Evaluation of Losses in EWA Water Distribution Grids

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In many urban centers including Bahrain, high water demands and lack of investment in the rehabilitation of water distribution supply networks have contributed to network losses. Network losses have been attributed to damages from construction activities, unbalanced pressure differences, illegal connection and faulty metering. In Bahrain the water supply network has been experiencing high losses estimated at 31.6%, 35.7%, 22.8%, 24.6% and 34% with corresponding leakage rates of 25, 27.6, 18.3, 17.6 and 22.3% in 1993, 1996, 2000, 2005 and 2008, respectively. The network losses represent the difference in volume measured at the main distribution point near the sources and the meter reading at the consumer connection, while the leakage represents the amount of water seeped from a section of the network at a given location. The leakage rate in Bahrain in 2006 was estimated at 16.5% compared to 32% in Mecca, 62% in Manila, and 4.7% in Singapore. The implementation of a leakage program in Bahrain has reduced the losses through replacing old pipes, elimination illegal connection, installation of meter on main pipes, enhanced maintenance and public reporting. However, the program did not achieve good results as it did not take into consideration pressure influence.

This research evaluates the application of a hydraulic model to identify areas of high leakage and pressure distribution and compare the model prediction with field leakage values. The method stressed on the application of the INFOWATER model to evaluate the impact of pressure distribution and selection of appropriate pressure control valves to reduce the amount of the leakage taking into consideration the model compatibility with the existing GIS software. The model was applied to a 5 km^2 area in Hamad Town covering five pilot zones (1203, 1204, 1205, 1206 and 1207) connected to about 71,000 residences with a population size of 35,000 persons, and land surface elevation ranges from 30 cm to 42 m above sea level. The network consisted of a distribution main pipe with diameters of 80-600 mm covering 63 km length and lateral of 12-50 mm covering 96 km with 8 storage tanks and pumping levels of 69.5-78 m. The model simulation indicated two periods as having high water consumption rates at 8 am at a flow rate of 38 liter/second and 5 pm at a flow rate of 47 liter/second. Comparison between pressure distributions of the selected zones and leakage incidents record (as reported by the public) indicated that high leakage rates corresponded with zones with high pressure.

The existing distribution of the network pressure far exceeds the designed pressure which represents one of the major causes to the high water losses. Model simulation suggested the installation of pressure control valves at some connection points at zone 1203, which would reduce the pressure in the range of 10-25 m with significant impact in lowering the leakage rates. For the other zones: 1204, 1205, 1206 and 1207, the corresponding pressure ranges should be at 10-30, 11-20, 8-30 and 9-16 m, respectively. The pressure control can be within the range of 30-61 m. A reduction of losses by 10% can result in a saving of 64 Mcm/yr. The current rehabilitation practice of replacing old pipes will result only in a temporary solution. It is recommended that calibration of the developed model prediction with field values using pressure valves connected to the SCADA system is made. It is also recommended to transfer information from a large number of monitoring points to the control command center that can control the opening and closing of pressure valves to maintain pressure balance.