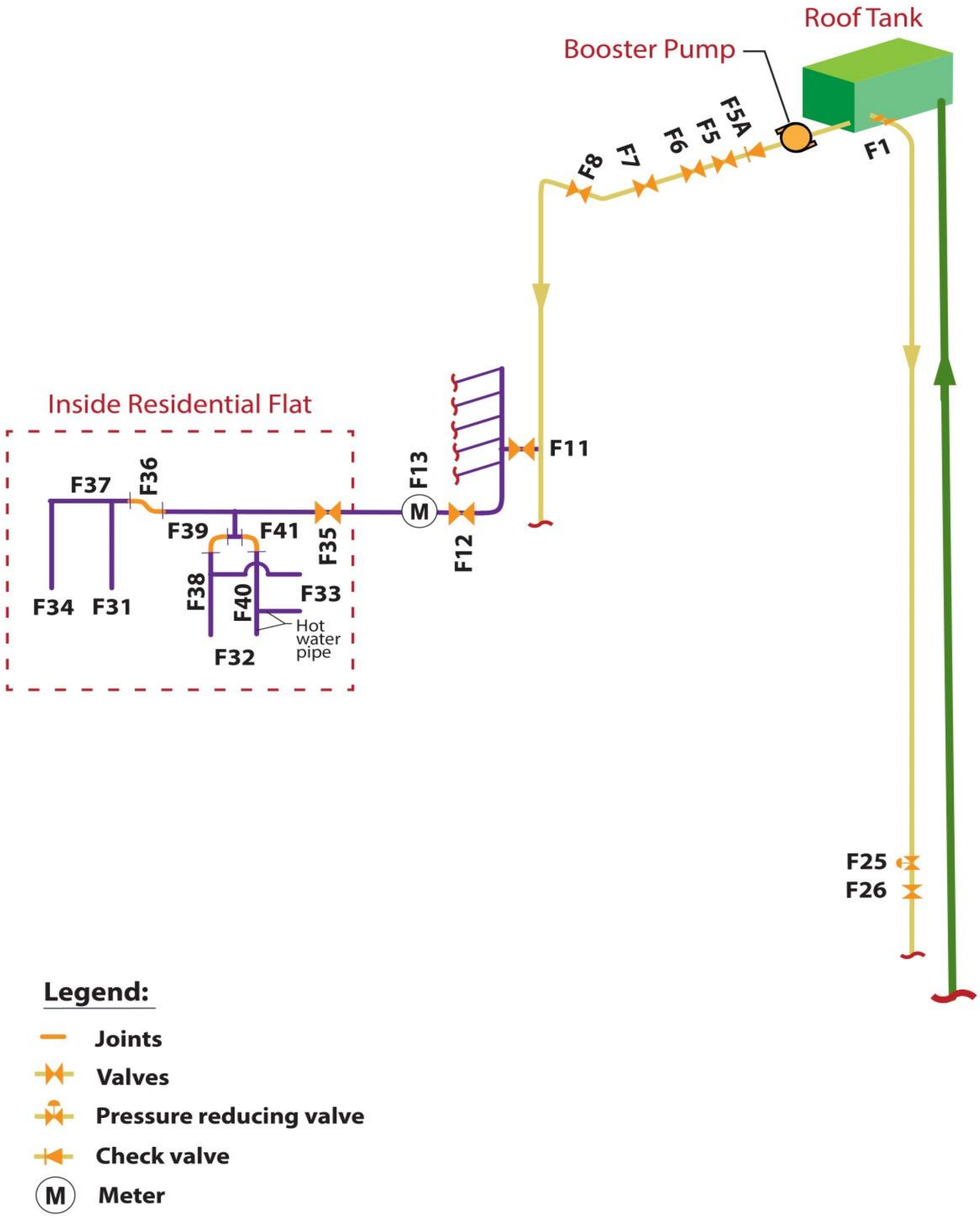
Item No.	Location	Description	Photo
L24	27/F external wall	76.1 mm dia. copper pipe	
L25	26/F meter cabinet	80 mm dia. pressure reducing valve (copper alloy)	
L26		80 mm dia. gate valve (cast iron)	
L27	20/F external wall	76.1 mm dia. socket (copper)	
L28		76.1 mm dia. copper pipe	
L29	10/F external wall	54 mm dia. socket (copper)	

Item No.	Location	Description	Photo
L30	10/F external wall	54 mm dia. copper pipe	
L30A	1/F external wall	35 mm dia. socket (copper)	
L30B		35 mm dia. copper pipe	
L31	Flat on 33/F	Tap at kitchen (copper alloy)	
L32		Shower tap at toilet (copper alloy)	
L33		Basin tap at toilet (copper alloy)	

Item No.	Location	Description	Photo
L34	Flat on 33/F	Tap for washing machine (copper alloy)	
L35		20 mm dia. gate valve (copper alloy)	
L36		22 mm dia. elbow at kitchen (copper)	
L37		22 mm dia. copper pipe at kitchen	
L38		22 mm dia. copper pipe (cold water) at toilet	
L39		22 mm dia. elbow (cold water) at toilet (copper)	
L40		22 mm dia. copper pipe (hot water) at toilet	

Item No.	Location	Description	Photo
L41	Flat on 33/F	22 mm dia. elbow (hot water) at toilet (copper)	

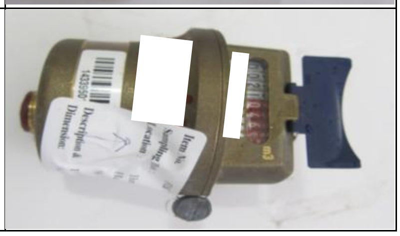
Components of pipes and fittings dismantled from the water supply chain in Hung Hei House of Hung Fuk Estate



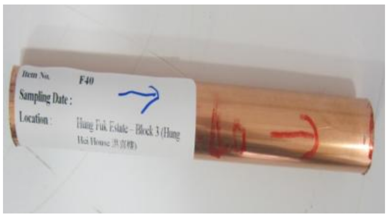
List of the components of pipes and fittings dismantled from the water supply chain in Hung Hei House of Hung Fuk Estate

Item No.	Location	Description	Photo
F1	Upper roof floor	150 mm dia. gate valve (cast iron)	
F5	Roof floor	65 mm dia. gate valve (copper alloy)	
F5A		65 mm dia. check valve (cast iron)	
F6		100 mm dia. gate valve (cast iron)	

Remark: Item no. not assigned in numerical order

Item No.	Location	Description	Photo
F7	Roof floor	100 mm dia. gate valve (cast iron)	
F8		80 mm dia. gate valve (cast iron)	
F11	16/F meter cabinet	40 mm dia. gate valve (copper alloy)	
F12		20 mm dia. stopcock (copper alloy) before meter	
F13		15 mm dia. meter (copper alloy)	

Item No.	Location	Description	Photo
F25	7/F meter cabinet	100 mm dia. pressure reducing valve (copper alloy)	
F26		100 mm dia. gate valve (cast iron)	
F31	Flat on 16/F	Tap at kitchen (copper alloy)	
F32		Shower tap at toilet (copper alloy)	
F33		Basin tap at toilet (copper alloy)	
F34		Tap for washing machine (copper alloy)	

Item No.	Location	Description	Photo
F35	Flat on 16/F	20 mm dia. gate valve (copper alloy)	
F36		22 mm dia. elbow at kitchen (copper)	
F37		22 mm dia. copper pipe at kitchen	
F38		22 mm dia. copper pipe (cold water) at toilet	
F39		22 mm dia. elbow (cold water) at toilet (copper)	
F40		22 mm dia. copper pipe (hot water) at toilet	
F41		22 mm dia. elbow (hot water) at toilet (copper)	

Leaching test results of the components dismantled from the water supply chain in

Hong Ching House of Kai Ching Estate

			Before cleansing deposits							
			Leached amount by concentration				Leached amount by mass			
Item No.	**Description**	**Immersion water volume^ (mL)**	**Lead (µg/L)**	**Chromium (µg/L)**	**Cadmium (µg/L)**	**Nickel (µg/L)**	**Lead (µg)**	**Chromium (µg)**	**Cadmium (µg)**	**Nickel (µg)**
H1	150 mm dia. gate valve (cast iron)	7000.0	< 1	< 1	< 1	7.5	0.0	0.0	0.0	52.5
H2	159 mm dia. elbow (copper)	5000.0	< 1	< 1	< 1	10.6	0.0	0.0	0.0	53.0
H3	159 mm dia. copper pipe	3900.0	< 1	< 1	< 1	10.5	0.0	0.0	0.0	41.0
H4	150 mm dia. gate valve (cast iron)	7000.0	< 1	< 1	< 1	9.0	0.0	0.0	0.0	63.0
H5	159 mm dia. elbow (copper)	8000.0	< 1	< 1	< 1	10.0	0.0	0.0	0.0	80.0
H6	159 mm dia. copper pipe	2000.0	< 1	< 1	< 1	12.9	0.0	0.0	0.0	25.8
H7	159 mm dia. elbow (copper)	5000.0	< 1	< 1	< 1	9.6	0.0	0.0	0.0	48.0
H8	159 mm dia. copper pipe	2000.0	< 1	< 1	< 1	10.6	0.0	0.0	0.0	21.2
H9	108 mm dia. socket (copper)	2300.0	< 1	< 1	< 1	11.0	0.0	0.0	0.0	25.3
H10	108 mm dia. copper pipe	1700.0	< 1	< 1	< 1	9.8	0.0	0.0	0.0	16.7
H11(Inlet)	100 mm dia. pressure reducing valve (copper alloy)	500.0	14.2	< 1	< 1	4.6	7.1	0.0	0.0	2.3
H11(Outlet)	100 mm dia. pressure reducing valve (copper alloy)	1300.0	33.8	< 1	< 1	6.1	43.9	0.0	0.0	7.9
H12	100 mm dia. gate valve (cast iron)	2800.0	1.6	< 1	< 1	2.7	4.5	0.0	0.0	7.6
H13	65 mm dia. gate valve (copper alloy)	500.0	20.2	< 1	< 1	17.4	10.1	0.0	0.0	8.7
H14	108 mm dia. socket (copper)	2400.0	< 1	< 1	< 1	9.8	0.0	0.0	0.0	23.5
H15	108 mm dia. copper pipe	1700.0	< 1	< 1	< 1	11.1	0.0	0.0	0.0	18.9
H16	76.1 mm dia. socket (copper)	1100.0	< 1	< 1	< 1	10.2	0.0	0.0	0.0	11.2
H17	76.1 mm dia. copper pipe	950.0	< 1	< 1	< 1	10.3	0.0	0.0	0.0	9.8
H18	54 mm dia. elbow (copper)	600.0	4.8	< 1	< 1	11.0	2.9	0.0	0.0	6.6
H18A	54 mm dia. socket (copper)	540.0	2.6	< 1	< 1	11.9	1.4	0.0	0.0	6.4
H18B	54 mm dia. copper pipe	410.0	< 1	< 1	< 1	8.2	0.0	0.0	0.0	3.4
H19	76.1 mm dia. socket (copper)	1000.0	< 1	< 1	< 1	10.2	0.0	0.0	0.0	10.2
H20	76.1 mm dia. copper pipe	840.0	< 1	< 1	< 1	9.8	0.0	0.0	0.0	8.2

			Before cleansing deposits							
			Leached amount by concentration				Leached amount by mass			
Item No.	**Description**	**Immersion water volume^ (mL)**	**Lead (µg/L)**	**Chromium (µg/L)**	**Cadmium (µg/L)**	**Nickel (µg/L)**	**Lead (µg)**	**Chromium (µg)**	**Cadmium (µg)**	**Nickel (µg)**
H21	35 mm dia. elbow (copper)	192.0	4.1	< 1	< 1	11.6	0.8	0.0	0.0	2.2
H22	35 mm dia. copper pipe	174.0	< 1	< 1	< 1	11.8	0.0	0.0	0.0	2.1
H23	35 mm dia. gate valve (copper alloy)	200.0	51.7	< 1	< 1	45.4	10.3	0.0	0.0	9.1
H24	22 mm dia. elbow (copper)	72.0	11.2	< 1	< 1	15.5	0.8	0.0	0.0	1.1
H24A	22 mm dia. copper pipe	65.0	38.1	< 1	< 1	26.1	2.5	0.0	0.0	1.7
H25	20 mm dia. stopcock (copper alloy) before meter	78.0	177.3	< 1	< 1	108.1	13.8	0.0	0.0	8.4
H26	15 mm dia. meter (copper alloy)	104.0	36.0	< 1	< 1	39.4	3.7	0.0	0.0	4.1
H27	22 mm dia. elbow (copper)	117.0	37.1	< 1	< 1	14.8	4.3	0.0	0.0	1.7
H29	22 mm dia. copper pipe	74.0	17.1	< 1	< 1	20.5	1.3	0.0	0.0	1.5
H30	22 mm dia. elbow (copper)	123.0	140.5	< 1	< 1	22.3	17.3	0.0	0.0	2.7
H31	22 mm dia. socket (copper)	78.0	91.1	< 1	< 1	33.2	7.1	0.0	0.0	2.6
H32	22 mm dia. copper pipe	74.0	22.4	< 1	< 1	19.6	1.7	0.0	0.0	1.5
H33	Tap at kitchen (mixer) (copper alloy)	31.0	133.1	< 1	< 1	112.0	4.1	0.0	0.0	3.5
H33A	Tap at kitchen_ part 2 (swan neck) (copper alloy)	89.0	23.9	< 1	< 1	54.8	2.1	0.0	0.0	4.9
H34	Shower tap at toilet (copper alloy)	158.0	< 1	< 1	< 1	12.0	0.0	0.0	0.0	1.9
H35	Basin tap at toilet (copper alloy)	36.0	127.0	< 1	< 1	63.3	4.6	0.0	0.0	2.3
H36	Tap for washing machine (copper alloy)	65.0	211.0	2.5	< 1	1569.0	13.7	0.2	0.0	102.0
H37	20 mm dia. gate valve (copper alloy)	92.0	161.7	< 1	< 1	77.7	14.9	0.0	0.0	7.1
H38	22 mm dia. elbow at kitchen (copper)	40.0	372.8	< 1	< 1	90.8	14.9	0.0	0.0	3.6
H39	22 mm dia. copper pipe at kitchen	46.0	348.8	< 1	< 1	25.6	16.0	0.0	0.0	1.2
H40	22 mm dia. elbow (hot water) at toilet (copper)	86.0	7440.0	< 1	< 1	20.7	639.8	0.0	0.0	1.8
H41	22 mm dia. copper pipe (hot water) at toilet	98.0	78.9	< 1	< 1	13.5	7.7	0.0	0.0	1.3
H42	22 mm dia. elbow (cold water) at toilet (copper)	69.0	51.2	< 1	< 1	20.4	3.5	0.0	0.0	1.4
H43	22 mm dia. copper pipe (cold water) at toilet	79.0	69.0	< 1	< 1	32.6	5.5	0.0	0.0	2.6

^Volume of water used to fill up the component for leaching test

Leaching test results of the components dismantled from the water supply chain in

Hong Ching House of Kai Ching Estate

			After cleansing deposits							
			Leached amount by concentration				Leached amount by mass			
Item No.	**Description**	**Immersion water volume (mL)^**	**Lead (μg/L)**	**Chromium (μg/L)**	**Cadmium (μg/L)**	**Nickel (μg/L)**	**Lead (μg)**	**Chromium (μg)**	**Cadmium (μg)**	**Nickel (μg)**
H11(Inlet)*	100 mm dia. pressure reducing valve (copper alloy)	500.0	37.0	<1	<1	8.4	18.5	0.0	0.0	4.2
H11(Outlet)*	100mm dia. pressure reducing valve (copper alloy)	1300.0	54.4	<1	<1	9.4	70.7	0.0	0.0	12.2
H12	100 mm dia. gate valve (cast iron)	2800.0	2.1	<1	<1	5.5	5.9	0.0	0.0	15.4
H13	65 mm dia. gate valve (copper alloy)	500.0	22.7	<1	<1	23.2	11.4	0.0	0.0	11.6
H23	35 mm dia. gate valve (copper alloy)	200.0	53.2	<1	<1	50.0	10.6	0.0	0.0	10.0
H24	22 mm dia. elbow (copper)	72.0	1.3	<1	<1	17.0	0.1	0.0	0.0	1.2
H24A	22 mm dia. copper pipe	65.0	16.2	<1	<1	17.9	1.1	0.0	0.0	1.2
H25	20 mm dia. stopcock (copper alloy) before meter	78.0	42.0	<1	<1	28.8	3.3	0.0	0.0	2.2
H26	15 mm dia. meter (copper alloy)	104.0	11.6	<1	<1	20.5	1.2	0.0	0.0	2.1
H30	22 mm dia. elbow (copper)	123.0	81.8	<1	<1	15.1	10.1	0.0	0.0	1.9
H31	22 mm dia. socket (copper)	78.0	7.2	<1	<1	16.2	0.6	0.0	0.0	1.3
H32	22 mm dia. copper pipe	74.0	1.5	<1	<1	16.0	0.1	0.0	0.0	1.2
H37	20 mm dia. gate valve (copper alloy)	92.0	47.8	<1	<1	78.1	4.4	0.0	0.0	7.2
H42	22 mm dia. elbow (cold water) at toilet (copper)	69.0	3.2	<1	<1	17.2	0.2	0.0	0.0	1.2
H43	22 mm dia. copper pipe (cold water) at toilet	79.0	1.6	<1	<1	3.0	0.1	0.0	0.0	0.2

* The cleansing for H11(Inlet) and H11(Outlet) was not effective as shown by the higher reading after cleansing. The results were not adopted in para. 2.5.5.

^ Volume of water used to fill up the component for leaching test

Leaching test results of the components dismantled from the water supply chain in

Yuet Ching House of Kai Ching Estate

			Before cleansing deposits							
			Leached amount by concentration				Leached amount by mass			
Item No.	**Description**	**Immersion water volume (mL)^**	**Lead (µg/L)**	**Chromium (µg/L)**	**Cadmium (µg/L)**	**Nickel (µg/L)**	**Lead (µg)**	**Chromium (µg)**	**Cadmium (µg)**	**Nickel (µg)**
Y1	150 mm dia. gate valve (cast iron)	7000.0	< 1	< 1	< 1	8.7	0.0	0.0	0.0	60.9
Y2	159 mm dia. elbow (copper)	6000.0	< 1	< 1	< 1	11.4	0.0	0.0	0.0	68.4
Y3	159 mm dia. copper pipe	3000.0	< 1	< 1	< 1	13.2	0.0	0.0	0.0	39.6
Y4	159 mm dia. copper pipe	1900.0	< 1	< 1	< 1	12.2	0.0	0.0	0.0	23.2
Y4A	159 mm dia. elbow (copper)	3000.0	1.8	< 1	< 1	12.0	5.4	0.0	0.0	36.0
Y5	100 mm dia. gate valve (cast iron)	3000.0	< 1	< 1	< 1	10.1	0.0	0.0	0.0	30.3
Y6	100 mm dia. gate valve (cast iron)	2800.0	< 1	< 1	< 1	9.4	0.0	0.0	0.0	26.3
Y7	108 mm dia. socket (copper)	2360.0	< 1	< 1	< 1	9.5	0.0	0.0	0.0	22.4
Y8	108 mm dia. copper pipe	1800.0	< 1	< 1	< 1	8.9	0.0	0.0	0.0	16.0
Y9	65 mm dia. gate valve (copper alloy)	400.0	98.4	< 1	< 1	71.4	39.4	0.0	0.0	28.6
Y10 (Inlet)	65 mm dia. pressure reducing valve (copper alloy)	300.0	62.4	< 1	< 1	20.4	18.7	0.0	0.0	6.1
Y10 (Outlet)	65 mm dia. pressure reducing valve (copper alloy)	500.0	37.2	< 1	< 1	19.6	18.6	0.0	0.0	9.8
Y11	65 mm dia. gate valve (copper alloy)	400.0	172.2	< 1	< 1	27.7	68.9	0.0	0.0	11.1
Y12	66.7 mm dia. socket (copper)	800.0	< 1	< 1	< 1	12.4	0.0	0.0	0.0	9.9
Y13	66.7 mm dia. copper pipe	600.0	< 1	< 1	< 1	14.7	0.0	0.0	0.0	8.8
Y14	54 mm dia. socket (copper)	500.0	< 1	< 1	< 1	13.1	0.0	0.0	0.0	6.6
Y15	54 mm dia. copper pipe	400.0	< 1	< 1	< 1	13.9	0.0	0.0	0.0	5.6
Y16	35 mm dia. gate valve (copper alloy)	68.0	117.7	< 1	2.7	159.9	8.0	0.0	0.2	10.9
Y17	35 mm dia. elbow (copper)	205.0	< 1	< 1	< 1	14.4	0.0	0.0	0.0	3.0
Y18	35 mm dia. copper pipe	173.0	< 1	< 1	< 1	12.7	0.0	0.0	0.0	2.2

Item No.	Description	Immersion water volume (mL)^	Before cleansing deposits							
			Leached amount by concentration				Leached amount by mass			
			Lead (µg/L)	Chromium (µg/L)	Cadmium (µg/L)	Nickel (µg/L)	Lead (µg)	Chromium (µg)	Cadmium (µg)	Nickel (µg)
Y19	20 mm dia. stopcock (copper alloy) before meter	65.0	100.4	< 1	< 1	60.6	6.5	0.0	0.0	3.9
Y20	15 mm dia. meter (copper alloy)	100.0	202.2	1.4	< 1	215.0	20.2	0.1	0.0	21.5
Y20A	22 mm dia. elbow (copper)	71.0	2620.0	< 1	< 1	56.0	186.0	0.0	0.0	4.0
Y20B	22 mm dia. copper pipe	75.0	59.8	< 1	< 1	92.6	4.5	0.0	0.0	6.9
Y21	66.7 mm dia. socket (copper)	740.0	< 1	< 1	< 1	11.4	0.0	0.0	0.0	8.4
Y22	66.7 mm dia. copper pipe	680.0	< 1	< 1	< 1	13.1	0.0	0.0	0.0	8.9
Y23	22 mm dia. elbow (copper)	69.0	577.5	1.8	< 1	160.5	39.8	0.1	0.0	11.1
Y24	22 mm dia. socket (copper)	76.0	2345.0	2.5	< 1	195.0	178.2	0.2	0.0	14.8
Y25	22 mm dia. copper pipe	70.0	79.4	1.4	< 1	120.9	5.6	0.1	0.0	8.5
Y26	22 mm dia. copper pipe	72.0	358.0	2.4	< 1	209.0	25.8	0.2	0.0	15.0
Y27	Tap at kitchen (swan neck) (copper alloy)	95.0	16.3	< 1	< 1	17.5	1.5	0.0	0.0	1.7
Y27A	Tap at kitchen _ Part 2 (mixer) (copper alloy)	56.0	37.1	< 1	< 1	54.7	2.1	0.0	0.0	3.1
Y28	Shower tap at toilet (copper alloy)	136.0	4.7	< 1	< 1	157.6	0.6	0.0	0.0	21.4
Y29	Basin tap at toilet (copper alloy)	29.0	51.6	< 1	< 1	240.9	1.5	0.0	0.0	7.0
Y30	Tap for washing machine (copper alloy)	65.0	3.6	< 1	< 1	804.5	0.2	0.0	0.0	52.3
Y32	22 mm dia. tee at kitchen (copper)	90.0	6655.0	< 1	< 1	125.0	599.0	0.0	0.0	11.3
Y33	22 mm dia. copper pipe at kitchen	64.0	1310.0	< 1	< 1	102.0	83.8	0.0	0.0	6.5
Y34	22 mm dia. elbow (cold water) at toilet (copper)	82.0	244.5	< 1	< 1	12.5	20.0	0.0	0.0	1.0
Y35	22 mm dia. copper pipe (cold water) at toilet	74.0	222.5	< 1	< 1	55.0	16.5	0.0	0.0	4.1
Y36	22 mm dia. elbow (hot water) at toilet (copper)	80.0	2866.0	< 1	< 1	38.0	229.3	0.0	0.0	3.0
Y37	22 mm dia. copper pipe (hot water) at toilet	75.0	334.8	< 1	< 1	43.4	25.1	0.0	0.0	3.3

^ Volume of water used to fill up the component for leaching test

Leaching test results of the components dismantled from the water supply chain in Yuet Ching House of Kai Ching Estate

			After cleansing deposits							
			Leached amount by concentration				Leached amount by mass			
Item No.	Description	Immersion water volume (mL)^	Lead (μg/L)	Chromium (μg/L)	Cadmium (μg/L)	Nickel (μg/L)	Lead (μg)	Chromium (μg)	Cadmium (μg)	Nickel (μg)
Y4A	159 mm dia. elbow (copper)	3000.0	<1	<1	<1	12.7	0.0	0.0	0.0	38.1
Y9	65 mm dia. gate valve (copper alloy)	400.0	42.6	<1	<1	41.0	17.0	0.0	0.0	16.4
Y10 (Inlet)*	65 mm dia. pressure reducing valve (copper alloy)	300.0	167.2	<1	<1	11.8	50.2	0.0	0.0	3.5
Y10 (Outlet)	65 mm dia. pressure reducing valve (copper alloy)	500.0	18.2	<1	<1	10.4	9.1	0.0	0.0	5.2
Y11	65 mm dia. gate valve (copper alloy)	400.0	93.8	<1	<1	21.5	37.5	0.0	0.0	8.6
Y16	35 mm dia. gate valve (copper alloy)	68.0	62.6	<1	<1	52.0	4.3	0.0	0.0	3.5
Y19	20 mm dia. stopcock (copper alloy) before meter	65.0	22.5	<1	<1	34.1	1.5	0.0	0.0	2.2
Y20	15 mm dia. meter (copper alloy)	100.0	2.9	<1	<1	16.8	0.3	0.0	0.0	1.7
Y20A	22 mm dia. elbow (copper)	71.0	95.6	<1	<1	17.6	6.8	0.0	0.0	1.2
Y20B	22 mm dia. copper pipe	75.0	<1	<1	<1	19.8	0.0	0.0	0.0	1.5
Y32	22 mm dia. tee at kitchen (copper)	90.0	316.0	<1	<1	12.4	28.4	0.0	0.0	1.1
Y33	22 mm dia. copper pipe at kitchen	64.0	6.5	<1	<1	25.2	0.4	0.0	0.0	1.6
Y34	22 mm dia. elbow (cold water) at toilet (copper)	82.0	24.8	<1	<1	11.8	2.0	0.0	0.0	1.0
Y36	22 mm dia. elbow (hot water) at toilet (copper)	80.0	113.6	<1	<1	14.6	9.1	0.0	0.0	1.2
Y37	22 mm dia. copper pipe (hot water) at toilet	75.0	3.6	<1	<1	16.4	0.3	0.0	0.0	1.2

* The cleansing for Y10(Inlet) was not effective as shown by the higher reading after cleansing. The results were not adopted in para. 2.6.3.

^ Volume of water used to fill up the component for leaching test

Leaching test results of the components dismantled from the water supply chain in

Luen Yat House of Kwai Luen Estate Phase 2

			Before cleansing deposits							
			Leached amount by concentration				Leached amount by mass			
Item No.	Description	Immersion water volume (mL)^	Lead (µg/L)	Chromium (µg/L)	Cadmium (µg/L)	Nickel (µg/L)	Lead (µg)	Chromium (µg)	Cadmium (µg)	Nickel (µg)
L1	150 mm dia. gate valve (cast iron)	7560.0	< 1	< 1	< 1	6.3	0.0	0.0	0.0	47.6
L2	159 mm dia. socket (copper)	5500.0	< 1	< 1	< 1	6.3	0.0	0.0	0.0	34.7
L3	159 mm dia. copper pipe	5000.0	< 1	< 1	< 1	6.2	0.0	0.0	0.0	31.0
L4	65 mm dia. booster pump (stainless steel)	15000.0	1.9	< 1	< 1	10.2	28.5	0.0	0.0	153.0
L5	65 mm dia. gate valve (copper alloy)	500.0	432.8	< 1	< 1	2.2	216.4	0.0	0.0	1.1
L5A (Inlet)	65 mm dia. check valve (cast iron)	172.0	<1	< 1	< 1	8.4	0.0	0.0	0.0	1.4
L5A (Outlet)	65 mm dia. check valve (cast iron)	610.0	< 1	< 1	< 1	12.4	0.0	0.0	0.0	7.6
L6	100 mm dia. gate valve (cast iron)	2660.0	<1	< 1	< 1	10.7	0.0	0.0	0.0	28.5
L7	100 mm dia. gate valve (cast iron)	2680.0	<1	< 1	< 1	6.2	0.0	0.0	0.0	16.6
L7A	108 mm dia. copper pipe	2000.0	<1	< 1	< 1	5.8	0.0	0.0	0.0	11.6
L7B	108 mm dia. elbow (copper)	4400.0	<1	< 1	< 1	6.4	0.0	0.0	0.0	28.2
L8	50 mm dia. gate valve (copper alloy)	233.0	45.0	< 1	< 1	14.6	10.5	0.0	0.0	3.4
L8A	54 mm dia. copper pipe	410.0	< 1	< 1	< 1	7.4	0.0	0.0	0.0	3.0
L8B	54 mm dia. elbow (copper)	570.0	30.2	< 1	< 1	7.7	17.2	0.0	0.0	4.4
L9	108 mm dia. socket (copper)	2610.0	< 1	< 1	< 1	6.3	0.0	0.0	0.0	16.4
L10	108 mm dia. copper pipe	2800.0	< 1	< 1	< 1	6.6	0.0	0.0	0.0	18.5
L11	35 mm dia. gate valve (copper alloy)	80.0	133.9	< 1	< 1	15.6	10.7	0.0	0.0	1.2
L12	20 mm dia. stopcock (copper alloy) before meter	67.0	384.5	< 1	< 1	15.8	25.8	0.0	0.0	1.1
L13	15 mm dia. meter (copper alloy)	104.0	633.5	< 1	< 1	23.5	65.9	0.0	0.0	2.4
L14	22 mm dia. elbow (copper)	120.0	372.0	< 1	< 1	6.8	44.6	0.0	0.0	0.8

Item No.	Description	Immersion water volume (mL)^	Before cleansing deposits							
			Leached amount by concentration				Leached amount by mass			
			Lead (µg/L)	Chromium (µg/L)	Cadmium (µg/L)	Nickel (µg/L)	Lead (µg)	Chromium (µg)	Cadmium (µg)	Nickel (µg)
L15	35 mm dia. copper pipe	185.0	22.8	< 1	< 1	11.2	4.2	0.0	0.0	2.1
L15A	35 mm dia. elbow (copper)	155.0	186.0	< 1	< 1	7.2	28.8	0.0	0.0	1.1
L16	22 mm dia. socket (copper)	62.0	65.2	< 1	< 1	7.1	4.0	0.0	0.0	0.4
L17	22 mm dia. socket (copper)	63.0	31.0	< 1	< 1	7.4	2.0	0.0	0.0	0.5
L18	22 mm dia. elbow (copper)	115.0	200.0	< 1	< 1	5.8	23.0	0.0	0.0	0.7
L19	22 mm dia. socket (copper)	66.0	20.4	< 1	< 1	5.8	1.3	0.0	0.0	0.4
L20	22 mm dia. copper pipe	70.0	8.7	< 1	< 1	6.2	0.6	0.0	0.0	0.4
L21	22 mm dia. copper pipe	69.0	19.5	< 1	< 1	6.2	1.3	0.0	0.0	0.4
L22	22 mm dia. copper pipe	68.0	17.2	< 1	< 1	6.4	1.2	0.0	0.0	0.4
L22A	22 mm dia. copper pipe	63.0	13.0	< 1	< 1	6.3	0.8	0.0	0.0	0.4
L23	76.1 mm dia. socket (copper)	980.0	< 1	< 1	< 1	7.2	0.0	0.0	0.0	7.1
L24	76.1 mm dia. copper pipe	880.0	< 1	< 1	< 1	7.8	0.0	0.0	0.0	6.9
L25 (Inlet)	80 mm dia. pressure reducing valve (copper alloy)	245.0	110.0	< 1	< 1	10.0	27.0	0.0	0.0	2.5
L25 (Outlet)	80 mm dia. pressure reducing valve (copper alloy)	700.0	47.1	< 1	< 1	8.2	33.0	0.0	0.0	5.7
L26	80 mm dia. gate valve (cast iron)	1400.0	2.4	< 1	< 1	6.0	3.4	0.0	0.0	8.4
L27	76.1 mm dia. socket (copper)	1000.0	< 1	< 1	< 1	6.5	0.0	0.0	0.0	6.5
L28	76.1 mm dia. copper pipe	800.0	< 1	< 1	< 1	6.6	0.0	0.0	0.0	5.3
L29	54 mm dia. socket (copper)	500.0	< 1	< 1	< 1	9.0	0.0	0.0	0.0	4.5
L30	54 mm dia. copper pipe	400.0	19.7	< 1	< 1	9.4	7.9	0.0	0.0	3.8
L30A	35 mm dia. socket (copper)	182.0	142.6	< 1	< 1	9.1	26.0	0.0	0.0	1.7
L30B	35 mm dia. copper pipe	178.0	24.7	< 1	< 1	9.1	4.4	0.0	0.0	1.6
L31	Tap at kitchen (mixer) (copper alloy)	70.0	49.6	< 1	< 1	95.8	3.5	0.0	0.0	6.7
L31A	Tap at kitchen_ Part 2 (swan neck) (copper alloy)	57.0	101.5	< 1	< 1	32.8	5.8	0.0	0.0	1.9
L32	Shower tap at toilet (copper alloy)	135.0	20.6	< 1	< 1	16.0	2.8	0.0	0.0	2.2

			Before cleansing deposits							
			Leached amount by concentration				Leached amount by mass			
Item No.	**Description**	**Immersion water volume (mL)^**	**Lead (µg/L)**	**Chromium (µg/L)**	**Cadmium (µg/L)**	**Nickel (µg/L)**	**Lead (µg)**	**Chromium (µg)**	**Cadmium (µg)**	**Nickel (µg)**
L33	Basin tap at toilet (copper alloy)	40.0	29.0	< 1	< 1	16.6	1.2	0.0	0.0	0.7
L34	Tap for washing machine (copper alloy)	65.0	42.5	< 1	< 1	52.2	2.8	0.0	0.0	3.4
L35	20 mm dia. gate valve (copper alloy)	68.0	219.5	< 1	< 1	20.9	14.9	0.0	0.0	1.4
L36	22 mm dia. elbow at kitchen (copper)	80.0	44.4	< 1	< 1	6.4	3.6	0.0	0.0	0.5
L37	22 mm dia. copper pipe at kitchen	68.0	10.9	< 1	< 1	5.2	0.7	0.0	0.0	0.4
L38	22 mm dia. copper pipe (cold water) at toilet	65.0	14.5	< 1	< 1	4.4	0.9	0.0	0.0	0.3
L39	22 mm dia. elbow (cold water) at toilet (copper)	68.0	81.4	< 1	< 1	5.8	5.5	0.0	0.0	0.4
L40	22 mm dia. copper pipe (hot water) at toilet	67.0	111.6	< 1	< 1	5.4	7.5	0.0	0.0	0.4
L41	22 mm dia. elbow (hot water) at toilet (copper)	102.0	2380.0	< 1	< 1	5.0	242.8	0.0	0.0	0.5

^ Volume of water used to fill up the component for leaching test

Leaching test results of the components dismantled from the water supply chain in

Luen Yat House of Kwai Luen Estate Phase 2

Item No.	Description	Immersion water volume (mL)^	After cleansing deposits: Leached amount by concentration: Lead (µg/L)	Chromium (µg/L)	Cadmium (µg/L)	Nickel (µg/L)	After cleansing deposits: Leached amount by mass: Lead (µg)	Chromium (µg)	Cadmium (µg)	Nickel (µg)
L5	65 mm dia. gate valve (copper alloy)	500.0	48.4	< 1	< 1	4.0	24.2	0.0	0.0	2.0
L8	50 mm dia. gate valve (copper alloy)	233.0	44.3	< 1	< 1	10.1	10.3	0.0	0.0	2.4
L8B	54 mm dia. elbow (copper)	570.0	11.2	< 1	< 1	7.7	6.4	0.0	0.0	4.4
L11	35 mm dia. gate valve (copper alloy)	80.0	62.8	< 1	< 1	12.5	5.0	0.0	0.0	1.0
L12	20 mm dia. stopcock (copper alloy) before meter	67.0	12.9	< 1	< 1	46.6	0.9	0.0	0.0	3.1
L13	15 mm dia. meter (copper alloy)	104.0	20.9	< 1	< 1	7.5	2.2	0.0	0.0	0.8
L14	22 mm dia. elbow (copper)	120.0	211.0	< 1	< 1	5.5	25.3	0.0	0.0	0.7
L15	35 mm dia. copper pipe	185.0	4.2	< 1	< 1	9.2	0.8	0.0	0.0	1.7
L15A	35 mm dia. elbow (copper)	155.0	123.0	< 1	< 1	6.5	19.1	0.0	0.0	1.0
L18	22 mm dia. elbow (copper)	115.0	54.6	< 1	< 1	7.3	6.3	0.0	0.0	0.8
L21	22 mm dia. copper pipe	69.0	5.7	< 1	< 1	5.9	0.4	0.0	0.0	0.4
L26	80 mm dia. gate valve (cast iron)	1400.0	<1	< 1	< 1	5.0	0.0	0.0	0.0	7.0
L30	54 mm dia. copper pipe	400.0	<1	< 1	< 1	6.8	0.0	0.0	0.0	2.7
L30A	35 mm dia. socket (copper)	182.0	29.5	< 1	< 1	8.0	5.4	0.0	0.0	1.5
L35	20 mm dia. gate valve (copper alloy)	68.0	24.5	< 1	< 1	23.3	1.7	0.0	0.0	1.6
L39	22 mm dia. elbow (cold water) at toilet (copper)	68.0	46.2	< 1	< 1	5.4	3.1	0.0	0.0	0.4
L41	22 mm dia. elbow (hot water) at toilet (copper)	102.0	405.5	< 1	< 1	4.8	41.4	0.0	0.0	0.5

^ Volume of water used to fill up the component for leaching test

Annex 2.4(a)

Elemental analysis of the components dismantled from the water supply chain in Hong Ching House of Kai Ching Estate

Item No.	Description	Lead content (%)
	Copper pipes	
H18B	54 mm dia. copper pipe	0.003
H22	35 mm dia. copper pipe	0.005
H24A	22 mm dia. copper pipe	0.005
H29	22 mm dia. copper pipe	0.003
H39	22 mm dia. copper pipe at kitchen	0.005
H43	22 mm dia. copper pipe (cold water) at toilet	0.007
	Valves	
H13	65 mm dia. gate valve (copper alloy)	7.1
H23	35 mm dia. gate valve (copper alloy)	7.5
H25	20 mm dia. stopcock (copper alloy) before meter	6.8
H37	20 mm dia. gate valve (copper alloy)	7.4
	Water meter	
H26	15 mm dia. meter (copper alloy)	2.5
	Taps	
H33	Tap at kitchen (mixer) (copper alloy)	2.0
H33A	Tap at kitchen_Part 2 (swan neck) (copper alloy)	0.019
H35	Basin tap at toilet (copper alloy)	2.0
H34	Shower tap at toilet (copper alloy)	1.5
H36	Tap for washing machine (copper alloy)	1.8
	Joints	
H5	159 mm elbow (copper) (brazing materials)	0.007
H9	108 mm dia socket (copper) (brazing materials)	0.003
H16	76.1 mm dia socket (copper) (solder materials)	0.066
H18	54 mm dia. elbow (copper) (solder materials)	41
H19	76.1 mm dia. socket (copper) (solder materials)	0.045
H21	35 mm dia. elbow (copper) (solder materials)	40
H24	22 mm dia. elbow (copper) (solder materials)	36
H31	22 mm dia. socket (copper) (solder materials)	33
H38	22 mm dia. elbow at kitchen (copper) (solder materials)	38

Remark : According to the specifications of HD, soldering could only be used for copper pipe joints less than or equal to 76.1mm diameter. For copper pipe joints greater than 76.1mm diameter, silver brazing, which would not contain lead, should be used. The leaching test results showed that silver brazing joints exhibited no lead leaching.

Annex 2.4(b)

Elemental analysis of the components dismantled from the water supply chain in Yuet Ching House of Kai Ching Estate

Item No.	Description	Lead content (%)
	Copper pipes	
Y13	66.7 mm dia. copper pipe	0.001
Y22	66.7 mm dia. copper pipe	0.001
Y15	54 mm dia. copper pipe	0.004
Y18	35 mm dia. copper pipe	0.003
Y20B	22 mm dia. copper pipe	0.003
	Valves	
Y9	65 mm dia. gate valve (copper alloy)	5.9
Y11	65 mm dia. gate valve (copper alloy)	7.2
Y16	35 mm dia. gate valve (copper alloy)	8.7
Y19	20 mm dia. stopcock (copper alloy) before meter	5.9
	Water meter	
Y20	15 mm dia. meter (copper alloy)	2.2
	Taps	
Y27	Tap at kitchen (swan neck) (copper alloy)	0.017
Y27A	Tap at kitchen_Part 2 (mixer) (copper alloy)	2.1
Y28	Shower tap at toilet (copper alloy)	1.8
Y29	Basin tap at toilet (copper alloy)	2.9
Y30	Tap for washing machine (copper alloy)	1.4
	Joints	
Y12	66.7 mm dia. socket (copper) (solder materials)	34
Y14	54 mm dia. socket (copper) (solder materials)	16
Y17	35 mm dia. elbow (copper) (solder materials)	0.045
Y21	66.7 mm dia. socket (copper) (solder materials)	38
Y23	22 mm dia. elbow (copper) (solder materials)	19

Remark : According to the specifications of HD, soldering could only be used for copper pipe joints less than or equal to 76.1mm diameter. For copper pipe joints greater than 76.1mm diameter, silver brazing, which would not contain lead, should be used. The leaching test results showed that silver brazing joints exhibited no lead leaching.

Annex 2.4(c)

Elemental analysis of the components dismantled from the water supply chain in Luen Yat House of Kwai Luen Estate Phase 2

Item No.	Description	Lead content (%)
	Copper pipes	
L30	54 mm dia. copper pipe	0.004
L30B	35 mm dia. copper Pipe	0.007
L38	22 mm dia. copper pipe (cold water) at toilet	0.003
	Valves	
L5	65 mm dia. gate valve (copper alloy)	4.8
L8	50 mm dia. gate valve (copper alloy)	5.0
L11	35 mm dia. gate valve (copper alloy)	5.5
L12	20 mm dia. stopcock (copper alloy) before meter	3.9
L35	20 mm dia. gate valve (copper alloy)	5.1
	Water meter	
L13	15 mm dia. meter (copper alloy)	2.5
	Taps	
L31	Tap at kitchen (mixer) (copper alloy)	1.9
L31A	Tap at kitchen_Part 2 (swan neck) (copper alloy)	0.019
L32	Shower tap at toilet (copper alloy)	1.5
L33	Basin tap at toilet (copper alloy)	1.1
L34	Tap for washing machine (copper alloy)	1.6
	Joints	
L2	159 mm dia. socket (copper) (brazing materials)	0.007
L18	22 mm dia. elbow (copper) (solder materials)	42
L30A	35 mm dia. socket (copper) (solder materials)	27

Remark : According to the specifications of HD, soldering could only be used for copper pipe joints less than or equal to 76.1mm diameter. For copper pipe joints greater than 76.1mm diameter, silver brazing, which would not contain lead, should be used. The leaching test results showed that silver brazing joints exhibited no lead leaching.

Annex 2.5

Results of analysis of lead in the deposits inside the components of the water supply chain in Hong Ching House of Kai Ching Estate

Item No.	Description	Weight of lead in deposit (mg)
H2	159 mm dia. elbow (copper)	0.16
H3	159 mm dia. copper pipe	0.32
H4	150 mm dia. gate valve (cast iron)	0.01
H11 (Inlet)	100 mm dia. pressure reducing valve (copper alloy)	0.78
H11 (Outlet)	100 mm dia. pressure reducing valve (copper alloy)	1.09
H12	100 mm dia. gate valve (cast iron)	0.23
H13	65 mm dia. gate valve (copper alloy)	2.41
H16	76.1 mm dia. socket (copper)	0.14
H17	76.1 mm dia. copper pipe	0.03
H18	54 mm dia. elbow (copper)	1.30
H21	35 mm dia. elbow (copper)	0.42
H23	35 mm dia. gate valve (copper alloy)	3.00
H24	22 mm dia. elbow (copper)	38.22
H24A	22 mm dia. copper pipe	0.40
H25	20 mm dia. stopcock (copper alloy) before meter	1.39
H26	15 mm dia. meter (copper alloy)	0.25
H27	22 mm dia. elbow (copper)	20.46
H30	22 mm dia. elbow (copper)	19.34
H31	22 mm dia. socket (copper)	16.12
H32	22 mm dia. copper pipe	0.66
H37	20 mm dia. gate valve (copper alloy)	1.80
H38	22 mm dia. elbow at kitchen (copper)	31.90
H40	22 mm dia. elbow (hot water) at toilet (copper)	13.63
H41	22 mm dia. copper pipe (hot water) at toilet	0.01
H42	22 mm dia. elbow (cold water) at toilet (copper)	2.70
H43	22 mm dia. copper pipe (cold water) at toilet	0.41

Results of analysis of lead in the deposits inside the components of the water supply chain in Yuet Ching House of Kai Ching Estate

Item No.	Description	Weight of lead in deposit (mg)
Y4	159 mm dia. copper pipe	0.22
Y4A	159 mm dia. elbow (copper)	0.01
Y5	100 mm dia. gate valve (cast iron)	0.01
Y9	65 mm dia. gate valve (copper alloy)	5.55
Y10 (Inlet)	65 mm dia. pressure reducing valve (copper alloy)	2.38
Y10 (Outlet)	65 mm dia. pressure reducing valve (copper alloy)	0.16
Y11	65 mm dia. gate valve (copper alloy)	11.07
Y14	54 mm dia. socket (copper)	0.24
Y15	54 mm dia. copper pipe	0.05
Y16	35 mm dia. gate valve (copper alloy)	5.83
Y19	20 mm dia. stopcock (copper alloy) before meter	1.12
Y20	15 mm dia. meter (copper alloy)	0.06
Y20A	22 mm dia. elbow(copper)	2.72
Y20B	22 mm dia. copper pipe	0.04
Y25	22 mm dia. copper pipe	0.09
Y26	22 mm dia. copper pipe	0.68
Y32	22 mm dia. tee at kitchen (copper)	23.20
Y33	22 mm dia. copper pipe at kitchen	0.72
Y34	22 mm dia. elbow (cold water) at toilet (copper)	2.11
Y36	22 mm dia. elbow (hot water) at toilet (copper)	1.86
Y37	22 mm dia. copper pipe (hot water) at toilet	0.01

Results of analysis of lead in the deposits inside the components of the water supply chain in Luen Yat House of Kwai Luen Estate Phase 2

Item No.	Description	Weight of lead in deposit (mg)
L5	65 mm dia. gate valve (copper alloy)	0.55
L8	50 mm dia. gate valve (copper alloy)	0.18
L8B	54 mm dia. elbow (copper)	3.00
L11	35 mm dia. gate valve (copper alloy)	1.20
L12	20 mm dia. stopcock (copper alloy) before meter	0.05
L13	15 mm dia. meter (copper alloy)	11.46
L14	22 mm dia. elbow (copper)	32.00
L15 -1	35 mm dia. copper pipe	0.48
L15 -2	35 mm dia. copper pipe	0.20
L15A	35 mm dia. elbow (copper)	9.32
L18	22 mm dia. elbow (copper)	8.36
L21	22 mm dia. copper pipe	0.37
L22	22 mm dia. copper pipe	0.00
L25(Outlet)	80 mm dia. pressure reducing valve (copper alloy)	0.03
L26	80 mm dia. gate valve (cast iron)	0.02
L30	54 mm dia. copper pipe	0.58
L30A	35 mm dia. socket (copper)	2.25
L35	20 mm dia. gate valve (copper alloy)	0.06
L39	22 mm dia. elbow (cold water) at toilet (copper)	5.62
L41	22 mm dia. elbow (hot water) at toilet (copper)	10.80

Hong Ching House of Kai Ching Estate **Annex 2.6**

Data for Mathematical Modeling (Using leaching test results before cleansing deposits)

Item No.	Location	Description	Lead leached (before cleansing deposits) (μg/L)	Immersion water volume (mL)	Lead leached in 24 hrs, μg/unit	Unit (No./ m) per supply chain	Total amount of lead leached in 24 hrs (μg)
H1	Working platform at lift machine roof	150 mm dia. gate valve (cast iron)	< 1	7000	0.0		0.0
H2		159 mm dia. elbow (copper)	< 1	5000	0.0		0.0
H3		159 mm dia. copper pipe	< 1	3900	0.0		0.0
H4	Main roof floor	150 mm dia. gate valve (cast iron)	< 1	7000	0.0		0.0
H5		159 mm dia. elbow (copper)	< 1	8000	0.0		0.0
H6		159 mm dia. copper pipe	< 1	2000	0.0		0.0
H7		159 mm dia. elbow (copper)	< 1	5000	0.0		0.0
H8		159 mm dia. copper pipe	< 1	2000	0.0		0.0
H9	30/F	108 mm dia. socket (copper)	< 1	2300	0.0		0.0
H10		108 mm dia. copper pipe	< 1	1700	0.0		0.0
H11 (Inlet)	25/F	100 mm dia. pressure reducing valve (copper alloy)	14.2	500	7.1	1	7.1
H11 (Outlet)		100 mm dia. pressure reducing valve (copper alloy)	33.8	1300	43.9	1	43.9
H12		100 mm dia. gate valve (cast iron)	1.6	2800	4.5	2	9.0
H13	23/F	65 mm dia. gate valve (copper alloy)	20.2	500	10.1	1	10.1
Use H18		54 mm dia. elbow (copper)	4.8	600	2.9	1	2.9
Use H18A	20/F	54 mm dia. socket (copper)	2.6	540	1.4	1	1.4
Use H18B		54 mm dia. copper pipe	< 1	410	0.0		0.0
Use H18	14/F meter room	42 mm dia. elbow (copper)	4.8	600	2.9	2	5.8
Use H18B		42 mm dia. copper pipe	< 1	410	0.0		0.0
Use H18A		35 mm dia. socket (copper)	2.6	540	1.4	6	8.4
H21		35 mm dia. elbow (copper)	4.1	192	0.8	1	0.8
H22		35 mm dia. copper pipe	< 1	174	0.0		0.0
H23		35 mm dia. gate valve (copper alloy)	51.7	200	10.3	1	10.3
H24		22 mm dia. elbow (copper)	11.2	72	0.8	3	2.4
H24A		22 mm dia. copper pipe (sample length 0.21m)	38.1	65	2.5	5	59.0
H25		20 mm dia. stopcock (copper alloy) before meter	177.3	78	13.8	1	13.8
H26		15 mm dia. meter (copper alloy)	36	104	3.7	1	3.7
H27	14/F corridor	22 mm dia. elbow (copper)	37.1	117	4.3	2	8.7
H30		22 mm dia. elbow (copper)	140.5	123	17.3	1	17.3
H31		22 mm dia. socket (copper)	91.1	78	7.1	2	14.2
H32		22 mm dia. copper pipe (sample length 0.23m)	22.4	74	1.7	20	144.1
H33	Flat on 14/F	Tap at kitchen (mixer) (copper alloy)	133.1	31	4.1	1	4.1
H33A		Tap at kitchen _ Part 2 (swan neck) (copper alloy)	23.9	89	2.1	1	2.1
H37		20 mm dia. gate valve (copper alloy)	161.7	92	14.9	1	14.9
H38		22 mm dia. elbow at kitchen (copper)	372.8	40	14.9	9	134.2
Use H31		22 mm dia. sockets at kitchen (copper)	91.1	78	7.1	3.5	24.9
H39		22 mm dia. copper pipe at kitchen (sample length 0.14m)	348.8	46	16.0	9	1031.5
Use H31		15 mm dia. socket at kitchen (copper)	91.1	78	7.1	0.5	3.6
Use H39		15 mm dia. copper pipe in kitchen (sample length 0.14m)	348.8	46	16.0	2	229.2

The system volume of the water supply chain (from roof to 14/F meter room) = 2038 L

The system volume of the water supply chain (from 14/F meter room to flat on 14/F) = 18 L

	Components	Total lead leached amount		Percentage
Scenario 1	**Copper pipes** with lead containing deposits	1463.8	µg	84%
	Copper alloy fittings (Valves, water meters and taps) with lead containing deposits	49.5	µg	3%
	Leaded solder joints with lead containing deposits	220.2	µg	13%
	Total lead leached in the water supply chain	1733.5	µg	

	Components	Total lead leached amount		Percentage
Scenario 2	**Copper pipes** with lead containing deposits	0.0	µg	
	Copper alloy fittings (Valves, water meters and taps) with lead containing deposits	49.5	µg	18%
	Leaded solder joints with lead containing deposits	220.2	µg	82%
	Total lead leached in the water supply chain	269.7	µg	

Scenario 3	**Lead concentration**	2.7	µg/L

Hong Ching House of Kai Ching Estate **Annex 2.6**

Data for Mathematical Modeling (Using leaching test results after cleansing deposits)

Item No.	Location	Description	Lead leached (after cleansing deposits) (μg/L)	Immersion water volume (mL)	Lead leached in 24 hrs, μg/unit	Unit (No./ m) per supply chain	Total amount of lead leached in 24 hrs (μg)
H1	Working platform at lift machine roof	150 mm dia. gate valve (cast iron)	< 1	7000	0.0		0.0
H2		159 mm dia. elbow (copper)	< 1	5000	0.0		0.0
H3		159 mm dia. copper pipe	< 1	3900	0.0		0.0
H4	Main roof floor	150 mm dia. gate valve (cast iron)	< 1	7000	0.0		0.0
H5		159 mm dia. elbow (copper)	< 1	8000	0.0		0.0
H6		159 mm dia. copper pipe	< 1	2000	0.0		0.0
H7		159 mm dia. elbow (copper)	< 1	5000	0.0		0.0
H8		159 mm dia. copper pipe	< 1	2000	0.0		0.0
H9	30/F	108 mm dia. socket (copper)	< 1	2300	0.0		0.0
H10		108 mm dia. copper pipe	< 1	1700	0.0		0.0
H11(Inlet)	25/F	100 mm dia. pressure reducing valve (copper alloy)	37	500	18.5	1	18.5
H11(Outlet)		100 mm dia. pressure reducing valve (copper alloy)	54.4	1300	70.7	1	70.7
H12		100 mm dia. gate valve (cast iron)	2.1	2800	5.9	2	11.8
H13	23/F	65 mm dia. gate valve (copper alloy)	22.7	500	11.4	1	11.4
Use H18		54 mm dia. elbow (copper)	4.8	600	2.9	1	2.9
Use H18A	20/F	54 mm dia. socket (copper)	2.6	540	1.4	1	1.4
Use H18B		54 mm dia. copper pipe	<1	410	0.0		0.0
Use H18	14/F meter room	42 mm dia. elbow (copper)	4.8	600	2.9	2	5.8
Use H18B		42 mm dia. copper pipe	< 1	410	0.0		0.0
Use H18A		35 mm dia. socket (copper)	2.6	540	1.4	6	8.4
H21		35 mm dia. elbow (copper)	4.1	192	0.8	1	0.8
H22		35 mm dia. copper pipe	< 1	174	0.0		0.0
H23		35 mm dia. gate valve (copper alloy)	53.2	200	10.6	1	10.6
H24		22 mm dia. elbow (copper)	1.3	72	0.1	3	0.3
H24A		22 mm dia. copper pipe (sample length 0.21m)	16.2	65	1.1	5	25.1
H25		20 mm dia. stopcock (copper alloy) before meter	42	78	3.3	1	3.3
H26		15 mm dia. meter (copper alloy)	11.6	104	1.2	1	1.2
H27	14/F	22 mm dia. elbow (copper)	37.1	117	4.3	2	8.7
H30		22 mm dia. elbow (copper)	81.8	123	10.1	1	10.1
H31		22 mm dia. socket (copper)	7.2	78	0.6	2	1.1
H32		22 mm dia. copper pipe (sample length 0.23m)	1.5	74	0.1	20	9.7
H33	Flat on 14/F	Tap at kitchen (mixer) (copper alloy)	133.1	31	4.1	1	4.1
H33A		Tap at kitchen_ Part 2 (swan neck) (copper alloy)	23.9	89	2.1	1	2.1
H37		20 mm dia. gate valve (copper alloy)	47.8	92	4.4	1	4.4
H38		22 mm dia. elbow at kitchen (copper)	372.8	40	14.9	9	134.2
Use H31		22 mm dia. sockets at kitchen (copper)	7.2	78	0.6	3.5	2.0
H39		22 mm dia. copper pipe at kitchen (sample length 0.14m)	348.8	46	16.0	9	1031.5
Use H31		15 mm dia socket at kitchen (copper)	7.2	78	0.6	0.5	0.3
Use H39		15 mm dia copper pipe in kitchen (sample length 0.14m)	348.8	46	16.0	2	229.2

*** leaching test results before cleansing deposits were adopted in case no leaching test results after cleansing deposits available**

The system volume of the water supply chain (from roof to 14/F meter room) = 2038 L

The system volume of the water supply chain (from 14/F meter room to flat on 14/F) = 18 L

Scenario 2	**Components**	**Total lead leached amount**		**Percentage**
	Copper pipes with lead containing deposits partially removed	0.0	µg	
	Copper alloy fittings (Valves, water meters and taps) with lead containing deposits partially removed	26.8	µg	14%
	Leaded solder joints with lead containing deposits partially removed	171.6	µg	86%
	Total lead leached in the water supply chain	198.4	µg	

Scenario 3	**Lead concentration**	1.5	µg/L

Yuet Ching House of Kai Ching Estate **Annex 2.6**

Data for Mathematical Modeling (Using leaching test results before cleansing deposits)

Item No.	Location	Description	Lead leached (before cleansing deposits) (µg/L)	Immersion water volume (mL)	Lead leached in 24 hrs, µg/unit	Unit (No./ m) per supply chain	Total amount of lead leached in 24 hrs (µg)
Y1	Main roof floor	150 mm dia. gate valve (cast iron)	< 1	7000	0.0		0.0
Y2		159 mm dia. elbow (copper)	< 1	6000	0.0		0.0
Y3		159 mm dia. copper pipe	< 1	3000	0.0		0.0
Y4		159 mm dia. copper pipe	< 1	1900	0.0		0.0
Y4A		159 mm dia. elbow (copper)	1.8	3000	5.4	2	10.8
Y5		100 mm dia. gate valve (cast iron)	< 1	3000	0.0		0.0
Y6	29/F	100 mm dia. gate valve (cast iron)	< 1	2800	0.0		0.0
Y7		108 mm dia. socket (copper)	< 1	2360	0.0		0.0
Y8		108 mm dia. copper pipe	< 1	1800	0.0		0.0
Y9	29/F	65 mm dia. gate valve (copper alloy)	98.4	400	39.4	1	39.4
Y16	20/F meter room	35 mm dia. gate valve (copper alloy)	117.7	68	8.0	1	8.0
Y17		35 mm dia. elbow (copper)	< 1	205	0.0		0.0
Y18		35 mm dia. copper pipe	< 1	173	0.0		0.0
Y19		20 mm dia. stopcock (copper alloy) before meter	100.4	65	6.5	1	6.5
Y20		15 mm dia. meter (copper alloy)	202.2	100	20.2	1	20.2
Y20A		22 mm dia. elbow (copper)	2620	71	186.0	2	372.0
Y20B		22 mm dia. copper pipe (sample length = 0.24m)	59.8	75	3.0	3	37.5
Y23	20/F corridor	22 mm dia. elbow (copper)	577.5	69	39.8	3	119.5
Y24		22 mm dia. socket (copper)	2345	76	178.2	1	178.2
Y25		22 mm dia. copper pipe (sample length = 0.22m)	79.4	70	5.6	5	126.3
Y26		22 mm dia. copper pipe (sample length = 0.23m)	358	72	25.8	5	560.3
Y27	Flat on 20/F	Tap at kitchen (swan neck) (copper alloy)	16.3	95	1.5	1	1.5
Y27A		Tap at kitchen_ Part 2(mixer) (copper alloy)	37.1	56	2.1	1	2.1
H37		20 mm dia. gate valve (copper alloy)	161.7	92	14.9	1	14.9
Y32		22 mm dia. tee at kitchen (copper)	6655	90	599.0	0.67	399.3
Y33		22 mm dia. copper pipe at kitchen (sample length = 0.2m)	1310	64	83.8	5	2096.0
Use Y23		22 mm dia. elbow at kitchen (copper)	577.5	69	39.8	5	199.2
Use Y26		15 mm dia. copper pipe at kitchen (sample length = 0.2m)	358	72	25.8	0.5	64.4
Use Y23		15 mm dia. socket at kitchen (copper)	577.5	69	39.8	1	39.8

The system volume of the water supply chain (from roof to 20/F meter room) = 720 L

The system volume of the water supply chain (from 20/F meter room to flat on 20/F) = 11 L

	Components	Total lead leached amount		Percentage
Scenario 1	**Copper pipes** with lead containing deposits	2884.6	µg	68%
	Copper alloy fittings (Valves, water meters and taps) with lead containing deposits	53.9	µg	1%
	Leaded solder joints with lead containing deposits	1308.4	µg	31%
	Total lead leached in the water supply chain	4246.9	µg	

	Components	Total lead leached amount		Percentage
Scenario 2	**Copper pipes** with lead containing deposits	0.0	µg	
	Copper alloy fittings (Valves, water meters and taps) with lead containing deposits	53.9	µg	4%
	Leaded solder joints with lead containing deposits	1308.4	µg	96%
	Total lead leached in the water supply chain	1362.3	µg	

Scenario 3	**Lead concentration**	3.5	µg/L

Yuet Ching House of Kai Ching Estate **Annex 2.6**

Data for Mathematical Modeling (Using leaching test results after cleansing deposits)

Item No.	Location	Description	Lead leached (after cleansing deposits) (µg/L)	Immersion water volume (mL)	Lead leached in 24 hrs, µg/unit	Unit (No./ m) per supply chain	Total amount of lead leached in 24 hrs (µg)
Y1	Main roof floor	150 mm dia. gate valve (cast iron)	< 1	7000	0.0		0.0
Y2		159 mm dia. elbow (copper)	< 1	6000	0.0		0.0
Y3		159 mm dia. copper pipe	< 1	3000	0.0		0.0
Y4		159 mm dia. copper pipe	< 1	1900	0.0		0.0
Y4A		159 mm dia. elbow (copper)	< 1	3000	0.0		0.0
Y5		100 mm dia. gate valve (cast iron)	< 1	3000	0.0		0.0
Y6	29/F	100 mm dia. gate valve (cast iron)	< 1	2800	0.0		0.0
Y7		108 mm dia. socket (copper)	< 1	2360	0.0		0.0
Y8		108 mm dia. copper pipe	< 1	1800	0.0		0.0
Y9	29/F	65 mm dia. gate valve (copper alloy)	42.6	400	17.0	1	17.0
Y16	20/F meter room	35 mm dia. gate valve (copper alloy)	62.6	68	4.3	1	4.3
Y17		35 mm dia. elbow (copper)	< 1	205	0.0		0.0
Y18		35 mm dia. copper pipe	< 1	173	0.0		0.0
Y19		20 mm dia. stopcock (copper alloy) before meter	22.5	65	1.5	1	1.5
Y20		15 mm dia. meter (copper alloy)	2.9	100	0.3	1	0.3
Y20A		22 mm dia. elbow (copper)	95.6	71	6.8	2	13.6
Y20B		22 mm dia. copper pipe (sample length = 0.24m)	< 1	75	0.0	3	0.0
Y23	20/F	22 mm dia. elbow (copper)	577.5	69	39.8	3	119.5
Y24		22 mm dia. socket (copper)	2345	76	178.2	1	178.2
Y25		22 mm dia. copper pipe (sample length = 0.22m)	79.4	70	5.6	5	126.3
Y26		22 mm dia. copper pipe (sample length = 0.23m)	358	72	25.8	5	560.3
Y27	Flat on 20/F	Tap at kitchen (swan neck) (copper alloy)	16.3	95	1.5	1	1.5
Y27A		Tap at kitchen_ Part 2 (mixer) (copper alloy)	37.1	56	2.1	1	2.1
H37		20 mm dia. gate valve (copper alloy)	161.7	92	14.9	1	14.9
Y32		22 mm dia. tee at kitchen (copper)	316	90	28.4	0.67	19.1
Y33		22 mm dia. copper pipe at kitchen (sample length = 0.2m)	6.5	64	0.4	5	10.4
Use Y23		22 mm dia. elbow at kitchen (copper)	577.5	69	39.8	5	199.2
Use Y26		15 mm dia. copper pipe at kitchen (sample length 0.2m)	358	72	25.8	0.5	64.4
Use Y23		15 mm dia. socket at kitchen (copper)	577.5	69	39.8	1	39.8

*** leaching test results before cleansing deposits were adopted in case no leaching test results after cleansing deposits available**

The system volume of the water supply chain (from roof to 20/F meter room) = 720 L

The system volume of the water supply chain (from 20/F meter room to flat on 20/F) = 11 L

Scenario 2	**Components**	**Total lead leached amount**		**Percentage**
	Copper pipes with lead containing deposits partially removed	0.0	µg	
	Copper alloy fittings (Valves, water meters and taps) with lead containing deposits partially removed	24.7	µg	4%
	Leaded solder joints with lead containing deposits partially removed	569.5	µg	96%
	Total lead leached in the water supply chain	594.2	µg	

Scenario 3	**Lead concentration**	1.0	µg/L

Luen Yat House of Kwai Luen Estate (Phase 2) **Annex 2.6**

Data for Mathematical Modeling (Using leaching test results before cleansing deposits)

Item No.	Location	Description	Lead leached (before cleansing deposits) (μg/L)	Immersion water volume (mL)	Lead leached in 24 hrs, μg/unit	Unit (No./ m) per supply chain	Total amount of lead leached in 24 hrs (μg)
L1	Upper roof floor	150 mm dia. gate valve (cast iron)	< 1	7560	0.0		0.0
L2		159 mm dia. socket (copper)	< 1	5500	0.0		0.0
L3		159 mm dia. copper pipe	< 1	5000	0.0		0.0
L4	Roof floor	65 mm dia. booster pump (stainless steel)	1.9	15000	28.5	1	28.5
L5		65 mm dia. gate valve (copper alloy)	432.8	500	216.4	1	216.4
L5A (Inlet)		65 mm dia. check valve (cast iron)	<1	172	0.0		0.0
L5A (Outlet)		65 mm dia. check valve (cast iron)	< 1	610	0.0		0.0
L6		100 mm dia. gate valve (cast iron)	<1	2660	0.0		0.0
L7		100 mm dia. gate valve (cast iron)	<1	2680	0.0		0.0
L7A		108 mm dia. copper pipe	<1	2000	0.0		0.0
L7B		108 mm dia. elbow (copper)	<1	4400	0.0		0.0
L8		50 mm dia. gate valve (copper alloy)	45	233	10.5	1	10.5
L8A		54 mm dia. copper pipe	< 1	410	0.0		0.0
L8B		54 mm dia. elbow (copper)	30.2	570	17.2	4	68.9
L11	33/F meter cabinet	35 mm dia. gate valve (copper alloy)	133.9	80	10.7	1	10.7
L12		20 mm dia. stopcock (copper alloy) before meter	384.5	67	25.8	1	25.8
L13		15 mm dia. meter (copper alloy)	633.5	104	65.9	1	65.9
use L21		22 mm dia. copper pipe (sample length 0.22m)	19.5	69	1.3	1.22	7.5
L14		22 mm dia. elbow (copper)	372	120	44.6	2	89.3
use L18		22 mm dia. elbow (copper)	200	115	23.0	4	92.0
L15		35 mm dia. copper pipe (sample length 0.19m)	22.8	185	4.2	5	111.0
use L16		22 mm dia. socket (copper)	65.2	62	4.0	1	4.0
L15A		35 mm dia. elbow (copper)	186	155	28.8	2	57.7
L16	33/F corridor	22 mm dia. socket (copper)	65.2	62	4.0	6	24.3
L17		22 mm dia. socket (copper)	31.0	63	2.0	1	2.0
L18		22 mm dia. elbow (copper)	200	115	23.0	4	92.0
L19		22 mm dia. socket (copper)	20.4	66	1.3	1	1.3
L20		22 mm dia. copper pipe (0.22m)	8.7	70	0.6	0.22	0.6
L21		22 mm dia. copper pipe (0.22m)	19.5	69	1.3	22	134.6
L22		22 mm dia. copper pipe (0.22m)	17.2	68	1.2	0.22	1.2
L22A		22 mm dia. copper pipe (0.2m)	13	63	0.8	0.2	0.8
L31	Flat on 33/F	Tap at kitchen (mixer) (copper alloy)	49.6	70	3.5	1	3.5
L31A		Tap at kitchen_ Part 2 (swan neck) (copper alloy)	101.5	57	5.8	1	5.8
L35		20 mm dia. gate valve (copper alloy)	219.5	68	14.9	1	14.9
L36		22 mm dia. elbow at kitchen (copper)	44.4	80	3.6	4	14.2
L37		22 mm dia. copper pipe at kitchen (sample length 0.2m)	10.9	68	0.7	9	33.4
Use L16		22 mm dia. socket at kitchen (copper)	65.2	62	4.0	3	12.1
L36		15 mm dia. elbow at kitchen (copper)	44.4	80	3.6	4	14.2
Use L37		15 mm dia. copper pipe at kitchen (sample length 0.2m)	10.9	68	0.7	2.5	9.3
Use L16		15 mm dia. socket at kitchen (copper)	65.2	62	4.0	3	12.1

The system volume of the water supply chain (from roof to 33/F meter cabinet) = 250 L

The system volume of the water supply chain (from 33/F meter cabinet to flat on 33/F) = 17 L

	Components	Total lead leached amount		Percentage
Scenario 1	**Copper pipes** with lead containing deposits	298.2	µg	35%
	Copper alloy fittings (Valves, water meters and taps) with lead containing deposits	143.9	µg	16%
	Leaded solder joints with lead containing deposits	419.9	µg	49%
	Total lead leached in the water supply chain	862.0	µg	

	Components	Total lead leached amount		Percentage
Scenario 2	**Copper pipes** with lead containing deposits	0.0	µg	
	Copper alloy fittings (Valves, water meters and taps) with lead containing deposits	143.9	µg	26%
	Leaded solder joints with lead containing deposits	419.9	µg	74%
	Total lead leached in the water supply chain	563.8	µg	

Scenario 3	**Lead concentration**	8.7	µg/L

Luen Yat House of Kwai Luen Estate (Phase 2) **Annex 2.6**

Data for Mathematical Modeling (Using leaching test results after cleansing deposits)

Item No.	Location	Description	Lead leached (after cleansing deposits) (µg/L)	Immersion water volume (mL)	Lead leached in 24 hrs, µg/unit	Unit (No./ m) per supply chain	Total amount of lead leached in 24 hrs (µg)
L1	Upper roof floor	150 mm dia. gate valve (cast iron)	< 1	7560	0.0		0.0
L2		159 mm dia. socket (copper)	< 1	5500	0.0		0.0
L3		159 mm dia. copper pipe	< 1	5000	0.0		0.0
L4	Roof floor	65 mm dia. booster pump (stainless steel)	1.9	15000	28.5	1	28.5
L5		65 mm dia. gate valve (copper alloy)	48.4	500	24.2	1	24.2
L5A (Inlet)		65 mm dia. check valve (cast iron)	<1	172	0.0		0.0
L5A (Outlet)		65 mm dia. check valve (cast iron)	< 1	610	0.0		0.0
L6		100 mm dia. gate valve (cast iron)	<1	2660	0.0		0.0
L7		100 mm dia. gate valve (cast iron)	<1	2680	0.0		0.0
L7A		108 mm dia. copper pipe	<1	2000	0.0		0.0
L7B		108 mm dia. elbow (copper)	<1	4400	0.0		0.0
L8		50 mm dia. gate valve (copper alloy)	44.3	233	10.3	1	10.3
L8A		54 mm dia. copper pipe	< 1	410	0.0		0.0
L8B		54 mm dia. elbow (copper)	11.2	570	6.4	4	25.5
L11	33/F meter cabinet	35 mm dia. gate valve (copper alloy)	62.8	80	5.0	1	5.0
L12		20 mm dia. stopcock (copper alloy) before meter	12.9	67	0.9	1	0.9
L13		15 mm dia. meter (copper alloy)	20.9	104	2.2	1	2.2
use L21		22 mm dia. copper pipe（sample length 0.22m)	5.7	69	0.4	1.22	2.2
L14		22 mm dia. elbow (copper)	211	120	25.3	2	50.6
use L18		22 mm dia. elbow (copper)	54.6	115	6.3	4	25.1
L15		35 mm dia. copper pipe (0.19m)	4.2	185	0.8	5	21.1
use L16		35 mm dia. socket (copper)	65.2	62	4.0	1	4.0
L15A		35mm dia. elbow (copper)	123	155	19.1	2	38.1
L16	33/F corridor	22 mm dia. socket (copper)	65.2	62	4.0	6	24.3
L17		22 mm dia. socket (copper)	31.0	63	2.0	1	2.0
L18		22 mm dia. elbow (copper)	54.6	115	6.3	4	25.1
L19		22 mm dia. socket (copper)	20.4	66	1.3	1	1.3
L20		22 mm dia. copper pipe (0.22m)	8.7	70	0.6	0.22	0.6
L21		22 mm dia. copper pipe (0.22m)	5.7	69	0.4	22	39.3
L22		22 mm dia. copper pipe (0.22m)	17.2	68	1.2	0.22	1.2
L22A		22 mm dia. copper pipe (0.2m)	13	63	0.8	0.2	0.8
L31	Flat on 33/F	Tap at kitchen (mixer) (copper alloy)	49.6	70	3.5	1	3.5
L31A		Tap at kitchen _ Part 2 (swan neck) (copper alloy)	101.5	57	5.8	1	5.8
L35		20 mm dia. gate valve (copper alloy)	24.5	68	1.7	1	1.7
L36		22 mm dia. elbow at kitchen (copper)	44.4	80	3.6	4	14.2
L37		22 mm dia. copper pipe at kitchen (sample length 0.2m)	10.9	68	0.7	9	33.4
Use L16		22 mm dia. socket at kitchen (copper)	65.2	62	4.0	3	12.1
Use L36		15 mm dia. elbow at kitchen (copper)	44.4	80	3.6	4	14.2
Use L37		15 mm dia. copper pipe at kitchen (sample length 0.2m)	10.9	68	0.7	2.5	9.3
Use L16		15 mm dia. socket at kitchen (copper)	65.2	62	4.0	3	12.1

The system volume of the water supply chain (from roof to 33/F meter cabinet) = 250 L

The system volume of the water supply chain (from 33/F meter room to flat on 33/F) = 17 L

Scenario 2	**Components**	**Total lead leached amount**		**Percentage**
	Copper pipes with lead containing deposits partially removed	0.0	µg	
	Copper alloy fittings (Valves, water meters and taps) with lead containing deposits partially removed	23.5	µg	9%
	Leaded solder joints with lead containing deposits partially removed	225.1	µg	91%
	Total lead leached in the water supply chain	248.6	µg	

Scenario 3	**Lead concentration**	1.5	µg/L

Leaching test results of the components dismantled from the water supply chain in

Hung Hei House of Hung Fuk Estate

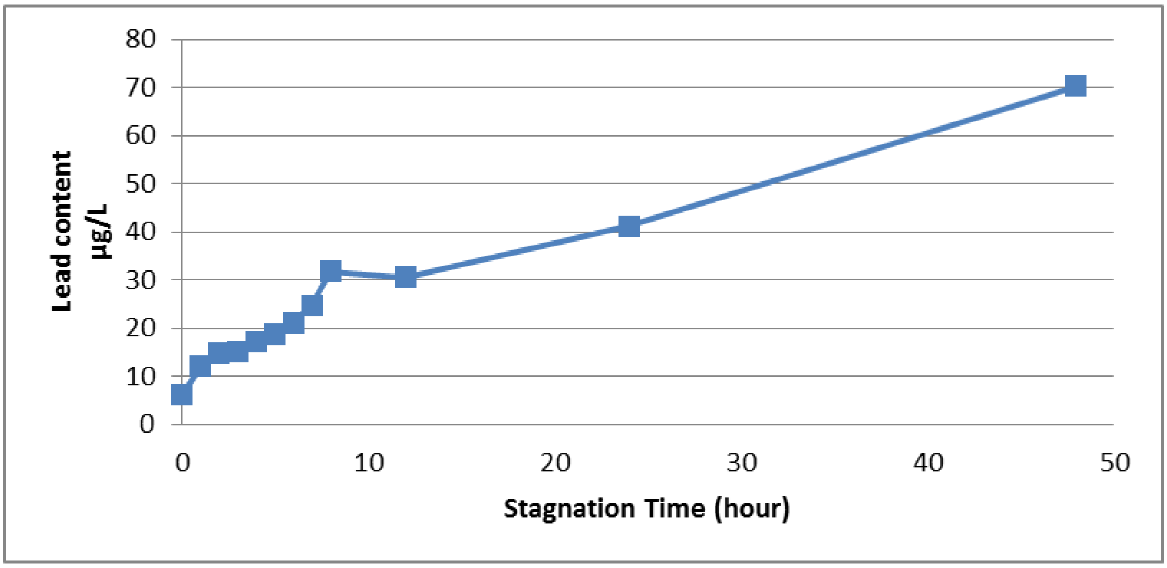
Item No.	Description	Immersion water volume (mL)^	Before cleansing deposits: Leached amount by concentration				Before cleansing deposits: Leached amount by mass			
			Lead (µg/L)	Chromium (µg/L)	Cadmium (µg/L)	Nickel (µg/L)	Lead (µg)	Chromium (µg)	Cadmium (µg)	Nickel (µg)
F1	150 mm dia. gate valve (cast iron)	7000.0	1.6	<1	<1	5.2	11.2	0.0	0.0	36.4
F5	65 mm dia. gate valve (copper alloy)	500.0	46.8	<1	<1	5.2	23.4	0.0	0.0	2.6
F5A (Inlet)	65 mm dia. check valve (cast iron)	200.0	<1	<1	<1	4.0	0.0	0.0	0.0	0.8
F5A (Oulet)	65 mm dia. check valve (cast iron)	3300.0	<1	<1	<1	5.6	0.0	0.0	0.0	18.5
F6	100 mm dia. gate valve (cast iron)	2700.0	1.3	<1	<1	4.0	3.5	0.0	0.0	10.8
F7	100 mm dia. gate valve (cast iron)	2700.0	< 1	<1	<1	5.0	0.0	0.0	0.0	13.5
F8	80 mm dia. gate valve (cast iron)	1500.0	< 1	<1	<1	5.0	0.0	0.0	0.0	7.5
F11	40 mm dia. gate valve (copper alloy)	125.0	54.8	< 1	< 1	27.1	6.9	0.0	0.0	3.4
F12	20 mm dia. stopcock (copper alloy) before meter	90.0	58.4	<1	<1	7.9	5.3	0.0	0.0	0.7
F13	15 mm dia. meter (copper alloy)	80.0	4.4	<1	<1	10.4	0.4	0.0	0.0	0.8
F25	100 mm dia. pressure reducing valve (copper alloy)	1400.0	13.1	<1	<1	3.2	18.3	0.0	0.0	4.5
F26	100 mm dia. gate valve (Cast Iron)	2800.0	1.7	<1	<1	2.9	4.8	0.0	0.0	8.1
F31	Tap at kitchen (mixer) (copper alloy)	92.0	6.8	<1	<1	66.4	0.6	0.0	0.0	6.1
F31A	Tap at kitchen_ Part 2 (swan neck) (copper alloy)	70.0	<1	<1	<1	35.7	0.0	0.0	0.0	2.5
F32	Shower tap at toilet (copper alloy)	152.0	16.8	<1	<1	71.6	2.6	0.0	0.0	10.9
F33	Basin tap at toilet (copper alloy)	60.0	9.9	1.6	<1	63.3	0.6	0.1	0.0	3.8
F34	Tap for washing machine (copper alloy)	62.0	1.7	<1	<1	4.2	0.1	0.0	0.0	0.3
F35	20 mm dia. gate valve (copper alloy)	95.0	18.0	<1	<1	5.1	1.7	0.0	0.0	0.5
F36	22 mm dia. elbow at kitchen (copper)	70.0	< 1	<1	<1	2.2	0.0	0.0	0.0	0.2
F37	22 mm dia. copper pipe at kitchen	65.0	< 1	<1	<1	3.0	0.0	0.0	0.0	0.2
F38	22 mm dia. copper pipe (cold water) at toilet	67.0	< 1	<1	<1	5.6	0.0	0.0	0.0	0.4
F39	22 mm dia. elbow (cold water) at toilet (copper)	65.0	< 1	<1	<1	5.2	0.0	0.0	0.0	0.3
F40	22 mm dia.copper pipe (hot water) at toilet	67.0	< 1	<1	<1	4.9	0.0	0.0	0.0	0.3
F41	22 mm dia. elbow (hot water) at toilet (copper)	70.0	< 1	<1	<1	7.3	0.0	0.0	0.0	0.5

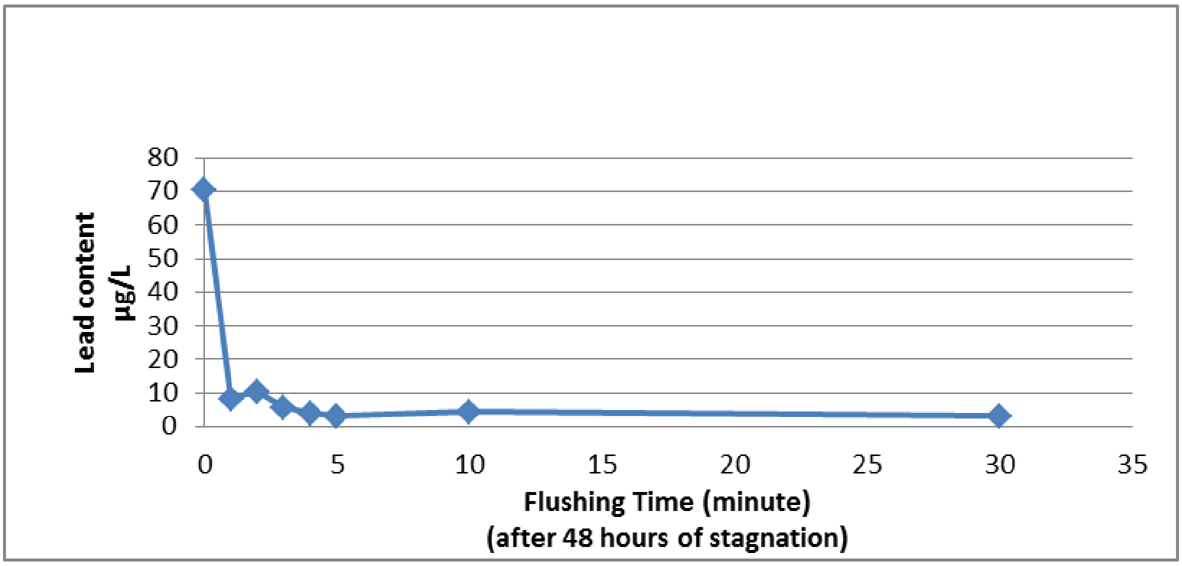
^ Volume of water used to fill up the component for leaching test

Annex 2.8

Results of Stagnation and Flushing Tests

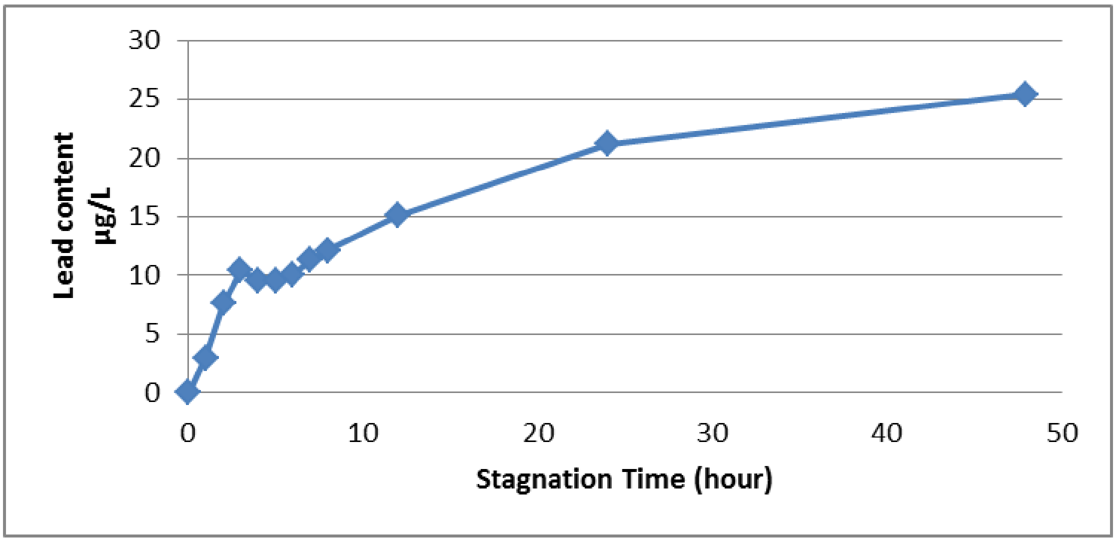
Location :
Pantry Tap at Estate Management Office, Hong Ching House of Kai Ching Estate

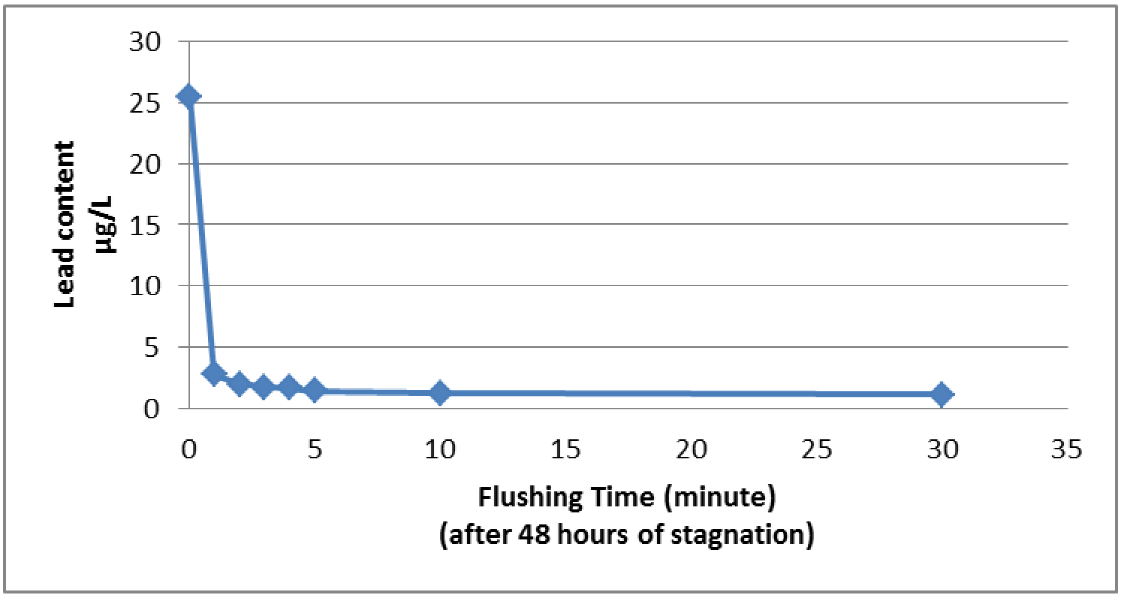




Results of Stagnation and Flushing Tests

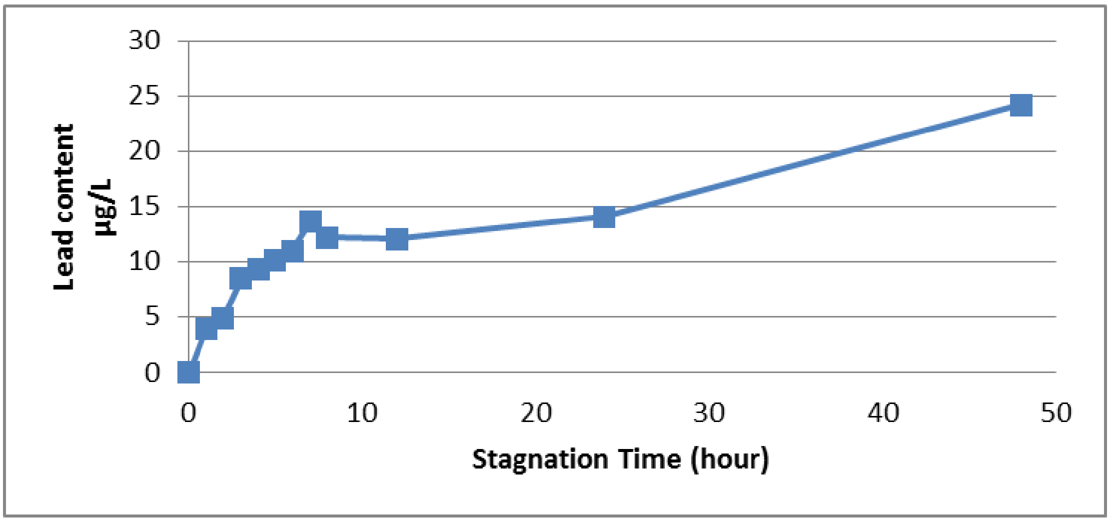
Location :
Vacant flat at Mun Ching House of Kai Ching Estate

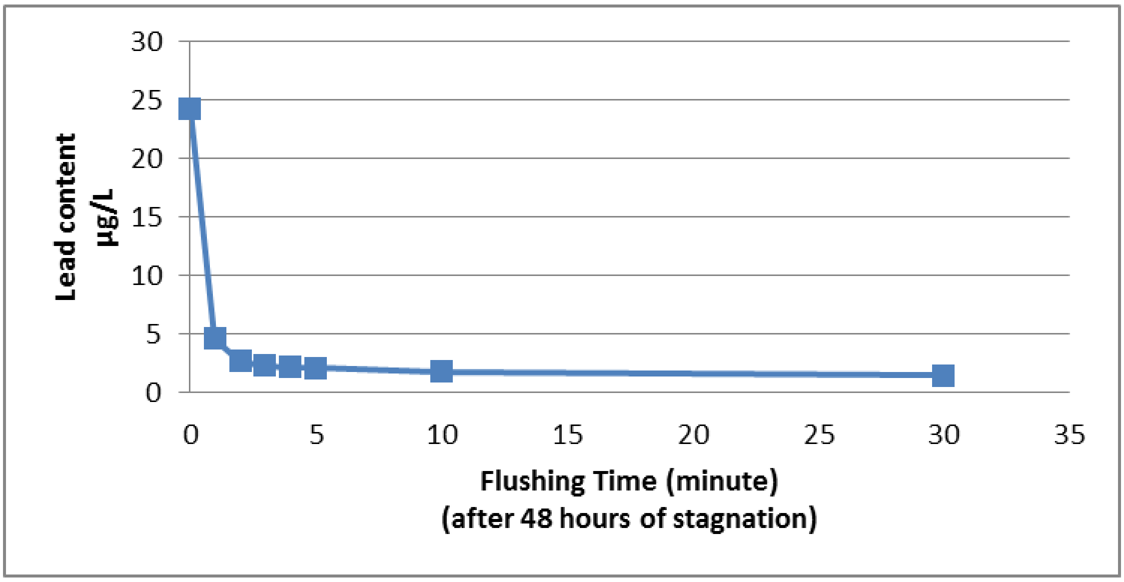




Results of Stagnation and Flushing Tests

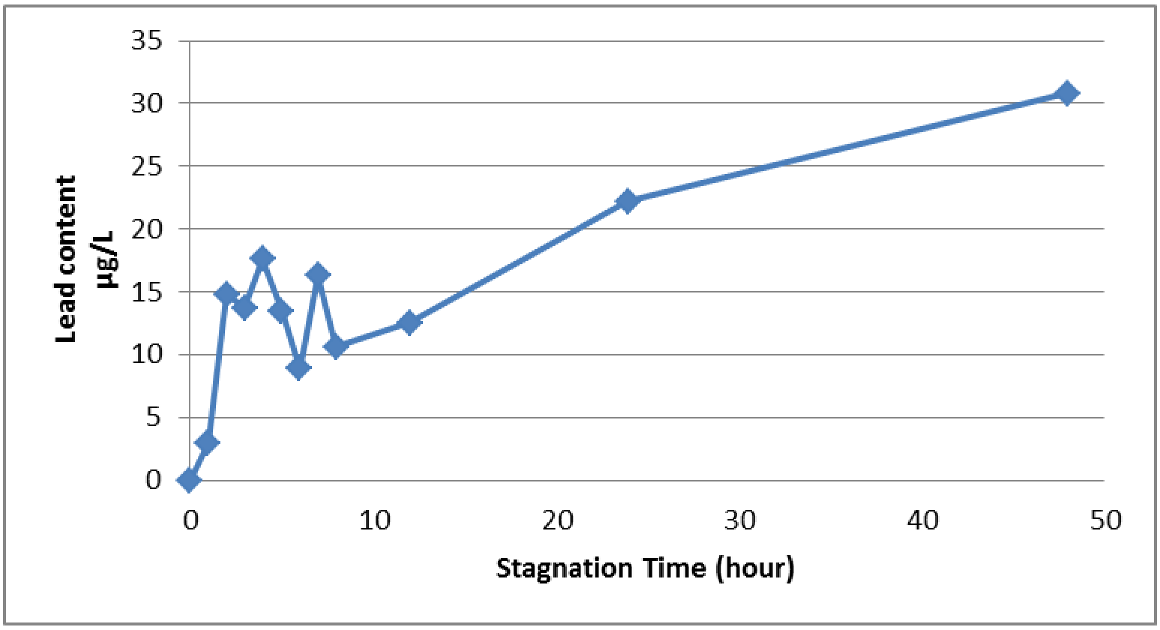
Location :
Vacant flat at Lok Ching House of Kai Ching Estate

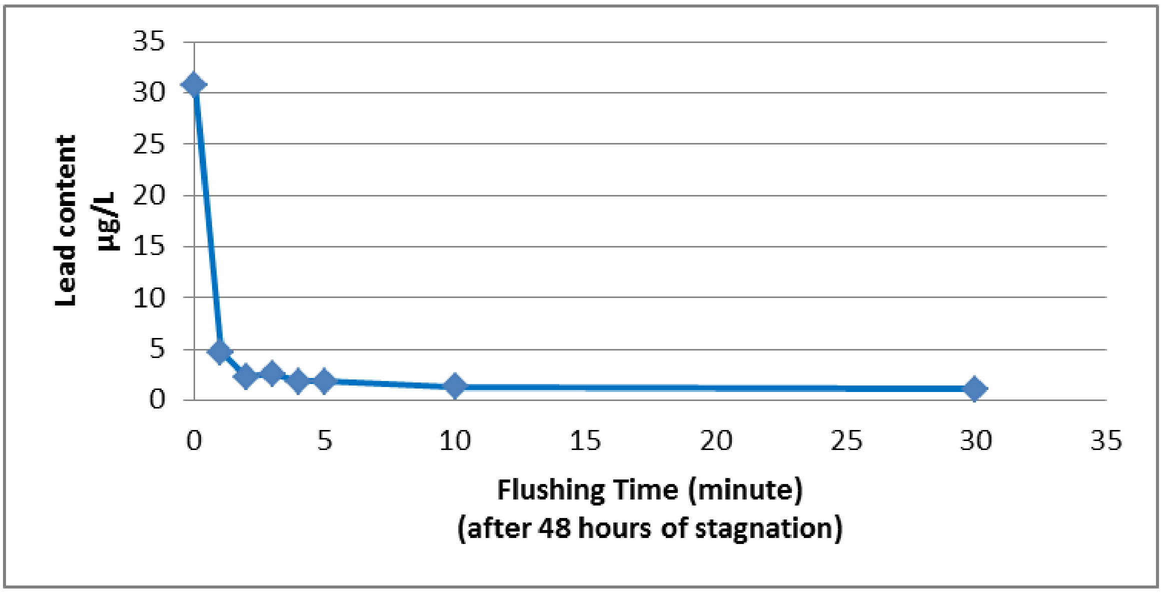




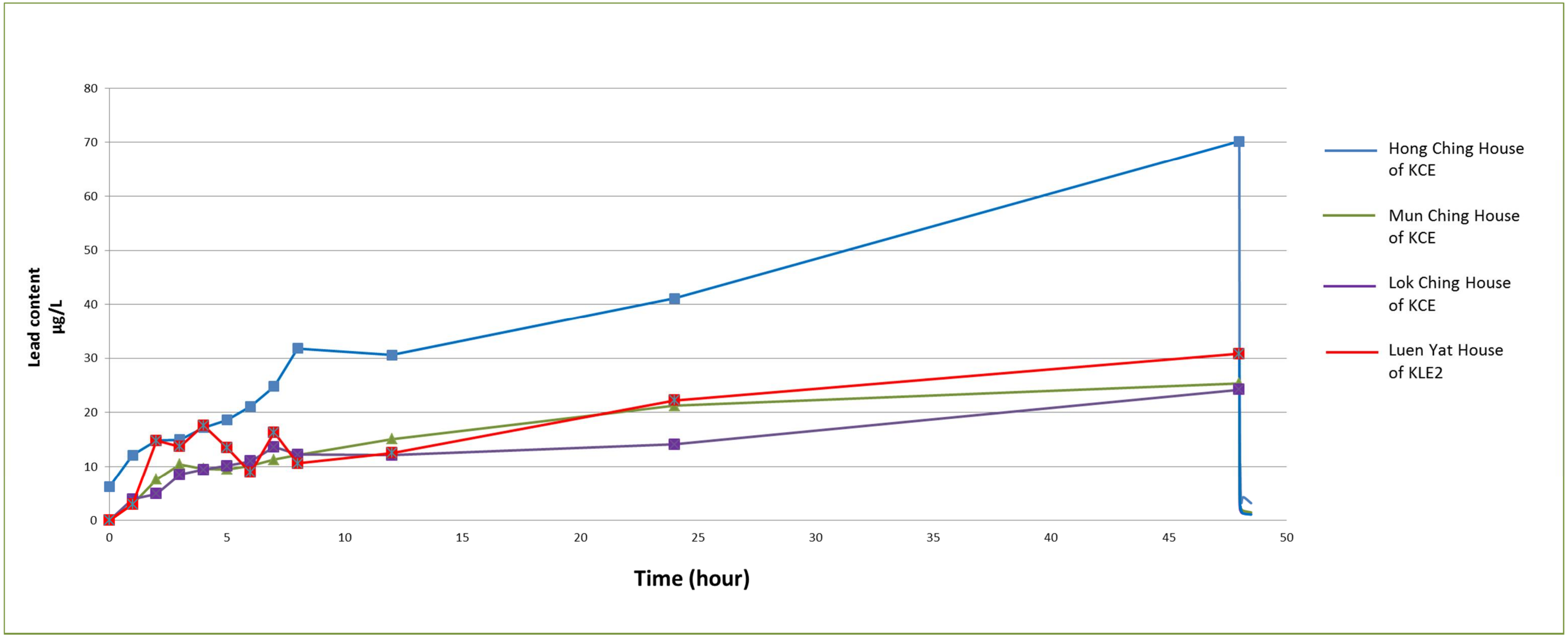
Results of Stagnation and Flushing Tests

Location :
Vacant flat at Luen Yat House of Kwai Luen Estate Phase 2





Combined Graph of Stagnation and Flushing Tests



Survey of the inside service system of water supply chains in 11 public rental housing developments with excess lead in drinking water samples

Public Rental Housing Development	Water Supply Chain					Leaded content found in some of the solder joints in the development
	From roof tank to the individual flat	Estimated length of copper pipe with solder joints (m)	Estimated no. of solder joints	Estimated no. of copper alloy valves	Estimated no. of copper alloy taps	
Kai Ching Estate	14/F, Hong Ching House	90	130	4	4	49.8% - 50.9%
	20/F, Yuet Ching House	100	130	4	4	
Kwai Luen Estate Phase2	33/F, Luen Yat House	70	140	11	4	29% - 53%
Wing Cheong Estate	G/F, Wing Chun House (Pantry)	100	140	9	1	31% - 54%
Lower Ngau Tau Kok Estate Phase 1	1/F, Kwai Hin House	90	160	11	4	48% - 53%
Shek Kip Mei Estate Phase 2	26/F, Mei Leong House	50	120	4	4	32% - 44%
Hung Hom Estate Phase 2	7/F, Hung Yan Hse	110	170	3	4	18% - 49%
Tung Wui Estate	G/F, Wui Sum House (Toilet)	40	90	3	1	36% - 47%
Yan On Estate	1/F, Yan Chung House	100	180	5	4	29% - 41%
Choi Fook Estate	18/F, Choi Lok House	60	110	3	4	52% - 59%
Un Chau Estate	16/F, Un Kin House	150	210	5	4	31% - 49%
Ching Ho Estate Phase 1	36/F Ching Chung House	80	130	4	4	50% - 61%

List of pipes and fittings in water supply chain in Hong Ching House of Kai Ching Estate

Components		Installed on site Brand	Submitted to WA in WWO46 Brand	On the directory list accepted by the WA	Lead Content(%)	BS Compliance* (Lead content)
Copper Pipes	54 mm dia.	Opal	Crance/Tube-e	N/A	0.003	✓
	35 mm dia.	Opal	Crance/Tube-e	N/A	0.005	✓
	22 mm dia.	Opal	Crance/Tube-e	N/A	0.003-0.007	✓
Cast Iron Gate Valves	100 mm dia., 150 mm dia.	Waterfront	Waterfront	✓	N/A	N/A
Copper Alloy Fittings	65 mm dia. gate valve	Victory	Waterfront	✓	7.1	X
	35 mm dia. gate valve	Victory	Ring	✓	7.5	X
	20 mm dia. gate valve	Victory	Wealthmark	✓	7.4	X
	20 mm dia. stopcock	Victory	Wealthmark	✓	6.8	X
Pressure Reducing Valve	100 mm dia.	Yue Hing	Yuen Hing**	N/A	Inlet : 4.6 Outlet: 4.5	✓
Copper Alloy Taps	Shower tap	Anspron	Anspron	✓	1.5	✓
	Basin tap	Anspron	Anspron	✓	2.0	✓
	Tap for washing machine	Daimler	A.T.A/Shing Shun	✓	1.8	✓
	Kitchen tap	Anspron(Model:A6205)	Ansporn(Model:A6103)	✓	2.0	✓

Remarks:

*According to BS requirements for copper pipes and the types of copper alloy used for the fittings, the copper pipes could contain lead as impurity up to 0.085% (BS 1057:2006+A1:2010), valves 4-6% (BS EN 1982:2008) and taps 0.5-2.5% (BS EN 1982:2008).

** The brand name should read as Yue Hing, possibly a typo in WWO46

Annex 3.2

List of pipes and fittings in water supply chain in Yuet Ching House of Kai Ching Estate

Components		Installed on site	Submitted to WA in WWO46	On the directory list accepted by the WA	Lead Content(%)	BS Compliance* (Lead content)
		Brand	Brand			
Copper Pipes	66.7 mm dia.	Opal	Crance/Tube-e	N/A	0.001	✓
	54 mm dia.	Opal	Crance/Tube-e	N/A	0.004	✓
	35 mm dia.	Opal	Crance/Tube-e	N/A	0.003	✓
	22 mm dia.	Opal	Crance/Tube-e	N/A	0.003	✓
Cast Iron Gate Valves	100 mm dia., 150 mm dia.	Waterfront	Waterfront	✓	N/A	N/A
Copper Alloy Fittings	65 mm dia. gate valve At 29/F meter room	Victory	Waterfront	✓	5.9	✓
	65 mm dia. gate valve At 18/F pipe duct room	Victory	Waterfront	✓	7.2	X
	35 mm dia. gate valve	Victory	Ring	✓	8.7	X
	20 mm dia. stopcock	Victory	Wealthmark	✓	5.9	✓
Pressure Reducing Valve	65 mm dia.	Yue Hing	Yuen Hing**	N/A	Inlet : 4.5 Outlet: 4.2	✓
Copper Alloy Taps	Shower tap	Anspron	Anspron	✓	1.8	✓
	Basin tap	Anspron	Anspron	✓	2.9	X
	Tap for washing machine	Daimler	A.T.A/Shing Shun	✓	1.4	✓
	Kitchen tap	Anspron(Model:A6205)	Ansporn(Model:A6103)	✓	2.1	✓

Annex 3.2

List of pipes and fittings in water supply chain in Luen Yat House of Kwai Luen Estate Phase 2

Components		Installed on site	Submitted to WA in WWO46	On the directory list accepted by the WA	Lead Content(%)	BS Compliance* (Lead content)
		Brand	Brand			
Copper Pipes	54 mm dia	Opal	Crance/Tube-e	N/A	0.004	✓
	35 mm dia	Opal	Crance/Tube-e	N/A	0.007	✓
	22 mm dia	Opal	Crance/Tube-e	N/A	0.003	✓
Cast Iron Gate Valves	150 mm dia.	AVK	C.N.B/Waterfront/Ever Meter	✓	N/A	N/A
	100 mm dia (Upper Roof Floor)	Waterfront	Waterfront	✓	N/A	N/A
	100 mm dia. (Roof Floor)	AVK	C.N.B/Waterfront/Ever Meter	✓	N/A	N/A
	80 mm dia.	AVK	Waterfront	✓	N/A	N/A
Copper Alloy Fittings	65 mm dia. gate valve	TOYO	TOYO	✓	4.8	✓
	50 mm dia. gate valve	Wealthmark	Ring	✓	5.0	✓
	35 mm dia. gate valve	Wealthmark	Ring	✓	5.5	✓
	20 mm dia. stopcock	Wealthmark	Wealthmark	✓	3.9	✓
	20 mm dia. gate valve	Wealthmark	Wealthmark	✓	5.1	✓
Pressure Reducing Valve	80 mm dia.	Welson	Yuen Hing	N/A	Inlet : 6.5 Outlet: 6.2	X
Check Valve	65 mm dia.	Waterfront	Waterfront	✓	N/A	N/A
Copper Alloy Taps	Shower tap	Shing Shun	Shing Shun	✓	1.5	✓
	Basin tap	Shing Shun	Shing Shun	✓	1.1	✓
	Tap for washing machine	Shing Shun Model : SS-8311	Shing Shun Model: F99096	✓	1.6	✓
	Kitchen tap	Shing Shun	Shing Shun	✓	1.9	✓

W The Water Authority
43/F Immigration Tower, 7 Gloucester Road, Hong Kong.
Tel : 2824 5000 Fax : 2802 7333 email : wsdinfo@wsd.gov.hk

Form Serial No. …………………….
(for official use)

*NOTIFICATION / APPLICATION FOR CONSTRUCTING, INSTALLING, ALTERING OR REMOVING AN INSIDE SERVICE OR FIRE SERVICE

Part I (To be completed by the Licensed Plumber* and the Authorized Person) ***(See Note 1)***

To the Water Authority,

Plumbing Installation for the Premises at

----

*I/We am/are engaged by the *Registered Consumer / Registered Agent / Applicant for new water supply in Part II to *construct / install / alter / remove a/an *inside service / fire service at the above premises, which has been approved by the Water Authority. Details are as follows:-

WSD approval letter reference : ____________________ dated ____________ ASN ____________

Plumbing covered by this Form: *Whole of the Works / Part of the Works (please specify : ____________________

____) covered by the WSD approval letter.

Approved drawing no. (if no drawing has been required, describe briefly the plumbing works): ____________

____

Size and no. of water meters involved/required : ____________________

Anticipated date when water supply is required : ____________________ *(see Note 4)*

Remarks : ____________________

A set of duly completed Annex to this Form is attached to show details of pipes and fittings installed/intended to be installed at the above premises.

2. PURPOSE OF SUBMISSION *(please check one box only) (See Note 2):-*

☐ *I/We hereby notify that the plumbing works detailed above *were/will be commenced on ____________. *I/We CERTIFY that the pipes and fittings installed / intended to be installed, including those as listed on the attached Annex to this Form and those not listed, are as prescribed by the Waterworks Regulations.

☐ Your permission is sought for *me/us to *construct / install / alter / remove a/an *inside service / fire service at the above premises. As some pipes and fittings intended to be installed have not been approved by the Water Authority, *I/we understand that prior approval from the Water Authority must be obtained before commencement of the plumbing works.

3. *I/We fully understand the purpose and agree to the Water Authority using data collected from *me/us for the purpose of or directly related to applying for constructing, installing, altering or removing an inside service or fire service. If *I/we do not provide sufficient data, the Water Authority may not be able to process my/our application. *I/We agree that these data and other related information may be transferred to other Government bureaux and departments. *I/We understand that *I/we can request the Departmental Secretary of the Water Supplies Department at 48/F, Immigration Tower, 7 Gloucester Road, Hong Kong for access to and correction of personal data.

Licensed Plumber

Plumber's Licence No: ____________________

Signature : ____________________

Date : ____________________

Tel No : ____________________

Fax No : ____________________

E-mail : ____________________

Name: ____________________

Preferred Contact Method : * by mail/e-mail/fax

Authorized Person

(only applicable to a new buildings project)

Signature : ____________________

Date : ____________________

Tel No : ____________________

Fax No : ____________ E-mail : ____________

Name: ____________________

*HKID/Passport/Business Registration No. : ____________

Address: ____________________

____

Preferred Contact Method : * by mail/e-mail/fax

WWO 46(6/2012a)

*delete whichever is not applicable

W The Water Authority
43/F Immigration Tower, 7 Gloucester Road, Hong Kong.
Tel : 2824 5000 Fax : 2802 7333 email : wsdinfo@wsd.gov.hk

Form Serial No. …………………….
(for official use)

Part II (To be completed by the Registered Consumer / Registered Agent / Applicant for new water supply) ***(See Note 1)***

To the Water Authority,

I endorse the information submitted by my Licensed Plumber *and the Authorized Person in Part I.

I fully understand the purpose and agree to the Water Authority using data collected from me for the purpose of or directly related to my Licensed Plumber's application for constructing, installing, altering or removing an inside service or fire service. If I do not provide sufficient data, the Water Authority may not be able to process my Licensed Plumber's application. I agree that these data and other related information may be transferred to other Government bureaux and departments. I understand that I can request the Department Secretary of the Water Supplies Department at 48/F, Immigration Tower, 7 Gloucester Road, Hong Kong for access to and correction of personal data.

Signature : ______________________________

(* Registered Consumer / Registered Agent / Applicant for new water supply)

Name : ______________________________

Tel No : ______________________________

Fax No : ______________________________

Date : ______________________________

*delete whichever is not applicable

W The Water Authority
43/F Immigration Tower, 7 Gloucester Road, Hong Kong.
Tel : 2824 5000 Fax : 2802 7333 email : wsdinfo@wsd.gov.hk

Form Serial No. ……………………
(for official use)

Part III (To be completed by the Water Authority)

To the Licensed Plumber,
Licensed Plumber Mailing Address

1. ☐ Plumbing detailed in Part I and at the Annex is accepted.
   ☐ Plumbing detailed in Part I and at the Annex is not accepted for the following reasons:

   ____

   ____

2. ☐ Commencement date of the plumbing works as detailed in Part I is noted.
   ☐ Permission is given for you to proceed with the plumbing detailed in Part I and at the Annex.

3. ☐ Other remarks: ______________________________

   ____

______________________________ Name : ______________________________

(Signed for the Water Authority) Post : ______________________________

Tel No : ______________________________

Date : ______________________________ Fax No : ______________________________

 *delete whichever is not applicable

W The Water Authority
43/F Immigration Tower, 7 Gloucester Road, Hong Kong.
Tel : 2824 5000 Fax : 2802 7333 email : wsdinfo@wsd.gov.hk

Form Serial No. …………………….
(for official use)

Part IV (To be completed by the Licensed Plumber) *(see Note 6)*

(For new building project, also to be signed by the Applicant and the Authorized Person)

To the Water Authority,

ASN : ……………………

* Whole of the plumbing / Part of the plumbing (please specify and submit relevant drawings : ____) covered by this Form was completed on ________________.

Your inspection and approval of the plumbing is requested. * I also undertake the correctness of the meter positions of the *whole of the plumbing / part of the plumbing mentioned above.

____ Date : ______________________________

(Signature of the Licensed Plumber in Part I)

* I am satisfied with the correctness of the meter positions indicated above by the Licensed Plumber.

____ Date : ______________________________

(Signature of the Applicant of new building project)

* I am satisfied with the correctness of the meter positions indicated above by the Licensed Plumber.

____ Date : ______________________________

(Signature of the Authorized Person)

*delete whichever is not applicable

W The Water Authority
43/F Immigration Tower, 7 Gloucester Road, Hong Kong.
Tel : 2824 5000 Fax : 2802 7333 email : wsdinfo@wsd.gov.hk

Form Serial No. …………………….
(for official use)

Part V (To be completed by the Water Authority)

To the Licensed Plumber,
Licensed Plumber Mailing Address

Plumbing detailed in Part IV are last inspected on ______________________. Pursuant to the Waterworks Ordinance and Regulations, no irregularities were found and the plumbing detailed in Part IV is approved.

____
(Signed for the Water Authority)

Date : ______________________________

Name : ______________________________

Post : ______________________________

Tel No : ______________________________

Fax No : ______________________________

*delete whichever is not applicable

Form Serial No……………………

(For official use)

Premises Address……………………………………………………………………………………

PIPES AND FITTINGS INSTALLED/INTENDED TO BE INSTALLED:-

Page ...... of ....

Description of Pipes and Fittings	Size	Manufacturer	Country of Origin	Standards of Compliance (Note 7(i))	Category of Compliance (Note 7 (ii))	FOR OFFICIAL USE					
						Receipt of Samples		Testing of Samples		Return of Samples	
						Serial No.	Date Received	Date	Result	Notified on	Collected on

Please use additional sheet(s) if required

Please see notes overleaf

Annex to WWO46 (6/2012a)

Notes :-

1. The Form is applicable to premises supplied or to be supplied with water from the Waterworks. Parts I and IV of the Form and the Annex are to be completed by the Licensed Plumber. For a new building project, the Authorized Person is required to sign in Part I also. Part II is to be completed by the Registered Consumer/Agent/Applicant of new water supply. Omission of any details in the Form and the Annex may cause delay to your application.

2. Provided that all pipes and fittings intended to be installed are approved by the Water Authority, Parts I and II of this Form shall be submitted to notify the Water Authority of the details and commencement date of plumbing works. If any of the pipes and fittings used/to be used have not yet been approved by the Water Authority, prior approval must be obtained from the Water Authority before the commencement of plumbing works.

3. The Form with the Annex shall be mailed/faxed to the Water Authority.

4. Different sets of Forms are required for different phases of the plumbing that require water supply at different dates. **The Registered Consumer/Agent/Applicant of new water supply in Part II and/or the Licensed Plumber/Authorized Person in Part I shall inform the Water Authority in writing whenever there is any change to the 'anticipated date when water supply is required' in Part I of the Form.**

5. A copy of the form will be returned to the Licensed Plumber with signature of staff of the Water Authority in Part III and/or Part V or where appropriate.

6. Reporting completion of part of the plumbing, (including water pipe to be concealed) shall be made in Part IV of the Form.

7. All pipes used/intended to be used are required to be reported in the Annex. For fittings, only draw-off taps, stop valves, gate valves, ball valves and combination fittings need to be reported. A directory of pipes and fittings approved by the Water Authority can be found in the website http://www.wsd.gov.hk/p&f.html. For pipes and fittings not yet approved by the Water Authority, submission of details and samples of such pipes and fittings listed in the Annex may be required.

   (i) British Standards for pipes and fittings are as follows:-

Copper tubes	BS EN 1057
Chlorinated polyvinyl chloride pipes and fittings	BS 7291, Parts 1 & 4
Crosslinked polyethylene pipes and fittings	BS 7291, Parts 1 & 3
Ductile iron pipes	BS 4772
Galvanized steel tubes (metallic components)	BS 1387
Grey iron pipes	BS 4622
Polybutylene pipes and fittings	BS 7291, Parts 1 & 2
Polyethylene pipes	BS 6730 & BS 6572
Stainless steel tubes	BS 4127
Unplasticised polyvinyl chloride pipes	BS 3505
Ball valves	BS 1212, Part 1
Copper alloy gate valves	BS 5154
Draw-off taps and stop valves	BS 1010, Part 2
Mixing valves	BS 1415, Part 1 or 2
Sluice valves	BS 5163

   (ii) Categories of compliance of fittings are as follows:-

   Category A – Bearing the British Standard Institution Kitemark

   Category B – Accepted by the Water Supply (Water Fittings) Regulations, United Kingdom (formerly known as the Water Byelaws)

   Category C - Accepted by the Water Authority in writing (to quote WSD reference number)

   Category D - Bearing the Water Authority Stamping

8. Licensed Plumber should always be aware of the anti-corruption laws and avoid to contravene them during their course of works. For details, please refer to the website of Independent Commission Against Corruption at http://www.icac.org.hk/

Guidance Notes to Licensed Plumber for Submission of Form WWO 46

(I) Commencement of Plumbing Works

(i) Licensed Plumber should submit Parts I and II of the Form and the Annex to notify the Water Authority of the details and commencement date of the plumbing works. Parts IV and V of the Form are to be used for reporting completion of plumbing works and are NOT required to be submitted by Licensed Plumber at this time.

(ii) Information on Parts I and II of the Form will be input to the computer and the notification will be assessed.

(iii) On completion of the processing, Licensed Plumber will receive Part III of the Form with a Form Serial No. printed on it. A copy of Parts I and II of the Form will also be returned to Licensed Plumber.

(II) Completion of Plumbing Works

(i) Licensed Plumber should submit Parts IV and V of the Form together with a copy of Parts I, II and III of the Form to report completion of whole or part of the plumbing, including water pipe to be concealed. **Please quote Form Serial No. and ASN on Part IV.**

(ii) Information on the submitted forms will be input to the computer and the application will be assessed.

(iii) On completion of the inspection of plumbing works, Licensed Plumber will receive Part V of the Form. A copy of Parts I, II, III and IV of the Form will also be returned to Licensed Plumber.

To : The Water Authority
43/F, Immigration Tower, 7 Gloucester Road, Hong Kong
Tel. 2824 5000 Fax. 2802 7333
Email: wsdinfo@wsd.gov.hk

APPLICATION FOR CERTIFICATE REGARDING WATER SUPPLY AVAILABILITY/CONNECTION*

BUILDING (STANDARDS OF SANITARY FITMENTS, PLUMBING, DRAINAGE WORKS & LATRINES) REGULATIONS

Lot No.: Date:
Address:

Please supply the following certificate:

***I - Availability of Water Supply:**
1. Potable Water ☐
2. Flushing Water ☐

(a) Anticipated Completion Date ____________________

(b) Proposed development: ____________________ Estimated daily demand ____________ litres

☐ Residential: No. of flats ______________ Anticipated Population ______________

☐ Commercial: No. of units ______________ Nature ____________________________

☐ Industrial No. of units ______________ Nature ____________________________

* (c) Attached is a copy of the water supply clause(s) in conditions set for this land.

* (d) This development is a Section 16 application case under the Tower Planning Ordinance and approved on ____________________________ with
*(i) no comment on water supply issue from the Town Planning Board, or
*(ii) comment(s) on water supply issue from the Town Planning Board as shown in the attached copy.

* (e) This is a redevelopment case without any need for Section 16 application under the Town Planning Ordinance.

***II - Connection of Water Supply:**
1. Potable Water ☐
2. Flushing Water ☐

Please quote ASN: ____________________

I serve this notice on the period of availability of site under safe condition for connection works (3 months advance notice normally required) and undertake to make the inside service ready for connection:

____

I confirm that the plumbing fittings and pipes used in the captioned project are in full compliance with Waterworks standards and requirements.

I fully understand the purpose and agree to the Water Authority using data collected from me for the purpose of or directly related to applying for new water supply. If I do not provide sufficient data, the Water Authority may not be able to process my application. I agree that these data and other related information may be transferred to other Government bureaux and departments. I understand that I can request the Departmental Secretary of the Water Supplies Department at 48/F., Immigration Tower, 7 Gloucester Road, Hong Kong for access to and correction of personal data.

Authorized Person's Signature ______________________________
Name (in Block Letters) ______________________________
HKID No. ______________________________
Company Name ______________________________
Business Registration No. ______________________________
Preferred contact method: *by mail/e-mail/fax
Mailing Address ______________________________
E-mail ______________________________
Fax No. ______________________________
Tel No. ______________________________

☐ Tick as appropriate
* Delete as appropriate

SAVE WATER – SAVE MONEY

WWO 132(10/2004)

W

水 務 署
Water Supplies Department

香港灣仔告士打道七號入境事務大樓
Immigration Tower, 7 Gloucester Road, Hong Kong

電子郵遞 *e-mail* wsdinfo@wsd.gov.hk

電　話 *Telephone* 2829 4367　　圖文傳真 *Facsimile* 2824 0578

檔　號 *Reference* (11) in WSD 3318/50 Pt.4 T/J(7)　　10 August 2012

Distribution : To all Licensed Plumbers and Authorised Persons

Dear Sirs,

WSD Circular Letter No. 2/2012
Cleansing and Disinfection of Fresh Water Inside Service

I attach a copy of the guidelines on cleansing and disinfection of fresh water inside service for your reference.

Should you have any enquiries, please contact our Engineer Mr. Angus FAN at tel. no. 2829 4726.

This Circular Letter is to supersede Circular Letter No. 6/2002 issued on 26 August 2002.

Yours faithfully,

Original signed

(CHIN Chu Sum)
for Water Authority

Encl.

(with Chinese translation)

c.c. Housing Department
Buildings Department
Architectural Services Department
Fire Services Department
The Hong Kong Housing Society
The Hong Kong Institute of Architects
The Hong Kong Institution of Engineers
The Hong Kong Institute of Surveyors
Hong Kong Federation of Plumbing & Drainage Ltd.
The Institute of Plumbing and Heating Engineering – Hong Kong Council
Hong Kong Plumbing and Sanitary Ware Trade Association Ltd.
Hong Kong Licensed Plumbers Association Ltd.
Hong Kong Plumbing General Union
Hong Kong Water Works Professional Association Ltd.
The Hong Kong Institution of Plumbing and Drainage Ltd.
The Association of Registered Fire Service Installation Contractors of Hong Kong Limited
Real Estate Development Association of Hong Kong
WSD 3318/15/81
WSD 3608/9/27/95
WSD 1612/4/7

Guidelines on Cleansing and Disinfection of Fresh Water Inside Service

Under the provision of Waterworks Regulation 7, a consumer or the agent shall be responsible for keeping an inside service clean. To this end, the consumer or agent concerned shall clean and disinfect a newly installed fresh water inside service before it is given a supply from the Water Supplies Department. Besides, after repair or maintenance of fresh water inside service, if there is a possibility that extraneous materials can get into the inside service, the inside service shall be cleaned and disinfected before water supply is resumed. The guidelines below on how to clean and disinfect the fresh water inside service are set out for general reference:-

(A) Newly Installed Fresh Water Inside Service

The newly installed fresh water inside service shall be cleaned and disinfected to the satisfaction of the Water Authority in accordance with the following procedures.

(I) Newly Installed Underground Fresh Water Mains

(1) Remove all extraneous materials inside the water mains. Fill the fresh water mains slowly with water and carry out the required water pressure testing. If the result of the test is satisfactory, clean the fresh water mains internally and flush them with potable water. For fresh water mains of sizes less than 600 mm in diameter, swab to remove the dirt and materials inadvertently left in the water mains and flush them with potable water.

(2) Fill the water mains completely with a homogeneous solution of chloride of lime for disinfection. The concentration of the solution has to meet the requirement that when the water mains are filled up with water, the free chlorine in the water will be at least 30 ppm. Keep the water mains under disinfection for at least 24 hours. After disinfection, flush the water mains thoroughly with potable water.

(3) Arrange with the Water Authority to collect samples at representative sampling point(s) as agreed by the Water Authority for bacteriological and chemical analysis. The test parameters and the related acceptance

criteria are listed in the Annex.

Any contamination in underground mains may lead to pollution of the government supply. To ensure quality control and minimize the risk of pollution to the government supply, the Water Authority will carry out sampling and analysis for this part of inside service.

The contact persons of the Water Authority for such arrangements are:-

Areas	Contact Person	Telephone No.
Hong Kong and Outlying Islands	Waterworks Chemist/Treatment (1)	2891 9276
Kowloon and New Territories East	Waterworks Chemist/Treatment (2)	2691 7689
New Territories West	Waterworks Chemist/Treatment (3)	2450 6121

The Water Authority will inform the Licensed Plumber concerned of the result of analysis. If the results are satisfactory, the fresh water mains can be put into operation. If not, the above disinfection and testing procedures shall be carried out again.

(4) To avoid possible contamination, the fresh water mains concerned shall be put into operation within 7 days from the successful disinfection. In this respect, Licensed Plumbers are advised to allow sufficient time for the Waterworks Chemists to carry out sampling and analysis and to avoid arranging disinfection immediately before long public holidays.

(II) Newly Installed Fresh Water Inside Service other than Those covered in (A)(I) above

(1) Flush the inside service concerned thoroughly with potable water.

(2) After flushing, follow one of the three procedures stated below to disinfect the inside service concerned.

Methods Using Chlorine as a disinfectant

(i) Fill the inside service concerned with a homogeneous solution of chloride of lime for disinfection. The concentration of the solution has to meet the requirement that when the inside service is filled up with water, the free chlorine in the water will be at least 30 ppm. After keeping the inside service under disinfection for at least 24 hours, the inside service shall be immediately drained and thoroughly flushed with potable water.

or

(ii) Fill the inside service concerned with chlorinated water at an initial concentration of 50 ppm for a contact period of one hour. If the free residual chlorine measured at the end of the contact period is less than 30 ppm, the disinfection process shall be repeated. After successful disinfection, the inside service shall be immediately drained and thoroughly flushed with potable water.

or

Methods Using Disinfectants other than Chlorine

(iii) Fill the inside service concerned with the disinfectant solution other than chlorine at the initial concentration and for the contact time specified by the manufacturer of the disinfectant. If the residual of the disinfectant at the end of the contact time is less than the manufacturer's recommendation, the disinfection procedure shall be repeated. After successful disinfection, the inside service shall be immediately drained and thoroughly flushed with potable water. Flushing shall continue in accordance with the disinfectant manufacturer's instructions/recommendations or until there is no evidence of the disinfectant chemical being present, or it is at a level that is no higher than that present in the potable water supplied.

(3) After disinfection, arrange with either the Water Authority or an accredited laboratory[1] to collect samples at representative sampling point(s) as agreed by the Water Authority for bacteriological and chemical analysis. The test parameters and the related acceptance criteria are listed in the Annex.

If the results are satisfactory, the fresh water inside service can be put

[1] The accredited laboratory shall be accredited for all the individual parameters listed in the Annex.

into operation. If not, the above disinfection and testing procedures shall be carried out again.

The contact persons of the Water Authority for such arrangements are:-

Areas	Contact Person	Telephone No.
Hong Kong and Outlying Islands	Waterworks Chemist/Treatment (1)	2891 9276
Kowloon and New Territories East	Waterworks Chemist/Treatment (2)	2691 7689
New Territories West	Waterworks Chemist/Treatment (3)	2450 6121

If the sampling and analysis is carried out by the Water Authority, the Water Authority will inform the Licensed Plumber concerned of the result of analysis. If an accredited laboratory is arranged to carry out the sampling and analysis, the result of analysis shall be submitted to the Water Authority.

(4) To avoid possible contamination, the fresh water inside service concerned shall be put into operation within 7 days from the successful disinfection. In this respect, Licensed Plumbers are advised to allow sufficient time for the Waterworks Chemists or the accredited laboratory to carry out sampling and analysis and to avoid arranging disinfection immediately before long public holidays.

(B) Repair or Maintenance of Fresh Water Inside Service

(I) Repair or Maintenance of Underground Fresh Water Mains

(1) Keep the excavation surfaces of trench clear from the pipe body and remove all extraneous materials in the fresh water mains. If the trench is flooded, pump water out of the trench.

(2) Clean the internal surface of the exposed pipe ends and the replacement pipe with a solution of chloride of lime. The concentration of free chlorine in the solution shall be at least 30 ppm.

(3) Fill the section of the water mains that has been shut down for repair or

maintenance with a homogeneous solution of chloride of lime for disinfection. The concentration of the solution has to meet the requirement that when the water mains are completely filled with water, the free chlorine in the water will be at least 30 ppm. Fill the water mains with water and isolate them when filling is completed. Keep the water mains under disinfection for at least 30 minutes. After disinfection, flush the water mains thoroughly with potable water through a fire hydrant, washout or, if no such facilities are available, through a submain temporarily put out of service.

(II) Repair or Maintenance of Fresh Water Inside Service other than Those covered in (B)(I) above

After completion of repair or maintenance works, fill the concerned inside service that has been shut down for repair or maintenance with a homogeneous solution of chloride of lime for disinfection. The concentration of the solution has to meet the requirement that when the inside service is completely filled with water, the free chlorine in the water will be at least 30 ppm. Isolate the inside service when filling is completed and keep the inside service under disinfection for at least 30 minutes. After disinfection, flush the inside service thoroughly with potable water.

(C) Proper Operation of Inside Service

Stagnant water provides a favourable breeding environment for bacteria. To minimize the possibility of bacteria growth after putting an inside service into operation, water outlets which are infrequently used or are connected to stagnant water supply pipeworks shall be flushed at full flow for a minimum period of one minute at least on a weekly basis and before use.

The test parameters shall include but not limited to the following:-

Test parameter	Acceptance Criteria
Turbidity (NTU)	≤ 3.0
Colour (HU)	≤ 5
pH at 25^{o}C	6.5-9.2
Free residual Chlorine (mg/L)	> 0 and ≤ 1.5
Conductivity at 25^{o}C (μS/cm)	≤ 300
Total coliforms (cfu/100mL)	0
E.coli (cfu/100mL)	0
Heterotrophic Plate Count (cfu/mL)	≤ 20

Additional parameters may be tested if there is any sign of suspected contamination.

Test results of water samples taken before and after the disinfection work in Mun Ching House

Table 1: Water samples taken from patient's home on 18/6/2015

Item	Location	Possible Source	Water samples LBC (cfu/ml)
1.	Kitchen	Tap water (pre) (cold)	Legionella species (total): 600 Lp1: 330 Lp 2-14: 270 Legionella species (non-pneumophila): <0.1
2.	Kitchen	Tap water w/o aerator (post-flush) (cold)	Legionella species (total): 191 Lp1: 61 Lp2-14:130 Legionella species (non-pneumophila): <0.1
3.	Toilet	Tap water (pre-flush) (cold)	Legionella species (total): 139 Lp1: 100 Lp2-14: 39 Legionella species (non-pneumophila): <0.1
4.	Toilet	Tap water w/o aerator (post-flush) (cold)	Legionella species (total): 31 Lp1: 11 Lp2-14: 20 Legionella species (non-pneumophila): <0.1
5.	Toilet	Shower water w/o shower head (pre-flush) (cold)	Legionella species (total): 280 Lp1: 170 Lp2-14:110 Legionella species (non-pneumophila): <0.1
6.	Toilet	Shower water w/o shower hose (post-flush) (cold)	Legionella species (total): 4.2 Lp1: 1.3 Lp2-14: 2.9 Legionella species (non-pneumophila): <0.1
7.	Toilet	Shower water w/o shower hose (post-flush) (hot)	Legionella species (total): 18.0 Lp1: 9.6 Lp2-14: 8.4 Legionella species (non-pneumophila): <0.1
8.	Roof water tank	Water from tank	Total <0.1

Lp1: *Legionella pneumophila* serogroup 1

Lp2-14: *Legionella pneumophila* serogroup 2-14

Table 2: Swab samples taken patient's home on 18/6/2015

Item	Location	Swab sample	Result
1	Kitchen	Tap aerator	Lp1 present Lp 2-14 present
2	Toilet	Tap aerator	No Legionella species isolated
3	Toilet	Shower head (internal)	No Legionella species isolated
4	Toilet	Shower hose (internal)	No Legionella species isolated

Table 3: Water samples taken from Mun Ching House on 6/7/2015

Item	Location	Possible Source	Water samples LBC (cfu/ml)
1.	10/F	Individual water pipe (post-water meter) supplying the affected apartment	Legionella species (total): 1.7 Lp1: 1.7 Lp2-14: <0.1 Legionella species (non-pneumophila): <0.1
2.	10/F	Water pipe (pre-water meter) supplying the same floor	Legionella species (total): 0.7 Lp1: 0.5 Lp2-14: 0.2 Legionella species (non-pneumophila): <0.1
3.	1/F	Water pipe on 1/F supplying guard room on G/F (i.e. most distal end of Wing A)	Legionella species (total): 0.3 Lp1: <0.1 Lp2-14: 0.3 Legionella species (non-pneumophila): <0.1

Table 4: Water samples taken from patient's home on 8/7/2015 (after home water taps replaced)

Item	Location	Possible Source	Water samples LBC (cfu/ml)
1.	Kitchen	Tap water (pre) (cold)	Legionella species (total): 14.3 Lp1: 14.3 Lp2-14: <0.1 Legionella species (non-pneumophila): <0.1
2.	Kitchen	Tap water w/o aerator (post-flush) (cold)	Legionella species (total): 2.5 Lp1: 1.1 Lp2-14: 1.4 Legionella species (non-pneumophila): <0.1
3.	Toilet	Tap water (pre-flush) (cold)	Legionella species (total): 3.4 Lp1: 1.7 Lp2-14: 1.7 Legionella species (non-pneumophila): <0.1
4.	Toilet	Tap water w/o aerator (post-flush) (cold)	Legionella species (total): 0.4 Lp1: 0.1 Lp2-14: 0.3 Legionella species (non-pneumophila): <0.1
5.	Toilet	Shower water w/o shower head (pre-flush) (cold)	Legionella species (total): 3.3 Lp1: 2.7 Lp2-14: 0.6 Legionella species (non-pneumophila): <0.1
6.	Toilet	Shower water w/o shower hose (post-flush) (cold)	Legionella species (total): 1.1 Lp1: 0.7 Lp2-14: 0.4 Legionella species (non-pneumophila): <0.1
7.	Toilet	Shower water w/o shower hose (post-flush) (hot)	Legionella species (total): 3.6 Lp1: 2.5 Lp2-14: 1.1 Legionella species (non-pneumophila): <0.1

Table 5: Water samples taken from patient's home on 24/8/2015 (after home water taps replaced and disinfection had taken place)

Item	Location	Possible Source	Water samples LBC (cfu/ml)
1.	Kitchen	Tap water (pre) (cold)	Legionella species (total): 0.1 Lp1: <0.1 Lp2-14: 0.1 Legionella species (non-pneumophila): <0.1
2.	Kitchen	Tap water w/o aerator (post-flush) (cold)	Legionella species (total): 0.1 Lp1: <0.1 Lp2-14: 0.1 Legionella species (non-pneumophila): <0.1
3.	Toilet	Tap water (pre-flush) (cold)	Legionella species (total): 0.1 Lp1: 0.1 Lp2-14: <0.1 Legionella species (non-pneumophila): <0.1
4.	Toilet	Tap water w/o aerator (post-flush) (cold)	Legionella species (total): <0.1
5.	Toilet	Shower water w/o shower head (pre-flush) (cold)	Legionella species (total): 0.1 Lp1: 0.1 Lp2-14: <0.1 Legionella species (non-pneumophila): <0.1
6.	Toilet	Shower water w/o shower hose (post-flush) (cold)	Legionella species (total): <0.1
7.	Toilet	Shower water w/o shower hose (post-flush) (hot)	Legionella species (total): <0.1

Table 6: Water pipe water samples taken from Mun Ching House on 24/8/2015 (after disinfection of wing A & B)

Item	Location	Possible Source	Water samples LBC (cfu/ml)
1.	10/F	Individual water pipe (post-water meter) supplying the affected apartment	Legionella species (total): <0.1
2.	10/F	Water pipe (pre-water meter) supplying the same floor	Legionella species (total): 0.1 Lp1: <0.1 Lp2-14: 0.1 Legionella species (non-pneumophila): <0.1
3.	1/F	Water pipe on 1/F supplying guard room on G/F (i.e. most distal end of Wing A)	Legionella species (total): <0.1

- END -