Bentley StormWater Solution

November 2009

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Water Industry Director EMEA

Bentley
Sustaining Infrastructure


RAIN, RAIN, RAIN, SNOW, CLOUDY, RAIN,
SNOW, RAIN, RAIN, CLOUDY, CLOUDY, CLOUDY, RAIN,
RAIN, RAIN, SNOW, SNOW, CLOUDY, RAIN, CLOUDY,
SUN, RAIN, SNOW, RAIN, RAIN, RAIN, RAIN,
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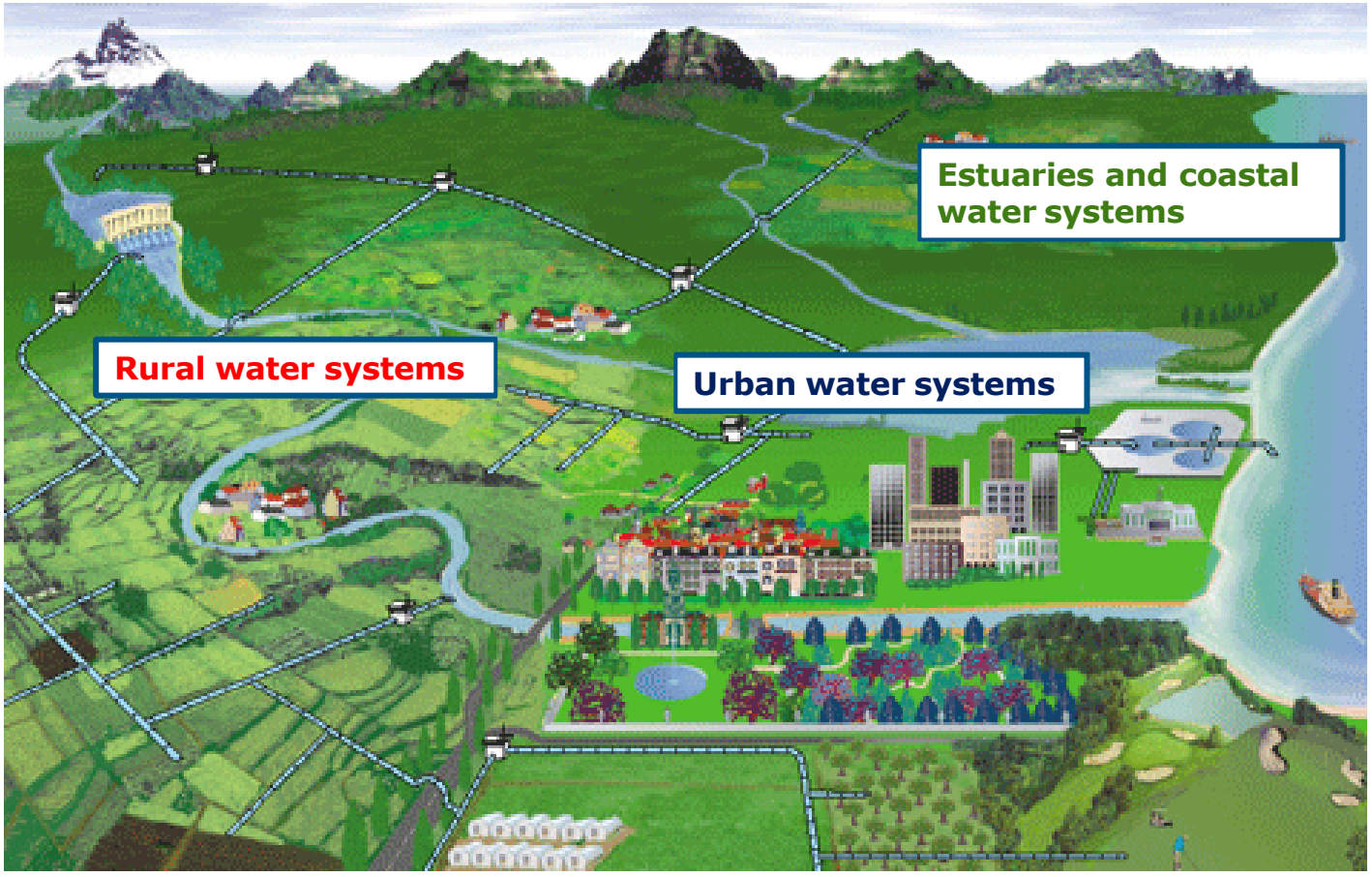
FEBRUARY

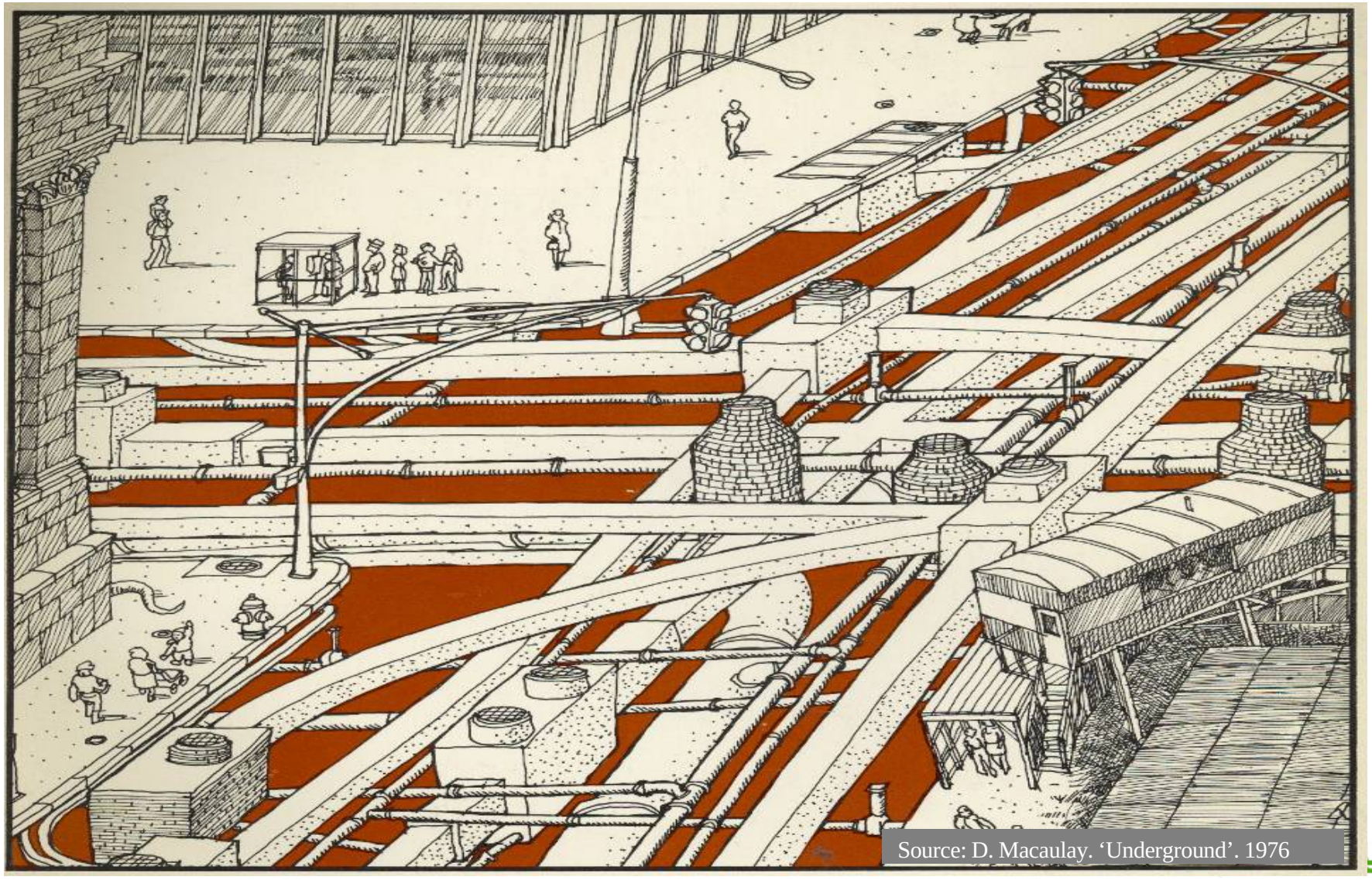
Agenda

1. Bentley StormWater Solution
2. Products Description
3. Application Examples
4. Demo
5. Contact Information

The World of Water



The Urban StormWater Challenges



Source: D. Macaulay. ‘Underground’. 1976

Global Trends & Quality of Life

- Climate Change
- Water Safety Planning
- Deteriorating and Ageing Infrastructure
- Globalisation
- Geopolitics
- Pressure on and Scarcity of Resources
- Emerging Technologies
- Demographics

Source: UN, UNEP, WaterforLIfe, HBS

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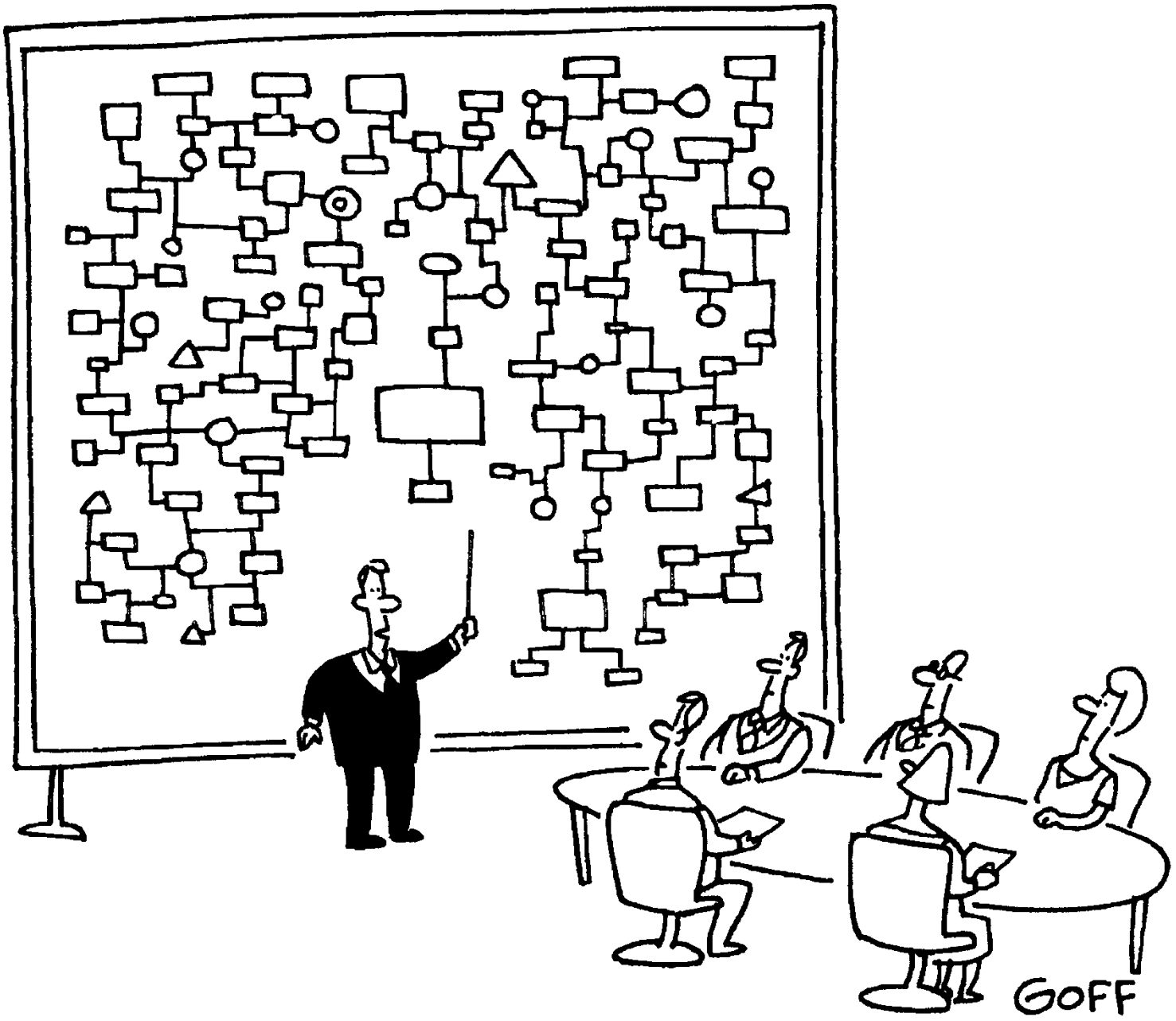


“And that’s why we need Bentley’s Haestad Software!!”

Bentley Haestad Product Line

HAESTAD METHODS
WATER SOLUTIONS

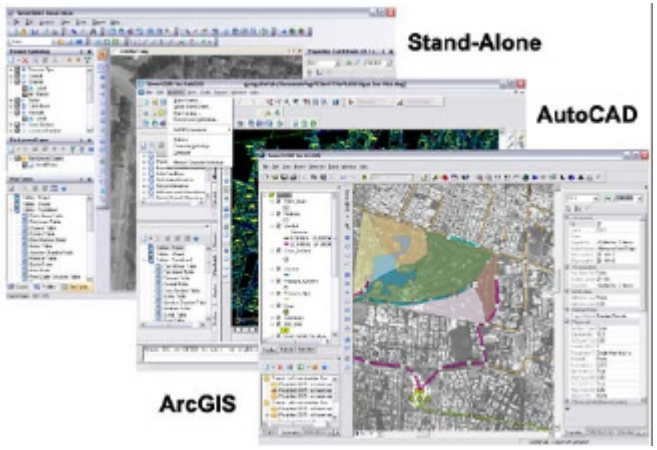
26 years
130,000 users
170 countries

WATER	WaterGEMS. Water distribution modeling with geospatial integration
	WaterCAD. Water distribution modeling and design
	Darwin Designer. Network design automation
	Darwin Calibrator. Model calibration optimization
	WaterSAFE. Advanced water quality and security
	Skelebrator. Network reduction or simplification
	HAMMER. Transient flow analysis and modeling
	SCADAConnect. Supervisory and control data integration
SEWER	SewerGEMS. Urban sewer modeling with GIS integration
	SewerCAD. Sanitary sewer design and modeling
STORM	CivilStorm. Stormwater management and dynamic modeling
	StormCAD. Storm sewer design and modeling
	PondPack. Detention pond design and analysis
	HEC-Pack. Floodplain modeling
	CulvertMaster. Culvert design and analysis
	FlowMaster. Hydraulics calculator
Other...	GISConnect. CAD / GIS Interoperability
	WaterObjects. .Net development environment
	Mohid. Catchment, costal and estuarial modelling solution

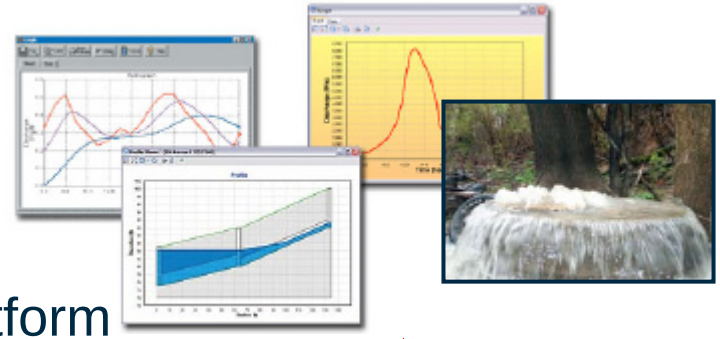
StormWater Products

SewerGEMS

Sanitary and Combined Dynamic Sewer Modeling

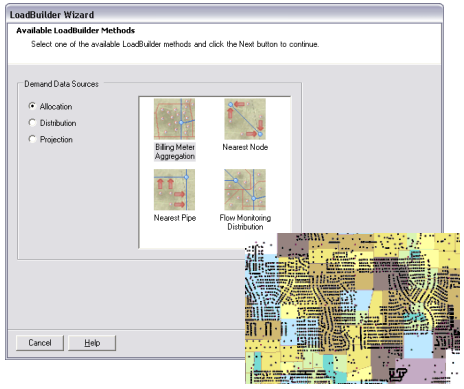


Multi platform environment

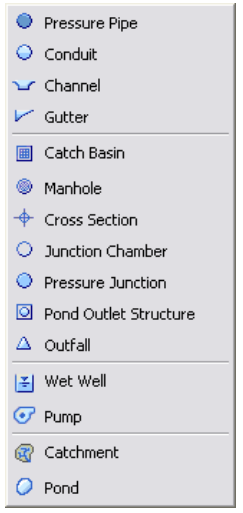


Dynamic modeling

Automatic sanitary loading allocation



Sanitary and combined sewer system element



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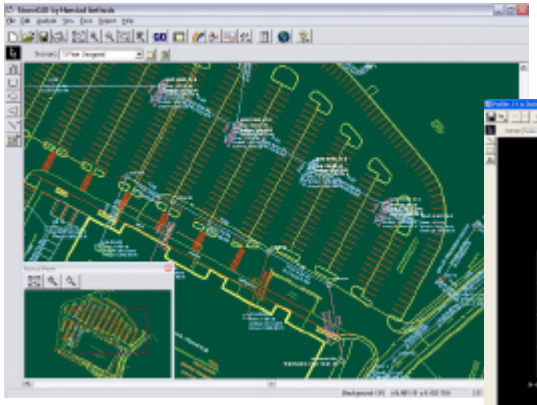
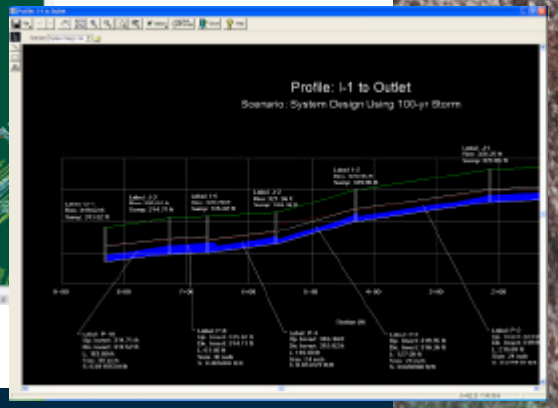
StormCAD

Storm sewer modeling and design

Capital cost analysis
Rational method hydrology
Gradually-varied flow analysis
HEC-22 methodology
Drawing review tools
Shapefile synchronized connections
Persistent database connections
Scenario manager
Scaled and schematic layout
Background support for model layout
CAD to model automated conversions
Profile manager
HEC-22 and AASHTO detailed reports
Curved pipe alignments
System capacity analysis
Accepted by FEMA

- Stand-Alone & AutoCAD interface
- Quick model building tools
- Easy-to-use layout & editing tools
- Automated system design
- Stunning result presentation tools

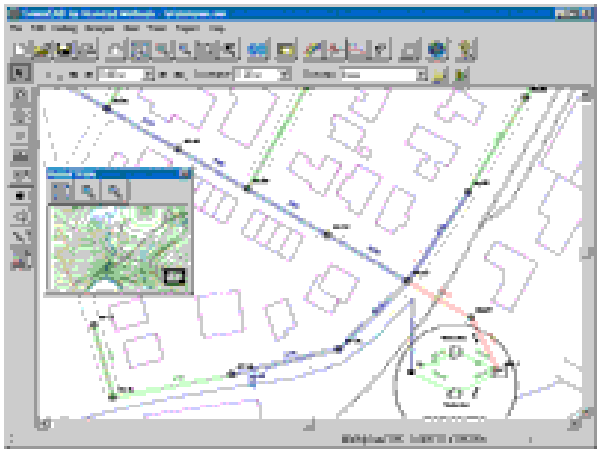


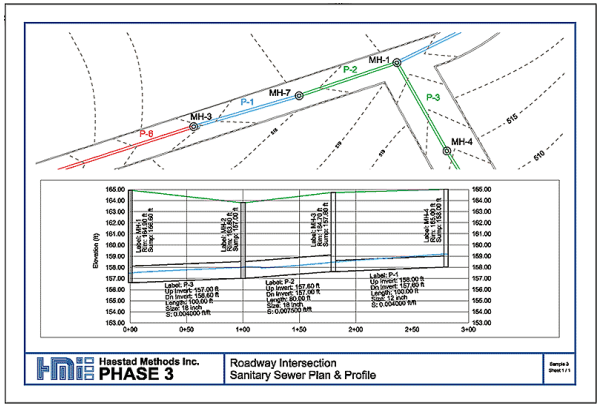


SewerCAD

Sanitary Sewer Design & Modeling

- Sanitary and wet-weather modeling
- Steady-state & Extended Period
- Pressure & gravity systems
- Automated design for pipes & inlets



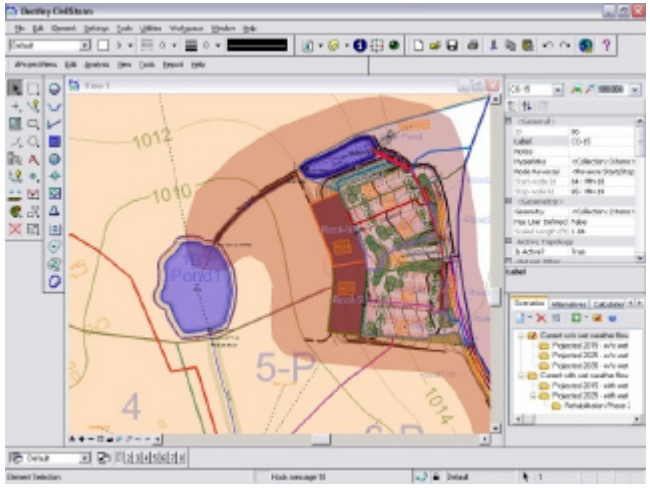


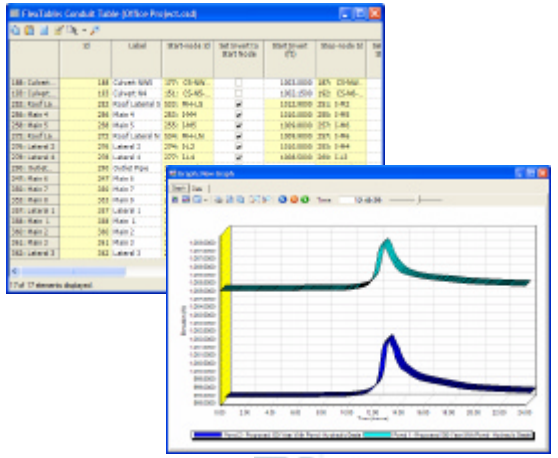
CivilStorm

Fully-dynamic stormwater analysis

- Model in geospatial environments
- Analyze complex stormwater systems
- Optimize system performance
- Present comprehensive results
- Experience the dynamic calculation engine

Stand-Alone , Micro Station and AutoCAD interface
Fully-dynamic modeling
Interconnected system modeling
Water quality assessments
Complex flow regime analysis
NPDES permit modeling
Scaled layout in Stand-Alone interface
Variety of methods for computing runoff
Profile manager
Scenario manager
Comprehensive engineering libraries
Model looped systems and diversions
Attenuate hydrographs due to storage





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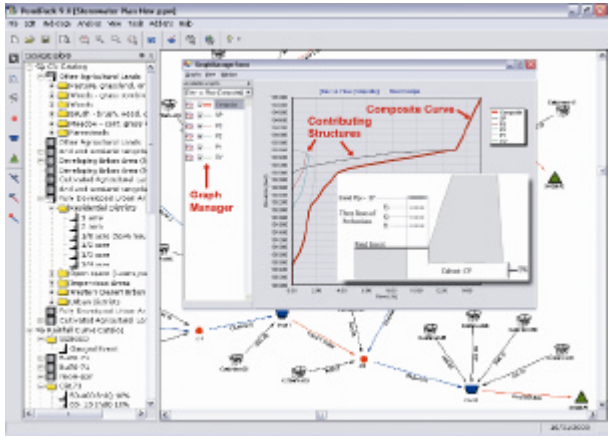
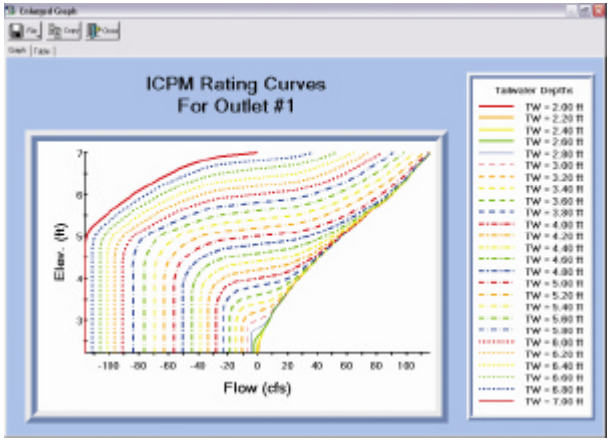
PondPack

Detention pond design and urban hydrology analysis

- Automate pond and outlet design
- Track project history
- Model interconnected ponds
- Account for travel time and time of concentration
- Perform complete system analyses

Interconnected pond modeling
Limited water quality analysis
Detailed graphing and reporting
ProjectWise integration
Accepted by FEMA
Intuitive interface
Unlimited number of storm events
Industry-standard runoff methods
Time of concentration calculator
Numerous peak flow methods
Water quality BMP calculations





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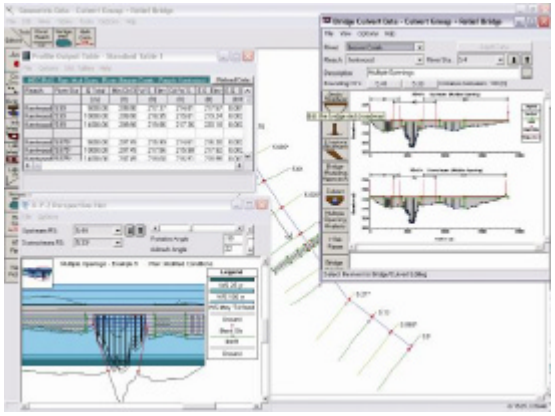
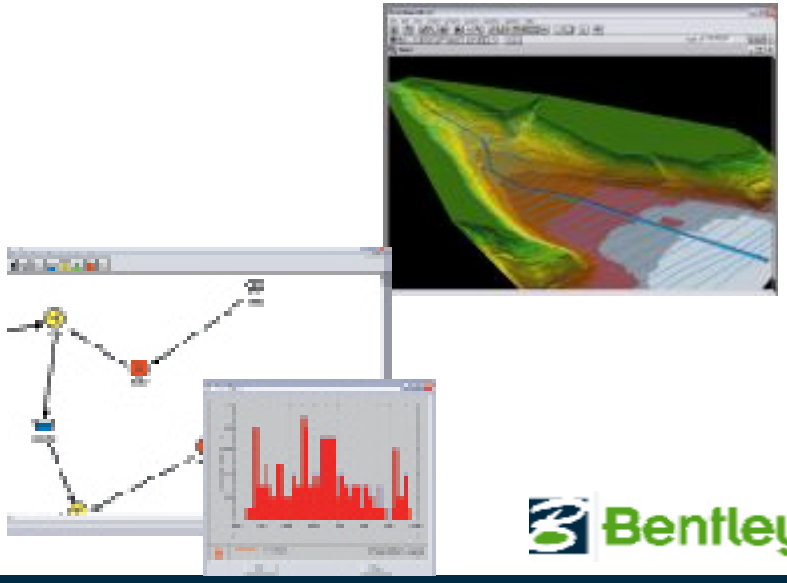
HEC-Pack

From Floodplain Hydrology to River Analysis



- Graphical HEC-1 for flood hydrology calculations
- HEC-HMS for hydrologic modeling
- HEC-RAS for river (floodplain) analysis
- Optimize system performance
- HEC-GIS for data sharing between HEC-RAS and ArcGIS

Bentley provides thousands of engineers with HEC software, documentation, and support for a variety of modeling tasks, from floodplain hydrology to river analysis to GIS integration. These important programs are all included in the HEC-Pack.



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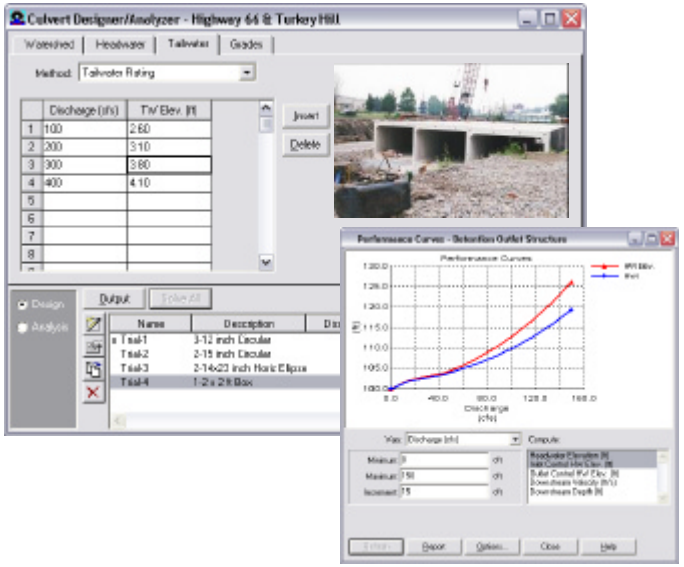
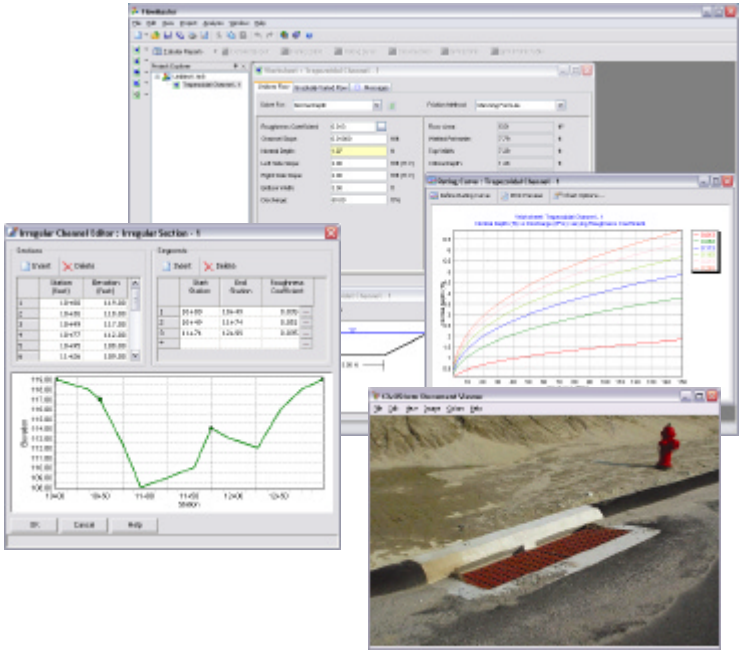
CulvertMaster

Culvert Design & Analysis

Model any situation that requires the design or evaluation of a culvert using HDS-5 methods, including roads, driveways, embankments, etc.





FlowMaster

Hydraulics calculator

Evaluate the hydraulics of virtually any type of hydraulic structure, including pipes, ditches, open channels, weirs, orifices, and inlets.

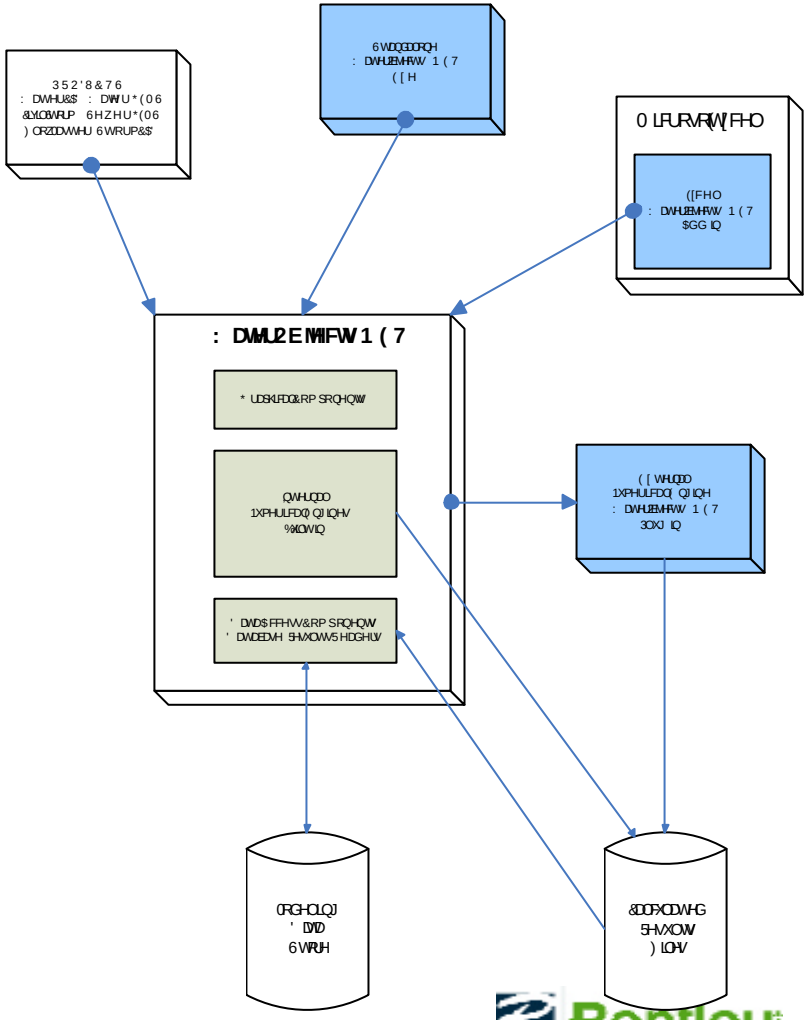
WaterObjects.NET

SDK / API for developers and system integrators

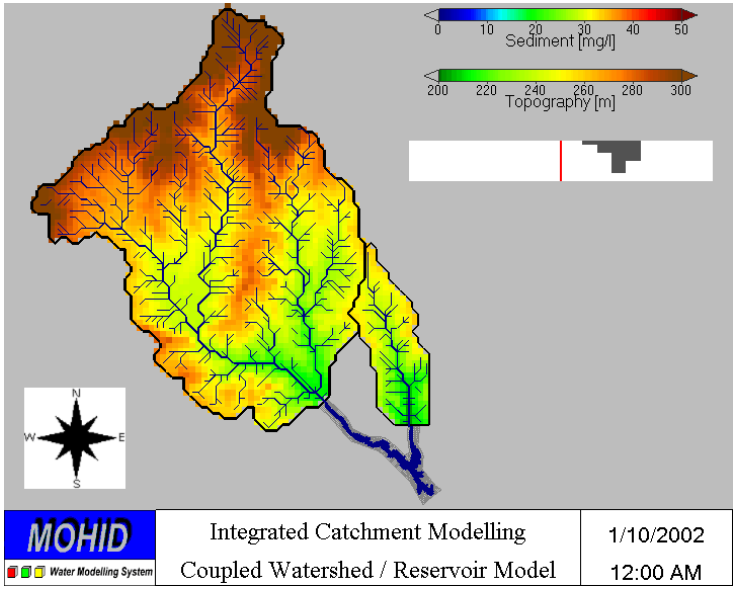
.NET-based software framework for engineering modeling applications

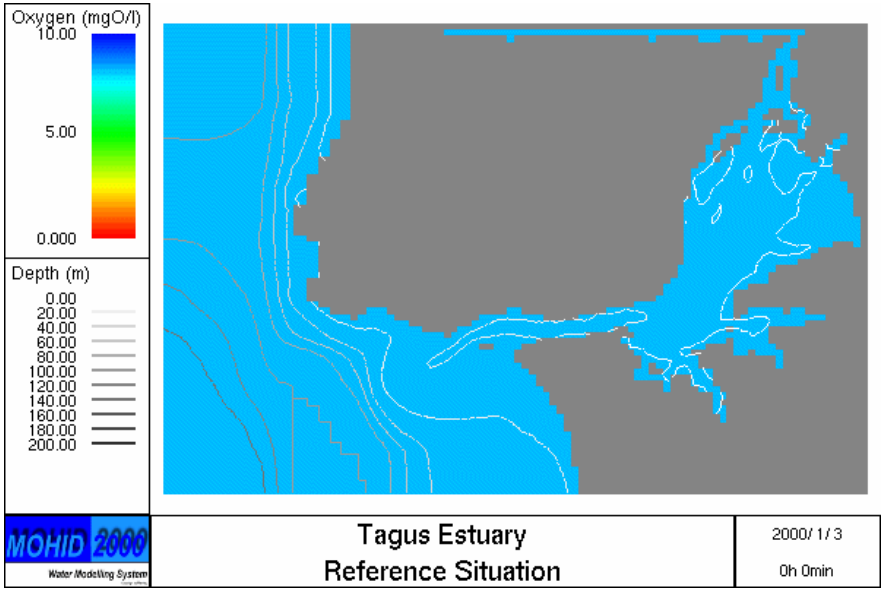
Major benefits:

- High-Performance
- Native support for analysis engines
- Multi-scenario, open-schema, unitized database
- Native support for network creation and analysis
- Stand-alone graphical drawing editor
- Windows, MicroStation, ArcGIS, and AutoCAD integration



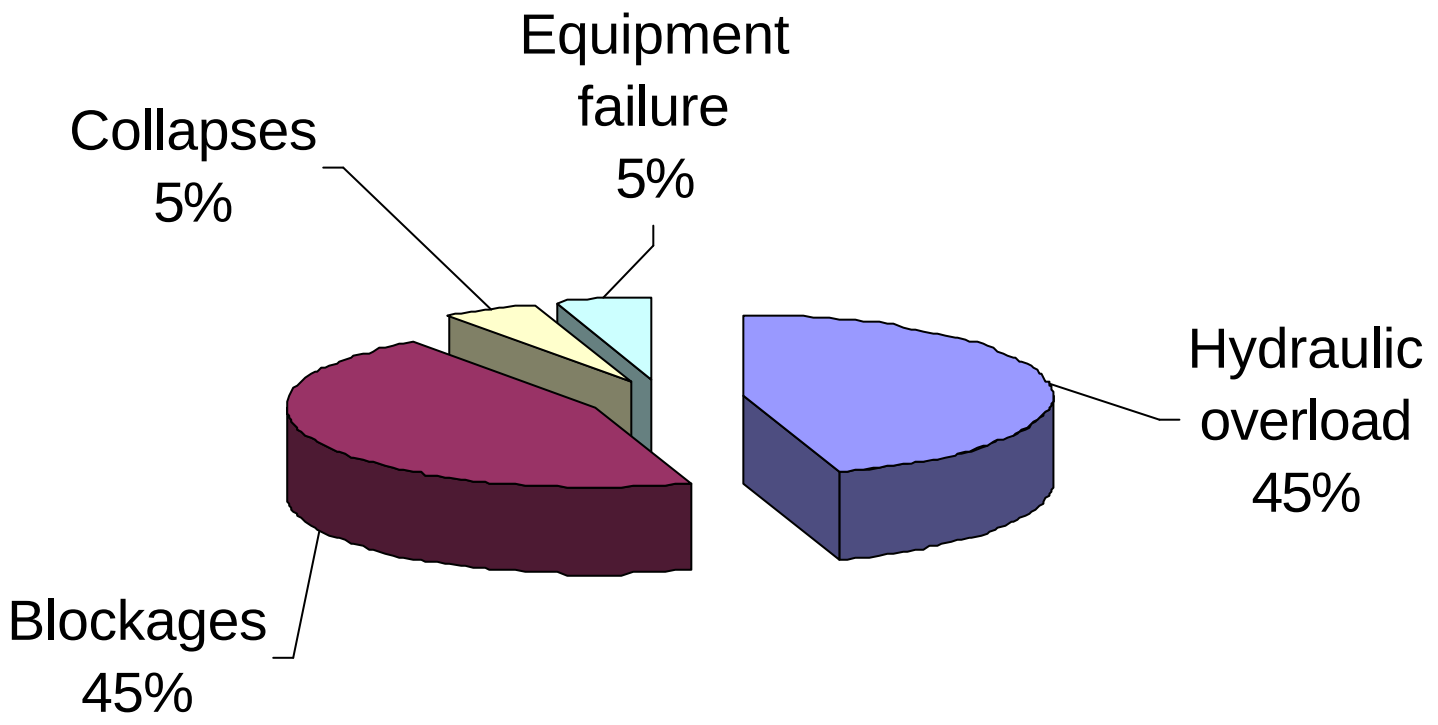
Mohid 2/3D Modelling





Example Applications

Sewer Deterioration Modelling

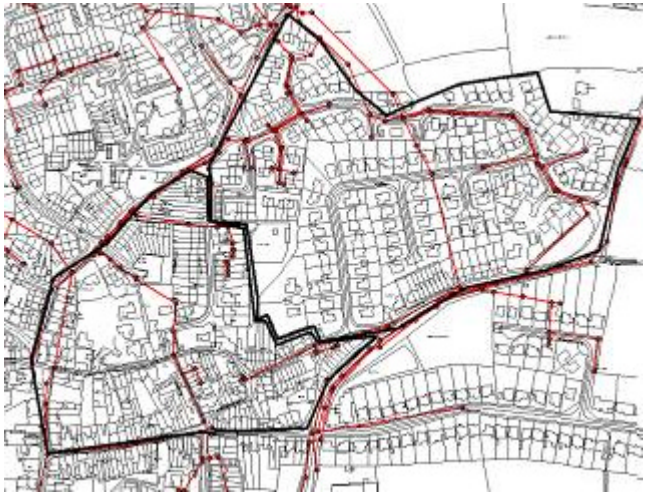


Causes of Sewer Flooding

Sewer Deterioration Modelling

Sewer Attribute Base

- Pipe performance
- Pipe service
- Installation age / era
- Size
- Material
- Depth
- Gradient
- Function
- Cross section
- Soil, traffic load, mining etc.

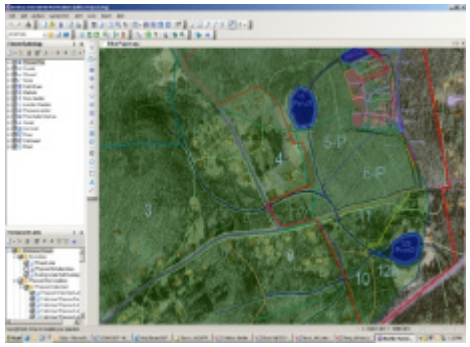


Timisoara city in Romania: combined sewer system

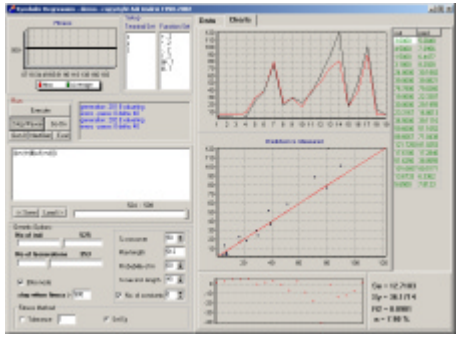
Solution Techniques

- Bentley SewerGEMS for Hydraulic performance assessment
- Genetic Programming for deterioration modeling
- Bayesian Probabilistic Network for Failure Risk Assessment and Uncertainty

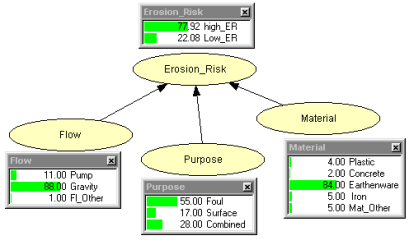
SewerGEMS



Bentley GP kernel

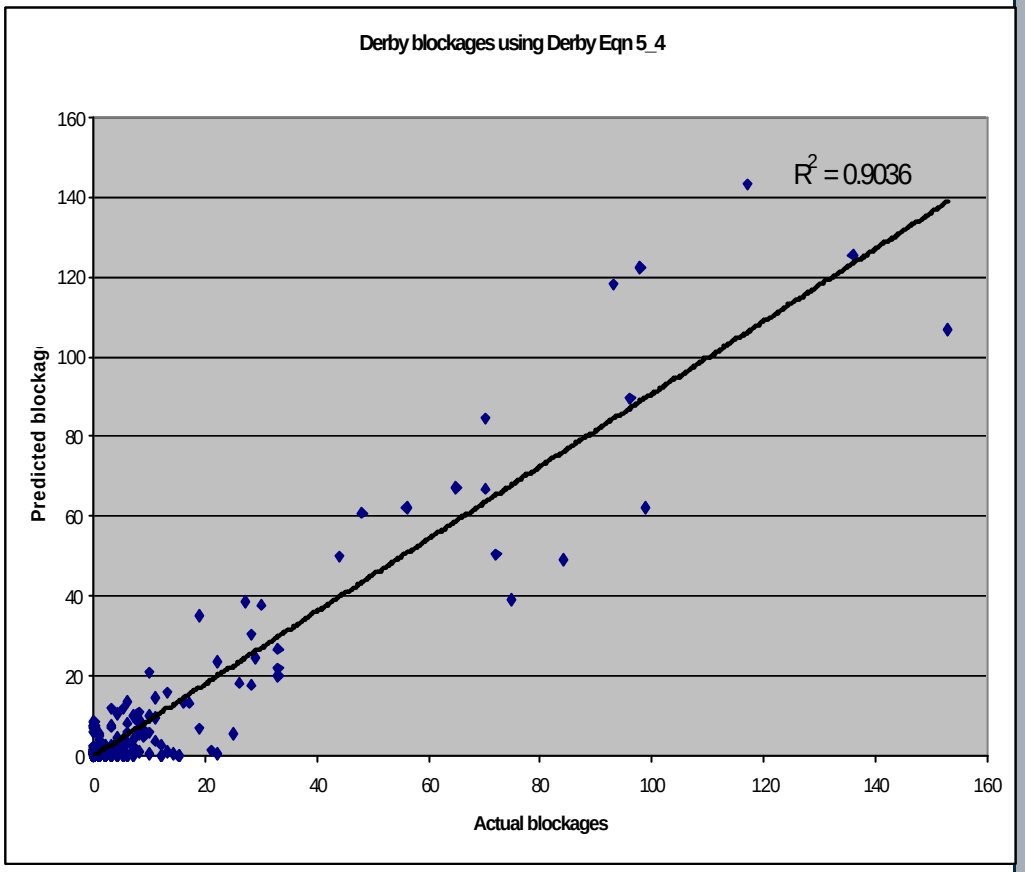


Bayesian Network



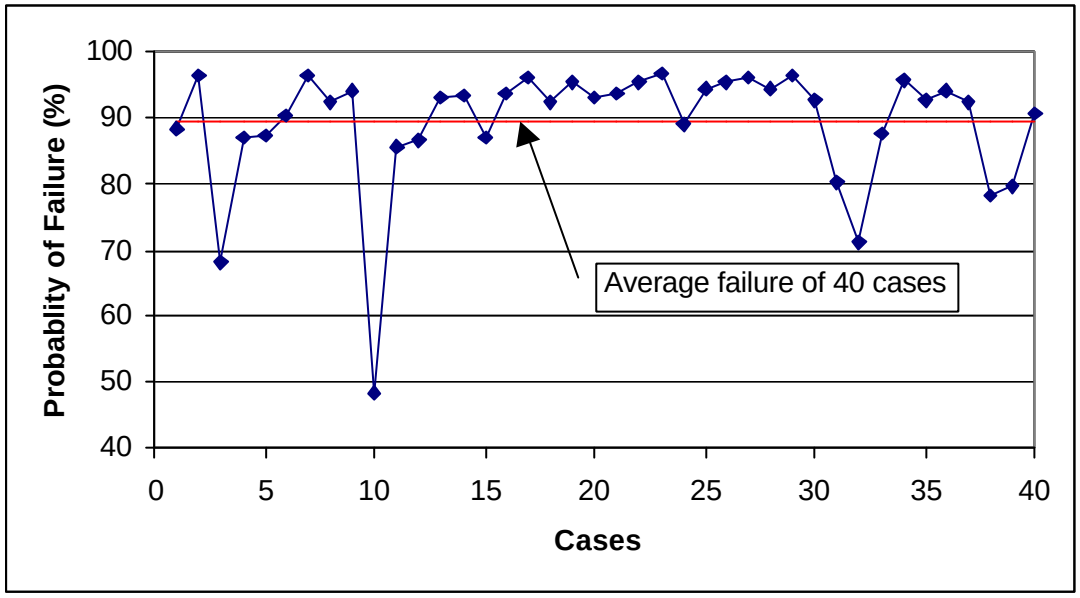
Deterioration Model Example

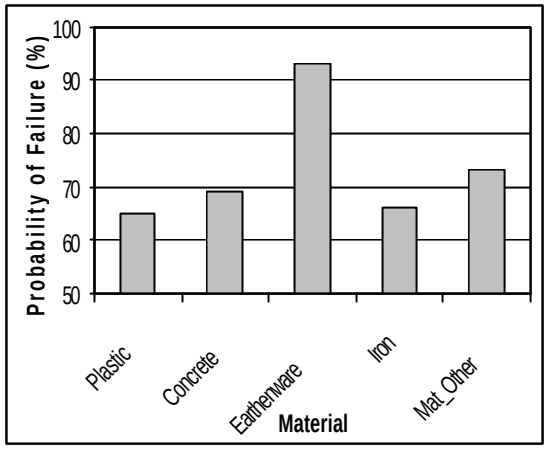
- CoD = 90%
- op – operational condition grade
- Age – age of sewer
- s24 – 'section 24 sewers' (old, small bore)

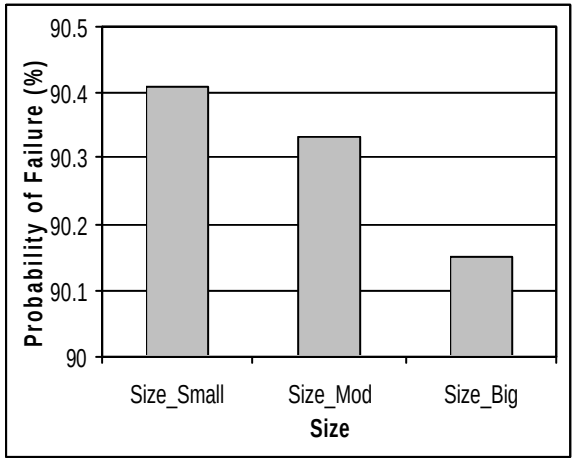


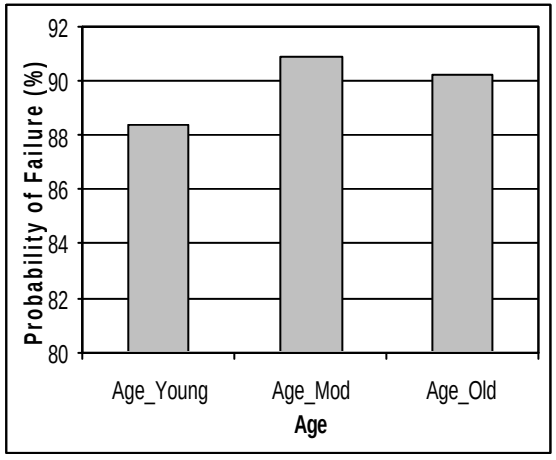
$$BL = 0.091978 \cdot \text{op} + 0.10927 \cdot \text{Age} \cdot \text{s24}$$

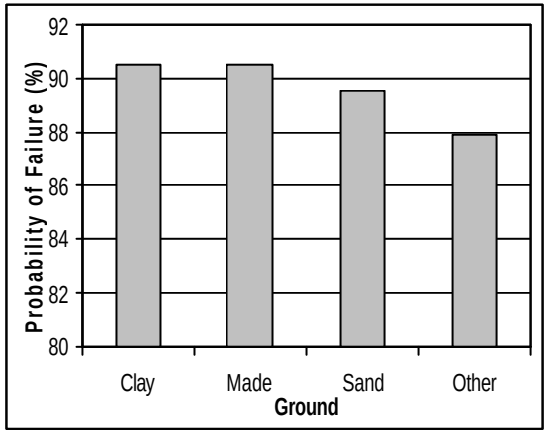
Failure Risk Model Example











Mohid – SewerGEMS Coupling Barcelona Implementation

Contact Information and Resources

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Tank You for Your Attention

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