Contents

• Introduction
• The History of the Otis Public Water Supply
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Location – Otis ANGB Water System

Cape Cod, Massachusetts
Water Utility GIS Inventory

- (1) Public Water Supply Well
- (2) Water Distribution Tanks
- (8) Water Use Zones
- (45 miles) Water Mains
- (7 miles) Water Service Pipes
- (460) Service Connections
- (1006) Gate Valves
- (275) Fire Hydrants
- (1335) Various Fittings
History of the Water System
1940 Before Construction – 6” Pipe
1940/1941 – Original Construction
System Designed for 70,000
Second Build-up 1955-1959
1966 – Maximum Buildup
2007 – Current Day
Water System Description

- 1600 Residents, 2000 Day Time, Transients
- Average Daily Usage is 152,000 gallons
- Tank Capacity is 700,000 gallons
- Over 1000 Active Gate Valves
- Over 52 miles of Active Pipeline
- Abandoned Infrastructure
Attributes from Construction History

- Cast-iron Pipe: 1936-1946
- Asbestos-cement Pipe: 1955-1960
- Ductile-iron Pipe: 1970-2010
- PVC Pipe: 2010-present
Data Development
GPS above ground Features
Paper Site Plans

Some Plans are better than others.
1955 Photo used to locate waterline
Pipe Connectivity

Less Work versus Better Inventory

Schematic

Spatial

Connectivity

45 degree Bend

Tee
Pipe Geometry

Tees and Crosses

11.25° Bends

22.5° Bends

45° Bends

90° Bends
GIS for Utility Infrastructure

- Design Database
- Collect Information – Drawings, CAD, Reports...
- GPS Features
- Scan Drawings
- Georeference Drawings and CAD
- Screen Digitize
- Populate Attributes
- Create Metadata
- Perform Field Checks and Updates

Create the GIS Database then you can do the Spatial Analysis
Water System GIS – Some Answers
Base of Tank 2 is 130ft (out of service)
Base of Tank 3 is 100ft Elevation (~60psi)
Some Hydrants and Services at 150ft (~40psi)
Water Pipe Sizes

Remember: Relative pipe size is cross-sectional area, not diameter.

Volume of water pipes is about 750,000 gallons.
Water System in Residential Area
Water System in Industrial Area

- Fuel Truck Parking
- Aircraft Hanger / Maintenance
- Water Main – wooded area
- Vehicle Maintenance
- Office Building
- Wash Rack
Non-Spatial Data

• SCADA – Supervisory Control And Data Acquisition
  – Tracks all equipment
  – Has sensors throughout the system
  – Time stamps everything
  – Creates flat files

• Example: Water Tank Level in two minute increments
Water Tank 2 – Out of Service
### Statistical Test

<table>
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<tr>
<th></th>
<th>w/ Tank 2</th>
<th>w/out Tank 2</th>
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<td><strong>Daily Use</strong></td>
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<td><strong>df</strong></td>
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Water Usage

Gallons per Hour Jan - Apr 2013

- Water Breaks
- Sleeping Base Flow
- Weekend Transients
- Morning
- Daytime Use
- Bed Time
- Pump Noise
Spatial Analysis

What can we do about low free chlorine levels in some locations?

Note: No significant difference between free chlorine concentration when ‘Tank 2’ is out of service
Several samples at each location over 15 months.
Chlorine Concentration Factors

- Initial Concentration (Treatment Concentration)
- Time since application
- Size and Material of Pipe
- Bioreactivity of Pipe
- Amount of Water Use
- Flow Character (Branched vs. Looped)
- Distance from source of application
Water Pipe Network

Distance between Well and School: 20,858 feet
Distance between Well and Water Tank 3: 14,178 feet
Free Chlorine Observations

Each point represents a median value from a series of samples over 15 months.

\[ y = -0.00008x + 1.4 \]

\[ R^2 = 0.8778 \]
Modeling Chlorine Distribution

• Convert Pipeline Vectors to a 5 meter Grid with a Value of 0 for each Cell
• Choose Source Location and Set Cell to 1
• Create Count Raster from Source
• Convert Count Grid to Distance Grid
• Use Equation: (Distance Grid * -0.00008) + 1.4
Model For Count Grid

Loop many times
Count Grid

Count from Well
- High: 1001
- Low: 0

Map showing locations of Tank 2, J Well, and Tank 3.
Distance Grid

Count Grid * -1 + Number of Loop Iterations * Cell Size Factor * 3.28
Cell Size Factor

Example 5 meter Cell Size

Some Data
Number of Cells * Diagonal of Cell Size
6 * 7.071m = 42.43m

Most Data
Number of Cells * Variable Factor
6 * 5.895m = 35.37m

Number of Cells * Cell Size
6 * 5m = 30m

MS Excel Solver to determine factor
Modeled Chlorine Distribution

(Distance Grid * - 0.00008) + 1.4

Well Treatment 1.4 mg/l
- Less than 0.3
- 0.3 - 0.5
- 0.5 - 1.8
Modeled Chlorine Distribution

Well Treatment 1.8 mg/l
- Red: Less than 0.3
- Yellow: 0.3 - 0.5
- Green: 0.5 - 1.8
Modeled Chlorine Distribution

Tank Treatment 1.4 mg/l
- Less than 0.3
- 0.3 - 0.5
- 0.5 - 1.8
Modeled Chlorine Distribution

Tank Treatment 1.8 mg/l
- Less than 0.3
- 0.3 - 0.5
- 0.5 - 1.8
Questions