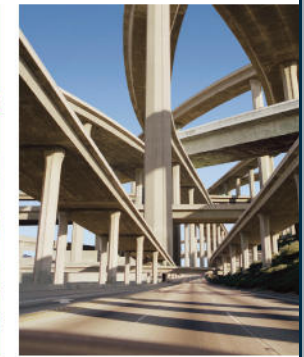
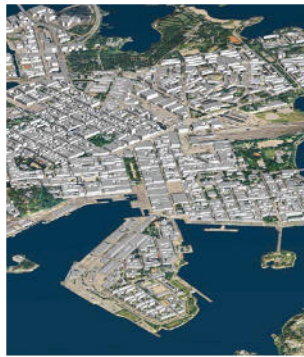


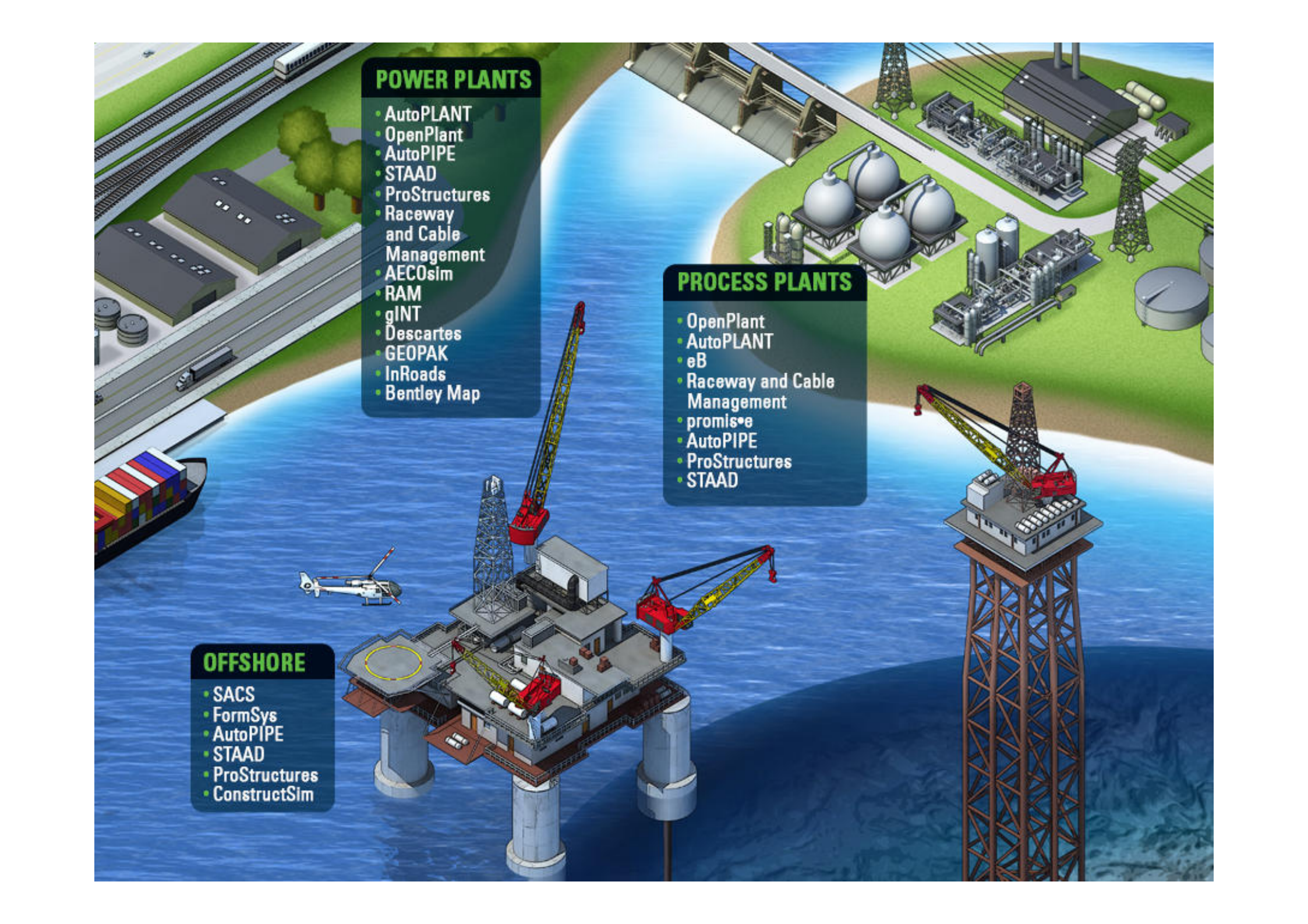


La modellazione per la gestione efficiente della rete idrica

Pedro Pina

Bentley Solutions for Infrastructure



An isometric illustration showing various industrial and offshore construction projects. In the top left, there's a land-based facility with large storage tanks and a train. In the top right, a power plant with large cooling towers and a dam are visible. In the bottom left, a large offshore oil platform is being constructed on a barge in the water, with a helicopter nearby. In the bottom right, another offshore platform is shown. The background is a blue body of water.

POWER PLANTS

- AutoPLANT
- OpenPlant
- AutoPIPE
- STAAD
- ProStructures
- Raceway and Cable Management
- AECOsim
- RAM
- gINT
- Descartes
- GEOPAK
- InRoads
- Bentley Map

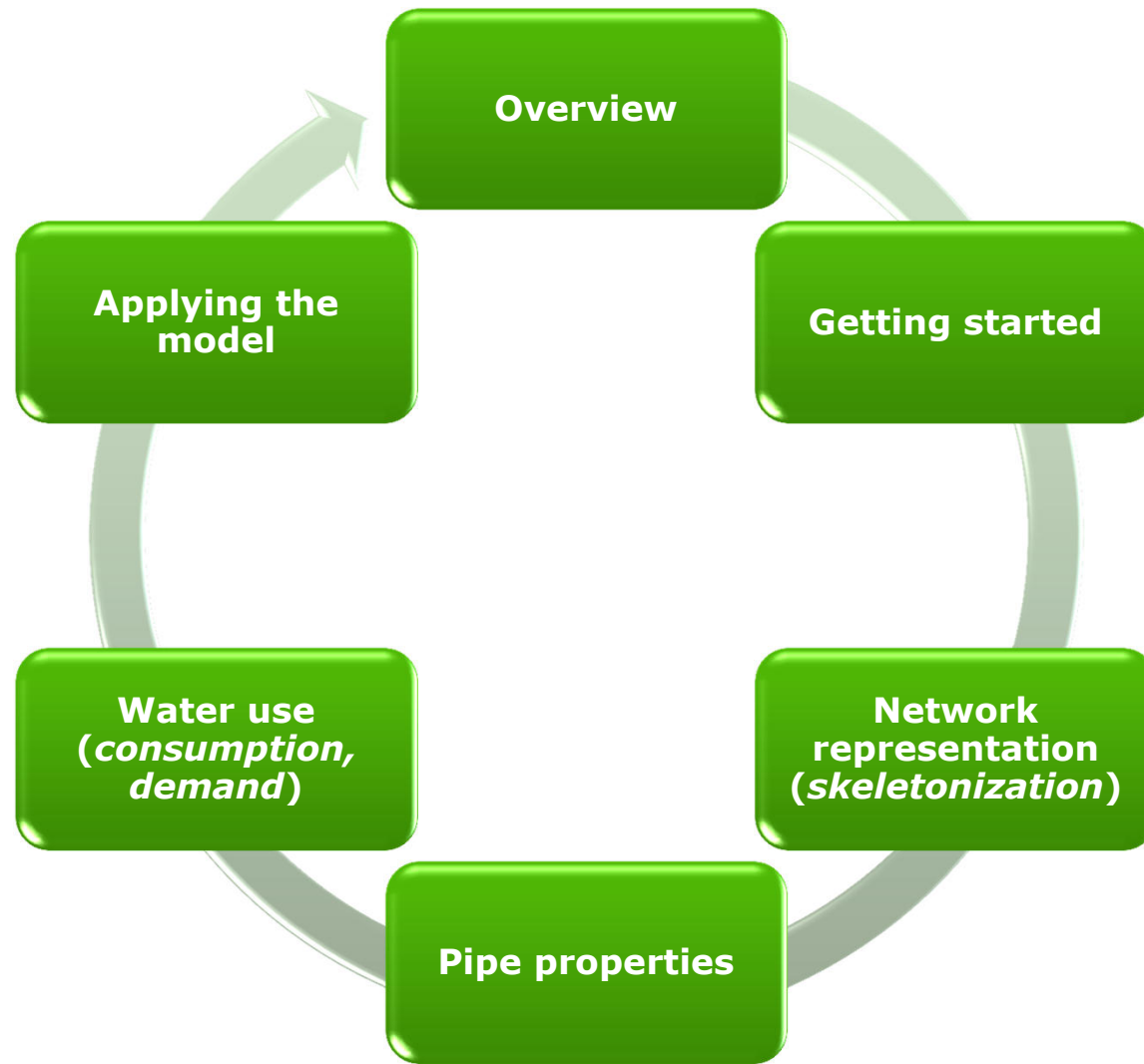
PROCESS PLANTS

- OpenPlant
- AutoPLANT
- eB
- Raceway and Cable Management
- promis.e
- AutoPIPE
- ProStructures
- STAAD

OFFSHORE

- SACS
- FormSys
- AutoPIPE
- STAAD
- ProStructures
- ConstructSim

Using Models



Steps in Modeling

1. Define scope of modeling
2. Select an appropriate model software
3. Learn how to utilize the software
4. Build the Model Network, Assign Demands and Elevations
5. Skeletonize the model
6. Calibrate the model
7. Define the specific situation to be modeled
8. Input the situation-specific data
9. Run the model
10. Are results reasonable? Make recommendations
....Additional runs required?

Building the Model

Model Sources

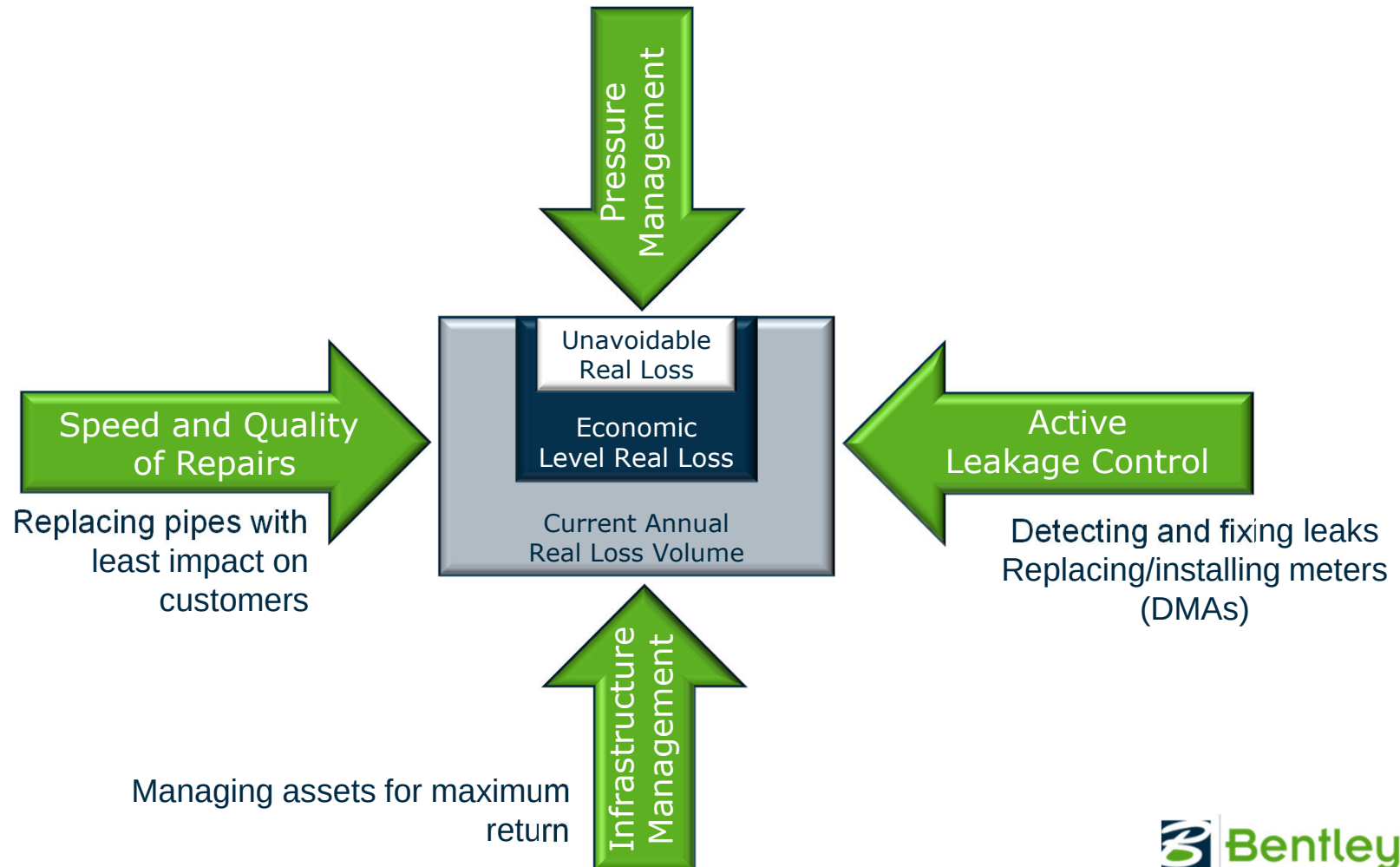
- Maps form the basis for representing the system
- Use CAD/GIS drawings when available
- Use the latest available maps
- Verify maps with as-built drawings where needed
- Verification with field personnel

Constructing the Network

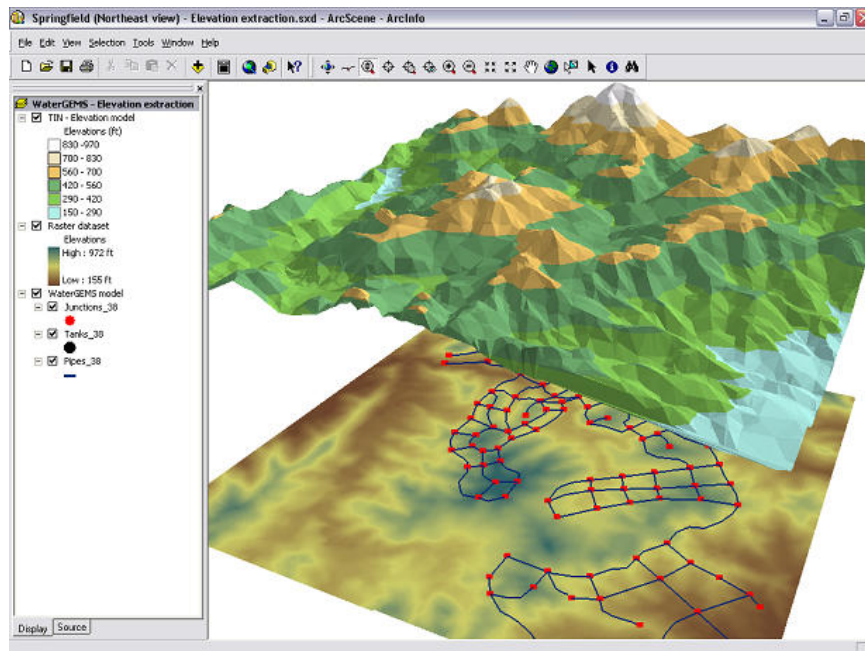
- Multi-Platform
- Convert maps to model
- Manual process or automated using CAD / GIS
- Assign node/link identifiers (e.g. numbers or labels)
 - Naming conventions
 - Automatic labeling
 - Auto prompting

Strategy: A Long-term Approach with Immediate [Near-term] Benefits

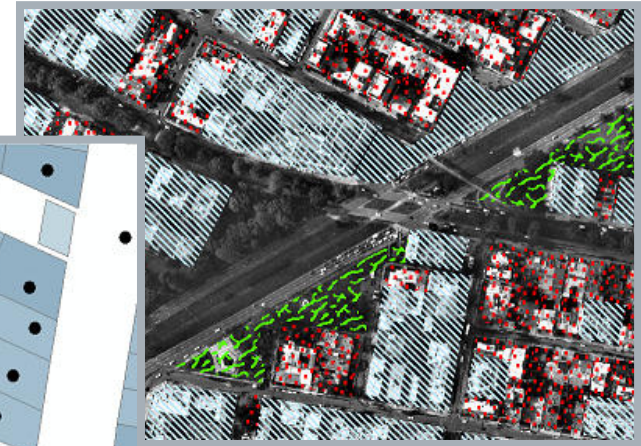
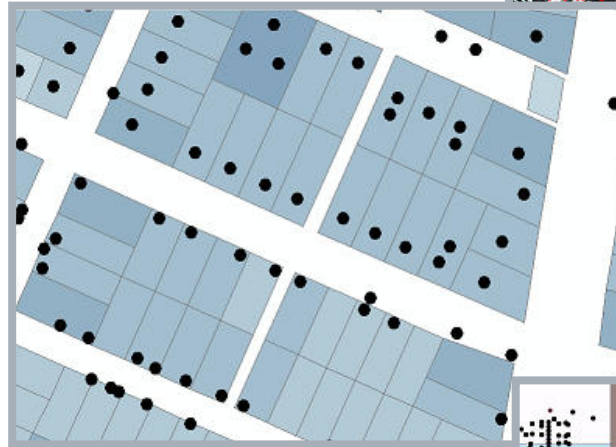
Implement IWA best practices



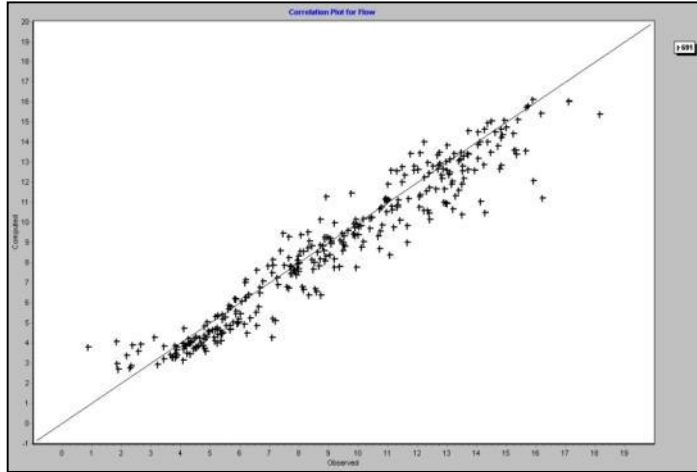
Model Building



Assign Demands



Calibration



To fit the characteristics of the hydraulic model to the best representation of the real world

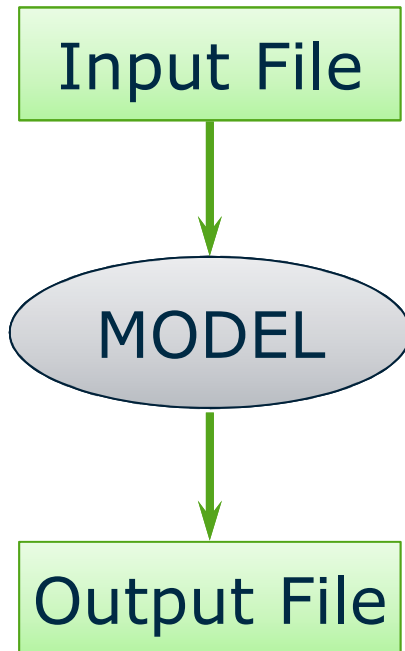
Measurement Devices (Data-Loggers)



Remotely piloted control stations



Traditional Method of Managing Runs

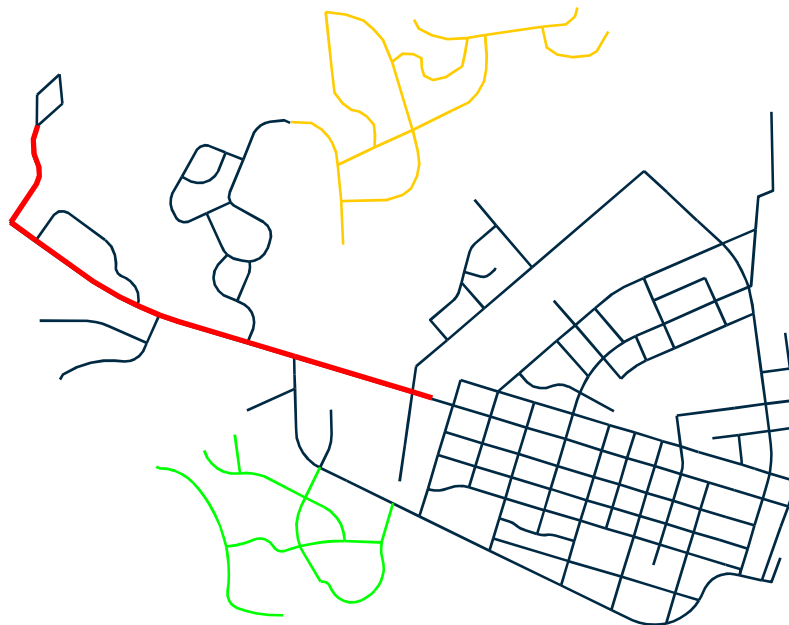


Input File 1	Output File 1
Input File 2	Output File 2
Input File 3	Output File 3
Input File 4	Output File 4
Input File 5	Output File 5
Input File 6	Output File 6
Input File 7	Output File 7
Input File 8	Output File 8
Input File 9	Output File 9
.	.
.	.

Scenario Control Center™

Scenario Management

Current Scenario



Alternatives

Physical: Optimized

Demand: Today

Active Topology: Current

Physical: 2010

Demand: 2010

Active Topology: New 2010

Physical: Wellesley 2020

Demand: 2020

Active Topology: New 2020

Physical: New Design

Demand: Max 2020

Active Topology: New 2020

Main Rule!

Garbage in = Garbage out

Performance Stages	Decision Time	Management Indicators	Customer Service	Water Losses	Emergencies	Level of IT integration	Software	Services
Pre-Effective	Months	Annually for global reporting	No 24*7 emergency support and customer phone service	No real control, usually above 50%	Very frequently, long delay for resolution	Invoicing and wages	Billing CAD	Hydraulic Project (rehabilitation , new) + Emergency repairs +Master Planning
Effective	Weeks	Several times per year for control	24*7 emergency service (call center and emergency teams)	35 to 50%	Frequent, Usually sorted out during night and weekends	Invoicing, subcontracting, administrative, client interaction,	All the Above + CRM M&O	Software Customization and Integration
Efficiency	Days	Monthly	Same as above + Control room + telemetry	20 to 35%	Low frequency, resolution at night and weekends	Same as above + telemetry, GIS, Network modeling	All the Above + Asset Management, GIS, Modeling, Telemetry	System Integration, hydraulic consultancy, Telemetry Services
Excellence			Same as above + SCADA +		Rare, Usually sorted	All integrated with real	All the Above + Control	System Integration, strategic consultancy

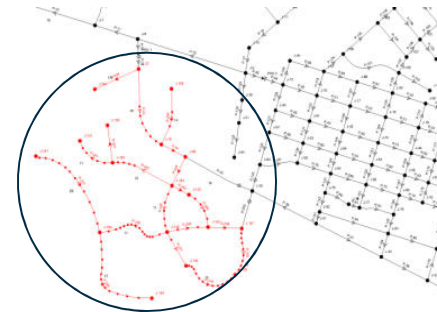
Active Leakage Control Using WaterCAD/WaterGEMS

" The use of DMAs has proved suitable for leakage control with many differing network configurations, irrespective of whether the customers are unmetered or metered and on both continuous and intermittent supply systems."

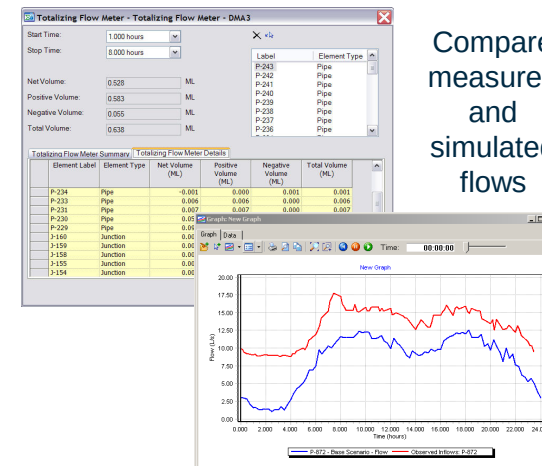
J A E Morrison, S Tooms, G Hall

Source: Sustainable District Metering – Water Loss 2007

DMA MANAGEMENT

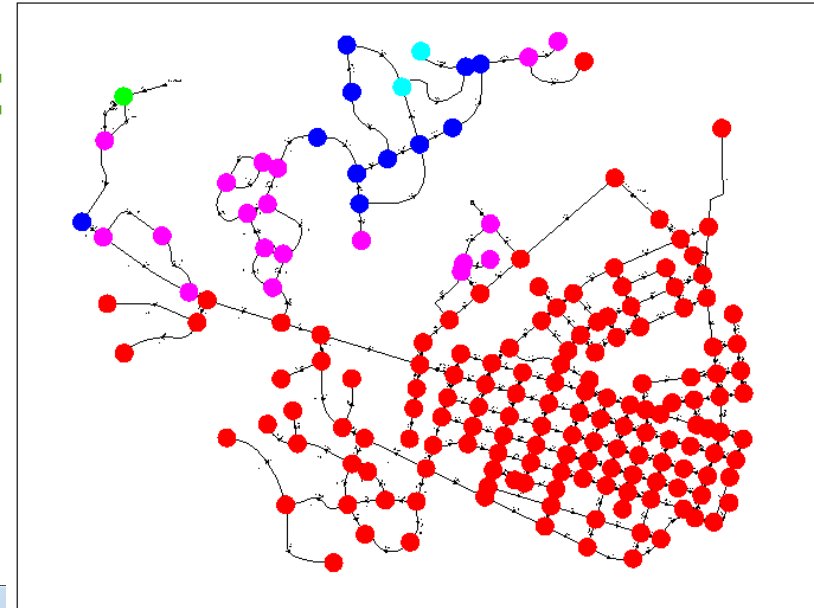
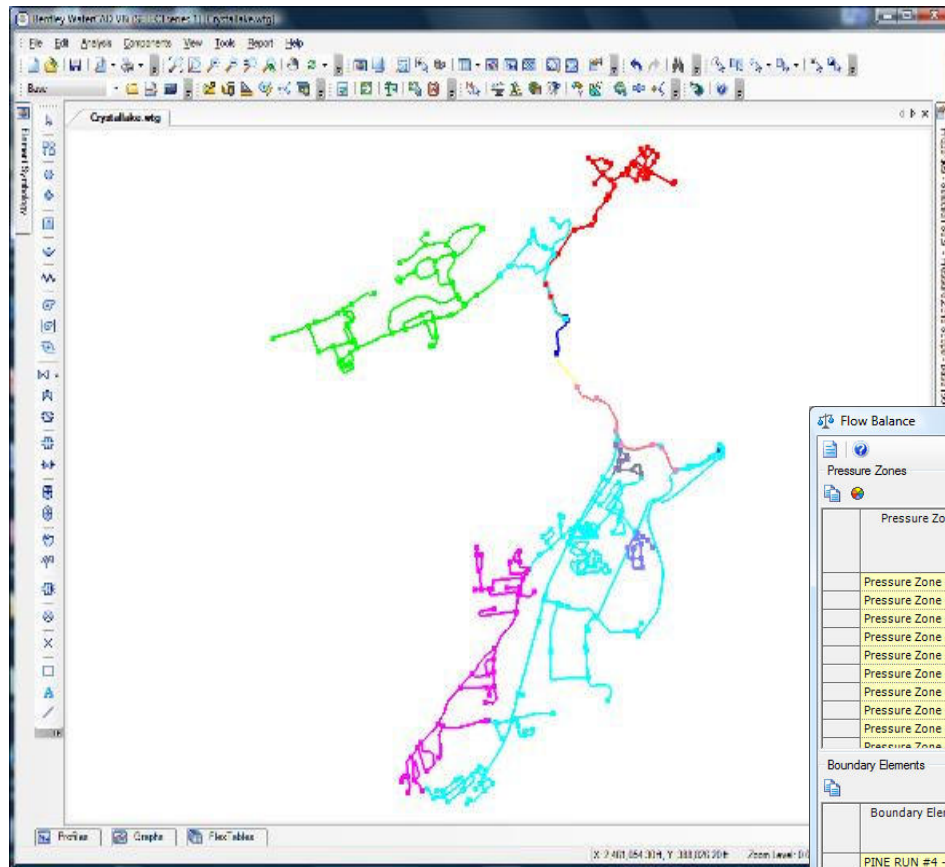


Create DMAs easily and quickly



Compare measured and simulated flows

Pressure Management



Flow Balance

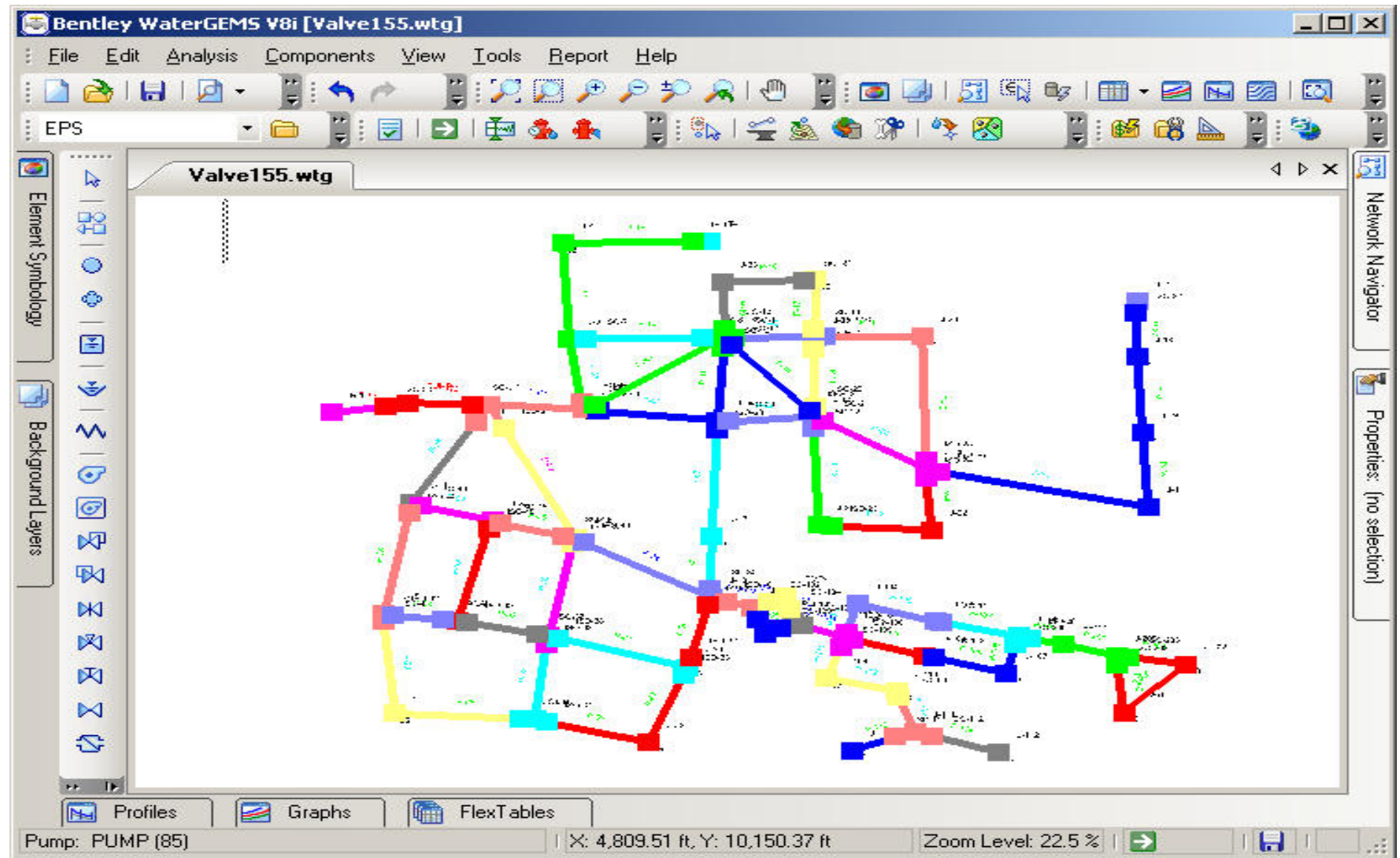
Pressure Zones

Pressure Zone	Zone	Net Inflow (gpm)	Demand (gpm)	Maximum Elevation (ft)	Minimum Elevation (ft)	Maximum Hydraulic Grade (ft)	Minimum Hydraulic Grade (ft)	Maximum Pressure (psi)	Minimum Pressure (psi)
Pressure Zone - 1	Gtown	164	141	980	610	1,022.03	1,000.00	170	9
Pressure Zone - 2	<None>	0	0	1,868	1,868	1,885.00	1,885.00	0	0
Pressure Zone - 3	SugarHill	664	372	927	597	983.84	917.33	162	44
Pressure Zone - 4	Hilltop	-2,082	1,069	1,860	1,312	1,892.00	1,660.48	154	13
Pressure Zone - 5	<None>	49	49	1,630	1,516	1,752.07	1,751.95	102	53
Pressure Zone - 6	<None>	240	240	1,360	1,213	1,590.05	1,588.79	163	100
Pressure Zone - 7	<None>	49	49	1,635	1,520	1,762.05	1,761.60	105	55
Pressure Zone - 8	<None>	5	5	1,683	1,420	1,784.87	1,702.51	122	34
Pressure Zone - 9	PineRidge	3	3	1,420	1,200	1,478.35	1,452.79	110	25
Pressure Zone - 10	<None>	8	8	1,200	870	1,704.33	1,703.73	167	41

Boundary Elements

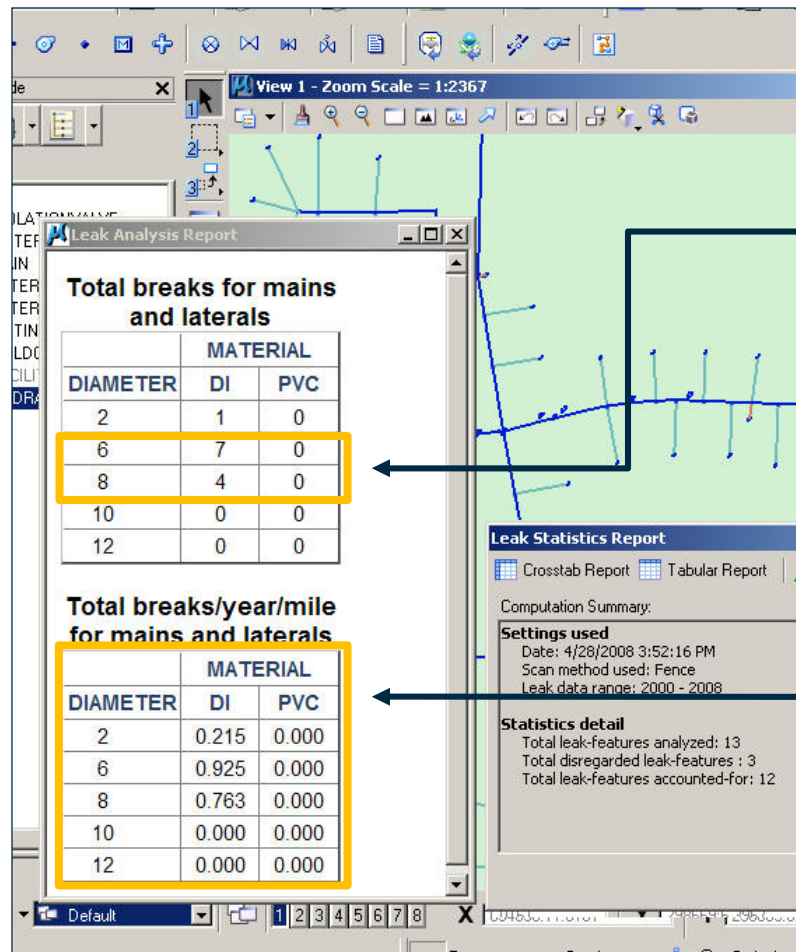
Boundary Element	Upstream Pressure Zone	Downstream Pressure Zone	Flow (gpm)
PINE RUN #4 - GE...	Pressure Zone - 10	Pressure Zone - 1	164
P-1485	Pressure Zone - 11	Pressure Zone - 1	0
P-1515	Pressure Zone - 1	Pressure Zone - 11	0
P-2265	Pressure Zone - 2	Pressure Zone - 4	0
SUGAR NOTCH PU...	Pressure Zone - 3	Pressure Zone - 11	0
SUGAR NOTCH PU...	Pressure Zone - 11	Pressure Zone - 3	664
CRESTWOOD PRV	Pressure Zone - 4	<None>	0
JOHNSON STREET	Pressure Zone - 4	Pressure Zone - 8	929
GRACEDALE PRV	Pressure Zone - 4	Pressure Zone - 7	49
NORTH MAIN PRV	Pressure Zone - 4	<None>	429

Criticality Analysis



Infrastructure Lifecycle Management

Support to ASSET MANAGEMENT

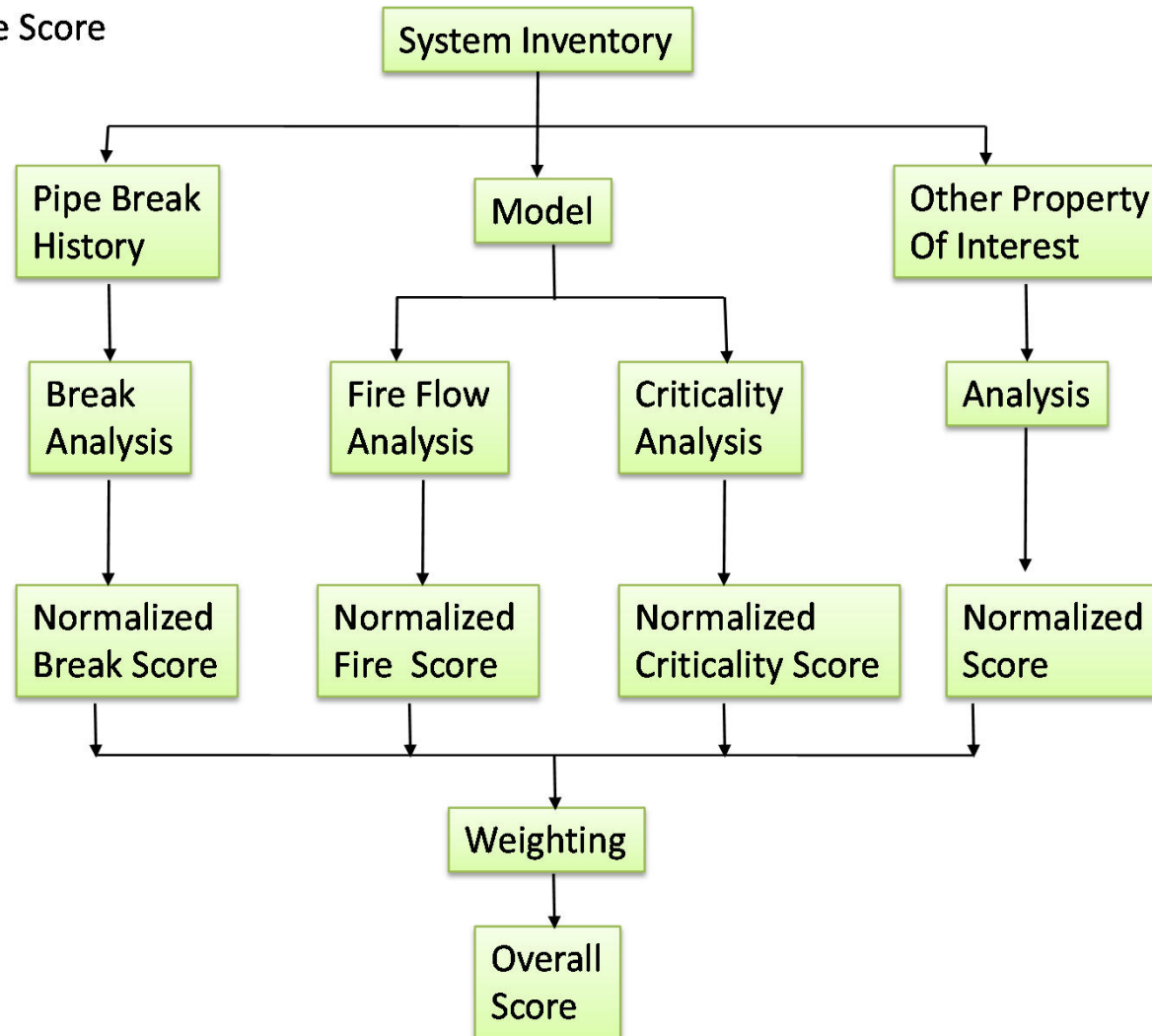


Identify areas with bad leak history and pipe/joint problems

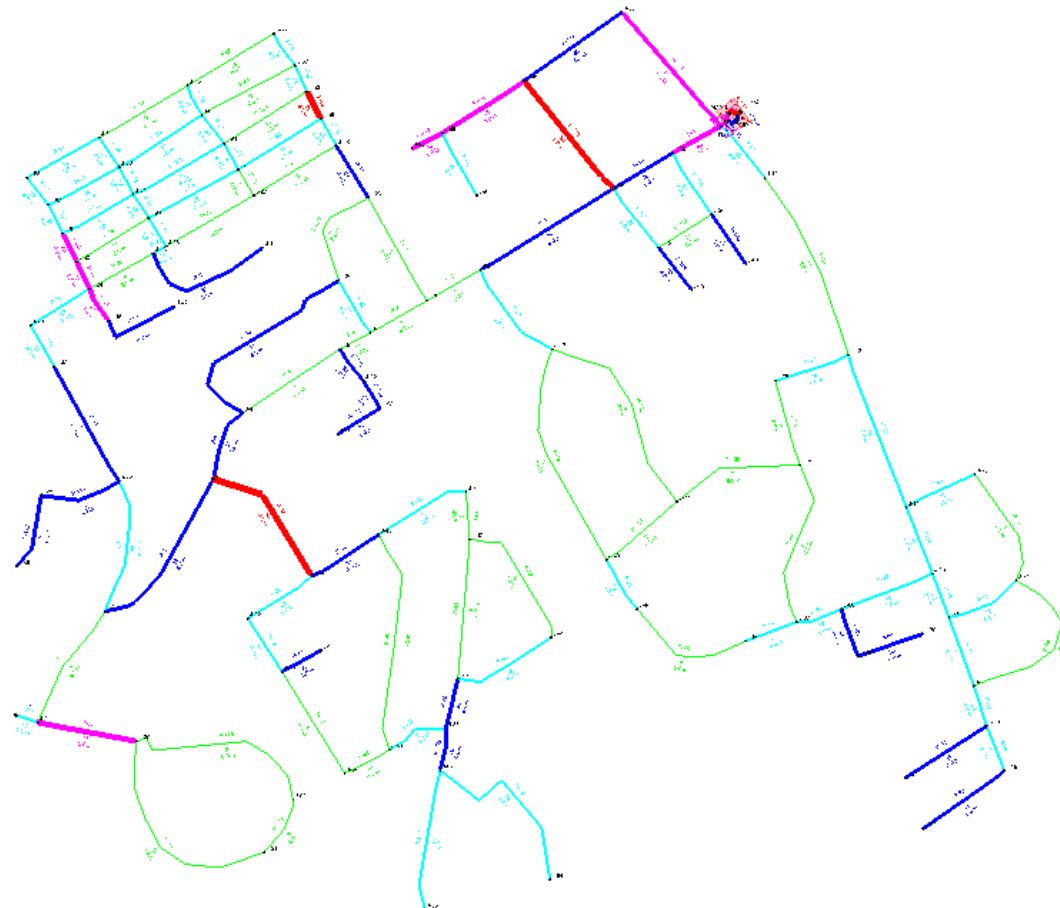
Prioritize capital investments, by generating reports of historical leakage locations and correlating with other properties (pipe diameter, material, etc.) and model dynamical properties

Workflow

Pipe Score



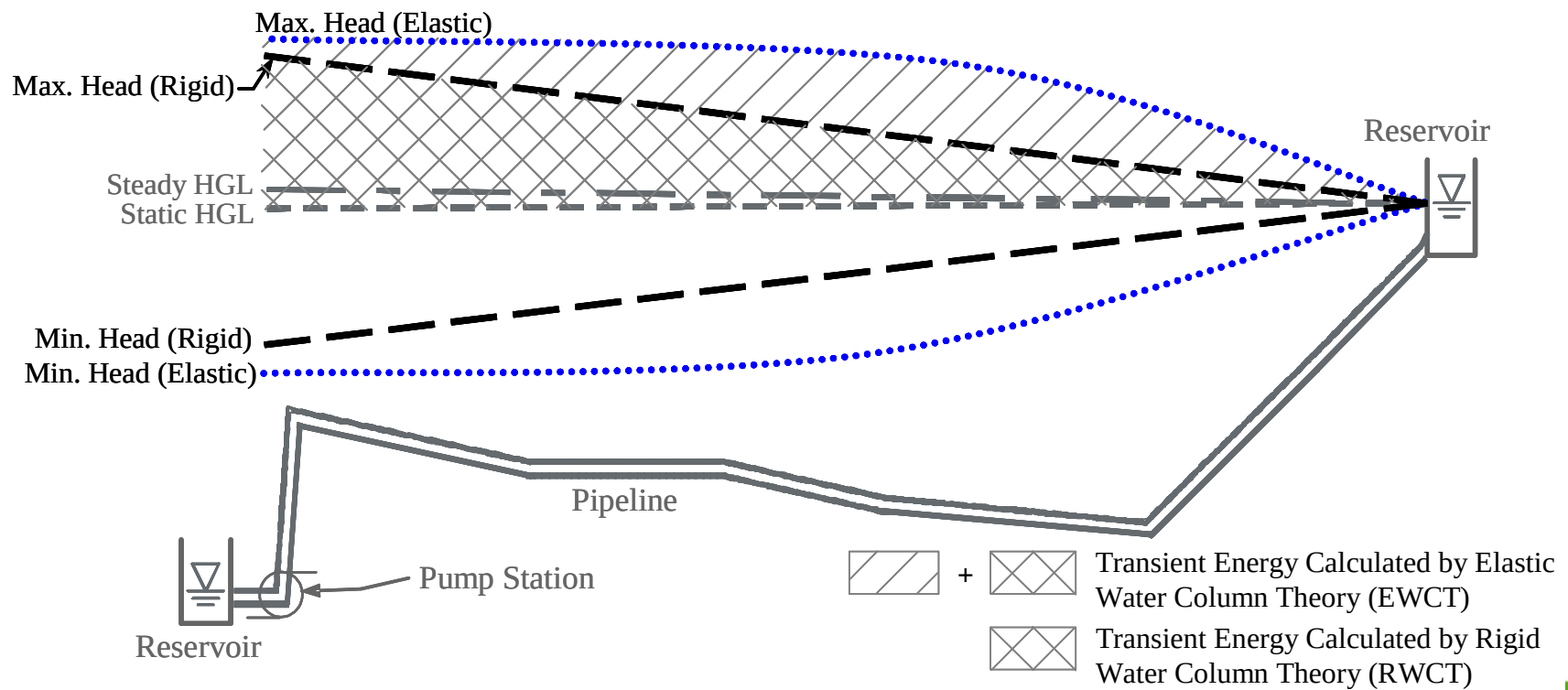
Color Coding by Score



Typical Application – Hydraulic Transients - HAMMER

High pressure waves
Can break pipes

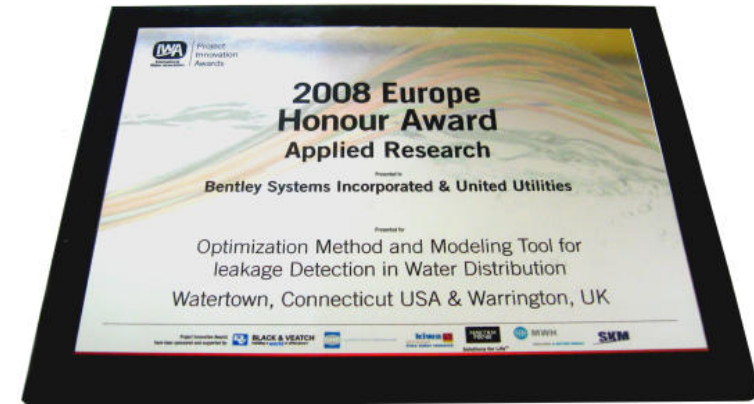
Can design
Protection/Prevention



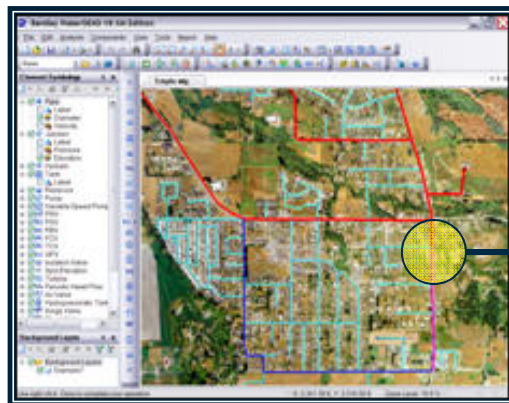
Active Leakage Control Using WaterCAD/WaterGEMS

DARWIN CALIBRATOR

- Innovative and unique approach, using Genetic Algorithm optimization technology
- Predicts the location and size of water losses (both real and apparent)



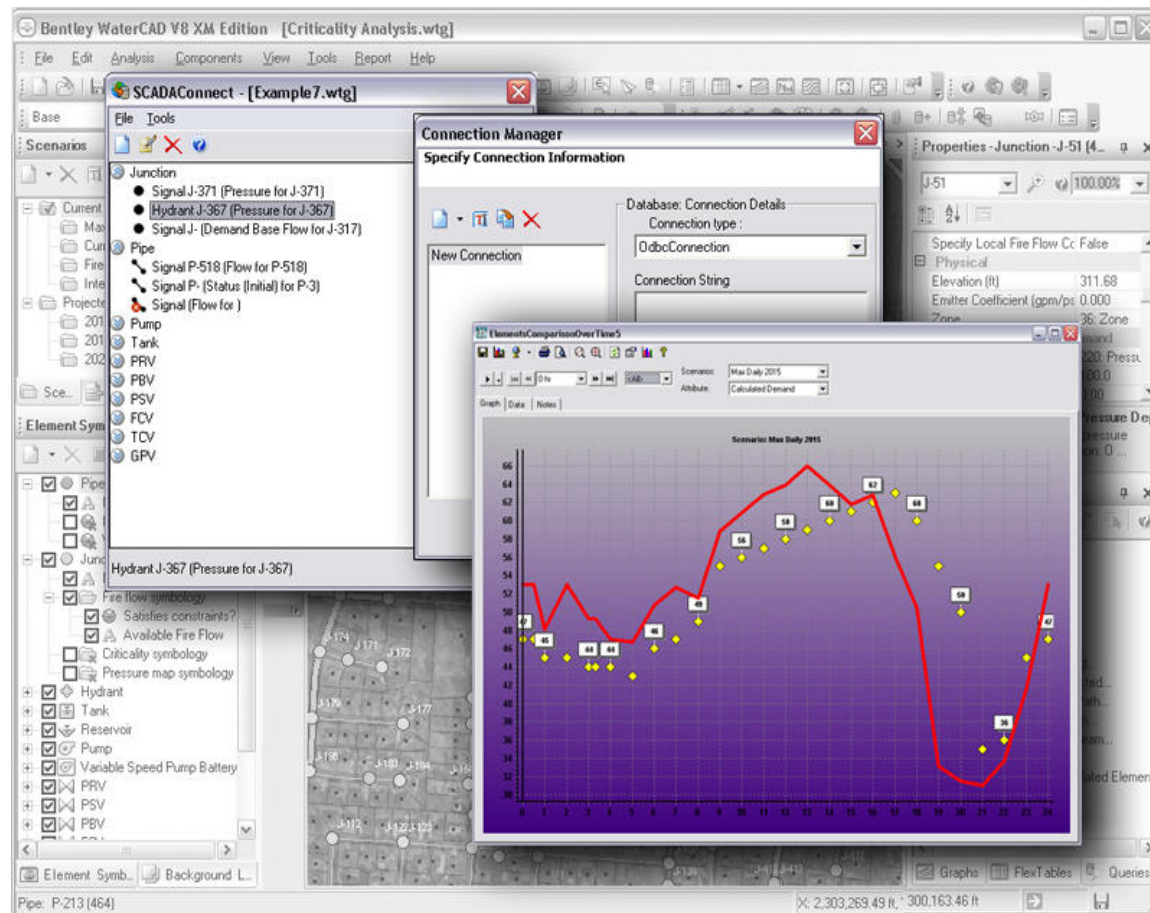
IWA-award winning optimization technology



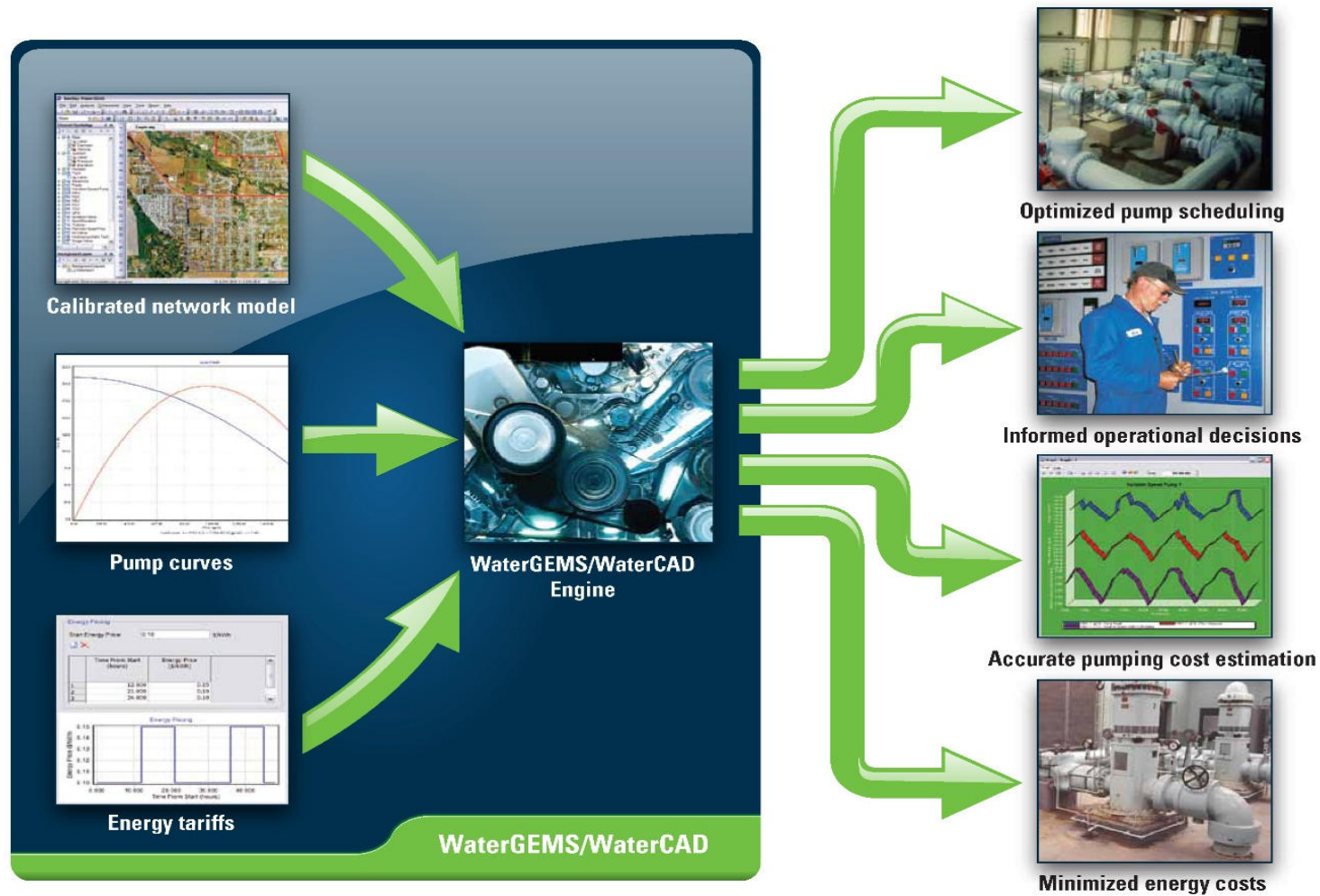
Field personnel can focus on area(s)
detected by Darwin Calibrator



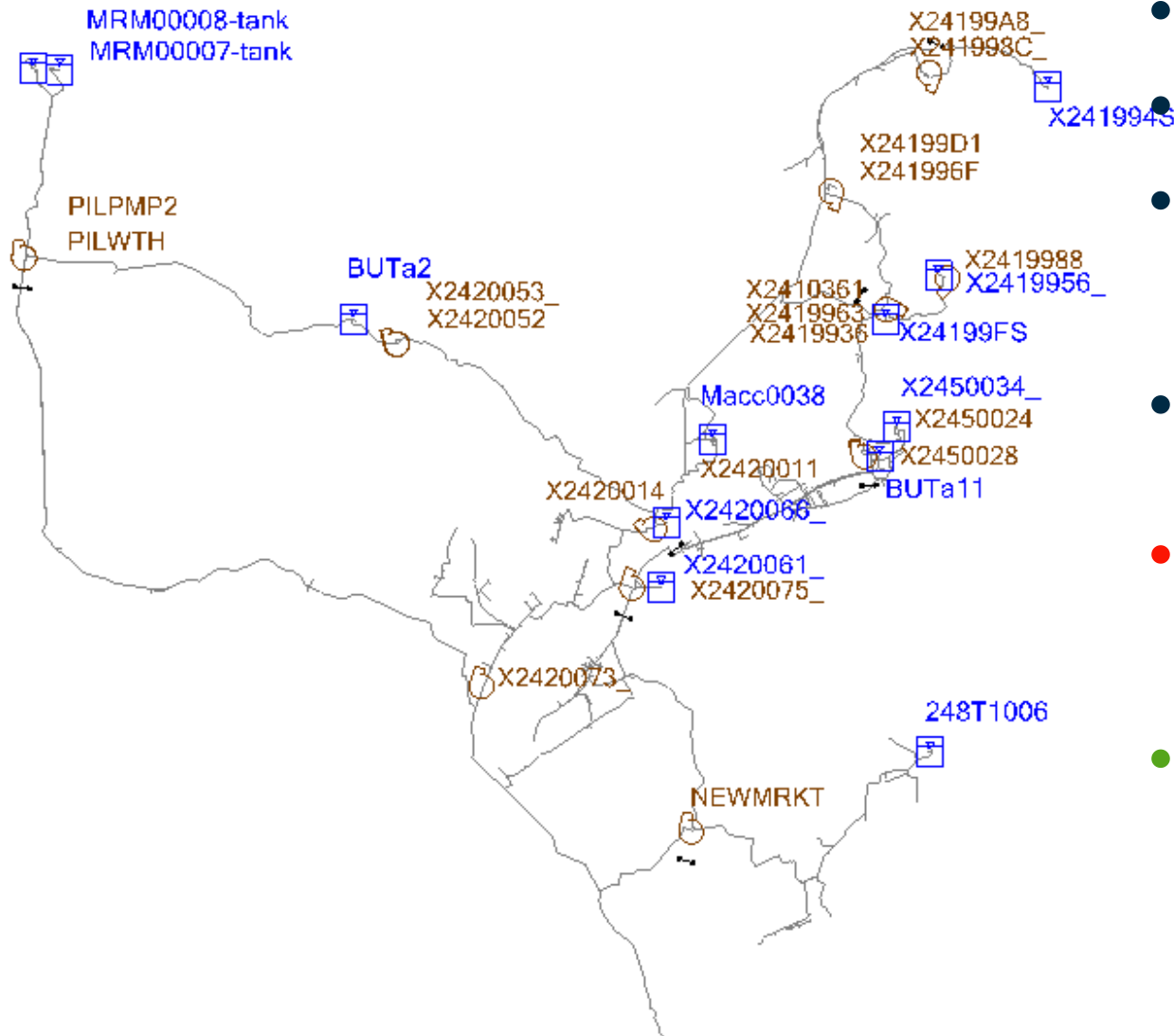
Using SCADA and Field data



Pump Management



CSP Case Study (Wu, Woodward & Allen 2009)



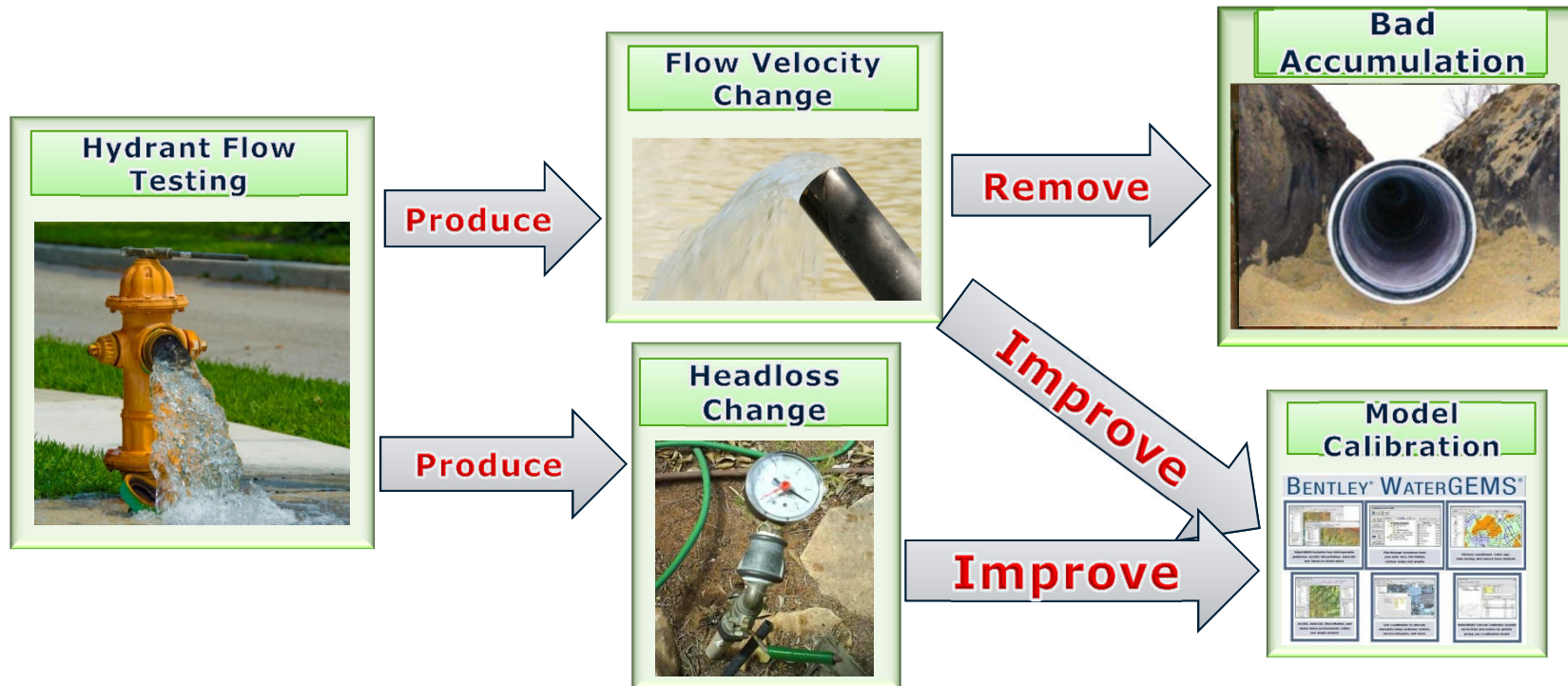
- DMZ system
- 57 MI/day
- 11 pump stations and 9 tanks
- Energy cost: £330K/year
- Recorded daily energy cost: £912
- Modeled daily energy cost: £923

Energy Cost comparison

Pump ID	Existing controls		Optimized controls	
	Pump utilization (%)	Daily cost (£)	Pump utilization (%)	Daily cost (£)
X2420052_	100	181.99	100	181.73
X2420014_	40	142.11	41	120.51
X2420075_	42	201.95	37	141.19
X2410361_	50	31.99	42	22.65
X2419963_	50	31.99	42	22.65
X241998C_	26	7.92	31	5.18
X2450024_	40	37.35	21	13.87
PILWTH	82	236.19	40	98.33
NEWMRKT	23	111.63	22	88.98
Total cost(£)		983.12		695.10

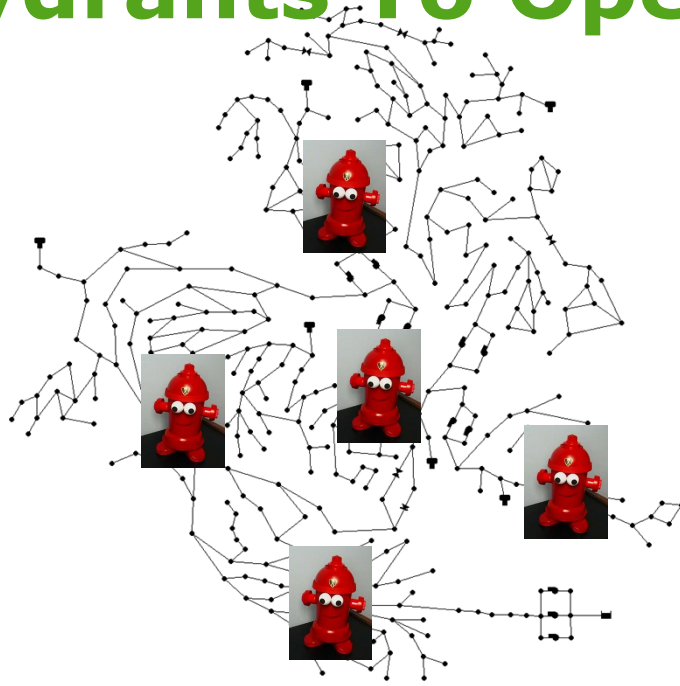
- Overall saving is 29% of original energy cost
- By shifting pumping hours and increasing supply of 3.5 MI/d from gravity source

Flushing Problem



- Opening hydrant changes head loss and flow velocity of pipes, which is useful
 - Greater the change, more helpful for the model calibration
 - Changing velocity helps remove bad accumulations in the pipe

Hydrant Selection - Find Best Hydrants To Open

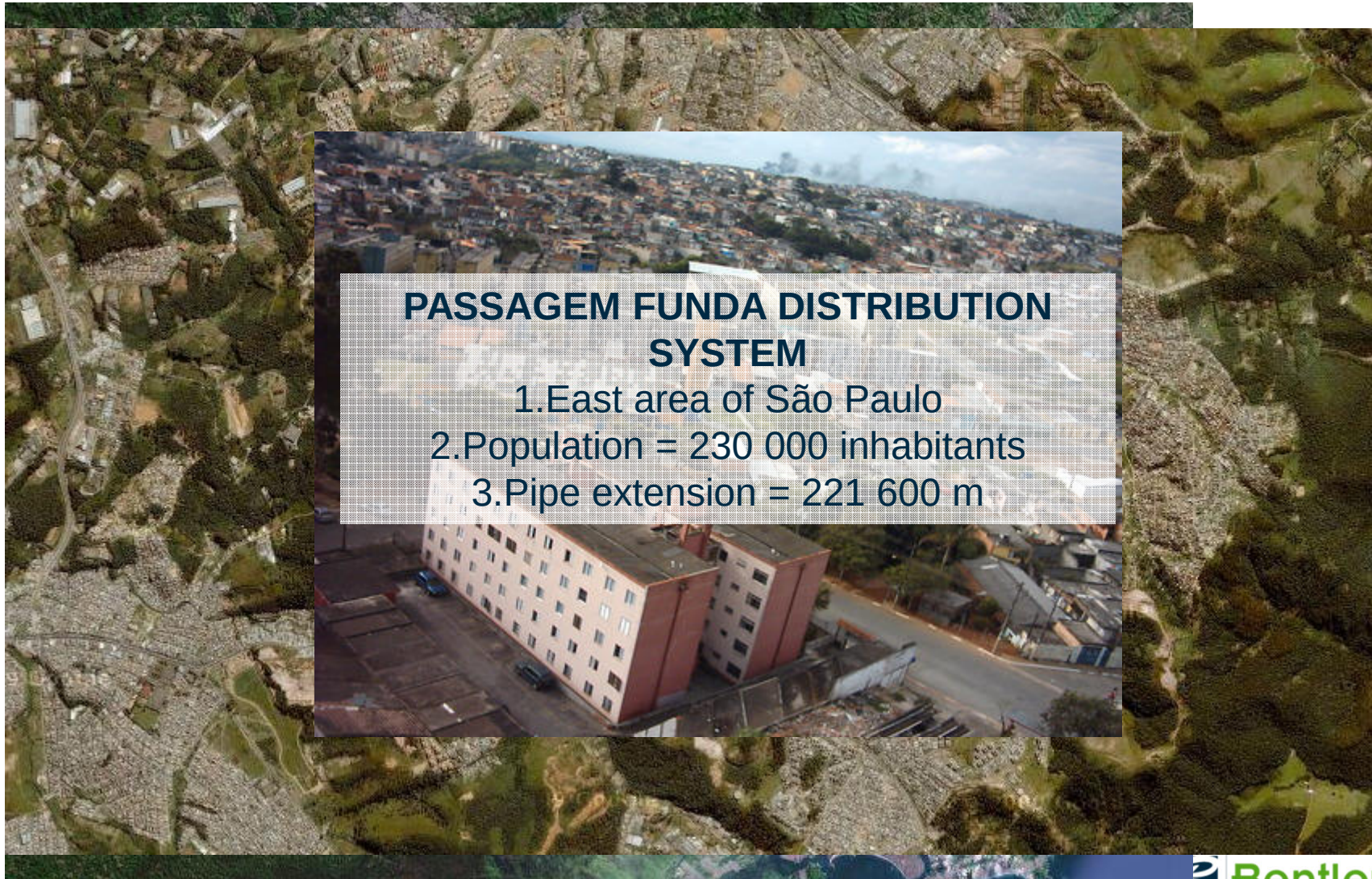


Which one?
How many?
How much flow?

Find a way to evaluate the capability of a combination of hydrants

- We don't want to open all hydrants <- Limited number of hydrants should be opened
 - Which one to open? -> Affect as much as possible pipes [Efficiency]
 - How many to open? -> Require as few as possible [Cost]
 - How much hydrant flow should be used? -> Smaller the better

Case Study – Sabesp, S.Paulo



PASSAGEM FUNDA DISTRIBUTION SYSTEM

1. East area of São Paulo
2. Population = 230 000 inhabitants
3. Pipe extension = 221 600 m

SABESP Case Study

Problems

- 50% water loss
- Poor service (frequent disruptions)

Solutions

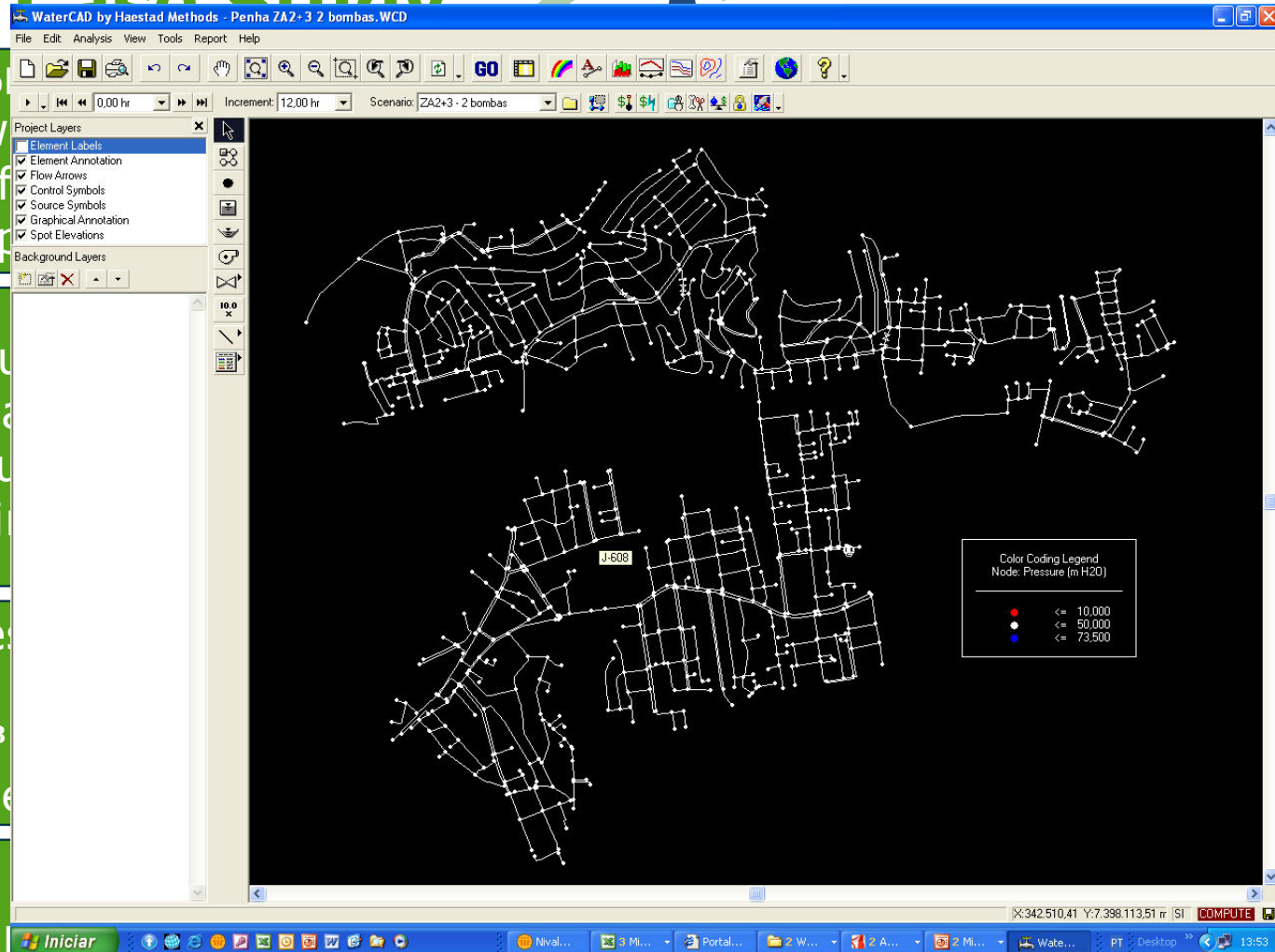
- Pump maintenance
- New Pressure Reducing Valves (PRV) installed

Results

- 36.74 % reduction in water loss
- ~12.000.000m³ of water saved
- Improved service

Next Steps

- Efficient Leakage Detection (Darwin Calibrator)
- Using the Model for Maintenance and Operations



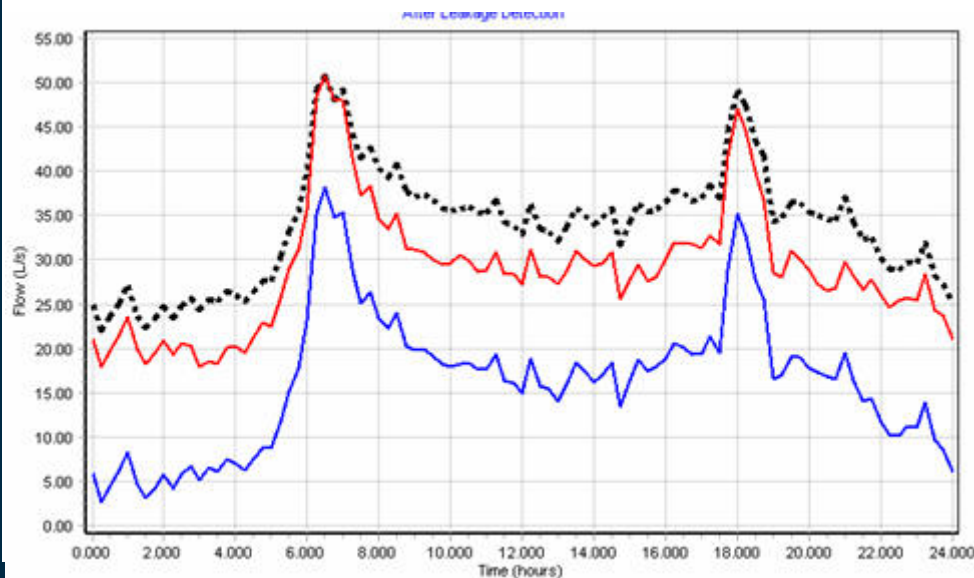
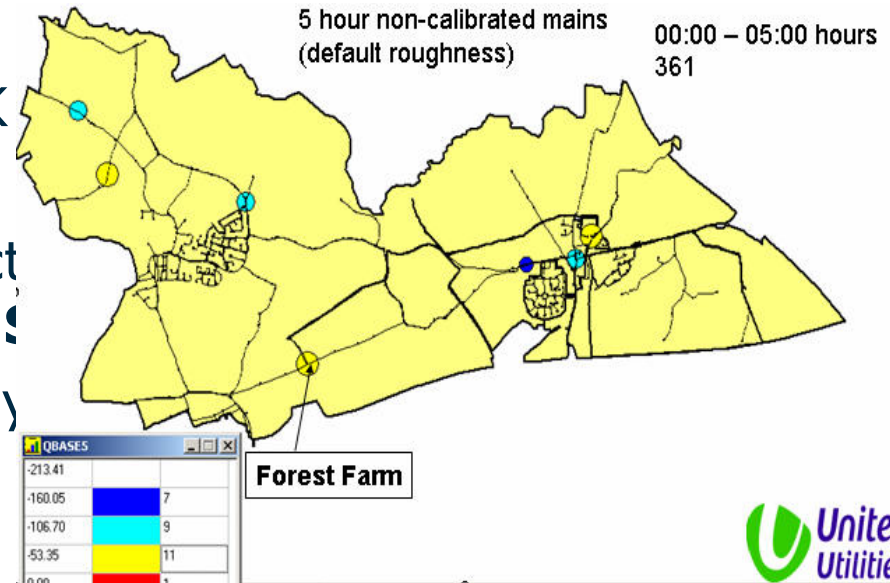
Model

Case Study - United Utilities

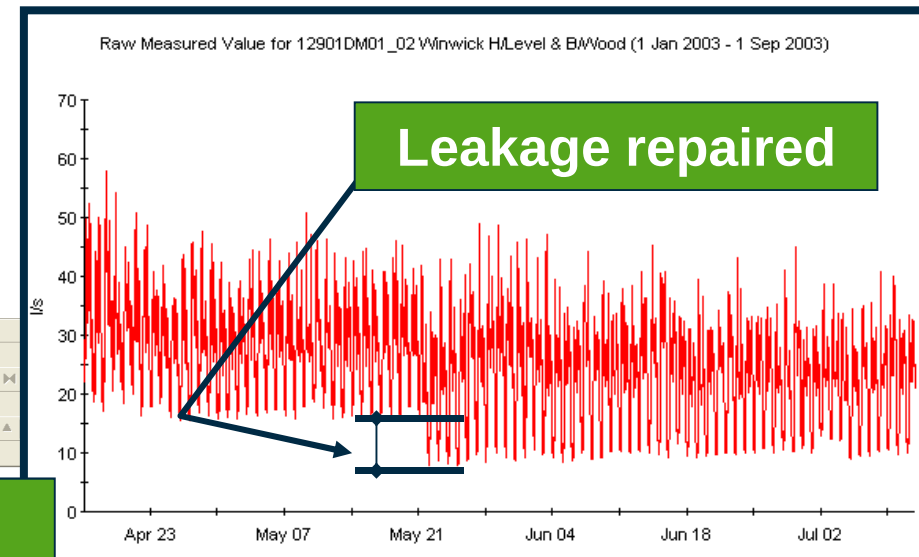
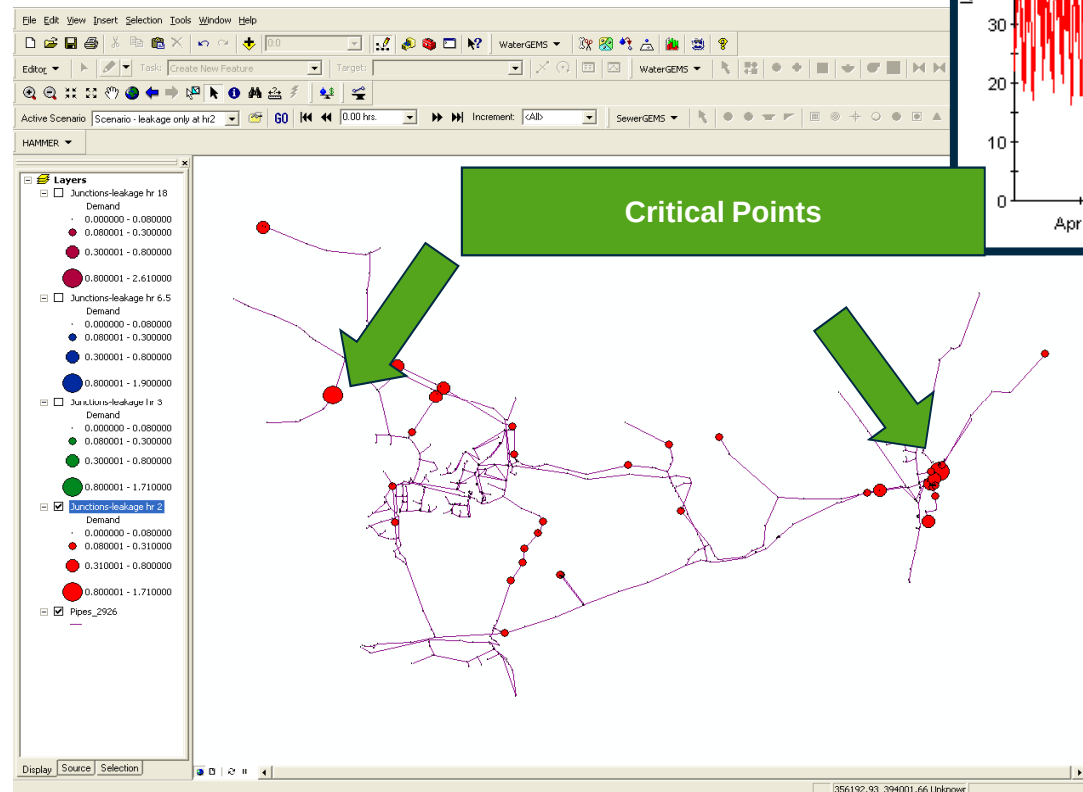
- United Utilities is the UK's largest operator of water systems
- United supplies 2,000 million litres of water every day via a network of around 40,000 kilometres of water mains, 1,444 kilometres of aqueduct and over 100 water treatment works.
- It covers a population approaching seven million people

Leakage Detection Benchmark

- A DMA water system in UK
 - High leakage rate
- Apply the latest leakage detection methodology in **WaterGEMS**
- Enable informed field survey



Leakage Map Detected by GA-based Model Calibration for DMA129-01 at Hour 2:00 AM



Look For:

www.Bentley.com
Water Solutions

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