

AIR SCOURING OF WATER MAINS - AN ASSET MANAGEMENT APPROACH



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ABSTRACT

Mains cleaning programs are now common practice in the water industry to improve or maintain drinking water quality to meet business plan targets, guideline requirements and customer expectations. In addition to cleaning the mains, a carefully planned program provides the additional opportunity to collect important system asset information.

Western Water commenced a systematic mains cleaning program in year 2000 primarily using air scouring technique. The mains cleaning program compliments a wide range of treatment plant improvements completed over recent years. The program is also driven by Western Waters' strategic plan to control taste and odours throughout the water supply system.

This paper discusses:

- ◆ issues that lead to Western Water implementing a system wide mains cleaning program;
- ◆ the air scouring process;
- ◆ critical operational and planning activities undertaken as part of the mains cleaning program; and
- ◆ systems developed to collect and digitise system asset information.

KEYWORDS

Air scouring, GIS, Water Quality, Asset Management.

1.0 INTRODUCTION

The primary objectives of supplying potable water to Western Water customers is to ensure that the product is clear, safe and pleasant to drink, meets appropriate drinking water quality standards, delivers business plan targets and the requirements of our Customer Charter.

Over recent years many water quality improvement works have been completed throughout Western Water's system to meet these objectives. Completion of these programs ensures that water supplied to the majority of our customers is now filtered and disinfected.

The introduction of a largely filtered system over recent years however does not totally eliminate sediments from entering and settling within our water supply system.

Treatment plant malfunctions allowing turbidity and microbiological break through, burst mains, mains replacement works, open service basins, seasonal flow / pressure variations, deteriorating old mains, irregular tank cleaning programs and poor mains system designs all contribute to sediment build up, water discolouration and microbiological regrowth within mains supply systems.

This situation presented the ongoing need for the introduction of a system wide mains cleaning program. Western Water commenced systematic mains cleaning program in 2000 primarily using air scouring technique, however in some situations it was still recognised that flushing and swabbing techniques were more suited.

The objective of the mains cleaning program is to remove a build up of sediment and biofilms in the system to compliment a wide range of treatment plant improvements completed over recent years.

The program is also driven by the company strategic plan to control taste and odours throughout

the water supply system and reduce customer dirty water related complaints.

In addition to cleaning the mains, it was recognised that a systematically planned program provided the added opportunity for members of the mains cleaning team to collect important asset information that will;

- ◆ identify system water quality hot spots;
- ◆ locate unlined sections of mains;
- ◆ locate inoperable hydrants and valves;
- ◆ identify critical valves and hydrants;
- ◆ accurately locate hydraulic zones;
- ◆ transpose hard copy mains cleaning plans and operational instructions to digital format for future planning reference; and
- ◆ update our Geographical Information System (GIS) with accurate map base information.

2.0 ISSUES

The major issues considered in the decision making process to implement system wide mains cleaning program throughout Western Water were as follows:

- ◆ A perception of taste and odours existing throughout Western Water's system.
- ◆ Customer dirty water complaints have traditionally been managed by reactive flushing. Normal practice is that maintenance teams flush only at the initiation of a customer complaint.
- ◆ A systematic mains cleaning program has not been undertaken since the inception of Western Water in December 1994.
- ◆ Prior to year 2,000, bacteriological compliance throughout Western Water consistently failed to meet system compliance standards. Sporadic instances of low level (3 to 20) total coliforms were detected throughout all systems without obvious cause.
- ◆ The need for programmed mains cleaning was highlighted during October to December 1999 when a spate of microbiological exceedance events were reported at numerous routine customer monitoring locations throughout the towns of Gisborne, Woodend, Riddells Creek and Macedon.

This series of events initiated a controlled study of a 150mm-diameter section of typical water main in Gisborne from which the elevated coliforms were detected. The comparative study of air scouring versus flushing resulted in a significant amount of sediment containing elevated counts of coliforms being removed from the section of main during flushing and air scouring.

In addition to exposing a dirty system, the study also confirmed that air scouring was a more effective means of removing loose sediments and biofilms in mains >100mm in diameter.

The result from the study was assumed as being representative of the condition of water mains throughout all Western Water systems.

3.0 AIR SCOURING PROCESS

Traditional methods of cleaning water mains are flushing and swabbing, however both techniques have some limitations. Flushing is ineffective in low-pressure areas and large diameter mains where velocities are low and swabbing can result in lost, torn or jammed swabs. Air scouring is an alternative to these techniques, which has proven to be effective in areas where swabbing or flushing is unsuitable.

The air scouring technique involves the injection of filtered compressed air into an isolated section

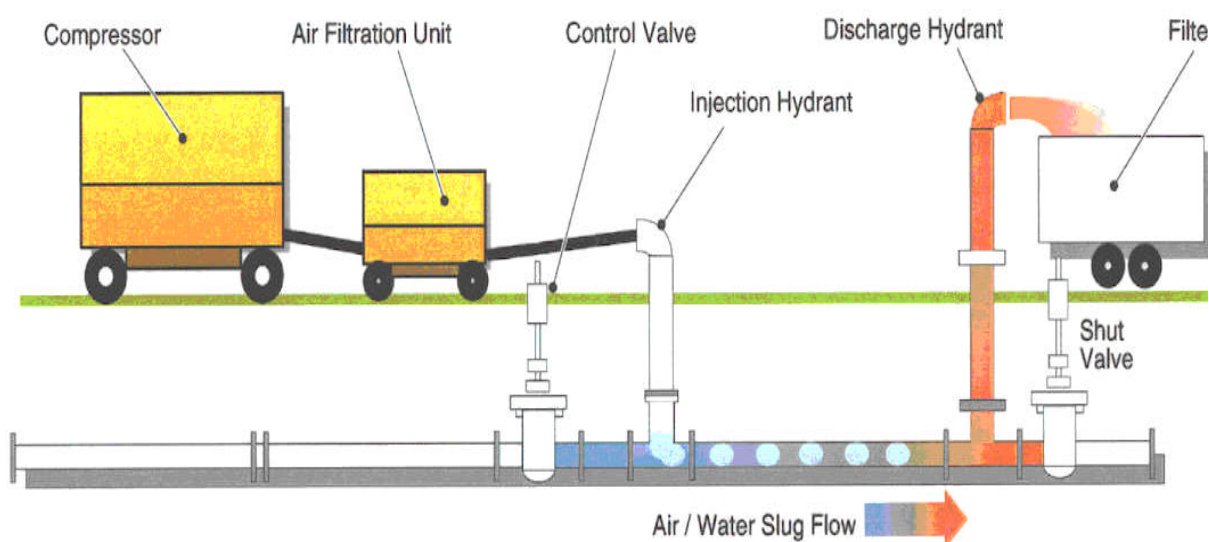
of water main to generate increased velocity, which is greater than the minimum velocity required to remove suspended sediments. Air scouring involves a mix of air and water called a slug flow. Given a constant supply of air and water the slug flow strips any loose deposits and some slime from the pipes. Industry experience indicates that air scouring uses approximately 40% less water than normal flushing techniques.

Loose deposits occurring in water mains are the main cause of customer complaints. The removal of these deposits certainly gives rise to a reduction in complaints and improved water quality at customer taps.

Air scouring is designed for water mains less than 225mm diameter however given favourable site conditions it is possible to clean 300mm diameter mains.

It is Western Water's experience that air scouring, if undertaken correctly, is the most effective and efficient means of cleaning water <300mm in diameter. It is also recognised that a carefully planned mains cleaning operation can also provide significant added benefits in optimising the management and knowledge of water supply assets.

Figure 1: *Typical arrangement for air scouring operations*



4.0 AIR SCOURING EQUIPMENT

The air scouring equipment consists of three distinct features:

- ◆ The compressor
- ◆ The air cooler
- ◆ The filtering system

The compressor is sized to the pressure rating of the filtration unit. A 175 cfm compressor is the minimum requirement to undertake air scouring operations, cleaning mains up to 225mm in diameter. The volume of compressed air entering the main is controlled by a series of operating valves including a pressure-regulating valve.

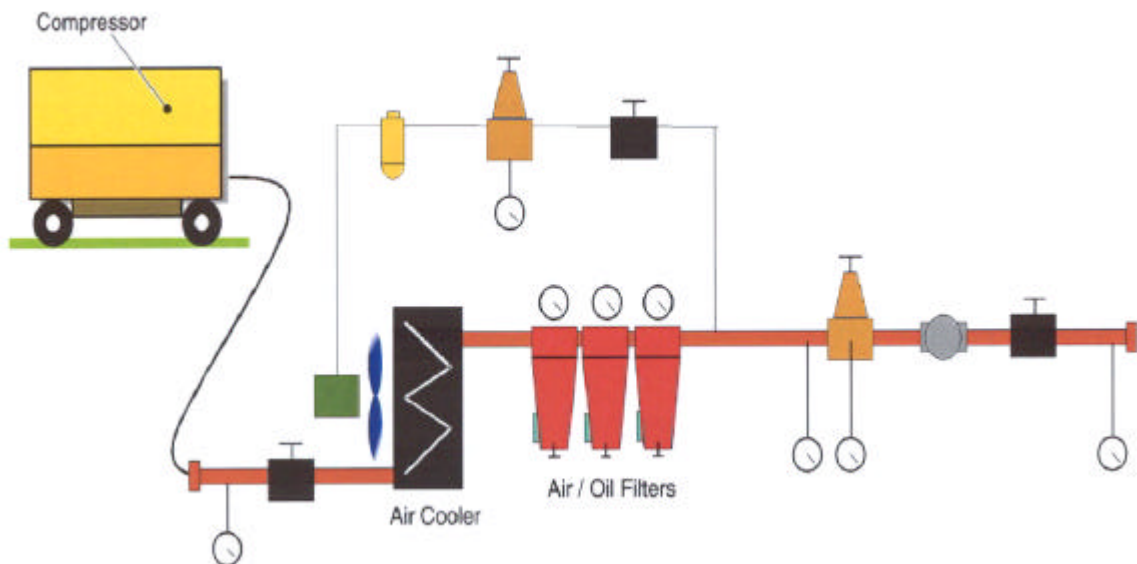
The compressed air first passes through a fan driven air cooler, which greatly reduces the amount of oil passing through the system in the vapour phase. The temperature generated from the compressor is typically 60 deg C, which is reduced to approximately 20 deg C after the air passes through the air cooler. The air then passes through a series of three filters:

- ◆ **Pre-filter (1 micron):** The depth filter removes oil and water vapour.

- ◆ **Sub micron filter (.01 micron):** The depth filter removes any bacteria, dirt and dust particles as well as any remaining oil and water vapour.
- ◆ **Activated carbon filter:** Removes any remaining oil vapour, oil and related taste and odours.

A series of gauges indicate inlet pressure from the compressor, outlet pressure across the filters, mains static pressure and operating regulated pressure. Filtered air to breathing standard is then injected into the main to commence the cleaning process.

Figure 2: *Arrangement of equipment for air scouring*



5.0 SYSTEM CLEANING REQUIREMENTS

The estimated total length of mains to be cleaned throughout Western Water is estimated at 1,500 kilometres. This equates to 18 months of mains cleaning at average rate of 4 kilometres of cleaning per day. It was decided that cleaning operations be conducted over periods of low demand, which is typically during the months of April through to the end of October.

Based on this scheduling, mains cleaning of the entire Western Water system would be completed over an estimated period of three years and continued thereafter on a cyclic basis.

6.0 DETERMINING CLEANING PRIORITIES

At the program concept stage, selecting priority areas for mains cleaning could not be accurately determined primarily because of inaccurate complaint data and lack of IT recording and reporting systems.

Priority mains cleaning was therefore initially flagged in areas unaffected by water restrictions. Under this arrangement it was proposed that the townships of Woodend, Romsey, Lancefield and Sunbury (whilst on Melbourne water supply) would be scheduled for cleaning using a mix of air scouring and flushing during 2000 – 2001 financial year. However, with the lifting of restrictions in November 2000, all towns will now be cleaned progressively to completion over a three year period and will continue thereafter on a cyclic basis.

7.0 BENEFITS

The benefits of implementing of a system wide mains cleaning program throughout Western Water is as follows:

- ◆ Improved level of service to customers
- ◆ Compliments the completion of water treatment capital works improvements
- ◆ Meet the requirements of our Customer Charter
- ◆ Meet business plan targets for microbiological, physical and chemical performance.
- ◆ Improved compliance with 1984 WHO drinking water quality guidelines
- ◆ Reduced dirty water quality complaints
- ◆ Contribute to the elimination of taste and odour problems within the mains systems
- ◆ Collect system information that can be used to update system plans and improve the management and knowledge of our assets.

8.0 ENVIRONMENTAL CONSIDERATIONS

Mains cleaning using air-scouring technique requires careful environmental consideration due to the high concentrations of sediments removed during the process (estimated three times the normal sediment volumes removed by normal flushing methods). To comply and go beyond EPA (Environmental Protection Authority) discharge requirements, the construction and utilisation of a mobile filtration unit was introduced. The trailer also provides a means of diffusing and controlling the water discharged to the environment.

Photograph 1: *Filtration trailer used to collect discharged sediment and control discharge.*



9.0 KEY PLANNING & OPERATIONAL PROCESSES

Preliminary Operational Checks

Prior to undertaking air scouring it is imperative that the following operational checks be carried out

on the equipment and the water supply system.

9.1 Air Purification Unit & Compressor

Prior to the commencement of air scouring operations, preliminary equipment and system operational checks are conducted on a daily basis to ensure;

- ◆ There is no debris, etc in the air cooler tube / fins. Debris can be expelled using compressed air or high pressure water spray.
- ◆ The compressor is in good working order and not generating large quantities of oil.
- ◆ All connecting hoses are deaned. Disinfection of all hoses is undertaken on a regular basis with dilute sodium hypochlorite solution (4%).
- ◆ Hoses are stored in a contamination free environment e.g. sealed container. Before connecting the hoses all lines are blown out with filtered compressed air.
- ◆ Air hose safety clips are fastened securely.
- ◆ Air hose lengths are kept to a minimum to reduce pressure losses.
- ◆ The air intake to the compressor is positioned away from any polluted environment. A polluted environment may risk a contaminated water main.
- ◆ The air scouring unit is located on a relatively level surface.
- ◆ A tee piece fitted with a ball valve is installed on the hydrant connection. This enables the main to be depressurised of air and make it safe for the operator to disconnect the hose connection either from the main, compressor or air scouring unit.
- ◆ All air filters are checked for correct operation before commencement of cleaning works.
- ◆ The non-return valve is not allowing water to back feed into air filters.
- ◆ The lubricator is filled with the appropriate oil.
- ◆ Air scouring valves are in the correct start up position before starting the compressor.

9.2 Water Supply System

A preliminary site inspection is conducted under strict supervision of the air scouring team leader to ensure;

- ◆ All nominated valves and hydrants are working and exposed.
- ◆ Ensure the area to be cleaned is completely isolated from service and all isolation valves checked for leakage.
- ◆ All valve offtakes along the line to be air scoured are shut.
- ◆ Appropriate work signage is displayed.
- ◆ All non-sprung air balls are capped to reduce air pressure losses.
- ◆ Filter trailer is safely in position and all connections are secured.
- ◆ Standpipes are securely wedged.
- ◆ All nominated discharge points are above ground level to avoid infiltration of contaminants
- ◆ Discharge points do not cause property damage, flooding and erosion of earth drains.
- ◆ Customer safety and traffic management initiatives are in place

Where necessary, the installation of additional fittings enables minimal inconvenience to customers and ensures that the mains' cleaning is conducted in the most effective and efficient way possible. All customers affected by air scouring are advised at an early stage generally through a card notification drop. Critical customers which include hospitals, health centres, schools, doctor and dental surgeries, dialysis patients, day care centres, kindergartens and public meeting places are personally consulted to ensure that they are not inconvenienced and continue to function normally throughout the proposed cleaning period. Cleaning operations are restricted where possible to daylight hours between 9.00am and 4.00pm.

Where hygiene or health related issues arise in premises where the mains supply water is shutdown for a specified period, a mobile tanker is made available on a priority basis. Western Water

currently has two “mini res” tanker units in operation.

10.0 COLLECTION AND RECORDING OF ASSET INFORMATION

The key to successful mains cleaning is having clear, accurate and detailed sets of operating plans.

The plans should be very specific and provide wide-ranging information as follows;

- ◆ Segmenting of areas for daily cleaning operations
- ◆ Location of critical customers and operating valves
- ◆ Identify special needs customers (dialysis patients, schools, medical surgeries, etc)
- ◆ Areas assigned for either flushing, air scouring or swabbing
- ◆ Valve, hydrant and system operational arrangements

The completion of a “field operation log sheet” on a daily basis is a key means of obtaining critical operational data that can be used to improve knowledge of systems operations and assets. The information is collected on a daily basis and is presented to a planner who in turn updates system drawings and operational procedures accordingly. The most appropriate means of updating asset drawings and planning mains cleaning programs is through the utilisation of our “Geographical Information System” or GIS.

11.0 MAINS CLEANING PLANNING ON “GIS”

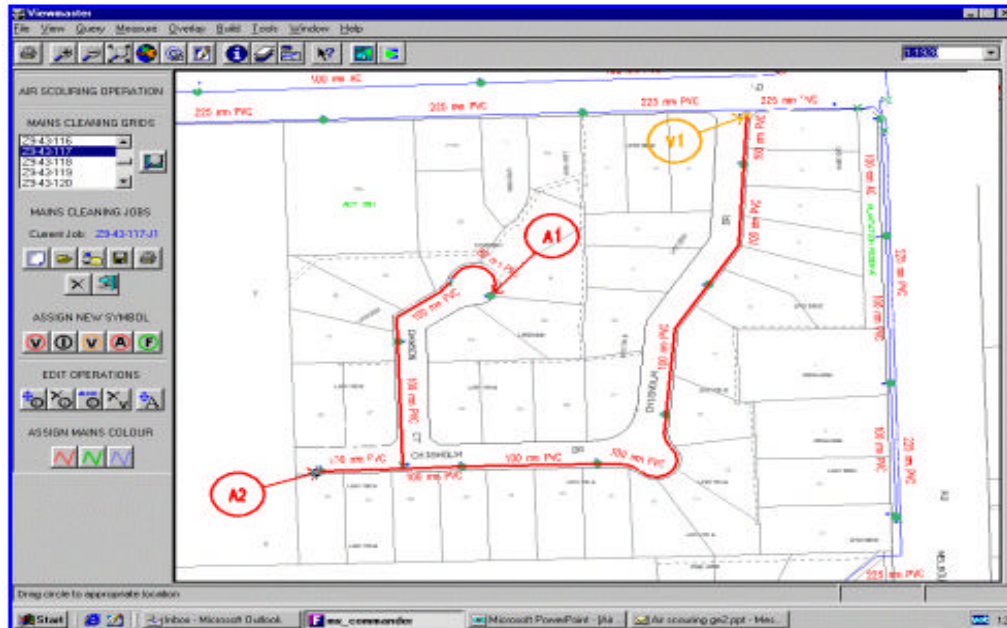
A mains cleaning planning application has been developed on the Western Water geographical information system (GIS). A digitised plan nominating the sequential operation of all hydrants, valves, injection and discharge points are produced on this system. The application involves the user creating a mains cleaning job. The user selects a grid area from the operating panel and then applies symbols / colours to pipes and relevant nodes. Modifying the graphics assigns injection points, flush points, scouring points, shut valves and closed valves.

Pipe colours can be modified according to the status of the pipe for the relevant job (i.e. flushed, air scoured or swabbed). Attached to each daily work job is an electronic version of the field operation log sheet.

The benefits of planning mains cleaning on GIS are as follows;

- ◆ Inoperable / faulty / incorrectly located fittings reported to the planner so that adjustments can be made to the program and water supply plans upgraded accordingly.
- ◆ Plans stored sequentially for future reference hence eliminating intensive re planning.
- ◆ Opportunity to check asset systems and upgrade GE database accordingly
- ◆ Storage of critical water quality monitoring and cleaning operations data
- ◆ Accurate costing of works

Figure 2: *Planning a mains cleaning program on GIS*



12.0 CONCLUSION

A carefully planned mains cleaning operation primarily using air scouring technique provides Western Water with the opportunity to improve the operating knowledge and performance of its system. The added advantage of being able to digitise mains cleaning plans and register updated system information on a GIS database provides a cost effective means of improving water quality and system operational data and performance. Information collected throughout the cleaning program when entered onto a GIS database encourages an initiative that will be enhanced over time through the input of additional asset information. Western Water will take approximately three years to complete mains cleaning of its system and will continue thereafter on a cyclic basis. These initiatives collectively are expected to deliver improved service level to customers, provide improved drinking water quality compliance and meet our company business objectives.

13.0 ACKNOWLEDGEMENTS

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