Water Mains & Leakage Control:

All Water Companies are directed to reduce leakage to manageable and cost efficient levels in AMP3, It is likely that this directive will continue to be applicable in AMP4 and probably even more so in AMP5 when even more stringent targets will be set by the environmental lobby and political drivers.

However, whatever directive and funding is applicable, it is logical if not essential that modern materials and methods of operation are used to ensure that the most efficient use is made of diminishing resources, in short - it is not prudent to design and install water mains and services in the same manner as we did 50 years ago, or even 20 years ago for that matter.

The paper is intended as a review of the methods of operation and installation of apparatus in a rapidly changing environment for delivering water services to new and existing customers

It is intended to reduce both Capital Expenditure (CAPEX) and Operational Expenditure (OPEX) in the creation and maintenance of water supply schemes.

Objective:

To construct and manage maintenance free water distribution systems cost effectively.

Scope:

The creation of new assets and the upkeep of these new and existing assets in relation to the water distribution system and including trunk mains and services, but excluding booster stations, service reservoirs and water towers.

Contents:

Format:

I have tried to keep what could have become a large wordy document in a “readable” format, with key sections emboldened to draw the reader’s eye.

References are as shown in the respective appendices.

1 Setting the scene:

We lay new mains and services, rehabilitate existing mains and maintain these mains and services as a requirement to provide customers with an “adequate” and wholesome water supply.

In considering how these requirements are met: -

We have to continually challenge ‘the way we do things’ in order to make progress

- Do we continue to use new materials in old-fashioned ways?
- Are we using new technology to its best advantage?
- Can we use technology to drive down costs – especially **LEAKAGE** ?
- Is improved customer service a conflict of interest or an achievable goal?
- Do we need to maintain the distribution system?
- Can we reduce or remove **liability** for assets in the Public Highway?
- Benchmark ourselves on similar industries (Gas) where leakage is none existent.

What are the ground conditions to be found on site?

- Contaminated Soils
- Heavy plant & material stores
- Programme of operations
- Other utilities

What “political” implementations are there on site ?

- Sensitive areas (SSSI’s)
- Noise pollution
- Off peak working hours
- Traffic control
- Delivery & storage of materials
- Programme of other utilities work.

Health and Safety issues

- Safe working conditions
- Deep excavations
- Safety of the general public
- Safety for the work force
- Changing rooms & toilet facilities

Operational Issues

- Maintenance of apparatus
- Removal of “trip hazards”
- Highway adoptions

Manage installations effectively:-

The following is NOT acceptable !!!!!!

2 Water Mains

- New technology in the form of polyethylene pipes has offered water companies the opportunity to lay 'permanent assets'

- Extensive tests carried out by and on behalf of the water industry have led to the conclusion that polyethylene pipe can be expected to maintain its characteristics of strength and flexibility, without degradation, for hundreds of years
  - Providing the design rules regarding pipe pressure rating are adhered to and ground conditions regarding contamination are observed.

- The only self-imposed restriction that might prevent our mains network becoming a complete leak-free permanent asset rests with: -

- Our ability to weld the pipes **correctly**, and the necessity to install and maintain mechanical fittings on the network

a) Welding of pipes

- Nothing could be more relevant to the TQ concept of 'getting it right' first time than that of welding PE pipe.

- The water industry has come a long way in education and training of personnel associated with mainlaying. Proper site conditions including appropriate tools and equipment, preparation and cleanliness of the pipe surface to be welded and a knowledge of the operation of welding equipment are all paramount to securing a sound weld.

- As PE pipe and welding machine technologies and mainlaying techniques move forward, there is a necessity to promote improvement through training to keep pace with these developing technologies and techniques.

- Awareness training with annual assessment of welders together with 'joint ownership' should be applied by the industry in order to continue to guarantee high quality joints and use the new technologies and techniques to best advantage.

- These matters will not be pursued in this project paper. This information is documented elsewhere with further information being available from various sources

b) The necessity to install and maintain mechanical fittings

- Stop taps and sluice valves constitute by far the largest number of mains fittings on the distribution system and there are generally two reasons why we have installed sluice valves in the past.

i) To enable a section of main to be isolated whilst new mains or service connections are being made to the existing system

ii) To enable a section of main to be isolated in the event of a leak or burst

- With the introduction and development of under pressure drilling technology, valves are no longer required to control the installation of new mains and service connections onto the existing distribution system

<u>This leaves only one reason for installing most valves on the system, namely to isolate in the event of a leak or burst.</u>

- Up until the introduction of PE mains, previously used mains materials, both metals and plastics, were manufactured in lengths no greater than 6 metres with mechanical joints used as the method of jointing.

- Not only the joints, but also the pipes themselves were and are prone to failure, either through corrosion or ground movement and valve control was seen as an important asset to facilitate the repair of the mains.

- Over recent years we have seen the introduction of the repair clamp, which allows the repair of mains insitu and under pressure, which in many instances can be used and is a great improvement on the traditional method of isolation, cutout and replacement (involving more joints, including mechanical flanged joints, and thus increasing the potential for future failure)

- But by far the biggest technological leap forward has been the introduction of PE pipes, which provides a joint less system apart from its interruption to install on-line fittings such as valves, hydrants and meters.

- **There are <u>no</u> recorded instances of PE pipe failure as a result of material degradation or operational activities.**

- **<u>Failures have been confined to joints as a result of bad jointing practice.</u>**

- Because a properly constructed PE system is leak free (apart from potential leakage from the mechanical joints of fittings) then the only need to isolate a section of main would be as a result of a burst and the main would burst, only as a result of accidental damage.

- **Therefore valve control is only required on new PE systems generally for the event of <u>accidental</u> damage.**

- Therefore by reducing the number of valves we install on our new systems we will reduce the number of mechanical joints and therefore reduce further the potential for joint leakage and the **<u>COST</u>** of carrying out the work in the first place.

- Pipe squeezing is available and successful on water mains up to and including 180mm OD with the squeeze-off made much easier with the introduction of the 8 bar thinner walled pipe.

- **In the absence of valves squeeze-offs will only be required in the event of accidental damage !**

- Maintenance of valves except on the larger mains is expensive and should be “designed out” wherever possible.

- Conventional operational standards state that ‘valves on 600mm mains and larger shall be operated and visually inspected on an annual basis’. There is no requirement for the maintenance of valves on mains less than 600mm.

- Do we therefore perceive that our valves as unimportant with little need to operate?
  or do we continue to subscribe to the unspoken philosophy ?
  - install an abundance of sluice valves that require a heavy maintenance and expense.

- **We should now feel confident to view differently the installation of valves on new PE mains.**

3a Water Services:

- The water industry has laid polyethylene service pipes since the mid eighties, with the 'communication' element of the service pipe laid by the company, from the water main to the boundary of the property with the street.

- The communication pipe has previously terminated at a boundary box before continuing into the property with the 'supply' pipe, laid on behalf of or by the homeowner and for which they are responsible.

- The connection onto the PE main is in the form of an electrofusion ferrule with mechanical joints into and out of the boundary box.

- **Therefore such an arrangement is not conducive to the need to remove joints and therefore potential sites for leakage which could be <u>before the meter</u>.**

- **There is also the potential insurance issue of "trip hazards" of the boundary box in the public highway, not to mention the maintenance of such apparatus that requires expensive excavation and reinstatement – this is particularly important with the implementation of the New Street Works Act and financial liabilities placed on a Utility, Anecdotal evidence indicates that any boundary box repair can cost well in excess of £1,000, and possibly up to £ 50,000 if insurance claims are taken into account,**

- Further, pressure being applied by the water industry regulator for water companies to accept the maintenance of service pipes up to the point of delivery, i.e. the side of the property being served.

- **It therefore follows that if the communication pipe were connected to the water main with an electrofusion coupling, then the same principals of joint free / leak free services would be applicable. Parallels to the Gas industry can be drawn where exactly the same pipe technology produces a zero leakage scenario.**

- Service pipes can be easily squeezed off to eliminate flows in the event of an emergency.

- Legal issues in regard the interpretation of the Water Industry Act 1991 are covered in Appendix A

3b. Existing Systems:

<u>The water industry uses two forms of water management facility, both of which are provided by the water companies, leading to inefficiencies in handling and often damaged during installation.</u>

Boundary boxes:

- Traditionally the location of control valve to a property.
- Usually located at the back of the footpath.
- Are not particularly suitable for new meter technology
- Are not customer friendly - poor accessibility in a public space
- Are not easily installed - require levelling to avoid trip hazard
- Are expensive to install - require heavy excavation plant etc.
- Are expensive to maintain. - require expensive excavation to give access.
- Potentially a site for leakage - more joints on pipe work
- OFWAT seeking to get water companies to <u>maintain</u> all pipe up to the dwelling.

Groundbreaker
Facilitates solutions to all of the above problems by:-

- Removing the need for and liability of Street Furniture
- Being fixed to the outer wall of the structure rather than being built into it.
- Meeting the requirements of OFWAT for water supplies to a property.
- Providing the simplest solution to water supply requirements,
- Facilitating the reduction of water leakage by eliminating joints in pipes.
- Being at ground level allows for flexibility water service in house designs.
- Allowing the developer or MU Contractor to install the meter box & service pipe himself, ***With his labour at his rate within his programme of events.***
- Meeting all Water Regulation requirements.
- Facilitating implementation of new meter reading technology including AMR
- Providing full accessibility for both customer and Water Company.
- Secure by Design
- Facilitates AMR & AMM meter reading systems (up to 5x more range than boundary boxes.

Please note: There is no product similar to Groundbreaker on the market !

4 Proposals:

- The reduction of sluice valves on all new and relay schemes.
  i.e. 1 No sluice valve per 100 No properties.

- Squeeze-off equipment should be used for pipes up to and including 180 dia to instigate a repair, in place of sluice valves.

- The installation of hydrants for washout or air-scouring purposes on new and relay schemes should be reduced.

- 8 Bar pipe should be promoted. 8 Bar is more than adequate for 95% of distribution mains (up to and including 225 mm dia.)

- Careful use of bedding, surround and backfill if not "**No dig technology**" should be encouraged.

- Use of **Electrofusion joints** wherever possible, joint records being retained.

- Appropriately qualified operators using the correct equipment used only.

- Encourage the use of **wall mounted water management systems** to measure water "At the point of delivery"

Appendix A – Legal & Regulation Issues

A.1 OFWAT directives;

- Promoting competition and Customer Service in Water Industry.
- Reduce leakage from service pipes to single digit %.
- Water Undertaker responsibility for whole of Service pipe – ***"owning" that under the highway, and "maintaining" that under private property*.**
- Requiring efficiencies in the Water Industry.
- Allowing meters to be installed on existing properties on changing hands.

Water Industry Act 1991;

- Allows Water Undertakers to delegate powers as appropriate.
- Allows for the vesting of equipment in the Undertaker as appropriate.

Water Regulations Act 1999;

- Revokes all previous Water Bye laws.
- Requires new service pipes to be sealed prior to connection.
- Allows for self-certification of work by developers.

Competition Act 1998;

- Allows the Director General for Water Services (OFWAT) to take action against companies for abuse of a dominant position.

Water Industry Act 2003;

- Updates 1991 Act, provides more transparent financial arrangements to developers

Building Regulations, Part M;

- Amendments to dwelling design criteria, for accessibility and lifestyles.

Building Regulations, Part Q:

- In draft form – looks at the provision of Broadband to new properties

New Traffic Management Act

- Utilities responsible for assets in highway, levy of fines.

EC Directive:

- To reduce plumbsolvency in increments by 2003 / 2103.

- **A.2 Legal Issues:**

  - **Under the Water Industry Act 1991**
    - **Section 45(6) -**

      Water Companies can only recover an amount equal to the expenses reasonably incurred in carrying out water connection work.

    - **Section 46(1) -**

      Duty to "lay so much of the service pipe as is necessary.

      - **46(3)c ii –**

        Requires the service pipe to "have a stopcock fitted to it by the undertaker (or his agent) in the premises" (my underline)

        Allows for the water undertaker or his contractor to carry out such duties, **a self laid, self certified pipe vested in the undertaker would meet this requirement.**

    - **Section 46(5) –**

      Makes reference to a distance of 18 metres from the centre line of the street as the limit of the water communication pipe, but makes no mention of the maximum length of the entire service pipe. It therefore follows that a water undertaker can effectively set its own definitions within the definitions of Section 47.

      Perhaps the most practical interpretation is to use PA Lamont's histogram (copy attached) to calculate the practical length of service pipe to individual properties

    - **Section 46(6) –**

      States that is the duty of the water undertaker to ensure that a stopcock is fitted on a water service, that will be owned by the water undertaker, but does not state where that must be, nor that it must be fitted by the water undertaker.

    - **Section 47(c)**

      Within the conditions of connection to a water main, the water undertaker "may make compliance with one or more of the requirements ....." of which 47(c) is the requirement for a water meter to be fitted in accordance with the specifications by that undertaker. It therefore follows that the water undertaker can define what and where it requires the wall mounted water meter to be installed, this has been confirmed by OFWAT.

    - **Section 49**

      Supplemental Provisions with Respect to the Metering Conditions, paragraph 2 (a)(b) continues and clarifies that the Undertaker shall publish the specifications approved by the Undertaker under Section 47 2(c) or (d) in such a manner as he considers appropriate.

      Therefore, as long as a water undertaker gives notice to developers within its area, and that the conditions set out are reasonable then the water undertaker has powers to define where the water meter shall be.

    - **Section 162**

      Provides the power to the Undertaker to carry out works in connection with metering as specified in sub-section (3) and more specifically the "installation of any pipes or other apparatus on the premises" whether it be by the Undertaker or a contracted company. A wall mounted meter box would fall into the category of "other apparatus".

- Section 163(2) –

Provides that the stopcock must be fitted **as close as practicable** to the boundary of the street in which the water main is laid.

Practicality should mean that the water undertaker takes into account recent legislation such as the Traffic Management Act that imposes duties and costs in the maintenance of street furniture.

Practicality also means the removal of potential sources of LEAKAGE such as joints on service pipes by removing street furniture.

Practicality means that water meters should be accessible to the undertaker and customer alike to make their reading easier and more cost effective; meters in holes in a footpath or garden are not accessible.

NB: The WATER METER should be as close as PRACTICABLE to the property served

- **Section 219 – definitions –**

Does to some extent define the limits of responsibility to the ownership of apparatus, but this is mitigated by the powers available to a water undertaker to define what and more importantly what is not adoptable by the water undertaker.

- **Water Supply (Water Fittings) Regulations 1999.**

  - Section 4 requires any water fitting to be compliant with appropriate quality and standards of manufacture.

  - Sections 5, 6 & 8 allow for **self-certification** of work carried out by **appropriately qualified persons.**

  - **Section 10 requires that every supply pipe shall have a stop valve Conveniently located to enable the supply to that premises to shut off to that sole property.**

  - Requires that the ends of the service pipe be “sealed” to prevent the ingress of foreign bodies during the construction period.

The best method of sealing the pipe is to make a connection to the stop valve and meter assembly (Groundbreaker).

Appendix B Technical Issues:

- **Plastics Technology**
  - Resistant to impact & corrosive substances.
  - UV stable and receptive to thin surface treatments.

- **Frost Protection**
  - WIS 4.37.01
  - BS 6700
  - Water Regulations G4.4 - 12

- **WRAS & WRc approval**
  - Precautions against freezing of water - WRAS ISG 0-02-02
  - Selection of materials for use in contaminated land – WRAS ISG 9-04-03

- **Simplicity of fittings**
  - Control Valve WIS 4.23.04
  - Non Return Valve WIS 5.11.01
  - Manifold WIS 4.37.01
  - Meter Connection WIS 4.37.01 - 1.5" BSP thread
  - Connections WIS 4.32.11 or greater

- **Simplicity of operation**
  - Accessibility for customer
  - Accessibility for Service Provider

- **Simplicity of maintenance**
  - Extended design life.
  - Accessibility for customer
  - Accessibility for Service Provider
  - Remote reading facility.

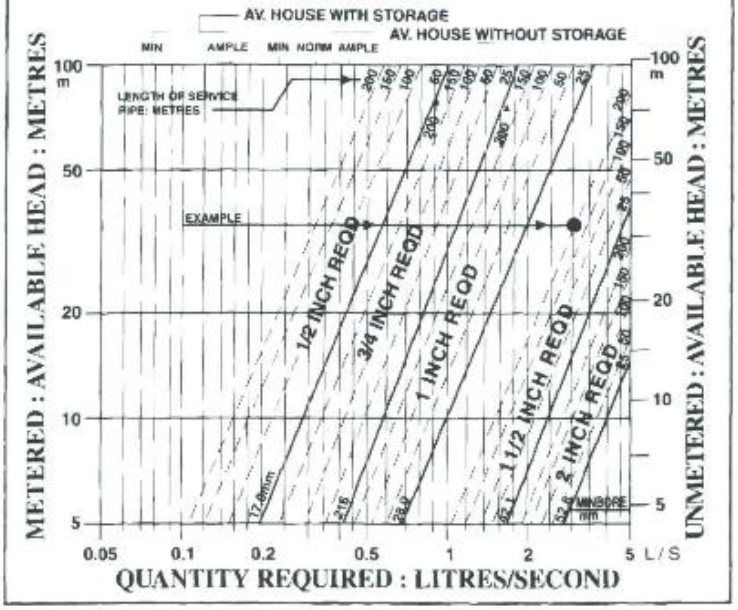
- **Meter accessibility**
  - Accessibility for customer
  - Accessibility for Service Provider
  - Remote reading facility.

- **Meter reading**
  - To meet all existing and future technologies (AMR & AMM)

- **Meter exchange**
  - Accessibility for customer
  - Accessibility for Service Provider
  - Multi service capacity to other utility service providers

DESIGN CHART FOR SERVICE PIPES OF P.V.C.

UNPLASTICISED P.V.C. TO B.S. 3505:1968 (AMENDED 1975)
CLASS 'E' (1/2, 3/4 & 1 INCH) : CLASS 'D' (ABOVE 1 INCH)



NOTES

AVAILABLE HEAD:- is the difference (M) between head in supply main & height at which water is required to be delivered (say 6M to ioft of average house).

LENGTH OF SERVICE:- is total length (M) from main to highest point at which water is required (say horizontal length + 6M for average house).

LOSS OF HEAD:- Allowance has been made for pipe friction (Colebrook:Smooth) and losses through S,C. ferrule, stopcock, meter (positive type) & outlet fittings.

EXAMPLE

Size required to supply 3L/S through metered service 200M. long with available head of 35M.
ANSWER: 1¼ inch (3.0L/S max.)

Information and diagram by P.A Lamont

NOTES

AVAILABLE HEAD:- is the difference (M) between head in supply main & height at which water is required to be delivered (say 6M to ioft of average house).

LENGTH OF SERVICE:- is total length (M) from main to highest point at which water is required (say horizontal length + 6M for average house).

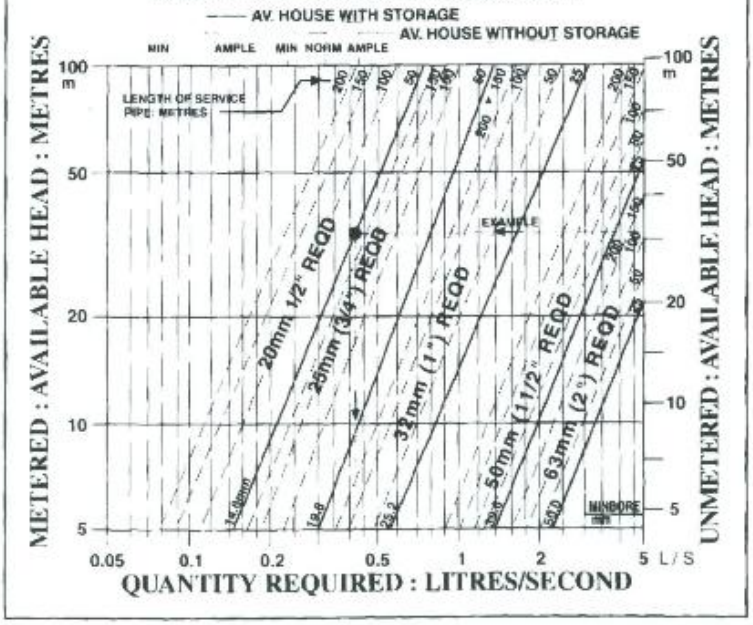
LOSS OF HEAD:- Allowance has been made for pipe friction (Colebrook:Smooth) and losses through S,C. ferrule, stopcocks, meter (positive type) & outlet fittings.

EXAMPLE

Size required to supply A.V. house (unmetered, without storage) with service 50M long and available head of 30M.
ANSWER: 20mm (¾)(14.8 min bore) delivers 0.42L/S (ample).

Information and diagram by P.A Lamont

DESIGN CHART FOR SERVICE PIPES OF POLYTHENE MEDIUM DENSITY: B.S. 6572



Appendix C

Insulation Matters:

Water in an exposed situation will freeze – this is a statement of fact.

However there are a number of factors that can affect the time it takes for that water to freeze.

- The volume of water likely to freeze
- The pressure at which water is held.
- The movement of the water likely to freeze
- The material used to contain the water
- The amount of insulation wrapped around the material containing the water.
- The environment in which the water is located
- The temperature range to which the water is exposed
- The time of exposure of the water to temperatures that would cause freezing

Given that modern materials such as mdpe offers natural insulation to water contained within them, i.e. water in a 25mm OD poly pipe will only start to freeze after 12 hours exposure to temperatures as low as -18^0 C (Source Glynwed Pipes).

Movement of water to a property is a natural protection to a pipe; therefore prolonged periods of static water during cold periods should be monitored carefully.

However, the reference winters of 1947 & 1965 indicate that sub zero temperatures are only applicable for limited periods and that with careful planning damage to pipes and freezing of water within them can be avoided.

Whilst the "thermal envelope" of a dwelling is generally assumed to be the inner surface of the external wall to that property for ease of calculations; there is evidence that leaching of heat from inside to outside a property is a very real factor – up to 0.25 W/mK (source Building Research Council).

This phenomenon is often manifested as a frost-free apron around a dwelling even on the coldest of days.

The final consideration is therefore "risk assessment" of what is required to eliminate freezing of pipes within the UK, given the range of temperatures known to exist and referring back to the winters of '47 & '65 the standard tests to measure resistance to freezing is described in Water Industry Standard (WIS 4-37-01) this assumes no external heat source to the water pipes.

However, it follows that if sufficient insulation is placed around a pipe even in an external and exposed location, the freezing of the water within that pipe can be delayed to a point beyond that at which freezing would otherwise occur.

In providing insulation, two factors have to be considered, should this insulation be Passive or Active – either relying on its own mass and thermal resistivity for protection, or electro / mechanical devices that could be subject to failure at critical times.

We at Steve Leigh & Associates have carefully considered the issues and concluded that an insulated duct to the water pipes leading to and from Groundbreaker provides all the thermal insulation to protect the pipes from the British seasonal variations.

The duct provided allows for a minimum of 38mm of closed cell insulation with thermal properties of 0.031 W/mK at 0^0 C (0.027 W/mK at -50^0 C)