Town of Markham Water Distribution System Model

Hydraulics & Water Quality Simulation Capability

System Engineering
Waterworks

June, 2009

Purpose of Presentation

To inform General Committee

regarding the

Water Distribution System Model

Developed by Waterworks

(System Engineering)

Contents of Presentation

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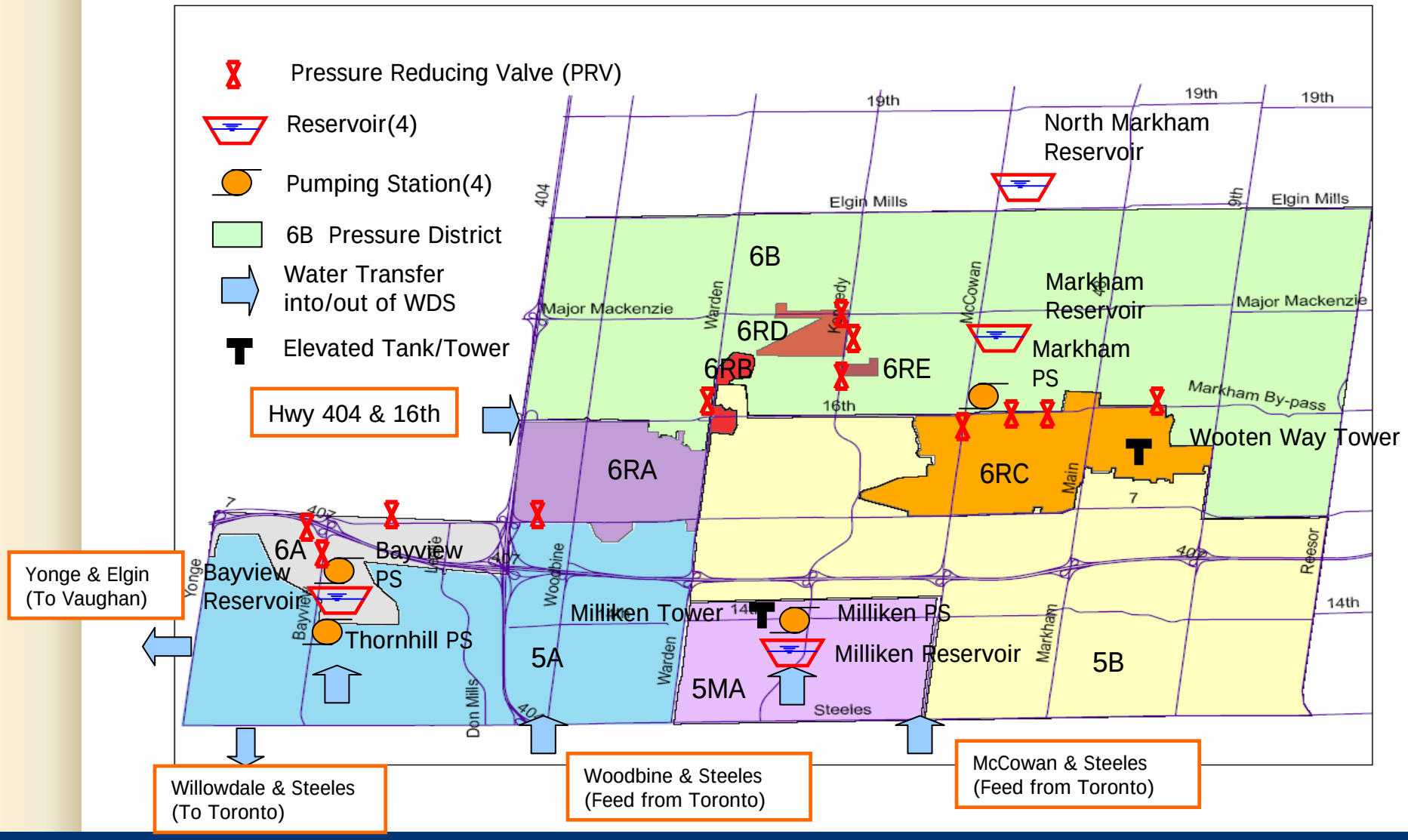
Water Distribution System Components



Water Distribution System Components

System Components (Markham, York Region & Toronto owned)

- Length of Pipes – 1047 km
- Valves – 9,744
- Hydrants – 7,661
- Pumping Stations – 4 pumping stations
- Reservoirs – 4 reservoirs
- Elevated Tanks – 2 elevated tanks

Water Consumption

- Yearly consumption (2008) : 34,646,685 m^3/year
- AvgDay demand (2008) : 94,922 m^3/day
- Number of Customer Accounts : 70,554 (Residential & ICI)

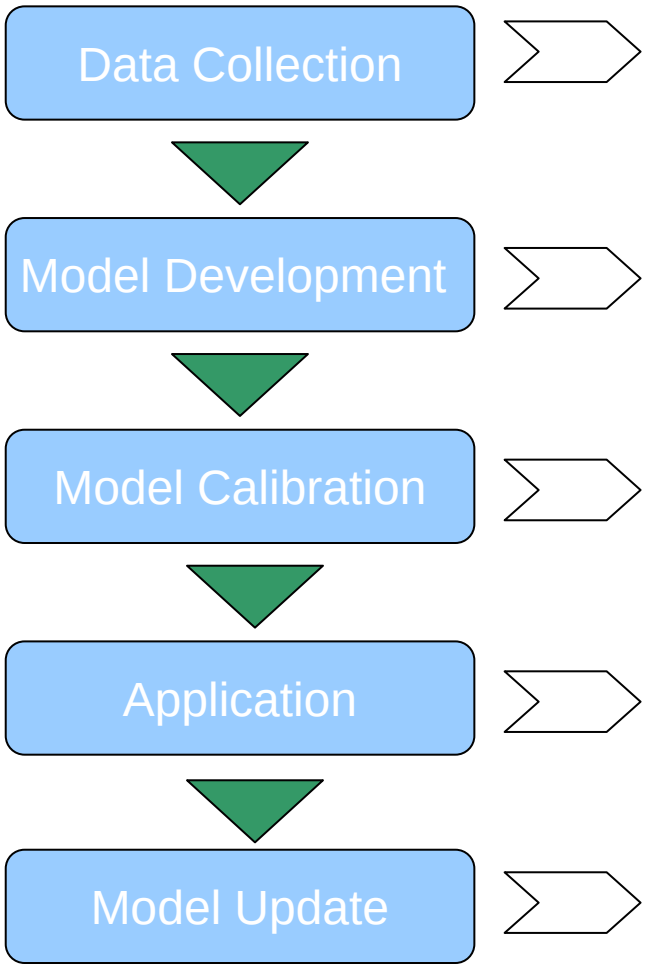
Water System Model

- Waterworks selected state-of-the-art modelling software INFOWATER developed by USA based MWH Soft.
- INFOWATER is fully integrated with the Town's GIS system.
- INFOWATER can also be integrated with the SCADA system to feed real-time data.
- The City of Toronto, York Region and other municipalities including Peel Region have also adopted this modelling package.
- The resulting model is a mathematical representation of the real system using computer software to simulate hydraulic and water quality behaviour from a set of parameters and boundary conditions.

Waterworks developed hydraulic & water quality models in-house to reduce dependency on the external experts for the application and maintenance of the model.

Model Development

Steps to create and calibrate Average Day, Max Day & Min Day models:



Pipe network, valves, water demand, pumps, tanks, reservoirs, boundary meter, operational information etc..

Assemble pipe network, add demands, pumps, valves, tanks, reservoirs, controls, boundary conditions etc..

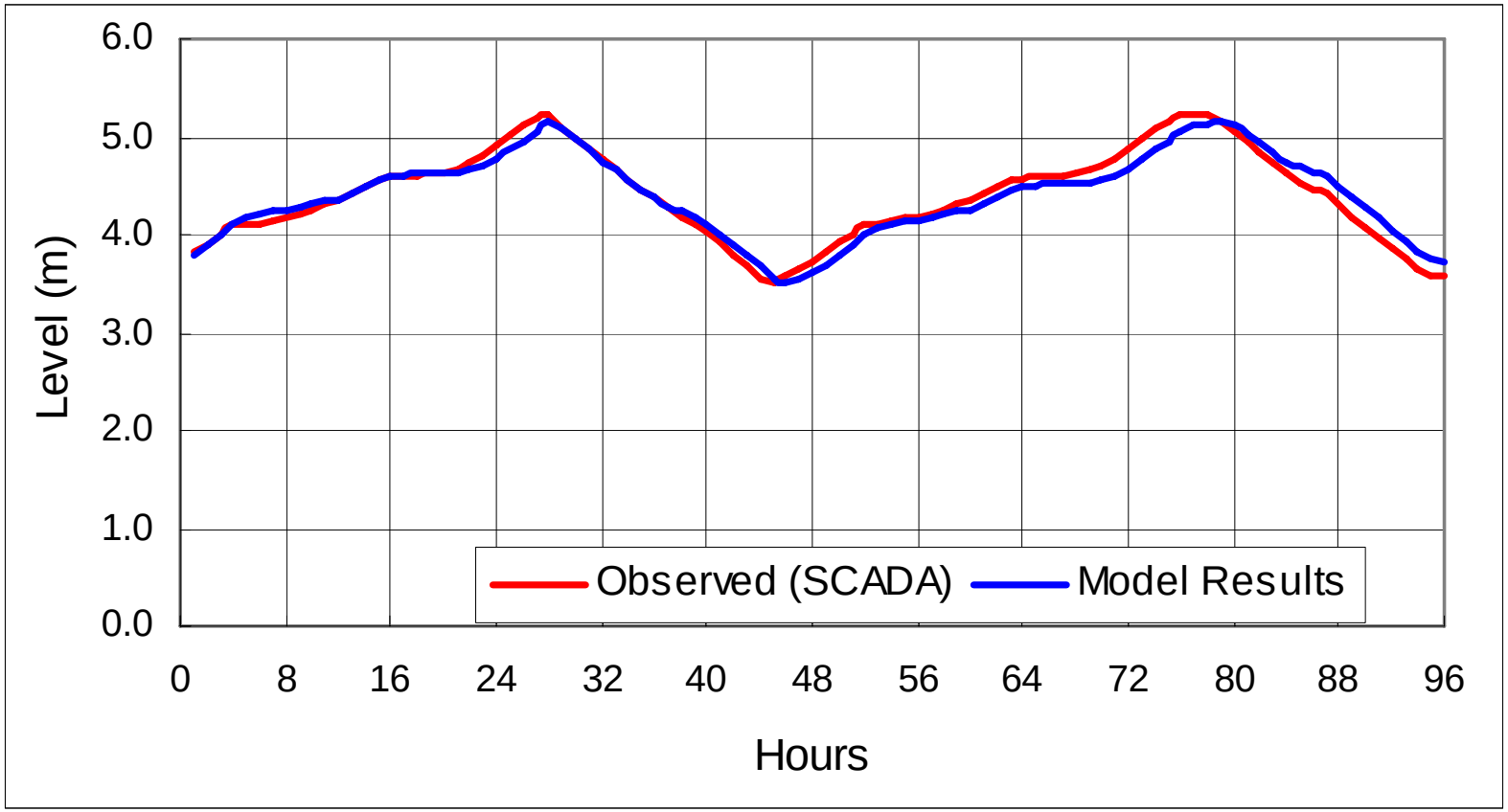
Compare and adjust model against field data (including SCADA)

Hydraulic analysis, water quality analysis, fire flow analysis etc..

Periodically update model to include new in development and latest boundary conditions

Model Calibration

(North Markham /Stouffville Reservoir levels)



- ❑ Filling time about 28 hours
- ❑ Draining time about 18 hours
- ❑ Filling & Draining cycle is about 46 hours

- ❑ Pump shuts at level = 5.20 m
- ❑ Pump re-start at level = 3.60 m

Hydraulic Model & Applications

- Operational Studies (pressure, flow, backflow etc..)
- Facilitation of timely response to customer queries/complaints
- System Analyses such as:
  - Optimization, risk and reliability
  - Engineering studies (fire flow, dead-ends elimination, capital projects)
  - System management (SMA, Infrastructure rehabilitation planning)
  - Master & functional service planning
  - Growth management and new development support

Model Applications – System-wide Water Pressures Evaluation

Water Pressure
During Average Day
Demand at 8:00 AM

Area of low water pressure concerns

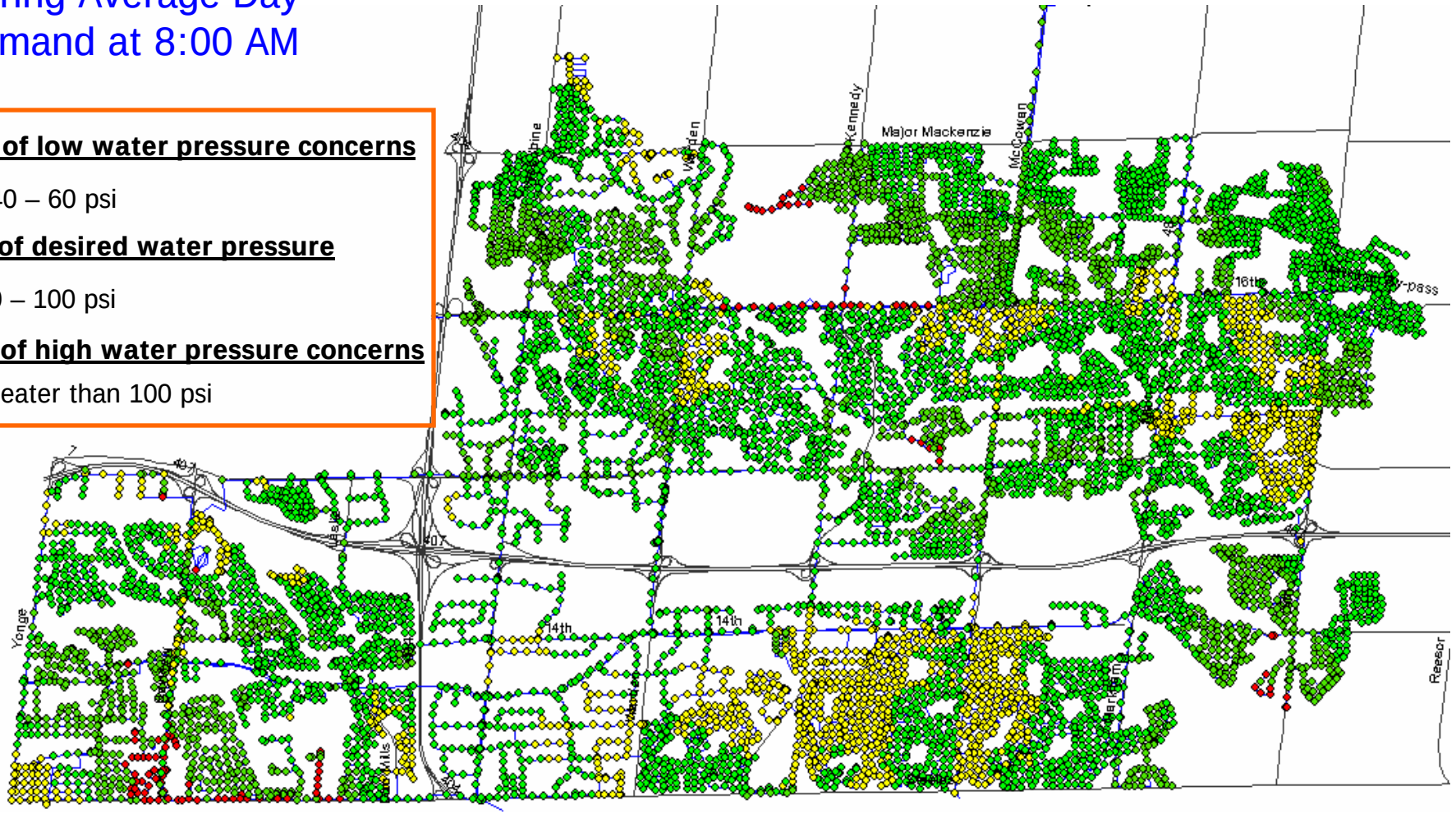
40 – 60 psi

Area of desired water pressure

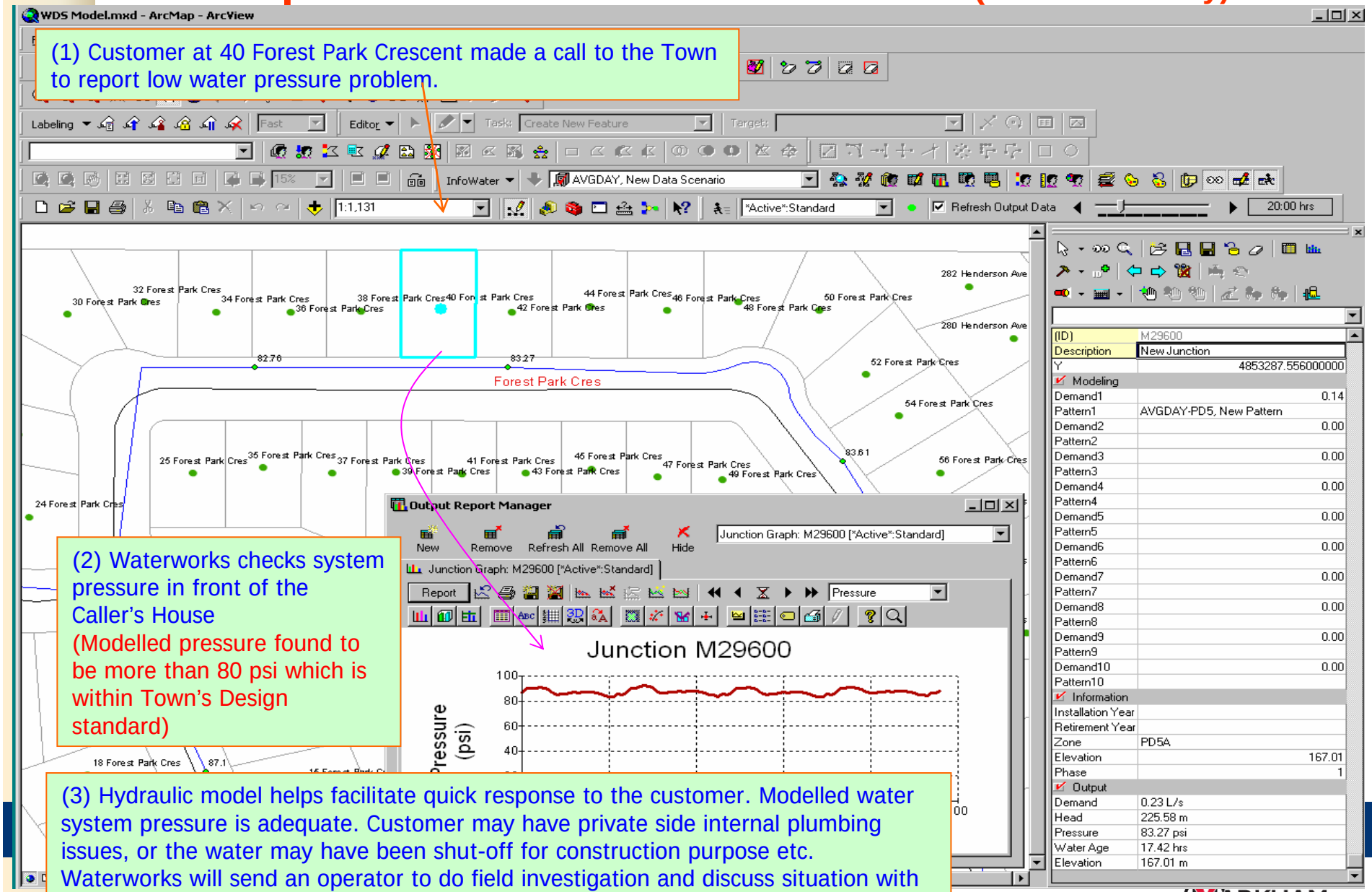
60 – 100 psi

Area of high water pressure concerns

Greater than 100 psi



Model Applications – Efficient Response to Customer Complaints for Low Water Pressure (Illustration Only)



Water Quality Model & Applications:

❖ **The Water Quality Model of the water system:**

- Simulates water quality in the Markham water distribution system based upon results (flow direction, velocity etc) from the hydraulic model.

- It is an important engineering tool for the efficient analysis of:
  - Water age analyses
  - Chlorine decay analyses
  - System contamination & contaminant transport
  - Source tracing & multi-quality source blending
  - Identification of affected area for system isolation and customer notification

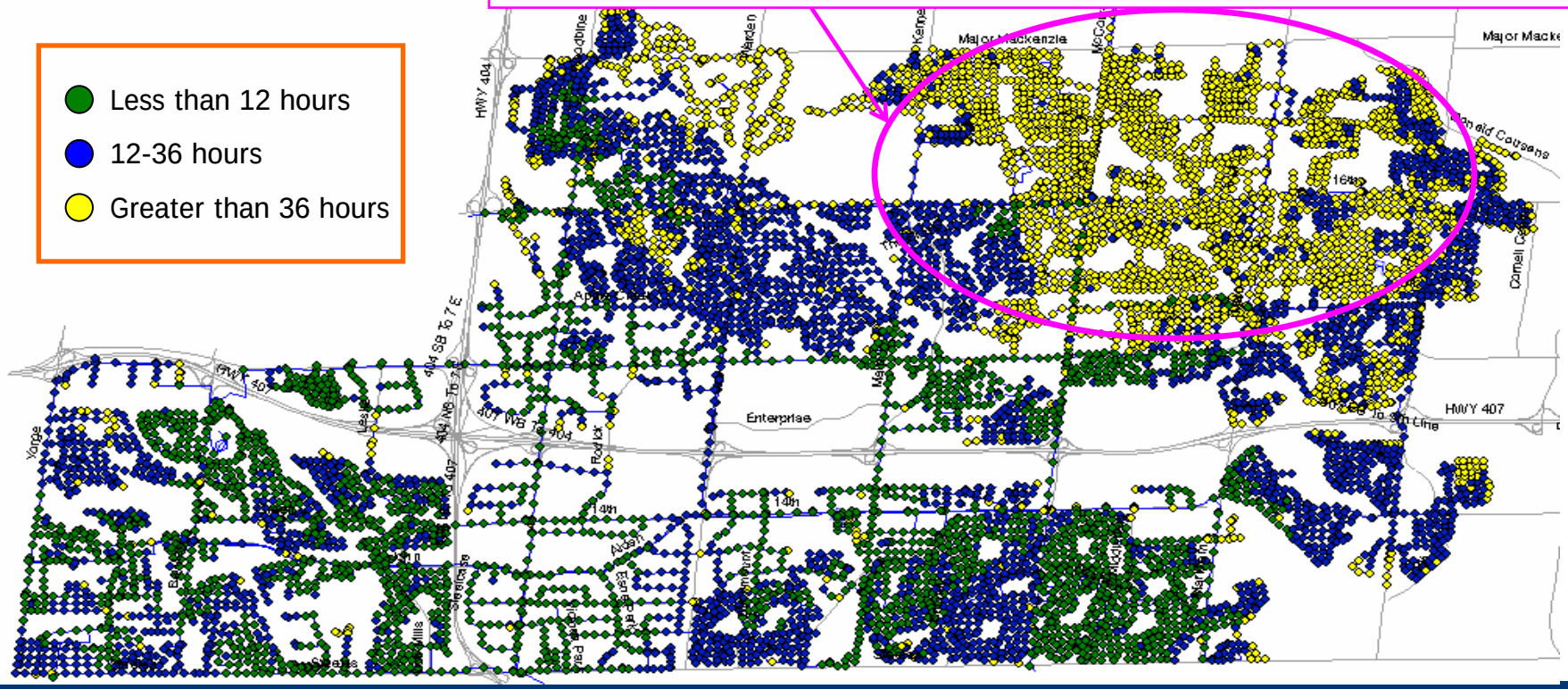
Model Applications – System-wide Water Quality Evaluation in Terms of Water Age

Water Age During Average Day Demand Scenario

1) Model results identified relatively aged water as in the circled area. Decay of chlorine residual increases with water age which raises concerns for potential of lower water quality.

2) The reason for this high water age is the long retention time in Stouffville reservoir (about 48 hours) when both the south & north cells of the reservoir operate at the water level of 6.0 m.

- Less than 12 hours
- 12-36 hours
- Greater than 36 hours

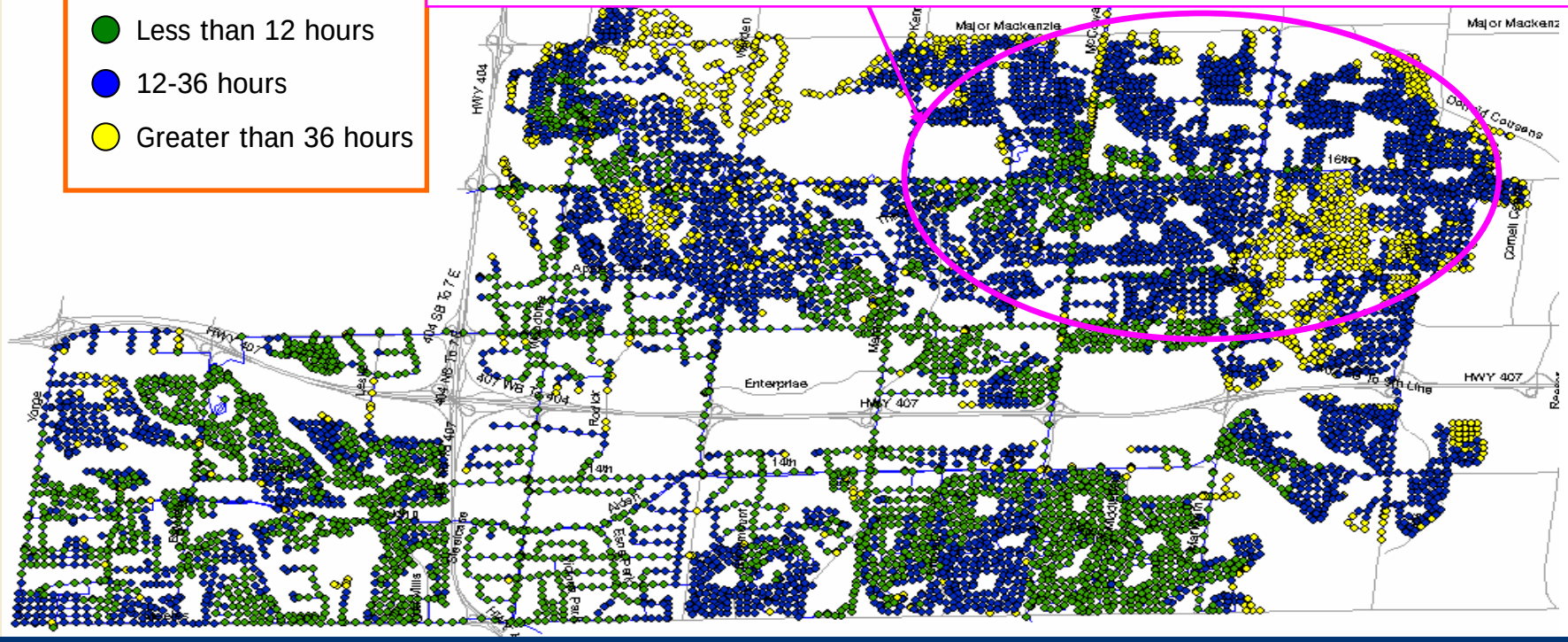


Model Applications – System-wide Water Quality Evaluation in Terms of Water Age (Cont'd)

- **Waterworks department requested Region of York to reduce water retention time in Stouffville reservoir. We suggested to lower the operating water level, and if possible to operate only one cell of the reservoir.**
- **Region of York lowered water level from 6.0 m to 5.0 m and started to operate only the south-cell of the reservoir**
- **As a result, the water age (water quality) in the circled area significantly improved.**

Water Age During Average Day Demand Scenario

- Less than 12 hours
- 12-36 hours
- Greater than 36 hours

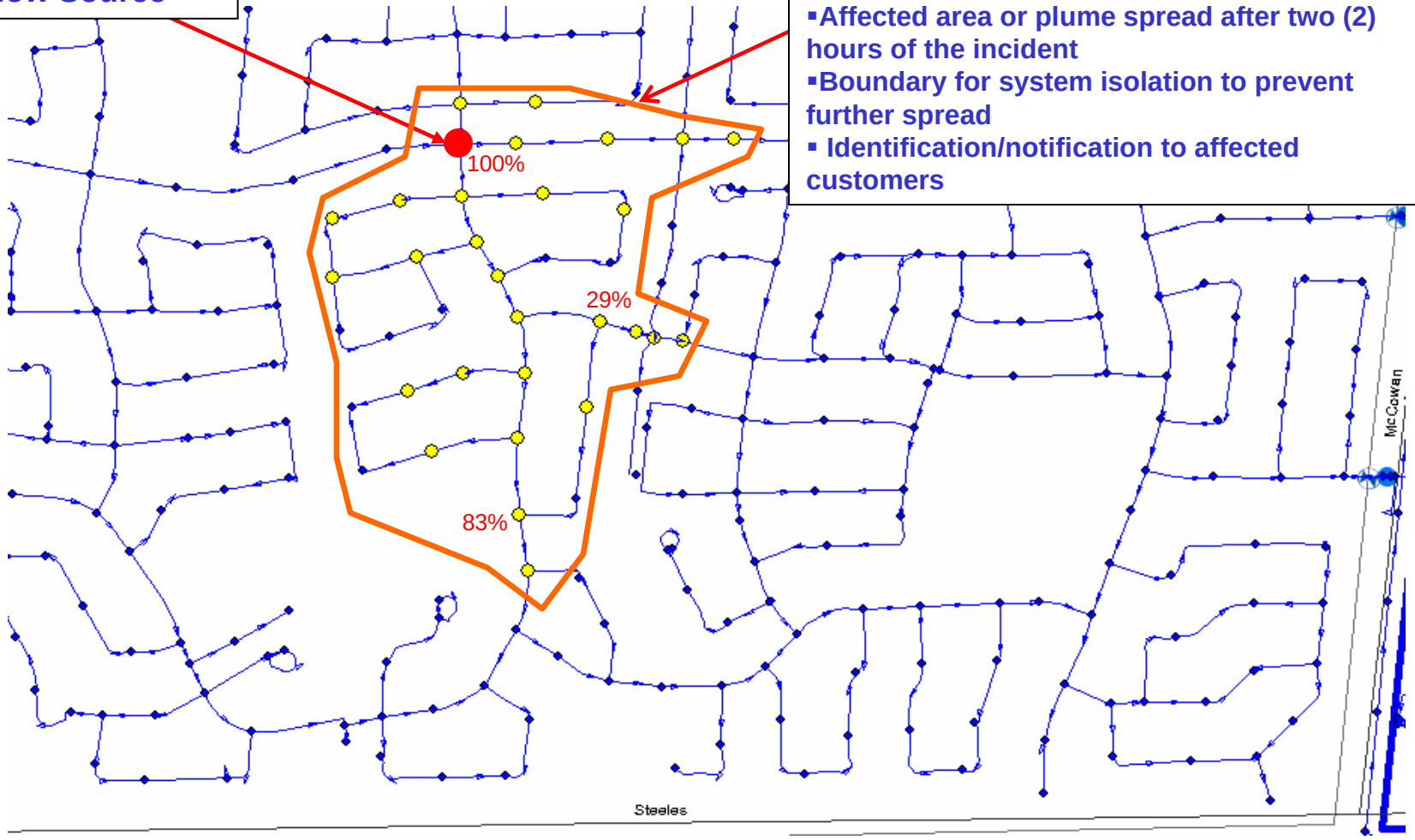


Model Applications – System Contamination & Plume Spread Analysis- Illustration Only

System Contamination-Backflow Source

After 2 hrs

- Affected area or plume spread after two (2) hours of the incident
- Boundary for system isolation to prevent further spread
- Identification/notification to affected customers

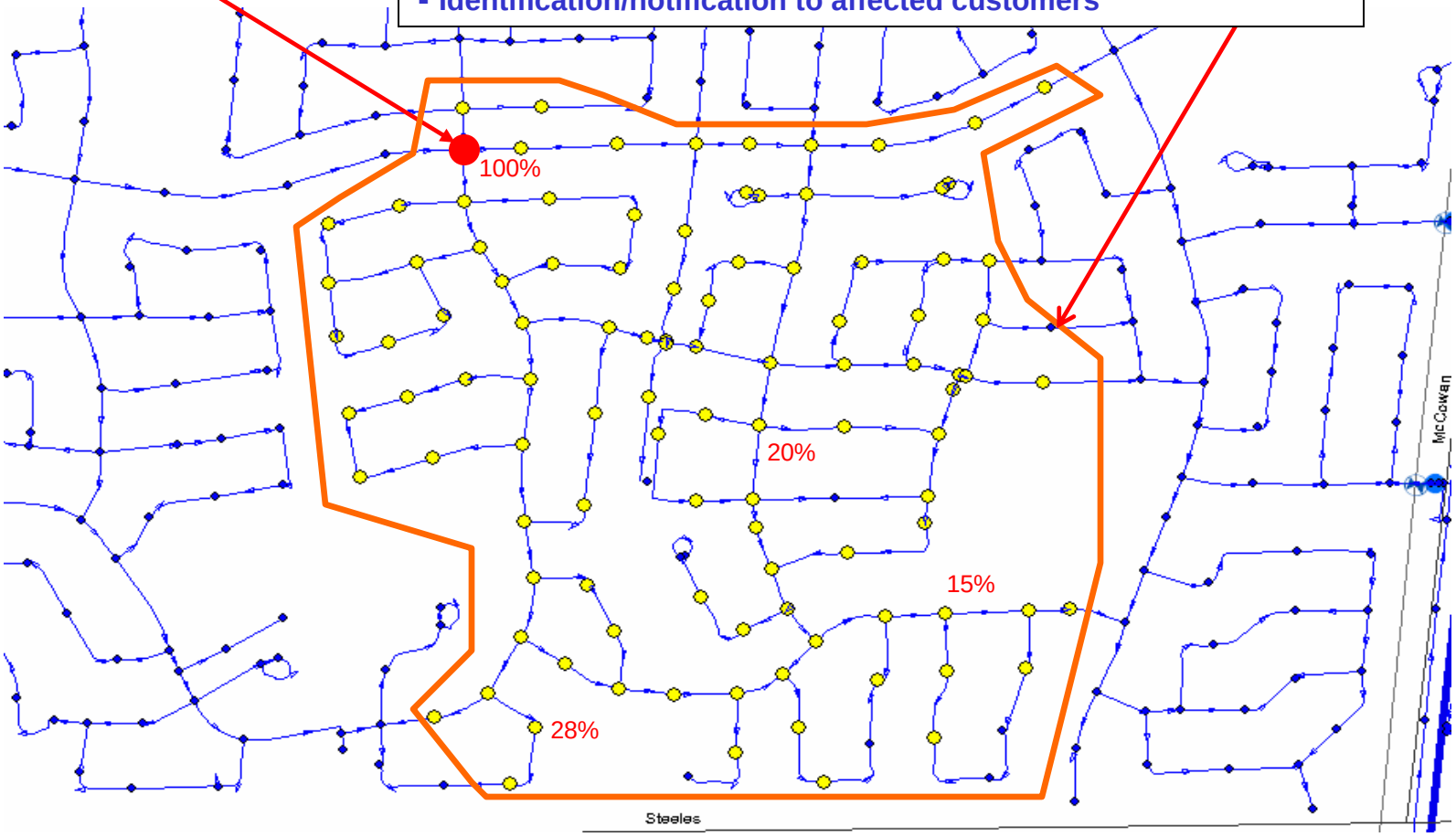


Model Applications – System Contamination & Plume Spread Analysis (Cont'd)- Illustration Only

System Contamination-Backflow Source

After 4 hrs

- Affected area or plume spread after four(4) hours of the incident
- Boundary for system isolation to prevent further spread
- Identification/notification to affected customers

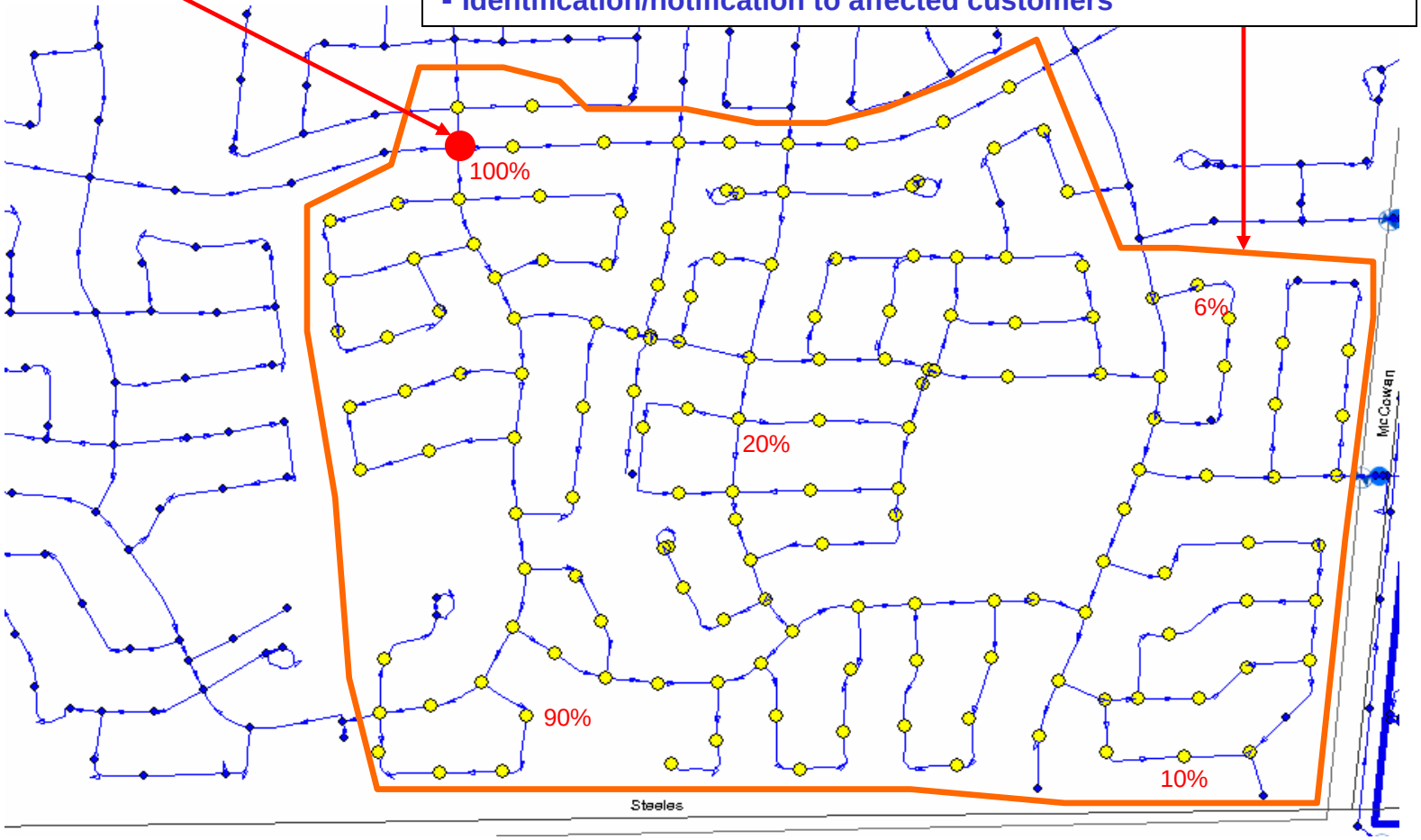


Model Applications – System Contamination & Plume Spread Analysis (Cont'd)- Illustration Only

System Contamination-Backflow Source

After 6 hrs

- Affected area or plume spread after six (6) hours of the incident
- Boundary for system isolation to prevent further spread
- Identification/notification to affected customers



Going Forward

- ❑ Periodic updating of the hydraulic & water quality models to incorporate newly assumed pipes (from new development)
- ❑ Semi-annual updating of the software to incorporate newest capability
- ❑ Continue to apply models in support of day to day water system operation
- ❑ Undertake system risk and vulnerability analyses
- ❑ Undertake water conservation and leakage control analyses
- ❑ SCADA integration with the water distribution system model for:
  - incorporation of real time system boundary conditions
  - real-time simulation of pressure and flows in water distribution system
  - real-time simulation of water quality in the distribution system