Benefits of Model Integration with GIS

Tualatin Valley Water District's Move Towards a Ubiquitous Model

AWWA PNWS 2015 Annual Conference

Engineers...Working Wonders With Water®

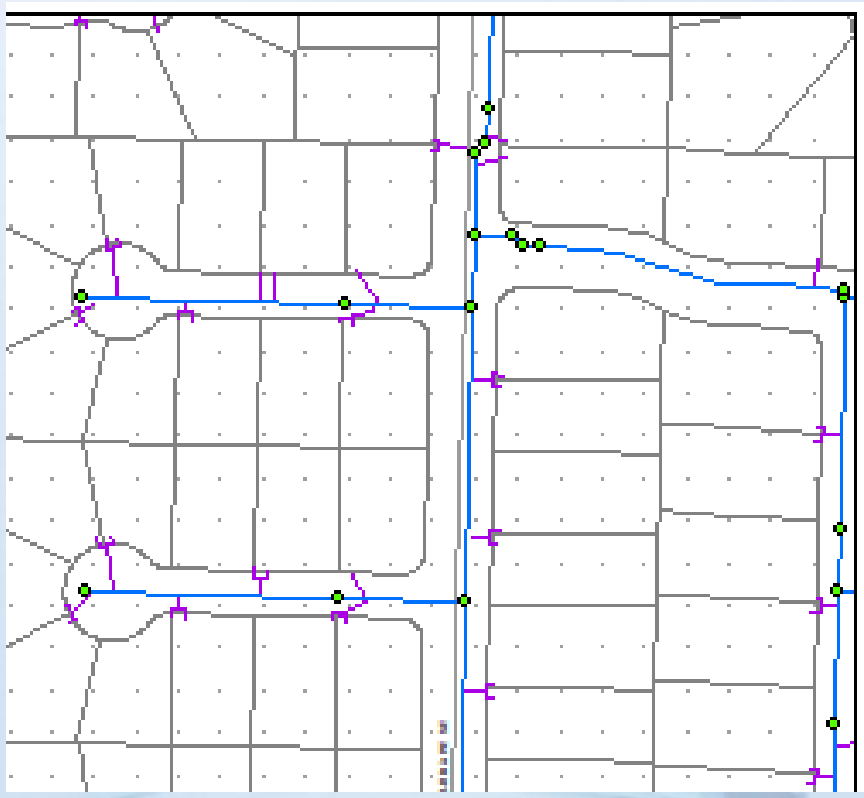
Outline

1. How do models and GIS overlap?
2. Benefits of integrating GIS into your model
3. How to do it

HOW DO MODELS & GIS OVERLAP?

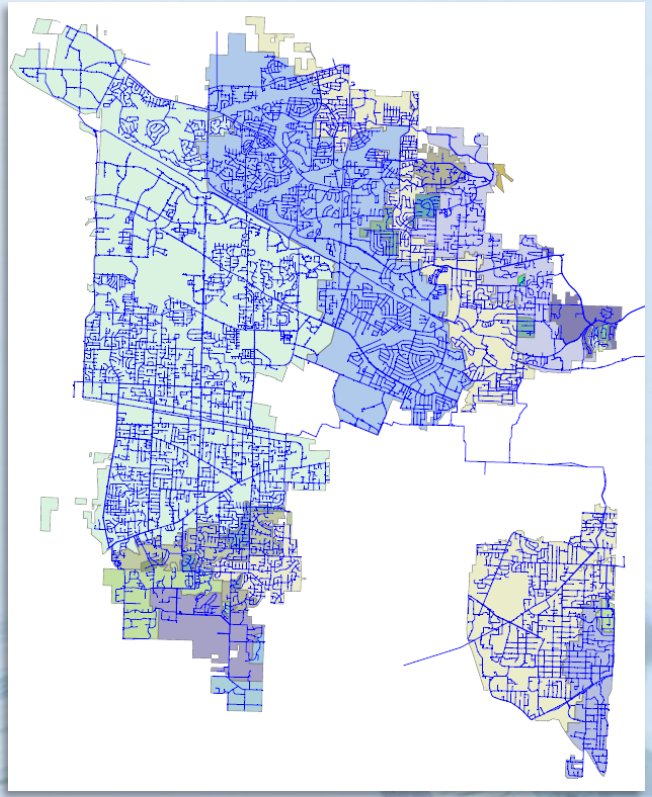
A hydraulic model data set consists of three basic components:

1. Facilities
   - Pipes, reservoirs, pumps, valves, manholes, junctions and sometimes hydrants.
2. Demands or Loads
   - Derived from land use, customer billing readings, flow tests, or other information
3. Operating Information
   - Derived from SCADA data, interviews with operators, or other data sources.



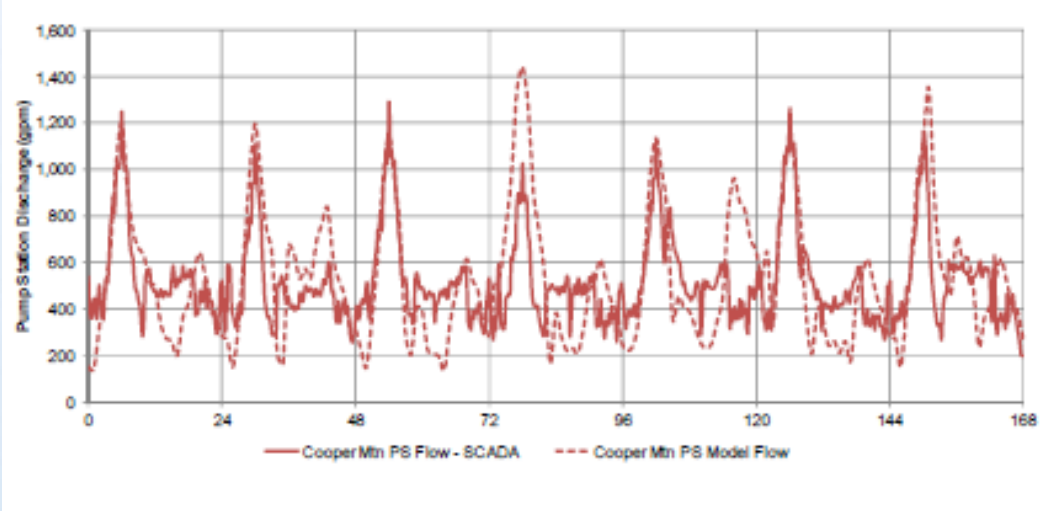
Modeling Applications

- Facilities
  - Planning for size and location of mains and storage facilities.
  - Evaluate distribution system capacity.
  - Create system curves and determine pump size.
- Demands or Loads
  - Master planning and feasibility studies.
  - Analyze fire flow capacity.



Operating Information ground truths model

- Identify the cause of operating problems.
- Define new operating strategies.
- Evaluate energy costs.
- Emergency response planning.
- Water source/age tracking.
- Identify flow, pressure, and water quality monitoring locations.
- Evaluate chlorine decay.

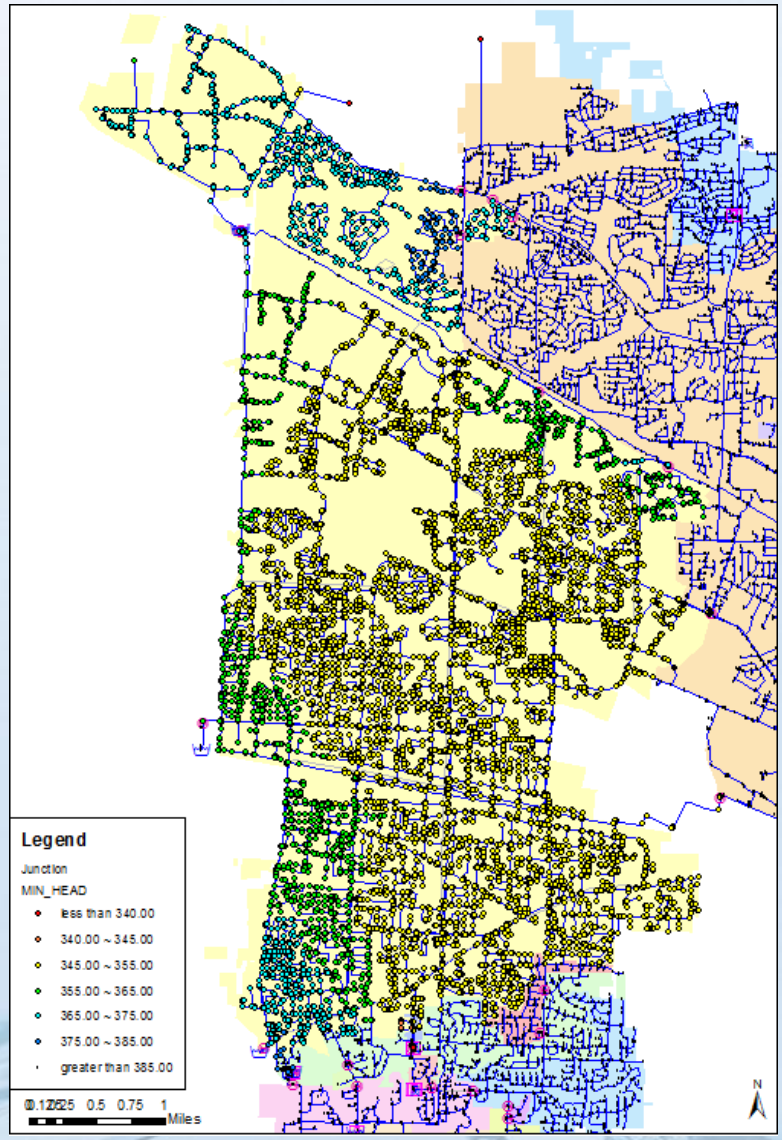


GIS applications related to modeling

- Facilities
  - Creating the pipes in the water model.
  - Creating the model junctions by importing the GIS valve coverage.
  - Assigning elevation data to the nodes.
- Demands or Loads
  - Evaluating land use.
  - Locating customer meters.
  - Developing growth projections.
  - Planning infrastructure to support new development.

GIS helps conceptualize model results

- Planning
  - Communicating planning ideas and concepts.
  - Presenting some model results.
  - Assisting with emergency response planning.

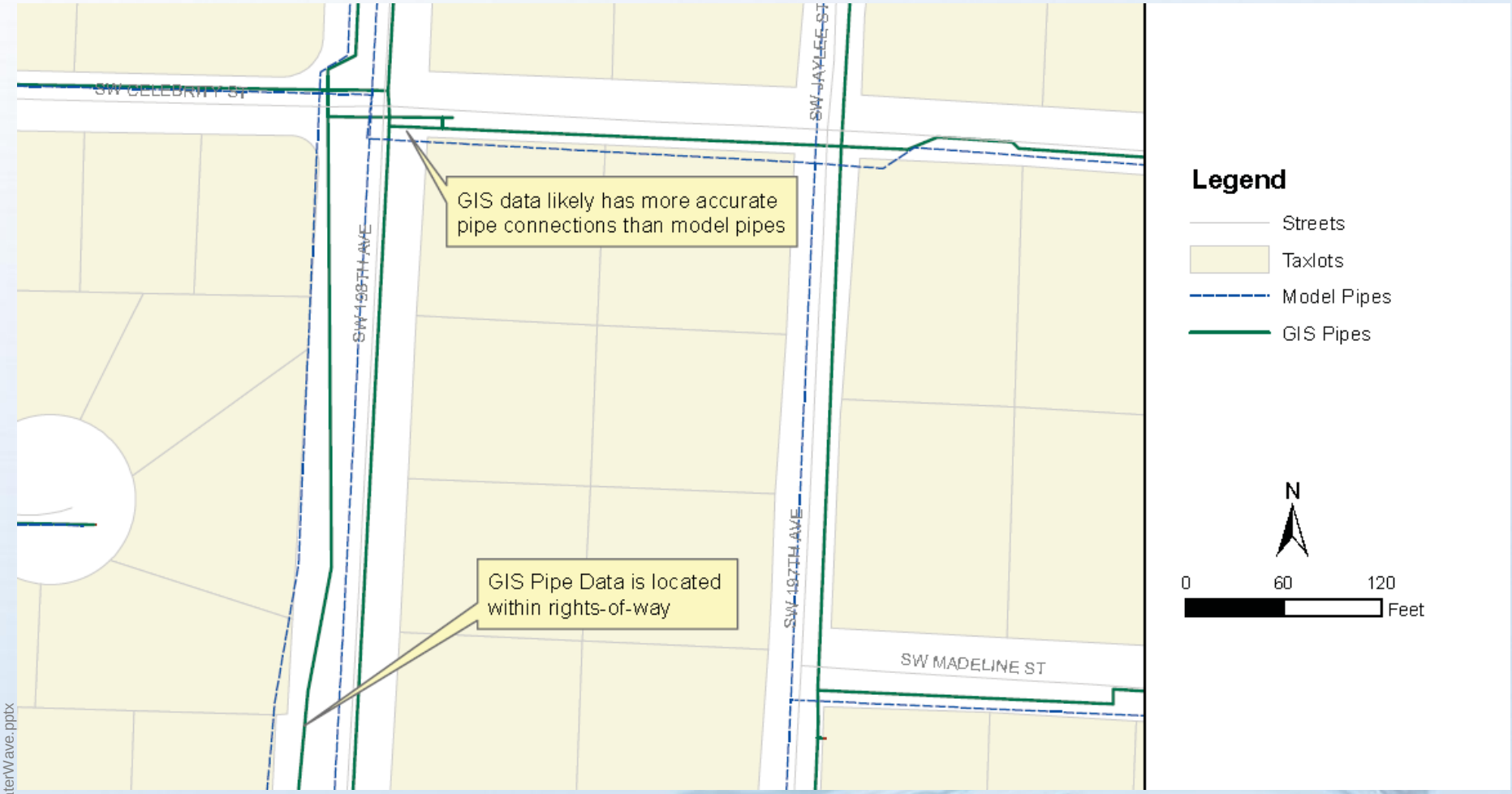


BENEFITS OF FULL GIS/MODEL INTEGRATION

One Database to Update

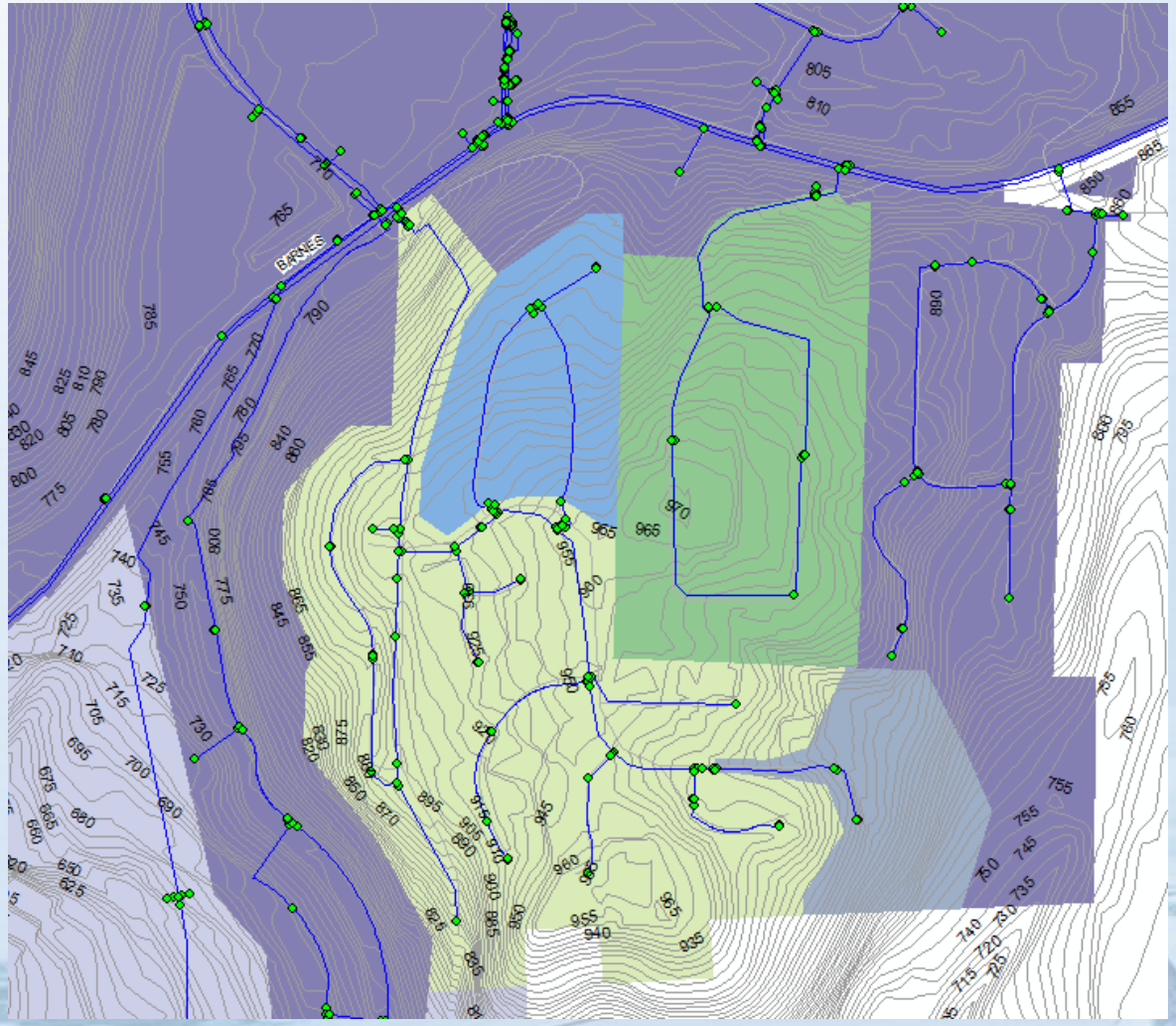
- Saves time
- Minimizes errors and discrepancies

Accurate Model Scale & Projection



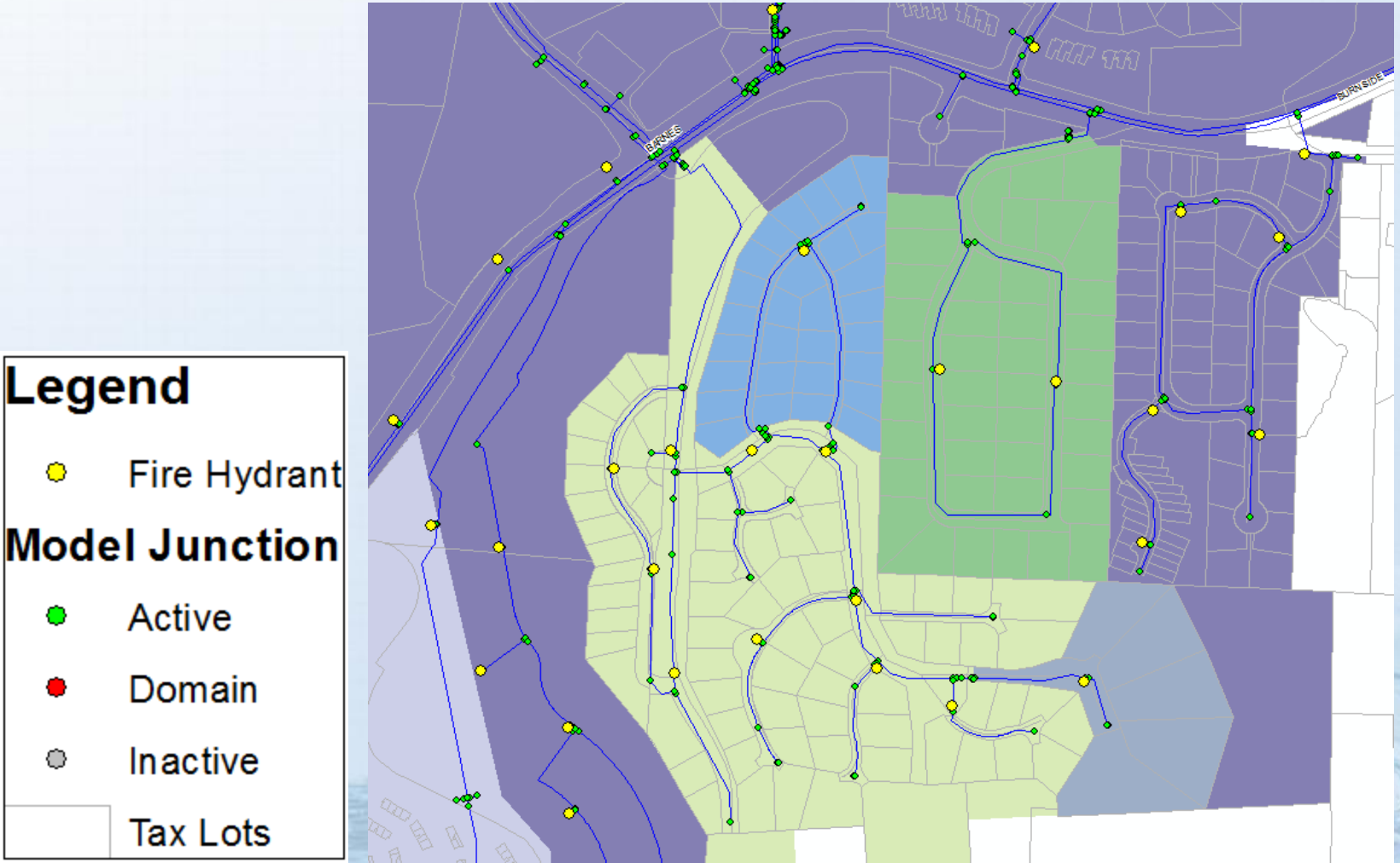
Integration (not just overlap) with other GIS layers

- Assigning elevation data to nodes given contours



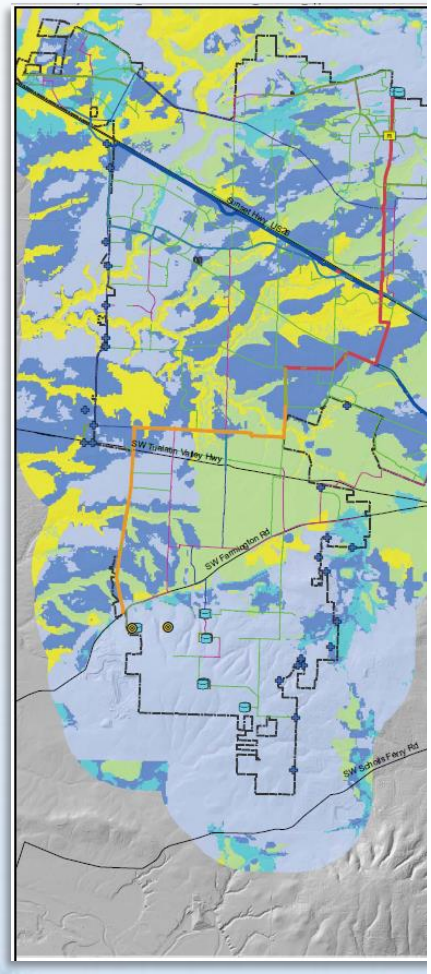
Integration with other GIS layers

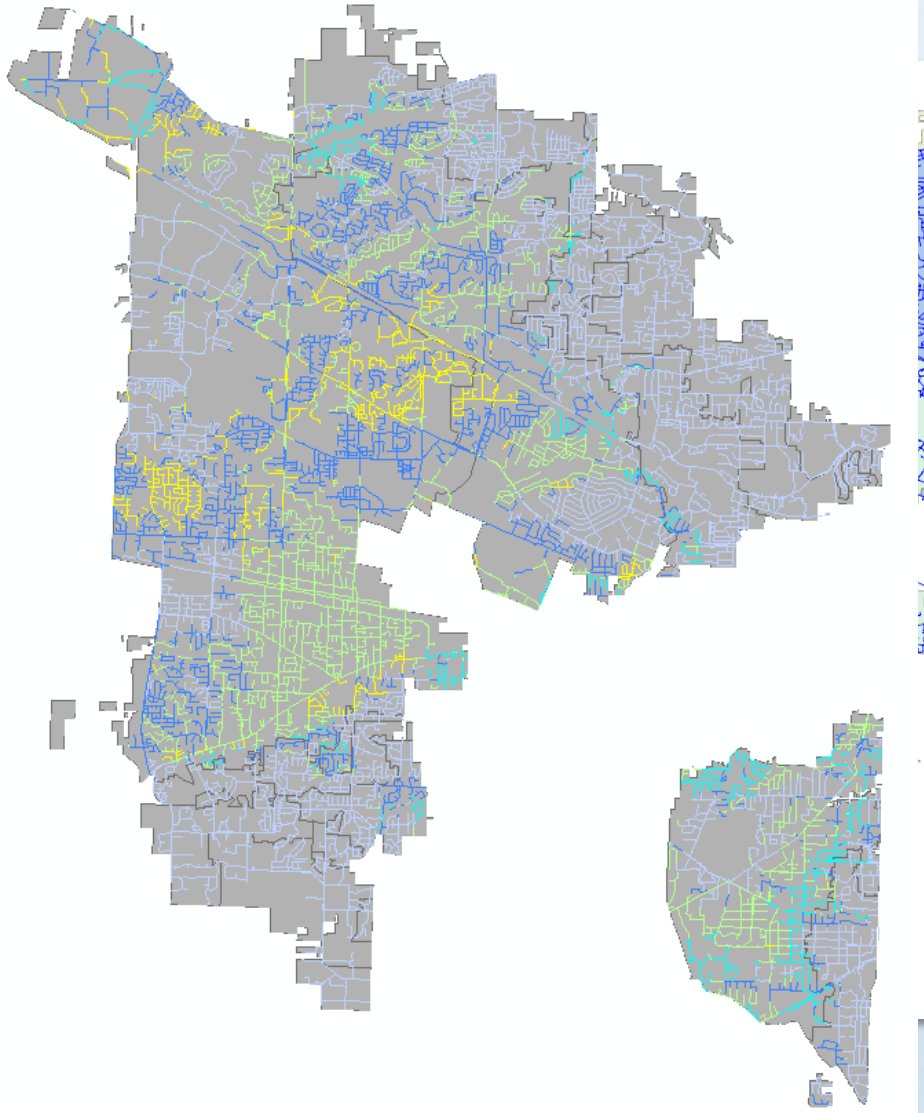
- Selecting by proximity
  - Assigning fire flows to nodes given nearby fire hydrants and adjacent properties

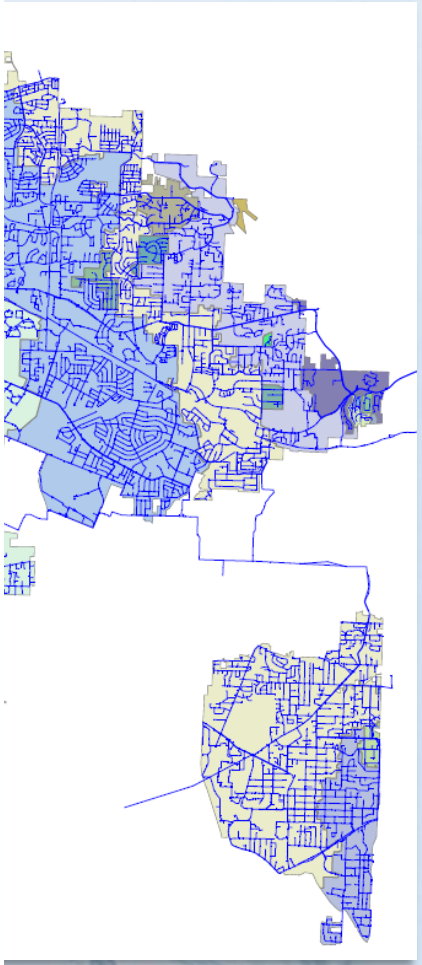


Integration with other GIS layers

- Seismic resiliency overlap

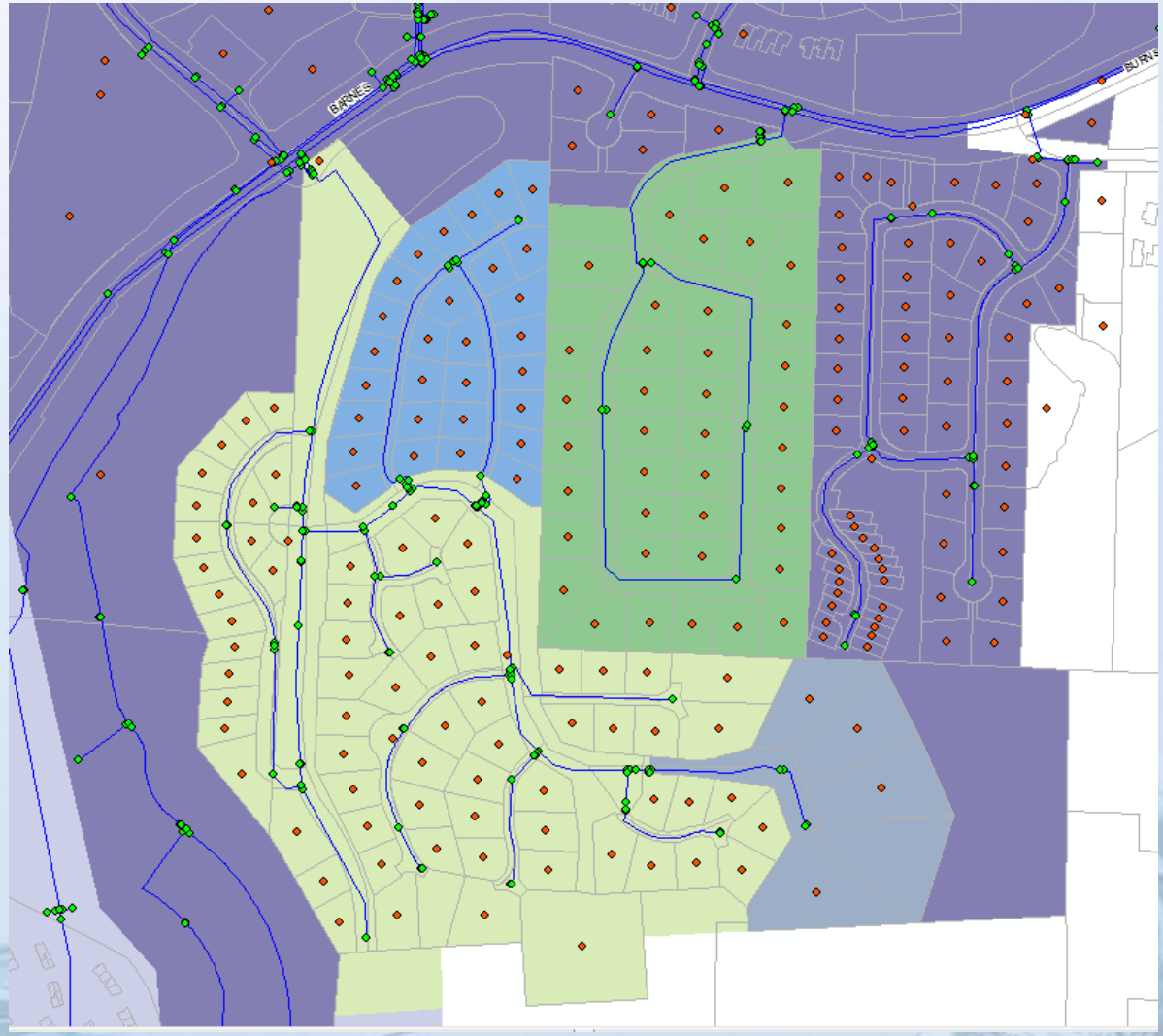






Ability to overlap with Billing Data & Water Meters

- More accurate demands by location



Legend

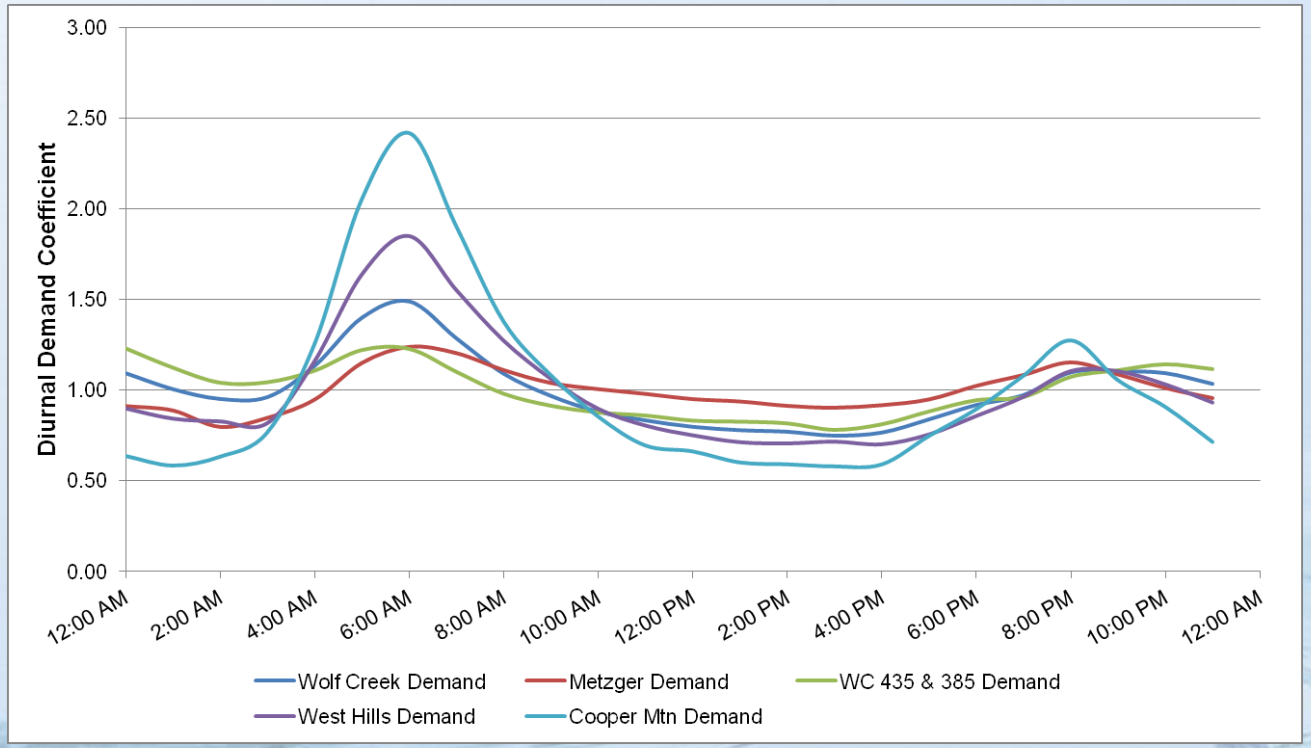
- Customer Meters

Model Junction

- Active
- Domain
- Inactive
- Tax Lots

Ability to overlap with Billing Data & Water Meters

- Better model calibration
  - TVWD boosted zones having higher MDD which matched BPS run time and tank cycling
  - Variation in diurnal demands



Ability to overlap with Billing Data & Water Meters

- More accurate system analyses and therefore tailored recommended improvements
  - Pump station sizing given accurate peak demands at a higher elevation

Incorporating Asset Management

- Linking asset ID to GIS ID to Model ID
- Overlapping capital improvements with repair and replacement (R&R) projects

Innovyze's Infomaster

- NASSCO PACP, MACP and LACP V6.0 certified
- Assesses likelihood of failure and consequence of failure
- Features:
  - Water and sewer network business intelligence
  - Risk-based rehabilitation planning
  - Proactive operational planning
  - Condition assessment management
  - Infrastructure data validation
  - CCTV data management

Improved communication with internal staff

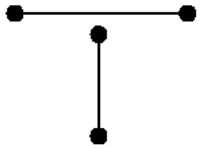
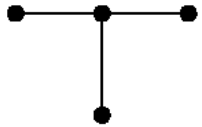
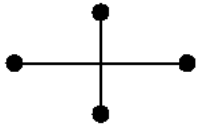
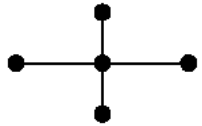
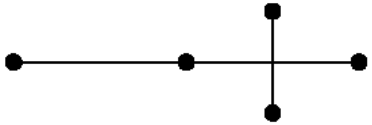
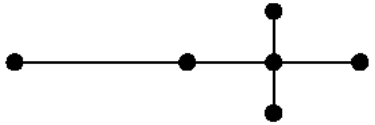
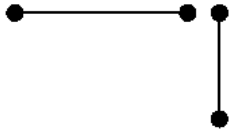
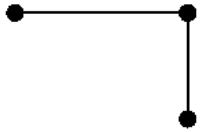
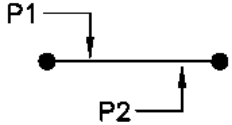
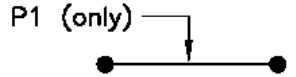
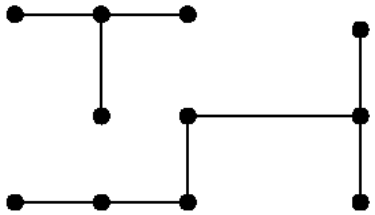
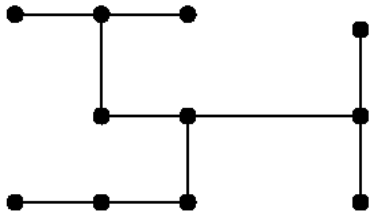
- Flushing hydrants
- Checking closed valves

HOW TO INTEGRATE GIS INTO YOUR MODEL

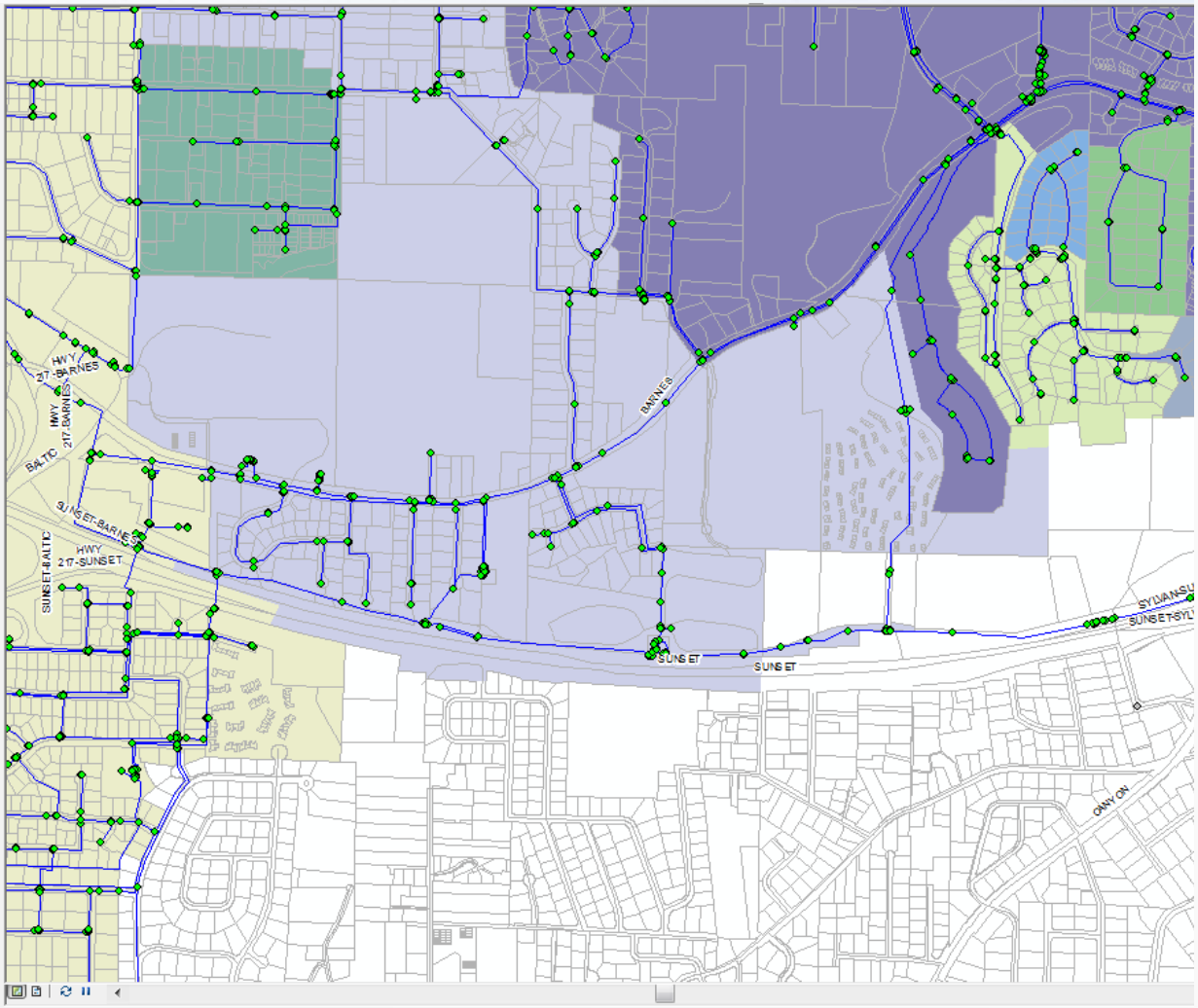
GIS Prep Work – Pipe Topology

- Pipe cleanup
  - Topology (connectivity). Typical GIS is not set up with the same standards as modeling requirements.
    - GIS focuses on accurate location, not connectivity
    - Modeling focuses on connectivity, not location
  - Correcting overlaps

Examples of Incorrect and Correct Topology

NAME	INCORRECT	CORRECT
PIPE JUNCTION		
TEE		
FOUR–WAY		
FOUR–WAY		
ORPHAN PIPE		
DUPLICATE PIPE		
ISOLATED NETWORK		

GIS Prep Work – Attributes to Include



Model Explorer

2013_MACRO_CALIB_ADJ

2064_BASE:Standard

Refresh Output

00:00 hrs

PIPE: WAT21362

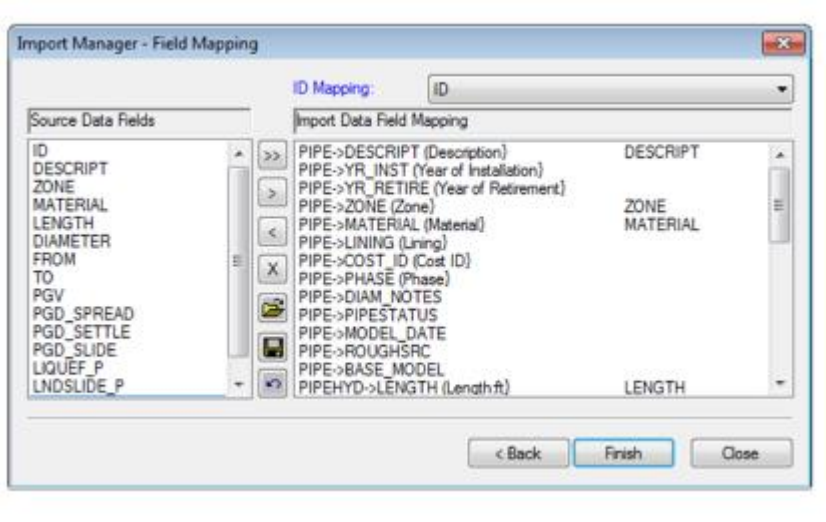
(ID)	WAT21362
Description	
Geometry	Reverse
Start Node	MDLND6446
End Node	MDLND38222
Modeling	
Length (ft)	1137.60
Diameter (in)	18.00
Roughness	110.00
Minor Loss	0.00
Totalizer	No
Check Valve	No
Information	
Year of Installation	
Year of Retirement	
Zone	575
Material	DI
Lining	
Cost ID	
Phase	
DIAM_NOTES	
PIPESTATUS	
MODEL_DATE	4/3/2014 12:00:00 AM
ROUGHSRC	Previous Master Plan
BASE_MODEL	Yes

GIS Prep Work – Billing Data & Water Meters

- Previously did not have water meters in GIS
- Needed to create points for meters
- Linked Utility Billing addresses to METRO addresses
  - First pass achieved 92% match rate (60,000 meters)
  - Remainder were matched by hand
- With address points in GIS, we extracted billing info and imported into a table.

Build the model for future maintenance

- Maintain a one-to-one relationship between the elements in the model and the elements in the GIS
- Maintain these fields for four types of identified modifications
  - Deleting pipes
  - Changing pipe status from active to abandoned
  - Adding a pipe
  - Splitting a pipe



Build the model for future maintenance

- Reduce effort in updates
  - Automated update procedure rather than manually matching elements from GIS and model.
  - Flexibility to re-import all pipes or just those that have been updated
- Maintain a master model that is copied for scenario planning
- Schedule regular updates with the same staff

QUESTIONS?

Build the model for future maintenance

Carollo developed a simple, yet powerful method of linking the District's GIS with their computer model. The following outlines the critical steps Carollo used to link the two systems.

- Maintain a one-to-one relationship between the elements in the model and the elements in the GIS. If the one-to-one linkage is not maintained, when the pipes are re-imported, the model would likely assign new Model ID numbers to the pipes, which would cause the loss of modeling data, such as controls, that were tied to the specific pipes. The data would need to be manually fixed and could result in days of lost production. The one-to-one relationship is maintained by:
  - Importing all water system facilities from GIS into the model.
  - Developing new data fields within the model to track unique identification numbers and the source of the elements. These data fields are in addition to the regular data fields typically used for any model and include:
    - - MODEL_ID (Pipe ID used by the model),
    - - FROM_ (upstream node number used by the model),
    - - TO_ (downstream node number used by the model),
    - - PWD_GIS (Indicates the original source of the elements),
    - - PWD_MODEL (Indicates whether pipes from GIS are used by the model).
  - Maintaining connectivity in the model and avoiding renumbering entities. This is done through the first three data fields listed above.
  - Allowing the flexibility needed in the model to connect facilities (such as pumping stations) schematically rather than to scale. The last two data fields listed above allow the facility manager the flexibility to include or exclude selected entities.
- Maintain these fields for four types of identified modifications, which include deleting pipes, changing pipe status from active to abandoned, adding a pipe, and splitting a pipe.

Integration with other City or utility GIS for public presentation & communication

<TVWD example map>