# DIAGNOSIS OF A WATER DISTRIBUTION SYSTEM

**by**

**Stephane Joseph**

**Vice-President, sales**

**Aqua Data Inc., Canada**

## Introduction

The health condition of an athlete usually determines the quality of the performance. Generally speaking, our physical condition will help to evaluate how well and how long we can expect to be active and productive. The same examples could apply to most infrastructures but more particularly, the underground water distribution system ( WDS ). The overall condition of the WDS must be known before any replacement or rehabilitation program can be undertaken.

Like us, unfortunately, distribution systems are also aging. To add to the problem, they are constantly in use and as well, they are required to meet the demands of a growing population whose increasing demand diminishes water reserves. In some cases, potable water availability drives the economic growth of entire regions. Water availability and quality have become issues at the forefront of popular opinion. Concerns for the availability of sufficient potable water resources are on a constant rise. In the future, I foresee communities playing much stronger roles in making administrative decision, which involves or even affects potable water resources. Can we always count on our fatigued and weakened existing water networks to support us?

## Status of water distribution systems

The impact of the unprecedented economic and population growth since World War 2 resulted in the installation of millions of miles of underground water pipes, along with the construction of adjoining living and working spaces. Since the late 40s, engineering consulting firms have taken part in hundreds, if not thousands of infrastructure construction work worldwide. It is a known fact that most of these underground projects have been neglected, or worst ignored from the day they were installed. Because of its subterranean location, WDS assessment can become a very complex venture. To fully understand its condition and operation and to properly evaluate its rehabilitation needs are the most pressing challenges for most utilities around the world. When it comes to deciding on budget allocations, however, politicians are often more preoccupied with dealing with concrete projects that can be seen by all tax payers.

Expansion rather than rehabilitation and management work has been predominant over the past years. Projects involving new constructions were flourishing and were logically favoured over rehabilitation ventures. Today, a study by the American Water Works Association estimates the rehabilitation needs for North America at 138.4 billions US dollars. Of that amount, 77.2 billion is for water transmission and distribution of water. The wastewater needs are parallel to those of the water needs. These figures are used here to illustrate the seriousness of the problem, even in one of the most developed areas in the world. The dilemma most people have today is the decision on how and where any available money should be spent.

The utilities should first consider looking at the inventory listings of the WDS. Usually, a map is available and is used for the beginning of the field data collection work. Basically, the field crews will report their observations and bring corrections to the original location plan supplied by the utility. For report preparation, the updated plan, which now shows a much more realistic representation of the system, can then be used to illustrate the various hydraulic and mechanical conditions observed. It is difficult to assess the components of the WDS since most of its components are buried 1 to 3 meters underground. A fire hydrant is however easily accessible and is used to gather hydraulic readings, identify the locations of leaks, and assess water quality. A professional expertise is recommended when it comes to gathering field data and building the database. Take a doctor, for example. Before preparing for surgery, she or he will examine the patient and identify the problem, which is then considered extensively until the appropriate surgical procedure is determined. We can apply these same principles to WDS evaluation, management and master planning.

A good WDS assessment should meet the following objectives:

- mechanical evaluation of all system components,
- hydraulic readings throughout the entire system,
- leak survey,
- water quality analysis,
- updating of the water distribution system's plan,
- completing the database,
- development of the hydraulic model,
- calibration of the hydraulic model, and
- preparation of the unidirectional flushing sequences.

The above information will allow managers to pinpoint the system's weaknesses which will then help them to better estimate the investments required to begin a rehabilitation program based on the priorities. The installation of hydraulic software and computerized databases combined with proper training will transform traditional management.

## LEAKAGE

Can you imagine the costs for the loss of 30% or even 40 % of the total annual water production in a city of 200,000 people? Start counting the costs required for pumping and chlorination and add the high volume of that water loss which often infiltrates into the wastewater collection system, and you will arrive at a shocking figure. These percentages of water losses are not uncommon. By simply finding and repairing the leaks on a system enough savings will be provided to cover the investment in a WDS diagnosis. Let’s look at the wastewater collection system for a moment. They are usually located close to the WDS and are often the same age. A leak will usually flood the surrounding area and consequently create stress conditions around both the water and sewer pipes. The structural integrity of the pipes is often affected, diminishing the reliability and life expectancy of the system. Often, the lost water will infiltrate into the sewer pipes and add to the volume of wastewater to be treated. Leaks can also be driven toward the water table, finding their ways to rivers or other streams. Actually, a leak will always find the path of least resistance and this is not always up to the surface. Leakage is a problem that won't go away by itself. WDS leakage is one of, if not the most, pressing problem for all water utilities worldwide. Keep in mind that we are addressing a subject, which can eventually compromise our everyday way of life.

## Hydraulic Model

The hydraulic model is, in my opinion, the most practical tool any engineer can use. It alleviates the challenge for the design and analysis of the WDS. It is often used to develop, amend, or refresh master plans, which can then address priorities for the next 5 to15 years. The goal is to eventually permit the WDS to operate at its normal operating condition. The hydraulics of the system are also better understood when static and dynamic pressure readings have been taken on all the fire hydrants and other accessible entries to the system. The interpretation of the results allows the pinpointing of weaknesses which can be caused by closed or half-closed valves, unknown pipe diameters or their locations, low Hazen-Williams coefficients, leakage, etc. To have an accurate model of the WDS is, by itself, a complicated task without having the use of proper techniques and technologies for field data collection and analysis. Apart from supplying the database with accurate information, specialized field tests are required to calibrate the hydraulic model. The Hazen-Williams coefficient and flow-pressure tests provide essential data to characterize and validate the theoretical hydraulic model. The expression: "You may be the smartest engineer in the country but if you don't have reliable data on your desk, it becomes very difficult to take the right decision", cannot be denied.

In 1997, The Regional Municipality of Peel in Ontario, Canada decided to go ahead with a pilot project. Computerized field data collection pertaining to hydraulics, mechanics, water quality and leakage was first performed. From that followed the preparation of the hydraulic model while performing the related field tests, the programming of the unidirectional flushing sequences and training. The mandate also included the installation of the Aqua Cad software and training pertaining to its use. The overall objectives of the project were to get the actual picture of the WDS, to computerize the database, to update all graphics and to prepare a priority list showing the most important to the least pressing needs for replacement or repair. For the operations department, we've installed the Aqua Cad Management module which was needed to keep track of all past and future interventions. The final report showed results where the deficiency percentages were higher than average for mechanical repair and leakage, and about normal for hydraulics and water quality. During the report presentation, I felt that all participants, including the City Engineers, the Director of Public Works, the Fire Chief and members of the Council, for the first time, clearly understood the overall condition of the entire network.

## Conclusion

New management techniques work. In over 90% of the time, a diagnosis, including the installation of bar codes for computerized management, will generate concrete savings that will surpass all costs incurred in less than 3 years. The mechanical reliability of the infrastructure is also essential. The Canadian National Fire Code addresses this issue by recommending periodic WDS inspections. Leak surveys are also conducted at regular intervals. Many utilities have now adopted long term programs for WDS improvement. Aqua Data can be assigned to perform field data collection and analysis, report presentation and software installation and can also assist in providing assistance for repair work.