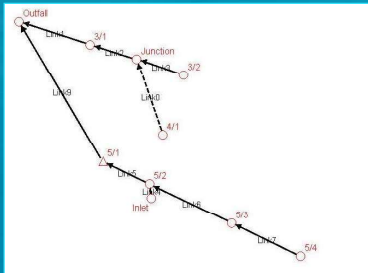


Hydraulic Analysis

Link/Node Network Flow Routing

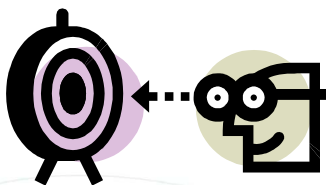


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Empowering water experts

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Objectives

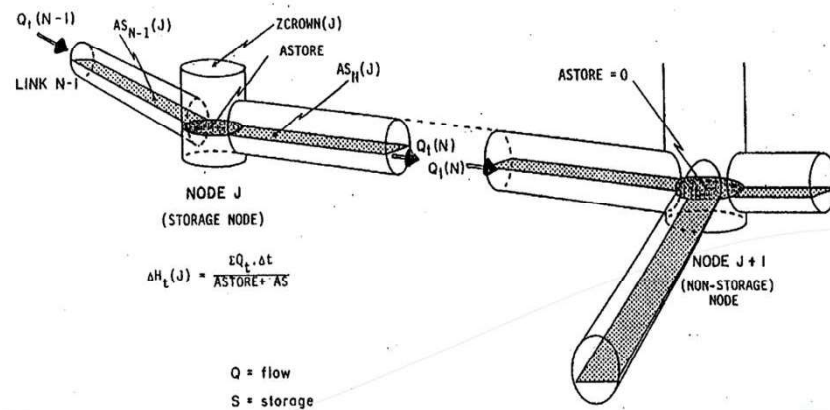
- Review SWMM (Link and Node) Hydraulics Theory
- Create a pipe model for 1D Hydraulics
- Import data from external databases
- Run a combined Runoff and Hydraulics model
- Effectively review hydraulic model results



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Link-Node Representation

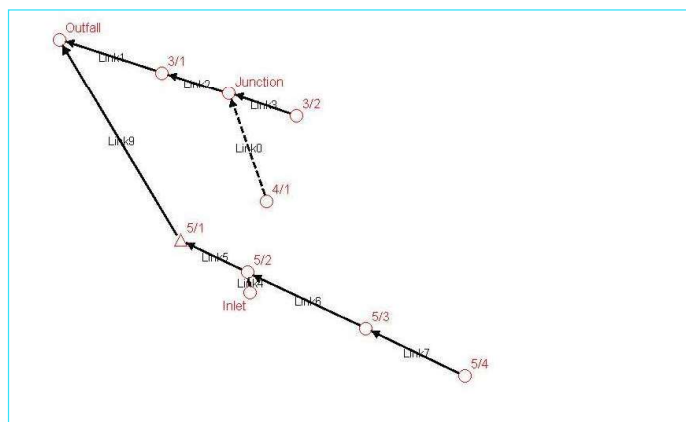


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Nodes and Links

- Nodes
 - Manhole
 - Inlet
 - Storage Node
 - Catch Basin
 - Outlet
 - Junction
- Links
 - Pipe (closed)
 - Channel (open)
 - Pump
 - Orifice
 - Weir
 - Rating Curve
 - Bridge & River Links

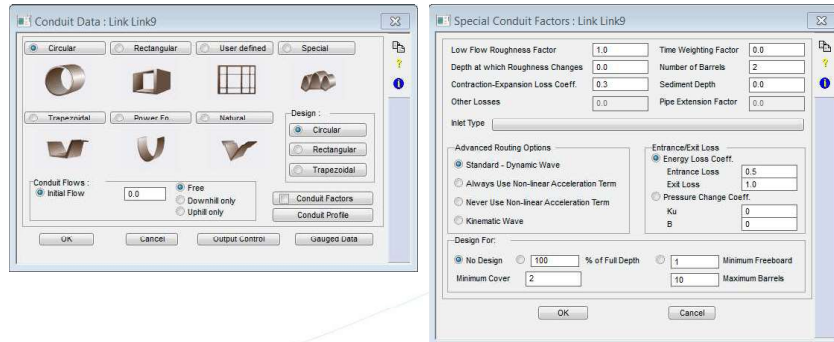


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Links – Shapes & Options

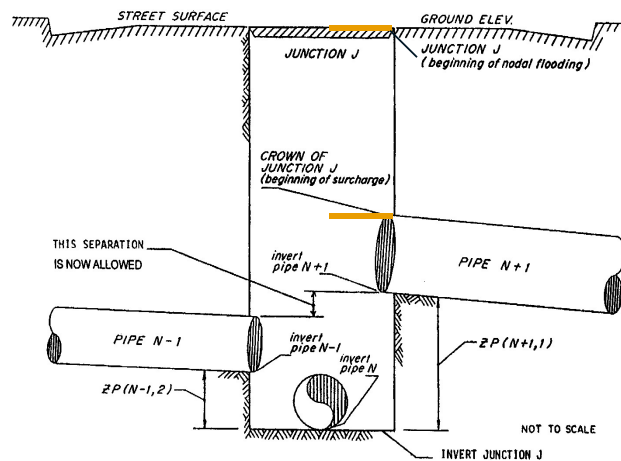
- All shapes open and closed are possible
- Special Conduit Factors such as Minor Losses, Barrels, sediment depth and Culvert Entrance



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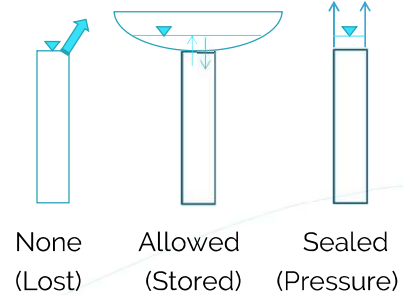
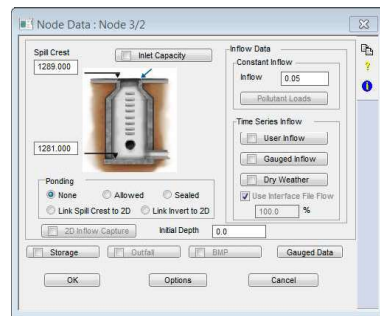
Definition of Junction Elevations



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Node Ponding Options

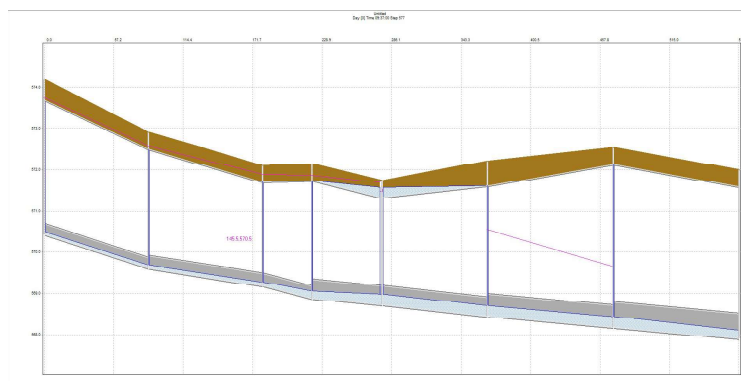


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Dual Drainage

- Simulate Major and Minor Drainage in Parallel (multilink)
- Account for restriction of curb openings and inlet grate etc.



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Dynamic Models

- **CONCEPT:** Use the full St. Venant equations to route flows.
- **Data Needs:**
 - Conduit Geometry
 - Conduit Inverts (slope not required)
 - Node Rims and Inverts
- **Limitations:**
 - Model Stability (sometimes)
 - Smaller time step (Courant Condition some schemes)
 - Geometric simplification to tackle above issues is becoming rare

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St. Venant Equations

Continuity Equation (Conserves Mass)

$$\frac{\partial A}{\partial t} + \frac{\partial Q}{\partial x} = 0$$

Momentum Equation (Conserves "Energy")

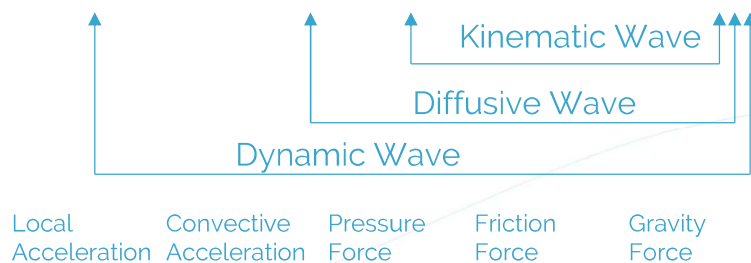
$$\frac{\partial Q}{\partial t} + \frac{\partial \left(\frac{Q^2}{A} \right)}{\partial x} + gA \frac{\partial y}{\partial x} + gA(S_e + S_c + S_f - S_o) = 0$$

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Momentum Equation

$$\frac{\partial Q}{\partial t} + \frac{\partial \left(\frac{Q^2}{A} \right)}{\partial x} + gA \frac{\partial y}{\partial x} + gA(S_e + S_c + S_f - S_o) = 0$$



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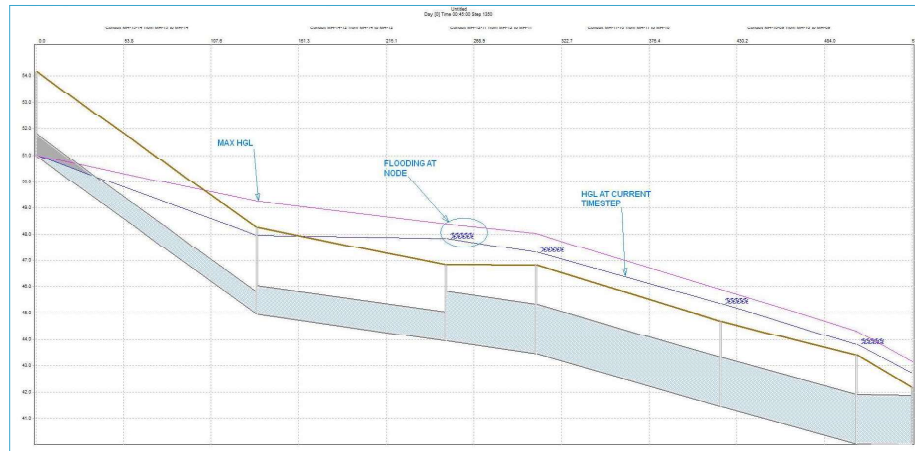
Hydraulic Results

- Hydraulic Grade Line (Max HGL and animation of HGL)
- Node time series:
 - Water Surface Elevations
 - Overflow
- Link Time Series:
 - Velocity and Flow
 - Upstream and Downstream Water Surface Elevation
 - Volume
- Many single valued results:
 - Losses, Freeboard, d/D, Qmax/Qdes...

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Hydraulic Results: (HGL)

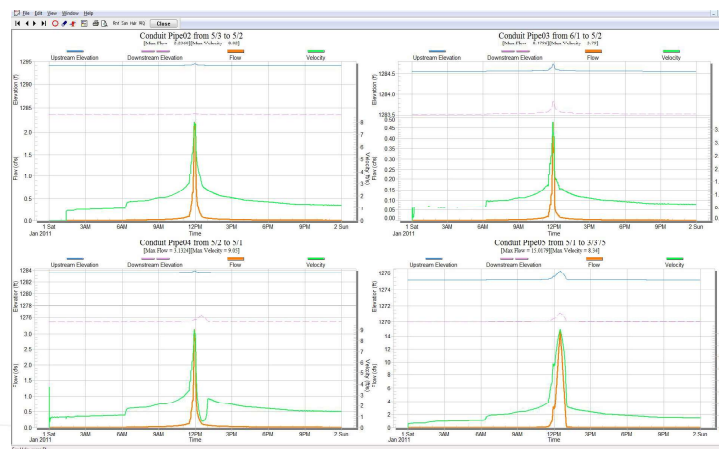


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Hydraulic Results: Levels & Flows

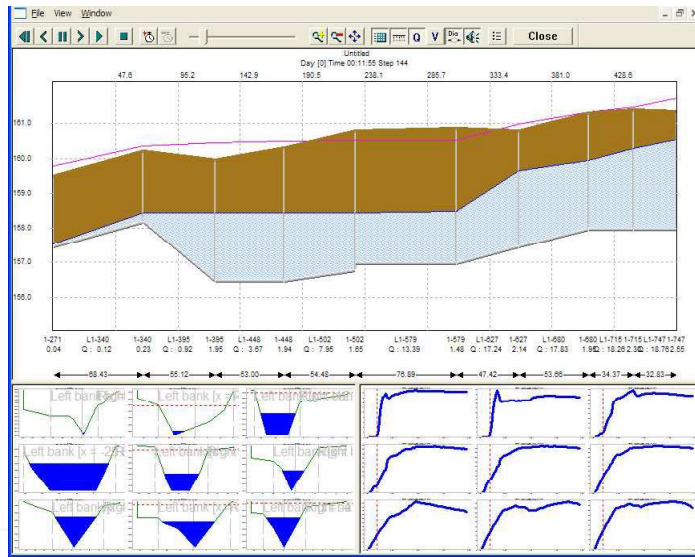
- Full Control of the plotting i.e. series, display, quantity



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1D Dynamic Results



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Hydraulics: Network Creation

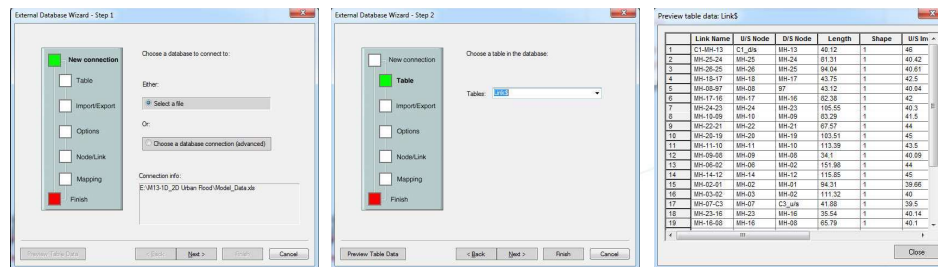
- Digitize
 - Use Node tool in the Hydraulics Layer
 - Use Link tool in Hydraulics Layer (connect nodes or nodes will be created as you create links)
- Import
 - Create nodes/links from CAD file (dwg or dxf)
 - Import LandXML or XPX or CSV text files
 - Import nodes/links from ODBC database (Shapefile or Geodatabase, Spreadsheets, databases etc.)
- Activate
 - Select Nodes/Links from Runoff Layer and activate (+ tool)
 - Links should only be active in one layer – not both!
 - Nodes maybe active in both Layers

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Import/Export External Databases

- Import and Export from Excel, Access, Dbase
- Map source fields to target fields in xp database

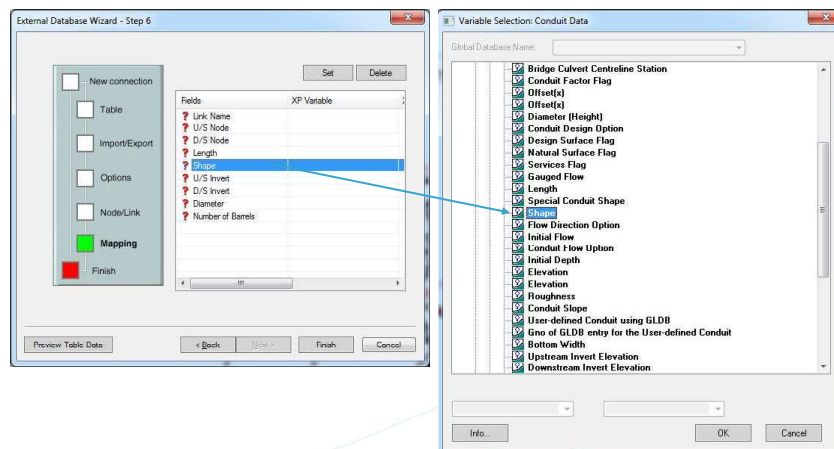


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External Database Wizard

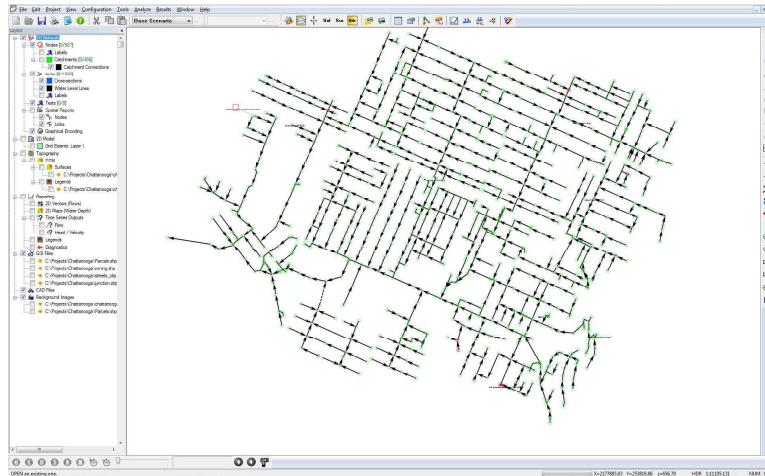
- Map data fields to XP Database definitions



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Network Created!



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Workshop



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