REPORT

of the

INVESTIGATION

on

THE PROBLEM OF

WATER MAIN BURSTS

September 1996

Office of the Commissioner for Administrative Complaints

Hong Kong
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INTRODUCTION

BACKGROUND

1.1 From time to time, there are reports concerning suspension of water supply due to bursts of water mains. This is a matter of concern to this Office and the public as sudden and frequent suspensions of water supply would undoubtedly cause inconveniences to families and shop operators and have consequential social and economical costs. Against this background, this Office conducted some preliminary enquiries with the Water Supplies Department (WSD) on the issue. According to the WSD, there were 1,108, 993 and 1,313 bursts of water mains (both fresh water and salt water) during the periods from 1 April 1993 to 31 March 1994, from 1 April 1994 to 31 March 1995 and from 1 April 1995 to 31 March 1996 respectively, making an average of 3 bursts per day in 1993/94, 2.7 bursts per day in 1994/95 and 3.6 bursts per day in 1995/96 respectively. (Note: See also para. 3.4 below.)

1.2 As prevention and reduction of water mains bursts would be dependent on the availability and effectiveness of WSD’s procedures and actions, this Office considered that it would be in the public interest to conduct a direct investigation into the matter to see whether there were adequate preventive measures and actions taken by the WSD to tackle any identified/potential problems in the present water supply system, including the ageing of the water pipes and bursts of such pipes resulted from construction activities such as roadworks which are the two main causes for bursts. The Commissioner for Administrative Complaints (COMAC), by virtue of his authority vested in Section 7(1)(b) of the COMAC Ordinance (Cap. 397), completed an investigation into the procedures and actions of the WSD for the prevention and reduction of the occurrence of bursts of water mains.
PURPOSE AND AMBIT OF THE INVESTIGATION

1.3 The purpose of this direct investigation is to examine WSD's procedures and actions for the prevention and reduction of the occurrence of bursts of water mains in order to establish if they are -

(a) adequate and effective for their intended purposes; and

(b) being implemented in a timely, programmed and co-ordinated manner in accordance with suitable priority.

1.4 The investigation has focused on the following aspects -

(a) WSD's assessment of the current state of the water mains in Hong Kong, the size of the problem and whether it has increased or decreased in recent years with the support of suitable statistical indicators.

(b) WSD's current strategies on preventing and minimizing bursts of water mains.

(c) Information on each of the preventive measures currently undertaken or under consideration by the WSD, including their scope, feasibility, financial and staffing implications, operational considerations, legislative progress, priority, effectiveness, etc.

(d) The progress in respect of the preventive measures referred to in para. (c) above.

(e) Other measures considered but rejected, including any experiences of overseas water authorities.

1.5 The maintenance of the water supply system inside public housing estates is under the care of the Housing Authority as the landlord, as in the case of private developments. The subject matter is outside the scope of this investigation. This Office however notes that a replacement programme for the water pipes in public housing estates is in place and being implemented.
This Office will keep in view of the situation and will consider looking into the matter if circumstances so warrant.

INVESTIGATION

1.6 In the course of the investigation, relevant papers, files and statistical data were provided to the Investigation Officers of this Office for examination and analysis by the WSD.

1.7 Meetings and discussions between representatives of the WSD and the Investigation Officers were held on various occasions in May, June and July 1996. A visit was made to the Eastern Treatment Works in May 1996 to acquire a better understanding of the whole water supply system, including the treatment works, pumping station and service reservoir. Field studies were conducted on the work of a roadworks inspection team of the WSD (see para. 4.18 - 4.20) in May 1996. A visit was also made to the site of water main burst in the Kwun Tong district in June 1996.

REPORT

1.8 COMAC announced this investigation on 11 December 1995 and a draft investigation report was sent to the Director of Water Supplies (DWS) for comments on 5 August 1996. His comments were received on 4 September 1996. This final report was issued on 16 September 1996.

1.9 There are seven chapters in this investigation report. The first six chapters deal with the background information and special features of the water supply system in Hong Kong, the problem of bursts of water mains, WSD's assessment of the current state of affairs, WSD's current strategies and measures for preventing and minimizing main bursts and finally with our observations, findings, conclusion and recommendations of this investigation. The last chapter covers the comments of the department on this investigation report and the final remarks of this Office in response to the comments.
BACKGROUND

2.1 In Hong Kong, raw fresh water for treatment is fed either directly from the water system in China or from one of the storage reservoirs by gravity or via pumps through water tunnels or large diameter pipelines to the water treatment works. In the treatment works, the incoming water will first pass through clarifiers and filter beds to remove the suspended solids, colour and turbidity, and then be treated by addition of chlorine solution and fluoride compound for disinfection and dental care. Water coming out from the treatment works is pumped and in some cases flows by gravity to the service reservoirs (which are located at suitable elevations throughout the territory, each serving a particular area according to geographical and hydraulic conditions) and then distributed to consumers through extensive networks of primary and secondary distribution mains, area distribution mains and submains. The pressure in the system is generally sufficient to provide a direct supply to the bottom six or seven storeys above street level. Upper floors of tall buildings are supplied from their own roof tanks, filled by their own pumping systems.

2.2 The WSD also supplies sea water for flushing to over 70% of the population throughout the urban areas and the new towns. In the salt water pumping stations at sea front, sea water will first pass through the inlet screens to remove floating objects and then be disinfected with chlorine, before being pumped to the salt water service reservoirs and for distribution to consumers through a different network of salt water mains.
2.3 Water mains are normally laid underground to a depth with a minimum cover of 450 millimetres (mm) in footways or 1000 mm in carriageways, depending on the size of pipe and availability of space to accommodate the pipe and other existing utility services. As at 31 March 1996, the total length of water mains laid in the territory was 5,656 kilometres (km) with 4,603 km for fresh water and 1,053 km for salt water.

2.4 According to the DWS, the water supply system in Hong Kong has been expanding rapidly in the past two decades. A large proportion of the fresh water mains on Hong Kong Island, in Kowloon and in the older generation of new towns, such as Tsuen Wan, Kwun Tong were laid in the early years (1950s, 60s and 70s). Many of the salt water mains in these areas were laid in the 1970s. While water mains generally have a long designed life (50 years for fresh water mains and 20 years for salt water mains), the actual service life depends on many factors. Generally speaking, about 30% of Hong Kong's water mains are estimated to be over 25 years old and approaching the end of their designed life in the next 20 years or so and hence may need to be replaced or rehabilitated.

THE WATERWORKS ORDINANCE

2.5 Legislation for operating the waterworks in Hong Kong is prescribed in the Waterworks Ordinance, Chapter 102 of the Laws of Hong Kong; the 'Water Authority' mentioned therein being the DWS. Sections 31 and 33 of the Ordinance are relevant to this investigation. They are quoted as follows -

(a) **Section 31 - Damage, etc., to waterworks**

Any person who, without the permission in writing of the Water Authority, alters, interferes with, damages or destroys any part of the waterworks shall be guilty of an offence.

(b) **Section 33 - Cost of repairing damage and recovery of damages or loss**

(1) The Water Authority may carry out repairs or other works to any fire service, inside service or any part of the waterworks
which is altered, interfered with, damaged, or destroyed as a result of the commission of an offence, and the cost of such repairs or other works may, upon an order of a magistrate, be recovered from the person convicted of the offence in the same manner as if it were a fine imposed by a magistrate under the Magistrates Ordinance (Cap. 227).

(2) If the Water Authority suffers any damage or loss as a result of the commission of any offence referred to in subsection (1), such damage or loss may, upon an order of a magistrate, be recovered from the person convicted of the offence in the same manner as if it were a fine imposed by a magistrate under the Magistrates Ordinance (Cap. 227).

Further discussion on the specific contents of the Ordinance relevant to this investigation is in Chapter 4.

SPECIAL FEATURES OF THE HONG KONG SYSTEM

Space Constraint

2.6 In Hong Kong, due to space constraint, water mains and other utility service installations are often laid in congested condition under the footways with little and inadequate clearance from each other. According to the DWS, this has made the water mains susceptible to damages caused by trench works, roadworks and building works in close proximity to the water mains. This has also sometimes led to difficulties in carrying out the necessary maintenance or repair work for the mains, particularly in the event of an emergency. In newly developed areas, they are normally laid as planned under footways/verges in a more systematic manner with reasonable clearance from each other.
Density of Developments

2.7 Hong Kong has been experiencing a rapid development in its infra-structural projects and expansion of public utilities necessitating a great deal of construction activities being carried out in many locations which may affect water mains. Projects such as those involving land reclamation, laying of various installations by the utility companies, road and flyover construction and building site redevelopment are but a few examples. In this regard, the number of road openings for all types of activities had increased from 47,413 in 1990 to 58,102 in 1994 and 60,235 in 1995. According to the DWS, because roads in the territory, especially those in urban areas are usually narrow and congested with underground utilities, construction activities carried out under such congested condition have a much greater chance of causing damage or disturbance to the water mains located or embedded in the vicinity resulting in main bursts.

Pipe Materials

2.8 There are the following types of pipe materials either currently or previously used in the water mains in Hong Kong -

(a) Galvanised Iron (GI);
(b) Mild Steel (MS);
(c) Ductile Iron (DI);
(d) Unplasticised Polyvinyl Chloride (uPVC);
(e) Asbestos Cement (AC);
(f) Cast Iron (CI);
(g) Glass Reinforced Plastic (GRP); and
(h) Medium Density Polyethylene (MDPE).

These materials have their own special properties and characteristics and are used in different circumstances. For example -
(a) AC pipes were commonly used in the 1960s and 1970s on account of their relatively low cost and that they are durable in withstanding internal water pressures. They are however brittle and relatively weaker than MS and DI pipes in withstanding excessive external load/pressure. Use of AC pipes has been discontinued for some years since 1981 but there are still large quantities of these pipes in the existing water mains systems.

(b) Un-lined GI pipes were commonly used in the past but has seldom been used since the 1980s. Its use has indeed been forbidden under the Waterworks Ordinance since 1994 and has since been replaced by lined-GI pipes which are more resistant to internal corrosion than un-lined ones, and hence they would have a longer serviceable life and require less maintenance. Despite this, the use of lined-GI pipe is only limited to temporary pipes and pipes in exposed positions or difficult and vulnerable areas.

(c) DI is a material more resistant to external disturbance and is therefore less vulnerable to damage and requires less maintenance repairs. Since 1981, DI pipes have been adopted in most of the mainlaying jobs as a standard practice and have been used to replace AC and CI pipes of a diameter of 80 - 600 mm.

(d) GRP pipes are only used for large diameter low pressure mains conveying raw water from China.

(e) uPVC pipes are relatively weak in resisting direct impact. They are laid outside carriageways and in small diameter, mostly used in salt water supply systems.

(f) CI pipes are brittle and are no longer used.

2.9 The sizes of water pipes range from 20 mm to 2,300 mm in diameter. Generally speaking, pipes of larger sizes serve larger areas and in turn a larger number of consumers. Further information on the use of the above and other pipe materials in the local water supply system will be described in Chapter 4.
Records of water mains

2.10 Although the WSD has a full record of where water mains were laid in the territory, systematic recording of the date of laying new mains and the pipe materials has, however, only been put into practice since the early 80s. As many pipes were laid before this period, the pipe materials of a large proportion of water mains (about 58% by length) are not known and the age of the water mains varies widely. Generally speaking, in the new towns most of the water mains were laid following their pace of development. In the old urban areas, the mains were laid in the early days when accurate records were not kept although the DWS has indicated that some of them have been replaced in the course of time. The statistics of the total length of water mains currently in use over the territory, broken down by the types of supply and types of pipe materials, as at 31 March 1996 are shown at Annex 2.1.
DEFINITION OF BURST AND LEAK

3.1 According to the DWS, escape of water from a water mains is classified either as a main burst or leak. It is classified as a burst if there is an immediate need to isolate supply because of any of the following conditions -

(a) The outflow of water is significant in quantity.

(b) The velocity of water escaping from the fault location is high.

(c) There is an imminent danger of flooding the area, and/or causing significant traffic disruption or causing damage to adjacent roads, lands, structures, property or slopes, or affecting the safety of the public at large.

(d) The pressure drop due to the fault is such that a continuous water supply to the affected area can no longer be maintained.

3.2 Escape of water from a water main is classified as a leak for events other than those mentioned above and where immediate isolation of supply is not required.

3.3 Depending on the scale and location of the work, leaking or burst of water mains are repaired by either WSD's term contractors or WSD's direct labour. In general, direct labour are deployed for repairing works for exposed pipes of small diameter (100 mm and below) and submains in back lanes and village areas. Term
contractors are employed to repair all other pipes of larger diameter (150 mm and above) which are either exposed or buried, particularly in footways and carriageways where road opening works are involved. In the latter case, the work of the term contractors is carried out under the supervision of the WSD staff.

3.4 For the purpose of this investigation, the focus will be on the main bursts repaired by WSD's term contractors which averaged about 3.1 cases per day since 1990/91. Other main burst cases, i.e. bursts repaired by WSD's direct labour are excluded because of the relatively minor inconveniences they would have caused. In this regard, this Office notes that practically bursting of water mains could not be totally avoided. Moreover, not all main bursts will cause suspension of supplies and hence inconveniences to consumers for the following reasons -

(a) For bursts of small diameter mains, e.g. those repaired by WSD's direct labour, the effect of supply interruption so caused is usually small. Very often, consumers may not experience any supply interruption at all during the time of water main repair as the water stored in the water tanks in the buildings should be able to maintain a continuous supply for them within a reasonable period of time.

(b) Repair to leaks, whether in large or small diameter pipes and whether by WSD's term contractors or direct labour, are normally scheduled to be carried out at night time or during off-peak hours, and hence the effect of supply interruption so caused will always be minimal. In some cases, although the work on site may be seen to be carried out at day time or during peak hours of demand, the duration of actual water cut-off is always arranged to take place at night time or during off-peak hours.

(c) In the event of a major main burst affecting a large number of consumers, the WSD will always arrange to provide alternative supply to meet immediate water demand and minimize inconveniences to consumers whenever possible as follows -
(i) Owing to the existence of the ring system in all densely populated areas - a system in which the distribution mains are connected to form rings or loops throughout the distribution area, should repair work be necessary on one leg of the distribution main, water supply will still be maintained via the other leg, thus reducing the inconvenience to the consumers. Moreover, it is often able to isolate the section of water main with the burst and continue supply without interruption. The number of consumers affected by the main bursts can therefore be reduced to the minimum.

(ii) Where it is necessary to meet the immediate demand by the affected residents for alternative water supply, emergency standpipes attached to fire hydrants located in the area can be installed and/or emergency water wagons arranged.

(iii) If immediate repair of a main is not possible, consideration is always given to by-passing the damaged section by laying a smaller diameter temporary water main to maintain, as far as practicable, supply to the affected area.

WSD’S ASSESSMENT OF THE CURRENT STATE OF THE WATER MAINS IN HONG KONG

3.5 According to the DWS, all government water mains are designed, laid and tested to the standards prevailing at the time of laying, and should be able to serve over a few decades without problem if they are not subsequently disturbed.

The Statistics

3.6 The DWS has provided this Office with the following statistics on the main burst problem in the last six years from 1990/91 to 1995/96 -
(a) by types of water supply, sizes of main and incidents affecting large areas and necessitating radio announcements (Annex 3.1);

(b) by types of pipe material (Annex 3.2);

(c) by causes of bursts (Annex 3.3);

(d) by rate of main bursts per year per km of water mains laid (Annex 3.4).

Regarding the meaning of 'large areas' referred to para. (a) above, the DWS has advised that because of the vastly different situations in different parts of Hong Kong, it is not possible to have a clear cut definition on the term 'large areas' that can be applied throughout the territory for making radio announcement for notification of supply interruption to consumers. The WSD regional staff will base on their own experience and judgement to decide on the necessity of making radio announcements after considering the factors like the number and type of consumers to be affected, the estimated duration of interruption and the effect of the interruption to the consumers.

Causes of Bursts

3.7 According to the DWS, main bursts are mainly due to external disturbances including roadworks, deep excavation, heavy traffic loading, vibration, ground movement. Those due to deterioration of the pipe materials such as ageing or corrosion constitute only a small proportion of the overall water mains failure cases. Statistics of main bursts analysed by main causes of defect is at Annex 3.3. In the past six years, an average of 28% of main bursts were attributed to direct damage of construction activities. 52.9% were caused by other external disturbance and 19.1% were due to factors other than external disturbances.

External Factors

3.8 According to a study conducted by the Working Group on Prevention of Damage to Water Mains (to be explained in further details in para. 4.2 to 4.6), water
mains damage is mainly caused by external factors including -

(a) indiscriminate use of heavy mechanical plant in close proximity to water mains;
(b) ground settlements caused by trench works or broken drains below foundation of water mains;
(c) ground movements brought about by slope failure or deep excavation;
(d) removal of lateral support to water mains due to road excavation or trench works;
(e) ground vibrations caused by piling or blasting;
(f) disturbance due to traffic loading arising from parking of heavy vehicles on footpaths;
(g) shallow cover to water mains due to a change in road level; and
(h) growth of tree roots in the vicinity of water mains.

Internal Factors

3.9 Internal factors causing water main bursts include -

(a) erosion;
(b) corrosion;
(c) faulty material; and
(d) faulty workmanship.

Size of the Problem

3.10 The DWS considered that the size of the main burst problem is generally not large on the basis of the following statistics -
(a) The number of main bursts (both fresh water and salt water) on average is around 1,135 per year in the past 6 years. It represents only about one main burst in every 5 kilometres of water mains each year (Annex 3.4).

(b) About 47% of the main burst occurred in salt water mains (Annex 3.4) affecting only the flushing water supply. Hence the inconvenience caused to the consumers due to supply interruption is not that serious because it is a WSD's waterworks requirement that flushing supply to all premises must be provided via storage tanks (roof tanks) which serve to balance the supply and minimize the supply interruption. In respect of fresh water supply, the installation of similar storage tanks, though not being mandatory, has also become an increasingly common and essential engineering feature, particularly for multi-storey buildings.

(c) 72% of the main bursts were confined to small sized mains not exceeding 150 mm diameter (Annex 3.1) and hence only small areas or a small population were affected in most cases.

(d) Less than 5% of main bursts occurred in pipes of diameter exceeding 300 mm (Annex 3.1). As some of these pipes are trunk mains supplying water to various service reservoirs, supply to consumers were totally not affected in these cases because the water stored in the service reservoir serves as a buffer to maintain supply to consumers while repair was in progress. In fact one of the purposes of having a service reservoir as an important component in the water supply system is to take care of such technical faults which cannot be totally avoided in any system.

(e) Only 12% of main bursts affected large areas which required the arrangement of radio announcement for notification of supply interruption to consumers (Annex 3.1). This is an indication that the areas and hence the number of consumers affected by the remaining main burst incidents were relatively small.
(f) A very large proportion (91.5%) of main bursts was related to AC pipe (42.7%), CI pipe (12.2%), GI pipe (15.2%) and uPVC pipe (21.4%) (Annex 3.2), whereas those related to DI pipe and MS pipe were very small (5.3%). Main burst problems are expected to become smaller as the existing AC, CI, GI and uPVC pipes are being gradually replaced by stronger and better quality pipes. The WSD has abandoned the use of AC pipe since 1981. The use of GI pipes has also been discouraged since the early 80's.

The Trends

3.11 As to the trend of the main burst problem, the DWS has made the following additional comments -

(a) The number of main bursts not due to external disturbance remained quite static for the period from 1990/91 to 1994/95, taking into account the rapid expansion of the system (Annex 3.3). This is probably due to the ageing effect of the water main system being countered by the gradual replacement of aged pipes as well as weaker pipes by stronger pipes.

(b) There is a marked decreasing trend in the annual total number of main burst incidents due to direct damage by construction contractors (Annex 3.3), in spite of the increase in the number and scale of construction activities in the territory since 1992. This is probably largely due to the effort of the WSD Roadworks Inspection Teams (RITs) which were set up in 1993 specifically to tackle the problem. (See para. 4.18 - 4.20)

(c) The annual total number of main bursts remained quite static for the period form 1990/91 to 1994/95. (Annex 3.3)

(d) The rate of main bursts per km of water mains laid was on a decreasing trend for the period from 1992/93 to 1994/95 (Annex 3.4), whilst the
accumulated total length of mains laid had increased.

(e) The increase in the total number of main bursts from 993 in 1994/95 to 1,313 in 1995/96 was probably due to the exceptionally heavy rain recorded in the summer months in 1995 and the rapid increase in construction activities as a result of the Airport Core Programme Projects, roadworks, new developments and redevelopments in the territory. In this regard, the number of sites identified by the RITs in 1994/95 was 9,776 where the number in 1995/96 was 22,531. The number of sites causing concern to the WSD as a result of RIT inspections was 3,015 in 1994/95 whereas the number for 1995/96 was 7,264. (See also para. 3.14 below)

(f) A significant portion of the increases in main bursts in 1995/96 was confined to the small sized mains not exceeding 150 mm diameter and hence only a small area or a small population was affected in most cases.

Comparison with Other Countries

3.12 According to the result of the Study of Pipe Burst Problems in the Fresh and Flushing Water Systems Operated by the WSD conducted by an independent consultant, the Hydraulics and Water Research (Asia) Ltd (HWR), retained by the WSD in 1992 (details to be discussed in para. 4.7 - 4.9), failures rates in Hong Kong were many times greater than those recorded elsewhere. The very high incidence of corrosion failures of galvanized iron pipes in Hong Kong had a predominant influence on the Hong Kong figures.

3.13 On this point, whilst commenting that care should be taken when attempting to make a comparison with those in cities overseas, the DWS has referred to the following factors which are unique to Hong Kong -

(a) The total length of water mains in an average overseas city is invariably greater for obvious geographical reasons.
(b) The mode of traffic flow is unique in Hong Kong whereas in other major cities, frequent and heavily loaded vehicular traffic which has an impact on the safety of the water mains only concentrate on roads within the town or business centres.

(c) Utility congestion in roads is never a problem in most of the major cities because of their land abundance.

(d) Above all, the most unique phenomenon in Hong Kong is its rapid increases in large scale development and redevelopment and other infra-structural construction projects in recent years which has absolutely no parallel in all parts of the world. Unfortunately it is also this very phenomenon which accounts for the majority of the main bursts.

ASSESSMENT OF THIS OFFICE

3.14 This Office notes that the problem of water main bursts seemed to have been gradually contained during the period from 1990/91 to 1994/95. The latest main bursts figures for 1995/96 are, however, causing concern. The statistics have revealed the following situations -

(a) The downward trend in respect of the total number of water main bursts since 1992/93 was drastically reversed in 1995/96. There was a 32% increase from a total of 993 bursts in 1994/95 to 1,313 in 1995/96. Comparing to the average of 1,100 for the period from 1990/91 to 1994/95, there was a 19% increase in 1995/96. (Annex 3.1)

(b) The percentage of water main bursts attributed to GI pipes has increased from an annual average of 14.3% (for the period from 1990/91 to 1994/95) to 18.9% in 1995/96. (Annex 3.2)

(c) The percentage of water main bursts attributed to factors other than external disturbances such as erosion, corrosion, faulty material and faulty workmanship has increased from an annual
average of 17.9% (for the period from 1990/91 to 1994/95) to 24.1% in 1995/96. (Annex 3.3)

(d) The rate of bursts per km of water main has increased from 0.18 in 1994/95 to 0.23 in 1995/96. (Annex 3.4)

(e) Although in terms of the actual number, the major increase in main burst in 1995/96 was confined to small sized mains not exceeding 150 mm diameter (para. 3.10 (c)), mains with a diameter between 150 - 300 mm had experienced the largest increase in percentage - 50% from 197 bursts in 1994/95 to 297 bursts in 1995/96. (Annex 3.1)

(f) The situations described in para. (b) and (c) above could be an indication of a growing problem of water main bursts due to ageing GI pipes, a situation which was also picked up by the HWR consultant referred to in para. 3.12.

3.15 The latest statistics covering 1995/96 revealed that there were an average of 3.6 main bursts per day which required repairing works by WSD’s term contractors. There was also an average of 1 burst in every 2.7 days which had affected large areas and necessitating radio announcements. This Office however does not consider it entirely meaningful to comment categorically on whether the problem of water main bursts is serious or not. Obviously, we do not want to see a single incident of main burst. In this regard, this Office acknowledges the unique situation in Hong Kong (para. 3.13) and could understand the difficulties in preventing main bursts in the territory. On the other hand, precisely because of the more vulnerable surroundings facing the territory, this Office considers that it is all the more important that there must be adequate and effective preventive strategies and measures to address the situation. The recent increase in the incidents of water main burst also calls for a more critical re-assessment of the situation.
4

WSD’S CURRENT STRATEGIES AND MEASURES FOR PREVENTING AND MINIMIZING MAIN BURSTS

FORMATION OF THE WORKING GROUP ON PREVENTION OF DAMAGE TO WATER MAINS

4.1 In Hong Kong, due to limited available space, underground utilities are generally laid in congested conditions susceptible to damage caused by trench works, road works and building works in proximity to them. Water main is one of such underground utilities. The statistics at Annex 3.3 indicate that a large number of main burst incidents were caused by such construction activities. Apart from the inconvenience caused to the consumers whose supply may be affected, such main burst incidents may bring about a certain degree of social disruption.

4.2 Having regard to the increase in the occurrence of serious main bursts due to damage, which caused public concern, the DWS directed on 22 October 1991 that an inter-departmental working group comprising representatives of the WSD and the Highways Department (HyD) be formed to study this problem and to explore possible ways to prevent or minimize such incidents as well as to examine what other external factors contributed to damage to water mains. The Working Group, named as the Working Group on the Prevention of Damage to Water Mains (the Working Group), was subsequently formed on 28 October 1991 to, inter alia, review the adequacy of the provisions in contract conditions and specifications for construction works (e.g. road works, trench works,
excavation works) in safeguarding against damage to underground water mains and in establishing liability in the event of damage. The composition and terms of reference of the Working Group are at Annex 4.1.

**Scope of Study and Conclusions**

4.3 The Working Group’s study covered the following subjects -

(a) factors contributing to damage to water mains;

(b) current provisions and practice for the control of trench works and road works;

(c) contractual and legal liabilities in connection with the protection of water mains and recovery of losses on damage to water mains;

(d) procedures for notification, investigation and recording of main burst incidents; and

(e) feasibility of prosecuting parties responsible for damaging water mains.

4.4 With specific regard to item (a) in para. 4.3 above, the Working Group acknowledged that all government water mains were designed, laid and tested to the standards prevailing at the time of laying, and should be able to serve over a few decades without problem if they were not subsequently disturbed. A substantial proportion of the cases of main bursts were mainly due to external factors. Those due to deterioration of the pipe materials constituted only a small proportion of the overall water mains failure cases. After deliberation, the Working Group concluded, inter alia, that -

(a) all government water mains laid in the ground were pressure tested before they were put into service and should have a very long serviceable life if they were not subsequently disturbed; and
(b) water mains damage was mainly caused by external factors (mentioned in para. 3.8 above).

Recommendations of the Working Group and Implementation

4.5 After the conclusion of its study, the Working Group had drawn up a total of 28 recommendations which were later accepted by the WSD for further study with a view to their implementation. These recommendations can broadly be classified under the following categories -

(a) vigilance to prevent water main damage and the proposed setting up of the WSD’s RITs;

(b) legal proceedings and Waterworks Ordinance;

(c) training of WSD staff;

(d) liaison with other parties;

(e) watermains in footpath;

(f) WSD main burst record;

(g) contract administration and site supervision;

(h) revision of Conditions of Permit and Government contract specifications;

(i) adoption of government requirements by utility companies;

(j) revision of Crown Land Ordinance;

(k) Works Branch Technical Circular; and

(l) upgrading of information system.

4.6 At the request of this Office, the WSD has produced an updated situation report on the recommended actions as stipulated in the Working Group’s report, and a copy of which is in Annex 4.2. Some of the Working Group’s findings and conclusions will also be discussed in more details in the remainder of this Chapter.
The frequency of watermains failures in Hong Kong is a cause of concern to the WSD. According to the findings of the Working Group (paras. 4.4(a) to (b) above), a major cause of pipeline failures is perceived to be the result of damage caused by contractors (i.e. contractors under government contracts, contractors appointed by utility companies and those by private developers) and/or workers retained by them. To complement the Working Group's activities, the WSD commissioned in September 1992 the HWR Consultant (para. 3.12) to perform a short study to review the factors which contributed to pipeline failures in Hong Kong, assess the seriousness of the problem and make recommendations for minimizing the frequency of mains bursts.

**Scope of Study and Conclusions/Recommendations**

The HWR study comprised, amongst other things, a report on relevant United Kingdom (UK) legislation, practices and experience together with an analysis of the WSD database on pipe failures to identify the major significant factors. The contents of the *WSD's Mainlaying Practice* and use of pipe materials were also reviewed as part of the consultancy study. More specifically, the HWR Consultant undertook researches in the following task areas with relevant conclusions and recommendations made -

**(a) Mains failure records** - The WSD started to collect data on mains failures in 1988. A number of significant enhancements were proposed to increase the reliability of the data collected and to ensure that its use be maximised in as efficient a manner as possible. Associated recommendations were also made in respect of the maintenance of water mains records generally: first, that an attempt to reduce the large number of mains currently recorded as being of "unknown" material was made by cross referencing observations about material type when mains burst; and second, that some form of geographical
referencing system should be introduced to allow system data to be attributed to particular mains as part of an Asset Inventory System. (An Asset Inventory System means a geographical referencing system for individual pipelines, which allows specific data, such as hydraulic and quality performance data, frequency of interruptions and condition data, to be attributed to the relevant main with ease.)

(b) **Condition data and sampling** - Much could be done to further the WSD’s understanding of pipe performance by introducing a system of regular sampling. This could be achieved on three levels: first, the routine recording of observations as part of the burst reporting system for all failures; second, the regular taking of pipe samples from failure sites or elsewhere when works were taking place to allow detailed inspection and/or materials testing; and third, a programme of detailed condition assessment of strategically significant mains. Condition data should complement mains failure history data in allowing appropriate strategies to be developed for asset management purposes such as developing a mains renewal programme.

(c) **Damage prevention** - The importance of developing a good system of communication with contractors (para. 4.7 above) was highlighted, particularly in respect of advising them of mains locations. The proposed setting up of RITs (para. 3.11(b) above) as recommended by the Working Group was highly encouraged. A system of coordination of works between different utilities could also lead to reduced damage occurrences and the expansion of the cooperative approach established to date between the WSD and HyD was recommended. Damage might be avoided by placing vulnerable mains “out of reach” of construction activities; the installation
of mains below the level of heavy services congestion might also be feasible using trenchless techniques and consideration of these was recommended.

(d) Investment policy and materials selection - Brittle materials were particularly at risk from the ground movement and disturbance factors which were so significant in Hong Kong and it was recommended that a programme for their replacement be developed. Corrosion of galvanised iron in the small diameter submains was seen as a major problem in Hong Kong and it was recommended that these be replaced using a modern material such as MDPE pipes. In order to develop a feasible approach to co-ordinate these various initiatives, it was recommended that an investment plan be developed, making projections of capital requirements in the medium to long term with a prioritized approach to where money should be spent.

4.9 Following the release of the HWR Consultant’s report on its study, the WSD had examined the feasibility of the various recommendations adopted for implementation and had drawn up an action plan in respect of such recommendations. A copy of an updated action plan is at Annex 4.3.

CURRENT MEASURES BEING UNDERTAKEN BY THE WSD FOR PREVENTING AND MINIMIZING MAIN BURSTS

Use of Stronger and Better Quality Pipe Materials

4.10 The HWR consultancy study (para. 4.7 above) had revealed that the majority of failed pipes (excluding GI submains) were of brittle materials. The risk of imposition of external stress on the pipes found in Hong Kong, whether it being resulted from ground movement or damage by contractors, was likely to be high owing to the combination of ground type and density of development. Brittle materials such as CI and AC did not perform well in such conditions and their use should be avoided. The HWR Consultant had therefore recommended, inter alia,
that a WSD policy be adopted for replacing these materials.

4.11 The WSD has begun to embark on a programme of replacing existing old pipe materials by stronger and better quality pipe materials. Details of this replacement programme are described and examined below -

(a) Use of DI Pipes

4.12 In the 1960s and 1970s, AC pipes of diameter 100 mm to 500 mm were used in the water supply system on account of its relatively low cost. Despite being brittle and vulnerable to disturbances, AC pipes were considered to have good corrosion resistance and low friction coefficient and to have an equally long serviceable life as other pipe materials if left undisturbed. It was in the late 1970s when the new towns were undergoing a rapid pace of development that AC pipes were then considered not suitable for the construction of the new water supply systems in the newly reclaimed or filled areas under tight programmes, owing to the problems arising from ground settlement and more stringent compaction requirements for roadworks which might cause damage to them. The study report prepared by the WSD in 1980 established that DI was the best pipe material to replace the AC pipes, taking into account the cost, strength and durability factors. The first DI pipe supply contract was awarded in 1981. DI pipes have since then been adopted in most of the mainlaying jobs as a standard practice and been used to replace AC and CI pipes (for diameter 80 to 600 mm). A photograph of the DI pipe is in Annex 4.4.

4.13 According to the DWS, the DI pipes are more resistant to external disturbance, and hence they are less vulnerable to damage and require less maintenance repairs. The use of DI pipes has proved to be effective as revealed by the fact that the percentages of DI pipe bursts are much smaller than those of AC and CI pipe bursts in recent years (the statistics at Annex 3.2 refer).

(b) MDPE Pipes

4.14 MDPE pipes have been in use in the U.K. for over ten years and account for a significant percentage
of the total length of all new mains being laid in that country. According to the findings of the HWR study, MDPE is a modern material whose characteristics are likely to be well suited to the conditions in Hong Kong. MDPE pipes are more resistant to corrosion and external disturbance, and hence they are less vulnerable to damage and will require less maintenance when compared to the GI or uPVC pipes. The HWR Consultant also recommended that the WSD should consider adopting a wider usage of such materials over the territory.

4.15 Following its study in May 1994 which established that MDPE pipes would be a promising material for adoption in Hong Kong, the WSD had issued interim design guidelines for their use in November 1994. A contract was awarded in October 1995 for the supply and laying of DN50 MDPE pipes (approx. 3 km) by a contractor, as a trial use in a village supply project. The WSD has considered it necessary to carry out a trial use of the pipe material in order to gauge the competence of the contractors and WSD’s own staff in the design, laying, operation and maintenance of this new type of pipe material. A number of professional and technical staff have since been sent to the U.K. to learn and gain experience in this respect. The effectiveness of the MDPE pipes will be reviewed by the WSD after their trial uses. If they prove to be successful, MDPE pipes (50 mm to 315 mm in diameter) will be used to replace the use of un-lined GI and uPVC pipes. Photographs of the MDPE, lined GI and uPVC pipes are also found in Annex 4.4.

(c) Use of "Lined GI" Pipes

4.16 The use of un-lined GI pipes in the WSD supply networks was discouraged since the early 1980s. Its use had since then been limited to difficult and vulnerable locations or being used for those installed in exposed positions or as temporary pipes. According to a study undertaken by the WSD in April 1989, lined GI pipes were one of the alternative pipe materials for the replacement of GI pipes. They were more resistant to internal corrosion than un-lined ones, and hence they would have longer serviceable life and require less maintenance. A supplementary study report prepared in April 1992 also recommended the use of lined GI pipes for submains.
4.17 Following the successful trial laying of lined GI pipes in 1993, the WSD had started to prepare supply contract documents (including specifications) in April 1994 and subsequently awarded 3 contracts for the supply of lined GI pipes and fittings in March 1995. The WSD has decided that lined GI pipes (100 mm and below in diameter) be used to replace the use of un-lined GI pipes in due course.

The WSD’s RITs

4.18 As a positive measure to ensure the protection of water mains, regular inspections should be conducted by the WSD staff on road works and trench works so that warnings could be given to the concerned parties/contractors when malpractices are observed. Before 1992, due to limited resources and the heavy workload in their duties, the WSD staff concerned could do very little in this aspect of work except for some casual inspections as part of their duties. However, oversight activities could only be effective if full time on site inspection or very frequent supervisions could be made to the sites. The Working Group (para. 4.2 above) therefore recommended that the then set-up in the WSD be strengthened to cater for more inspection programmes of road works and trench works for the purposes of effectively reducing the chances of water mains being damaged and that dedicated WSD RITs be established. This recommendation which was also supported by the HWR Consultant has been put into implementation. Such teams were initially set up at ‘half strength’ commencing from September 1992. In October 1994, the WSD obtained approval from the Administration for expanding the Teams to full strength commencing from July 1995.

4.19 At present, there is a full WSD RIT comprising 1 Waterworks Inspector, 1 Assistant Waterworks Inspector, 8 Works Supervisors II and 2 Motor Drivers in each of the WSD’s 5 Operational Regions (i.e. Hong Kong & Islands, Mainland South East, Mainland South West, Mainland North West and Mainland North East). The main duty of such a team is to carry out planned inspections of all roadworks which may affect the existing WSD water mains and to give advice to the contractors to prevent damage to water mains. During the course of and/or prior to such inspections, a leaflet prepared by the WSD on the “Guidelines for Excavation Near Watermains” (copy at
Annex 4.5) may also be distributed to the contractors concerned advising them on the preventive measures, amongst others, to be undertaken on trench works. These inspection teams normally cover all construction activities which take place on roads (carriageways and footpaths) including road construction, drainage work, sewerage work, gas main laying and maintenance, all public utility cable and wire laying work. In connection with our inspection to the work of such teams (para. 1.7 above), this Office has been given to understand that their scope of work also covers construction activities in private lots if such activities may affect WSD’s water mains in the vicinity of the sites. It is further noted that similar inspection teams are also set up in the utility companies for similar purposes.

4.20 The resources put by the WSD in setting up the full scale RITs have apparently proved to be worthwhile in preventing and reducing damages to water mains. From the statistics given in Annex 3.3, direct damage cases caused by contractors have declined since 1993/94 despite the fact that the number and scale of construction activities have increased rapidly during the same period of time. The setting up of the WSD’s RITs which was also supported by the HWR Consultant is an effective initiative for improving the communication between the WSD and the contractors and for preventing and minimizing damages caused by such contractors to water mains.

Regular Programmes for Replacement/Improvement of Mains by the WSD’s Operational Regions

4.21 The WSD has drawn up regular programmes for replacement/improvement of water mains by its five Operational Regions. The scope of such works includes the laying of new mains on a small scale basis for -

(a) replacement of the aged and problematic mains;

(b) improvement of supply; and

(c) relocation of the existing water mains necessitated by projects undertaken by other organisations.
4.22 This replacement measure has been adopted by
the WSD as a standard practice for a long period of time.
The average total length of new replacement and
improvement mains laid by the five Operational Regions
together was about 93 km in each of the past five years,
and this represents about 1.7% of the accumulated total
length of water mains in the territory per year. As
regards the costs of this programme, the total
expenditure amounted to HK$53 million in the 1994/95
financial year.

4.23 This Office notes from the information provided
by the WSD that in urban areas including the older urban
areas, some of the aged mains have been replaced in the
course of time and new mains are being laid to cope with
redevelopments taking place in a scattered fashion. New
mains are automatically laid to tie in with the planned
urban renewal schemes. Therefore, both new and old mains
co-exist in these areas. According to the WSD, the on-
going water main replacement programme has already given
appropriate weight to the old and problematic mains in
such 'old' areas. Moreover, the consultancy study on the
Asset Management Plan (pars. 4.34 and 4.35 below) will
also look at those pipes approaching the end of their
designed life. Hence, a more focused attention will
continue to be paid to the aged mains, some of which co-
exist in the older urban areas.

4.24 From our records, this Office previously
received and handled several complaints against the WSD
regarding the suspension of water supplies to local
residents. In one of such cases, a complaint was lodged
against the repeated sudden suspensions of fresh/salt
water supplies to the residents in a private residential
complex near Lung Cheung Road, Kowloon. Investigation
carried out by the relevant government departments had
revealed, inter alia, that the reasons for the main
bursts resulting in the suspension of water supplies
might have been a mixture of causes, i.e. the (combined)
effect of the exceptionally heavy or even overloaded
construction traffic on the surface road generated from
the nearby roadwork project and/or the "ageing" water
mains in question.

4.25 In the above complaint case, the WSD had
advanced the laying of one new fresh water and one new
salt water main along the road in question with adequate
protection, and had also arranged for the restoration of
both the fresh and salt water supplies subsequently to the satisfaction of the residents concerned. As this Office notes, the findings of this case indicated, inter alia, that the advanced laying of new and stronger water mains, or replacement of 'questionable' water mains, would be a good and effective measure in preventing and minimizing water main bursts in the territory.

Regular Leak Detection Tests

4.26 The Waste Detection Unit (WDU) of the WSD is responsible for carrying out systematic and effective leak detection tests (such as night flow tests, step tests, sounding and visual inspections and leakage surveys by leak noise correlators) at regular intervals, including valve maintenance checks in waste detection areas. The main purpose of carrying out such detection tests is to locate leaks at early stages for preventing them from developing into bursts, thus reducing the consequential losses and inconvenience to the public. Waste detection (or leakage detection) is more than just a routine work task for the WSD which has been giving its continued attention in providing improved leakage detection equipments and techniques as well as relevant professional training for its staff for decades.

4.27 Leakage detection in the WSD first started in 1938. In 1957, a dedicated Waste Detection Section was set up. In 1966, a water resource survey was jointly conducted by the WSD and a consultant. A report was produced in 1968 recommending improvement to leakage detection activities. Upon the regionalization of the operation and maintenance of the supply and distribution system in 1986-87, leakage detection work was assigned to the five Operational Regions. In mid-1992, a centralized WDU was re-established to oversee all leakage detection work over the territory. At present, this Unit, which is headed by a Chief Technical Officer, comprises a total of 131 staff.

4.28 Regular leak detection tests include the following -

(a) "Minimum Night Flow Tests" (MNFT) by "waste metering" - The distribution system is subdivided into small areas (i.e. waste detection areas) where night flow tests are
carried out at intervals (the present practice is about 9 to 15-month intervals). The flow into the area is monitored during night hours, i.e. from 23:00 hrs. to 06:00 hrs. the next day. Further action, if necessary, (e.g. step test (para. 4.28(b) below) or sounding and visual inspection (para. 4.28(c) below)) will be taken to identify the cause of excessive night flow in a waste detection area.

(b) **Step tests (or Leakage tests)** - Using the existing waste meters and by isolating the distribution mains in sections in a planned sequence, step tests are carried out at night. The sections of water mains bearing excessive flow rates will be checked for leaks or waste by sounding and visual inspection.

(c) **Sounding and visual inspection** - Visual inspection means inspection for apparent leaks or defects in the distribution system, e.g. gate valves, air relief valves and exposed water mains. Sounding is carried out, with the aid of instruments (e.g. leak noise correlator, electronic leak detector and stethoscope) to pinpoint leaks in buried water mains.

4.29 Statistics of leak detection tests carried out on fresh and salt water mains by the Waste Detection Unit in 1994/95 and 1995/96 are as follows -

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of night flow tests</th>
<th>No. of step tests</th>
<th>No. of sounding &amp; visual inspection tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994/95</td>
<td>462</td>
<td>58</td>
<td>1672</td>
</tr>
<tr>
<td>1995/96</td>
<td>417</td>
<td>72</td>
<td>2153</td>
</tr>
</tbody>
</table>

4.30 Since 1992, electronic leak detection equipments have widely been used replacing obsolete and mechanical ones. The efficiency of the WDU has been much enhanced. Such detection tests have proved to be effective for their intended purposes, as evident by the large number of leaks located. The following table is a summary of ‘leaks detected’ and ‘water saving achieved’
from 1991/92 to 1995/96 for the effectiveness of leak
detection tests carried out by the WDU -

<table>
<thead>
<tr>
<th>Year</th>
<th>Total No. of Leaks Detected (Fresh water + Salt water)</th>
<th>Estimated Water Saving Achieved (cubic metres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991/92</td>
<td>1226</td>
<td>37 million</td>
</tr>
<tr>
<td>1992/93</td>
<td>769</td>
<td>76 million</td>
</tr>
<tr>
<td>1993/94</td>
<td>1248</td>
<td>73 million</td>
</tr>
<tr>
<td>1994/95</td>
<td>1843</td>
<td>90 million</td>
</tr>
<tr>
<td>1995/96</td>
<td>1976</td>
<td>75 million</td>
</tr>
</tbody>
</table>

Replacement of Salt Water Mains (Stage I) by Operational Regions

4.31 In addition to its regular programmes for replacement/improvement of water mains (paras. 4.21 to 4.25 above), the WSD sought funds under the Capital Works Reserve Funds in 1994 to replace salt water mains over the territory. This works programme involves the replacement of approximately 35,000 metres of aged salt water mains in Quarry Bay, Kennedy Town, Shek Tong Tsui, Wong Chuk Hang, Tsuen Wan, Tuen Mun, Tsing Yi, Kwai Chung, Sham Shui Po, Kowloon City, Ho Man Tin, To Kwa Wan, Yau Tong, Kwun Tong and Lam Tin. The relevant works started in 1994/95, and are due for completion in 1998/99. The total cost of this programme is HK$80 million at the 1994 price level.

4.32 According to the WSD, the sections of main to be replaced have all been carefully pre-determined. The supply system will not be affected except when final connections of the new mains to the existing system are made. However, such pipe connection works will be carried out at night time to minimize the inconvenience to the public.

Other Works Items under the Capital Works Reserve Funds (CWRF)

4.33 Apart from the programmes/measures mentioned in the above paragraphs, the WSD has in hand the following works items under the CWRF which contribute to enhance the reliability of the water supplies system in the
territory and to avoid causing unnecessary inconvenience to the public. Such items include -

(a) Improvement to Hong Kong Central Mid Level and High Level Areas Fresh and Salt Water Supply System - Stage I (Category A project with a project estimate of HK$5 million). This project commenced in March 1995, and is estimated to be completed in February 1998.

(b) Improvement to Salt Water Flushing Supply System in Kowloon Central Area (Category A project with a project estimate of HK$134 million). This project commenced in April 1995, and is estimated to be completed in October 1998.

(c) Improvement of Water Supply to Western, Central and Wan Chai Areas and Extension of Water Supply to Central and Wan Chai Reclamation - Stage I (Category A project with a project estimate of HK$30 million). This project commenced in January 1996, and is estimated to be completed in early 2001.

Development of Asset Management Plan (AMP)

4.34 In pursuance of the recommendations made by the HWR Consultant, the WSD has also undertaken to develop an AMP, the purpose of which is to develop a comprehensive and cost-effective management plan for running and maintaining the water supply system in the territory by employing the latest technology. With the development of an AMP, the WSD hopes to be able to undertake preventive maintenance or replacement of water mains in a more systematic and scientific manner to minimize the number of main bursts.

4.35 Funding for employing consultants to undertake the AMP was approved by the Finance Committee in November 1995. The consultant concerned has commenced in February 1996 to study on the condition and performance of the underground water supply system, and will take 14 months to complete the study.
OTHER MEASURES BEING UNDERTAKEN BY THE WSD FOR PREVENTING AND MINIMIZING MAIN BURSTS

Prevention of Main Bursts/Leaks Caused by Basement Excavation

4.36 In recent years, it has been a common practice in the construction industry to carry out deep excavation for the construction of basements in private developments. The construction process may cause settlement of ground which can cause damage to water mains in the vicinity. There has been in the past a considerable number of main bursts/leaks caused directly or indirectly by deep basement excavations.

4.37 In 1992, the WSD set up a study team to look into the prevailing practice and control on ground settlement necessary for the protection of the water mains in the vicinity of a deep basement excavation. After studying relevant past case history on main bursts caused by ground settlement, carrying out tests for establishing the acceptable amount of settlement and others, a report was issued by the department in May 1993 which addressed various precautionary measures for the protection of water mains near a deep excavation. Based on the report, a flow chart on checking and monitoring the basement excavation work (Annex 4.6) was issued for the WSD staff to follow for minimizing/preventing main bursts/leaks caused by a basement excavation.

OTHER MEASURES UNDER CONSIDERATION BY THE WSD FOR PREVENTING AND MINIMIZING MAIN BURSTS

Enhanced Waste Detection Improvement Plans

4.38 In October 1993, the WSD appointed a consultant to study the enhancement of the waste detection practices adopted by the WSD. In June 1995, the consultancy study was extended to conduct a trial implementation plan on continuous monitoring. A trial implementation plan by the consultant is in hand to try out the continuous monitoring and pressure management in two selected water supply zones, namely, Yau Tong and Repulse Bay. If it proves to be practically viable and cost effective, the same “continuous monitoring” policy will apply to other water supply zones. (“Continuous monitoring” is the strategy whereby permanently installed meters assisted by
modern reliable data loggers or telemetry, continuously record inflows and outflows to closed or semi-closed hydraulic supply zones. Continuous monitoring of pressure at strategic sites within the water supply distribution system is undertaken as part of the pressure management.)

4.39 With the aim of effectively identifying any leakage spot in the water supply systems, the scope of the work of the captioned improvement plans is to establish more “district metering” and “waste metering” (para. 4.28(a) above) areas for effecting continuous flow monitoring in the expanding water supply systems. (“District metering” is a continuous flow monitoring method whereby flow meters are installed at strategic points such that a larger area, usually covering several waste detection areas, is supplied via a meter or a combination of meters. Changes in the total quantity of water supplied into the district are used as a guide for detecting leaks.) Introduction of “network modelling” technique is to enhance the planning and design of “district metering” areas for continuous monitoring in the existing and new supply systems. (“Network modelling” is the technique required in the creation of a calibrated mathematical model, by the use of a network model analysis computer program WatNet 5.4 to accurately simulate the hydraulic behaviour of the actual network.) As regards the operation of such plans, flow monitoring of the distribution system can, by and large, be carried out in the day time without causing any water supply interruption. Night flow tests will be minimized and night activities will then be concentrated on leak sounding and leak pin-pointing.

Long Term Programmes for Replacement of Aged Mains

4.40 The WSD has drawn up tentative long term programmes to replace those existing mains approaching the end of their designed “life span” in the next 20 years. These amount to roughly 30% of the existing mains. The need for replacing the existing mains is to be established not just on their age, but also their conditions. In planning the proposed replacement work, the WSD would take into its consideration the HWR Consultant’s recommendations regarding the assessment of pipe condition and strategy for maintenance and replacement. According to the WSD, the total cost
involved is roughly estimated to be several thousand millions at 1995 price level.

Rehabilitation of Mains

4.41 The WSD has under its consideration a plan to rehabilitate the aged and problematic mains by employing latest techniques - techniques for reconditioning the main without replacement. The technique has been used in many overseas countries. A pipe rehabilitation trial is being arranged to assess the suitability of using the technique in Hong Kong. The regional staff of the WSD will identify those pipes that are badly encrusted and suitable for rehabilitation and will evaluate the impact to consumers arising from the rehabilitation work.

4.42 Following the recommendation of the HWR Consultancy study, a desk study on pipe rehabilitation technique was initiated by the WSD staff. Enquiries were then made to investigate suitable techniques available in the market and trials were planned to be made. Potential pipeline sections suitable for rehabilitation trial were identified in August 1995. The WSD is making arrangement to collect pipe samples to confirm the need for rehabilitation, subject to the availability of funds from the recurrent votes. The financial implications of the plan will be assessed by the WSD in the detailed feasibility study after the pipe rehabilitation trial. The priority of this plan has been accorded a 'low' rating by the WSD, and its effectiveness has yet to be verified and reviewed after more trials are made.

Digitization of Mains Record Plans

4.43 The WSD has a proposal to digitize its present paper mains record plans so as to make a full use of the computerized mapping systems for easy updating, retrieval and information exchange with other public utilities and government departments. This proposal, if adopted, will allow quick and reliable information exchange on utility records between the WSD and other utilities, and hence will indirectly reduce the incidence of damage to underground water mains.

4.44 The cost for the digitization of mains record plans is estimated to be HK$13 million at the 1995 price
level. The commitment of the necessary funds for the
digitization of mains record plans was approved by the
Finance Committee on 17 November 1995, and the
appointment of consultant by the WSD is in hand. It is
anticipated that this project will commence in August
1996 and will be completed in 26 months. The
effectiveness of this proposal will be assessed by the
WSD after its implementation.

Application for Creation of a New Block Allocation Sub-
head for Minor Improvement to Waterworks Installations

4.45 The WSD sought to obtain approval from the
Administration in August 1995 for the creation of a new
block allocation sub-head under Head 709 of the CWRF
(instead of under Sub-head 120 and 121 of the recurrent
votes) for the purposes of carrying out minor improvement
to waterworks installations including the programmed
replacement/improvement of water mains. The required
allocation of funds for replacement/improvement of water
mains under the proposed new block allocation sub-head
for the financial year 1996/97 is estimated to be HK$76
million, which has already taken into account the current
available staff resources to cope with the work.

4.46 According to the DWS, if the above proposal is
approved by the Administration, the number of main bursts
and the associated emergency repair costs can be
suppressed by the implementation of the relevant
replacement/improvement programmes.

CONTRACTUAL AND CRIMINAL LIABILITIES IN CONNECTION WITH
THE PROTECTION OF WATER MAINS

Civil Liabilities

4.47 As mentioned in para. 4.4 above, it has been
concluded previously by the Working Group (para. 4.2)
that a substantial proportion of the cases of main bursts
are mainly due to external factors. Such factors include
the construction activities (i.e. trench works,
excavation works and others) carried out by the
contractors. Parties carrying out trench works and
excavation works on public roads which may affect water
mains can broadly be classified under three categories:
contractors under government contracts, utility companies
and private developers. According to the findings of the Working Group, the first two categories account for more than 99% of the trench and excavation works surveyed and included in the study.

4.48 As regards government contracts, they include mainly roadworks by the HyD or Territory Development Department, civil engineering works by Civil Engineering Department, drainage works by the Drainage Services Department and mainlaying works by the WSD. In general, all the relevant government departments follow the same standard General Conditions of Contract (GCC) laid down by the Works Branch of the Government Secretariat. For example, clause 22 of the GCC stipulates, inter alia, that the contractor "...shall indemnify and keep indemnified the employer against all losses and claims for injury or damage to any person or property whatsoever......, which may arise out of or in consequence of the execution of the works and against all claims...... whatsoever in respect thereof or in relation thereto".

4.49 However, unlike in the case of works contracts offered by government departments, there were previously no standard forms of contract which utility companies were required to use. The conditions governing such contracts only included provisions required by each company. In 1992, the Working Group (para. 4.2), having examined this matter, considered that the Government standard contract conditions and specifications which placed the liability of identifying underground services and prevention of damage onto the contractors were good practices and recommended that utility companies be urged to adopt similar provisions in their contracts with their own contractors. Nowadays, similar contract conditions and specifications for care of works and utility services are adopted for use in the relevant contracts of the utility companies.

4.50 Apart from the above mentioned contractual provisions relating to the indemnity of damages and/or losses by the roadworks contractors to the Government, provisions also exist in the excavation permits for the same purposes. Under the Crown Land Ordinance (Cap. 28), all road excavation works by utilities are required to obtain a permit, namely, the Excavation Permit (sample at Annex 4.7) which is issued by the HyD. Clause 14(a) of this Permit requires that the "Permittee shall take all
necessary precautions to protect utility services and any other installations and the Permittee shall be responsible for any such damage”. Moreover, Clause 14(b) of the same Permit also stipulates requirements for the Permittee to pay the Government the cost of indirect consequences.

4.51 According to the deliberation of the Working Group (para. 4.2 above), the existing provisions in the GCC as well as the Conditions of Permit are considered adequate to require roadworks contractors to recompense the Government in the event that it can be established that the contractor concerned is liable for water mains damage. For Government contracts, monies may be deducted through the operation of the GCC. Where work is executed through an excavation permit, demand notes may be sent by virtue of the Conditions of Permit.

Compensation for Damage to Watermains under the Magistrates Ordinance, Cap. 227

4.52 When damage to a water main arises out of the execution of, or as a consequence of, the work carried out by a contractor, it can be legally an unlawful act. Section 98 of the Magistrates Ordinance, Cap. 227 provides that “where a magistrate...convicts a person of an offence and passes such sentence (if any) as may otherwise by law be passed, he may, in addition to the order or sentence, order the offender to pay to any aggrieved person such compensation for loss of or damage to property not exceeding $100,000, as he thinks reasonable”. Therefore, if the contractor is convicted of the offence, apart from the penalty being imposed on him, the Water Authority may recover, upon the order of the magistrate, any damage or loss from him subject to the limit of $100,000.

Action under the Common Law

4.53 Where the cost of damage or loss exceeds the limit of compensation under the Magistrates Ordinance, the WSD can institute civil proceedings against the contractor and claim for damages due to negligence which is an independent tort. If the lawsuit is successful, the WSD could be adequately compensated for all the damages and/or losses caused to its waterworks. Even if
an employee of the contractor causes the damage or loss, both the employee and the contractor are jointly and severally liable for the torts committed by the employee. If the WSD alleges negligence, it has to establish evidence and has also to prove several legal considerations, namely, that the contractor owed the WSD a legal duty of care; that the contractor broke his legal duty of care; and that the WSD suffered damage in consequence of the breach. Since 1993, the WSD has instituted only one case of civil proceedings against a contractor causing damage to a water main. (According to the WSD, this case was successfully settled at the Small Claims Tribunal in 1995.)

4.54 At present, provisions are available in the works contracts (paras. 4.48 & 4.49 above) for the compensation of the damage caused to a water main. In accordance with these provisions, in the event of damage to a water main, the WSD could recover the cost of repairs and associated loss, provided liability can be established. In 1994/95, the total expenditure for repair of water mains damaged by the contractors concerned was HK$2.9 million. The amount recovered so far for the damage cases occurring in the same financial year was HK$2.3 million through the issue of demand notes. Ongoing actions are being taken by the WSD to pursue with the concerned parties and insurers for settlement of the outstanding damage costs.

Criminal Liabilities

4.55 As mentioned in para. 4.52 above, any damage caused to a water main can be an unlawful act. Depending on the circumstances of the particular case, the contractor may be criminally liable under the law. Section 31 of the Waterworks Ordinance, Cap. 102 reads -

"Any person who, without the permission in writing of the Water Authority, alters, interferes with, damages or destroys any part of the waterworks (Note: Defined under Section 2 as any property occupied, used or maintained by the Water Authority for the purposes of the Ordinance.) shall be guilty of an offence".
The maximum penalty for this offence is a fine of $5,000 upon summary conviction. No custodial sentence is provided.

4.56 This Office notes, however, that the WSD has considered it difficult over the past years to establish cases for taking prosecution actions against contractors causing damages to water mains and to secure any successful prosecutions in court. According to the WSD, an eye-witness's account of the incident would be required, amongst others, to establish liability. However, in most cases, such is not always available, and circumstantial evidence might have to be relied on to establish liability but this kind of evidence is neither easy to obtain.

4.57 The WSD sought legal advice from the Prosecution Division of the Attorney General's Chambers in early 1992 regarding the feasibility of taking prosecution actions against those contractors causing damages to water mains. The advice given was such that a clear and deliberate intention to perform such act as described in Section 31 of the Waterworks Ordinance (para. 4.55 above) must be established before a conviction could be secured. For this reason coupled with the difficulty in collecting the necessary evidence relating to liability, the WSD has found it virtually impossible to prosecute anyone, including workers retained by waterworks or road works contractors/sub-contractors, found or suspected to have damaged WSD-owned waterworks, including water pipes as a result of their gross negligence or even recklessness.

4.58 At present, the Department is processing two damage cases with a view to contemplating legal proceedings against the concerned contractors who have damaged WSD's water mains several times. This Office will continue to note with interest the progress and outcome of these cases.

Legal Advice Obtained by the COMAC

4.59 In view of the fact that construction activities contribute a significant portion of water bursts, this Office considers it important that appropriate prosecution actions (say, under the Waterworks Ordinance) must be taken against those
suspected to be responsible for causing the damage, particularly those who have done it more than once. To seek clarification on this matter, this Office has consulted our legal advisors particularly on whether damages caused to waterworks by recklessness can amount to an offence under Section 31 of the Waterworks Ordinance (para. 4.55 above). The legal advice given by our legal advisors is such that wrongful intent is not a pre-requisite for an offence under that section and that conduct less than recklessness (and, a fortiori, recklessness) can amount to an offence. The sole determinant of liability is whether the person has 'permission in writing of the Water Authority', although 'inevitable accident' is always a defence.

4.60 On the basis of the above legal opinion (which contradicts with that obtained by the WSD in 1992 (para. 4.57 above)), it can be argued that it is not necessary to establish a "clear and deliberate intention" in order to secure a conviction in court in respect of a wrongful act under Section 31 of the Waterworks Ordinance; rather a lesser degree of proof of intention, e.g. recklessness, would be sufficient for the same purposes. In the light of this legal advice, this Office suggests that the WSD should review its present strategy regarding the dealing of offenders causing damages to waterworks with a view to initiating, where necessary and appropriate, more prosecution actions. In view of the considerable number of cases of damages caused by contractors to waterworks, this Office considers that apart from taking civil actions leading to recovery of such damages, the WSD should, under suitable circumstances, also consider initiating prosecution actions against the parties concerned in order to achieve the desired deterrent effect.

Offence of Criminal Damage

4.61 Whilst the Waterworks Ordinance provides sanctions in respect of an unlawful act of causing damages to a water main (para. 4.55 above), the Crimes Ordinance (Cap. 200) provides an even stiffer penalty in respect of a more serious nature of the same act. Section 60 of this Ordinance reads -

"A person who without lawful excuse destroys or damages any property belonging to another intending
to destroy or damage any such property or being reckless as to whether any such property would be destroyed or damaged shall be guilty of an offence.”

As the maximum penalty for this offence is an imprisonment of 10 years, it provides a far tougher punishment and hence a greater deterrent effect than those found in the Waterworks Ordinance. Although it is believed that the WSD has never resorted to any prosecution action under the Crimes Ordinance in respect of any criminal damages caused to its water mains, this Office considers it useful for the WSD to note the existence and the possible applicability of an alternative method to deal with the problem in manifestly serious and blatant cases.

Liaison between the WSD and other Government Departments and Utility Companies

4.62 At present, there are three committees which are set up to, inter alia, maintain close liaison amongst government departments concerned (including the WSD) and utility companies regarding matters relating to road works, road openings and other similar operations. They are, namely, the Road Opening Co-ordinating Committee (ROCC), the Utilities Technical Liaison Committee (UTLC) and the Joint Utilities Policy Group. The general objective of such committees is to minimize disruption and inconvenience caused by the road/trench works and operations to the general public.

4.63 Through the above committees, the WSD is kept informed of the state and progress of the road/trench works and operations so as to prevent and minimize incidents of main bursts caused by them. To achieve this aim, the WSD from time to time produces a list of main burst incidents caused by road/trench works and building contractors concerned and submits this list to the ROCC and UTLC for distribution to all concerned parties for their attention. By doing so, the utility companies and the relevant government departments could be made aware of the irresponsible behaviour and malpractices of some of their contractors relating to road/trench works and would take appropriate actions against such contractors accordingly.
4.64 Apart from the above three committees, the Committee on Contractors Records (CONREC), which is formed under the auspices of the Works Branch of the Government Secretariat and comprises representatives from relevant government departments including the WSD, also deals with matters relating to the management and control of the contractors and approved lists. The WSD contractor's performance reports are submitted to the Works Branch. This Office notes, however, that no WSD contractor was disqualified from bidding relevant government contracts in the past five years simply because he had caused damages to water mains.
OVERALL FINDINGS
AND OBSERVATIONS

GENERAL

5.1 After studying all the relevant information provided by the WSD, this Office has gained a better understanding of the issues involved. This chapter will set out our overall findings and observations with a view to drawing our conclusion and recommendations on this investigation in the following chapter.

Problem of Bursts of Water Mains in Hong Kong

5.2 There has been a yearly average of 1,135 water main bursts requiring repairing work by WSD’s term contractors over the last six financial years. (Of them, 604 cases related to the supply of fresh water and 531 the supply of flush water.) This represents about an average of 3.1 such bursts per day or one water main burst in every 5 km of water mains each year as against an accumulated total length of 5,656 km of water mains laid in the territory as at the end of the financial year of 1995/96. This Office notes, however, that not all of such main bursts have resulted in the suspension of water supply and hence have caused inconvenience to the consumers in the affected areas. In most cases of water main bursts, consumers will not experience any supply interruption at all during the time of water main repair although such cases may bring about social inconveniences such as interruption to traffic.

5.3 The statistics at Annex 3.3 readily support the fact that main bursts in Hong Kong are mainly due to external disturbances (including road works, deep excavation and others as well as those directly damaged by construction activities) and that those due to the
deterioration of the pipe materials such as ageing or corrosion only constitute a small proportion of the overall water mains failure cases, i.e. a yearly average of 80.9% of main bursts due to such external disturbances as against a yearly average of only 19.1% of main bursts not due to external disturbances over the last six financial years, although the percentage of main bursts attributed to factors other than external disturbances has increased from an annual average of 17.9% (for the period from 1990/91 to 1994/95) to 24.1% in 1995/96.

5.4 This Office acknowledges that the relatively large number of main bursts experienced in Hong Kong is mainly the result of the rapid development in infrastructure and expansion of public utilities which necessitate a great deal of construction activities to be carried out in the vicinity of water mains in the territory. In view of this, it is imperative that adequate and effective preventive strategies and measures should be devised to cope with this situation.

5.5 Regarding the increase in the number of water main bursts to a total of 1,313 in 1995/96 (compared with 993 in 1994/95), this Office understands from the information provided by the WSD that this might have been due to a combination of several factors (see para. 3.11(e) above). Whatever such factors, this Office is of the opinion that this reflects the need on the part of the WSD to tighten up its surveillance on the operation of the water supply system. This may also call for an interim review of the effectiveness of the various measures adopted by the WSD for preventing and reducing water main bursts.

Measures Adopted by the WSD for Preventing and Minimizing Main Bursts

5.6 Following the formation of the Working Group in 1991 and the commission of the HWR Consultant in 1992 to, inter alia, study the problem of water main bursts in Hong Kong, the WSD has adopted and implemented various measures with the aim of preventing and minimizing main bursts. Such measures reinforce the existing ones in areas such as legislation and enforcement, staff training, departmental co-ordination, contract administration, road opening permit conditions, record
keeping and use of information technology. A lot of resources have been put into the implementation of these proposals, and they include notably the formulation of long term programmes for replacing problematic or aged water mains and the setting up of the RITs in 1992 for the purpose of stepping up surveillance of all road work activities which may affect water mains. Such improvement measures have largely proved to be quite effective in containing the problem of water main bursts in the territory. Other longer-term improvement measures and proposals are either in the planning stage or scheduled for implementation at a later date subject to the voting of the necessary funds by the Administration.

5.7 According to the WSD, about 30% of the water mains laid in the territory will be approaching the end of their designed life in the next 20 years. To ensure a smooth and uninterrupted operation of the water supply system in Hong Kong, it is important that the WSD formulate a long term replacement programme in respect of such aged water mains. However, this Office notes that although the WSD has a full record of the water mains laid in the territory, a systematic recording of the dates of laying new mains and the pipe materials has only been put into practice since the early 1980s. In view of the absence of such important data in respect of the period before the 1980s, the WSD may have difficulties in working out an accurate assessment of the condition and performance of the entire underground water supply system and hence in drawing up an effective long term replacement programme.

OVERALL OBSERVATIONS

5.8 This Office has the following overall observations on this investigation -

(I) Problematic Water Mains

(a) Of the accumulated total length of 5,656 km of water mains laid in the territory as at the end of 1995/96, about 30% of them will be approaching the end of their designed life in the next 20 years. This represents about a total length of 1,697 km of such water mains.
(b) As the present WSD's records on the dates of the water mains laid and the pipe materials used are incomplete, this may pose a hurdle to the department formulating a cost-effective water mains replacement strategy.

(c) Advanced laying of water mains, or replacement of 'questionable' water mains, has proved to be an effective measure in reducing the incidences of water bursts and hence minimizing inconveniences to the consumers in the affected areas (paras. 4.24 to 4.25 above). It will therefore be worthwhile for the Administration to pursue the investment of the AMP (paras. 4.34 to 4.35 above) as well as the implementation of the associated long term programmes for replacing aged water mains (para. 4.40 above).

(d) Notwithstanding the merits of advanced replacement of ageing water mains (para. 5.8(c) above), the WSD is experiencing constraints in replacing a water main or laying a new water main. Laying of water mains necessitates road opening which is always the subject of public criticism due to interruption of traffic and other similar reasons.

(II) Effectiveness of the Measures Adopted by the WSD for Preventing and Minimizing Water Main Bursts

(e) The dedicated RITs have proved to be an effective and useful measure in the surveillance of roadwork activities which may affect WSD's water mains, thereby reducing the incidences of water main bursts (para. 4.20 above). Whilst the Teams, since their set-up in 1992, have established and maintained liaison generally with the roadworks contractors, they have no legal power to require such contractors to immediately cease road works even if circumstances warrant so
doing. Members of the RITs only act by way of tendering 'advice' to the contractors concerned although in the case of non-compliance of such advice, warning letters will be issued against the contractors concerned. However, if the RITs were entrusted with the necessary legal power, they could function more effectively and cause such roadworks to be immediately ceased in serious situations, thereby forestalling any incidences of water main bursts. The particular road works should be allowed to be resumed once the required remedial measures have been taken.

(f) In view of the ever increasing road work activities necessitated by infrastructure and other developments and redevelopments in the territory, it seems necessary and worthwhile for the WSD to review the existing staffing of the RITs with a view to, where necessary, expanding their strength.

(g) Despite the WSD's previous efforts made to promote the roadworks contractors' awareness of the need and proper way to protect water mains during their excavation near water mains, such efforts had not apparently yielded the desired results. Although the incidences of damages to water mains directly caused by construction activities have continued to decline since the setting up of the RITs in 1992/93, it is believed that the results were attributable more to the efforts of the RITs than to the increased awareness of the roadworks contractors of the need to protect WSD's water mains. It may therefore seem necessary for the WSD to renew its efforts in educating the roadworks contractors on the need to protect water mains in the vicinity of their roadworks. This will certainly help reduce the incidences of damages caused to water mains by construction activities.
(h) There are in place several committees (paras. 4.62 to 4.64 above) through which the WSD can be kept informed of the state and progress of the road/trench work activities being carried out in the territory. Such committees serve as useful links for the WSD to work out proper ways to prevent and reduce incidences of water main bursts caused by road work activities as well as to synchronise the laying/replacement of water mains with road re-construction works. Regarding the CONREC (para. 4.64 above) in particular, this Office notes that although the WSD might reflect the unsatisfactory performance of its own contractors to the Works Branch (but not the CONREC), no such contractor had ever been sanctioned in the past five years simply because the contractor had caused damages to water mains. It is further noted that there is no such item or requirement in the contractor’s performance report leading to mandatory suspension of contractor due to poor performance on this aspect. However, the WSD has in early 1994 requested the CONREC to include the requirement to report on the contractor’s performance in regard to “care of utilities” and that the revised contractor’s performance report is expected to be promulgated shortly.

(III) Legal Position Regarding the Protection of Water Mains

(i) Although legal sanctions are available in the relevant legislation against those parties who have repeatedly damaged water mains, the WSD has not initiated prosecution actions against any of such parties for some legal technicality reasons and others. As damages to water mains caused directly by construction activities constitute a fairly large proportion of water main bursts (a yearly average of 28% of such cases over the last
six financial years), this Office considers it important that repeated offenders should be prosecuted in order to achieve the deterrent effect amongst the roadworks contractors and other parties concerned.

(j) In the light of the legal advice obtained by this Office (paras. 4.59 to 4.60 above), the WSD should seriously review their current policy regarding initiating prosecutions under Section 31 of the Waterworks Ordinance. The WSD may like to obtain further legal advice before proceeding with such legal actions.

(k) The maximum penalty for the offence under Section 31 of the Waterworks Ordinance relating to the damage to any waterworks is only $5,000, and has not been recently increased. This punishment is considered to be on the side of leniency. It is noted that the WSD has already conferred with the Attorney General’s Chambers with a view to increasing the maximum fine to $25,000.

(l) Although many legal remedies are available in the relevant legislation as well as the relevant roadworks contracts and the Conditions of Permit for the recovery of damages and losses caused to its water mains, the WSD has rarely taken any civil actions for the recovery of such damages together with the related compensation against the parties concerned. The WSD has so far resorted largely to the issues of demand notes under the Conditions of Permit against such parties. Therefore, this Office has a concern whether full compensation together with recovery of losses can be guaranteed solely by the issue of such demand notes.
CONCLUSION AND RECOMMENDATIONS

CONCLUSION

6.1 There is no water supply system in major cities of the world that is totally free from water main bursts. This reality, however, does not change the fact that the problem of water main bursts is a matter of public concern. Apart from the immediate effect of suspension of supply, water main bursts could bring about major inconveniences such as paralysing road traffic and loss of productivity to the community which cannot be easily quantified. The issue is therefore clearly something which must be addressed properly by the WSD as prevention is better than cure. In this regard, this Office notes that the WSD is fully aware of its responsibility and the need for effective preventive measures. Considerable efforts have been put in the prevention of water main bursts and these efforts have largely proven to be fruitful.

6.2 This Office is also given to understand that the WSD of Hong Kong is highly regarded by water supply undertakings of various major cities in the world for its success in solving water resources problems and the efficient management of its most complex water supply system serving a huge population under a unique situation of extreme crowdedness and shortage in land and water resources. Among those cities with large population in Asia, WSD’s performance has been considered exemplary and highly ranked by its counterparts. The Asian Development Bank has indeed recently picked the WSD as one of the six most successful and best managed public water utilities in Asian countries and a survey of them is being conducted with a view to identifying their strong points.
and to drawing up models and recommendations for the guidance of the less-efficient utilities in Asia.

6.3 There is, however, no cause for complacency and this Office notes that the WSD has a declared stance that it would continue to strive for improvement to the service they are responsible for providing to the people of Hong Kong. This Office has also identified several areas which need further consolidation for the purpose of preventing and minimizing the number of water main bursts in the territory.

RECOMMENDATIONS

6.4 On the fundamental problem of incomplete records of the water mains, it is a historical problem with no easy or immediate solution. Improvement to the situation should be pursued on a long term basis. As recommended by the HWR consultant, mains information and conditions should continue to be updated/enhanced through inspections of roadworks and of water main burst sites. The development of the AMP by a consultant which commenced in February 1996 should be a major step forward to resolve the fundamental but historical problem (see para. 4.34 - 4.35). Hopefully, with the AMP in place in the middle of 1997, the WSD would be able to carry out preventive maintenance and replacement of water mains in a more systematic and scientific manner and the problem of main bursts could be minimized accordingly.

6.5 This Office has the following recommendations for consideration by the Administration -

(I) Replacing Problematic Water Mains

(a) To critically monitor and perform continued assessment on the conditions of problematic mains and consider the need for applying for necessary funding from the Administration in preparation for rescheduling and advancing the respective mains replacement programmes where necessary (paras. 4.24 to 4.25).
(II) Strengthening Existing Preventive Measures

(b) To consider the need to renew and strengthen the efforts in educating and requiring roadworks contractors in following proper work practices to avoid damages to water mains in the light of the growing number of roadworks activities in the territory.

(c) To consider the feasibility of requiring the roadworks contractors to place an appropriate deposit against damages caused to government properties including water mains before granting excavation permits.

(d) To keep in view the manpower planning for the RITs to cope with the ever increasing roadworks activities. Where necessary, to formulate long term plans for roadworks inspections taking into account known large scale infra-structure construction and development activities in the future.

(e) To consider the feasibility of including in the excavation permit issued by the HyD the power for the WSD to stop roadworks which, if to continue, would cause serious damage to water mains (para. 5.8 II(e)).

(III) Taking Legal Action and Enhancing Deterrent Effect

(f) To step up prosecution action against offenders, in particular repeated offenders, causing damages to water mains.

(g) To review WSD's current policy regarding initiating prosecution action under Section 31 of the Waterworks Ordinance against persons causing damages to water mains on grounds of recklessness or even gross negligence, and to seek legal advice on the matter if necessary.

(h) To keep in view the proposal to revise the current level of the penalty (a maximum of
$5,000) provided in the Waterworks Ordinance.

(i) To consider the need for taking more civil actions, where necessary, for recovery of damages.

(j) To clarify the legal position regarding the applicability of the Crimes Ordinance in prosecuting persons causing damages to water mains for the offence of criminal damage and step up prosecution action as appropriate.
7

Final Remarks

COMMENTS FROM THE WSD

7.1 The conclusion of this report in paras. 6.1 to 6.3 is acceptable to the DWS. As regards the 10 recommendations in para. 6.5 for the prevention and reduction of the occurrence of bursting of water mains, this Office is pleased to note that they have all been accepted either in full or in principle by the DWS subject to details for implementation to be worked out. The DWS’s detailed responses to these recommendations are summarised below together with this Office’s final observations -

Recommendations (a)

(i) The DWS indicates no objection to the recommendation of critically monitoring and performing continued assessment on the conditions of problematic mains and of considering the need for applying for necessary funding from the Administration in preparation for re-scheduling and advancing the respective mains replacement programmes where necessary. He also makes the point that assessment of the conditions of all water mains and the replacement of ageing and problematic mains is already an on-going exercise of the WSD and that advancing any part of the main replacement programme will have to satisfy three main criteria, namely, fund availability, site practicability and engineering economics.

(ii) In relation to the case quoted in paras. 4.24 and 4.25 above (which is used as an example for illustrating the advanced laying of new water main or replacement of ‘questionable’ water main as a good and effective measure in preventing and minimizing main bursts), the DWS states that the advantage of advanced laying of new mains to replace
existing mains should not be too highly emphasised. The full views of the DWS are reproduced as follows -

"Firstly, the water mains in Lung Ping Road serving the complainants’ premises were laid in the late 60’s and early 80’s and cannot be regarded as aged mains. They served the consumers in the area for years without any problem until early 1995 when two major construction projects in the area commenced. A number of water supply interruptions suffered by the complainants were caused by damage by contractor working at Lung Cheung Road, a spot far away from the complainants’ premises, and the damage was subsequently repaired rather than replaced by new mains. The rest of the supply interruptions were all caused by the exceptionally heavy or even overloaded construction vehicles along Lung Ping Road. It should be noted that the new water mains, or the so-called ‘advanced’ mains laid, which resolved the problem in Lung Ping Road, were laid in time for the purpose of supplying the new large private development in the proximity. In conclusion, the incident in Lung Cheung Road is typically a damage case and not a problematic or ageing case and should not have resorted at the present stage to replacement by new water mains."

(iii) This Office has taken note of the fact that in many water mains bursts like the Lung Cheung Road/Lung Ping Road case, the real cause(s) of main bursts could not have easily been made known. There could have been a combination of several factors contributing to such bursts, e.g. the (combined) effect of the heavy traffic, indirect damages caused by nearby construction activities and/or ‘ageing’ water mains. In the case under discussion, the damaged water mains were laid as long ago as in the 1960s. Whilst such mains could not be regarded as ‘aged’ mains, they already had a life span of more than 25 years. Their relatively ‘advanced’ age, coupled with the effect of exceptionally heavy traffic nearby and perhaps other reasons, had certainly rendered the mains more vulnerable to damage and hence bursts. Therefore, it is an undeniable truth that timely replacement of ‘questionable’ water mains and/or laying of new and
stronger pipes is a good measure in preventing water mains bursts.

(iv) This Office is as prudent as the WSD about the necessity to commit public expenditure relating to any proposal of 'advanced' laying or replacement of mains. We therefore hope that with the development of the Asset Management Plan (paras. 4.34 and 4.35), the WSD would be able to make a more accurate and better professional judgement, amongst others, on the replacement of water mains in the most timely, cost-effective and scientific manner.

Recommendation (b)

(v) The DWS agrees to the recommendation of considering the need to renew and strengthen its efforts in educating the roadworks contractors in following proper work practices in order to avoid damages to water mains, and also considers that continued education to all parties is always necessary.

(vi) The DWS also states that the WSD's efforts in promoting the roadworks contractors' awareness of the need to protect water mains and the setting up of RITs go hand in hand and that there is no evidence that the former is not producing effect. To promote the awareness of the construction workers to care for underground utilities in the Hong Kong situations is as important and difficult as in the case of construction site safety to protect their own lives. Education is no doubt very useful and important but would require the global effort of the community and not just that of a Department. Notwithstanding this, the DWS pledges to continue to make efforts in educating the contractors and their workforce.

(vii) This Office acknowledges that the road to educating the roadworks contractors, whether in caring for underground utilities or in caring for construction site safety, is not a smooth one. Nevertheless, we are pleased to learn that the DWS undertakes to take the lead in making efforts in such a direction.
Recommendation (c)

(viii) The DWS agrees to, in consultation with the HyD, further examine the effectiveness and benefit of the recommendation of requiring the roadworks contractors to place an appropriate deposit against damages caused to water mains although he expresses the view that the government's interest is already well guarded by the provisions of relevant contract and permit conditions as far as indemnity is concerned. The WSD can recover the cost of damage and losses by other means as long as it can establish the contractor's liability for damaging water mains without requiring the roadworks contractors to place a deposit against damage caused to the government. Besides, the existing Crown Land Ordinance does not have the provision for demanding a deposit, the size of which is also difficult to determine.

(ix) This Office is content to leave this technical matter to the executive departments to further explore its feasibility for implementation having regard to the relevant legislative requirements and constraints.

Recommendation (d)

(x) The DWS states that review on the staff strength of the RITs is being carried out at regular intervals. Based on the review conducted in late 1994, the staff strength of RITs was doubled from 5 Assistant Waterworks Inspectors and 20 Works Supervisors II to 5 Waterworks Inspectors and 40 Works Supervisors. The WSD after the latest review of the situation as at 31.3.96 decided to continue with the practice and the scope of roadwork inspections. The DWS considers that expanding the strength of the RITs is not possible at the moment due to financial constraint under the system of fund bidding.

(xi) This Office is fully conscious of the implications of any recommendations necessitating the commitment of extra resources. Nonetheless, this Office trusts that the DWS would not dispute the need for keeping in view the manpower planning
of the RITs and for formulating long term plans to cope with ever increasing roadworks activities. Bidding of resources would, of course, be made only when it is considered justified and necessary following detailed and timely reviews.

Recommendation (e)

(xii) The DWS sees no objection to follow up on this recommendation by passing it to the HyD for consideration. He points out, however, that from the contract administration point of view, the act of stopping work by any party is a major issue with wide contractual implications. The current practice for the WSD to alert the engineer in charge of the roadworks/project to take appropriate action under the provision of the contract is considered most appropriate. He expresses concern that if the WSD is empowered to stop works of other contractors, other utility undertakers will seek similar power to protect their properties resulting in a large number of parties being involved in a roadworks contract leading to confusion and contractual implications.

(xiii) This Office fully appreciates the concern as expressed by the DWS over some of possibly less desirable effects connected with the implementation of this recommendation. His concern is both reasonable and legitimate. But in view of the need for developing a better system aimed at preventing damages to water mains, this Office is firmly of the opinion that the matter is worth pursuing by the Administration and is pleased to note that the DWS has agreed to refer the matter to the HyD for consideration.

Recommendation (f)

(xiv) The DWS states that the WSD has already stepped up prosecution against offenders causing damage to water mains and that two damage cases are being processed by the WSD’s Prosecution Unit against the concerned contractors causing damage to water mains. He opines that, in general, the number of cases of prosecution made must be judged by taking a balance between the amount of staff effort required, the
difficulties in collection of useful evidence, the legal opinion on the chance of a successful conviction and the magnitude of the resultant reward by the court.

(xv) For reasons given in para. 4.60 above, this Office considers it important and essential for the WSD to initiate more prosecution actions against repeated offenders. This Office has noted that for a number of reasons including the legal advice it received from the AGC (para. 4.57) and perhaps the difficulties in gathering sufficient evidence, the WSD has not initiated any prosecutions in the past years and that only two damage cases are at present being processed. This Office is of the view that more prosecution efforts should be made, where necessary, in order to achieve a better deterrent effect.

Recommendation (g)

(xvi) The DWS agrees to this recommendation but states that legal advice must be sought before considering reviewing the present practice. This Office concurs with the course of action proposed by the DWS.

Recommendation (h)

(xvii) The DWS sees no objection to continue to keep in view the proposal to revise the current level of the penalty provided in the Waterworks Ordinance.

Recommendation (i)

(xviii) Whilst indicating no objection to considering the need for taking more civil actions for the recovery of damages, the DWS considers it more efficient and effective to issue demand notes to the concerned parties to recover all the costs of damage and losses caused to water mains than to take civil action. Only when the parties concerned fail to settle the demand notes will the necessary legal actions be taken against them. The need for more or for less civil proceedings to recover damage cost
depends entirely on how the parties causing damage respond to such demand notes. Moreover, the compensation recovered through either method (i.e. issue of demand notes or civil actions) is full compensation of the cost of repair and losses.

(xix) This Office, whilst noting with pleasure the above comments from the DWS, wishes to emphasize its paramount concern that the Administration should not hesitate to take legal actions for the full recovery of damages and other costs from the responsible parties whenever necessary.

Recommendation (j)

(xx) The DWS undertakes to seek legal opinions on the possible application of the Crimes Ordinance in prosecuting persons causing damages to water mains for the offence of criminal damage.

7.2 This Office has carefully considered the comments made by the WSD and considers that there is no need for any changes to be made to our conclusion and recommendations in Chapter 6.

EPILOGUE

7.3 This Office is pleased to learn that the conclusion of this report and, on the whole, all the recommendations are acceptable to the DWS. It should be mentioned, in particular, that this Office is as cautious and prudent as the WSD about making any proposal of an untimely or premature replacement of water mains as a preventive measure to resolve the problem of water mains bursts in the territory. Replacement of water mains should be planned and carried out on a timely and cost-effective basis and should not be taken as the only solution to the problem. As we have recommended in this report, the Administration should devote more resources to the formulation of other more effective preventive measures and strategies which do not necessarily require the commitment of large public funds.

7.4 The problem of water mains bursts has already been a matter of public concern because of the various inconveniences and hefty economical costs it may cause to
our community as a whole. The Administration should therefore continue to work out the best possible strategies to prevent the occurrence of water main bursts in order to minimize such inconveniences and social costs to the least possible extent. It also remains the responsibility of the Administration to keep every aspect of the overall preventive measures and plans under constant review in order to achieve the same purposes.

7.5 Lastly, this Office would like to be kept informed by the Administration in due course on the implementation of the 10 recommendations and any major changes in the policy of the water supply system in Hong Kong.

----- End -----

Office of the Commissioner for Administrative Complaints
Ref: CAC/WP/14/1 S.F. 9 Pt. II
September 1996
ANNEXES
### Length of Water Mains Broken Down by Types of Supply and Pipe Materials

<table>
<thead>
<tr>
<th>Pipe Materials</th>
<th>Cumulative total length of water mains as at 31.3.96 (km)</th>
<th>Percentage of sub-total out of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fresh Water</td>
<td>Salt Water</td>
</tr>
<tr>
<td>GI</td>
<td>709.5</td>
<td>4.9</td>
</tr>
<tr>
<td>CI</td>
<td>3.2</td>
<td>1.5</td>
</tr>
<tr>
<td>DI</td>
<td>644.3</td>
<td>248.5</td>
</tr>
<tr>
<td>AC</td>
<td>131.7</td>
<td>37.4</td>
</tr>
<tr>
<td>MS</td>
<td>367.0</td>
<td>51.9</td>
</tr>
<tr>
<td>uPVC</td>
<td>68.8</td>
<td>87.2</td>
</tr>
<tr>
<td>GRP</td>
<td>10.2</td>
<td>0</td>
</tr>
<tr>
<td>Others</td>
<td>14.8</td>
<td>0.3</td>
</tr>
<tr>
<td>Unknown</td>
<td>2653.8</td>
<td>620.9</td>
</tr>
<tr>
<td><strong>Total =</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Statistics of Main Bursts broken down (a) by Size of Main; and (b) by Radio Announcement Made

(1990/91 - 1995/96)

<table>
<thead>
<tr>
<th>Financial Year</th>
<th>Period</th>
<th>Fresh Water &amp; Salt Water Main Bursts</th>
<th>Radio Announcement Made (Bursts affecting supply in large area)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Diameter(Dia.) of Main</td>
<td>Total</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not exceeding 300 mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>% Total</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>% Total</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>% Total</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sub-total</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>% Total</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No. of such cases</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>% Total</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(No) (A1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(%) (A2=A1*100/A7)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(No) (A3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>% Total</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>% Total</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>% Total</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(No) (A5)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(A4=A3*100/A7)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(No) (A7)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(B1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>% Total</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(B2=B1*100/A7)</td>
<td></td>
</tr>
<tr>
<td>90/91</td>
<td>1/4/90 - 31/3/91</td>
<td>736 (% 69.7%)</td>
<td>270 (25.6%)</td>
</tr>
<tr>
<td>91/92</td>
<td>1/4/91 - 31/3/92</td>
<td>773 (% 67.7%)</td>
<td>303 (26.6%)</td>
</tr>
<tr>
<td>92/93</td>
<td>1/4/92 - 31/3/93</td>
<td>868 (% 72.2%)</td>
<td>290 (24.1%)</td>
</tr>
<tr>
<td>93/94</td>
<td>1/4/93 - 31/3/94</td>
<td>793 (% 71.6%)</td>
<td>263 (23.7%)</td>
</tr>
<tr>
<td>94/95</td>
<td>1/4/94 - 31/3/95</td>
<td>746 (% 75.1%)</td>
<td>197 (19.8%)</td>
</tr>
<tr>
<td>95/96</td>
<td>1/4/95 - 31/3/96</td>
<td>964 (% 73.4%)</td>
<td>297 (22.6%)</td>
</tr>
<tr>
<td>Past 6 Financial Years ending 31/3/96</td>
<td>Yearly Average</td>
<td>813 (% 71.6%)</td>
<td>270 (24.5%)</td>
</tr>
</tbody>
</table>

Notes: (1) Main bursts refer to those main bursts repaired by WSD Term Contractors
### Statistics of Main Bursts broken down by “Types of Pipe Materials”

(1990/91 - 1995/96)

<table>
<thead>
<tr>
<th>Financial Year</th>
<th>Period</th>
<th>AC</th>
<th>% Total</th>
<th>No</th>
<th>% Total</th>
<th>No</th>
<th>% Total</th>
<th>No</th>
<th>% Total</th>
<th>No</th>
<th>% Total</th>
<th>No</th>
<th>% Total</th>
<th>No</th>
<th>% Total</th>
<th>No</th>
<th>% Total</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4/90 - 31/3/91</td>
<td>458</td>
<td>43.4%</td>
<td>164</td>
<td>15.5%</td>
<td>46</td>
<td>4.4%</td>
<td>154</td>
<td>14.6%</td>
<td>19</td>
<td>1.8%</td>
<td>193</td>
<td>18.3%</td>
<td>22</td>
<td>2.1%</td>
<td>1056</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/4/91 - 31/3/92</td>
<td>504</td>
<td>44.2%</td>
<td>178</td>
<td>15.6%</td>
<td>33</td>
<td>2.9%</td>
<td>146</td>
<td>12.8%</td>
<td>15</td>
<td>1.3%</td>
<td>230</td>
<td>20.2%</td>
<td>35</td>
<td>3.1%</td>
<td>1141</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/4/92 - 31/3/93</td>
<td>538</td>
<td>44.8%</td>
<td>153</td>
<td>12.7%</td>
<td>31</td>
<td>2.6%</td>
<td>165</td>
<td>13.7%</td>
<td>17</td>
<td>1.4%</td>
<td>268</td>
<td>22.3%</td>
<td>30</td>
<td>2.5%</td>
<td>1202</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/4/93 - 31/3/94</td>
<td>468</td>
<td>42.2%</td>
<td>106</td>
<td>9.6%</td>
<td>31</td>
<td>2.8%</td>
<td>173</td>
<td>15.6%</td>
<td>21</td>
<td>1.9%</td>
<td>236</td>
<td>21.3%</td>
<td>73</td>
<td>6.6%</td>
<td>1108</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/4/94 - 31/3/95</td>
<td>420</td>
<td>42.3%</td>
<td>92</td>
<td>9.3%</td>
<td>39</td>
<td>3.9%</td>
<td>146</td>
<td>14.7%</td>
<td>21</td>
<td>2.1%</td>
<td>234</td>
<td>23.6%</td>
<td>41</td>
<td>4.1%</td>
<td>993</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/4/95 - 31/3/96</td>
<td>522</td>
<td>39.8%</td>
<td>136</td>
<td>10.4%</td>
<td>52</td>
<td>4.0%</td>
<td>248</td>
<td>18.9%</td>
<td>18</td>
<td>1.4%</td>
<td>299</td>
<td>22.8%</td>
<td>38</td>
<td>2.9%</td>
<td>1313</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yearly Average</td>
<td>485</td>
<td>42.7%</td>
<td>139</td>
<td>12.2%</td>
<td>41</td>
<td>3.6%</td>
<td>172</td>
<td>15.2%</td>
<td>19</td>
<td>1.7%</td>
<td>243</td>
<td>21.4%</td>
<td>40</td>
<td>3.5%</td>
<td>1135</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
1. Main Bursts refer to those main bursts repaired by WSD Term Contractors.
## Statistics of Main Bursts broken down by “Causes of Bursts”
(1990/91 - 1995/96)

<table>
<thead>
<tr>
<th>Financial Year</th>
<th>Period</th>
<th>Category ‘A’ Cases Not Due to External Disturbances</th>
<th>Category ‘B’ Cases Due to External Disturbances</th>
<th>Sub-total</th>
<th>Total (Due to All reasons)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No.</td>
<td>% Total</td>
<td>No.</td>
<td>% Total</td>
</tr>
<tr>
<td>90/91</td>
<td>1/4/90 - 31/3/91</td>
<td>140</td>
<td>13.3%</td>
<td>360</td>
<td>34.1%</td>
</tr>
<tr>
<td>91/92</td>
<td>1/4/91 - 31/3/92</td>
<td>213</td>
<td>18.7%</td>
<td>425</td>
<td>37.2%</td>
</tr>
<tr>
<td>92/93</td>
<td>1/4/92- 31/3/93</td>
<td>231</td>
<td>19.2%</td>
<td>346</td>
<td>28.8%</td>
</tr>
<tr>
<td>93/94</td>
<td>1/4/93 - 31/3/94</td>
<td>197</td>
<td>17.8%</td>
<td>293</td>
<td>26.4%</td>
</tr>
<tr>
<td>94/95</td>
<td>1/4/94 - 31/3/95</td>
<td>203</td>
<td>20.6%</td>
<td>227</td>
<td>22.9%</td>
</tr>
<tr>
<td>95/96</td>
<td>1/4/95 - 31/3/96</td>
<td>317</td>
<td>34.1%</td>
<td>257</td>
<td>19.6%</td>
</tr>
<tr>
<td>Past 6 Financial Years ending 31/3/96</td>
<td>Yearly Average</td>
<td>217</td>
<td>19.1%</td>
<td>318</td>
<td>28.0%</td>
</tr>
</tbody>
</table>

Notes:
1. Main Bursts refer to those main bursts repaired by WSD Term Contractors.
2. Causes of Bursts:
   - C1 - Erosion (worn by water jets)
   - C2 - Corrosion
   - C3 - Faulty material
   - C4 - Faulty workmanship
   - C5 - Settlement/upheaval of ground
   - C6 - Ground vibration due to traffic/pilling/blasting
   - C7 - Shallow cover
   - C8 - Excessive external loading
   - C9 - Disturbance of anchor/thrust block or supporting pier
   - C10 - Damaged by construction activities or others
   - C11 - Other
Statistics of Rate of Main Bursts per kilometer of Water Mains
(1990/91 - 1995/96)

<table>
<thead>
<tr>
<th>Financial Year</th>
<th>Period</th>
<th>Accumulated Total Length of Water Mains Laid as at End of Period</th>
<th>No. of Main Bursts</th>
<th>Rate of Main Bursts per year per km of Water Mains</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Fresh Water (km) (A1)</td>
<td>Salt Water (km) (A2)</td>
<td>Total (km) (A3=A1+A2)</td>
</tr>
<tr>
<td>90/91</td>
<td>1/4/90 - 31/3/91</td>
<td>3993</td>
<td>897</td>
<td>4890</td>
</tr>
<tr>
<td>91/92</td>
<td>1/4/91 - 31/3/92</td>
<td>4182</td>
<td>950</td>
<td>5132</td>
</tr>
<tr>
<td>92/93</td>
<td>1/4/92 - 31/3/93</td>
<td>4306</td>
<td>979</td>
<td>5285</td>
</tr>
<tr>
<td>93/94</td>
<td>1/4/93 - 31/3/94</td>
<td>4384</td>
<td>1001</td>
<td>5385</td>
</tr>
<tr>
<td>94/95</td>
<td>1/4/94 - 31/3/95</td>
<td>4490</td>
<td>1028</td>
<td>5518</td>
</tr>
<tr>
<td>95/96</td>
<td>1/4/95 - 31/3/96</td>
<td>4603</td>
<td>1053</td>
<td>5656</td>
</tr>
<tr>
<td></td>
<td>Post 6 Financial Years ending 31/3/96</td>
<td>Yearly Average</td>
<td>604 (53.2%)</td>
<td>531 (46.8%)</td>
</tr>
</tbody>
</table>

Notes:
(1) Main Bursts refer to those main bursts repaired by WSD Term Contractors.
(2) ( ) The figure in bracket denotes the % of main bursts out of the Total main bursts
Annex 4.1

Composition and Terms of Reference of the Inter-Departmental Working Group on Prevention of Damage to Water Mains

Composition

Chairman : Assistant Director/Supply & Distribution(1), WSD

Members : Regional Highway Engineer/Kowloon, HyD
          Senior Engineer/Contract Adviser 1, HyD
          Senior Engineer/Utilities, HyD
          Chief Engineer/Mainland South East, WSD
          Chief Engineer/Regional Administration, WSD
          Senior Engineer/Construction(2), WSD
          Senior Engineer/Regional Administration(4), WSD (Secretary)

Terms of Reference

(a) To review adequacy of provisions in contract conditions and specifications for construction works in safeguarding against damage to underground water mains and in establishing liability in the event of damage.

(b) To review working procedures in using heavy construction plant in construction works which may cause damage to underground water mains.

(c) To review the adequacy of the existing control on construction works relating to site supervision and working procedures to prevent damage to water mains.

(d) To examine other external factors contributing to damage to water mains.

(e) To establish procedures for notification, investigation and recording of main burst incidents.

(f) In respect of (a) - (e), to examine and recommend improvement with a view to minimising incidents of damage to water mains due to the construction activities and to assess the resources required to implement such recommendation.
<table>
<thead>
<tr>
<th>Item No.</th>
<th>Recommendation</th>
<th>Action to be taken</th>
<th>Responsible Officer for initiating action</th>
<th>Situation as at 1.1.1996</th>
<th>File Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vigilance to prevent water main damage (para. 7.2.1)</td>
<td>- Prepare papers for the creation of posts initially for 5 AWWIs, 20 WSIs and 5 Motor Drivers and the acquisition of 5 medium vans.</td>
<td>ADS&amp;D(I)</td>
<td>Action completed.</td>
<td>WWO 1/12/1759/92 II</td>
</tr>
<tr>
<td>2</td>
<td>To assess the ultimate strength requirement of the WSD Inspection Team set up.</td>
<td>- Assess ultimate strength requirement in the light of practical experience.</td>
<td>ADS&amp;D(I)</td>
<td>Action completed.</td>
<td>(76) in WWO 1/12/1759/92 II</td>
</tr>
<tr>
<td><strong>3</strong></td>
<td>Legal proceeding and Waterworks Ordinance (para. 7.2.2 - 7.2.4)</td>
<td>- Revise DI 815 to incorporate such requirement and take appropriate action for criminal and civil proceedings as necessary.</td>
<td>CE/RA</td>
<td>Guidance Notes on the evidence required to be collected for taking legal action was issued in Sept. 95 for Regional staffs reference. HK Region had referred one legal proceeding case to the Prosecution Unit (PU) for advice. MSE Region had also identified one case, which would be brought forward to PU after preparation of the necessary documents.</td>
<td>(49) in WWO 1/12/1759/92 II</td>
</tr>
<tr>
<td>4</td>
<td>To consult Legal Department on prosecution procedure and how to assemble evidence and proof.</td>
<td>- Seek Legal Department's advice.</td>
<td>CE/RA</td>
<td>Action completed.</td>
<td>WWO 1/12/1759/92 II</td>
</tr>
<tr>
<td>5</td>
<td>To review the maximum fine for damage to waterworks imposed under the Waterworks Ordinance</td>
<td>- Review the maximum fine for damage to waterworks in conjunction with the penalties for other offences under the Waterworks Ordinance.</td>
<td>CE/RA</td>
<td>The 1st draft of the resolution for the revision of fines in the Waterworks Ordinance prepared by AGC had been agreed by Works Branch in Mar. 95. The maximum fine for damage to waterworks installations under Section 35(1) of the Waterworks Ordinance was to be revised from $5,000 to $25,000 on Level 4 of standard scale of fines.</td>
<td>(4), (6) &amp; (7) in WWO 1/12/1759/92 II</td>
</tr>
<tr>
<td><strong>6</strong></td>
<td>Training of WSD Staff (para. 7.2.5 - 7.2.6)</td>
<td>- Organize in-house training course.</td>
<td>SE/T</td>
<td>Two in-house seminars and four training courses on &quot;Prevention of Damage to Water Mains&quot; would be conducted in Jan. 96 for WWIs, AWWIs and WSIs in the Construction Division. Refresher course for Inspection Teams of Regions would be conducted in Mar./Apr. 96.</td>
<td>(60) &amp; (72) in WWO 1/12/1759/92 II</td>
</tr>
</tbody>
</table>

Note: * indicate required action completed
** Item requires routine action
Situation Report as at 1.1.1996
for recommended actions stipulated in
Report on Prevention of Damage to Water Mains

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Recommendation</th>
<th>Action to be taken</th>
<th>Responsible Officer for Initiating action</th>
<th>Situation as at 1.1.1996</th>
<th>File Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>9</strong></td>
<td>To organize periodic briefing to staff handling main bursts</td>
<td>Organize periodic briefing, get staffs feedback and send it to SET for consolidation and future training</td>
<td>CE/Regions SET</td>
<td>Periodic briefing were continuously conducted in the Regions No feedback had been received by SET so far</td>
<td>(67), (68), (70) - (72) &amp; (74) in WWO 1/12/1759/92 II</td>
</tr>
<tr>
<td><strong>10</strong></td>
<td>To build up a record with photographs showing the bad practice of Contractors and have it circulated internally for training of WSD technical staff</td>
<td>Arrange taking of photographs during routine inspection of the trench work and incident of damage and maintain record of photographs for reference and training purpose</td>
<td>CE/Regions SET</td>
<td>Record of photographs were continued to be taken and being maintained and circulated by Regions Photographs had been received from CE/MNW &amp; CE/HK which were then used in the training course mentioned in item No 6 They will also be used in future training courses</td>
<td>(67), (68), (70) - (72) &amp; (74) in WWO 1/12/1759/92 II</td>
</tr>
<tr>
<td><strong>11</strong></td>
<td>Liaison with other parties (para 72.1 - 72.11)</td>
<td>Prepare pamphlet and Guidelines</td>
<td>CE/RA</td>
<td>Action completed</td>
<td>WWO 1/1759/991</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Liaise with utility Companies and Government Departments on the nos. of copies of Guidelines required</td>
<td>CE/RA</td>
<td>Action completed</td>
<td>WWO 1/1759/991</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arrange printing and distribution of the Guidelines</td>
<td>CE/Regions</td>
<td>WSD requirements were stipulated in land circulations and replies to utility enquiries as a standard practice The concerned parties were reminded by WSD inspection teams to adhere to the requirements</td>
<td>(67), (68), (70) - (72) &amp; (71) in WWO 1/12/1759/92 II</td>
</tr>
<tr>
<td><strong>11</strong></td>
<td>To remind parties concerned to adhere to the WSD requirements strictly during the blasting and piling operation near water mains</td>
<td>Include WSD requirements on blasting and/or piling operation near water mains in land circulations and replies to ensure on existing waterworks installations</td>
<td>CE/Regions</td>
<td>WSD requirements were stipulated in land circulations and replies to utility enquiries as a standard practice The concerned parties were reminded by WSD inspection teams to adhere to the requirements</td>
<td>(67), (68), (70) - (72) &amp; (71) in WWO 1/12/1759/92 II</td>
</tr>
<tr>
<td><strong>11</strong></td>
<td>GEO and BOO to ensure that adequate temporary protection work be provided and dewatering be kept to a minimum</td>
<td>Formulate measures with GEO and BOO to ensure that adequate monitoring and temporary protection works be provided and dewatering be kept to a minimum for construction sites near water mains</td>
<td>CE/MSE (compile list)</td>
<td>Close liaison with GEO and BOO were maintained to monitor the temporary protection works provided to water mains affected by deep basement excavation</td>
<td>(71) in WWO 1/12/1759/92 II</td>
</tr>
<tr>
<td><strong>12</strong></td>
<td>To produce a list of main burst incidents caused by road work, trench work and building contractors, and submit to the Road Opening Coordinating Committee (ROCC) and Utilities Technical Liaison Committee (UTIC) for distribution to all concerned parties</td>
<td>Collect, compile and distribute list of mains burst incidents caused by others to UTIC and ROCC members</td>
<td>CE/MSE (compile list)</td>
<td>List of main burst incidents caused by others had been prepared and circulated on a monthly basis The format had been revised to include the clients of the contractors causing damage</td>
<td>(74) in WWO 1/12/1759/92 II</td>
</tr>
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<td>*13.</td>
<td>To inform individually the client/client department of the contractor causing the main burst so that they will be alerted to take whatever action to prevent their contractor to commit similar offence.</td>
<td>Review DI 855 to incorporate such requirement.</td>
<td>CE/RA</td>
<td>Action completed.</td>
<td>WWO 2/1003/69 IV</td>
</tr>
<tr>
<td></td>
<td><strong>Water mains in footpath</strong> <em>(para. 7.2.13)</em></td>
<td></td>
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<tr>
<td>*14.</td>
<td>To lay water mains beneath footpath in industrial areas with soil cover comparable to those under carriageway.</td>
<td>Revise Manual of Mainlaying Practice.</td>
<td>CE/Des</td>
<td>Action completed.</td>
<td>WWO 1/12/1759/92</td>
</tr>
<tr>
<td></td>
<td><strong>WSD main burst record</strong> <em>(para. 7.2.13 - 7.12.14)</em></td>
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<td>15.</td>
<td>To subdivide WSD record to damage under C10 in the computer main burst report into 3 different items as follows:</td>
<td>- Revised computer Main Burst report and its associated computer programme.</td>
<td>CE/MSE</td>
<td></td>
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<tr>
<td></td>
<td>(i) Damaged by building activities.</td>
<td>- To update DI 802 and 901.</td>
<td>CE/RA</td>
<td></td>
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<td></td>
<td>(ii) Damaged by road work;</td>
<td></td>
<td></td>
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<td></td>
<td>(iii) Damaged by utilities trench works.</td>
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<tr>
<td>16.</td>
<td>To record multiple causes of the main burst incident (each responsible for part of the incident) instead of a single cause entry.</td>
<td>Revise DI 802 &amp; 901.</td>
<td>CE/RA</td>
<td></td>
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<td></td>
<td></td>
<td>Modify computer programme to cater for such data entry and analysis.</td>
<td>CE/MSE SE/CpS</td>
<td></td>
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### Situation Report as at 1.1.1996

**for recommended actions stipulated in**

**Report on Prevention of Damage to Water Mains**

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| **17**  | **Contract administration and site supervision**  
(Para 7.2.15 -7.2.16)  
All relevant Government departments and utility undertakers to remind their site supervisory staff of the importance of good compaction in backfilling trenches | Include the compaction requirements in the Guidelines for Excavation near Watermains and remind, where appropriate, Government Departments and utility undertakers of such requirements | CE/RA / CE/Regions | Government departments and utilities had been reminded of the compaction requirements in the Guidelines for Excavation near Watermains  
Verbal reminders were also given on site by the Inspection Team and where necessary further confirmed in writing by the concerned WSD engineers | (68) (71) & (74) in WWO 1/12/1759/92 II |
| **18**  | **Revision of Conditions of Permit and government contract specifications**  
(Para 7.2.17 -7.2.21)  
The staff of HyD to draw the particular attention of utility undertakers to the need to lower or divert or protect their installations as a result of lowering of road levels or converting footpaths to carriageways | Request HyD to instruct their staff to notify WSD the need to lower, divert or protect the waterworks installations as a result of road works | CE/RA | HyD informed that all their staff involved in road works had been instructed as required | (62) & (75) in WWO 1/12/1759/92 II |
| **19**  | **Revision of Conditions of Permit and government contract specifications**  
(Para 7.2.17 -7.2.21)  
Standard working procedures in the vicinity of water mains be incorporated in the contract specifications and excavation permit conditions | CF/Des to initiate action to incorporate such procedures in the Works Branch Standard Contract Document  
Request HyD to include such procedures in the Conditions of Permit | CE/RA / C/D/Des | Action completed | (4) (6) & (38) in WWO 1/12/1759/92 II |
| **20**  | **Before using mechanical plant near utility services the contractor be required to submit trial hole proposals to the Engineer** | Initiate action to incorporate the requirement in the Works Branch Standard Contract Document | CE/RA | Action completed | |
| **21**  | **Requirements to pay government the cost of indirect consequences be added in Clause 14(b) of HyD Conditions of Permit** | Request HyD to revise Conditions of Permit | CE/RA | Action completed | WWO 1/12/1759/92 II |
| **22**  | **The requirement for trial hole be included in Conditions of Permit issued by HyD** | do | CE/RA | Action completed | WWO 1/12/1759/92 II |
| **23**  | **Clause 12 and 13 of Conditions of Permit issued by BLD be modified to similar workings as Clause 7 of that issued by HyD** | Request BLD to modify clause 12 and 13 of BLD Conditions of Permit | CE/RA | Action completed | WWO 1/12/1759/92 II |
The Situation Report as at 1.1.1996 for recommended actions stipulated in Report on Prevention of Damage to Water Mains

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<tr>
<td>*24.</td>
<td>Adoption of Government contract requirements by utility companies (para. 7.2.22)</td>
<td>- Request HD to urge the utility companies in UTLC to adopt similar Government standard contract conditions and specifications.</td>
<td>CE/RA</td>
<td>Feedback from some utility companies indicated that similar contract conditions and specifications for care of works and utility services have already been incorporated in their contracts with their own contractors and HD's Excavation Permit. HD hence considered that no further action would be required for this item.</td>
<td>(62) &amp; (75) in WWO 1/12/1759/92 II</td>
</tr>
<tr>
<td>*25.</td>
<td>Revision of Crown Land Ordinance (para. 7.2.23)</td>
<td>- Request HD to revise the Crown Land Ordinance.</td>
<td>CE/RA</td>
<td>Action completed.</td>
<td>(2) &amp; (35) in WWO 1/12/1759/92 II</td>
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<td></td>
<td>Works Branch Technical Circular (para. 7.2.24 - 7.2.25)</td>
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<tr>
<td>*26.</td>
<td>A Works Branch Technical Circular be issued requiring:</td>
<td></td>
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<tr>
<td></td>
<td>*(a) Works Department to remind the project engineers to ensure that their contractors have taken due care in protecting existing mains and that adequate and experienced supervising site personnel are provided on site.</td>
<td>Initiate action in Works Branch JDD and Draft Works Branch Technical Circular for the consideration of Works Branch.</td>
<td>SE/CA, WSD</td>
<td>Action completed.</td>
<td>(45) &amp; (52) in WWO 1/12/1759/92 &amp; (23) in Pt. II</td>
</tr>
<tr>
<td></td>
<td>*(b) Works Department to reflect the performance of the contractor in the protection of utilities in the contractors' confidential report.</td>
<td></td>
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</tbody>
</table>

The Contractor's Performance Report prepared by the CONREC Committee, which requires reporting on the contractor's performance in regard to "care of utilities", had been promulgated. WSD's concerns and requirements in this regard was considered to have been adequately provided for. (23), (41), (50) & (69) in WWO 1/12/1759/92 II
**Situation Report as at 1.1.1996**  
for recommended actions stipulated in Report on Prevention of Damage to Water Mains

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<tr>
<td><strong>27.</strong></td>
<td>The requirements in the Works Branch Technical circular on urban Tree Planting be made known to all parties concerned with tree planting adjacent to existing water mains.</td>
<td>Stipulate clearance requirement and incorporate in the proposed Works Branch Technical Circular on urban Tree Planting, Incorporate requirements in D.I. and make known to other parties such as USD and AFD.</td>
<td>CE/RA CE/Region</td>
<td>The requirement was included in the updated DI 810 and all parties concerned including USD/RSD and AFD will be advised to follow the requirements by the Regional staff handling land case and tree planting matters.</td>
<td>(9) &amp; (11) in WWO 1/12/1759/92 II</td>
</tr>
<tr>
<td>28.</td>
<td>Upgrading of information system (para. 7.26 - 7.27)</td>
<td>To continue the work of existing Working Group on Land Information System and to pursue the issue in an active manner.</td>
<td>CE/MSE SE/CpS</td>
<td>As the project for digitization of watermains record plans was approved by the Finance Committee and a number of consultants were short-listed for invitation of technical proposal, feasibility study of a GIS in WSD will be deferred after the completion of the pilot scheme of the digitization project by end of 1996.</td>
<td>(73) in WWO 1/12/1759/92 II</td>
</tr>
<tr>
<td>29.</td>
<td>Computerized land information system should be actively pursued to provide convenient access to information on existing water mains in greater details.</td>
<td>Methods be explored to facilitate locating underground water mains on site before digging trial holes.</td>
<td>Deploy consultant to conduct study.</td>
<td>Final report submitted by the Consultant. This item was included as Item 31 in the action plan. A paper on review of available means for detecting and identifying buried water mains was prepared and submitted for the management's consideration.</td>
<td>(73) in WWO 1/12/1759/92 II</td>
</tr>
</tbody>
</table>
## PIPE BURST PROBLEMS IN THE FRESH AND FLUSHING WATER SYSTEMS OPERATED BY WSD

### ACTION PLAN FOR IMPLEMENTATION OF RECOMMENDATIONS OF

#### HIGH PRIORITY

**Situation Report as at 30.4.96**

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<tr>
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<tbody>
<tr>
<td>1</td>
<td>Mains Failure Records (Section 5.1) To make data available for analysis on the past performance of pipelines so as to facilitate identification of failure causes and measures to minimise them.</td>
<td></td>
<td>- The &quot;Working Group on Implementation of Items Related to Main Burst Computer Programme&quot; was set up to handle Items 1.1 to 1.7. - The group has met five times.</td>
<td>CE/MSE as Chairman</td>
</tr>
<tr>
<td>1.1</td>
<td>To transfer as much of the judgement to Engineers as possible.</td>
<td>a) To review the existing procedures, division of responsibility and resources in handling mains failure.</td>
<td>Completed</td>
<td>CE/MSE</td>
</tr>
<tr>
<td>1.2</td>
<td>To include in the record forms additional information for discrimination between pipe and joint, reporting of unusual but relevant factors, developing communication with other interested parties and providing structured feedback about the observed condition of pipelines at burst sites.</td>
<td>a) To review and modify the current format for reporting main bursts.</td>
<td></td>
<td>SE/CpS</td>
</tr>
<tr>
<td>1.3</td>
<td>To combine mains and submains databases for analysis.</td>
<td>a) To define the common data fields in the two databases required to be analysed as a whole and to eliminate any inconsistency in data entry b) To modify existing computer programme.</td>
<td></td>
<td>SE/CpS</td>
</tr>
<tr>
<td>1.4</td>
<td>To establish a more structured procedure for using the mains burst records to improve the existing standard of mains records.</td>
<td>a) To set up procedure of reviewing the failure records to update the mains record plan if necessary.</td>
<td></td>
<td>SE/CpS</td>
</tr>
</tbody>
</table>
# HIGH PRIORITY

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</table>
| 1.5     | To improve the existing computer programme aiming at more efficient data storage and more user friendly interface | a) To define requirements for performance monitoring and technical analysis.  
   b) To design data entry and output format.  
   c) To modify existing computer programmes and develop additional ones to meet the requirements.  
   d) To carry out regular reviews.  
   e) To provide continuous support in computer programme updating. | - To be incorporated in the new main burst computer programme under preparation by CpS unit.  
   - Scheduled date of completion: July 96. | SE/CpS |
| 1.6     | To introduce a 'quality assurance' system.                                       | a) To define the items to be put under the 'quality assurance system'.  
   b) To review existing procedures and resources and develop check lists and procedures for the 'quality assurance system'. | - Passed to CpS Unit for incorporation in the computer programme. | CE/MSE |
| 1.7     | To prepare guidance manuals and training to staff for proper recording of data.  | a) To define training requirements.  
   b) To compile training materials.  
   c) To produce visual aids for training purposes.  
   d) To arrange training courses.  
   e) To produce manuals to assist staff in recording data. | - Completed  
   - Completed  
   - Completed  
   - On-going  
   - Completed | CE/MSE SE/T |
| 3.1     | To develop procedures for improving the communication of mains position to Contractors (para. 5.3.1). | a) To review the available means of detecting and identifying buried watermains. | - A paper on review of available means of detecting and identifying buried watermains was prepared. | CE/RA |
## PIPE BURST PROBLEMS IN THE FRESH AND FLUSHING WATER SYSTEMS OPERATED BY WSD

**ACTION PLAN FOR IMPLEMENTATION OF RECOMMENDATIONS OF HIGH PRIORITY**

**Situation Report as at 30.4.96**

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<tr>
<td>3.5</td>
<td>To ensure efficient and reliable operation of valves at all times for limiting the damage arising from bursts (para. 5.3.5).</td>
<td>a) To review and improve the current system and procedure of valve exercise and maintenance which should be accorded a high priority. &lt;br&gt; b) To propose and implement a system for effective monitoring.</td>
<td>) Regions were instructed to incorporate a full list of essential valves in Red &amp; Pink Routes, including the schedules for exercising and maintenance of such valves, in their own Regional Reference Book for their staff's reference and action.</td>
<td>CE/RA CE/Regions</td>
</tr>
<tr>
<td>4.0</td>
<td>Investment Poling &amp; Materials Selection (Section 5.4).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.4</td>
<td>To prohibit the use of uPVC pipe in chemically contaminated ground and industrial area (para. 5.4.1).</td>
<td>a) To identify where uPVC pipe shall be prohibited and draw up guidelines for its adoption.</td>
<td>Being reviewed.</td>
<td>CE/MSE</td>
</tr>
<tr>
<td>4.8</td>
<td>To develop Asset Management Plans (AMP) which should include long term investment plan to replace pipeline of materials in vulnerable locations and of G.I. in general (para. 5.4.5).</td>
<td>a) To study on the proposal and provide recommendations for the Management's consideration.</td>
<td>AMP was being developed by the consultant.</td>
<td>AD/S&amp;D(1)</td>
</tr>
</tbody>
</table>
## PIPE BURST PROBLEMS IN THE FRESH AND FLUSHING WATER SYSTEMS OPERATED BY WSD

### ACTION PLAN FOR IMPLEMENTATION OF RECOMMENDATIONS OF MEDIUM PRIORITY

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<tbody>
<tr>
<td>3.1</td>
<td>3.1 Damage Prevention (Section 5.3)</td>
<td>c) To implement GIS to facilitate record updating and exchange of information.</td>
<td>CpS Unit is working on the GIS system which is expected to be completed by the turn of the century.</td>
<td>To be considered in conjunction with the establishment of the GIS which is being undertaken by the CpS Unit.</td>
</tr>
<tr>
<td>3.3</td>
<td>3.3 To develop procedures for improving the communication of mains position to Contractors (para. 5.3.1).</td>
<td>a) To consider the wider usage of MDPE/HDPE pipe material (para. 5.4.3).</td>
<td>Study completed, and trial laying of MDPE pipe in village area was arranged.</td>
<td>CE/RA</td>
</tr>
<tr>
<td>3.4</td>
<td>3.4 To adopt trenchless techniques for pipe installation if possible (para. 5.3.3).</td>
<td>a) To conduct Study on the proposal and provide recommendations for the Management's consideration.</td>
<td>Study revealed that the joint is of proprietary design and its use is limited and may not be feasible under the current government tendering procedures. A review can be made after more offers from the market are available.</td>
<td>CE/RA in conjunction with CE/Des</td>
</tr>
<tr>
<td>4.6</td>
<td>4.6 To consider utilisation of self-anchoring joints in lieu of thrust or anchor blocks, particularly in congested area (para. 5.3.4).</td>
<td>a) To conduct Study on the merit of trenchless techniques under various circumstances and provide recommendations for the Management's consideration.</td>
<td>Study completed, and trial laying of MDPE pipe in village area was arranged.</td>
<td>CE/RA</td>
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</table>

**Situation as at 30.4.96**

- CpS Unit is working on the GIS system which is expected to be completed by the turn of the century.
- The study group found that trenchless technology had very limited applications for pipe installation, owing to high construction cost, lack of accurate records of existing utilities, difficulties in making tee connections and subsequent maintenance.
- Study revealed that the joint is of proprietary design and its use is limited and may not be feasible under the current government tendering procedures. A review can be made after more offers from the market are available.
- Study completed, and trial laying of MDPE pipe in village area was arranged.
**M2**

Pipe burst problems in the fresh and flushing water systems operated by WSP

**Action Plan for implementation of recommendations of**

**Medium Priority**

**Situation report as at 30.4.96**

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<tr>
<td>6.5</td>
<td>Wider Considerations (Section 6)</td>
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<tr>
<td>6.4</td>
<td>To develop a WSD management information system based on a GIS which should include the following modular system (para. 6.3)</td>
<td>a) To define objectives of the proposed management system</td>
<td>Same as Item 3.1</td>
<td>To be considered in conjunction with the establishment of the GIS</td>
</tr>
<tr>
<td></td>
<td>i) Customer Services and Mains Failure System;</td>
<td>b) To determine key functions</td>
<td></td>
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<td></td>
<td>ii) Flows and Pressures;</td>
<td>c) To review activities within functions.</td>
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<td></td>
<td>iii) Network Analysis;</td>
<td>d) To examine activity/data transfer resulting in a 'data matrix'.</td>
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<td></td>
<td>iv) Telemetry;</td>
<td>e) To define hardware and software requirements.</td>
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<td>v) Asset Condition;</td>
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<td></td>
<td>vi) Water Mains Record; and</td>
<td></td>
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<td>vii) Demand Record.</td>
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### Pipe Burst Problems in the Fresh and Flushing Water Systems Operated by WSD

**Action Plan for Implementation of Recommendations of Low Priority**

**Situation Report as at 30.4.96**

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<tr>
<td>1.</td>
<td>Mains Failure Records (Section 5.1) To make data available for analysis on the past performance of pipelines so as to facilitate identification of failure caused and measures to minimise them.</td>
<td>a) To study and develop a referencing system that will be compatible with a GIS system.</td>
<td>Same as Item 3.1 under Medium Priority on page no. M1.</td>
<td>To be considered in conjunction with the establishment of the GIS.</td>
</tr>
<tr>
<td>1.8</td>
<td>To develop a system of referencing for individual pipeline.</td>
<td>a) To conduct study on the proposed strategy and work out procedures for systematic recording of visible signs when reporting bursts, collect samples of damaged pipes for condition tests of laboratory analysis and implement programme of opportunistic in situ inspection of strategically significant mains.</td>
<td>Same as Item 3.1 under Medium Priority on page no. M1.</td>
<td>To be considered in conjunction with the establishment of the GIS.</td>
</tr>
<tr>
<td>2.</td>
<td>Condition Data and Sampling (Section 5.2)</td>
<td>a) To design and develop database and user programme for storing mains condition data such that the data can be linked to an asset register.</td>
<td>Same as Item 3.1 under Medium Priority on page no. M1.</td>
<td>To be considered in conjunction with the establishment of the GIS.</td>
</tr>
</tbody>
</table>
**PIPE BURST PROBLEMS IN THE FRESH AND FLUSHING WATER SYSTEMS OPERATED BY WSD**

**ACTION PLAN FOR IMPLEMENTATION OF RECOMMENDATIONS OF LOW PRIORITY**

**Situation Report as at 30.4.96**

<table>
<thead>
<tr>
<th>Item No</th>
<th>Recommendation</th>
<th>Action to be taken</th>
<th>Situation as at 30.4.96</th>
<th>Responsible Officer</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td><strong>Investment Policy &amp; Materials Selection (Section 5.4)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.7</td>
<td>To employ modern rehabilitation techniques wherever possible (para. 5.4.4).</td>
<td>a) To look into the market for available rehabilitation techniques.</td>
<td></td>
<td>CE/RA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) To identify suitable techniques for adoption and arrange trials if necessary.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td><strong>Practical Recommendations towards Integrated Implementation (Section 5.5)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1</td>
<td>To make all necessary preparatory investigations.</td>
<td>a) To decide on how the distribution systems may be divided into appropriate units for computer modelling and setting priorities.</td>
<td>N/A</td>
<td>- Not a specific recommendation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) To investigate into factors, e.g. soil aggressivity, influencing pipeline condition on a territory-wide basis</td>
<td></td>
<td>- To serve as reference for implementing other items</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) To determine the procedures, media and format for recording data collected during subsequent studies and for updating existing records.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>d) To review policy based on recommendations of studies.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>e) To carry out initial cost assessment for various proposal and set priorities.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Action Plan for Implementation of Recommendations of Low Priority

### Situation Report as at 30.4.96

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Recommendation</th>
<th>Action to be taken</th>
<th>Situation as at 30.4.96</th>
<th>Responsible Officer</th>
</tr>
</thead>
</table>
| 5.2      | To review the information obtained in Item 5.1 to develop plans for defining and conducting the pilot study. | a) To review information obtained from the preparatory investigation.  
b) To define the scope of the pilot study and draw up pilot study programme for a selected 'unit'.  
c) To arrange for the necessary funds. | N/A | ditto |
| 5.3      | To conduct the pilot study. | a) To carry out the pilot study.  
b) To report to the Management periodically for monitoring.  
c) To make recommendations on full scale study for the Management's considerations. | N/A | ditto |
| 6.1      | To use computer network models for simulation of water supply and distribution networks (para. 6.1). | a) To be included as part of the GIS. | Same as Item 3.1 under Medium Priority on page no. M1. | To be reviewed upon the establishment of GIS. |

### Wider Considerations (Section 6)

- To be included as part of the GIS.
## ON GOING WORKS

### Situation Report as at 30.4.96

<table>
<thead>
<tr>
<th>Item No</th>
<th>Recommendation</th>
<th>Action to be taken</th>
<th>Situation as at 30.4.96</th>
<th>Responsible Officer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>To develop procedures for improving the communication of mains position to Contractors (Para. 5.3.1).</td>
<td>a) To set up inspection team to complement the communication of mains details to Contractors.</td>
<td>Completed (Full Inspection Teams were set up in Regions in July 1995).</td>
<td>CE/Regions</td>
</tr>
<tr>
<td>2</td>
<td>To coordinate the work programmes between utilities and DSD (other than HyD), with a view to reducing the no. of times that roads are opened (para. 5.3.2.).</td>
<td>a) To set up a inter-utilities working group to study the feasibility of coordinating programmed works of each utility undertaker with a view to reducing road openings.</td>
<td>- Through the Utility Technical Liaison Committee (UTLC). - Through the Road Opening Coordination Committee (ROCC).</td>
<td>- CE/RA - WSD/ROCC representatives</td>
</tr>
<tr>
<td>3</td>
<td>Investment Policy &amp; Materials Selection (Section 5.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>To prohibit further use of brittle pipe material (i.e. C.I. &amp; A.C.) (para. 5.4.1).</td>
<td>a) To set up procedure to prohibit further use of C.I. pipes similar to that for A.C. pipe.</td>
<td>Completed.</td>
<td>CE/RA</td>
</tr>
<tr>
<td>2</td>
<td>To replace the existing brittle pipes whenever opportunities arise to do so at reduced cost (para. 5.4.1 &amp; 5.4.5).</td>
<td>a) To draw up and implement a replacement programme for existing brittle pipes adopting a prioritisation approach taking into consideration the no. of past failures and no. of consumers affected.</td>
<td>- On-going. - Due consideration have been taken in the yearly programme for improvement works.</td>
<td>CE/Regions</td>
</tr>
<tr>
<td>3</td>
<td>To tighten quality control on the use of uPVC pipes (para. 5.4.1).</td>
<td>a) To prepare technical notes on proper mainlaying practice for uPVC pipes. b) To tighten quality control on site.</td>
<td>- On-going</td>
<td>a) CE/RA to supplement the Mainlaying Practice. b) CE/Regions</td>
</tr>
</tbody>
</table>
## PIPE BURST PROBLEMS IN THE FRESH AND FLUSHING WATER SYSTEMS OPERATED BY WSD

**ACTION PLAN FOR IMPLEMENTATION OF RECOMMENDATIONS OF**

## ON GOING WORKS

### Situation Report as at 30.4.96

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Recommendation</th>
<th>Action to be taken</th>
<th>Situation as at 30.4.96</th>
<th>Responsible Officer</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5</td>
<td>To replace G.I. pipes with other new materials (para. 5.4.2. &amp; 5.4.3).</td>
<td>a) To identify suitable replacement pipe materials for G.I.</td>
<td>) Lined GI pipes have been adopted to replace the unlined ones as a standard practice.</td>
<td>CE/RA CE/Regions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) To implement trial schemes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) To adopt the replacement pipe materials in government and private projects.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>d) To replace existing G.I. pipe systematically.</td>
<td>- On-going</td>
<td></td>
</tr>
<tr>
<td>6.2</td>
<td>To prioritise the local areas where improvement works should take place to reduce leakage (para. 6.2).</td>
<td>a) To review main burst/leak statistics and other records.</td>
<td>) Due consideration have been taken in planning improvement works by Regions.</td>
<td>CE/Regions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) To prioritise the local areas where improvement is required to reduce leakage.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) To arrange for funds and carry out the improvement works.</td>
<td>- Category D Items have been created for carrying out the priority works.</td>
<td></td>
</tr>
<tr>
<td>6.3</td>
<td>To implement pressure control schemes for reduction of leakage in supply system (para. 6.2).</td>
<td>a) To continue the Study on pressure control.</td>
<td>)</td>
<td>The Standing Committee for Waste Detection and Unaccounted-for Water</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) To identify suitable system for implementing pressure control.</td>
<td>) On-going</td>
<td></td>
</tr>
</tbody>
</table>

### Wider Considerations (Section 6)

- Lined GI pipes have been adopted to replace the unlined ones as a standard practice.
- On-going
- On-going
- Category D Items have been created for carrying out the priority works.
ANNEX 4.4

M.S. spigot & socket ended pipes

D.I pipes - (5.5m)
Lined G.I. pipes

M.S. pipes double flanges ended
MDPE pipes
UPVC pipes
GUIDELINES

FOR EXCAVATION

NEAR

WATERMAINS

Water Supplies Department
July 1995
Guidelines for Excavation near Watermains

1. Introduction

1.1 All water mains are critically tested after laying and before they are put into service, and should have a very long serviceable life if they are not subsequently disturbed. However, every now and then main bursts do occur bringing about many undesirable consequences, such as water supply interruptions, road traffic disturbances, damages and very expensive repair costs. It has been noted that most of the main bursts are caused by external factors, many of which are related to roadworks and road opening activities.

1.2 The works contractor has legal and/or contractual obligations for protecting all existing services. This guidelines are issued to help the contractor to avoid causing damages to water mains but they will not relief him from any of his legal and/or contractual obligations.

2. Pipe materials

2.1 Pipe materials commonly used for various sizes of water mains are as follows:

<table>
<thead>
<tr>
<th>Pipe Material</th>
<th>Nominal Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild Steel (MS)</td>
<td>600 mm and above</td>
</tr>
<tr>
<td>Ductile Iron (DI)</td>
<td>80 mm and above</td>
</tr>
<tr>
<td>Asbestos Cement (AC)</td>
<td>100 mm to 450 mm</td>
</tr>
<tr>
<td>uPVC (uPVC)</td>
<td>100 mm and below</td>
</tr>
<tr>
<td>Galvanized Iron (GI)</td>
<td>100 mm and below</td>
</tr>
</tbody>
</table>

2.2 Asbestos Cement pipes are durable in withstanding internal water pressures but are relatively weaker than Mild Steel and Ductile Iron pipes in withstanding excessive external load/pressure. Use of A.C. pipe has been discontinued for some years, but there are still large quantities of these pipes in the existing water mains systems. It should be noted that their bursts are seldom due to aging effects but are often the result of being disturbed and damaged.

2.3 uPVC pipes are relatively weak in resisting direct impact. They are laid outside carriageways and in small diameter, mostly used in salt water supply systems.
2.4 Galvanized Iron pipes are only used in small diameter fresh water mains. They are strong in resisting impact and tensile stress, but they can get corroded more easily.

3. **Pipe joints**

3.1 Joints connecting AC, DI and sometimes MS pipes with plain ends rely on a mechanism to grip the pipe body, with rubber rings to achieve water tightness. All these joints are not designed to take much longitudinal stresses and may be detached if the water main is not properly supported or anchored.

3.2 Longitudinal stresses are most commonly found at bends and closed ends of pressurized pipeline. Concrete thrust blocks are normally cast at these locations to provide the necessary anchorage.

4. **Common causes of main burst**

4.1 Main bursts are caused by a variety of factors. Those common ones relating to road opening activities are:-

(a) damage of water mains and valves during excavation;

(b) excessive loading on water mains; and

(c) settlement of ground supporting water mains.

5. **Points To Consider**

5.1 **Before Excavation**

5.1.1 Exact position and cover of the water mains should be ascertained by hand-dug trial holes before starting to use mechanical plant for road breaking and excavation.

5.1.2 Currently the information provided by WSD on existing pipelines is basically extracted from mains record plans and is indicative only. The road opening contractor has legal/contractual obligations to find out the exact positions of the water mains by trial holes.
5.1.3 The minimum cover to a water main (e.g. 900 mm under carriageway and 450 mm under footpath) as stipulated in the Excavation Permit should not always be taken as the actual cover. In areas with congested utilities, some short sections of water mains may have been laid with a shallower cover. There are also cases in which the road levels have been lowered or the footpath has been converted into a carriageway, but due to various factors such as lack of works co-ordination, the water mains existing there have not been re-laid at a greater depth, thus leaving the covers much less than the minimum requirement.

5.2 During Excavation

5.2.1 Adequate site supervision and appropriate protective measures to water mains should be provided.

5.2.2 Indiscriminate use of heavy road breaking and excavation plant, coupled with the lack of adequate site control, are also factors leading to main bursts. There have been numerous cases where the water mains and/or valves are already located or exposed, and still damaged by the plant operators.

5.2.3 During the course of road opening the valve covers on the road surface are often removed, with the top of the valves exposed above the general excavation level. These valves are thus left in vulnerable positions easily damaged by the swinging parts of the road breakers or excavators.

5.2.4 Having excessively long lengths of water mains exposed during trench excavation for laying of drains and utilities, but with inadequate support to the pressurized water mains and/or their thrust blocks is a common cause of main burst. Exposure of a thrust block without providing proper support may result in its movement and detachment of the associated pipe joints and eventually a burst. WSD should therefore be consulted on all cases where exposure of thrust blocks or water mains are required to enable suitable protective measures to be taken.

5.2.5 Excessive loading on buried water mains often occurs after the road surfacing is removed when the covers to the water mains are much reduced. The passing of heavy excavators or compaction rollers above the water mains can easily damage the pipe bodies. The minimum cover to a water main should be 700 mm measured from existing or future subgrade (i.e. site formation level), whichever is the greater and should always be observed. In case this cannot be achieved, WSD should be consulted to enable suitable measure to be taken.
5.2.6 Settlement of the supporting layer underneath an existing water main may be due to:-

(a) undermining of the water main by trench excavation work alongside or across it;

(b) inadequate compaction of the backfill in a trench close to or below the water main; and

(c) de-watering for trench work, foundation or other construction works in close proximity to the water main, extracting the fine soil from the ground supporting the water main.

5.2.7 To ensure that valves can be operated at all times, all valve covers should be kept clear of excavated materials during trench excavation or reinstatement. They should not be buried under stockpile of excavated materials or paved over by road reinstatement. Any construction debris that falls into the valve pits should be cleared immediately.

6. **Other Important Points**

6.1 Some steps that can be taken to reinforce the current preventive measures are suggested below:

(a) Road opening contractors should be made aware of the fact that there is an extensive networks of water mains underneath the carriageways and pavements. It is essential that they should exercise every care to avoid damages to the water mains in the execution of their works.

(b) Road opening contractors should check if there are existing water mains that may be affected by their road opening activities, and to find out their exact positions/cover by hand-dug trial holes before commencing work.

(c) In opening a trench alongside an existing water main, the contractor should take all possible protective measures to support the water main, the associated thrust blocks and stabilize their supporting ground. To prevent ground settlements adjacent to or below existing water mains, all backfills must be adequately compacted to standards not less than the following :-
(i) The excavation shall be backfilled with suitable materials in compacted layers not exceeding 150 mm thick. Each layer of backfill materials shall be compacted with a power rammer, vibratory plate or vibratory roller. The in-situ dry density of the compacted backfill shall be not less than 95% of the maximum dry density, determined in accordance with the procedures set down in Test No. 12 & 15 in BS 1377:1975.

(ii) The backfill materials shall not contain broken concrete, bricks, clay, bituminous material, materials susceptible to spontaneous combustion, perishable materials or debris. Backfill material shall not exceed 75 mm maximum particle size.

(iii) Suitable backfill materials shall be carefully placed by hand and compacted by hand rammers up the level of 300 mm above the crown of water pipes.

(d) Whenever there are uncertainties or problems with regard to the locations and protection of existing water mains, the site staff or the responsible person of the work should contact the relevant Inspector/Inspection Team of WSD as listed in Appendix I. A sketch showing the boundaries of the five regions is at Appendix II.

(e) The party responsible for road opening work should provide adequate site supervision to ensure the above requirements are closely observed.

(f) Suggested method for the support of water main is given in Appendix III for reference. The proposed method of support is by no means exhaustive and the detail depends on site conditions and the type, size and length of the water main to be supported.

(g) Photos showing good practices and bad practices of works carried out adjacent to existing water mains and in supporting the water mains and/or the thrust blocks are given in Appendix IV for reference.
## Guidelines for Excavation near Watermains

(A) List of Contact Telephones during office hours:

<table>
<thead>
<tr>
<th>Region</th>
<th>Officer</th>
<th>Contact Telephone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hong Kong and Islands</td>
<td>Inspector/Hong Kong (Inspection)</td>
<td>2880 2536</td>
</tr>
<tr>
<td>Mainland South East</td>
<td>Inspector/ Mainland South East (Inspection)</td>
<td>2399 4362</td>
</tr>
<tr>
<td>Mainland South West</td>
<td>Inspector/ Mainland South West (Inspection)</td>
<td>2399 4193</td>
</tr>
<tr>
<td>Mainland North West</td>
<td>Inspector/ Mainland North West (Inspection)</td>
<td>2399 4293</td>
</tr>
<tr>
<td>Mainland North East</td>
<td>Inspector/ Mainland North East (Inspection)</td>
<td>2399 4263</td>
</tr>
</tbody>
</table>

(B) For emergency cases outside office hours in which consultation with WSD is required, contact with appropriate Regional Inspectors should be routed through the Technical Complaint Centre as follows:

<table>
<thead>
<tr>
<th>Region</th>
<th>Contact Telephone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hong Kong &amp; Outlying Islands</td>
<td>2811 0788</td>
</tr>
<tr>
<td>Kowloon and New Territories</td>
<td>2396 0210</td>
</tr>
</tbody>
</table>
挖掘水管附近泥土指引

1. 引言
1.1 所有水管在施工前均应进行严格测试。如非来自受干扰，水管均应有非常长久的使用期。不过有時水管爆裂的确发生并带来不少不良後果，例如供水中断、交通阻塞、道路及其他损坏，以及昂贵的修理費用。值得注意的是大部份水管爆裂都是因為外來因素引致的，这些外來因素多數與道路工程和開路工程有關。

1.2 工程承建商有法律上及/或合约义务保护所有现存装置。本指引旨在协助承建商避免引致水管受损，但承建商不能免除本身任何法律上及/或合约義務。

2. 水管質料
2.1 不同尺寸水管通常所用的水管質料如下：

<table>
<thead>
<tr>
<th>水管質料</th>
<th>名義直徑</th>
</tr>
</thead>
<tbody>
<tr>
<td>軟鋼（MS）</td>
<td>600毫米及以上</td>
</tr>
<tr>
<td>球墨鐵管（DI）</td>
<td>80毫米及以上</td>
</tr>
<tr>
<td>石棉水泥（AC）</td>
<td>100毫米至450毫米</td>
</tr>
<tr>
<td>硬塑膠管（uPVC）</td>
<td>100毫米及以下</td>
</tr>
<tr>
<td>鍍鋅鐵皮（GI）</td>
<td>100毫米及以下</td>
</tr>
</tbody>
</table>

2.2 石棉水泥水管较耐用於承受内/外水壓，但在承受過度外來負荷/壓力時，耐用程度则不及軟鋼和球墨鐵管。石棉水泥水管虽已停用多年，但在現時的水管系统中仍有一定斷水管。應留意這類水管爆裂很少是因爲老化所引致，通常都是因爲受到干擾和損壞而導致水管爆裂的。

2.3 硬塑膠管水管在抵抗直接沖擊方面較弱。這類水管敷設在行車道以外地方，而水管直径較小，大多份用於籠水供水系统。

2.4 鍍鋅鐵皮水管只用於小直径淡水管。這類水管在抵抗沖擊和張應力方面頗強，但較易腐蝕。
3. 水管接口
3.1 接駁石棉水泥、纖維銅管，以及有時接駁軟管水管的光面接口須依賴裝置焊接管身，並附膠環使接口不透水。所有這類接口的設計並不能承受過大的縱向壓力，而如水管沒有適當的支承或錨固，接口便有可能鬆脱。

3.2 縱向壓力通常在加壓水管的彎位和閉合接口處出現。在正常情況下，這些地點都會加建混凝土止推座，以提供必要的錨座。

4. 水管爆裂的常見原因
4.1 水管爆裂由不同原因所導致。常見與挖掘工程有關的原因如下：

(a) 挖土時損壞水管和水掣；
(b) 水管負荷過重；及
(c) 支撐水管的泥土沉降。

5. 注意要點
5.1 挖掘前
5.1.1 開始使用機械裝置進行掘開路面和挖掘工程時，應用手工挖掘探洞確定水管的準確位置和水管的覆蓋厚度。

5.1.2 水務署現時提供有關現有水管的資料，基本上是從水管記錄表中節錄出來的，只作指示用途。掘路承建商有法律及/或合約義務，用探洞找出水管的準確位置。

5.1.3 據路許可證內所訂明的水管最小覆蓋面（例如行車道下 900毫米及行人道下 450 毫米）不應一成不變的視為實際覆蓋厚度。在公用設備密集的地區、部份水管的短節可能設在較淺的覆蓋厚度下。有時道路水平下降或行人道改建成行車道，但因不同原因如工程緊密不足、現存水管並沒有在較深土層重鋪，因此覆蓋厚度較最低要求爲少。
5.2 挖掘中
5.2.1 應有充足的工地監察，並採取適當的保護水管措施。

5.2.2 胡亂使用重型掘開路面和挖掘機械設備，以及缺乏充足的工地管制，亦會引致水管爆裂。在很多情況下，雖然水管及/或水掣已標明位置或已外露，但仍被機械設備操作者損壞。

5.2.3 掘開路面時，路面的水掣蓋通常會被移開，使水掣的頂部露出一般挖掘水平之外，因此這類水掣便很容易被挖掘機或挖掘機的挖掘部份所損壞。

5.2.4 挖掘管道敷設構架和公用設備時，會有大段水管暴露於外，但加壓水管及/或止推座的支持不足，亦是水管爆裂的常見原因。止推座外露後沒有適當支持，會引致止推座移位，而使相連的水管接口鬆脫，最終導致水管爆裂。因此，凡需露出止推座或水管，均應先諮詢水務署，以便採取適當的保護措施。

5.2.5 挖掘路面後，水管的覆蓋厚度大為減少，於是便經常導致埋在地下的水管負荷過重。在水管上駛過的重型挖掘機或壓縮壓路機便會很易損壞管身。水管的最少覆蓋厚度是從現有的土基（即平整地面的水平）起計 700 毫米，兩者按其距離較大的，並須經常遵守這規定。如未能維持覆蓋厚度，則應諮詢水務署，以便採取適當措施。

5.2.6 現有水管下的支持土層沉降可能是由下列原因：

(a) 沿水管或橫跨水管進行掘坑工程而掏空水管底層土壤；

(b) 水管附近或水管下的坑道回填土壓不足；及
5.2.7

為了確保水掣隨時都可以操作，挖掘坑道或鋪路時，所有水掣蓋應與挖掘出的物料分開。水掣蓋應埋於挖掘出的物料堆下，或在鋪路時被鋪通。如有任何建築碎料跌入水掣井內，應即加以清理。

6. 其他要點

6.1 加強現時保護措施可採取下列建議的步驟：

(a) 開路承建商應注意到車道和人行道下有分佈廣泛的水管。因此進行工程時，必須十分小心避免損壞水管。

(b) 開路承建商應察察有否現有水管可能會受開路工程影響，並在動工前用手工挖掘探洞找出水管的正確位置/蓋覆厚度。

(c) 如沿現有水管開挖坑道，承建商應採取所有可能的保護措施支持水管和保護，並固定水管的支撐泥土。為預防現有水管附近或水管下的泥土沉降，所有回填土料必須充份地壓縮至不少於下列標準：

(i) 挖掘的地方應以適當土料填回，每層回填土料的壓實層應不超過 150 毫米。每層回填土料須用動力碎、震動板或震動碾壓機加以壓縮。回填壓縮土料在原有位置的乾密度不得少於最高乾密度的百分之九十五，而乾密度必須根據 BS 1377: 1975 的測試編號十二和十五訂定的程序確定。
(ii) 回填土料不應含有混凝土碎片、砖塊、粘土、含泥膏的物料、易於自燃的物料、易腐物料或破環物碎片。回填土料粒徑不應超過75毫米。

(iii) 合適的回填土料應小心用手放置，並用手動夯土機加以壓縮至水管頂部以上300毫米。

(d) 如就現有的水管位置和保護水管事有疑難，工地職員或工程負責人員應與水務署的有關視察隊督察聯絡，督察名單可見於附錄I。顯示五區界線的圖則載於附錄II。

(e) 負責開路工程的一方應提供足夠的工地監察，確保嚴格遵行上述規定。

(f) 建議支持水管的方法可見附錄III，以作參考。建議支持水管的方法並不能盡錄，而方法細節須視工地環境、需受支持水管的類型、尺碼和長度而定。

(g) 相片顯示在現存水管附近進行工程和支持水管及/或支撐座的正確和不正確的方法，可見於附錄IV，以作參考。
(A) 辦公時間內聯絡電話：

<table>
<thead>
<tr>
<th>部門</th>
<th>人員</th>
<th>聯絡電話</th>
</tr>
</thead>
<tbody>
<tr>
<td>香港及離島區</td>
<td>督察/香港(視察)</td>
<td>2880 2536</td>
</tr>
<tr>
<td>九龍東及西貢區</td>
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<tr>
<td>九龍西及黃埔區</td>
<td>督察/九龍西及黃埔區(視察)</td>
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</tr>
<tr>
<td>新界西及荃灣區</td>
<td>督察/新界西及荃灣區(視察)</td>
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</tr>
<tr>
<td>新界北及沙田區</td>
<td>督察/新界北及沙田區(視察)</td>
<td>2399 4263</td>
</tr>
</tbody>
</table>

(B) 如遇緊急情況，而需於辦公時間外諮詢水務署，可致電下列技術故障投訴中心，中心職員便會接駁至適當的分區督察處：

<table>
<thead>
<tr>
<th>部門</th>
<th>聯絡電話</th>
</tr>
</thead>
<tbody>
<tr>
<td>香港及離島區</td>
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</tr>
<tr>
<td>九龍及新界區</td>
<td>2396 0210</td>
</tr>
</tbody>
</table>
1. HONG KONG & ISLANDS REGION
   - ISLANDS: WESTERN AND CENTRAL
     - WANCHAI, EASTERN, SOUTHERN

2. MAINLAND SOUTH EAST REGION
   - TAIPO (PART)
     - SAI KUNG, KWUN TONG, WONG TAI SIN

3. MAINLAND SOUTH WEST REGION
   - KWAI CHUNG & TSING YU
     - SHAM SHUI PO, MONG KOK, YAUMATEI
     - KOWLOON CITY

4. MAINLAND NORTH WEST REGION
   - YUEN LONG
     - Tuen Mun, Tsuen Wan

5. MAINLAND NORTH EAST REGION
   - NORTH N.T.
     - TAIPO (PART)
     - SHA TIN

REGIONAL BOUNDARY

REVISED: 1-12-88

REGIONALIZATION OF WATER SUPPLIES DEPT.

SKETCH NO. 3363/1B
SPAN TO NEXT SUPPORT DEPENDS ON TYPE, SIZE AND LENGTH OF EXISTING WATERMAIN

I-BEAM / R.S.J.

FELT

SECTION A-A

I-BEAM / R.S.J. TO BE SUPPORTED BY PILES OR ANCHOR BLOCKS PLACED OUTSIDE ZONE OF SUBSIDENCE

ALL JOINTS CONNECTED BY ANGLES WITH BOLTS AND NUTS OR WELDING

FELT

I-BEAM / R.S.J.

PLANKING / SHEET PILING

TYPICAL SECTION

SUGGESTED METHOD FOR THE SUPPORT OF WATERMAIN
Example of Good Practice in Protection of Water Main

Rigid and secured support to water main
Example of Bad Practice in Protection of Water Main

No lateral support to exposed thrust block

Inadequate support to water main
Example of Bad Practice in Protection of Water Main

(i) No trial hole dug to locate water main
(ii) Use of heavy plant to excavate on top of water main

(i) 並無挖掘探洞找出水管位置
(ii) 在水管面使用重型機器挖掘
ANNEX 4.6

Procedure for Checking Basement Design to Protect Existing Water mains

Submission of basement design
(from 800, GEO or Authorized Person)

Drawing Office
to mark existing
watermain

Send no comment
reply to 800, GEO or A/P with
marked up plan

No

Any watermain in
the vicinity likely to
be affected

Seek advice of
Headwork Engineer
where trunk main
is affected

Yes

Make reply to 800, GEO,
or A/P with marked up plan
stating condition (A) at Annex

Contact the A/P for a joint site
investigation to confirm:
(i) Level and position of watermain
(ii) Age, material type and condition
of watermain
(iii) Location of loose joints and
anchor blocks
(iv) Degree for further bending which
can be tolerated by watermain

Keep 800 and GEO
informed of the
findings and agreement
with the A/P

Check basement excavation procedure
and supporting scheme, and
estimate possible settlement
for pipe foundation. Seek advice of
GEO as necessary

Is settlement exceeding
permissible limit?

Yes

No

Responsible Party
Relevant Region
Chief Draughtman
Distribution Engineer
Headwork Engineer
Distribution Engineer
Distribution Engineer & A/P
Distribution Engineer & A/P & GEO
Agree with the A/P on the following options at the cost of the developer:

1. Temporary isolation
2. Change with pipe material which can withstand the settlement
3. Diversion

1. State the degree of acceptable differential settlement and, in consultation with GEO, agree on a monitoring scheme which can include:
   - Settlement markers at pipe foundation
   - Movement markers at loose joints and anchor blocks
   - Level of ground water

2. State condition (B) at Annex in the agreement with the A/P

Check monitoring report and carry out regular site inspection during basement excavation.

Agree with the A/P to modify the excavation procedure or strengthening the support before proceeding further.

Is the max. acceptable degree of settlement exceeded?

- Yes
  - Carry out repair and initiate a claim for repair cost

- No
  - Check for any concealed damage at the end of basement excavation work

Is the watermain damaged?

- Yes
  - Distribution Engineer & Inspector

- No
  - END
Annex 4.7

EXCAVATION PERMIT NO. ...........................................

Section I

Application is hereby made under Section 8 of the Crown Land Ordinance to excavate trenches in the public thoroughfare known as shown in the attached plan for the purpose of

We undertake to observe the conditions accompanying this permit.

The proposed duration and approximate size(s) of the excavation(s) are as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Commencement Date</th>
<th>Duration of road excavation</th>
<th>Length</th>
<th>Width</th>
<th>Depth</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
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<td></td>
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<tr>
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<td>5</td>
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</table>

For further information please contact Mr. the person in charge of the work at telephone No. or Mr. Contractor’s representative of Co. at telephone No.

(Signed) Name of Utility Undertaking

Section II

To applicant:

In exercise of the authority vested in me, permission is hereby given for you to make the excavation(s) described above subject to the conditions accompanying this permit. This permit expires on

(Signed) for Director of Buildings and Lands

ADDITIONAL CONDITIONS
CONDITIONS OF PERMIT

ASSOCIATED LEGISLATION AND DOCUMENTS

1. In addition to the conditions set out in these Conditions of Permit, the Permittee shall comply with all the relevant provisions of the Crown Land Ordinance Cap. 28, and the provisions of any other legislation relating to the work covered by this Permit.

2. Wherever any parts of the Permittee’s specifications are used to cover the work under this Permit, such parts of the specifications shall only be used with the prior agreement from the Authority.

THE WORK

3. The work under this Permit includes all pipes, cables, ducts, covers, valve boxes, chambers and any other services or installations to be laid, repaired or installed by the Permittee and also includes all temporary work, excavation, backfilling to trenches, temporary reinstatement and/or permanent reinstatement, and other operations to be carried out by the Permittee.

GENERAL OBLIGATIONS

4. The Permittee shall execute the work under this Permit in strict accordance with these Conditions of Permit to the satisfaction of the Authority and shall comply with and adhere strictly to the specifications, (agreed between the Authority and the Permittee before the issue of the Permit) and instructions issued by the Authority on any matter related to the Permit.

5. A photocopy of this Permit shall be displayed on the site for inspection by Police Officers or other persons authorized by the Authority. A prominent notice both in English and Chinese showing the name of the Permittee, and a contact telephone number shall be displayed on the site. The contact telephone shall be manned at all times.

6. All pipes, cables, ducts, covers, valve boxes, chambers, and any other installations, laid or installed by the Permittee under this Permit are so laid or installed at the risk of the Permittee and they shall be adjusted, realigned or removed at no expense to Government whenever proven necessary by the Authority.

7. The Permittee shall indemnify and keep indemnified Government against all losses and claims for injury or damage to any person or property, nuisance, disruption or interference whatsoever which may arise out of or in consequence of the work of the Permittee, and against all claims, demands, proceedings, damages, costs, charges or expenses whatsoever in respect thereof or in relation thereto.

8. The Permittee shall notify the Senior Staff Officer/Traffic, Royal Hong Kong Police, in writing 7 days before the anticipated commencement date of his work except for emergency where this requirement may be waived and, in such case, covering notification in writing shall be given as soon as practicable. All such notifications shall include a plan to a suitable scale showing the location and extent of the work, unless such a plan has been submitted previously.

9. The Permittee shall notify each of the following (and such others as may be added from time to time by the Authority) in writing 7 days before the commencement of excavation:

- Hong Kong Island:
  - Hong Kong Electric Co. Ltd.
  - Hong Kong Telecom
  - Hong Kong & China Gas Co. Ltd.
  - Hong Kong Tramways Ltd.
  - Rediffusion (H.K.) Ltd.
  - Water Supplies Department
  - Mass Transit Corporation
    (for excavations within Mass Transit protection zones)
  - Senior Staff Officer/Traffic, Hong Kong Island, RHKP
  - Transport Department
  - Fire Services Department
  - Drainage Services Department
  - Hong Kong Regional Headquarters, U.S.D.
    (for excavations affecting roadside trees on Hong Kong Island)

- Officer Commanding, Island Troop, Hong Kong Signal Squadron, Headquarters of British Forces, H.M.S. Tamar

- Kowloon and New Territories:
  - China Light & Power Co. Ltd.
  - Hong Kong Telephone Co. Ltd.
  - Rediffusion (H.K.) Ltd.
  - Water Supplies Department
  - Mass Transit Corporation
    (for excavations within Mass Transit protection zones)
  - Civil Aviation Department
    (for Kai Tak Airport only)
  - Development and Airport Division.
  - Civil Engineering Department
    (for Kai Tak Airport only)
  - Senior Staff Officer/Traffic, Kowloon East or Kowloon Wes
    or N.T., RHKP
  - Transport Department
  - Fire Services Department
  - Drainage Services Department
  - Kowloon Regional Headquarters, U.S.D.
    (for excavations affecting roadside trees in Kowloon)
  - Regional Services Department Headquarters
    (for excavations affecting roadside trees in the New Territories)

- Officer Commanding, Kowloon Troop,
  - Hong Kong Gurkha Signal Squadron,
  - Gun Club Hill Barracks, British Forces Post Office 1
10. Throughout the progress of his work and during his occupation of the site, the Permittee shall be responsible for ensuring site safety.

11. This Permit expires on the date specified in Section II of the Permit unless otherwise extended by the Authority. Work shall be carried out as expeditiously as possible and completed by the date prescribed in the Permit Extension. Work shall not be delayed without valid reasons. Any excavation made without a valid permit is an offence and may result in prosecution under Section 8(4) of the Crown Land Ordinance Cap. 28.

COVER TO SERVICE AND INSTALLATIONS

12. (a) The minimum cover to the top of the services and installations including pipes, cables, ducts, chambers etc. shall be:

(A) Services other than high tension power cables of 33kV or above:

(i) Footway—450 millimetres from the surface of the footway provided that

(a) where the proposed services or installations occupy more than half the width of the footway, the minimum cover shall be increased to 900 millimetres, and

(b) for non-energised services, which include telecommunication cables but exclude power cables, water mains and gas mains, laid in ducts involving a maximum of two cable ducts or nominal diameter 100 millimetres or less, the minimum cover can be reduced to 300 millimetres provided that conspicuous identification devices are provided above the services;

(ii) Carriageway—900 millimetres from the surface of the carriageway;

(B) High tension power cables of 33kV or above:

(i) Footway—1,000 millimetres from the surface of the footway;

(ii) Carriageway—1,000 millimetres from the surface of the carriageway.

(b) Where in the opinion of the Authority, the minimum cover need be increased to make way for or to avoid any physical constraint, or any damage or fault in the services or installations may cause damage to the roads or adjoining properties, the Authority may require the services and installations be placed at such depth or such special precautions be taken as considered appropriate. In particular the Authority may require services running along the kerb zone, which is made up of the part of the footway within 300 millimetres from the kerbline and the part of the carriageway within 2,000 millimetres from the kerbline, to be placed with a minimum cover of 1,500 millimetres from the surface of the carriageway to allow construction of road gullies.

(c) In case where the Permittee has adequate reasons to justify that services and installations should be laid at depth less than the minimum cover quoted in sub-clause (a) above, the Permittee shall obtain the prior verbal approval of the Authority and shall submit as soon as practicable covering notice in writing giving the reasons therefor.

LENGTH OF EXCAVATION

13. No excavation shall be opened at any time for a length exceeding 100 metres unless otherwise permitted by the Authority.

CARE OF EXISTING WORKS AND INSTALLATIONS

14. (a) The Permittee shall take all necessary precautions to protect existing roads, buildings, slopes, structures, pipes, utility services and any other installations under or above the ground, adjacent to or within the site, from any damage which may arise out of the execution of or as a consequence of his work and, without prejudice to any other provisions of these Conditions of Permit, the Permittee shall be responsible for any such damage.

(b) Should any damage under sub-clause (a) be identified, the Permittee shall contact immediately the relevant parties responsible for carrying out the necessary repair. Such repair work shall be paid by the Permittee.

(c) The Permittee shall carry out all temporary work necessary to adequately support and protect adjacent roads, buildings, slopes, structures, pipes, utility services and other installations.

(d) Where any alterations to adjacent structures, pipes, utility services and installations are to be carried out by other parties to make way for the Permittee’s work or any part thereof, such work shall not commence until the alterations have been completed by the relevant parties. The Permittee shall be responsible for any necessary liaison and arrangements with the relevant parties for the required alteration works.

15. Fire hydrants, valves, stormwater drains and sewers, manholes, channels, gullies and other street hardware must be kept clear and unobstructed access to them shall be maintained at all times.

16. Street name plates and street furniture shall not be removed, covered or resited without the prior consent of the Authority. Traffic signs shall not be removed, covered or resited without the prior consent of the Commissioner for Transport.

LIGHTING, SIGNING AND GUARDING

17. Lighting, signing and guarding shall be provided and maintained at all times by the Permittee for any of his work on the roads and footway in accordance with the Road Traffic (Traffic Control) Regulations, and any other related legislation together with the Code of Practice for the Lighting, Signing and Guarding of Road Works.
18. Lighting, signing and guarding equipment which in the opinion of the Authority is in an unsatisfactory condition shall be replaced immediately by the Permittee. If the Permittee fails to provide satisfactory lighting, signing and guarding equipment or fails to replace any unsatisfactory equipment when instructed by the Authority to do so, the Authority shall have the right to carry out such lighting, signing and guarding as required, and all expenses incurred by the Authority in so doing shall be charged to the Permittee.

VEHICULAR AND PEDESTRIAN FACILITIES

19. No operations in connection with the execution of the work of the Permittee shall interfere unnecessarily or improperly with the convenience of the public or the access to, use and occupation of public or private roads or footpath or right-of-ways or to or of properties whether in the possession of Government or of any other person. The Permittee shall establish and maintain pedestrian and vehicular access, and any temporary diversions.

20. (a) Where any pedestrian and vehicular access is affected by materials excavated from the Permittee’s work, the Permittee shall have those excavated materials contained by vertical boards or suitable containers. Where necessary for the maintaining of pedestrian or vehicular access, the Permittee shall make arrangements to remove such excavated materials from site as deemed necessary for this purpose within the next day unless it is impracticable to do so, and, in which case, the Authority may allow other time limits. Should the Permittee fails to respond within the next day or other time limit allowed by the Authority, the Authority may enter the site and remove any excavated or other materials as deemed necessary and all such expenses so incurred by the Authority shall be paid by the Permittee.

(b) Materials unsuitable for the purpose of backfilling shall be removed from site as early as practicable.

21. In the case of excavation along building frontages, steel plates or other suitable means approved by the Authority, shall be provided by the Permittee so as to maintain access to adjoining premises.

UNATTENDED EXCAVATION

22. (a) The Authority reserves the right to take over the site after giving due notice to the Permittee if the excavation remains open without being worked on and without any reason giving to and accepted by the Authority.

(b) Any expenses incurred by the Authority for any work under this clause shall be paid by the Permittee.

(c) If the Permittee obtains the Authority’s permission for his excavation to remain open and not be worked on, the excavation shall be covered by steel plates or other means approved by the Authority.

NOISE CONTROL

23. All plant and equipment used by the Permittee for the work shall be effectively sound-reduced by means of silencers, mufflers, acoustic linings, screens, shields or other approved means. The maximum allowable noise levels for the Permittee’s work shall be as specified by the Noise Control Authority. If the noise level from the Permittee’s work exceeds this allowable level, the Permittee shall cease working until suitable abatement measures have been taken.

24. Under the Noise Control Ordinance, the Permittee shall apply for a Construction Noise Permit if he is to use powered equipment at night between the hours of 7 p.m. and 7 a.m. or on General Holidays including Sundays except when the work is necessary for the purpose of preventing injury to any person or saving the life of any person or preventing damage to any property.

SITE CLEANLINESS

25. The Permittee shall keep the site in a clean and tidy condition and free of litter and rubbish as required by the Public Health and Municipal Services Ordinance Cap. 132. The Authority shall have the right to enter the site and remove any litter, rubbish, excavated materials or other materials as deemed necessary and all such expenses so incurred by the Authority shall be paid by the Permittee.

EXCAVATION AFFECTING TREES

26. (a) Except for emergency work, the Permittee shall obtain prior approval from the following authorities for all excavations within 2.5 metres of roadside trees:

(i) Without tree felling
   —Hong Kong Island and Kowloon —Director of Urban Services
   —New Territories —Director of Regional Services

(ii) With tree felling
   —Hong Kong Island and Kowloon —Urban Council through the Director of Urban Services, and District Land Conference through District Lands Office
   —New Territories —Regional Council through the Director of Regional Services, and District Land Conference through District Lands Office

(b) For approval of tree felling, not less than 2 months advance notice must be given to the appropriate authorities.

BACKFILLING AND REINSTATEMENT

27. The Permittee shall carry out, at his own expenses, the following work to his excavation made under this Permit:

—backfilling; and
—temporary reinstatement or permanent reinstatement in lieu of temporary reinstatement if so agreed by the Authority.

28. (a) The excavation shall be backfilled with suitable materials in compacted layers not exceeding 150 mm thick. Each layer of backfill materials shall be compacted with a power rammer, vibratory plate or vibratory roller. The in-situ
dry density of the compacted backfill materials shall be not less than 95% of the maximum dry density, determined in accordance with the procedures set down in Test 11 in BS 1377:1977.

(b) The backfill materials shall not contain broken concrete, bricks, clay, bituminous material, materials susceptible to spontaneous combustion, perishable materials or debris. Backfill material shall not exceed 75 mm maximum particle size.

(c) If the Authority so requires, the Permittee shall carry out tests to determine the state of compaction of the backfill and the results shall be sent to the Authority within fourteen days of test.

(d) Suitable backfill materials may be carefully placed by hand and compacted in accordance with the Permittee’s specifications up to the level of:
   - 150 mm above the crown of the utility ducts, cables or pipes;
   - 150 mm above the roof of the chambers, junction boxes or other installations; or
   - 300 mm above the crown of water pipes.

29. (a) Temporary reinstatement shall be as follows unless otherwise agreed by the Authority:
   (i) Concrete footway — 20 mm thick cement sand mortar, or 20 mm thick 10 mm cutback or fine cold bituminous materials.
   (ii) Bituminous footway — 20 mm thick cement sand mortar, or 20 mm thick 10 mm cutback or fine cold bituminous materials.
   (iii) Concrete Carriageway — 100 mm thick 28 mm bituminous basecourse or 100 mm thick 10 mm cutback or fine cold bituminous materials.
   (iv) Bituminous Carriageway — 100 mm thick 28 mm bituminous basecourse or 100 mm thick 10 mm cutback or fine cold bituminous materials.

   (b) Material specified above shall be to the relevant specifications of the Authority.

30. The Permittee shall upon the completion of reinstatement clear away and remove from the site all equipment and surplus materials.

31. (a) Immediately after completion of the temporary reinstatement or, where the Permittee is to carry out the permanent reinstatement, the completion of the backfilling, the Permittee shall inform the Authority by submitting in duplicate a Reinstatement Notice stating that the excavation is ready for permanent reinstatement.

   (b) When urgent permanent reinstatement is required, the Permittee shall immediately inform the Authority by telephone, followed by written submission of the Reinstatement Notice.

   (c) Should the Reinstatement Notice not be given within 3 working days after the completion of the temporary reinstatement, the Authority shall have the right to take over the site without reference to the Permittee but without relieving the Permittee of any obligations under the conditions of this Permit.

32. (a) Permanent reinstatement as determined and carried out by the Authority shall be at the expense of the Permittee.

   (b) If considered appropriate, the Authority may require the Permittee to carry out the permanent reinstatement. The Permittee shall notify the Authority of the completion of the permanent reinstatement.

MAINTENANCE AND DEFECTS LIABILITY

33. In the case of permanent reinstatement by the Authority, the Permittee shall remain fully responsible for the maintenance of the backfilling and the temporary reinstatement until a period of 7 consecutive days has elapsed after the receipt of the Reinstatement Notice by the Authority.

34. In the case of subsidence of the permanently reinstated pavement (permanent reinstatement by either the Authority or the Permittee) or deterioration in the permanent reinstatement itself (permanent reinstatement by the Permittee) within 12 months of the permanent reinstatement, the Authority shall carry out the necessary remedial works, at the expense of the Permittee, unless the Permittee can prove conclusively that the defect was caused by a third party.

OVERHEAD CHARGES

35. All costs levied by the Authority on the Permittee shall include the appropriate Government overhead charges.

CONTRAVENTION AND ASSOCIATED REMEDIES

36. In the event of any contravention of the Conditions of Permit, this Permit may be cancelled forthwith without compensation by the Authority, who may immediately backfill the excavation and carry out reinstatement at the expense of the Permittee, without prior reference to the Permittee. Should the Authority cancel the Permit, or carry out the above backfill and reinstatement, the Permittee will be advised in writing as soon as practicable.

37. The Authority shall not be liable to any claim from the Permittee whatsoever arising out of or in consequence of his actions taken under the Conditions of Permit.

AMENDMENTS TO CONDITIONS AND SPECIFICATIONS

38. The Authority reserves the right to amend and add to the Conditions and the specifications in writing as necessary.

ADDITIONAL CONDITIONS

Published by Highways Department in June 1992 for Excavation Permits issued under Crown Lands Ordinance.
Excavation Permit No. ______________________

ADDITIONAL CONDITIONS OF PERMIT

1. A Publicity board both in English and Chinese showing the name of the Permittee, description of works, anticipated completion date and a contact telephone number should be displayed on the site throughout the road opening work. The contact telephone shall be manned at all times.

2. Further to Clause 9 of the Conditions of Permit, the Permittee shall also notify Wharf Cable Ltd., Electricity Advisory Services Ltd., Hutchison Communications Ltd., New T & T Hong Kong Ltd., and New World Telephone Ltd., in writing 7 days before the commencement of excavation.

3. Further to Clause 20(a) of the Conditions of Permit, the Permittee shall remove all excavated materials from the site within the next day unless such materials do not cause nuisance to the public.

4. All excavations / sections of trenches on footways where work is temporarily suspended shall be covered with timber decks.

5. Further to Clause 12(a) of the Conditions of Permit, the Permittee is required to strictly comply with the “KERB ZONE” requirement.

6. The Permittee shall notify the Authority in writing or by fax 2 days in advance of the intended commencement date except for emergency work. The notification shall include the Excavation Permit Number and commencement date.

7. Before starting of the work, the Permittee shall ensure that all resources (construction plants, materials, labours, etc) are available on site for the execution of the work.

8. The Permittee is required to carry out permanent reinstatement in the carriageway / footpath / scavenging lane.

* delete whichever is inapplicable
*9  This Permit covers only / does not cover the excavation circled red on the Permit Plan returned.

*10  Liaise with our Inspector, Mr. , at telephone No. 707 7 to phase your work in conjunction with our roadwork. No work is allowed to be carried out after the footway or carriageway is constructed.

*11  The Permittee shall carry out in-situ dry density tests to determine the state of compaction of the backfill to trenches in carriageway and the results shall be sent to this Region within fourteen days of test.

*12  The Permittee is required to bear the cost of full width rootway reinstatement for trench opened in the newly reconstructed footway.
ADDITIONAL CONDITIONS OF PERMIT

Al. The heading for Conditions of Permit 14 to 16 and Condition 14 is deleted and replaced by:

EXISTING WORKS AND INSTALLATIONS

14.(a) The Permittee shall take all necessary precautions to protect existing roads, buildings, slopes, structures, pipes, utility services and any other installations under or above the ground, adjacent to or within the site from any damage which may arise out of the execution of or as a consequence of his work. Should any such damage be identified to have been arising out of the execution or as a consequence of his works, the Permittee shall contact immediately the relevant parties responsible for the purpose of carrying out the necessary repair and, without prejudice to any other provision of these Conditions of Permit, the Permittee shall be responsible for any such damage and shall pay for such repair work.

(b) The Permittee shall carry out all temporary work necessary to adequately support and protect adjacent roads, buildings, slopes, structures, pipes, utility services and other installations.

(c) Where any alterations to adjacent structures, pipes, utility services and installations are to be carried out by other parties to make way for the Permittee's work or any part thereof, such work shall not commence until the alterations have been completed by the relevant parties. The Permittee shall be responsible for any necessary liaison and arrangements with the relevant parties for the required alteration work.

(d) Before commencing any excavation for road works, the Permittee undertaking the works shall ensure that a layout plan with the relevant details are forwarded to all relevant parties as stipulated in Clause 9 of the Conditions of Permit to request for indication of their existing installations that may be affected.

(e) Before using heavy mechanical plant for road breaking and excavation, the Permittee shall carry out any suitable investigation e.g. hand-dug trial pits to ascertain the exact positions and levels of the utilities.

(f) The Permittee shall ensure adequate and experienced site personnel are provided to oversee the operation of heavy mechanical plant, especially in close proximity to existing utilities. Excavation close or around utilities shall be carried out by hand digging methods.

(g) Where utilities installations or plants are exposed, the Permittee shall provide cover and warning signs to prevent damaging the utility installations and plants.

(h) The Permittee shall take reasonable and practical precautionary measures when passing heavy excavator or compaction roller over buried utility installations and plants with less than 1 metre overburden cover, especially when the road surface is removed.

(i) The Permittee shall not interfere with any concrete blocks and structures attached to the utilities.
## Legend of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>AC</td>
<td>Asbestos Cement</td>
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<tr>
<td>AMP</td>
<td>Asset Management Plan</td>
</tr>
<tr>
<td>CI</td>
<td>Cast Iron</td>
</tr>
<tr>
<td>COMAC</td>
<td>Commissioner for Administrative Complaints</td>
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<tr>
<td>CONREC</td>
<td>Committee on Contractors Records</td>
</tr>
<tr>
<td>CWRF</td>
<td>Capital Works Reserve Funds</td>
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<tr>
<td>DWS</td>
<td>Director of Water Supplies</td>
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<td>GCC</td>
<td>General Conditions of Contract</td>
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<tr>
<td>GI</td>
<td>Galvanized Iron</td>
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<tr>
<td>GRP</td>
<td>Glass Reinforced Plastic</td>
</tr>
<tr>
<td>HWR</td>
<td>Hydraulics and Water Research (Asia) Ltd.</td>
</tr>
<tr>
<td>HyD</td>
<td>Highways Department</td>
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<tr>
<td>km</td>
<td>kilometres</td>
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<tr>
<td>MDPE</td>
<td>Medium Density Polyethylene</td>
</tr>
<tr>
<td>mm</td>
<td>millimetres</td>
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<tr>
<td>MNFT</td>
<td>Minimum Night Flow Tests</td>
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<tr>
<td>MS</td>
<td>Mild Steel</td>
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<tr>
<td>PVC</td>
<td>Polyvinyl Chloride</td>
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<tr>
<td>RITs</td>
<td>Roadworks Inspection Teams</td>
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<tr>
<td>ROCC</td>
<td>Road Opening Co-ordinating Committee</td>
</tr>
<tr>
<td>uPVC</td>
<td>Unplasticised Polyvinyl Chloride</td>
</tr>
<tr>
<td>UTLC</td>
<td>Utilities Technical Liaison Committee</td>
</tr>
<tr>
<td>WDU</td>
<td>Waste Detection Unit</td>
</tr>
<tr>
<td>Working Group</td>
<td>Working Group on the Prevention of Damage to Water Mains</td>
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<tr>
<td>WSD</td>
<td>Water Supplies Department</td>
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水管爆裂問題
調查結果總結報告提要

引言

一直以來，不時都會有因水管爆裂而須暫停供水的事件發生。本署及市民對這類事件均甚表關注，因為經常突然暫停供水，無疑會給受影響的用戶帶來極大不便。根據水務署的紀錄，在一九九零／九一至一九九五／九六這六個財政年度期間，每年平均有1,135宗水管爆裂事件發生，需要水務署的定期合約承造商派員修理。這些事件中，食水管爆裂事件佔604宗，而鹹水管爆裂事件則佔531宗。換言之，本港平均每天有3.1宗水管爆裂事件發生。

2. 由於能否預防及減少水管爆裂事件發生，乃取決於水務署是否已在這方面制定並採取有效的程序和行動，因此，本署認為，為了公眾利益起見，實有必要就此事展開直接調查，研究水務署是否有效足夠的預防措施及行動，解決現時供水系統中那些已經發現／有可能發生的問題，包括喉管漸變殘舊及道路工程等一類建築工程引致喉管爆裂的問題。一九九五年十二月，申訴專員根據香港法例第397章申訴專員條例第7(1)(b)條所授予的權力，宣布展開調查，審研水務署在預防和減少水管爆裂事件方面的程序和所採取的行動。這項調查最近已經完成。

調查的目的及範圍

3. 這次調查主要涉及下列幾方面：

(a) 水務署評估本港水管現況的方式、喉管爆裂問題的嚴重程度，以及根據相關的統計數字所示，這類事件近年是否有所增加或減少。

(b) 水務署目前在預防及減少水管爆裂事件方面所採取的策略。
(c) 水務署現正採取或正予研究的各項預防措施的資料，包括所涉及的範圍、可行性、所需的經費和人手、運作上的問題、立法方面的進度、實施的優先次序及效用等。

(d) 上文(c)段所述各項預防措施的進展情況。

(e) 其他經予考慮但未被採納的措施，包括海外水務機構曾經試行的措施。

香港的供水系統

4. 在香港濾水廠過濾的原水，分別來自中國的輸水系統及本港的貯水庫。來自中國的原水會直接引入濾水廠過濾，至於貯水庫的原水，則由水務署利用抽水泵或地心吸力原理，將水經由引水隧道或大口徑的喉管引入濾水廠，進行過濾。經過濾後，水務署會利用抽水泵或地心吸力原理，將食水引入配水庫，再經由遍布全港的主配水管、副配水管、地區配水管及支水管供應給用戶。水務署亦供應沖廁用的鹹水，給予市區及新市鎮超過七成的人口。

5. 過去二十年，香港的供水系統迅速擴展。在港島、九龍及一些早期發展的新市鎮（例如荃灣、觀塘）範圍內的食水管，大部分都是在五十至七十年代期間敷設，而這些地區的鹹水管則很多都是在七十年代敷設。雖然水管的預定使用年限一般很長（食水管為50年，而鹹水管則為20年），不過，水管的實際使用年限卻受到多項因素影響。一般來說，香港約有30%的水管估計已敷設超過25年，而水管預定的使用年限亦會在未來20年內屆滿，需要予以更換或修復。

水管爆裂問題

6. 水務署署長表示，水管發生爆裂，主要是外在的干擾因素所造成，包括道路工程、掘路過深、交通負荷過重、地面震動及地層移動等。只有小部分的水管問題，是與喉管漸變殘舊或受到侵蝕等喉管用料退化問題有關。統計數字顯示，過去六年所發生的水管爆裂事件中，平均有
28%是建築工程所引致的，另外52.9%則由其他外在的干擾因素所致，例如掘溝工程引致地面下陷，又或重型車輛停留在行人道上令地面荷重而下陷等，唯有19.1%的事件是因水管受到腐蝕或侵蝕而引起。

7. 一九九零／九一至一九九四／九五年度期間，水管爆裂問題似乎逐漸受到控制。不過，一九九五／九六年，亦即最近期的水管爆裂事件統計數字，卻惹人關注。因水管爆裂而須由水務署定期合約承造商進行修理的事件，在一九九零／九一年度共1,056宗；一九九一／九二年度1,141宗；一九九二／九三年度1,202宗；一九九三／九四年度1,108宗；一九九四／九五年度993宗；而一九九五／九六年則為1,313宗。自一九九二／九三年度起，水管爆裂事件的數目有下降的趨勢。不過，到一九九五／九六年，數字又大幅回升。與一九九零／九一至一九九四／九五年度這幾年的平均數字(每年1,100宗)比較，一九九五／九六年度的升幅達19%。此外，並非由外在干擾因素(例如水管受侵蝕)引起的水管爆裂事件亦有所增加，由一九九零／九一至一九九四／九五年度每年平均17.9%增至一九九五／九六年度的24.1%。鑑於水管爆裂事件有增加趨勢，當局實有必要對這種情況進行審慎的評估。

預防水管損毀工作小組及喉管爆裂問題顧問研究

8. 鑑於水管因損毁而嚴重爆裂的事件有所增加，當局早於一九九一年十月已成立一個跨部門的預防水管損毀工作小組，成員包括水務署及路政署的代表。該工作小組其中一項職責，是要檢查道路和工程合約條款及細則的規定，是否足以保障地下水管免受損毀，以及在水管損毀時，是否能夠確立有關人士須承擔責任。為配合工作小組的工作，水務署在一九九二年九月聘請顧問公司展開一項研究，檢討本港喉管出現問題的成因，並評估問題的嚴重程度。工作小組及顧問公司均有提出多項建議，以解決水管爆裂問題，而水務署亦參照當中部分建議，制定一系列的措施，預防及減少本港所發生的水管爆裂事件(詳見下文第9及10段)。
水務署現時在預防和減少水管爆裂事件方面所採取的措施

9. 近年，水務署採取了多項措施，以預防和減少水管爆裂事件發生，主要包括:

(a) 選用更堅固和質素更佳的喉管 - 該署訂定並推行了一項計劃，選用用料更堅固和質素更佳的喉管替換現有的舊喉管。

(b) 水務署的道路工程視察組 - 一九九五年，水務署在轄下五個分區(港島及離島區、九龍東及西貢區、九龍西及葵青區、新界西及荃灣區和新界北及沙田區)各設立一個道路工程視察組，每組的實際員額已達編制規定，包括一名水務督察、一名助理水務督察、八名二級監工及兩名汽車司機。（這五個道路工程視察組在一九九二年九月成立之初，「實際員額只是編制額的一半」。）小組的主要職責，是要按照擬訂的計劃，視察所有可能影響水務署現有水管的道路工程，並向工程承造商提供意見，以免承造商施工時損毀水管。這些小組的視察範圍一般包括所有建築工程，例如築路、渠務、污水收集、煤氣管敷設及維修等工程，以及所有在道路上(行車道及行人徑)進行的公用設施電纜及電線敷設工程。上述小組的設立，已證明相當有效，能夠在某程度上預防和減少這些工程對水管造成的損壞。自一九九三／九四年度起，雖然這類建築工程的數量大幅增加，而且規模亦較大，不過，工程損毀水管的事件卻有所減少。

(c) 定期的更換及改善計劃 - 該署訂有計劃，定期更換殘舊和有問題的水管，以及遷移一些現有的水管，以改善供水系統。過去五年，水務署轄下五個分區每年所更換或改善的水管總長度平均約93公里，相當於同期每年全港水管累積總長度1.7%左右。

(d) 定期進行滲漏測試 - 水務署成立了一個中央的防漏組，監督在全港各區進行的滲漏偵測工作。該組定期進行有系統且具
成效的滲漏測試，務求能夠及早確定滲漏的位置，然後採取迅速恰當的措施予以補救。

(c) 制訂資產管理計劃 - 水務署已着手制訂資產管理計劃，目的是要擬訂一套全面而具成本效益的管理計劃，使該署能善用最新的科技來管理及保養本港的供水系統。這方面的研究工作已在一九九六年二月展開，並預期需時約14個月才能完成。

水務署在預防和減少水管爆裂事件方面考慮採取的其他措施

10. 水務署在預防和減少本港水管爆裂事件方面所採取的其他措施主要包括：

(a) 加強滲漏偵測改善計劃，使能更有效地確定供水系統出現滲漏的位置。

(b) 推行長遠的計劃，在未來20年更換殘舊的水管。

(c) 以不更換喉管的方式，修復殘舊及有問題的水管。

(d) 將現有的水管紀錄圖則數碼化，以便能夠善用電腦化地圖繪製系統，令更新及翻查資料更為便捷，與在其他公用設施機構及政府部門交換資料時，亦可更為方便。

為保護水管而訂明損毀水管人士須承擔合約及刑事上的責任

11. 目前，道路工程合約或施工許可證的條款一般均有規定，倘有關的承造商損毀水管，必須向政府作出賠償。此外，據本署所知，水務署在某些情況下，亦可提出民事訴訟，向損毀水管的人士追討賠償。不過，本署備悉，自一九九三年以來，水務署在這方面未曾提出過一次民事訴訟。

12. 根據水務設施條例第31條的規定，損毁水管的承造商除須承擔民事方面的責任外，亦會視乎個別事件的情況，或須承擔刑事責任。不過，據本署所知，基於多項原因，包括難以搜集足夠證據令違例者被定罪等，水務署一直是不大願意採取檢控行動。
觀察所得

13. 水務署的紀錄顯示，過去六個財政年度，平均每天有3.1宗水管爆裂事件(見上文第1段)。不過，並非所有水管爆裂事件均會引致供水中斷，因為以現時的科技而言，是有方法可將損毀的一段喉管分隔進行修理，而毋須暫停供水。

14. 水務署的紀錄亦證明，香港的水管爆裂事件主要肇源於外在的干擾因素，包括道路及其他建築工程。現時，香港的基礎建設發展步伐相當急速，因此，當局必須就上述問題制訂適當而有效的預防策略及措施。

15. 調查期間，本署亦發現一些問題，主要是：

(a) 水務署現時有關水管敷設日期，以及喉管用料等資料的紀錄並不完備，或會對該署制訂具成本效益的水管更換策略構成障礙。

(b) 道路工程覈查組並無法定權力，可以着令道路工程承造商暫停施工，即使當時的情況確有此需要。

(c) 水務署必須重新並加強教育道路工程承造商，使他們明白有需要保護在施工地盤或附近範圍內的水管免受損壞。

(d) 根據水務設施條例的規定，損毀水管的最高處分只是罰款5,000元，懲罰實在過輕。水務署已建議將罰款提高至25,000元。

結論

16. 本署審悉，水務署完全明白該署有責任亦有需推行有效的預防措施。事實上，該署亦已採取相當積極的行動，預防水管爆裂事件發生，而且大致上很有成效。本署亦明白，世界各大城市的供水系統，都會有水管爆裂事件發生。不過，縱使實情如是，亦無法改變一項事實，那就是水管爆裂事件始終是市民關注的問題，而箇中理由亦顯而易見。所謂預防勝於治療，水務署必須抱着持之以恆的態度，適當地處理這方面的問題。
建議

17. 本署提出共10項建議，供政府當局考慮：

(I) 更換有問題的水管

(a) 嚴格監察及定期評估有問題水管的狀況，並考慮是否需
要向政府當局申請撥款，使能按照需要重新編訂及提前
實施有關的水管更換計劃。

(II) 加強現有的預防措施

(b) 鑑於本港的道路工程數目不斷增加，當局應考慮是否需
要重新加強教育道路工程承造商，要求他們遵守恰當的
施工守則行事，避免在施工時損毀水管。

(c) 考慮是否可以在簽發路許可證之前，要求道路工程承
造商繳交適量的按金，以備承造商在施工期間損毀政府
產業(包括水管)時，作賠償之用。

(d) 留意道路工程視察組的人手規劃情況，確保人手足以應
付不斷增加的道路工程。倘若需要，當局應因應一些已
知道會展開的大型基建及發展工程項目而制訂長遠的道
路工程視察計劃。

(e) 考慮是否可以在路政署簽發的掘路許可證加入條文，賦
予水務署權力，可在該署認為繼續施工將會嚴重損毀水
管的情況下，着令道路工程承造商停工。

(III) 採取法律行動並加強阻嚇作用

(f) 加強檢控損毀水管的違例者，特別是屢犯者。

(g) 檢討水務署根據水務設施條例第31條的規定，以損毀水
管人士行為非莽率或嚴重疏忽為理由而提出檢控的現行
政策，並在有需要時就此事徵詢法律意見。
(h) 監察有關修訂水務設施條例現時所訂罰則（最高罰款5,000元）這項建議的進展情況。

(i) 考慮是否需要更積極地提出民事訴訟，追討賠償。

(j) 澗清當局在法律上是否可以引據刑事罪行條例，以刑事箝製罪名檢控損毀水管的人士，並適當當地加強檢控行動。

水務署的回應

18. 本署在一九九六年八月五日把本報告的擬稿送交水務署署長，以諮詢其意見。本署欣悉水務署署長對本報告的結論並沒有任何異議，而且大體上接納全部10項建議，現在只待研究實施細則。

結語

19. 水管爆裂已是眾所關注的問題，因為這個問題或會對香港市民造成諸多不便，同時亦或會對他們帶來巨大的經濟損失。因此，政府當局應該繼續竭盡所能，謀求良策，避免水管爆裂情況再次出現，從而盡量減少對市民所造成的不便，以及把對社會造成的損失減至最低。為達致這個目的，政府當局亦有責任定期檢討預防水管爆裂整體措施和計劃的各個範疇。

20. 最後，本署希望政府當局稍後能把上述10項建議的實施情況，以及本港供水系統政策上任何重大的改變，知會本署。

申訴專員公署
一九九六年九月
Executive Summary of the Final Results Report on the Problem of Water Main Bursts

Introduction

From time to time, there are reports concerning suspension of water supply due to bursts of water mains. This is a matter of concern to this Office and the public as sudden and frequent suspensions of water supply would undoubtedly cause inconveniences to the affected consumers. According to the Water Supplies Department (WSD), there has been a yearly average of 1,135 water main bursts requiring repairing work by WSD’s term contractors over the last six financial years from 1990/91 to 1995/96 with 604 cases involving fresh water mains and 531 flushing (sea) water mains. This represents an average of 3.1 such bursts per day.

2. As prevention and reduction of water mains bursts would be dependent on the availability and effectiveness of WSD’s relevant procedures and actions, this Office considered that it would be in the public interest to conduct a direct investigation into the matter to see whether there were adequate preventive measures and actions taken by the WSD to tackle any identified/potential problems in the present water supply system, including the ageing of the water pipes and bursts of such pipes resulting from construction activities such as roadworks. The Commissioner for Administrative Complaints (COMAC), by virtue of his authority vested in Section 7(1)(b) of the COMAC Ordinance (Cap. 397), announced in December 1995 an investigation into the procedures and actions of the WSD for the prevention and reduction of the occurrence of bursts of water mains. The investigation has recently been completed.

Purpose and Ambit of Investigation

3. The investigation has focused on the following aspects -

(a) WSD’s assessment of the current state of the water mains in Hong Kong, the size of the problem and whether it has increased
or decreased in recent years with the support of suitable statistical indicators.

(b) WSD's current strategies on preventing and minimizing bursts of water mains.

(c) Information on each of the preventive measures currently undertaken or under consideration by the WSD, including their scope, feasibility, financial and staffing implications, operational considerations, legislative progress, priority, effectiveness, etc.

(d) The progress in respect of the preventive measures referred to in para. (c) above.

(e) Other measures considered but rejected, including any experiences of overseas water authorities.

Water Supply System in Hong Kong

4. In Hong Kong, raw fresh water for treatment is fed either directly from the water system in China or from one of the storage reservoirs by gravity or via pumps through water tunnels or large diameter pipelines to the water treatment works. Water coming out from the treatment works is pumped and in some cases flows by gravity to the service reservoirs and then distributed to consumers through extensive networks of primary and secondary distribution mains, area distribution mains and submains. The WSD also supplies sea water for flushing to over 70% of the population throughout the urban areas and the new towns.

5. The water supply system in Hong Kong has been expanding rapidly in the past two decades. A large proportion of the fresh water mains on Hong Kong Island, in Kowloon and in the older generation of new towns, such as Tsuen Wan and Kwun Tong were laid in the early years (1950s, 60s and 70s). Many of the salt water mains in these areas were laid in the 1970s. While water mains generally have a long designed life (50 years for fresh water mains and 20 years for salt water mains), the actual service life depends on many factors. Generally
speaking, about 30% of Hong Kong’s water mains are estimated to be over 25 years old and approaching the end of their designed life in the next 20 years or so and hence may need to be replaced or rehabilitated.

Problem of Water Mains Bursts

6. According to the Director of Water Supplies, main bursts have primarily been caused by external disturbances including roadworks, deep excavation, heavy traffic loading, vibration and ground movement. Those due to deterioration of the pipe materials such as ageing or corrosion constitute only a small proportion of the overall water mains failures. Statistically, in the past six years, an average of 28% of main bursts were attributed to construction activities. Another 52.9% were caused by other external disturbances such as ground settlements brought about by trench works and traffic loading arising from parking of heavy vehicles on footpaths with only 19.1% attributable to external disturbances such as erosion and corrosion of water pipes.

7. The problem of water main bursts seemed to have been gradually contained during the period from 1990/91 to 1994/95. The latest main bursts figures for 1995/96 are, however, causing concern. There were a total of 1,056 bursts requiring repairs by WSD’s term contractors in 1990/91, 1,141 in 1991/92, 1,202 in 1992/93, 1,108 in 1993/94, 993 in 1994/95 and 1,313 in 1995/96. The downward trend in respect of the total number of water main bursts since 1992/93 was drastically reversed in 1995/96. Comparing to the average of 1,100 bursts for the period from 1990/91 to 1994/95, there was a 19% increase in 1995/96. Moreover, the percentage of water main bursts attributed to factors other than external disturbances (such as erosion, corrosion) has increased from an annual average of 17.9% (for the period from 1990/91 to 1994/95) to 24.1% in 1995/96. Such increases in the incidences of water main bursts call for a critical assessment of the overall situation.
8. In view of the increase in the occurrence of serious main bursts due to damage, an inter-departmental working group (named as the Working Group on the Prevention of Damage to Water Mains) comprising representatives of the WSD and the Highways Department (HyD) was formed as long ago as in October 1991 to, inter alia, review the adequacy of the provisions in contract conditions and specifications for roadworks construction activities in safeguarding against damage to underground water mains and in establishing liability in the event of damage. To complement the working group’s activities, the WSD commissioned in September 1992 a consultant to perform a study to review the factors which contributed to pipeline failures in Hong Kong and to assess the seriousness of the problem. Both the Working Group and the consultant had made various recommendations to redress the problem of water mains bursts and some of such recommendations subsequently formed the basis of a series of measures adopted by the WSD for preventing and minimizing main bursts in the territory (paras. 9 and 10 below).

Current Measures Undertaken by the WSD for Preventing and Minimizing Main Bursts

9. The WSD has in recent years been undertaking various measures for preventing and minimizing main bursts in the territory and they include notably the following ones -

(a) **Use of stronger and better quality pipe materials** - A programme has been drawn up and put into practice for replacing existing old pipe materials by stronger and better quality pipe materials.

(b) **WSD’s Roadworks Inspection Teams (RITs)** - The WSD has since 1995 set up a full strength RIT comprising 1 Water Works Inspector, 1 Assistant Water Works Inspector, 8 Works Supervisors II and 2 Motor Drivers in each of its 5 Operational Regions (i.e., Hong Kong & Islands, Mainland South East, Mainland South West, Mainland North West and Mainland North East).
(Such teams were initially set up at 'half strength' commencing from September 1992.) The main duty of such a team is to carry out planned inspections to all roadworks which may affect the existing WSD water mains and to give advice to the contractors to prevent damage to water mains. These inspection teams normally cover all construction activities including road construction, drainage work, sewerage work, gas main laying and maintenance, all public utility cable and wire laying work which take place on roads (carriageways and footpaths). The setting up of the RITs have apparently proved to be a worthwhile measure in preventing and reducing damages to water mains caused by such activities. These damage cases have declined in number since 1993/94 despite the fact that the number and scale of construction activities have increased rapidly during the same period of time.

(c) **Regular replacement/improvement programmes** - There are in place regular programmes for replacing aged and problematic mains and for re-locating existing water mains with a view to improving the supply system. The average total length of new replacement and improvement mains laid by the WSD's five Operational Regions was about 93 km in each of the past five years, representing about 1.7% of the accumulated total length of water mains in the territory per year.

(d) **Regular leak detection tests** - A centralised Waste Detection Unit has been established to oversee all leakage detection work over the territory. This Unit is responsible for carrying out systematic and effective leak detection tests at regular intervals to locate leaks at an early stage so that appropriate remedial measures can be promptly taken.

(e) **Development of an Asset Management Plan (AMP)** - The WSD has undertaken to develop an AMP, the purpose of which is to develop a comprehensive and cost-effective management plan for operating and maintaining the local water supply system by employing the latest available
technology. A relevant study has been commissioned since February 1996 which will take some 14 months to complete.

Other Measures Under Consideration by the WSD for Preventing and Minimizing Main Bursts

10. Other measures taken by the WSD to prevent and minimize main bursts in the territory include notably the following -

(a) Enhanced waste detection improvement plans for more effectively identifying any leakage spot in the water supply systems.

(b) Long term programmes for replacing aged mains in the next 20 years.

(c) Rehabilitation of aged and problematic mains without replacement.

(d) Digitization of existing mains record plans so as to make a full use of the computerized mapping systems for easy updating, retrieval and information exchange with other public utilities and government departments.

Contractual and Criminal Liabilities in Connection with the Protection of Water Mains

11. At present, provisions are generally available under the relevant roadworks contracts or excavation permits requiring contractors concerned to recompense the Government in the event of any damages caused by them to the water mains. In addition, it is understood that the WSD itself can, under appropriate circumstances, also institute civil proceedings to claim compensations against the wrong-doers. This Office notes, however, that since 1993, the WSD has instituted only one such case of civil proceedings.

12. Apart from civil liabilities, a contractor may, depending on the circumstances of the particular case, be held criminally liable for any damage caused by him to a water main under Section 31 of the Waterworks Ordinance. This Office notes, however, that the WSD has been
reluctant in instituting prosecution actions because of, inter alia, difficulties in gathering sufficient evidence to secure a conviction.

Observations

13. According to the WSD records, there has been a daily average of 3.1 water main bursts over the last six financial years (para. 1 above). However, not all of such bursts would necessarily result in the suspension of water supply because of the availability of technology to isolate a damaged section for repair without the need for an interruption of supply.

14. The WSD records readily support the fact that main bursts in Hong Kong are mainly due to external disturbances including road works and other construction activities. Given the rapid pace of infrastructural developments currently experienced in Hong Kong, it is imperative that adequate and effective preventive strategies and measures should be devised.

15. In the course of our investigation, this Office has also discovered mainly that -

(a) The present WSD's records on the dates when the water mains were laid and the pipe materials used are incomplete and this may pose a hurdle to the department formulating a cost-effective water mains replacement strategy.

(b) The RITs have no legal power to require the roadworks contractors to immediately cease work even if circumstances warrant so doing.

(c) It is necessary for the WSD to renew and strengthen its efforts in educating the roadworks contractors on the need to protect water mains located at their work sites or in the vicinity thereof.

(d) The maximum sanction for causing damage to a water main provided in the Waterworks Ordinance is only $5,000 which is grossly inadequate. The WSD has recommended the fine be increased to $25,000.
Conclusion

16. This Office notes that the WSD is fully aware of its responsibility and the need for effective preventive measures. Considerable efforts have been made in the prevention of water main bursts and these efforts have largely proven to be fruitful. This Office also appreciates that there is no water supply system in major cities of the world that is totally free from water main bursts. This reality, however, does not change the fact that the problem of water main bursts remains, for obvious reasons, a matter of public concern. The issue is therefore clearly something which must continuously be addressed properly by the WSD as prevention is better than cure.

Recommendations

17. This Office has made a total of 10 recommendations for consideration by the Administration -

(I) Replacing Problematic Water Mains

(a) To critically monitor and perform continued assessment on the conditions of problematic mains and consider the need for applying for necessary funding from the Administration in preparation for rescheduling and advancing the respective mains replacement programmes where necessary.

(II) Strengthening Existing Preventive Measures

(b) To consider the need to renew and strengthen the efforts in educating and requiring roadworks contractors in following proper work practices to avoid damages to water mains in the light of the growing number of roadworks activities in the territory.

(c) To consider the feasibility of requiring the roadworks contractors to place an appropriate deposit against damages caused to government properties including water mains before granting excavation permits.
(d) To keep in view the manpower planning for the RITs to cope with the ever increasing roadworks activities. Where necessary, to formulate long term plans for roadworks inspections taking into account known large scale infra-structure construction and development activities in the future.

(e) To consider the feasibility of including in the excavation permit issued by the HyD the power for the WSD to stop roadworks which, if allowed to continue, would cause serious damage to water mains.

(III) Taking Legal Action and Enhancing Deterrent Effect

(f) To step up prosecution action against offenders, in particular repeated offenders, causing damages to water mains.

(g) To review WSD's current policy regarding initiating prosecution actions under Section 31 of the Waterworks Ordinance against persons causing damages to water mains on grounds of recklessness or even gross negligence, and to seek legal advice on the matter if necessary.

(h) To keep in view the proposal to revise the current level of the penalty (a maximum of $5,000) provided in the Waterworks Ordinance.

(i) To consider the need for taking more civil actions, where necessary, for recovery of damages.

(j) To clarify the legal position regarding the applicability of the Crimes Ordinance in prosecuting persons causing damages to water mains for the offence of criminal damage and step up prosecution action as appropriate.
Response from the WSD

18. This investigation report was sent in draft to the DWS for comments on 5 August 1996. This Office is pleased to note that the DWS does not dispute the conclusion of the report and has accepted, on the whole, all of the 10 recommendations, subject to details of implementation to be worked out.

Final Remarks

19. The problem of water mains bursts has already been a matter of public concern because of the various inconveniences and hefty economical costs it may cause to our community as a whole. The Administration should therefore continue to work out the best possible strategies to prevent the occurrence of water main bursts in order to minimize such inconveniences and social costs. It also remains the responsibility of the Administration to keep every aspect of the overall preventive measures and plans under constant review in order to achieve the same purposes.

20. Lastly, this Office would like to be kept informed by the Administration in due course on the implementation of the 10 recommendations and any major changes in the policy of the water supply system in Hong Kong.

----- End -----

Office of the Commissioner for Administrative Complaints
September 1996
HK 628.15 H7
Hong Kong, Office of the
Commissiones for
administrative Complaints.
Report of the investigation on
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