

CHAPTER 8

Water Supplies Department

Managing and reducing water main bursts and leaks

**Audit Commission
Hong Kong
25 October 2010**

This audit review was carried out under a set of guidelines tabled in the Provisional Legislative Council by the Chairman of the Public Accounts Committee on 11 February 1998. The guidelines were agreed between the Public Accounts Committee and the Director of Audit and accepted by the Government of the Hong Kong Special Administrative Region.

Report No. 55 of the Director of Audit contains 11 Chapters which are available on our website at <http://www.aud.gov.hk>.

Audit Commission
26th floor, Immigration Tower
7 Gloucester Road
Wan Chai
Hong Kong

Tel : (852) 2829 4210
Fax : (852) 2824 2087
E-mail : enquiry@aud.gov.hk

MANAGING AND REDUCING WATER MAIN BURSTS AND LEAKS

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PART 1: INTRODUCTION

1.1 This PART describes the background to the audit and outlines the audit objectives and scope.

Background

Water supplies in Hong Kong

1.2 The Water Supplies Department (WSD) is responsible for supplying fresh water and salt water (seawater for flushing) in Hong Kong. In 2009, 952 million cubic metres (Mm³) of fresh water and 271 Mm³ of salt water were supplied to a population of seven million.

1.3 About 70% to 80% of fresh water in Hong Kong is supplied from Dongjiang (East River) in Guangdong Province in the Mainland under the Dongjiang Water Supply Agreement (Note 1). The remaining fresh water originates from rainwater collected through a network of catchments located across country parks and rural areas. Fresh water supply is complemented by salt water supply for flushing to reduce fresh water consumption. Fresh water supply is metered and chargeable based on the quantity used, while salt water is supplied free of charge.

Water supply and distribution systems

1.4 The WSD is responsible for planning, constructing, operating and maintaining the water supply and distribution systems. Raw fresh water from Dongjiang and rainwater from catchment areas are piped to impounding reservoirs for storage and to water treatment works for treatment to meet international hygiene standards. Salt water is also treated to conform to WSD standards. After treatment, fresh water and salt water are supplied to users through two separate water supply and distribution systems.

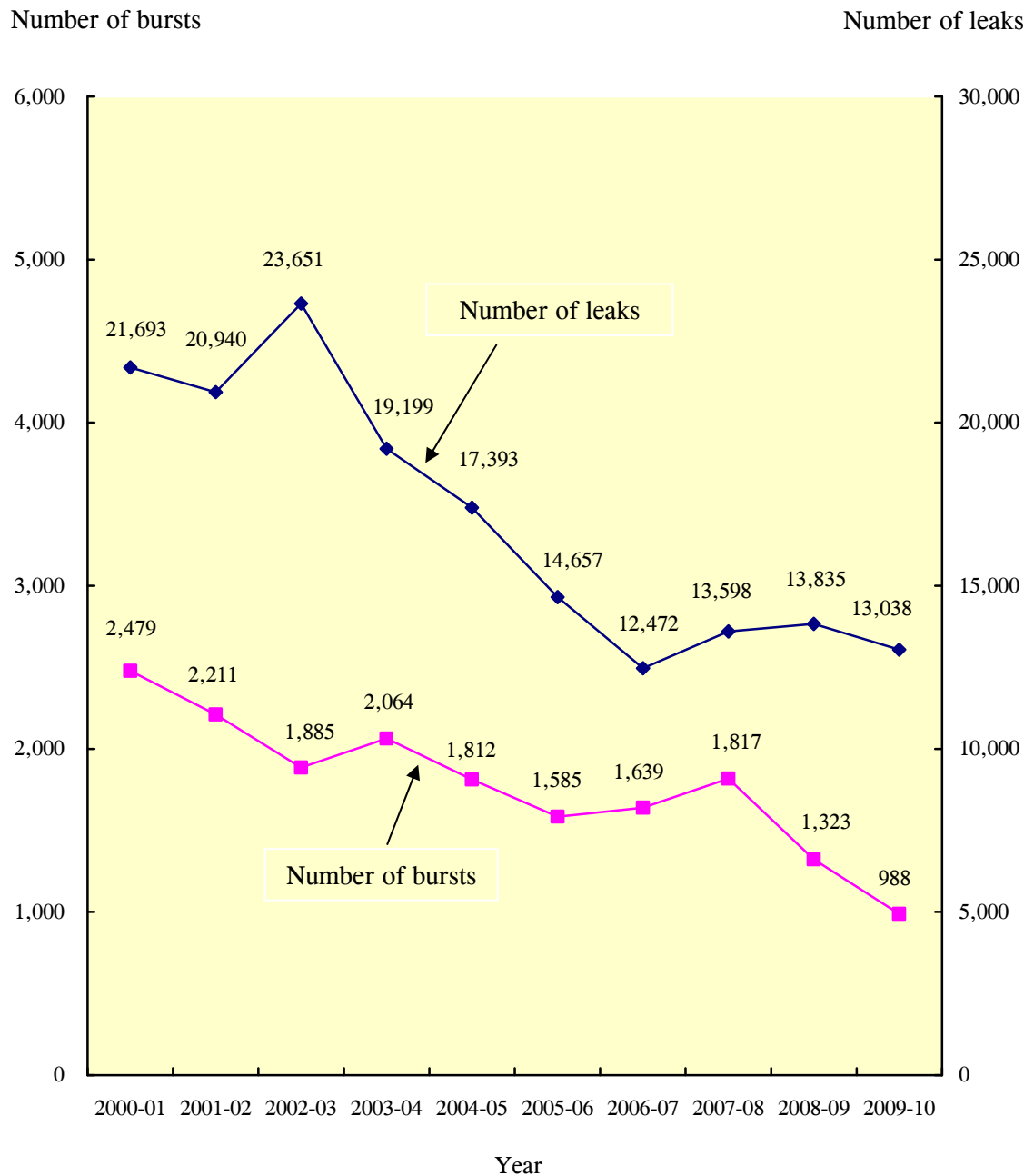
Note 1: *Under the agreement signed in December 2008, the Guangdong Provincial Government would supply water to Hong Kong from 2009 to 2011. The annual cost was fixed at \$2,959 million for 2009, \$3,146 million for 2010 and \$3,344 million for 2011.*

1.5 As of April 2010, there were about 7,800 kilometres (km) of water mains, comprising 6,200 km of fresh water mains and 1,600 km of salt water mains, most of which were laid underground. The service lives of fresh water mains range from 30 to 50 years depending on the ground conditions and the types of pipe materials. For salt water mains, owing to the corrosive effect of seawater, their service lives are shorter.

Main bursts and leaks

1.6 In the early 1990s, the WSD noted that a substantial portion of water mains were approaching the end of their service lives. Ageing water mains are prone to bursts and leaks (see para. 2.2), resulting in water loss, disrupting water supply and causing inconvenience to the public. Figure 1 shows the number of reported water main bursts and leaks from 2000-01 to 2009-10. The WSD estimated that, in 2009-10, the quantities of fresh water and salt water lost through reported bursts and leaks were 233,600 cubic metres (m³) and 188,600 m³ respectively.

Figure 1
Number of reported water main bursts and leaks
(2000-01 to 2009-10)



Source: WSD records

Remarks: The numbers include cases involving both fresh water and salt water mains carrying treated water.

Real losses of water

1.7 According to the International Water Association (IWA — Note 2), there are two types of water losses, namely:

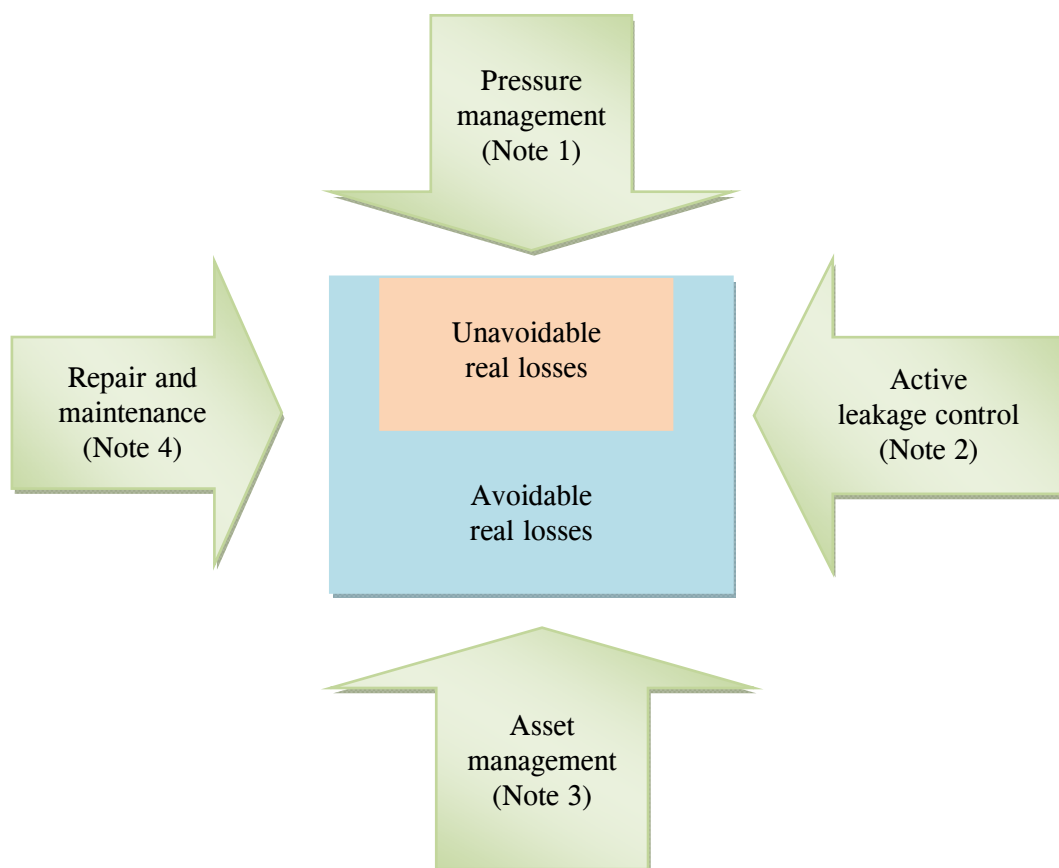
- (a) *Apparent water losses.* These comprise water consumed by users but not metered and charged, mainly due to inaccurate meter readings and unauthorised use of water; and
- (b) *Real water losses.* These include water losses from leakage in joints and fittings, and bursts and leaks of water mains. The frequencies of water main bursts, water flow rates and duration of leaks have a direct impact on the quantity of water losses.

1.8 Real water losses are unavoidable as it is not possible to prevent all water main bursts and leaks. Nevertheless, through better water main management, it is possible to reduce these losses. The IWA has recommended four management approaches to reduce real losses of water (see Figure 2).

Note 2: *The IWA has 10,000 individual and 400 corporate members from 130 countries. Through its network of members and experts in research, practice, regulation, industry, consulting and manufacturing, the IWA provides innovative, pragmatic and sustainable solutions to water supply problems.*

Figure 2

Four approaches to managing real losses of water



Source: IWA literature

Note 1: This refers to the adjustment of water pressure of a distribution system to an optimal level (see PART 4).

Note 2: This refers to actions to deal with unreported water main bursts and leaks (see PARTs 3 and 5).

Note 3: This refers to the programme on installation, maintenance and replacement of water mains (see PART 3).

Note 4: This refers to improvements in the speed and quality of water main repair and maintenance (see PART 2).

Repair of water mains

1.9 Repair works for water mains are carried out by WSD in-house staff and term contractors. There are 16 Distribution Sections under the four WSD Regional Divisions (namely Hong Kong and Islands, Kowloon, New Territories (NT) East and NT West Regional Divisions). Each Distribution Section comprises:

- (a) a works group for implementing mainlaying programmes and minor replacement programmes; and
- (b) a maintenance group for repairing water mains and carrying out routine cleansing work.

1.10 The WSD has awarded contracts to five term contractors (one for Hong Kong Island, one for Outlying Islands, and one for each of the other three WSD Regional Divisions) to provide water main repair services. Under the current term contracts, the five contractors are together required to provide a minimum of 33 emergency teams during normal working hours, and 18 emergency teams outside normal working hours for repair works.

Replacement and Rehabilitation Programme

1.11 In 1997, the WSD decided to replace and rehabilitate some 3,000 km of aged fresh water and salt water mains under a Replacement and Rehabilitation (R&R) Programme. The purpose was to reduce the number of water main bursts and leaks.

1.12 The R&R Programme was originally planned for implementation in four stages (Stages 1 to 4) from 2000 to 2020, with priority given to water mains in critical conditions, taking into account the pipe materials, leak and burst history, and the probability and consequence of pipe failures. In January 2005, the WSD decided to advance the target completion date of the Programme to 2015 to bring about earlier improvement to the water supply and distribution systems. The estimated cost of the R&R Programme was \$21.8 billion. Up to 31 March 2010, Stage 1 of the R&R Programme had been completed.

Management of water pressure

1.13 Service reservoirs storing fresh water and salt water are located in high-altitude areas for distributing water to users through networks of water mains. As fresh water and salt water are distributed by gravity, water within water mains is under pressure. The pressure, measured in metre head (Note 3), varies in different locations depending on the altitude and the distance from the service reservoirs. The water pressure is sufficient to distribute water to the lower floors (mostly up to the seventh floor) of buildings. For the upper floors, water is pumped to roof tanks of the buildings by their internal pumping systems before distribution to individual users.

1.14 High water pressure increases the speed of water flow. However, excessive water pressure may cause water main bursts and leaks. The WSD has set a performance target of maintaining a minimum water supply pressure of between 15-metre head and 30-metre head in the **fresh water** distribution systems. Since 1997, the WSD has implemented pressure management schemes (PMS) with a view to maintaining the pressure of fresh water (Note 4) at optimal levels. The schemes involve the installation of pressure reducing valves at strategic locations of the water distribution systems.

Leakage in fresh water distribution systems of residential developments

1.15 Since 2003, the WSD has installed bulk meters to monitor the **fresh water** consumption of selected residential developments. The water consumption recorded by a bulk meter is compared with the aggregate water consumption recorded by individual household meters in a residential development to identify fresh water leakage. For residential developments identified with significant water losses, the WSD would request the estate managements concerned to carry out rectification works.

1.16 In September 2005, the then Environment, Transport and Works Bureau (Note 5) supported in principle the WSD's proposal to implement a master metering policy (MMP) in two stages for monitoring fresh water losses in new and existing developments. Stage 1 of the MMP for new large developments commenced in January 2006. Stage 2 for existing large developments was planned to commence in 2012.

Note 3: *Metre head is a measure of water pressure. For example, the pressure at the bottom of a 10-metre-deep pool is 10-metre head.*

Note 4: *The pressure management schemes do not cover salt water mains.*

Note 5: *In July 2007, the Development Bureau was formed to take over, among others, the works policy portfolio of the Environment, Transport and Works Bureau.*

Audit review

1.17 The Audit Commission (Audit) has recently conducted a review to examine the WSD's management of water main bursts and leaks in the water supply and distribution systems. The review focused on the following areas:

- (a) repair of burst and leak water mains (PART 2);
- (b) implementation of Replacement and Rehabilitation Programme (PART 3);
- (c) management of water pressure (PART 4); and
- (d) leakage in fresh water distribution systems of residential developments (PART 5).

Audit has found that there are areas where improvements can be made by the WSD in managing and reducing water main bursts and leaks. Audit has made a number of recommendations to address the issues.

Acknowledgement

1.18 Audit would like to acknowledge with gratitude the full cooperation of the staff of the WSD and the Highways Department (HyD) during the course of the audit review.

PART 2: REPAIR OF BURST AND LEAK WATER MAINS

2.1 This PART examines the WSD's efficiency and effectiveness in repairing water mains involved in burst and leak cases.

Water main bursts and leaks

2.2 According to the WSD, an incident is classified as a water main **burst** when there is an immediate need to isolate water mains under one or more of the following circumstances:

- (a) the quantity of water outflow is significant;
- (b) the velocity of water escaping from the faulty main is high;
- (c) there is an imminent danger of flooding the area, causing significant traffic disruption or damage to adjacent roads, land, structures, properties or slopes, or affecting the safety of the public at large; and
- (d) continuous water supply to the affected area will not be maintained owing to a drop in pressure in the supply system.

An incident involving outflow of water from faulty mains without the need for an immediate isolation of the water mains is classified as a water main **leak**.

2.3 Table 1 shows the number of fresh water and salt water main bursts and leaks from 2007-08 to 2009-10.

Table 1

**Number of main bursts and leaks
(2007-08 to 2009-10)**

Year	Fresh water main burst	Salt water main burst	Fresh water main leak	Salt water main leak	Total
	(a)	(b)	(c)	(d)	(e) = (a) + (b) + (c) + (d)
	(No.)	(No.)	(No.)	(No.)	(No.)
2007-08	920	897	11,574	2,024	15,415
2008-09	655	668	11,740	2,095	15,158
2009-10	447	541	10,765	2,273	14,026
Total	2,022	2,106	34,079	6,392	44,599

Source: WSD records

Emergency repair of water mains

2.4 The WSD deploys both in-house staff and term contractors to carry out emergency repairs of water mains at any time. The main objective of taking immediate action on a main burst is to minimise the impacts on water supply to users. According to the WSD’s Guidance Notes and Departmental Instruction No. 802 on “Main bursts and emergency maintenance of water mains”, both issued in 2006:

- (a) upon receipt of a report of a main burst from the Customer Telephone Enquiry Centre (CTEC — Note 6), the responsible WSD turncock gang (Note 7) should depart for the spot within 15 minutes;

Note 6: *The Centre provides a round-the-clock hotline service to the public.*

Note 7: *A turncock gang comprises WSD workmen who turn off water main valves for carrying out repair works and turn them on after works completion.*

- (b) the turncock gang under the supervision of a duty works supervisor should complete the following tasks within the shortest possible time:
 - (i) providing temporary guarding facilities for isolating the burst main or reducing the outflow from the burst main;
 - (ii) notifying the term contractor for attending to the main burst and arranging work supervisors of the maintenance unit to supervise the repair works; and
 - (iii) informing the CTEC of the burst main and the areas where water supply is affected, and arranging emergency water supply;
- (c) the responsible term contractor should be notified to proceed to the site without delay. He will carry out on-site repair works with a view to restoring water supply as soon as practicable; and
- (d) the works supervisor handling the case should report without delay by telephone to the CTEC about the progress of the works to facilitate the dissemination of updated information to the public.

Maintenance term contract emergency teams

2.5 Emergency water main repair works are mainly carried out by term contractors. As laid down in the maintenance term contracts:

- (a) each emergency team provided by a term contractor should consist of a minimum of ten persons. In the event that the ten-person team is not adequate to handle the emergency works, the contractor should provide adequate labour and/or plants as instructed by the WSD;
- (b) as soon as a contractor is notified verbally that attendance to emergency works is required, he should make immediate arrangements and proceed to the site without delay where he will receive instructions on the works to be carried out. The contractor should complete the works with due diligence and without delay; and
- (c) for emergency works, should the contractor's emergency team (of at least five persons) arrive at the site within 1 hour and 25 minutes after receiving the instructions from the WSD, an enhancement factor for payment (provided by the contractor during tendering) will be applied to the rates of the items carried out under the works order.

Reinstatement of road surface

2.6 Before carrying out the water main repair works on carriageways and footpaths, the contractor has to apply for a permit from the HyD for the excavation works to be carried out. For works classified as emergency, the WSD has obtained Emergency Excavation Permits which eliminate the lengthy application process for individual incidents. Upon completion of the repair works, the contractor needs to:

- (a) ensure that the excavation is backfilled with appropriate fill materials (Note 8);
- (b) reinstate the affected road surface, road markings and any other installations to the conditions before the works;
- (c) reopen the affected carriageways and footpaths for use by the public;
- (d) submit a Completion Notice to the HyD for acceptance of the backfilling and reinstatement works; and
- (e) carry out improvement works if the backfilling and reinstatement works are not accepted by the HyD.

Performance targets

2.7 The WSD has set the following performance targets for 2009-10:

- (a) ***Time for isolation of burst mains*** (TIBM — the time between the receipt of a burst report and the isolation of the burst main):
 - (i) ***For small-size fresh water and salt water mains*** (pipe diameter up to 300 millimetres (mm)): 92% of cases not over 1.5 hours; and
 - (ii) ***For medium-size fresh water and salt water mains*** (pipe diameter over 300 mm and up to 600 mm — Note 9): 92% of cases not over 2.5 hours;

Note 8: *The fill materials should meet the requirements laid down in the General Specification for Civil Engineering Works published by the Government.*

Note 9: *The WSD had not set performance targets for large-size mains (pipe diameter over 600 mm).*

- (b) ***Time of supply interruption*** (TSI — the time between the isolation of the burst main and the resumption of water supply) ***for small-size and medium-size fresh water mains***: 70% of cases not over 7 hours and 85% of cases not over 8 hours; and
- (c) ***Provision of temporary emergency water supply***. If it is decided that there is a need for temporary emergency water supply, such service should be provided **within three hours** after the isolation of water mains for 90% of such cases.

The TIBM and the TSI targets have been included in the WSD performance pledge for 2009-10.

2.8 According to WSD guidelines, requests for provision of water wagons or water tanks for emergency water supply should be made to the responsible officers as early as possible (in any case not more than 45 minutes after the isolation of water mains).

Management information system on main bursts and leaks

2.9 For performance management and monitoring purposes, WSD regional staff are required to record details of all cases of main bursts and leaks in the computerised Management Information System on Main Bursts and Leaks, including:

- (a) location of the main burst or leak;
- (b) turncock gang's departure time for the spot;
- (c) type of the faulty main material and age of the main;
- (d) time records for calculating the TIBM and TSI (see para. 2.7(a) and (b));
- (e) the extent to which the traffic has been affected;
- (f) causes of the incidents; and
- (g) the number of maintenance team members involved.

Non-compliance case reports

2.10 According to WSD guidelines, for each main burst case where the performance targets for TIBM and TSI are not met, the WSD site staff should submit a non-compliance case report to the Regional Head within four days after the incident. The report contains major details of the incident and the reasons for not meeting the targets.

Causes of main bursts

2.11 An analysis of the causes of main bursts from 2007-08 to 2009-10 is shown in Table 2.

Table 2
Causes of main bursts
(2007-08 to 2009-10)

Cause	Year			Total	Percentage of all cases
	2007-08	2008-09	2009-10		
	(Number of bursts — Note 1)				
<i>External disturbances</i>					
Ground settlement or vibration (Note 2)	885	639	545	2,069	50%
Construction activities nearby	60	55	41	156	4%
<i>Other factors</i>					
Water main erosion or corrosion	397	360	257	1,014	25%
Faulty materials	205	140	7	352	8%
Faulty workmanship	10	9	5	24	1%
Unknown factors	260	120	133	513	12%
Total	1,817	1,323	988	4,128	100%

Source: WSD records

Note 1: The numbers do not include bursts of water mains carrying untreated water.

Note 2: According to the WSD, a defect is considered to be caused by ground settlement if there is an apparent subsidence of the affected area with respect to the surrounding ground. Ground settlement may arise from improper deposition or compaction of fill materials surrounding water mains. Vibration refers to the shaking movement of fill materials mainly arising from excessive traffic loading and other external activities such as piling and blasting.

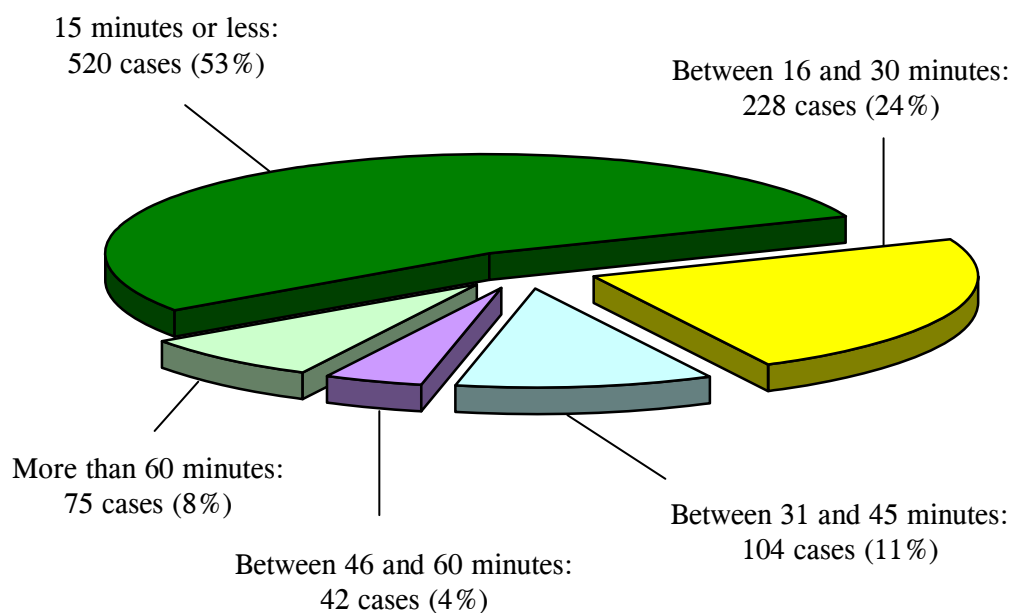
Audit observations and recommendations

Need to promptly notify term contractors to arrive at main burst sites

2.12 According to WSD guidelines, the responsible term contractor should be notified to proceed to the main burst site without delay (see para. 2.4(c)). In 2009-10, there were 969 main burst cases handled by term contractors (Note 10). Audit's analysis of the time between the turncock gangs' arrival at the main burst sites and the time of notifying the term contractors to proceed to the sites is shown in Figure 3.

Figure 3

Time between turncock gangs' arrival and notification to term contractors (2009-10)



Source: WSD records

Note 10: *Of the 988 main burst cases in 2009-10 (see Table 2 in para. 2.11), 19 cases were handled by WSD in-house staff.*

2.13 In September 2010, in response to Audit's enquiry, the WSD informed Audit that, upon arrival at the site and after confirming that there was actually a main burst, the turncock gang would ascertain and isolate the burst water main. The gang would also notify the term contractor to attend to the burst and provide him at the same time with all available information to facilitate mobilisation of labour and plant resources as early as possible for the repair works.

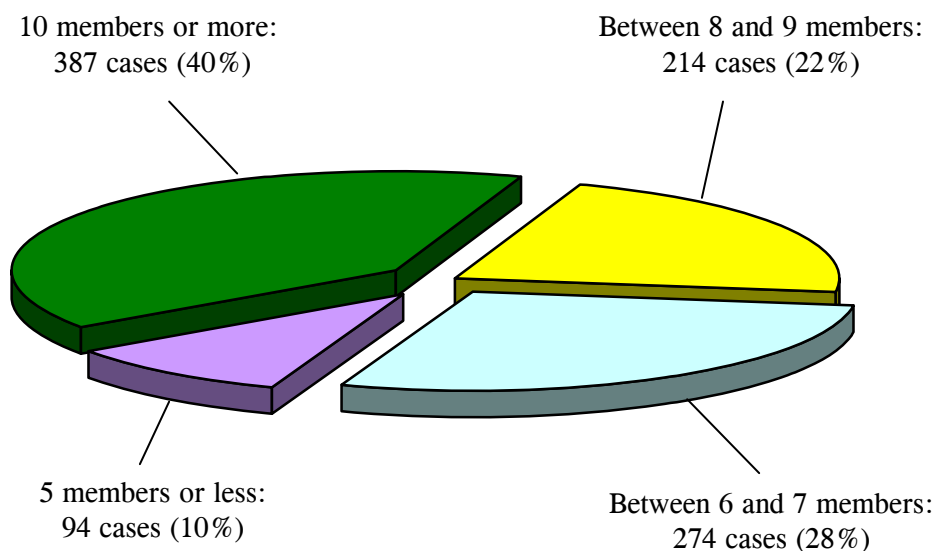
2.14 **Audit considers that WSD staff should promptly notify term contractors to arrive at main burst sites.** This is because the earlier arrival of the contractors' teams at main burst sites would contribute to the earlier completion of the works, and shorten the time of water supply suspensions. It is pertinent to note that a contractor will be entitled to higher rates if his team arrives at the site within 1 hour and 25 minutes after receiving notification (see para. 2.5(c)). **As far as Audit could ascertain, WSD staff did not document the justifications for not promptly (after arrival at main burst sites) notifying the term contractors. Audit considers that the WSD needs to make improvement in this area.**

Need to ensure sufficient emergency team members on site

2.15 According to the term contracts, a term contractor should make available at any hour of a day or night the stipulated number of emergency teams, each with a minimum of ten members (see para. 2.5(a)). Audit's analysis of the number of team members for the 969 main burst cases (handled by term contractors) in 2009-10 is shown in Figure 4.

Figure 4

**Number of emergency team members
taking part in main-burst repairs works
(2009-10)**



Source: WSD records

2.16 In 2009-10, there were 582 cases (60%) where less than ten emergency team members took part in repairing the burst mains. Audit noted that:

- (a) of the 582 cases, the TSI of 243 (42%) cases (including 63 fresh water main bursts and 180 salt water main bursts) was more than seven hours (see para. 2.7(b)). For instance, in one fresh water main burst, the contractor's six emergency team members took 17 hours to repair two burst spots; and
- (b) of the 243 cases, 59 (24%) cases (including 16 fresh water main bursts and 43 salt water main bursts) caused traffic disruption.

- 2.17 In August 2010, in response to Audit's enquiry, the WSD informed Audit that:
- (a) the number of emergency team members attending to various types of main bursts depended on the site conditions, nature and complexity of the repair works (e.g. complicated cases might require more than ten members and minor cases might require less than ten members); and
 - (b) the WSD monitored the adequacy of the workforce deployed by the contractor to attend to a main burst incident, and would require the contractor to strengthen the workforce deployment where necessary.

2.18 Audit notes that the existing term contracts do not specify the minimum number of emergency team members on site to attend to the various types of main bursts, and the contractors would determine the number of members for attending to a burst. **In Audit's view, the WSD needs to consider specifying in future term contracts the minimum number of emergency team members for attending to various types of main bursts, and to ensure that contractors provide sufficient staff for completing the repair works as soon as practicable.**

Room for improvement in road reinstatement works

2.19 In 2009, after completing the water main works for emergency repairs and the programmed mainlaying and subsequent road reinstatement works, WSD contractors submitted 9,954 Completion Notices to the HyD for acceptance of the backfilling and reinstatement works. Of these cases, the HyD rejected the works of 1,284 (13%) notices and required the contractors to carry out the reinstatement works again, involving reinstatement of paving blocks, concrete carriageways and footways, road markings and traffic aids.

2.20 Between 2005 and 2009, the number of Completion Notices submitted to the HyD a year ranged from 9,284 to 9,954. Audit examination revealed that, as at 31 March 2010, there were 296 outstanding WSD road reinstatement cases. Of these, 71 cases related to water mains works completed between 2005 and 2008. Details are shown in Table 3. Case 1 gives an example of such cases.

Table 3

**Outstanding WSD road reinstatement cases
(31 March 2010)**

Year of completion of water main works	Outstanding cases (No.)
2005	6
2006	12
2007	22
2008	31
2009	225
Total	296

} 71

Source: HyD records

Case 1

**Road reinstatement works at a street in Kowloon
(July 2007 to October 2009)**

- On 25 July 2007, a fresh water main of 150 mm diameter at a street in Kowloon burst. A WSD term contractor completed the repair works on 27 July 2007, including road reinstatement works.
- On 1 August 2007, the WSD issued a warning letter to the contractor expressing concern about the quality of the road reinstatement works.
- On 6 August 2007, the HyD rejected the reinstatement works on the grounds of the presence of uneven road surface and unsatisfactory texture of the road surface.
- On 29 August 2007 and 13 February 2009, the WSD issued warning letters to the contractor expressing concern about the quality of the road reinstatement works.
- On 28 April 2008, 18 June 2008 and 27 March 2009, the HyD carried out inspections of the reinstatement works. On each occasion, the HyD rejected the works on the same grounds given on 6 August 2007.
- On 28 October 2009, the HyD accepted the reinstatement works.

Audit observations

The term contractor took 27 months to complete the road reinstatement works to the satisfaction of the HyD. Three warning letters had been issued to the term contractor.

Source: HyD records

2.21 In June 2010, in response to Audit's enquiry, the WSD informed Audit that:

- (a) it had established mechanisms to monitor, review and enforce controls on contractors' performance on road reinstatement works; and
- (b) WSD supervisory teams oversaw and supervised term contractors' works, and checked compliance with the conditions of excavation permits. Monthly and quarterly progress meetings were held with term contractors to discuss matters including road reinstatement works. A contractor's performance appraisal included assessments on compliance with road opening conditions.

2.22 Audit is concerned about the unsatisfactory road reinstatement works, resulting in the need to carry out the works again, and in taking a long time to reinstate roads to the satisfaction of the HyD. These cases caused nuisance, inconvenience and disruption to the public. **Audit considers that the WSD needs to step up efforts to ensure that the term contractors carry out road reinstatement works promptly and effectively and that the works meet the HyD's requirements. The WSD also needs to expedite action on completing the long-outstanding road reinstatement works to the satisfaction of the HyD.**

Room for improvement in handling non-compliance cases

2.23 In 2009-10, the WSD achieved the performance targets for both TIBM and TSI (see para. 2.7(a) and (b)), as follows:

- (a) *TIBM for small-size fresh water and salt water main bursts.* Of the total 896 burst cases, 882 (98%) were not over 1.5 hours;
- (b) *TIBM for medium-size fresh water and salt water main bursts.* Of the total 64 burst cases, all were not over 2.5 hours; and
- (c) *TSI for small-size and medium-size fresh water main bursts.* Of the total 429 burst cases, 354 (83%) were not over 7 hours, and 389 (91%) were not over 8 hours.

2.24 In 2009-10, there were 75 non-compliance main burst cases (Note 11) with TSI ranging from 7.1 to 44.2 hours. Audit selected four non-compliance cases with TSI exceeding 15 hours for examination. Details are given in Table 4.

Table 4
TSI non-compliance cases
(2009-10)

Case	Time of notice received by CTEC	Location	TSI (hour)	Reason extracted from non-compliance case report
A	11:51 a.m. on 28 September 2009	Tsing Hoi Circuit, Tuen Mun	20	“Long time to resume supply.....because it took time for hardening of concrete thrust block”
B	1:49 a.m. on 13 December 2009	Woh Chai Street, Shek Kip Mei	16	“Close to residential blocks, defer demolition of concrete road slab and rock trench”
C	1:03 a.m. on 8 January 2010	Wai Chi Street, Shek Kip Mei	27	“.....delay of resumption was due to fresh water and salt water main bursts at the same time,service tees to adjacent building were found damaged, additional installation of sectional valves.....”
D	5:23 a.m. on 13 January 2010	Wai Chi Street, Shek Kip Mei	16	“.....additional sectional valves were installed during last burst on 8 January 2010”

Source: WSD records

Note 11: The WSD staff compiled a non-compliance case report for each burst case with TSI exceeding 7 hours.

2.25 Audit is concerned about the long time of water supply suspensions causing inconvenience and disruption to the public. For the four cases shown in Table 4, sufficient reasons were not provided in the non-compliance case reports for justifying the long time taken to complete the repair works. **To shorten the time of water supply suspensions, the WSD needs to consider conducting investigations and compiling detailed reports on serious non-compliance cases. The WSD should ascertain the causes of the long time taken and identify improvement measures. To enhance public accountability and transparency, the WSD may wish to consider disclosing burst details (e.g. location, buildings affected, the TSI, and the duration of providing temporary water supply) on its website as soon as possible after each burst.**

Need to monitor performance on provision of emergency water supply

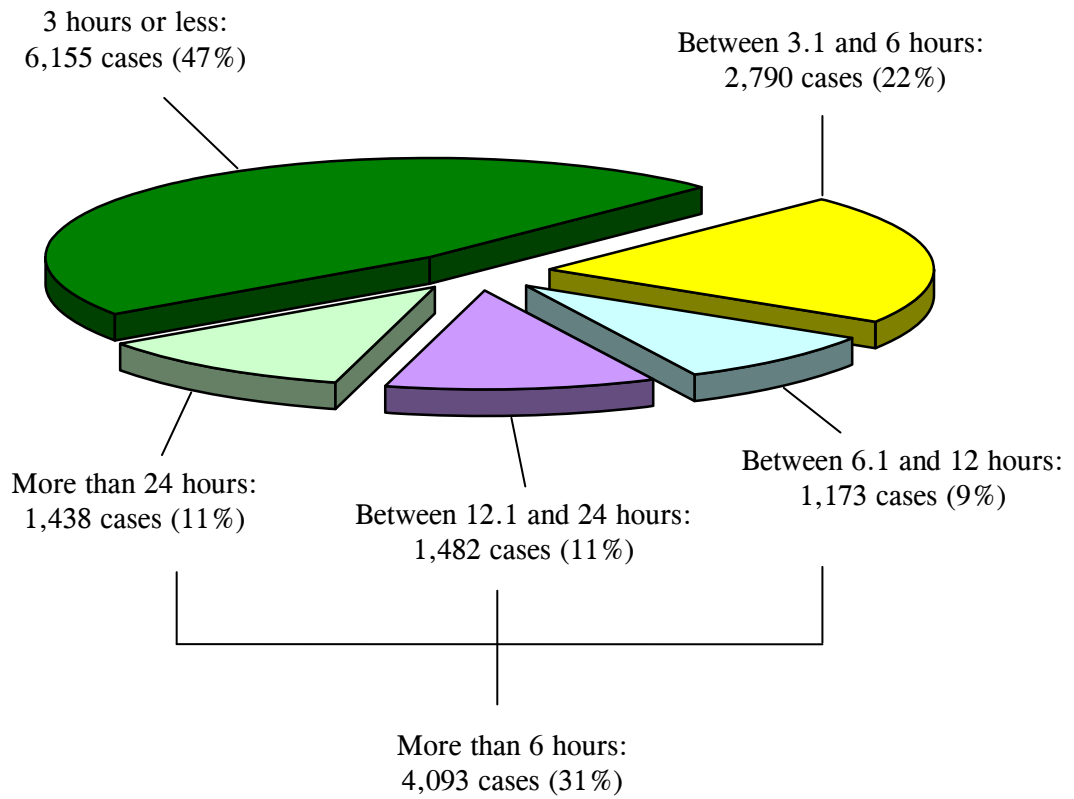
2.26 The WSD did not maintain statistics on the time taken to provide temporary emergency water supply to the public. **As the WSD has set an internal performance target of providing emergency water supply within three hours after isolation of water mains for 90% of the cases (see para. 2.7(c)), Audit considers that the WSD needs to maintain statistics for monitoring the extent of achievement of the target. The WSD may wish to consider including the target in the WSD performance pledge.**

Need to monitor performance on main leak cases

2.27 In 2009-10, there were 13,038 water main leak cases. Audit's analysis of the time taken to isolate leak water mains after receiving notifications of leak cases is shown in Figure 5.

Figure 5

**Time taken to isolate leak water mains after receiving notifications
(2009-10)**



Source: WSD records

2.28 In 4,093 (31%) of the 13,038 main leak cases, the WSD took more than six hours to isolate the water mains. In 34 of the 4,093 cases, each case involved a water loss of more than 500 m³. For a case occurring on 14 October 2009 at Des Voeux Road West, the WSD isolated the leak water main 16 hours and 30 minutes after receiving notification. A water loss of 20,500 m³ was recorded. In August 2010, in response to Audit's enquiry, the WSD informed Audit that:

- (a) there were often overriding considerations, such as serious traffic interruptions in the daytime and noise nuisances in the night-time, which had to be weighed against the option of immediate repair of leak mains; and
- (b) for public convenience, it was necessary to defer the leak main isolation to a time outside the peak water consumption hours (for maintaining normal water supply during peak hours).

2.29 **While Audit notes that the WSD accords high priority to attending to main burst cases, the WSD needs to take prompt actions on main leak cases (which may involve substantial water losses) as far as practicable. The WSD also needs to document the reasons for taking a long time to isolate leak water mains and consider setting performance targets in this regard.**

Need to address external disturbances causing main bursts

2.30 Between 2007-08 and 2009-10, 2,225 (54%) of the 4,128 main burst cases were caused by external disturbances (see Table 2 in para. 2.11), such as ground settlement or vibration, many of which related to road works and road opening activities. The WSD has issued guidelines to require its staff to check whether main bursts were caused by road works and trench works in the vicinity, and take follow-up action. **In view of the large proportion of bursts caused by external disturbances, Audit considers that the WSD needs to remind its staff to step up efforts in this area.**

Audit recommendations

2.31 **Audit has recommended that the Director of Water Supplies should:**

- (a) **take measures to ensure that WSD staff promptly notify maintenance term contractors to arrive at main burst sites, and document the justifications for not doing so (see para. 2.14);**

- (b) **consider specifying in term contracts the minimum number of emergency team members for attending to various types of main bursts (see para. 2.18);**
- (c) **take measures to ensure that term contractors provide sufficient staff for completing repairs of burst water mains as soon as practicable (see para. 2.18);**
- (d) **step up efforts to ensure that term contractors carry out road reinstatement works promptly and effectively and that the works meet the HyD's requirements (see para. 2.22);**
- (e) **expedite action on completing the long-outstanding road reinstatement works to the satisfaction of the HyD (see para. 2.22);**
- (f) **consider conducting investigations and compiling detailed reports on serious TSI and TIBM non-compliance cases to ascertain the causes of the long time taken to complete the tasks, and identify improvement measures (see para. 2.25);**
- (g) **consider publicising details of each main burst case on the WSD website (see para. 2.25);**
- (h) **maintain statistics for monitoring the extent of achievement of the target for providing emergency water supply, and consider including the target in the WSD performance pledge (see para. 2.26);**
- (i) **endeavour to take prompt actions on water main leak cases as far as practicable (see para. 2.29);**
- (j) **document the reasons for taking a long time to isolate leak water mains (see para. 2.29);**
- (k) **consider setting performance targets for the time for isolation of leak water mains (see para. 2.29); and**
- (l) **remind WSD staff to ascertain the underlying reasons for water main bursts caused by external disturbances, and take appropriate follow-up action (see para. 2.30).**

Response from the Administration

2.32 The **Director of Water Supplies** agrees with the audit recommendations. He has said that:

- (a) information on burst mains as ascertained on site by turncock gangs will facilitate the mobilisation of adequate plant, labour and materials by contractors for expeditious repair of burst mains;
- (b) the WSD has enlisted the assistance of the HyD in holding technical meetings on inspections and quality control of road reinstatement works for WSD staff, consultants and contractors to enhance their understanding of the relevant standards; and
- (c) the rate of rejection of road reinstatement works has been decreasing over the past several years and the efforts in these areas will be sustained.

2.33 The **Director of Highways** supports the audit recommendations in paragraph 2.31(d) and (e).

PART 3: IMPLEMENTATION OF REPLACEMENT AND REHABILITATION PROGRAMME

3.1 This PART examines the WSD's administration of works carried out under the R&R Programme.

Underground Asset Management Study

3.2 In February 1996, in view of frequent water main bursts and leaks, the WSD appointed a consultant (Consultant A) to carry out an Underground Asset Management Study. The purpose was to develop a comprehensive and cost-effective management plan for some 5,700 km of water mains in the water supply and distribution systems.

3.3 In 1997, upon completion of the Underground Asset Management Study, Consultant A recommended replacing and rehabilitating some 3,000 km of aged water mains in stages over 20 years. The WSD accepted Consultant A's recommendation, and formulated an R&R Programme, under which water mains with a higher risk of failure would be accorded higher priority for replacement and rehabilitation, taking into account the pipe materials, leak and burst history, and the probability and consequence of pipe failures.

Replacement and Rehabilitation Programme

20-year R&R Programme

3.4 In 1997, based on the Underground Asset Management Study, the WSD planned that the R&R Programme would be implemented in four stages (Stages 1 to 4) over a 20-year period from 2000 to 2020. Table 5 shows the scheduled commencement and completion dates of works under the 20-year R&R Programme compiled in July 2002.

Table 5
20-year R&R Programme
(July 2002)

Stage	Scheduled commencement	Scheduled completion	Length of water mains (km)
1	December 2000	March 2008	600
2	January 2006	June 2011	750
3	October 2010	March 2017	800
4	April 2016	December 2020	850
Total			3,000

Source: WSD records

15-year R&R Programme

3.5 In July 2004, a water main burst occurred in Admiralty, a busy business district, causing serious traffic congestions and water supply suspensions in the vicinity. The WSD noted that the burst water main had not been included in Stages 1 and 2 of the R&R Programme. In the light of the incident, the WSD carried out a re-prioritisation exercise for the R&R Programme, taking into account the latest information on leak and burst occurrences, pipe conditions and consequence of pipe failures.

3.6 In January 2005, to bring earlier improvements, the WSD revised the R&R Programme to advance the programme completion date from 2020 to 2015. In the revised 15-year R&R Programme, the WSD accorded higher priority to replacing water mains in critical locations, such as busy districts. Table 6 shows the scheduled commencement and completion dates of works under the 15-year R&R Programme compiled in January 2005.

Table 6
15-year R&R Programme
(January 2005)

Stage	Scheduled commencement	Scheduled completion	Length of water mains (km)
1	December 2000	March 2010	600
2	January 2007	June 2011	750
3	September 2008	December 2013	800
4	2011	2015	850
Total			3,000 (Note)

Source: WSD records

Note: These comprised about 2,500 km of fresh water mains and about 500 km of salt water mains.

Funding approval

3.7 Between 1999 and 2008, the Administration sought funding from the Public Works Subcommittee (PWSC) of the Finance Committee (FC) of the Legislative Council for the investigation, detailed designs and construction works under the R&R Programme. In the funding submissions, the Administration informed the PWSC and the FC that, upon completion of the R&R Programme:

- (a) the number of water pipe failures would be reduced from the 1999 level of 27,200 (1,850 bursts and 25,350 leaks) to 15,000 (1,000 bursts and 14,000 leaks) a year; and
- (b) the water leakage rate (Note 12) would be reduced from 25% to 15%. This 15% leakage rate would be comparable to that in other places, such as 23.5% in Taiwan, 23.5% in the UK, 16.8% in Portugal, 14.7% in the USA, 14.6% in Finland and 12.9% in Sweden.

Note 12: *The rate is expressed as:*

$$\frac{\text{Estimated quantity of water loss due to leaks}}{\text{Total water flow from the water supply system}} \times 100\%$$

3.8 The WSD estimated that the R&R Programme would cost about \$21.8 billion. Between November 1999 and July 2008, the FC approved funding of \$12.8 billion (Note 13) for the investigation, detailed designs and construction works under the programme.

Works implementation

3.9 The R&R Programme includes the following works:

- (a) ***Replacement works.*** The works usually involve laying new water mains alongside existing ones. After effecting water supply through the new water mains, the old mains would be abandoned; and
- (b) ***Rehabilitation works.*** The works involve inserting a new water main or a new lining into an existing one, without abandoning the existing main (see Photograph 1).

Photograph 1

Rehabilitation works in progress



Source: WSD records

Note 13: *The approved funding comprised \$3.77 billion for Stage 1, \$3.21 billion for Stage 2, \$5.62 billion for Stage 3 and \$0.2 billion for Stage 4. The WSD would seek additional funding for Stage 4 later.*

Works contracts

3.10 Before the commencement of each stage of the R&R Programme, the WSD would compile a priority list for the sections of water mains to be covered. In December 2000, the WSD commenced works under the R&R Programme using services provided by term contractors. Between March 2001 and March 2010, the WSD awarded 51 contracts to works contractors for implementing the R&R Programme (see Table 7).

Table 7
Works contracts under R&R Programme
(31 March 2010)

Stage	Number of contracts awarded	Contract sum (\$ million)	Status
1	22	2,287	All works contracts had been awarded.
2	17	2,754	All works contracts had been awarded.
3	12	4,396	Further works contracts would be awarded in future.
4	—	—	Works contracts had not been awarded.
Total	51	9,437	

Source: WSD records

Works procedures on public roads

3.11 Under most of the works contracts, the WSD issues works orders to the contractors for carrying out the works. After issuing a works order:

- (a) the contractor would make enquiries with the HyD about road excavation information and coordinate with the concerned organisations (mainly government departments and utility companies) to plan for excavation works on the same site. This could avoid repeated road openings and excavations in the vicinity;
- (b) a Traffic Management and Liaison Group (TMLG — Note 14) established under the contract would consider the temporary traffic arrangements (TTA) proposed for the works. The TMLG would approve the TTA if the proposed arrangements are satisfactory;
- (c) after approval of the TTA, the HyD would issue an excavation permit if it is satisfied with the application; and
- (d) after obtaining the excavation permit, the Road Management Office of the Hong Kong Police Force would ascertain that the works site is set up based on the approved TTA. However, for some complicated TTA, the Road Management Office may require the contractor to carry out a trial run before the commencement of the works. If the TTA lead to severe traffic congestions, the contractor would revise the TTA for the TMLG's approval and conduct further trial runs. After satisfactory trial runs, the works would commence.

Coordination enhancement measures

3.12 In February 2007, the WSD established an in-house Implementation Committee for coordination and experience sharing regarding the implementation of works under the R&R Programme. The Committee held meetings every three months. In January 2008, an Inter-departmental Committee (comprising representatives from the WSD, the Hong Kong Police Force, the Transport Department and other works departments) was formed for enhancing works coordination. The Committee held meetings every four months.

Note 14: *The TMLG comprises representatives from the WSD's project team, the contractor, the Transport Department, the Road Management Office of the Hong Kong Police Force, the responsible District Offices of the Home Affairs Department, and other related parties.*

Works progress

3.13 The R&R Programme commenced in December 2000 and was scheduled for completion by 2015. As at 31 March 2010, the works under Stage 1 had been completed. The works under Stages 2 and 3 were in progress. Table 8 shows the details of the works progress.

Table 8
Works progress of R&R Programme
(31 March 2010)

Stage	Length of water mains involved (a) (km)	Length of water mains completed (b) (km)	Progress $(c) = \frac{(b)}{(a)} \times 100\%$ (%)
1	600	599	100%
2	750	506	67%
3	800	120	15%
4	850	Works not yet commenced	
Overall	3,000	1,225	41%

Source: WSD records

Audit observations and recommendations

Improvements resulting from R&R Programme

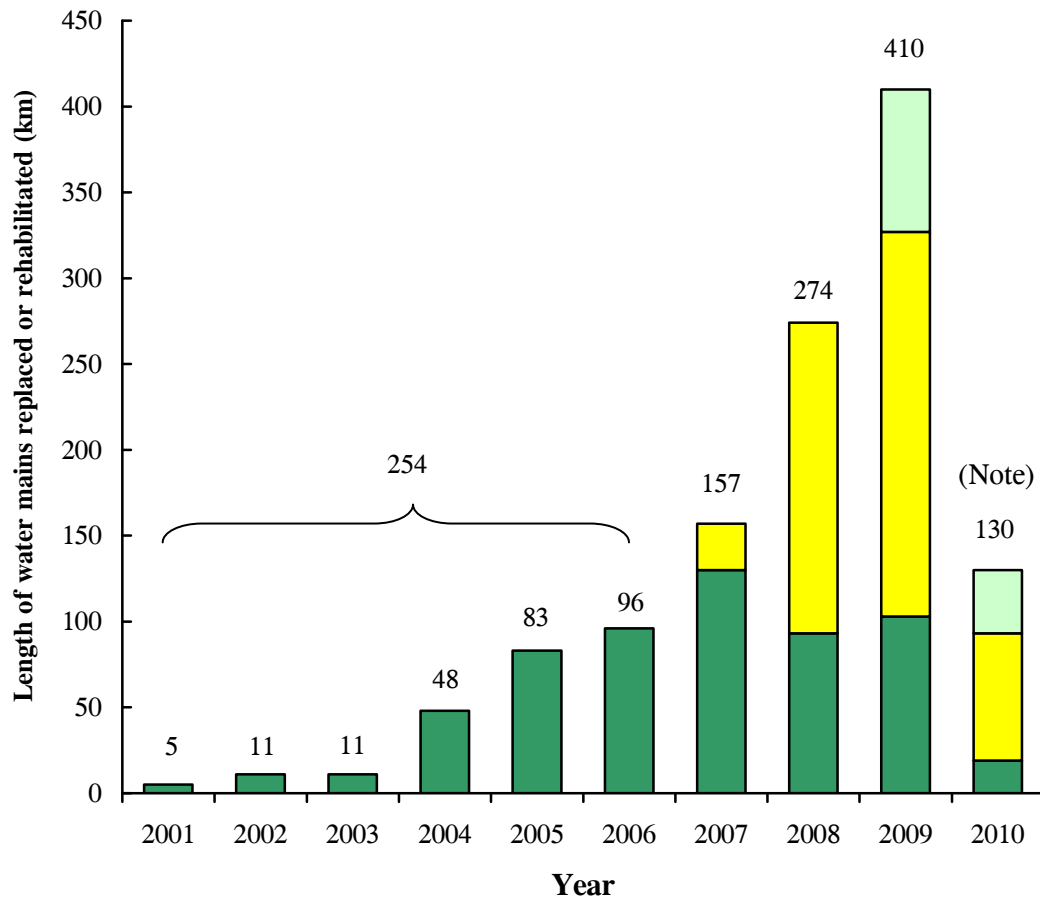
3.14 Since implementing the R&R Programme in December 2000, up to March 2010, the WSD had completed replacing and rehabilitating 1,225 km (41%) of the total 3,000 km of water mains covered in the Programme (see Table 8 in para. 3.13). As a result of the R&R Programme and other WSD initiatives, there had been improvements in the water distribution systems. For example:

- (a) the number of water main bursts was reduced by 60%, from 2,479 in 2000-01 to 988 in 2009-10;
- (b) the number of water main leaks was reduced by 40%, from 21,693 in 2000-01 to 13,038 in 2009-10; and
- (c) the water main leakage rate (see Note 12 in para. 3.7(b)) was reduced from 25% in 2000 to 21% in 2009. The WSD estimated that, in 2009, fresh water loss through such leakage was 185 Mm³.

Need to meet R&R Programme scheduled completion time

3.15 As shown in Figure 6, of the 1,225 km of water mains replaced and rehabilitated, only 254 km (21%) were completed in the first six years of the R&R Programme. From 2007 to 2009, the WSD accelerated the replacement and rehabilitation works. As at 31 March 2010, of the total 3,000 km of water mains covered in the Programme, 1,775 km (59%) had yet to be replaced or rehabilitated.

Figure 6
Yearly works completion
(2001 to 2010)



Legend:

- Stage 1 works
- Stage 2 works
- Stage 3 works

Source: WSD records

Note: This chart shows the works completed up to 31 March 2010.

- 3.16 In August 2010, in response to Audit's enquiry, the WSD informed Audit that:
- (a) the scale, extent and duration of the current R&R Programme were unprecedented; and
 - (b) during the initial stage of the R&R Programme, there was a learning process that required more time to study and critically review the method of implementation, and work out the optimum implementation strategy.

3.17 To meet the scheduled completion time in 2015, the WSD needs to keep up its efforts in replacing and rehabilitating water mains from 2010 to 2015. For similar programmes in future, the WSD also needs to consider distributing more evenly the workload over the implementation period. This may help bring about earlier benefits to the community and minimise the risk of programme slippage.

Need to ensure early completion of works

3.18 Up to 31 March 2010, the works under 18 contracts for Stage 1 and four contracts for Stage 2 had been substantially completed. Audit's examination of 576 works orders issued under four completed contracts of Stage 1 (Contracts A to D) revealed that the completion dates of 269 (47%) works orders were later than their respective scheduled completion dates (see Table 9).

Table 9
Completion of works orders under Contracts A to D

Works completion	Number of works orders	Percentage
On or before scheduled completion date	307	53%
Time after scheduled completion date:		
(a) 6 months or below	94	16%
(b) More than 6 months to 12 months	65	11%
(c) More than 12 months to 24 months	73	13%
(d) More than 24 months to 40 months	37	7%
Sub-total	269	47%
Total	576	100%

Source: WSD records

3.19 As at 31 March 2010, of the 269 works orders with delays, the WSD had assessed 88 orders, and granted extensions of time for 57 orders after assessing the contractors' justifications. According to the WSD, the major causes of granting extensions of time were as follows:

- (a) for 26 orders (46%), there were changes in works requirements, mainly to cope with unforeseeable site conditions or to safeguard a continuous water supply to the public; and
- (b) for 18 orders (32%), longer time was required for obtaining approval of TTA mainly due to changes in TTA requirements arising from concurrent works of other utility undertakings in close proximity.

3.20 **Audit considers that the WSD needs to take measures to minimise the time required for agreeing on works requirements and TTA so that the works can be completed as early as practicable.** In this connection, Audit notes that the Implementation Committee and Inter-departmental Committee (see para. 3.12) may contribute to enhancing the planning and coordination of such works among relevant departments.

Need to remove abandoned underground water mains

3.21 Audit noted that the WSD would not remove obsolete water mains for disposal after completing the replacement works (see para. 3.9(a)). In August 2010, in response to Audit's enquiry, the WSD informed Audit that:

- (a) new water mains were laid section by section in short lengths as long lengths of trench excavation on roads were not allowed;
- (b) an existing main to be replaced was usually laid underground and required to be maintained in service when laying a new main. Therefore, the old main could not be abandoned or removed while laying the new main;
- (c) the road surface was reinstated upon the completion of each section of a new main. When the laying of the new main was completed, a long length of the excavated road surface had been reinstated and reopened for public use; and
- (d) the removal of the abandoned main would require repeated road openings and TTA procedures similar to the laying of a new main. The time, cost and disruption to the public would be more or less doubled.

3.22 Audit notes that keeping abandoned water mains underground may aggravate the congestion of utilities in some areas and affect the progress of excavation and underground works (see para. 4.16(a)). **Audit considers that, whenever opportunities arise in future, the WSD needs to remove abandoned underground water mains, particularly in urban areas congested with underground utilities.**

Need to plan for another replacement and rehabilitation programme

3.23 Upon completion of the Stage 4 works in 2015, the R&R Programme would cover 3,000 km (38%) of the total 7,800 km of existing water mains. According to the WSD, it would carry out a post-implementation review to plan the way forward for the water mains not included in the R&R Programme.

3.24 For the current R&R Programme, the WSD took about four years to complete planning before commencing the works in December 2000. Some water main bursts and leaks involving ageing water mains had not been covered in the R&R Programme. For example, between 2007-08 and 2009-10, there were 8 water main burst cases and 193 leak cases in Ma On Shan, Tin Shui Wai and Tung Chung involving water mains which were not covered in the R&R Programme. Of these 201 cases, 100 (50%) were related to water mains over 20 years of age. **Audit considers that the WSD needs to commence planning for another replacement and rehabilitation programme for other ageing water mains not covered in the R&R Programme.**

Audit recommendations

3.25 **Audit has recommended that the Director of Water Supplies should:**

- (a) **keep up the efforts in replacing and rehabilitating water mains to ensure that the R&R Programme is completed by 2015 as scheduled (see para. 3.17);**
- (b) **consider distributing more evenly the workload over the implementation period of a water main replacement and rehabilitation programme in future (see para. 3.17);**
- (c) **take measures to minimise the time required for agreeing on works requirements and TTA with the government departments and related parties concerned (see para. 3.20);**
- (d) **remove abandoned underground water mains whenever opportunities arise in future, particularly in urban areas with congested underground utilities (see para. 3.22); and**
- (e) **commence planning for another replacement and rehabilitation programme for other ageing water mains not covered in the R&R Programme (see para. 3.24).**

Response from the Administration

3.26 The **Director of Water Supplies** agrees with the audit recommendations. He has said that:

- (a) the WSD will continue to press ahead with the existing R&R Programme and has planned to acquire resources for the replacement and rehabilitation of the remaining aged mains. With the advancement in leakage detection techniques, the WSD will also enhance its capability in pinpointing weak spots in water mains for prompt and early repairs to extend the life of aged mains; and
- (b) the WSD will continue to strive for better planning and coordination of road opening works to improve progress. For urban areas where a number of road openings are being carried out concurrently, there are often needs for modifying TTA and incorporating changes and adjustments to the works to cope with unforeseen site conditions.

PART 4: MANAGEMENT OF WATER PRESSURE

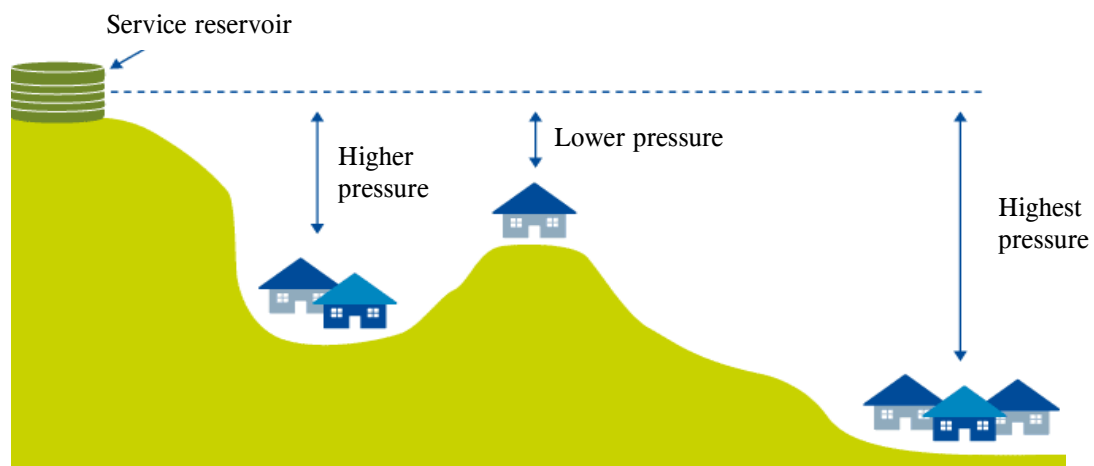
4.1 This PART examines the WSD's implementation of PMS to reduce leakage in fresh water distribution systems.

Water pressure in fresh water distribution systems

4.2 Presently, there are 166 service reservoirs located in high-altitude areas in 17 fresh water supply zones (Zones A to Q — see Table 10 in para. 4.9). Fresh water is distributed to users by gravity from the service reservoirs through extensive networks of water mains. As water is distributed by gravity, water within the water mains is under pressure which is dependent on the altitude of the locations and their distance from the service reservoirs. Figure 7 shows the water pressure in areas with different altitudes.

Figure 7

Water pressure in a water distribution system



Source: Audit sketch

Remarks: In general, pressure within water mains in a low-altitude area is higher than that in a high-altitude area.

4.3 Since 1961, the WSD has maintained a minimum fresh water supply pressure of between 15-metre head and 30-metre head, which is considered sufficient to provide a direct water supply up to seven storeys of a building. Water supply to the higher floors is provided by water tanks (located on the roofs) to which water is pumped by the pumping systems of the building. To ensure sufficient pressure for water supply, the WSD has developed a performance pledge of maintaining a minimum pressure of between 15-metre head and 30-metre head. On average, the fresh water supply pressure in Hong Kong is between 60-metre head and 80-metre head.

Pressure management schemes

4.4 High water supply pressure may cause water main bursts and leaks. Through pressure management, the WSD aims to reduce water pressure to an optimal level sufficient to meet the pledged minimum supply pressure. In October 1993, the WSD appointed a consultant (Consultant B) to carry out a “Study on Effective Leakage Reduction and Control for the Supply and Distribution System”. Since 1997, the WSD has implemented the PMS in selected areas to reduce the water supply pressure. PMS implementation involves planning and design under pressure management studies (hereinafter referred to as **PMS studies**), and construction and installation works (hereinafter referred to as **PMS works**). The PMS studies and works include:

PMS studies

- (a) development of **hydraulic network models** to provide an understanding of the fresh water distribution systems and to facilitate analyses of the system performance under various conditions;
- (b) design and supervision of field work for the calibration and validation of the hydraulic network models;
- (c) identification and design of **pressure management areas** (Note 15). For setting up of a pressure management area, it is necessary to identify one which can be isolated by closing boundary valves, and can be supplied with water via one of the inlet water mains to the area;
- (d) design of the most appropriate pressure management and continuous monitoring schemes for the fresh water distribution systems using the developed hydraulic network models;

Note 15: *A pressure management area is an area which has the potential for the reduction of excessive water pressure while maintaining satisfactory water supply to users.*

PMS works

- (e) construction of underground chambers for installing pressure reducing valves;
and
- (f) installation of pressure reducing valves and flowmeters.

4.5 The PMS for individual supply zones are implemented by the lowering of outlet pressure at the downstream end of the pressure reducing valve in stages and the monitoring of the pressure at critical pressure points. The final outlet pressure would be chosen through trial and error ensuring on the one hand that there would be adequate water pressure at the critical pressure points, and on the other hand that there would be no complaints from members of the public about the reduction in water pressure.

4.6 According to the WSD, the maintenance of an optimal level of water supply pressure through implementing the PMS would entail the following benefits:

- (a) reducing water losses due to water main bursts and leaks, particularly during low-demand periods (e.g. midnight);
- (b) lowering pressure-related water consumption (e.g. reduced outflow of water from showers due to lower pressure);
- (c) minimising water supply suspensions due to a lower frequency of water main bursts and leaks; and
- (d) saving water main maintenance and replacement costs.

Small-scale PMS

4.7 In July 1994, after completing the study mentioned in paragraph 4.4, Consultant B recommended that the WSD should implement the PMS to help reduce water leakage. **In April 1997, after conducting a further study on the Yau Tong and the Repulse Bay supply zones, Consultant B said that there was considerable scope for pressure reduction in Hong Kong. The WSD accepted the recommendations.**

4.8 In July 1997, the WSD commenced implementing **small-scale PMS** by installing pressure reducing valves and flowmeters in selected areas, where PMS studies were not required. Up to 31 March 2010, the WSD had implemented small-scale PMS in 27 areas, covering 133 km of water mains, and costing \$6.1 million. The WSD estimated that the implementation of small-scale PMS in these 27 areas would lead to a water saving of 4.95 Mm³ (or a notional saving of \$30.7 million — Note 16) a year.

Pressure management studies for water supply zones

4.9 In January 2003, the WSD appointed another consultant (Consultant C) to carry out a preliminary study of implementing the PMS in all the 17 fresh water supply zones. In this study, Consultant C assessed the potential for pressure reduction, and accorded priority to implementing the PMS in supply zones with short payback periods. In December 2004, Consultant C recommended that the WSD should:

- (a) carry out PMS studies (in order of priority) for 15 of the 17 supply zones (Zones A to O — see Table 10) to assess the cost-effectiveness, and the extent of the PMS implementation (Consultant C considered it not cost-effective to carry out studies for Zones P and Q — see Table 10); and
- (b) implement PMS works for the 15 supply zones within seven years after completion of the PMS studies.

Note 16: *The WSD estimated that the cost of fresh water was \$6.2 per m³.*

Table 10

**Priority for PMS studies
(December 2004)**

Zone	Supply zone	Estimated payback period	Priority
A B C D E	Central District Eastern District North Point and Shau Kei Wan Sai Wan Western District	Less than two years	High
F G H I J	Kowloon (Central and West) Tsuen Wan (East and West) Tai Po Tuen Mun Kowloon East	Two to five years	Medium
K L M N O	Aberdeen Red Hill Sai Kung Sha Tin Yuen Long	More than five years	Low
P Q	Sheung Shui and Fanling Outlying Islands	Not provided	N/A (Not cost-effective)

Source: WSD records

Audit observations and recommendations

Need to complete PMS studies as early as practicable

4.10 The implementation of the PMS helps reduce water losses, lower water consumption, minimise water supply suspensions and save cost (see para. 4.6). In January 2003, the WSD commenced the PMS studies for the 15 fresh water supply zones as recommended by Consultant C (see para. 4.9(a)). Up to March 2010:

- (a) the studies for seven supply zones (Zones A to F and H) and one sub-zone (Sub-zone G1 — Note 17) had been completed. **The WSD estimated that implementing the PMS works in these supply zones/sub-zone would achieve a fresh water saving of 23.1 Mm³ (or a notional saving of \$143 million) a year;**
- (b) the studies for four supply zones (Zones I and K to M) and one sub-zone (Sub-zone G2) were in progress, which were scheduled for completion by March 2011; and
- (c) the studies for the remaining three supply zones (Zones J, N and O) had not commenced.

Details of the progress of the studies are shown in Table 11.

Note 17: *Two large supply zones (Zones F and G) were each split into two sub-zones (Sub-zones F1 and F2, and G1 and G2) for separate studies.*

Table 11
Progress of PMS studies for 15 supply zones
(March 2010)

Zone/ Sub-zone	Commencement date	Completion date	Length of water mains covered in study (km)
A	September 2007	October 2009	177
B	September 2007	October 2009	234
C	January 2003	March 2005	139
D	September 2007	October 2009	73
E	October 2005	March 2008	163
F1	May 2006	July 2008	216
F2	September 2007	October 2009	566
G1	August 2005	October 2007	197
G2	February 2009	March 2011 (Note)	267
H	December 2005	June 2007	188
I	February 2009	March 2011 (Note)	272
J	Not yet commenced	N/A	N/A
K	February 2009	March 2011 (Note)	49
L	February 2009	March 2011 (Note)	31
M	February 2009	March 2011 (Note)	356
N and O	Not yet commenced	N/A	N/A
Total			2,928

Source: WSD records

Note: This is the scheduled completion date for the PMS studies.

- 4.11 In August 2010, in response to Audit's enquiry, the WSD informed Audit that:
- (a) the WSD would conduct the PMS studies for all the 17 supply zones (Zones A to Q). The sequence of conducting the studies was planned to even out the workload distribution of the Regions;
 - (b) the studies for 12 supply zones had either been completed or in progress; and
 - (c) the studies for the remaining five supply zones (Zones J and N to Q) were under planning.

4.12 **Audit considers that the WSD needs to complete the PMS studies for the remaining five supply zones as early as practicable. The WSD also needs to consider formulating an action plan with target completion dates for monitoring the progress of the studies.**

Need to complete PMS works as early as practicable

4.13 For the supply zones for which the PMS studies had been completed, the WSD has scheduled to complete implementing the works in these zones between January 2011 and March 2014 at a cost of \$106 million. Details are given in Table 12.

Table 12

**Time for completing PMS works after PMS studies
(March 2010)**

Zone/ Sub-zone	PMS study completion date	Scheduled PMS works completion date	Number of months	Estimated cost (\$ million)
A	October 2009	March 2014	53	8.3
B	October 2009	March 2014	53	13.8
C (Note)	March 2005	March 2013	96	18.1
D	October 2009	March 2014	53	5.8
E	March 2008	March 2014	72	10.0
F1	July 2008	January 2011	30	13.7
F2	October 2009	March 2014	53	20.5
G1	October 2007	March 2014	77	10.8
H	June 2007	December 2012	66	5.1
Total				106.1

Source: WSD records

Note: As of March 2010, the PMS works in two areas of Zone C had not commenced. The WSD planned to carry out the works in conjunction with the R&R Programme Stage 3 works which were scheduled for completion in March 2013.

4.14 Each supply zone/sub-zone comprises a number of pressure management areas. Up to March 2010, the WSD had completed the PMS works in 32 of the total 213 pressure management areas in the supply zones for which the PMS studies had been completed. Details are given in Table 13.

Table 13
Progress of PMS works
(March 2010)

Zone/ Sub-zone	Planned areas to be covered (a) (No.)	Areas with PMS works completed (b) (No.)	Areas with PMS works in progress (c) (No.)	Percentage of areas with PMS works completed (d) = $\frac{(b)}{(a)} \times 100\%$ (%)
A	16	0	0	0%
B	33	0	0	0%
C	14	10	2	71%
D	10	0	0	0%
E	20	1	3	5%
F1	29	15	14	52%
F2	39	0	0	0%
G1	30	5	4	17%
H	22	1	19	5%
Overall	213	32	42	15%

Source: WSD records

4.15 The WSD estimated that implementing the PMS works in the 32 areas, covering 78 km of fresh water mains at a cost of \$9.7 million, would achieve a fresh water saving (Note 18) of 2.46 Mm³ (or a notional saving of \$15.3 million) a year. Audit noted that, up to March 2010, the PMS works had not commenced in four supply zones/sub-zones, three of which (i.e. Zones A, B, and D) were accorded a high priority as they had high potential for pressure reduction, and had short payback periods (see Table 10 in para. 4.9).

4.16 Between May and August 2010, in response to Audit's enquiry, the WSD informed Audit that:

- (a) there were difficulties in carrying out the PMS construction and installation works, such as the non-availability of space for constructing pressure reducing valve chambers due to congestion of existing utilities;
- (b) before September 2008, the PMS works were carried out by WSD in-house staff. However, a lot of resources were required to identify suitable sites for constructing pressure reducing valve chambers, to review the design of the PMS and to make arrangement for the temporary suspension of water supply for the connection works. Very often, a number of trial pits had to be excavated before a suitable site could be identified. Sometimes, the PMS works could not proceed further due to non-availability of space for constructing the pressure reducing valve chambers;
- (c) in addition to requiring the four Regional Divisions (see para. 1.9) to carry out the PMS works, the WSD had engaged consultants to expedite the works;
- (d) the first consultancy for Sub-zone F1 commenced in September 2008, with works scheduled for completion within 30 months; and
- (e) the WSD would also engage consultants to carry out the PMS works for Zones A, B, D and E, and Sub-zones F2 and G1. Upon availability of funding, the works would commence in December 2011.

Note 18: *The water saving is estimated by comparing the water flow through the pressure reducing valves prior to and after implementation of PMS. The amount of water saving would vary among pressure management areas as they had different characteristics, such as length and age of water mains, consumption patterns, legitimate use of water at night, pressure-related consumption, and leakage in inside services (see para. 5.2).*

4.17 After completion of the relevant PMS studies, it requires a lot of resources (see para. 4.16(b)) and takes a long time (ranging from 30 to 96 months — see Table 12 in para. 4.13) to complete implementing the PMS works in the supply zones. **Audit considers that, in the light of the substantial benefits (see para. 4.15), the WSD needs to secure sufficient resources for planning and implementing the PMS works as early as practicable. The WSD also needs to formulate an action plan and set time schedules for monitoring the progress of the works.**

Need to accord high priority to exceptionally high pressure areas

4.18 The WSD has received complaints about high water supply pressure in some areas. In one recent case, the high water supply pressure led to leakage of some water pipes in a housing estate. After conducting an investigation in April 2010, the WSD found that the water supply pressure inside the water mains was around 90-metre head to 105-metre head. In May 2010, the WSD advised the residents to install pressure reducing valves.

4.19 The WSD is taking action to implement the PMS in water supply zones. However, for areas with exceptionally high water pressure, Audit considers that there is a need for the WSD to accord high priority to implementing the PMS. This would help reduce the risk of water main bursts and leaks in these areas.

Audit recommendations

4.20 **Audit has recommended that the Director of Water Supplies should:**

- (a) **complete the PMS studies as early as practicable for five supply zones (Kowloon East, Sha Tin, Yuen Long, Sheung Shui and Fanling, and Outlying Islands) and set target completion dates for the studies (see para. 4.12);**
- (b) **formulate an action plan with target completion dates for monitoring the PMS studies (see para. 4.12);**
- (c) **take measures to complete the PMS works as early as practicable in seven supply zones (Central District, Eastern District, North Point and Shau Kei Wan, Sai Wan, Western District, Kowloon (Central and West), and Tai Po) and one sub-zone (Tsuen Wan East) for which the PMS studies have been completed (see para. 4.17);**

- (d) **formulate an action plan with target completion dates for monitoring the PMS works (see para. 4.17); and**
- (e) **accord high priority to implementing the PMS for areas with exceptionally high water pressure (see para. 4.19).**

Response from the Administration

4.21 The **Director of Water Supplies** agrees with the audit recommendations. He has said that:

- (a) the management of water supply pressure by pressure reducing valves has been in use to a limited scale in the past. The WSD's experience with early models of these valves was that they required rather heavy maintenance. With observed performance improvements of this type of valve in pace with the development of the related technology, the WSD has in recent years been making more extensive use of such valves to implement the PMS;
- (b) while the highly congested underground space in developed areas of Hong Kong poses an overwhelming challenge limiting the pace of implementing the PMS, the WSD will strive to continue implementing the PMS in these areas where circumstances permit; and
- (c) for new development areas, such as the Kai Tak Development, provisions for the PMS will be made in planning the water supply systems.

PART 5: LEAKAGE IN FRESH WATER DISTRIBUTION SYSTEMS OF RESIDENTIAL DEVELOPMENTS

5.1 This PART examines actions taken by the WSD in reducing leakage in fresh water distribution systems of residential developments.

Maintenance of fresh water mains inside residential developments

Provisions under the Waterworks Ordinance

5.2 The WSD maintains and repairs fresh water distribution systems outside residential development land boundaries. For a residential development, the registered consumers are responsible for the maintenance and repairs of the systems within the development (**inside service**). The inside service includes pipes and fittings in premises, and those between premises and those connecting to the public mains. The registered consumers' agent (such as the estate management or communal service agent) takes up the responsibility for the maintenance and repairs of the communal service (including water pumps, tanks, communal water mains and other associated communal installations).

5.3 Under the Waterworks Ordinance (Cap. 102), if the WSD (Note 19) is satisfied that an inside service is in a condition that waste of water has occurred or is likely to occur, the WSD may:

- (a) by notice require the consumer to carry out repairs or other works specified in the notice to the inside service;
- (b) disconnect water supply to the inside service if the consumer or agent fails to carry out repairs or other works specified in the notice;
- (c) restrict or suspend water supply if it is satisfied that this is necessary or expedient to conserve water and to prevent waste of water; and
- (d) subject to the conditions (Note 20) stipulated in the Waterworks Ordinance, enter any premises at any reasonable time, or in case of urgency at any time, to:

Note 19: *Under the Waterworks Ordinance, the authority for enforcement is vested in the Water Authority, who is the Director of Water Supplies. For simplicity, the Water Authority is referred to as the WSD in this Report.*

Note 20: *Under the Waterworks Ordinance, except in case of urgency, neither the Water Authority nor a person authorised by him may enter any premises at any reasonable time unless he first obtains the consent of the occupier or first obtains a warrant from a magistrate.*

- (i) disconnect an inside service on the premises; or
- (ii) install, inspect, test, regulate, alter, repair or remove any inside service therein.

Water meters

5.4 Inside a residential development, water meters are installed for individual household users and the estate management (e.g. using water for cleansing of common areas and gardening). Individual households and the estate management are responsible for water charges based on the quantity of water used as recorded by the meters. For a residential development provided with fresh water for flushing, a meter is installed for the whole development and the estate management is responsible for the water charges.

Installation of bulk meters for large residential developments

5.5 Since 2003, the WSD has implemented a “water consumption monitoring of large housing estates” project by installing bulk meters outside the boundaries of selected residential developments to monitor fresh water consumption. The bulk meters are not registered in the names of any users and water bills would not be issued. **Subject to availability of resources, the WSD planned to install bulk meters, by 2015, for 246 large residential developments, each comprising not less than 1,000 households. Up to August 2010, 44 developments (including 20 private estates and 24 public estates) had been installed with bulk meters.**

5.6 **Unmetered water** (i.e. water not metered nor charged) is a shortfall in the quantity of water between that recorded by the bulk meters and that by the household meters. The WSD periodically monitors the amount of unmetered water of a residential development over a period of time, and conducts an investigation for a significant amount of unmetered water which may result from either leakage in the inside service or unauthorised use of water (Note 21). The WSD would require the estate management to carry out repair works if leakage is identified.

Note 21: *This audit focuses on real water losses and does not cover apparent water losses such as the unauthorised use of water (see para. 1.7).*

Inside service leakage problem

5.7 Between late 2003 and early 2004, two private housing estates were identified with a large amount of unmetered water arising from inside service leakage. The WSD subsequently requested the estate managements to repair the water pipes. However, up to August 2010, the water pipes had not been repaired satisfactorily in accordance with WSD's requirements.

Overseas experience

5.8 In April 2004, the WSD conducted a review to study the measures taken by Singapore, Malaysia and Macau in addressing the inside service leakage problem. The WSD found that the experience of Singapore and Macau was relevant to Hong Kong. After completing the study, the WSD considered that levying charges on unmetered water might help resolve the inside service leakage problem.

5.9 *Singapore experience.* The Singapore Public Utilities Board had implemented a master meter and sub-meter system to multi-tenanted residential buildings for more than 30 years. Under the system, individual users needed to pay for the water consumption as recorded by master meters.

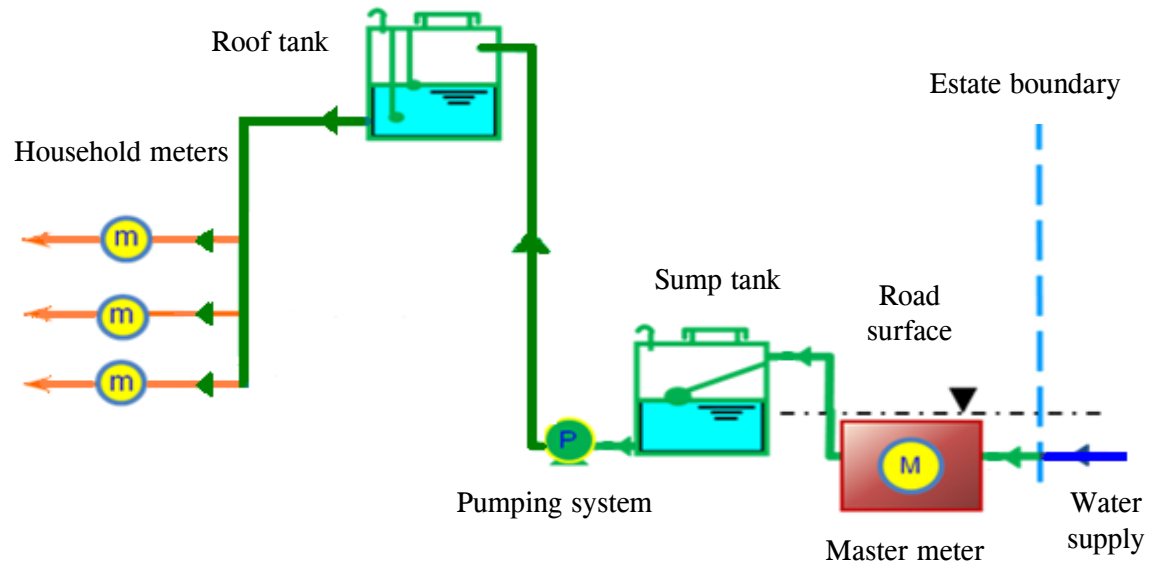
5.10 *Macau experience.* In 1996, the Macau Government enacted a new legislation specifying the responsibilities of homeowners of individual flats in a building for sharing the operation and maintenance costs of public facilities, including those of the internal water supply system. In 2002, the Water Authority of Macau implemented a new master metering policy, under which the Authority might impose a "spreading charge" on individual homeowners based on the amount of unmetered water. After the introduction of the policy for two years, the amount of unmetered water was reduced by more than 50%.

Master metering policy

5.11 In August 2005, the WSD sought policy endorsement from the Environment, Transport and Works Bureau on the implementation of an MMP. Under the proposed MMP, master meters would be installed inside residential developments for recording the total fresh water consumption. Any shortfall of fresh water consumption between the quantity of water recorded by the master meters and that recorded by the household meters would be unmetered water. After ascertaining the quantity of unmetered water, the WSD would then examine the need for levying charges (see para. 5.15). Figure 8 is a schematic diagram of the provision of a master meter in a fresh water distribution system of a residential development.

Figure 8

A master meter in a fresh water distribution system



Source: WSD records

5.12 After seeking legal advice, in late 2005, the WSD planned to implement the MMP in two stages, as follows:

- (a) **Stage 1 — new developments.** Stage 1 targeted on large developments with estate roads and underground/concealed piping of a substantial length within the private land of the developments. For plumbing proposals of new developments (except single detached village type buildings and single block buildings) first submitted to the WSD after 31 December 2005, developers (or their agents) should provide rooms or chambers for the installation of master meters, give undertakings to register as the consumers of the master meters, and arrange licensed plumbers to install master meters; and
- (b) **Stage 2 — existing developments.** The MMP would be gradually extended to cover existing buildings and housing estates.

5.13 In September 2005, the Environment, Transport and Works Bureau endorsed in principle the WSD's proposal to install master meters in residential developments. In November 2005, the Development Bureau said that it had no objection for the WSD to implement Stage 1 of the MMP using its existing resources. In January 2006, Stage 1 of the MMP commenced. The WSD informed licensed plumbers and Authorised Persons that the WSD would implement the MMP to new developments with plumbing proposals first submitted after 31 December 2005, and a charging calculation methodology on unmetered water was being worked out. For new developments not required to be installed with master meters, bulk meter chambers (for temporary installation of meters for checking water consumption) were provided as in the existing practice.

5.14 In November 2006, the WSD planned to commence Stage 2 (to cover existing developments with not less than 1,000 households) in January 2012 for completion in 10 years by 2022, subject to the availability of resources. Under Stage 2, the WSD would:

- (a) make enhancement to the computerised billing system and set up a database for implementing the MMP;
- (b) seek consent of registered consumers or estate managements for installing master meters; and
- (c) give priority to implementing master meters in buildings or estates with a serious leakage problem.

5.15 According to the WSD, it will review the situation and when there are a sufficient number of master meters in service, consult the public on whether a charging mechanism should be put in place.

Audit observations and recommendations

Audit examination

5.16 As of March 2010, of the 44 residential developments which had been installed with bulk meters, the WSD had compiled monitoring results for 40 developments. According to these results, Audit noted that:

- (a) in 31 developments, unmetered water was less than 20% of the water supplied to the developments; and

- (b) in 9 developments, unmetered water ranged from 20% to 74% of the water supplied to the developments. In 5 of these 9 developments, unmetered water was 35% or more (see Table 14).

Table 14

**Unmetered water in five residential developments
(based on March 2010 monitoring results)**

Development (Note)	Estimated daily average consumption		Unmetered water	Percentage of unmetered water
	Recorded by bulk meter	Recorded by household meters		
	(a)	(b)	(c) = (a) - (b)	(d) = $\frac{(c)}{(a)} \times 100\%$
	(m ³ per day)			(%)
A	6,768	1,758	5,010	74%
B	3,973	1,334	2,639	66%
C	2,716	1,024	1,692	62%
D	8,561	4,818	3,743	44%
E	1,128	729	399	35%

Source: WSD records

Note: For Developments A and D, fresh water consumption also included that for flushing.

5.17 Audit examination of the WSD's actions taken for Developments A and D (both developments were supplied with fresh potable water and fresh water for flushing) revealed the following:

- (a) **Development A.** Since October 2003, there had been a serious leakage problem. Despite repeated requests for repair by the WSD, the works only commenced in August 2009. Details are given in Case 2; and
- (b) **Development D.** Since November 2003, there had been a serious leakage problem. The estate management replaced some water pipes in late 2006 but the leakage problem persisted. Details are given in Case 3.

Case 2

Water leakage in Development A

- On 17 December 2003, the WSD commenced monitoring the fresh water consumption of the development installed with bulk meters.
- On 4 March 2004, the WSD noted that the average daily unmetered water for a four-month period amounted to 2,669 m³, or 58% of the water supplied to the development.
- On 18 August 2004, the WSD conducted an investigation.
- On 10 December 2004, the WSD informed the management office of the leakage problem. In response, the management office said that it would carry out large scale plumbing works to replace all ageing water pipes.
- On 2 February 2005, the management office informed the WSD that it would award a contract in March 2005 for the works, targeted for completion in two years.
- On 7 February 2006, the WSD informed the management office that severe leakage persisted (about 50,000 m³ of fresh water leaked every month) and urged the office to carry out remedial works immediately.
- On 25 July 2007, in response to the WSD's enquiry about the works progress, the management office informed the WSD that a long time was required for completing the tender exercise, and the works would require three years to complete.
- On 2 August 2007, the WSD requested the management office to expedite the works, and informed the office that it might need to pay for the cost of water leaked.
- On 15 November 2007, after seeking legal advice, the WSD noted that it could not charge the management office on unmetered water because the office was not registered for the bulk meter.
- On 4 March 2008, the management office informed the WSD that it would conduct a new tender exercise as the tenders received in the last exercise exceeded its budget.
- In August 2009, the works commenced.
- As of August 2010, the works were in progress.

Source: WSD records

Case 3

Water leakage in Development D

- On 17 December 2003, the WSD commenced monitoring the fresh water consumption of the development installed with bulk meters.
- On 17 May 2004, the WSD noted that the average daily unmetered water for a four-month period amounted to 5,040 m³, or 50% of the water supplied to the development.
- On 5 August 2004, the WSD conducted an investigation.
- On 17 August 2004, the management office informed the WSD that it had commenced works to replace some water pipes and the works would take 30 months to complete.
- In December 2006, the works were completed.
- On 16 July 2007, the WSD noted that the leakage problem persisted, where the average daily unmetered water for a five-month period amounted to 2,562 m³, or 35% of the water supplied to the development.
- On 22 August 2007, the WSD conducted an inspection and no visual leak was observed.
- On 31 March 2008, the WSD noted that, of the total of 67 km of water mains (comprising 34 km for potable water and 33 km for flushing water) in the development, only about 25 km (37%) were replaced.
- On 25 November 2009, the WSD noted that the leakage problem persisted, where the average daily unmetered water for a six-month period amounted to 3,367 m³, or 40% of the water supplied to the development.
- In December 2009, the WSD requested the management office to carry out an investigation and conduct repair works.
- As of August 2010, the works had not commenced and the management office had yet to pinpoint the leakage locations.

Source: WSD records

Need to take effective measures to reduce inside service leakage

5.18 According to the WSD's estimate of fresh water losses in Hong Kong, in 2009, the quantity of unmetered water through leakage in the inside services of residential developments was 17.63 Mm³, involving about \$80 million if the water had been metered and charged. In September 2010, in response to Audit's enquiry, the WSD informed Audit that:

- (a) the Development Bureau and the WSD had formulated a strategy in minimising fresh water losses in the inside services of private fresh water distribution systems in residential developments; and
- (b) the existing MMP addressed leakage problem of private mains within a particular building or estate. The bulk metering programme targeted the monitoring of water consumption by areas or districts which was useful in detecting water losses. The PMS were also effective in reducing water losses not only for government mains but also for those in private areas. These programmes and schemes were complementary to one another.

5.19 As unmetered water is not charged, some estate managements may not have the incentive to rectify inside service leakage in a timely and effective manner. **Audit considers that the WSD needs to review the existing strategy to minimise water losses of inside services, and explore measures to ensure that leak inside services are repaired expeditiously and satisfactorily.** In this connection, Audit notes that Stage 2 of the MMP for existing developments has not yet commenced (see para. 5.14).

Need to monitor unmetered water in new residential developments

5.20 Since January 2006, the WSD has implemented Stage 1 of the MMP in new developments (see para. 5.13). Up to April 2010, master meters had been installed in all the 20 new residential developments under Stage 1 of the MMP. In February and July 2010, in response to Audit's enquiry, the WSD informed Audit that:

- (a) no readings for master meters had been taken because leakage of inside services within new developments was expected to be insignificant in the early years after their completion; and
- (b) the WSD would later require its staff to commence taking readings for master meters.

5.21 **Audit considers that the WSD needs to monitor unmetered fresh water in new residential developments. This would help ensure the effective implementation of the MMP.**

Need to promote public awareness on repairing inside services

5.22 The WSD has published leaflets and produced Announcements in Public Interest to inform the public of their responsibilities for maintaining and repairing leak inside services in residential developments. **In view of the inside service leakage problem, the WSD needs to enhance its publicity efforts to promote public awareness of the importance of maintaining and repairing inside services of residential developments in a proper and timely manner.**

Audit recommendations

5.23 **Audit has recommended that the Director of Water Supplies should:**

- (a) **review the existing strategy for minimising fresh water losses in inside services of private fresh water distribution systems in residential developments (see para. 5.19);**
- (b) **explore measures to ensure that leak inside services are repaired in a timely and satisfactory manner (see para. 5.19);**
- (c) **monitor unmetered fresh water in new residential developments installed with master meters (see para. 5.21); and**
- (d) **launch publicity campaigns to promote public awareness of the importance of proper maintenance of inside services in residential developments (see para. 5.22).**

Response from the Administration

5.24 The **Director of Water Supplies** agrees with the audit recommendations. He has said that:

- (a) the WSD will review the existing strategy for minimising fresh water losses in inside services of private fresh water distribution systems to cope with the present situations, particularly the difficulties in implementing Stage 2 of the MMP;

- (b) under the publicity campaigns and education programme for water conservation, the WSD will build in elements to promote the public's awareness of their responsibility for proper maintenance of inside services; and
- (c) with the advancement of leakage detection techniques, it is encouraging to note that the industry is gearing itself up to provide services to the public to assist them to deal with leakage of inside services.

5.25 The **Secretary for Development** appreciates Audit's concern over the problem of water losses in the private fresh water distribution systems of large residential developments. She has said that:

- (a) it has been more than four years since implementing Stage 1 of the MMP in January 2006. The Development Bureau considers it opportune to conduct a review of the existing strategy for minimising fresh water losses in inside services of private fresh water distribution systems in large residential developments; and
- (b) with the support of the Development Bureau, the WSD will conduct a review, taking into account the experience gained from Stage 1 of the MMP, recent advancement of technology, Audit's recommendations and other relevant circumstances.

5.26 The **Secretary for Financial Services and the Treasury** has said that:

- (a) from the fees and charges perspective, the WSD should expedite the formulation of the charging calculation algorithm on unmetered water under the MMP in consultation with the Department of Justice so as to protect government revenue; and
- (b) the WSD should explore the possibility of charging the unmetered water that is identified by the bulk meters by amending the relevant legislation.

Acronyms and abbreviations

Audit	Audit Commission
CTEC	Customer Telephone Enquiry Centre
FC	Finance Committee
HyD	Highways Department
IWA	International Water Association
km	Kilometres
m ³	Cubic metres
mm	Millimetres
Mm ³	Million cubic metres
MMP	Master metering policy
NT	New Territories
PMS	Pressure management schemes
PWSC	Public Works Subcommittee
R&R	Replacement and Rehabilitation
TIBM	Time for isolation of burst mains
TMLG	Traffic Management and Liaison Group
TSI	Time of supply interruption
TTA	Temporary traffic arrangements
WSD	Water Supplies Department