Practical Application of GIS to Hydraulic Modeling
• **Aqua America**
  – Investor owned water and wastewater utility
  – 3 million people served across 8 states
  – Celebrating our 130th anniversary in 2016

• **Aqua Pennsylvania**
  – Largest operating company
  – Southeast PA surrounding Philadelphia and smaller systems throughout PA
Aqua Pennsylvania
Real World
• 4,400 miles of pipe
• 8 surface WTP
• 97 Tanks
• 109 Wells
• 319 regulator valves
• 113 pressure zones

Model World
68,000 pipe segments
59,000 junctions
78 tanks
80 source nodes
140 regulator sites

Southeast PA territory
Modeling and GIS Timelines at Aqua PA

PSW acquires Stoner software company (mid-1980's)

Initial model development by contractor using Stoner software (1980)

Initial in-house modeling (1989)

PSW sells off Stoner (1993)

Completion of SE PA model (1991-1993)

GIS Needs Study (1992)

“Temporary” GIS position created (1999)

Hire outside contractor to use GIS for fire hydrant mapping (2003)

Convert existing plates to GIS (2005-2006)

Step back from GIS and focus on mapping improvements (2000-2003)

GIS viewer available within office (2006)

GIS available to field crews (2008)

Begin software evaluations (2006)

GIS web applications deployed (2011)

Start using GIS to build models (2012)

Bentley software acquired (2007)

Start using GIS to build models (2012)
Q: How do we meet our hydraulic modeling needs given…

• Limited personnel resources
• Need to work across organizational boundaries
• Increased demand for hydraulic modeling
• Need to update the existing model and create a sustainable process for maintaining the model moving forward

A: We use GIS!

Hydraulic Modeling Challenges
• Limited staff experience with hydraulic modeling
• Hydraulic modeling experts busy with new responsibilities
• Losing experienced staff
  • Aqua PA had multiple 40+ year anniversaries in 2015
  • Superintendent of Network Operations nearing retirement
Personnel Challenges

Who has the skills needed to use GIS for hydraulic modeling?
• Train Aqua engineers to use GIS

• Train Aqua GIS staff to use hydraulic model

• Utilize contractors ✔
Crossing Organizational Boundaries

Before GIS

Engineering
- Modeling
- Cap planning
- Mapping

Network Operations
- Operate & maintain
- SCADA

Production
- Produce water
- Compliance

After GIS

Engineering
- Mapping
- Cap planning

Production
- SCADA

Network Operations
- Operate & maintain
- Produce Water

Compliance
- Modeling
Capturing Operational Parameters

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Increasing Hydraulic Modeling Requests

- Major source changes
- Water quality (water age)
- Wastewater modeling
- Tank painting
- Other states
- Hydraulic model used to “trace” water source
- Pipes in red receive > 90% of water from treatment plant
- But the model alone cannot relate these results to customers

- Incorporating model results into GIS allows for spatial analysis of customers affected
- **80,000 customers potentially impacted**
Scenario 1
- Existing hydraulic model
- Open in ArcGIS and spatially adjust
- Extract relevant features to GIS
- Initial GIS

Scenario 2
- Build basic GIS
- Export to SewerGEMS
- Evaluate growth potential

Scenario 3
- Outdated hydraulic model
- Open in GIS and update
- Export back for modeling
1,743 Miles (31%) Replaced or Rehabilitated over 19 Years

Why is updating our model so important?
Data challenges
Why not use geometric network?
• Data structure
• Facility simplification
• Water Demands
• C values
• Node elevations
GIS Data Structure:

Additional fields to support modeling
**GIS Field** | **Purpose**
--- | ---
**Model** | Yes/No - Controls whether the pipe is exported to model
**ModelCValue** | C Value for pipe
**ModelCheckValve** | Yes/No - Defines whether the pipe includes a check valve
**ModelLength** | Defines the length of the pipe to be used in the model
**ModelStatus** | Yes/No - Defines whether the pipe is active in the model
**ModelName** | Defines a name to be used by controls in the model
**ModelSystem** | Defines modeling “subsystems”
Why did we add “Model” field?

Simplify piping around treatment plant for modeling
GIS Data Structure:

Additional feature dataset to support modeling
How do we use “Model” feature dataset?
• Obtained annual water use for every meter (375,000) from Customer Information System (CIS)
• Geocoded customer locations using addresses from CIS
• Assigned demand to nearest node using LoadBuilder
Customer points using existing Banner (CIS) coordinates
1,570 gpm demand assigned to 8-inch pipe (nearest node) instead of 30-inch transmission main

Demand allocation for large customers
157 gpm demand assigned to wrong pressure zone

Demand allocation for large customers
Customer points using improved geocoding and manual placement
Assigning C-values by material and installation year
Spatial distribution of unlined Cast Iron by installation year
• Tools to assign elevations to nodes
• Variety of data sources supported
• Use “Selection Set” to avoid updating known elevations for key facilities
• Sustainability is as important as the initial build
• Identify the right combination of people & skills
• Don’t be afraid to modify data structure to accommodate different needs of GIS and hydraulic model
• Take advantage of software tools, but recognize potential issues
• Capture data before it’s too late
• Look for opportunities to break down organizational barriers
• It is practical to use GIS to support hydraulic modeling
THANK YOU!

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