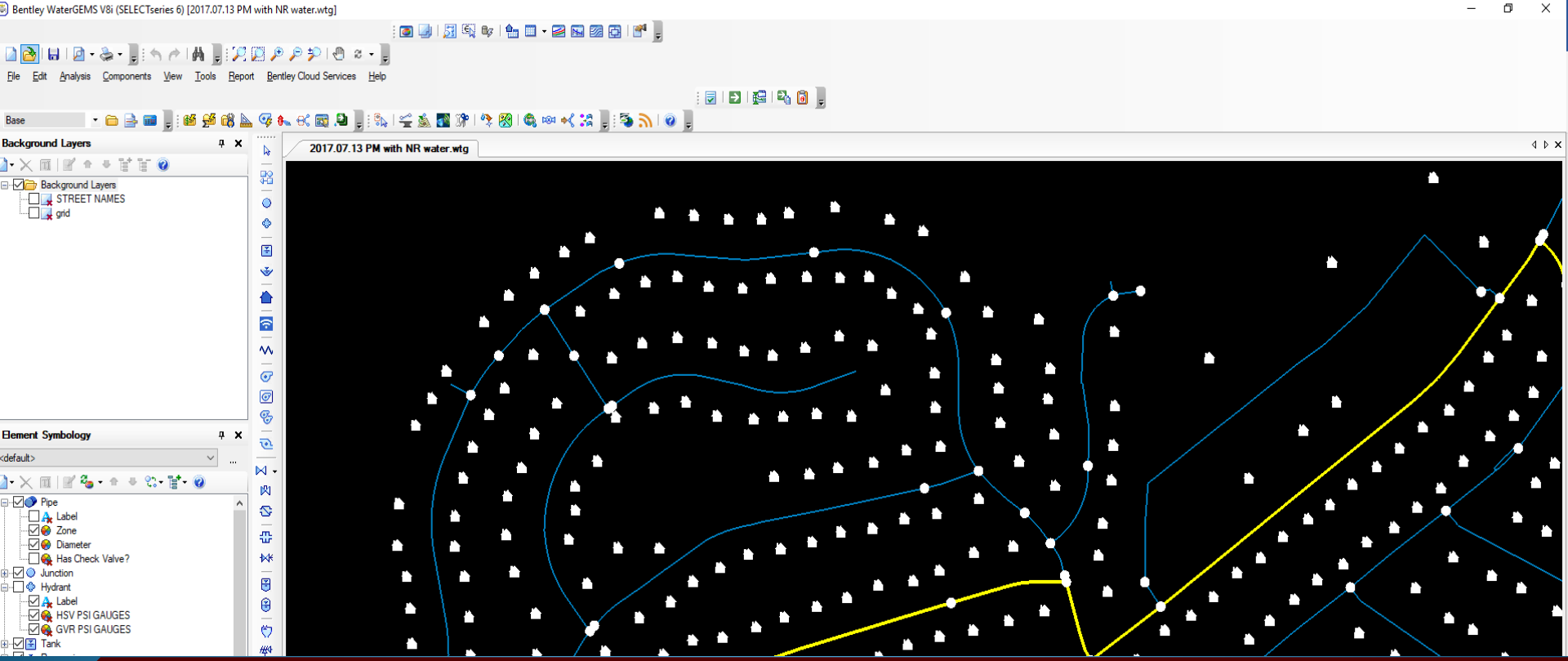


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Presenters: Kevin Mullins, PE, Sr. Project Manager

Bailee Robinson, PE, Project Manager

Huntsville Utilities

# Huntsville Utilities Hydraulic Water Model

## Prior to Project Initiation, We Asked:

1. Why Do You Want a Water Model?
2. How Will You Use It?
3. What Information Do you Already Have?
4. How Detailed Will Your Model Be?
5. What Software Platform Will You Use?
6. Who Will Maintain It?
7. Will You Use It? (If No…See Question 1)

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## Project Mission:

In order to meet the demands of future growth and provide effective service and capital planning, the utility finds it necessary to develop and maintain accurate computerized models for the utilities provided.

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# The Mission Goals were to:

- Develop and provide an accurate WaterGEMS model that Huntsville Utilities will:
  - Understand
  - Maintain
  - Utilize
  - Update

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# Project Platform

Because of Huntsville Utilities' familiarity and experience with the Bentley platform, Garver created and developed the model using Bentley's WaterGEMS  software.

- Latest version is CONNECT Edition
- Worked with Utilities GIS team to import GIS shapefiles as model layers to import pipes and pipe features


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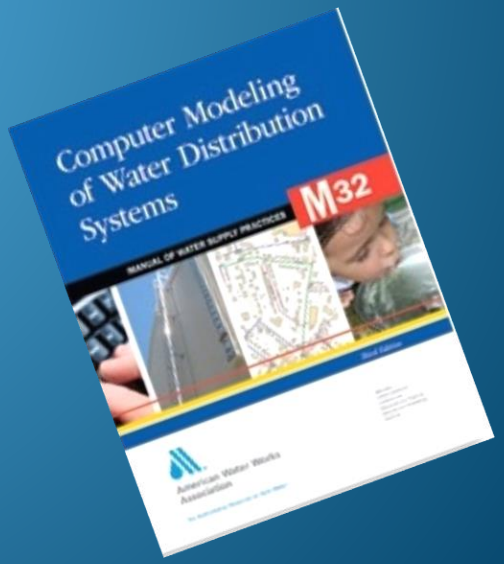
# Project Approach

In developing the hydraulic model, Garver followed the guidelines set forth in the American Water Works Association (AWWA) COMPUTER MODELING OF WATER DISTRIBUTION SYSTEMS – M32 Manual of Water Supply Practices.

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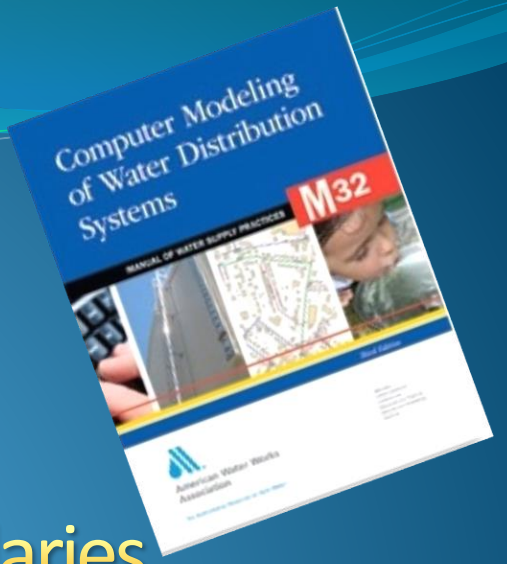
# Follow the M32 Pattern




- Define the boundary conditions
- Construct the physical elements
- Determine flow in and out of the boundaries
- Collect operational data
- Balance the flow and calibrate
- Analyze the data
- Utilize the information for planning and operation
- Update the information on a regular basis

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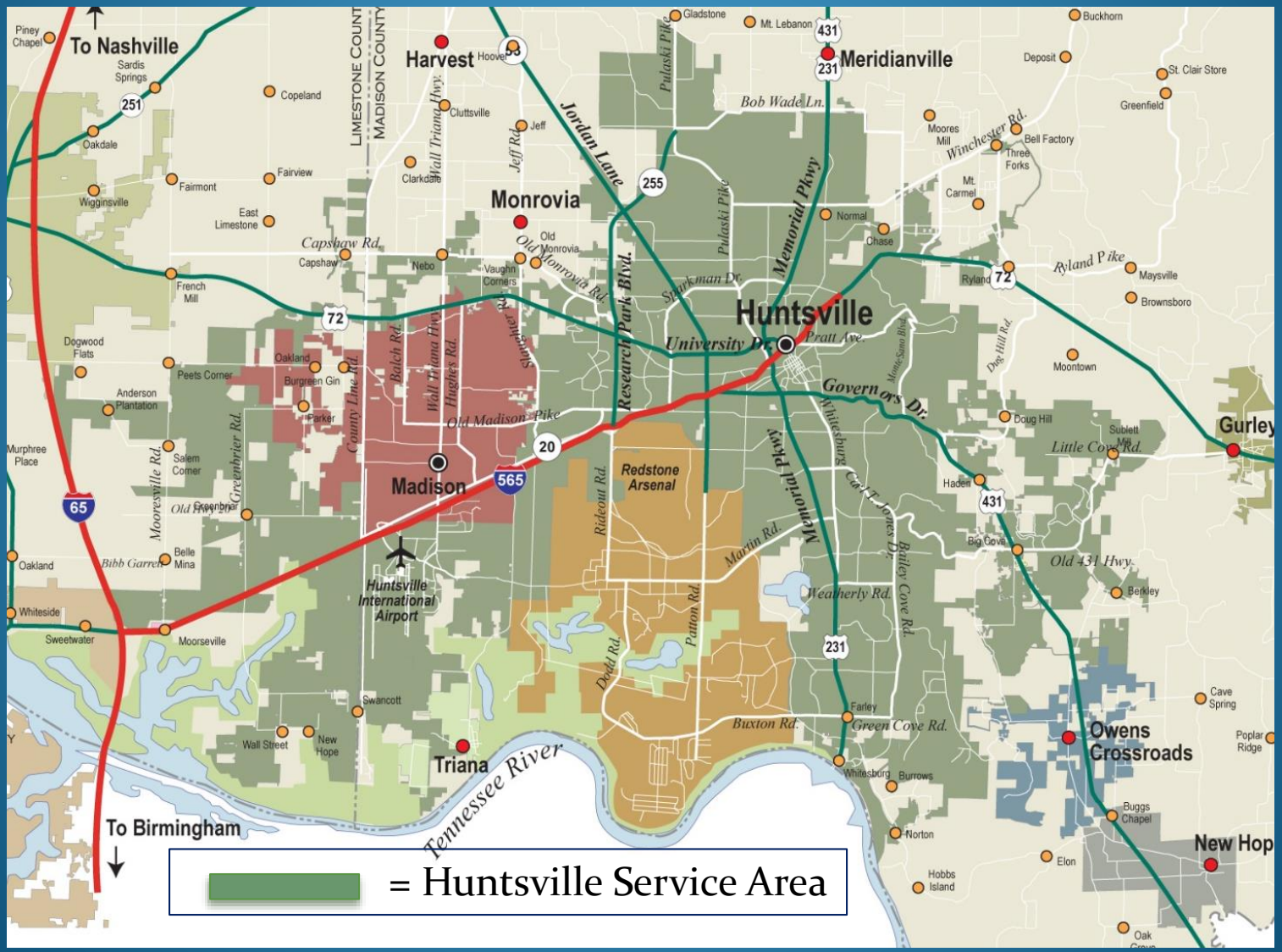
# Boundary Conditions




= Huntsville Service Area

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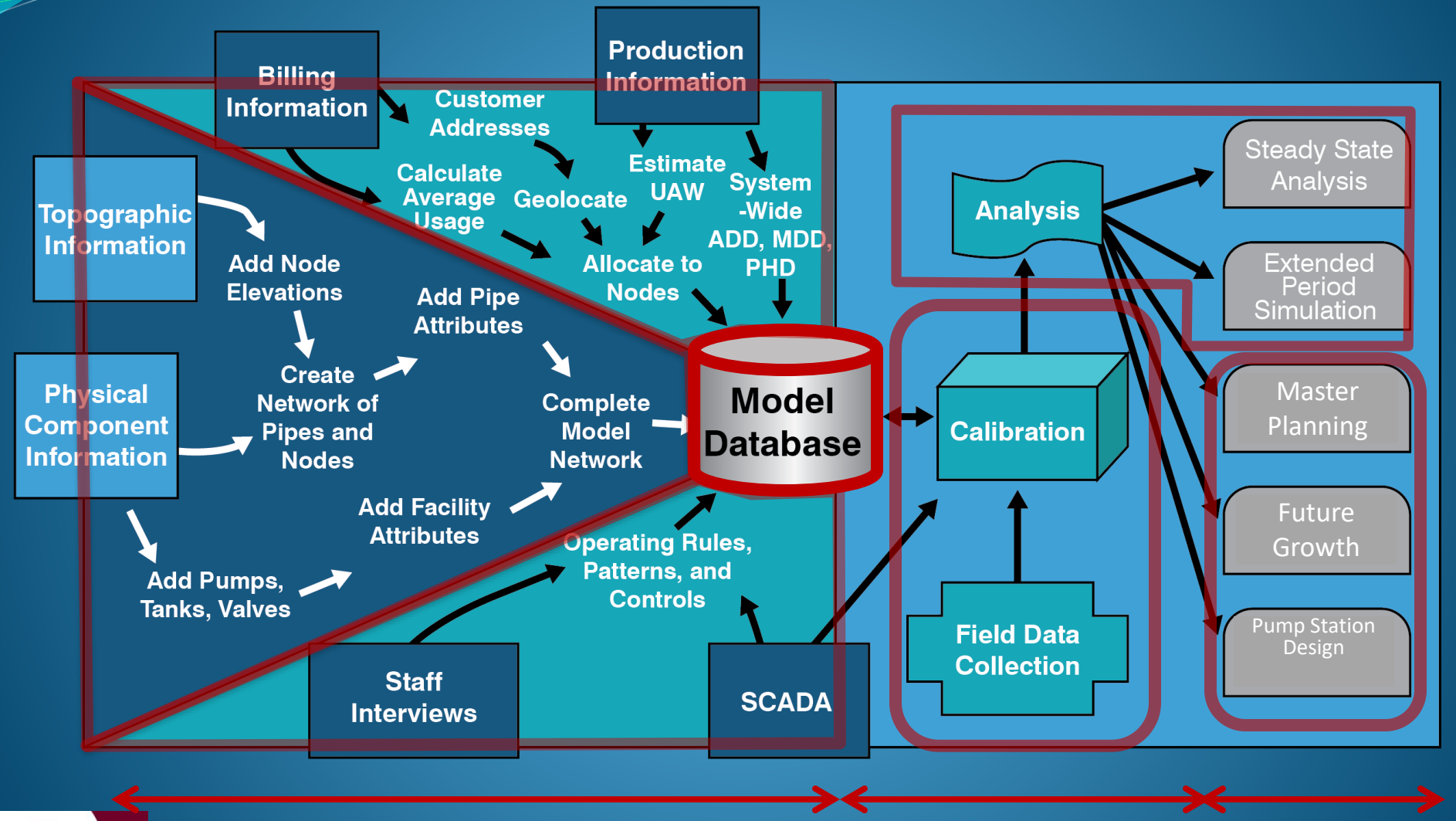
# Development of the Huntsville Model




60% to 70 % Effort

10% to 20% Effort

100% Benefit

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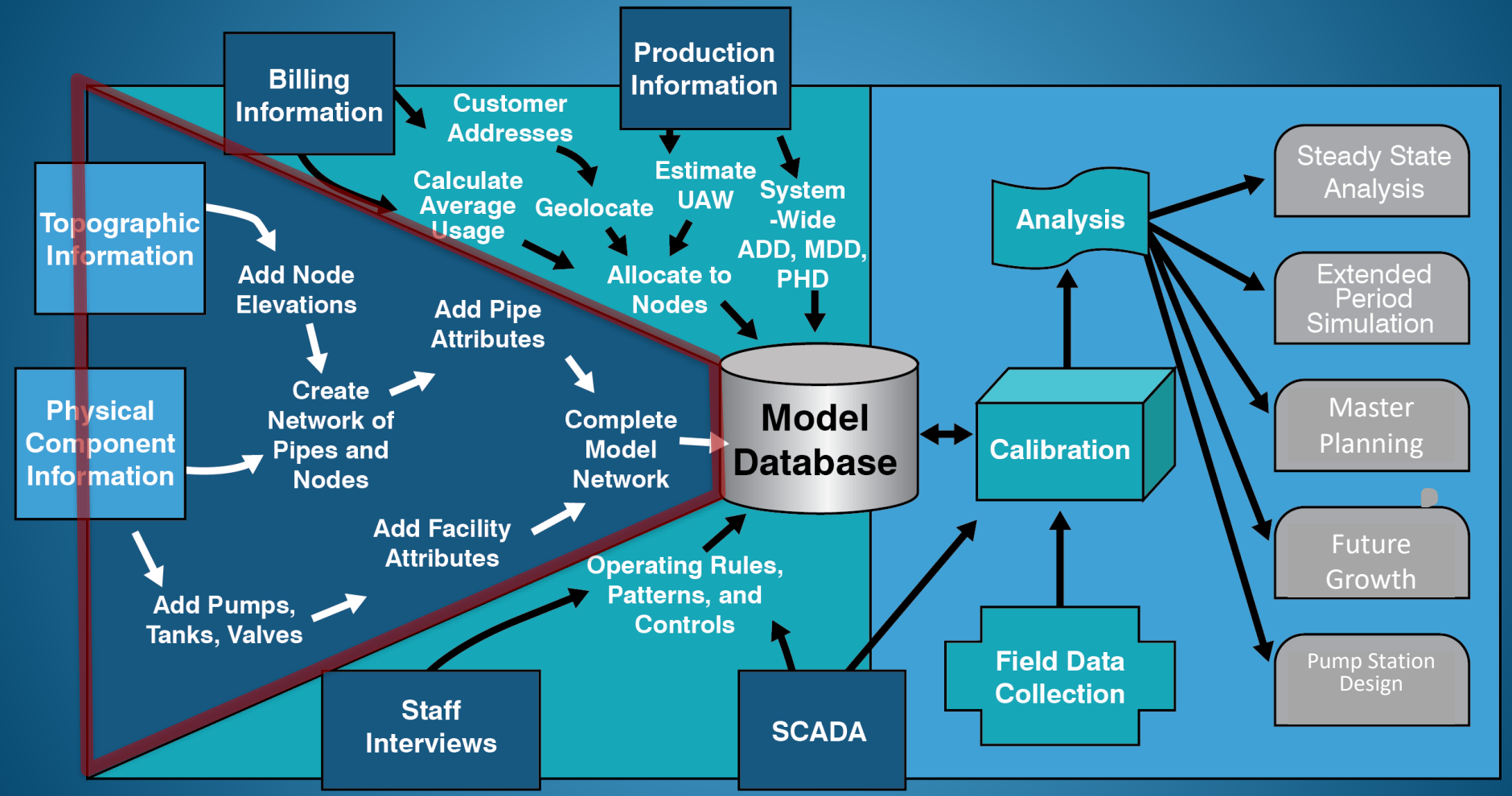
# Step 1: Physical Elements:

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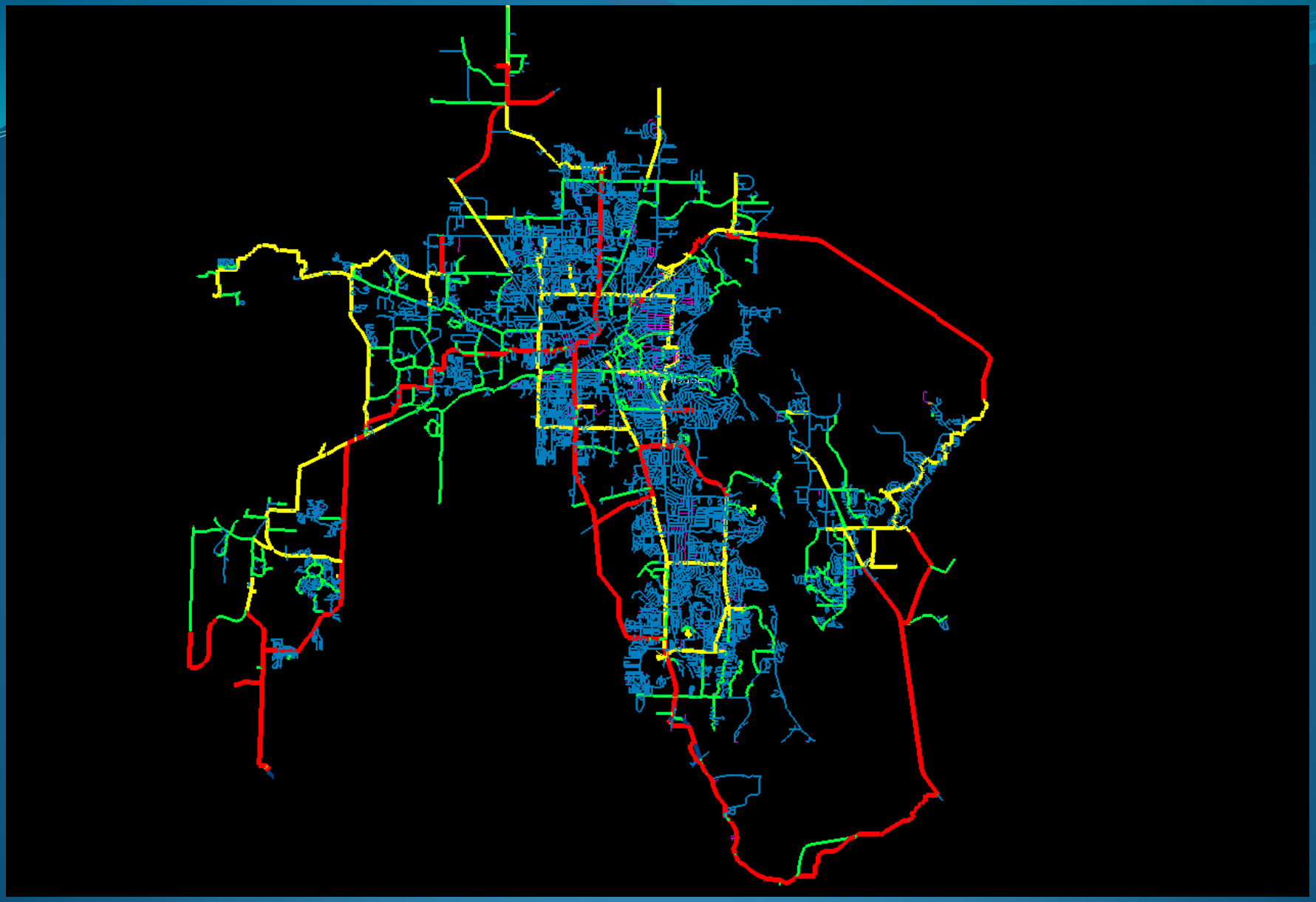

# Physical Elements: Pipes, Valves, Hydrants, etc

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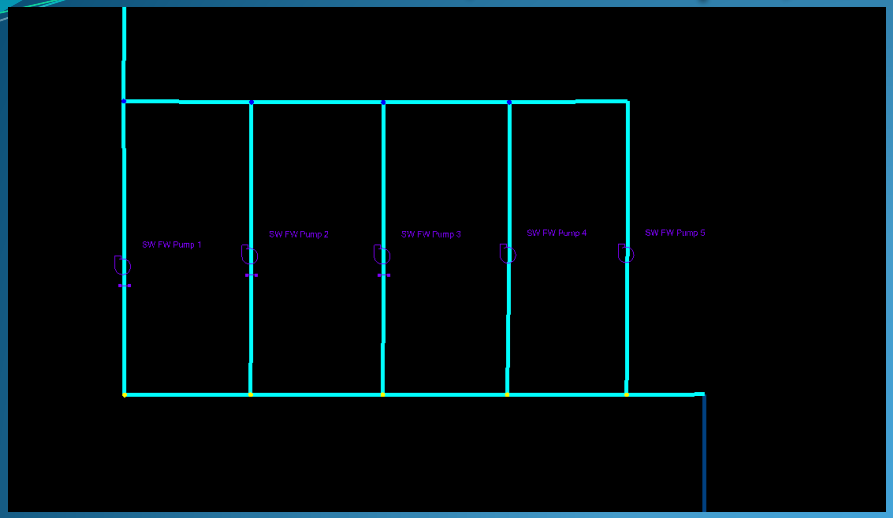
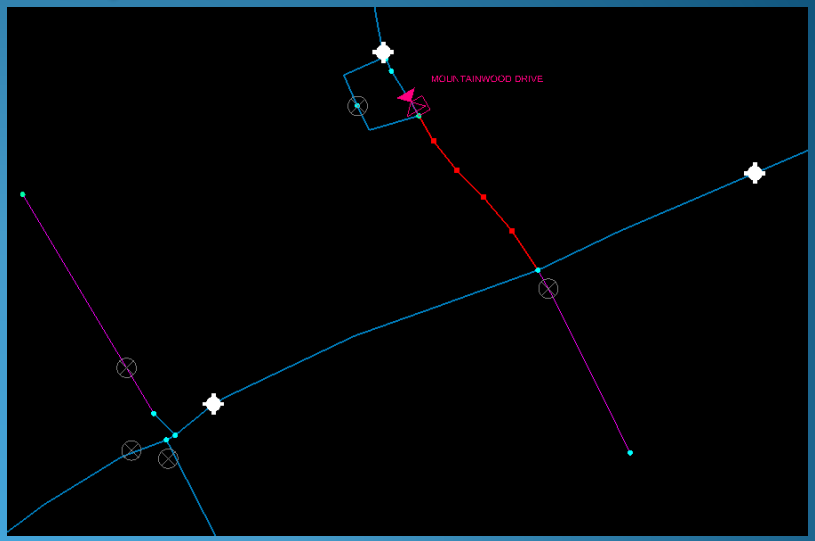
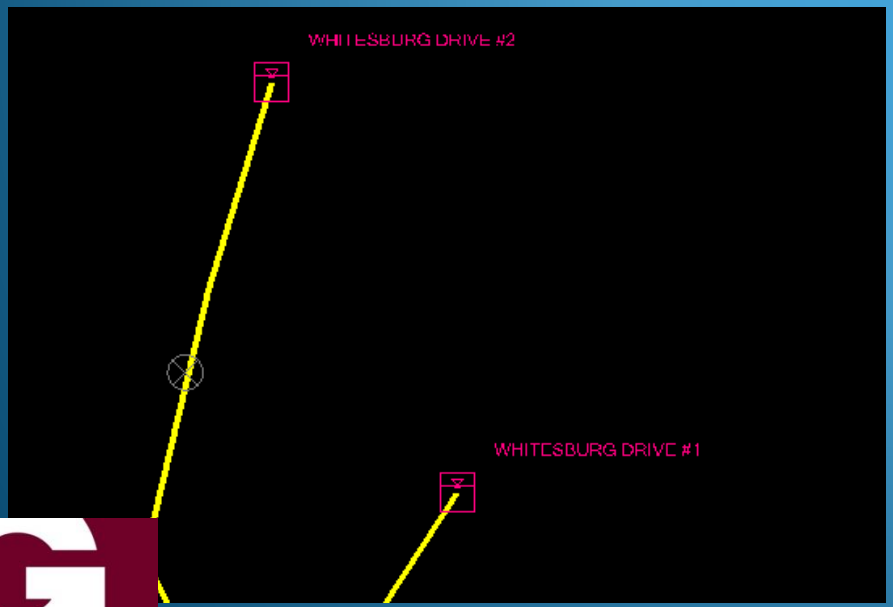
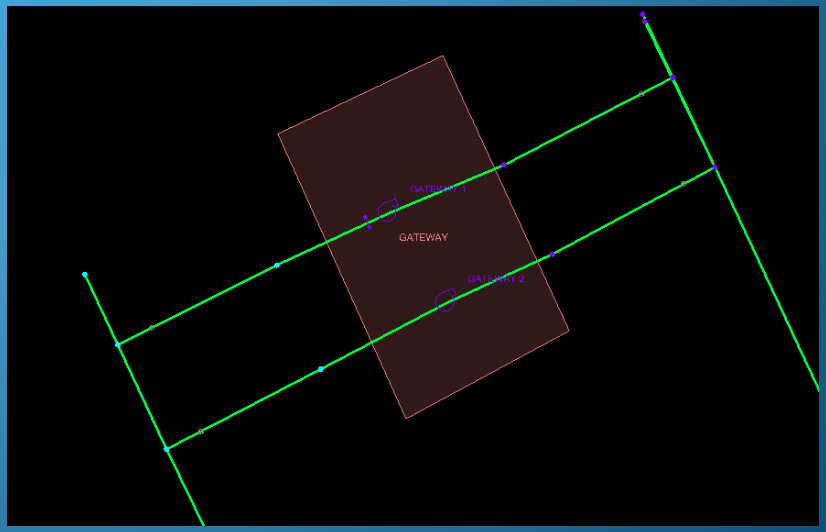
# Add Plants, Pumps, Tanks, PRVs....



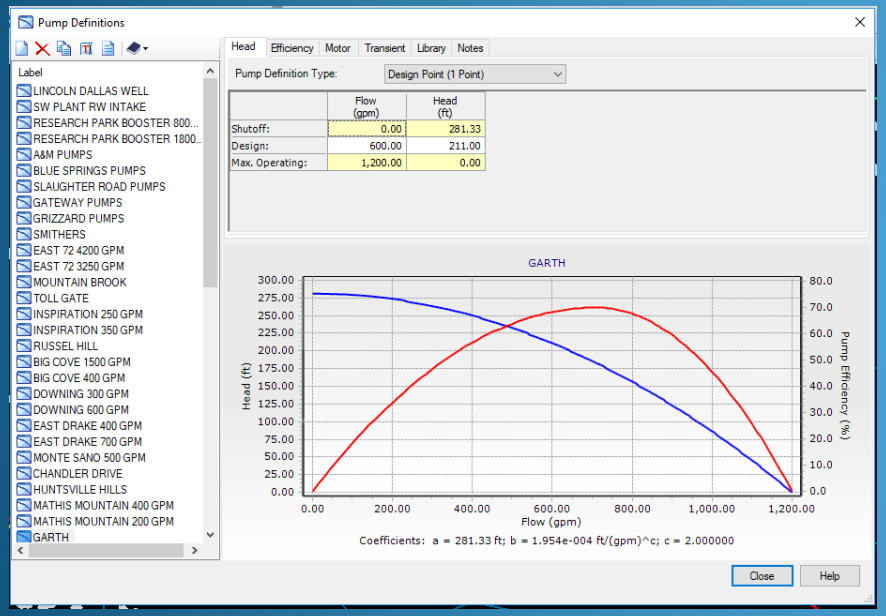



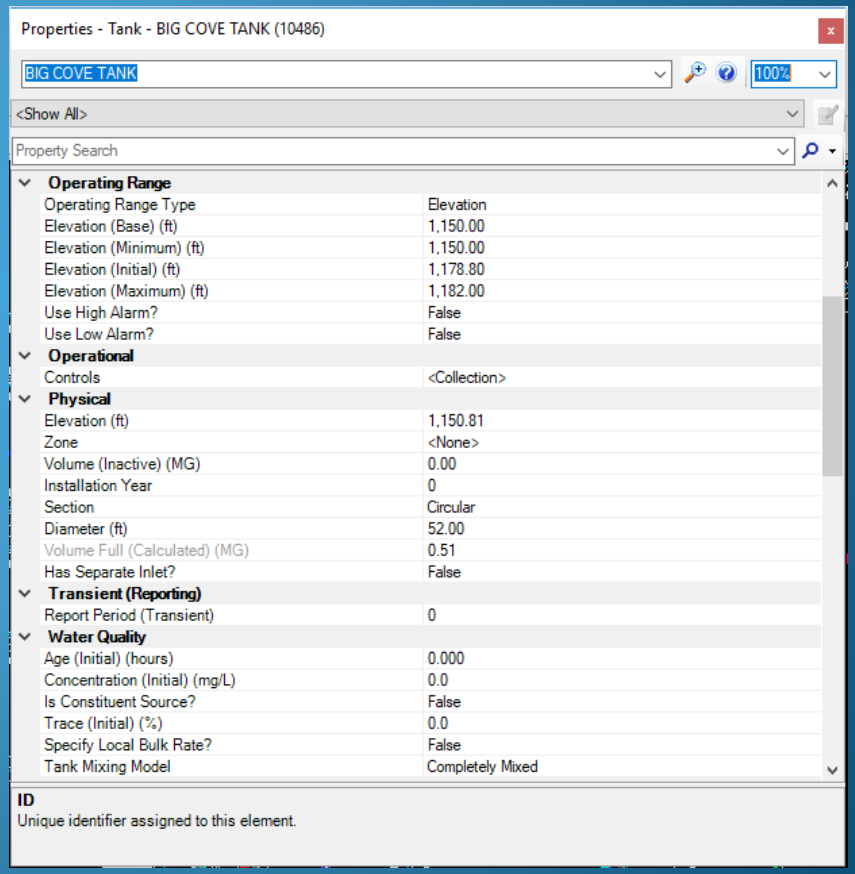



# Specific Properties for Each Facility:

## Pump Definition




## Storage Tank Parameters

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# Physical Elements Summary:

1. Physical elements were imported into the database consisting of:
   - 31,008 Pipes
   - 9,964 Hydrants
   - 81 Pumps
   - 35 Tanks
   - 4 Plants
2. Topographic Information was assigned to all physical elements
3. Connectivity verified

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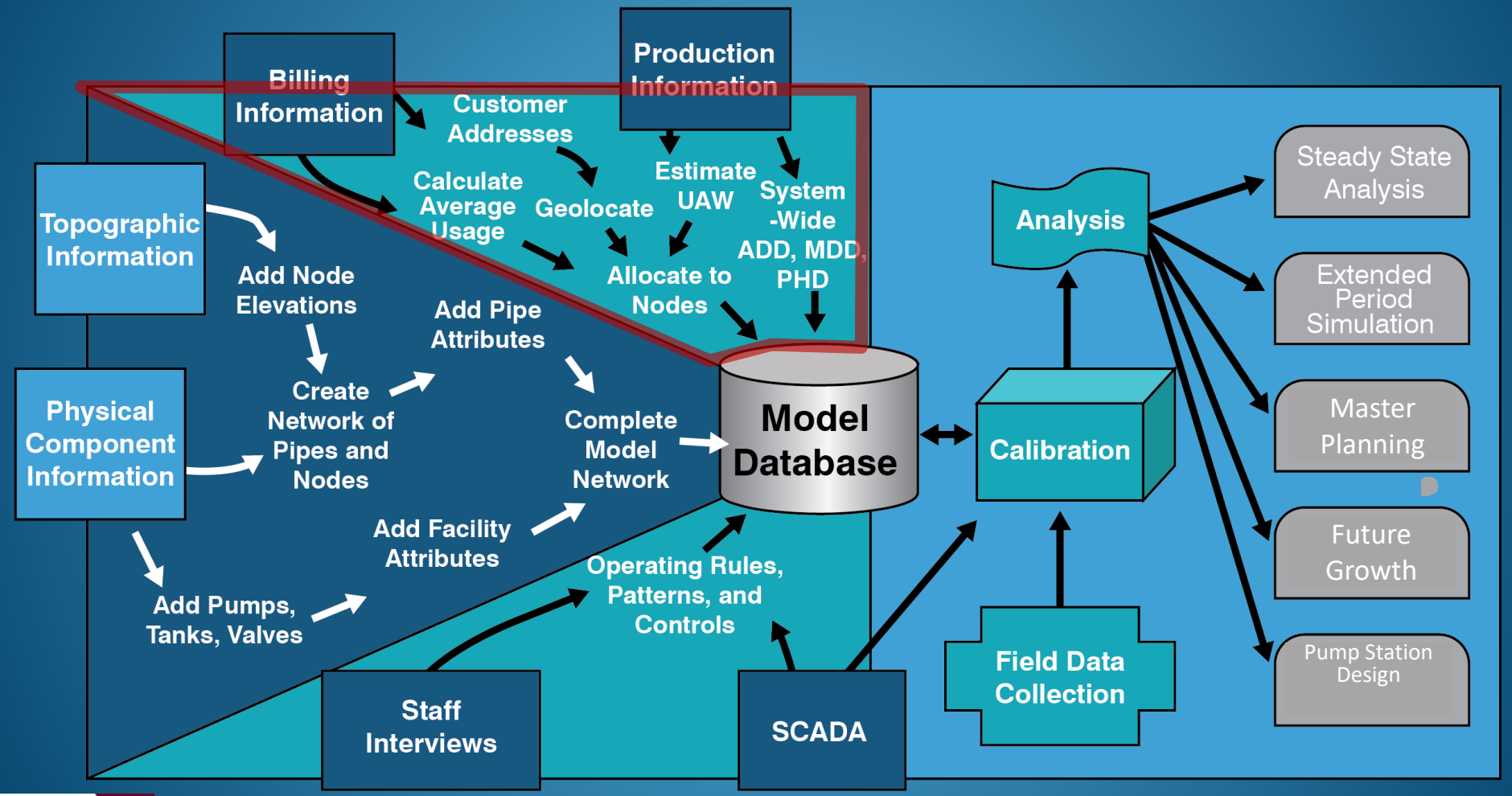
# Step 2: Production & Demand

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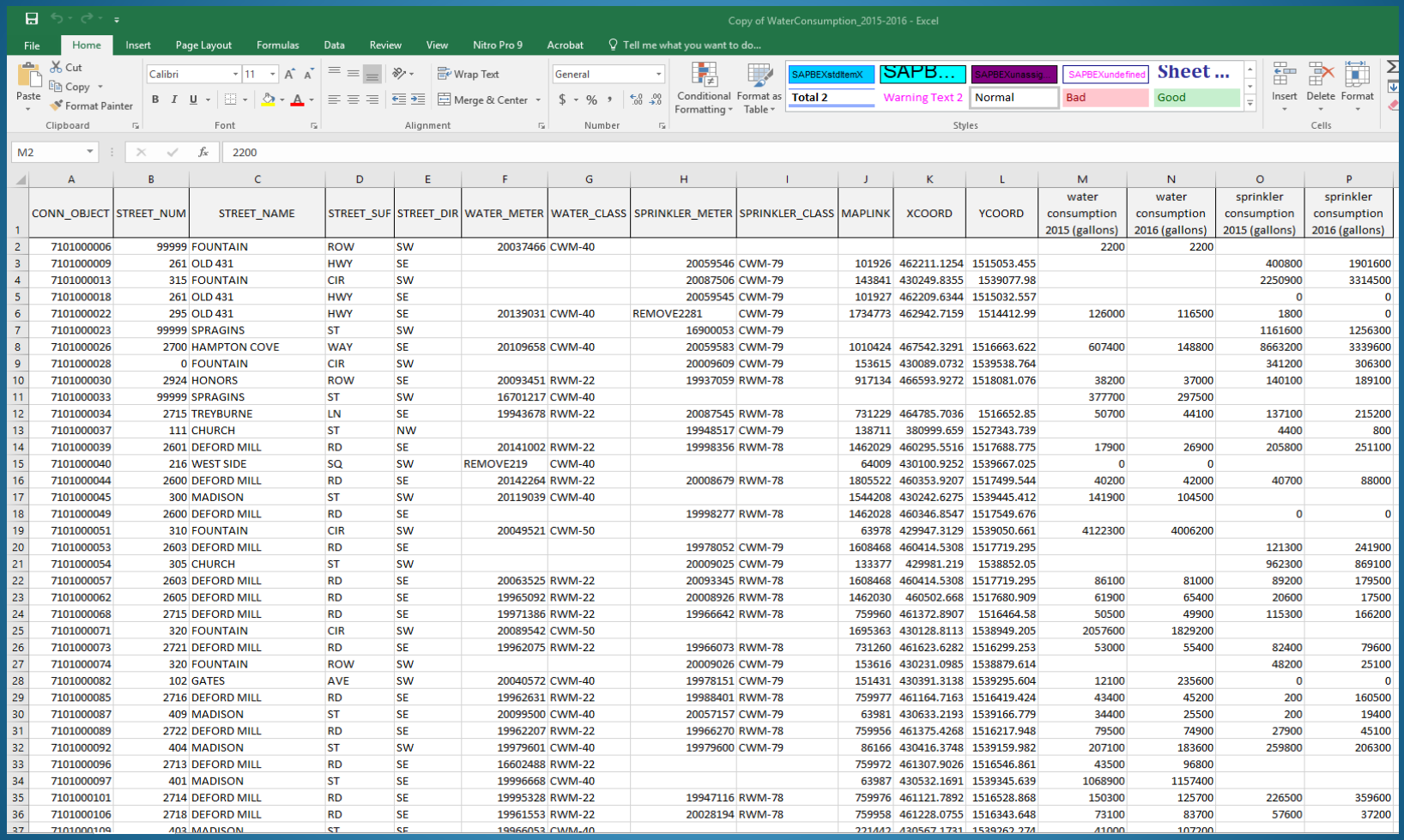
# Customer Data:



Copy of WaterConsumption_2015-2016 - Excel

| CONN_OBJECT | STREET_NUM | STREET_NAME | STREET_SUF | STREET_DIR | WATER_METER | WATER_CLASS | SPRINKLER_METER | SPRINKLER_CLASS | MAPLINK | XCOORD | YCOORD | water consumption 2015 (gallons) | water consumption 2016 (gallons) | sprinkler consumption 2015 (gallons) | sprinkler consumption 2016 (gallons) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7101000006 | 99999 | FOUNTAIN | ROW | SW | 20037466 | CWM-40 | | | | | | 2200 | 2200 | | |
| 7101000009 | 261 | OLD 431 | HWY | SE | | | 20059546 | CWM-79 | 101926 | 462211.1254 | 1515053.455 | | | 400800 | 1901600 |
| 7101000013 | 315 | FOUNTAIN | CIR | SW | | | 20087506 | CWM-79 | 143841 | 430249.8355 | 1539077.98 | | | 2250900 | 3314500 |
| 7101000018 | 261 | OLD 431 | HWY | SE | | | 20059545 | CWM-79 | 101927 | 462209.6344 | 1515032.557 | | | 0 | 0 |
| 7101000022 | 295 | OLD 431 | HWY | SE | 20139031 | CWM-40 | REMOVE2281 | CWM-79 | 1734773 | 462942.7159 | 1514412.99 | 126000 | 116500 | 1800 | 0 |
| 7101000023 | 99999 | SPRAGINS | ST | SW | | | 16900053 | CWM-79 | | | | | | 1161600 | 1256300 |
| 7101000026 | 2700 | HAMPTON COVE | WAY | SE | 20109658 | CWM-40 | 20059583 | CWM-79 | 1010424 | 467542.3291 | 1516663.622 | 607400 | 148800 | 8663200 | 3339600 |
| 7101000028 | 0 | FOUNTAIN | CIR | SW | | | 20009609 | CWM-79 | 153615 | 430089.0732 | 1539538.764 | | | 341200 | 306300 |
| 7101000030 | 2924 | HONORS | ROW | SE | 20093451 | RWM-22 | 19937059 | RWM-78 | 917134 | 466593.9272 | 1518081.076 | 38200 | 37000 | 140100 | 189100 |
| 7101000033 | 99999 | SPRAGINS | ST | SW | 16701217 | CWM-40 | | | | | | 377700 | 297500 | | |
| 7101000034 | 2715 | TREYBURNE | LN | SE | 19943678 | RWM-22 | 20087545 | RWM-78 | 731229 | 464785.7036 | 1516652.85 | 50700 | 44100 | 137100 | 215200 |
| 7101000037 | 111 | CHURCH | ST | NW | | | 19948517 | CWM-79 | 138711 | 380999.659 | 1527343.739 | | | 4400 | 800 |
| 7101000039 | 2601 | DEFORD MILL | RD | SE | 20141002 | RWM-22 | 19998356 | RWM-78 | 1462029 | 460295.5516 | 1517688.775 | 17900 | 26900 | 205800 | 251100 |
| 7101000040 | 216 | WEST SIDE | SQ | SW | REMOVE219 | CWM-40 | | | 64009 | 430100.9252 | 1539667.025 | 0 | 0 | | |
| 7101000044 | 2600 | DEFORD MILL | RD | SE | 20142264 | RWM-22 | 20008679 | RWM-78 | 1805522 | 460353.9207 | 1517499.544 | 40200 | 42000 | 40700 | 88000 |
| 7101000045 | 300 | MADISON | ST | SW | 20119039 | CWM-40 | | | 1544208 | 430242.6275 | 1539445.412 | 141900 | 104500 | | |
| 7101000049 | 2600 | DEFORD MILL | RD | SE | | | 19998277 | RWM-78 | 1462028 | 460346.8547 | 1517549.676 | | | 0 | 0 |
| 7101000051 | 310 | FOUNTAIN | CIR | SW | 20049521 | CWM-50 | | | 63978 | 429947.3129 | 1539050.661 | 4122300 | 4006200 | | |
| 7101000053 | 2603 | DEFORD MILL | RD | SE | | | 19978052 | CWM-79 | 1608468 | 460414.5308 | 1517719.295 | | | 121300 | 241900 |
| 7101000054 | 305 | CHURCH | ST | SW | | | 20009025 | CWM-79 | 133377 | 429981.219 | 1538852.05 | | | 962300 | 869100 |
| 7101000057 | 2603 | DEFORD MILL | RD | SE | 20063525 | RWM-22 | 20093345 | RWM-78 | 1608468 | 460414.5308 | 1517719.295 | 86100 | 81000 | 89200 | 179500 |
| 7101000062 | 2605 | DEFORD MILL | RD | SE | 19965092 | RWM-22 | 20008926 | RWM-78 | 1462030 | 460502.668 | 1517680.909 | 61900 | 65400 | 20600 | 17500 |
| 7101000068 | 2715 | DEFORD MILL | RD | SE | 19971386 | RWM-22 | 19966642 | RWM-78 | 759960 | 461372.8907 | 1516464.58 | 50500 | 49900 | 115300 | 166200 |
| 7101000071 | 320 | FOUNTAIN | CIR | SW | 20089542 | CWM-50 | | | 1695363 | 430128.8113 | 1538949.205 | 2057600 | 1829200 | | |
| 7101000073 | 2721 | DEFORD MILL | RD | SE | 19962075 | RWM-22 | 19966073 | RWM-78 | 731260 | 461623.6282 | 1516299.253 | 53000 | 55400 | 82400 | 79600 |
| 7101000074 | 320 | FOUNTAIN | ROW | SW | | | 20009026 | CWM-79 | 153616 | 430231.0985 | 1538879.614 | | | 48200 | 25100 |
| 7101000082 | 102 | GATES | AVE | SW | 20040572 | CWM-40 | 19978151 | CWM-79 | 151431 | 430391.3138 | 1539295.604 | 12100 | 235600 | 0 | 0 |
| 7101000085 | 2716 | DEFORD MILL | RD | SE | 19962631 | RWM-22 | 19988401 | RWM-78 | 759977 | 461164.7163 | 1516419.424 | 43400 | 45200 | 200 | 160500 |
| 7101000087 | 409 | MADISON | ST | SE | 20099500 | CWM-40 | 20057157 | CWM-79 | 63981 | 430633.2193 | 1539166.779 | 34400 | 25500 | 200 | 19400 |
| 7101000089 | 2722 | DEFORD MILL | RD | SE | 19962207 | RWM-22 | 19966270 | RWM-78 | 759956 | 461375.4268 | 1516217.948 | 79500 | 74900 | 27900 | 45100 |
| 7101000092 | 404 | MADISON | ST | SW | 19979601 | CWM-40 | 19979600 | CWM-79 | 86166 | 430416.3748 | 1539159.982 | 207100 | 183600 | 259800 | 206300 |
| 7101000096 | 2713 | DEFORD MILL | RD | SE | 16602488 | RWM-22 | | | 759972 | 461307.9026 | 1516546.861 | 43500 | 96800 | | |
| 7101000097 | 401 | MADISON | ST | SE | 19996668 | CWM-40 | | | 63987 | 430532.1691 | 1539345.639 | 1068900 | 1157400 | | |
| 7101000101 | 2714 | DEFORD MILL | RD | SE | 19995328 | RWM-22 | 19947116 | RWM-78 | 759976 | 461121.7892 | 1516528.868 | 150300 | 125700 | 226500 | 359600 |
| 7101000106 | 2718 | DEFORD MILL | RD | SE | 19961553 | RWM-22 | 20028194 | RWM-78 | 759958 | 461228.0755 | 1516343.648 | 73100 | 83700 | 57600 | 37200 |
| 7101000109 | 403 | MADISON | ST | SE | 19966053 | CWM-40 | | | 221442 | 430567.1731 | 1539262.274 | 41000 | 107200 | | |

## Spreadsheet Provided by HU Team (95,000 Records; 28 months)

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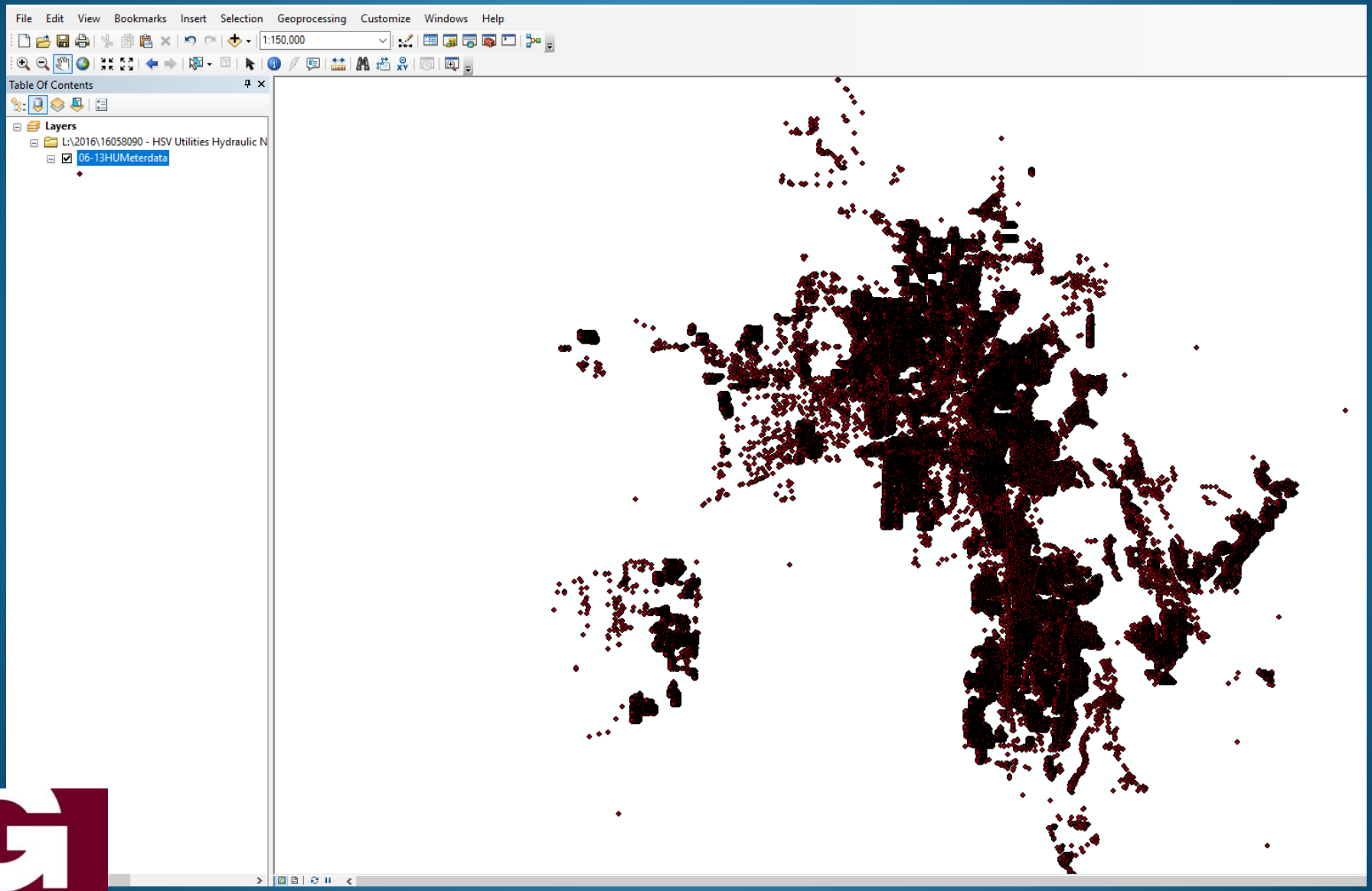
# Intermediate Step - ArcMAP

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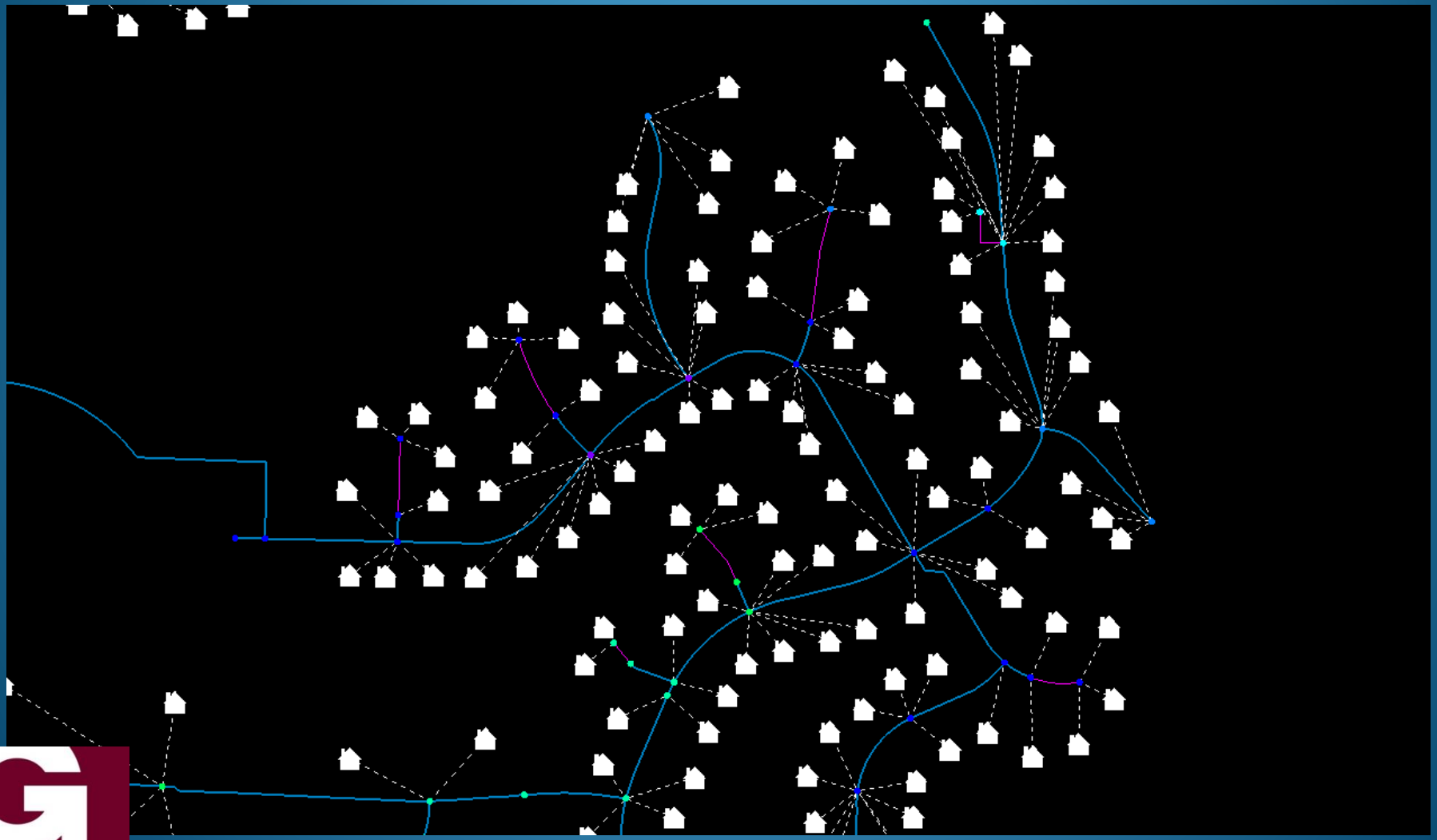
# Demands Assigned to Nodes



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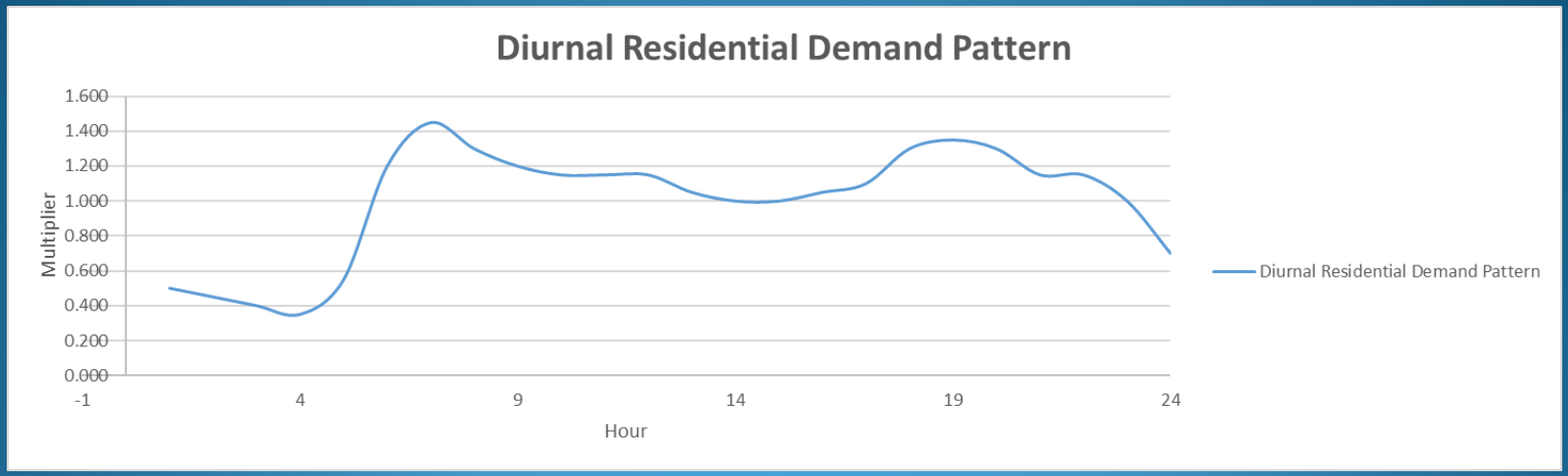
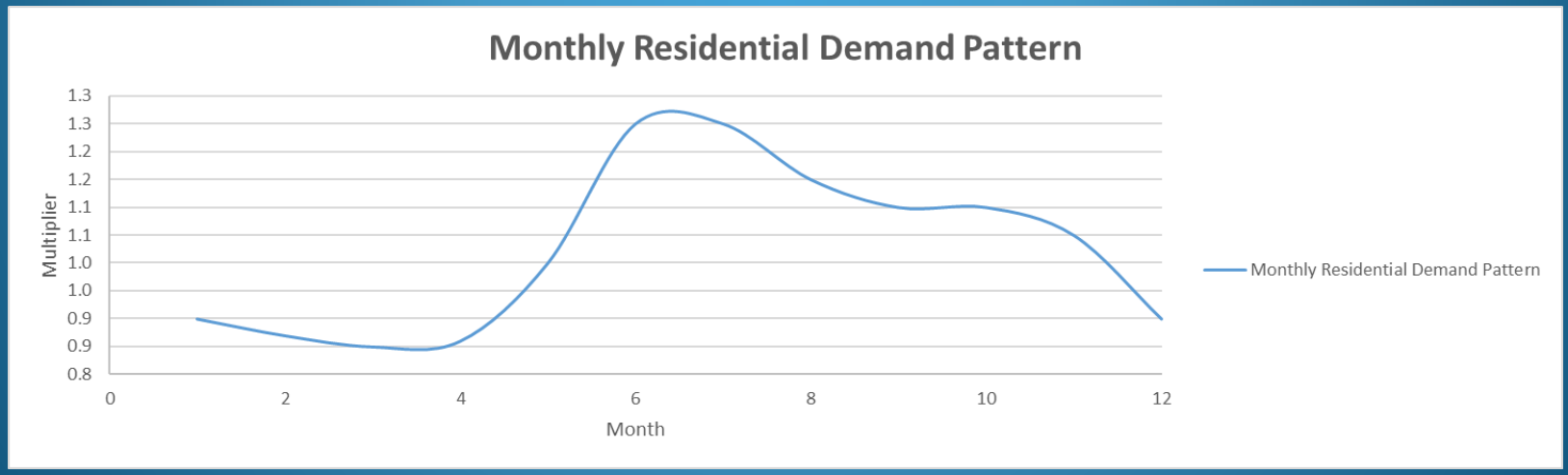
# Residential Demand Patterns

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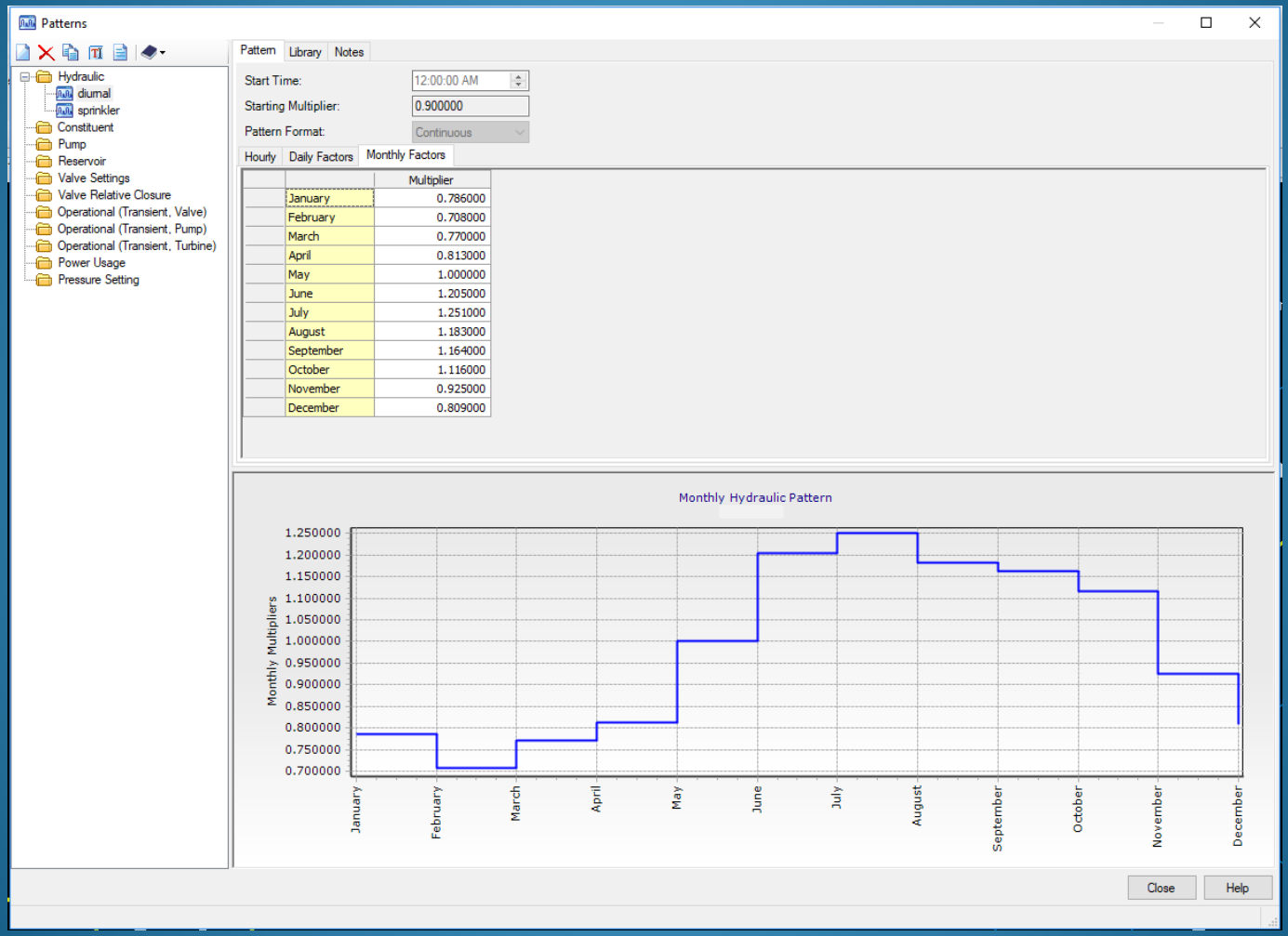
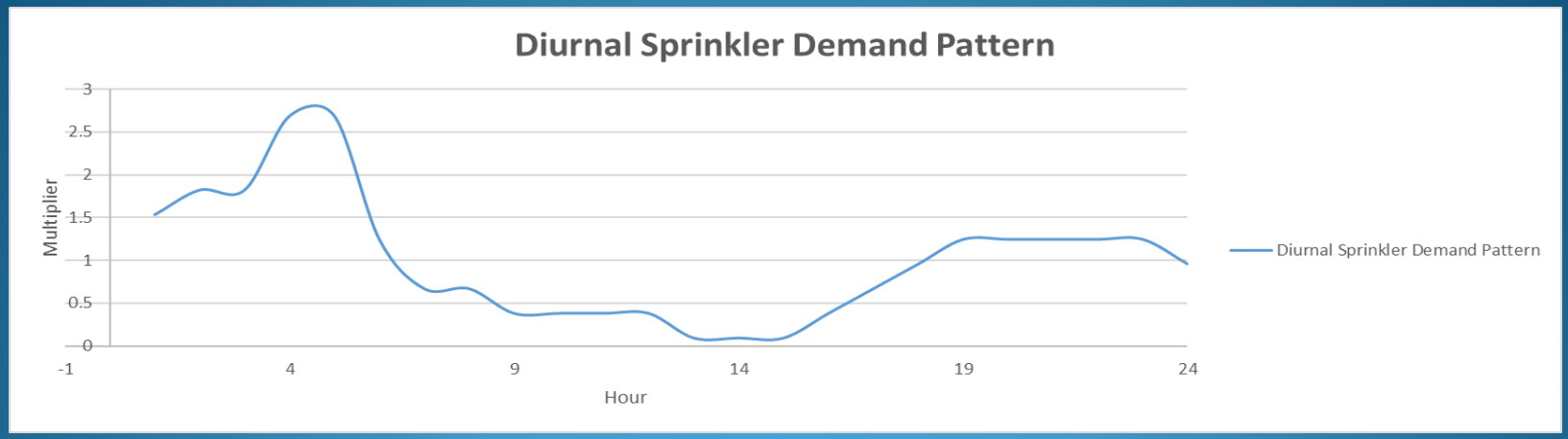
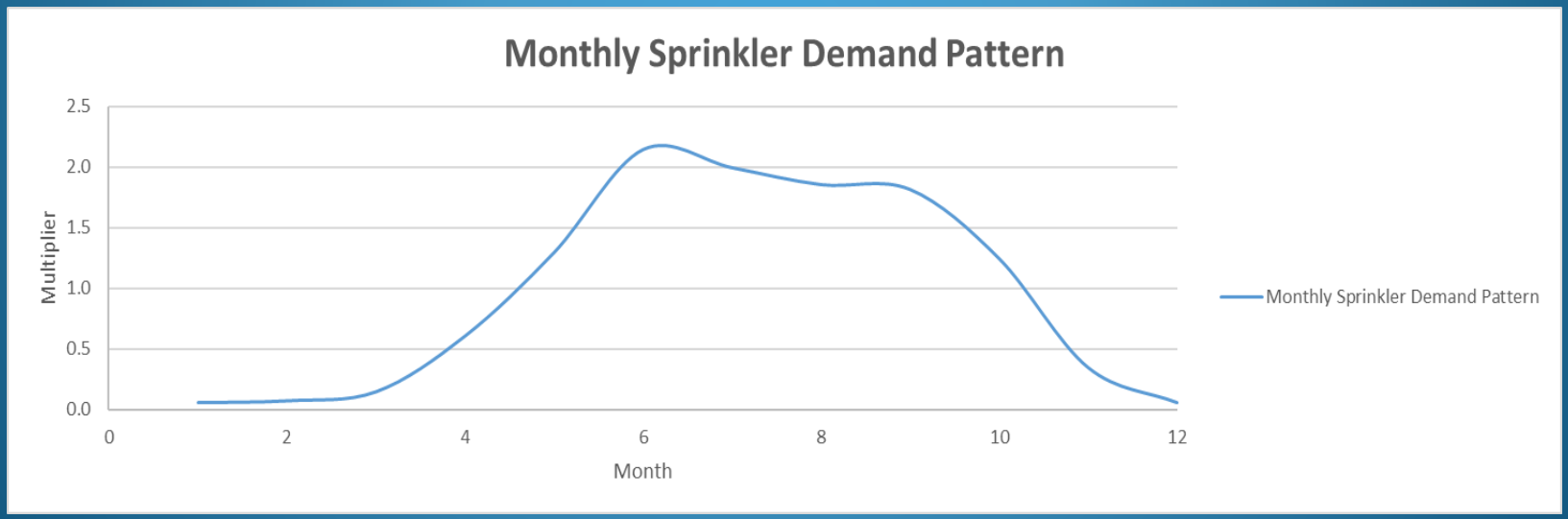
# Monthly Production Reproduce in the Model



# Sprinkler Demand Patterns

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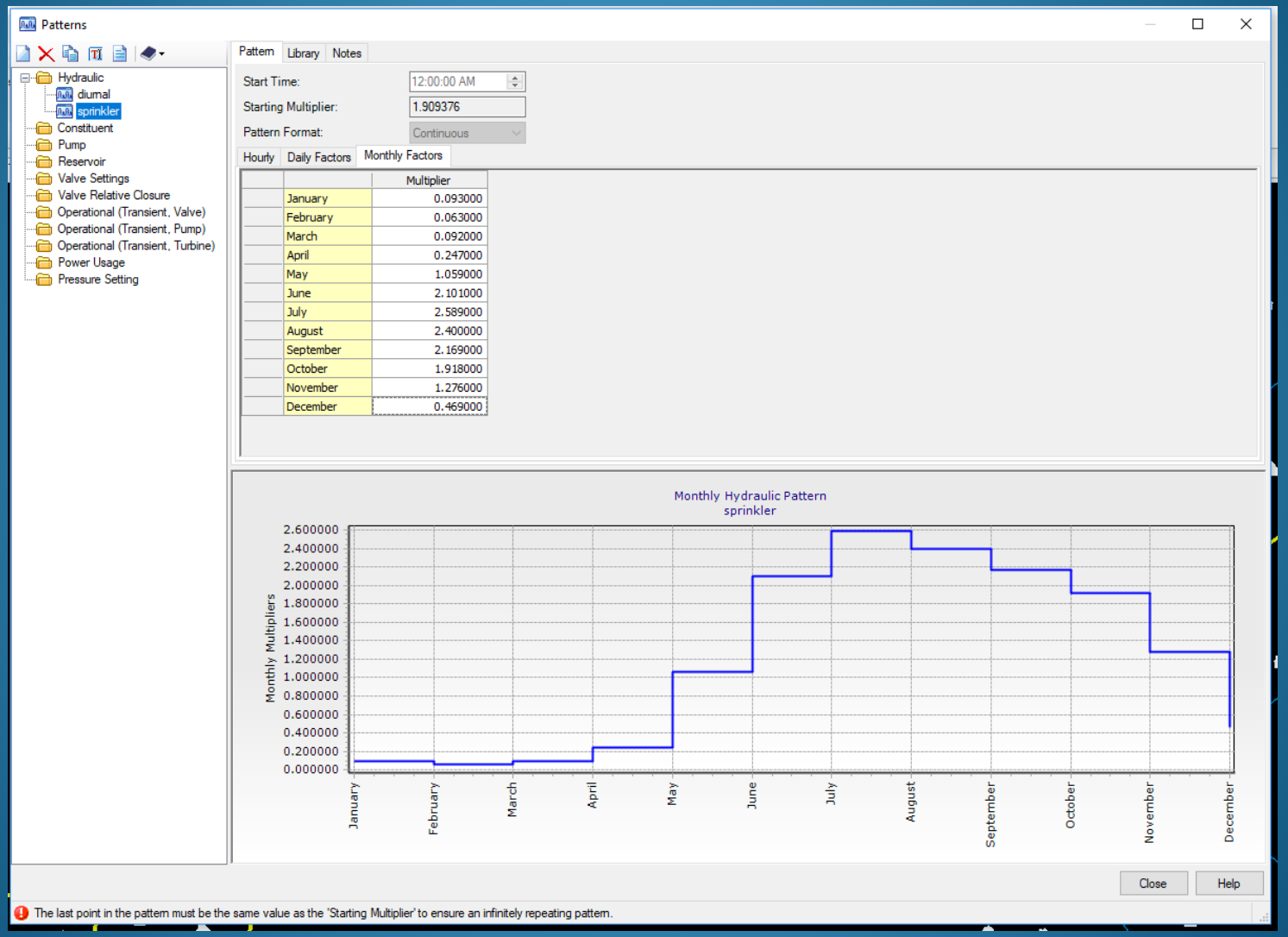
# Sprinkler Demand Patterns

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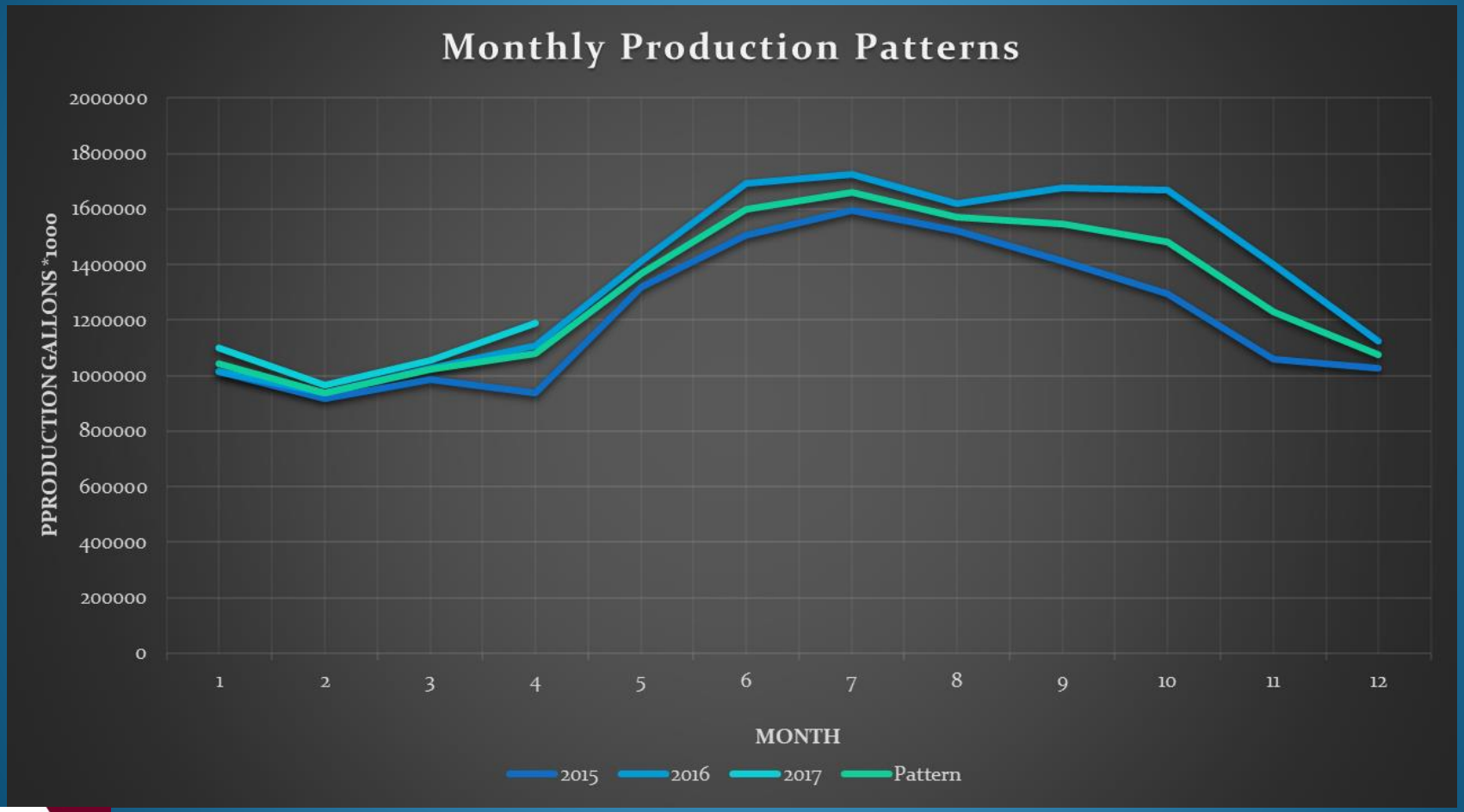
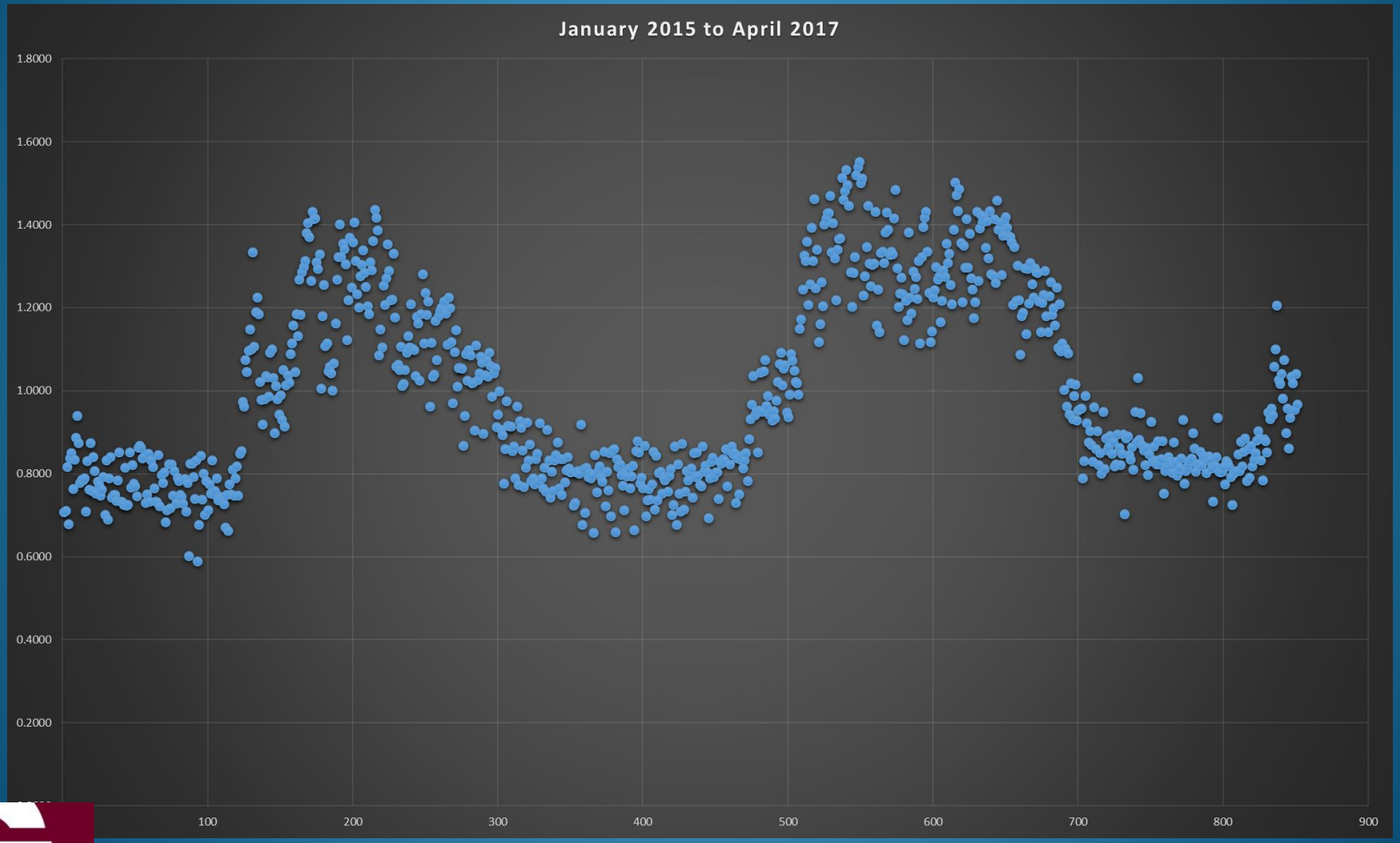
# Monthly Production Pattern



# Plant Production

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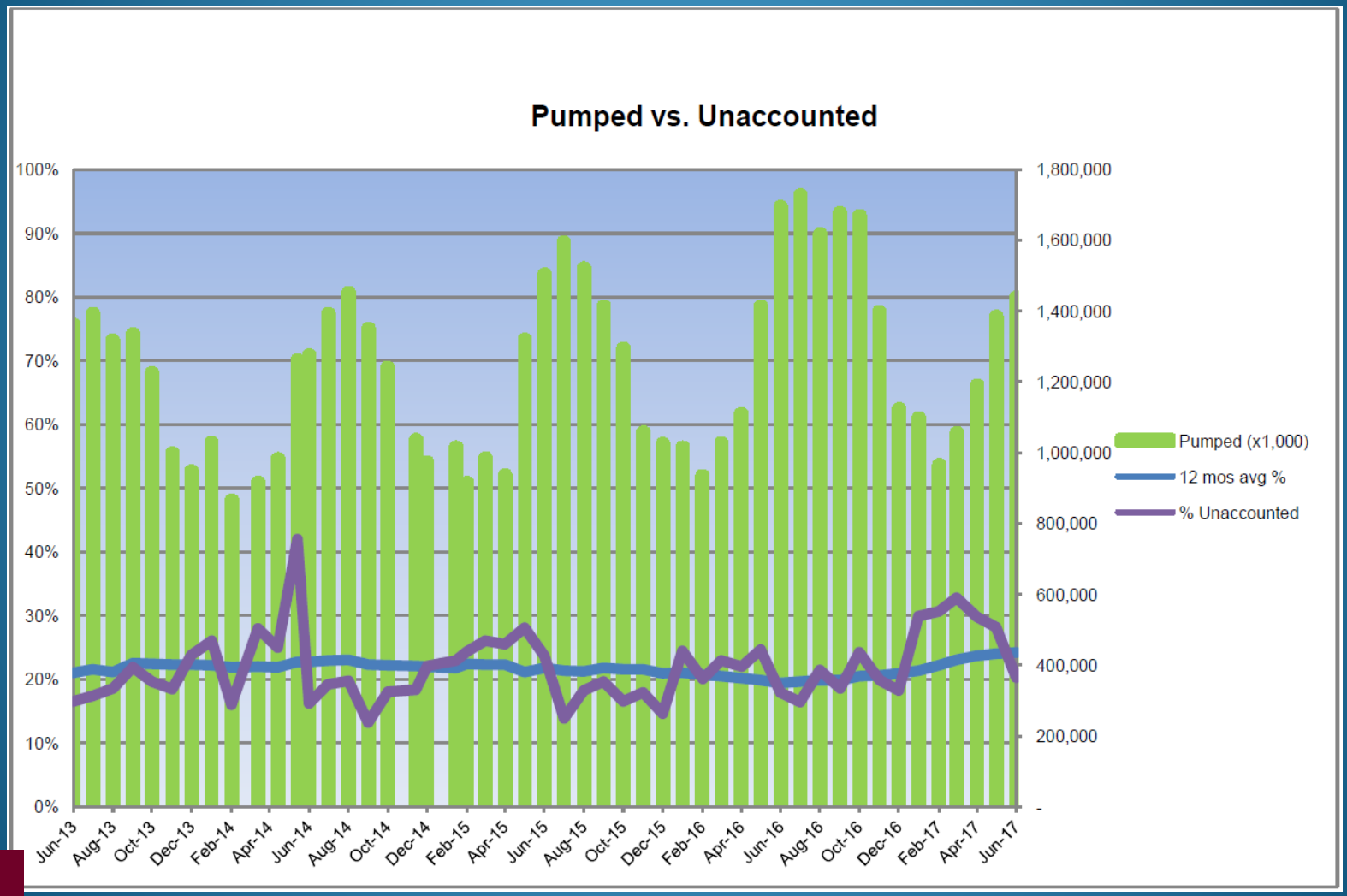
# Allocate non-Revenue Water:

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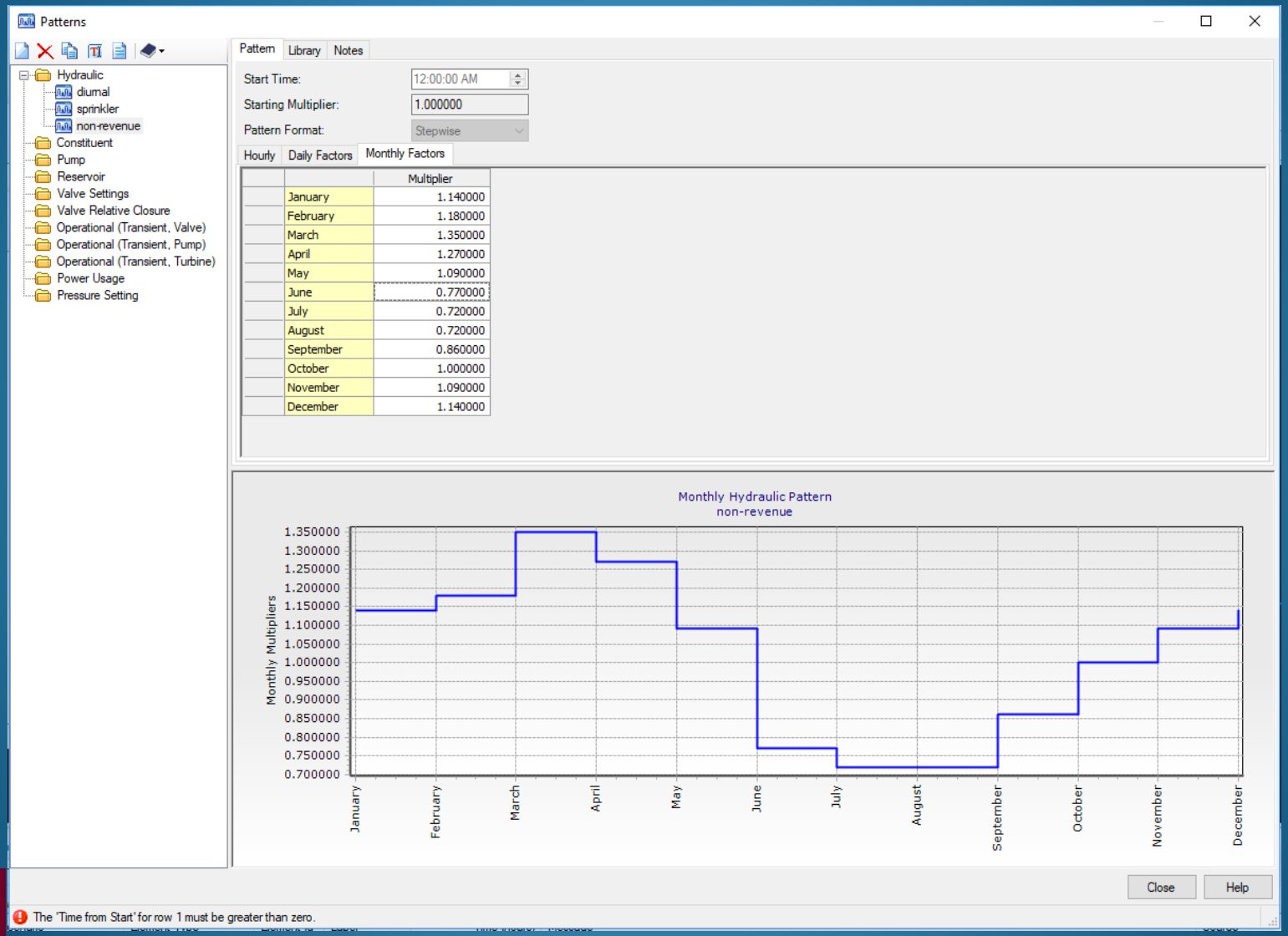
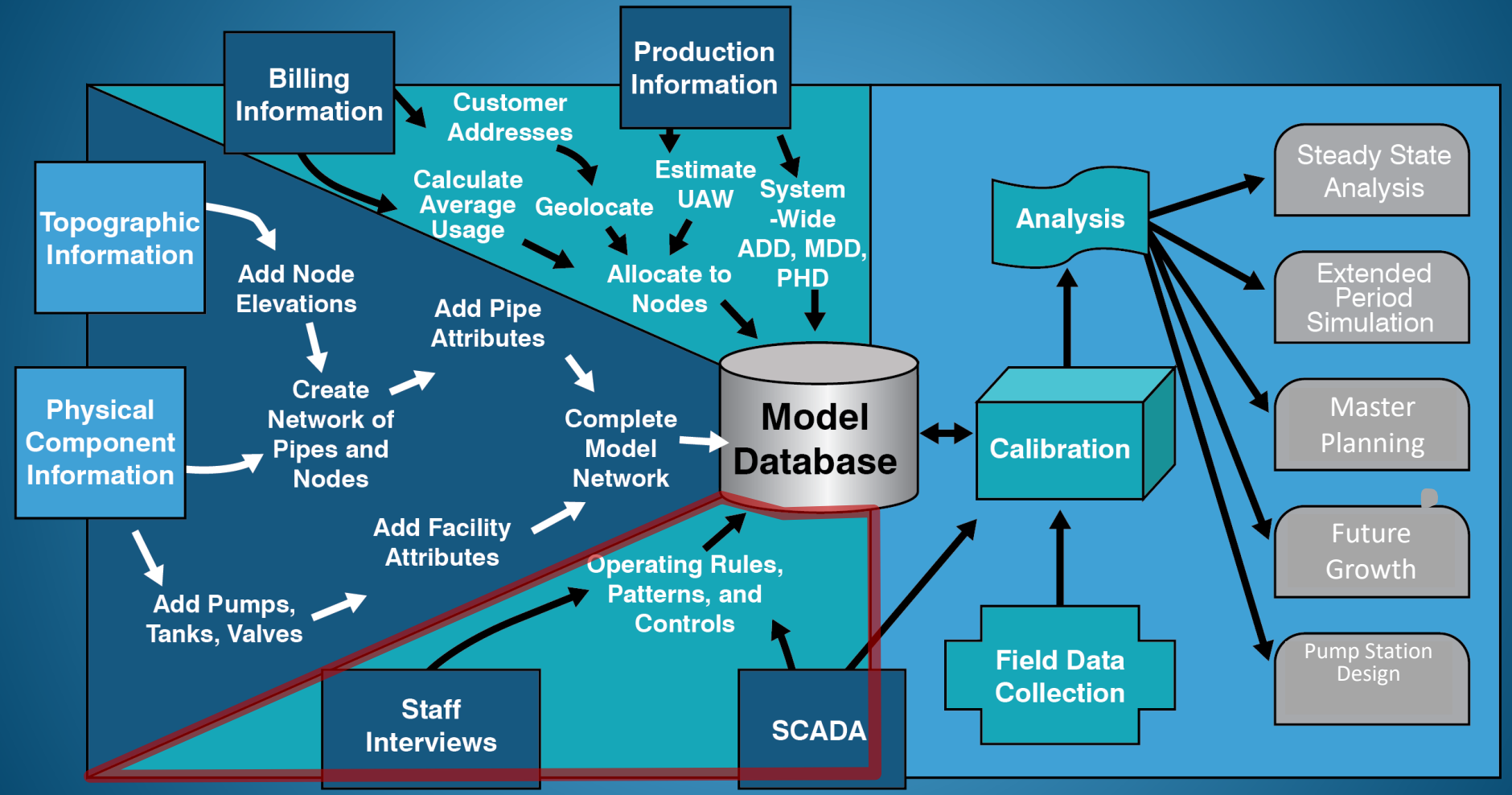
# Allocate non-Revenue Water:



# Set Up Operational Rules

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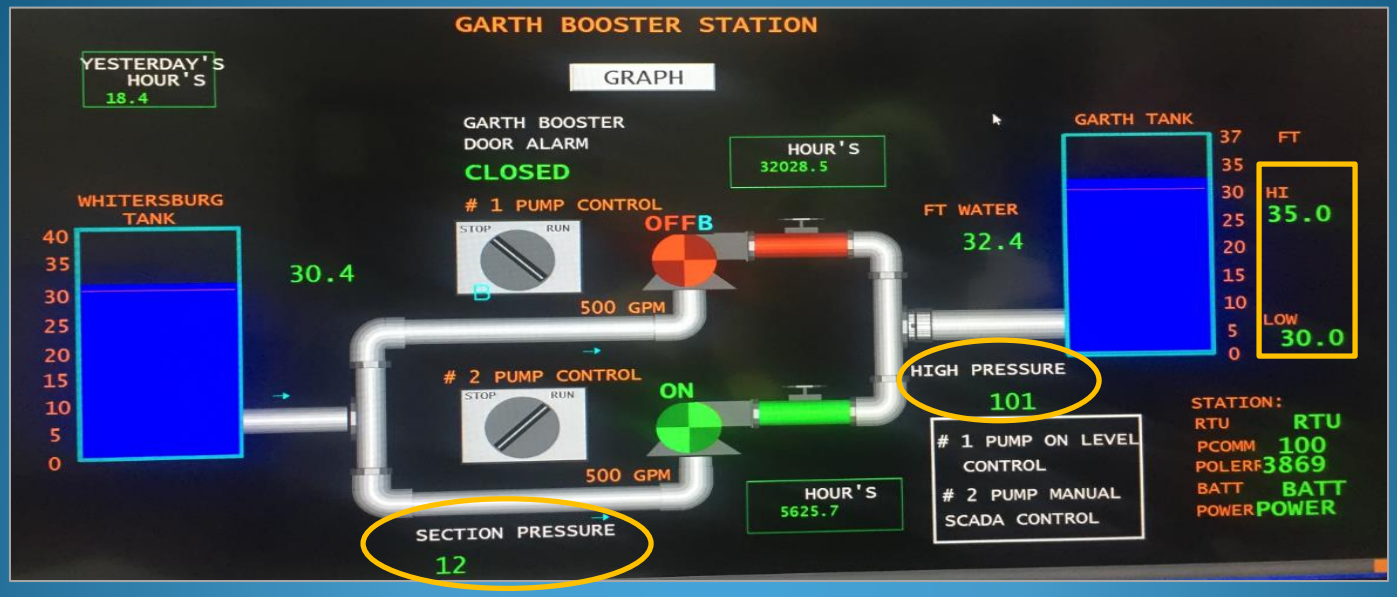
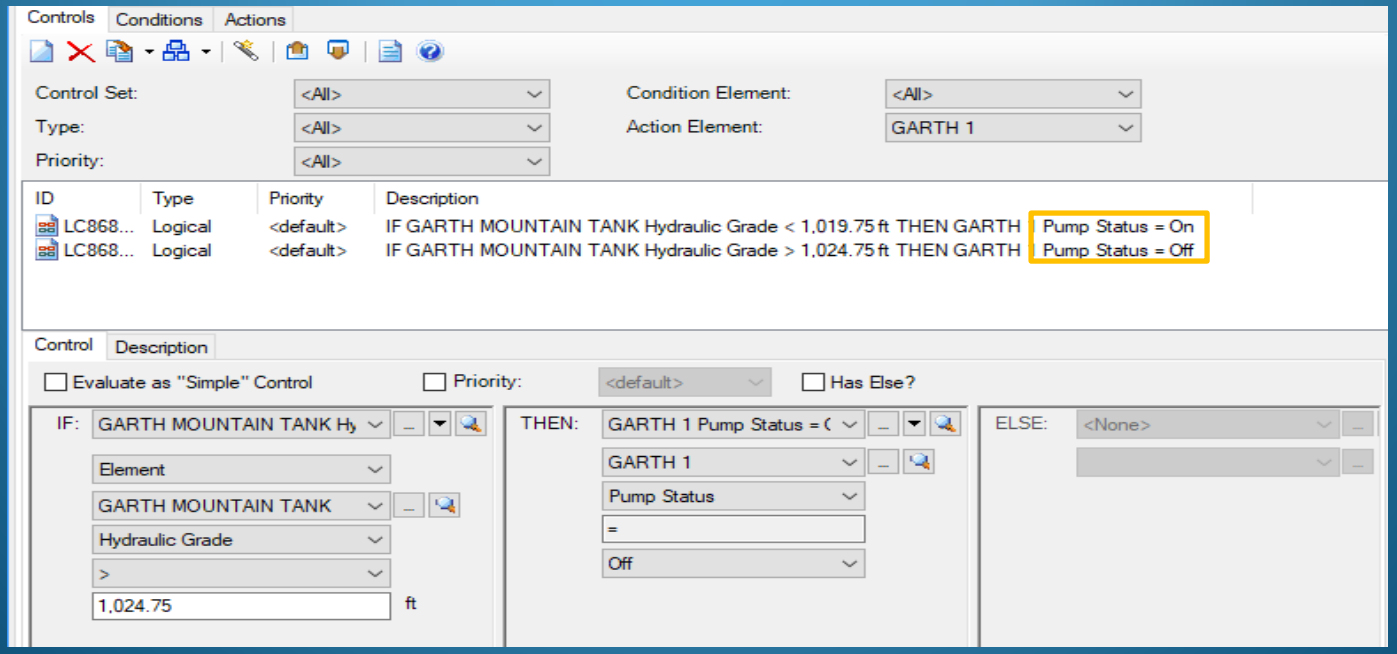
# Understand and Enter Operating Parameters

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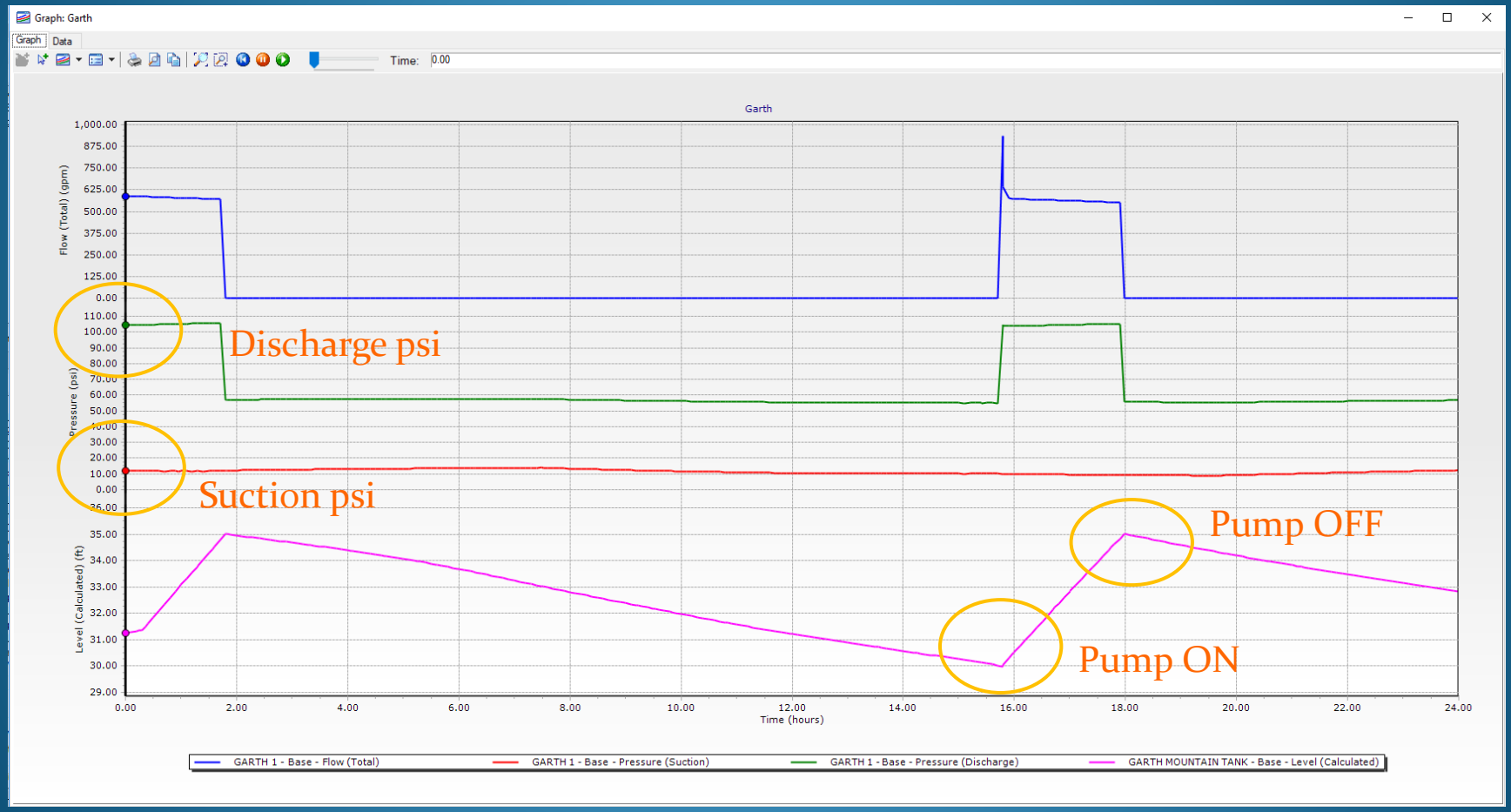
# Sample Calculation for Pump Cycles

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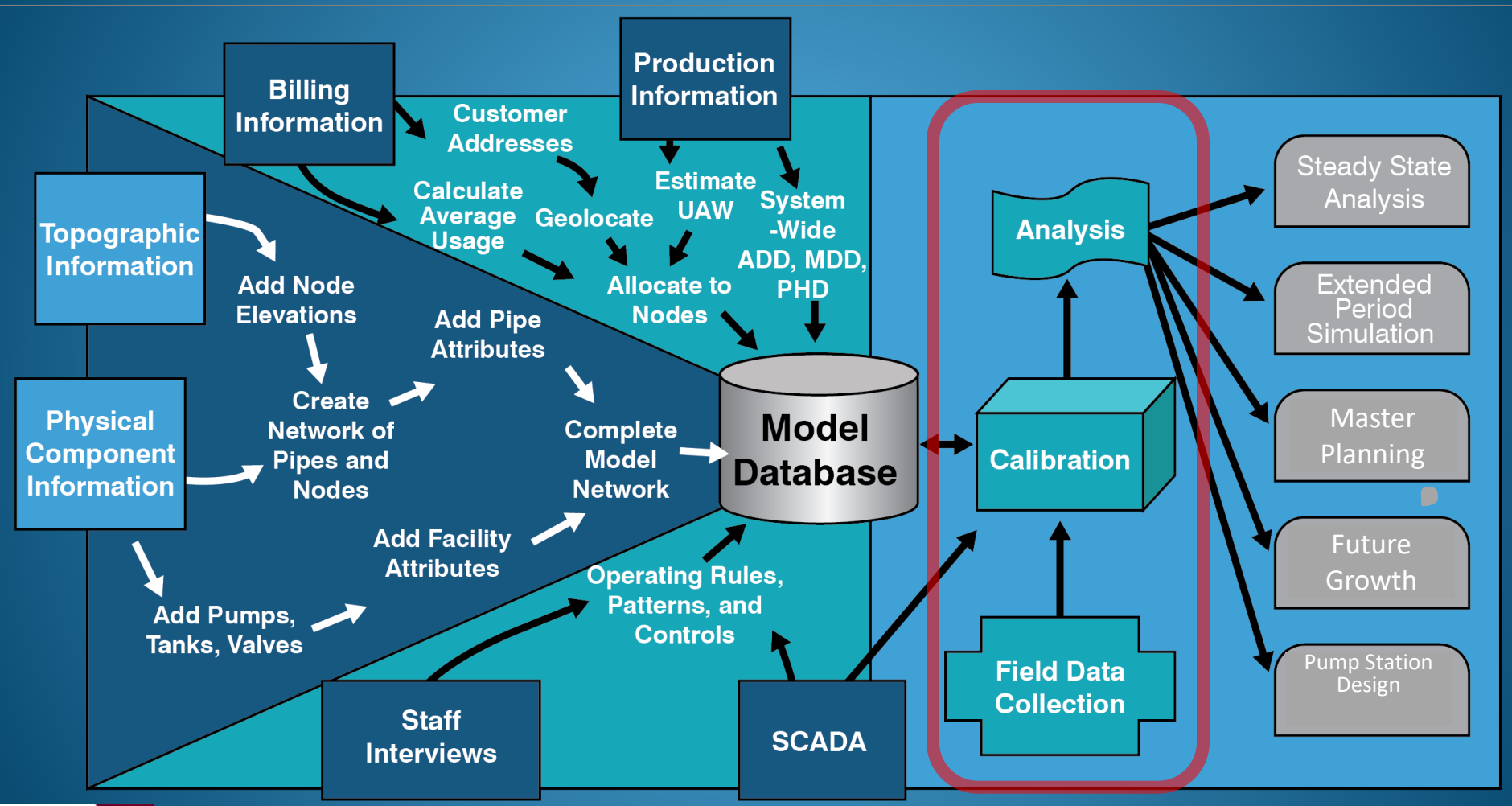
# Development of the Huntsville Model

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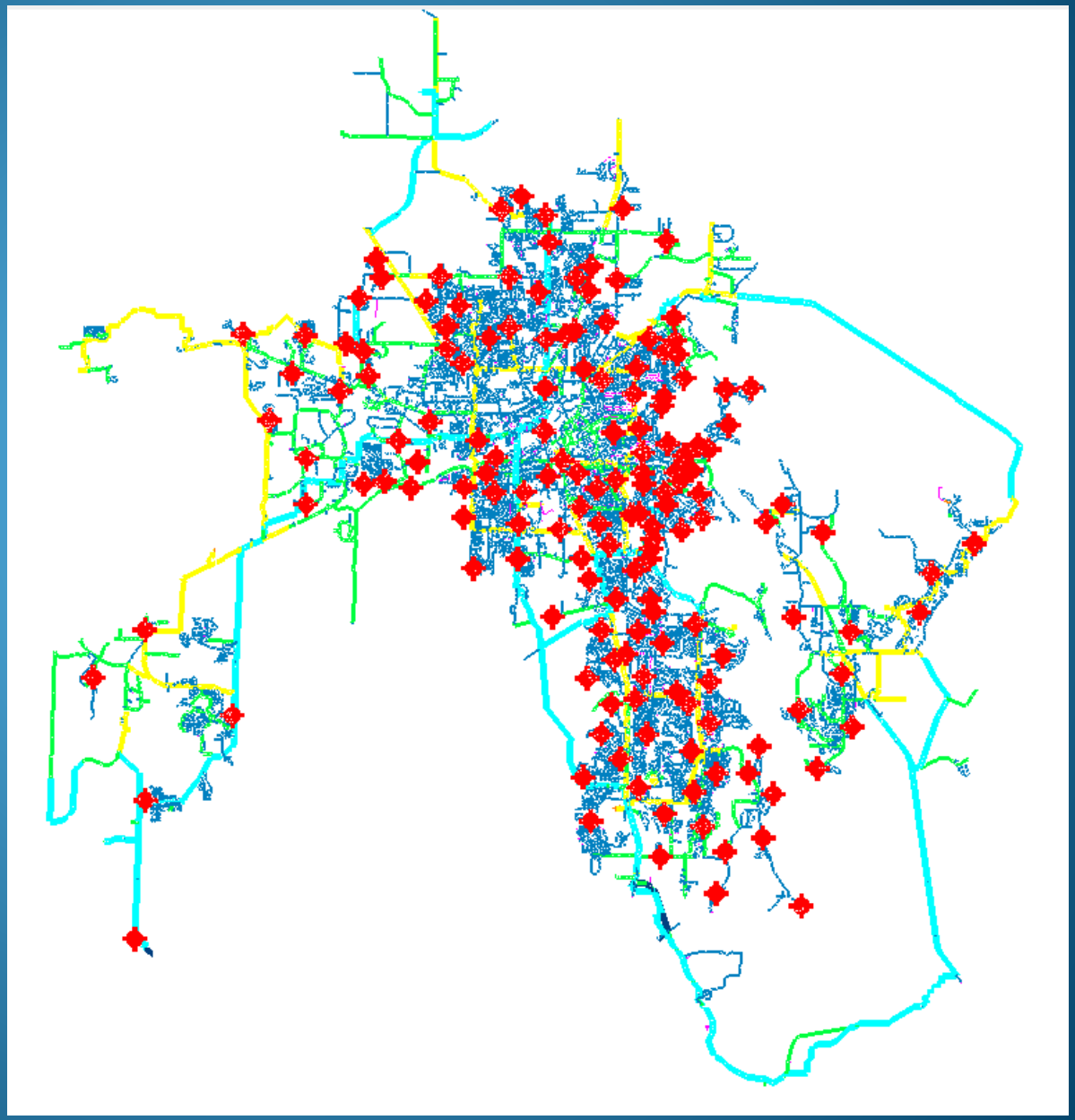
# Calibration Locations

158 Total Calibration Points



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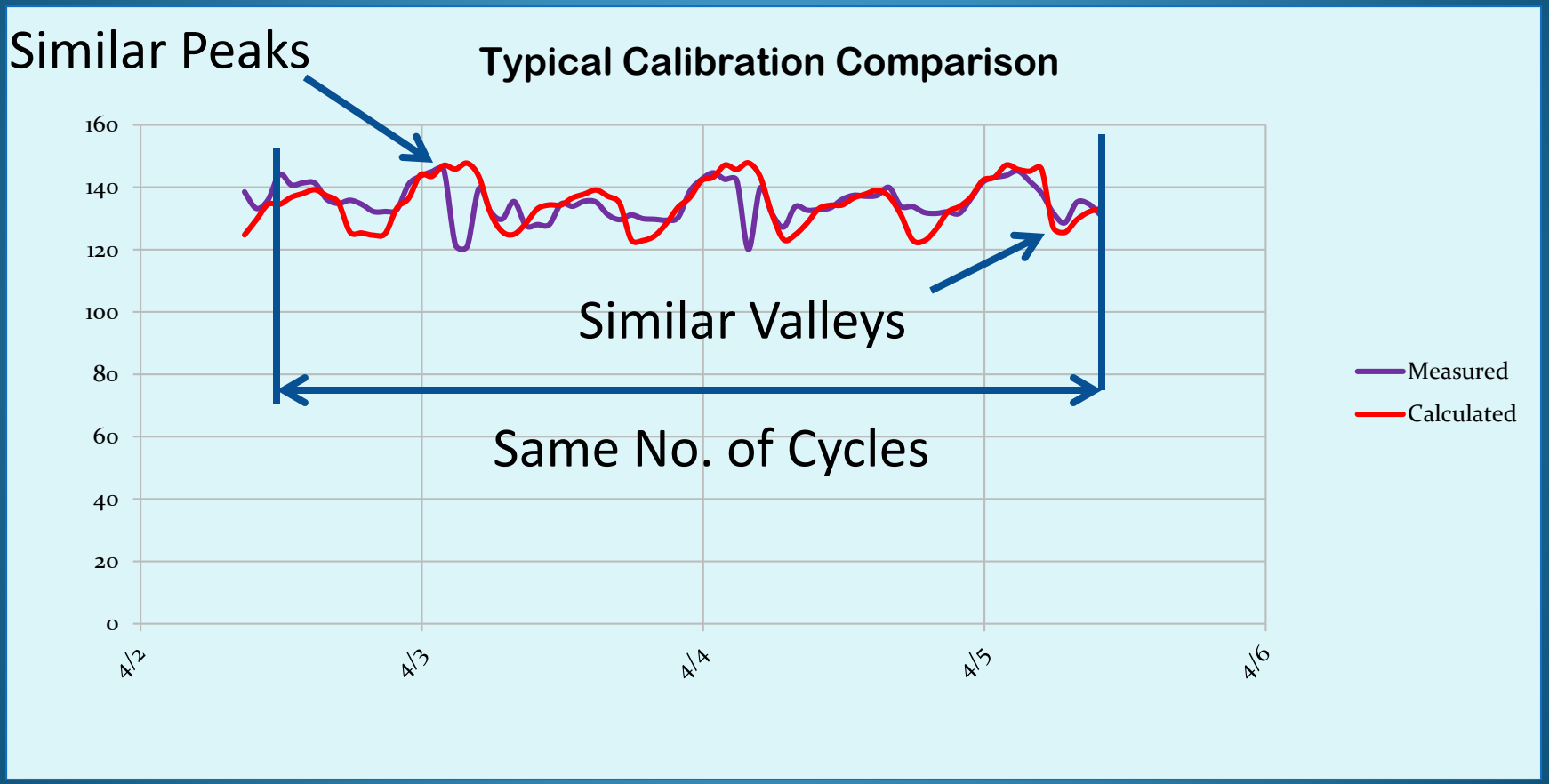
# Calibration-Comparison




| | Min (psi) | Max (psi) | Ave (psi) |
|---|---|---|---|
| Measured Data: | 120 | 146 | 135 |
| Calculated Data: | 123 | 148 | 135 |

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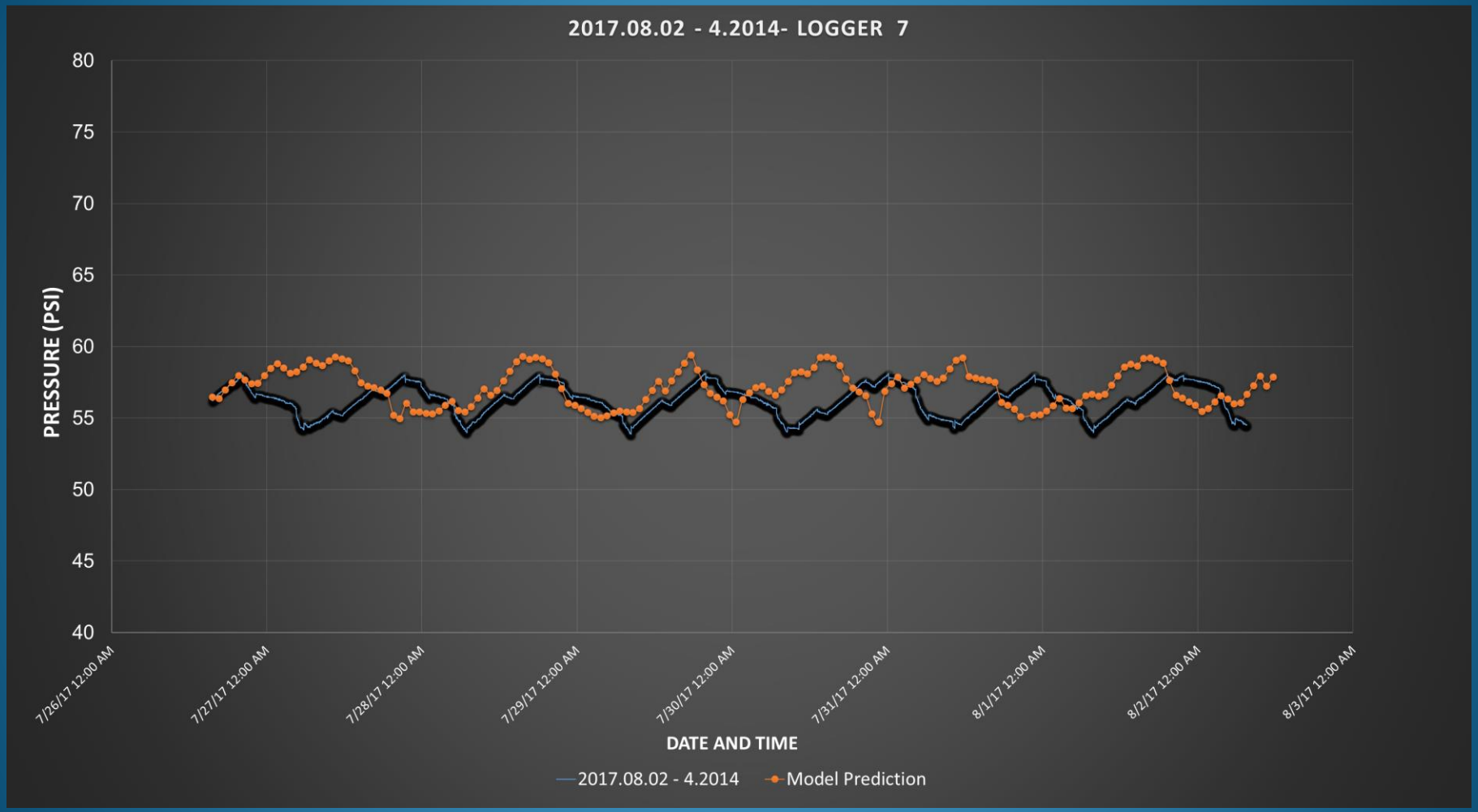
# Calibration-Actual Data vs Predicted

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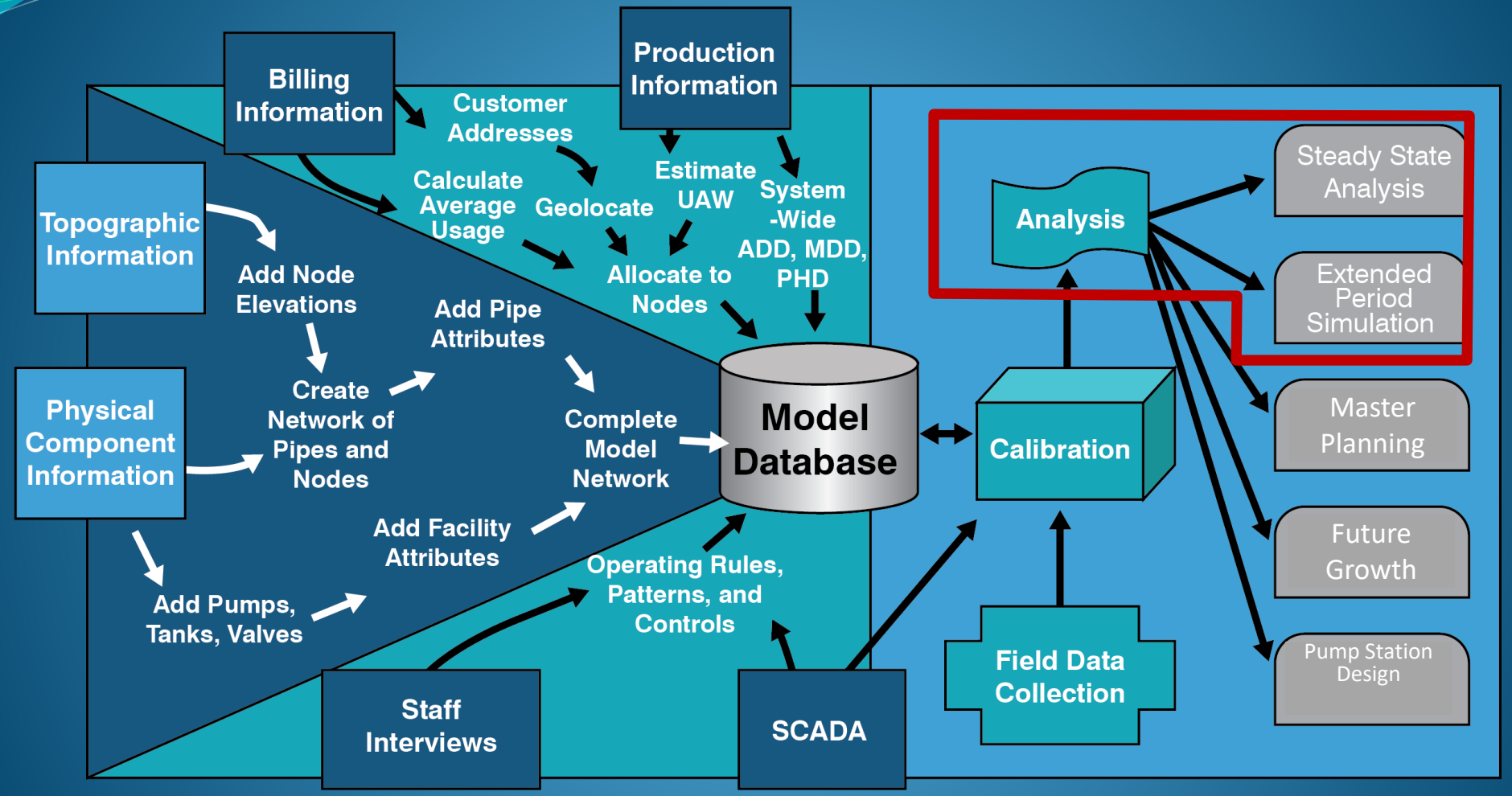
# Analysis: Steady State vs ESP

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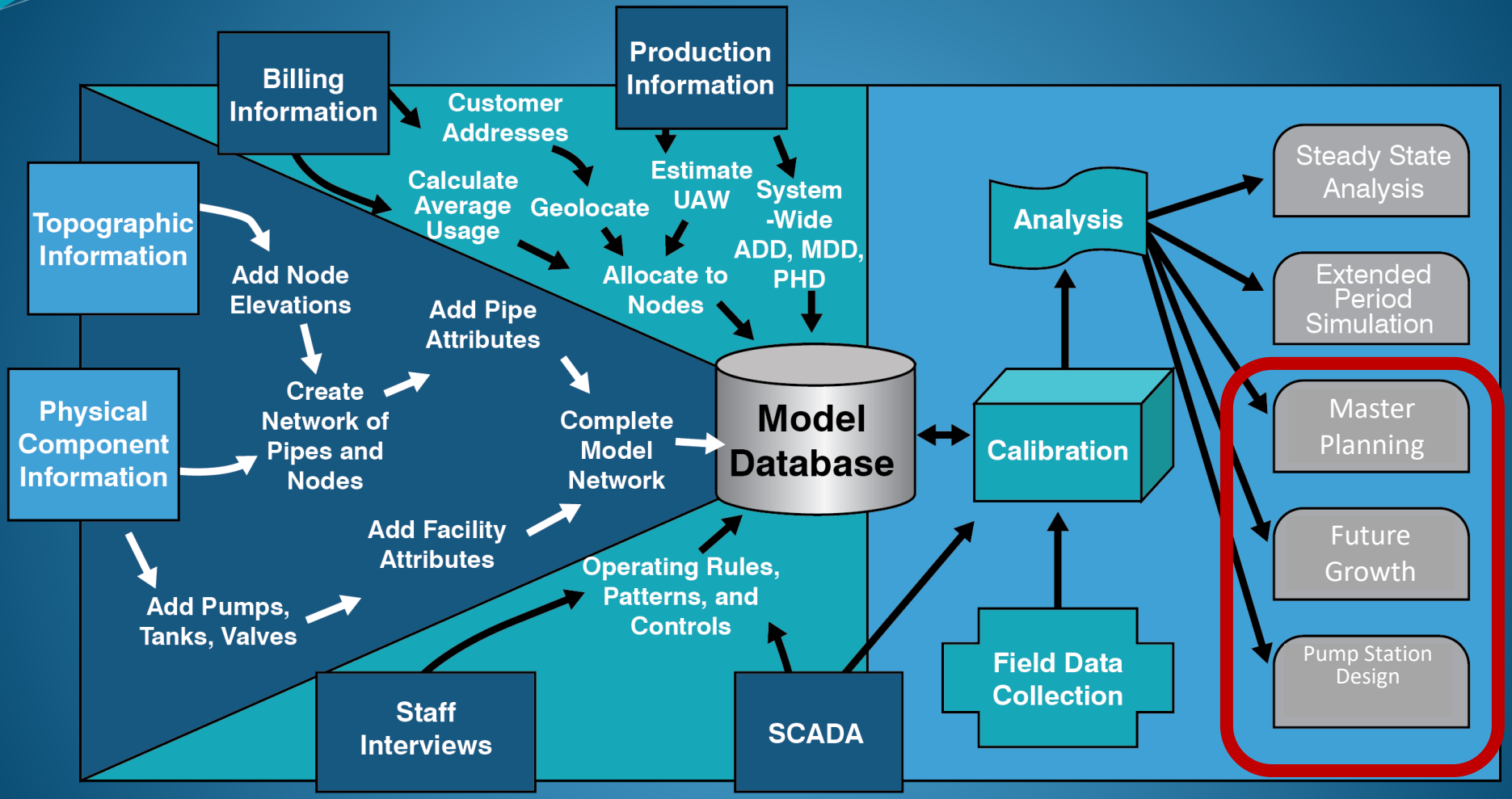
# Development of the Huntsville Model

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# Four Principal Uses of the Model

- Capital Planning
- Design
- System Operation
- Water Quality Optimization

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# Capital Planning

- Tool to Analyze the "What If" Scenarios
  - What if demand increases?
  - What if the service area changes?
  - What if a wholesale customer needs additional water?
  - What if there are regulatory changes?
- Assist with Capital Project Planning and Prioritization

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# Key Capital Planning Projects:

- Liberty Hill Pump Station (Facebook)
- Greenbriar Service Area Expansion (Mazda Toyota and Other TNTM)

# Design

- Resource for supporting calculations
- Alternatives Development allows for the creation of various Scenarios
    - Generate results for multiple scenarios at once, "Batch Runs"
- Model output is both graphical and tabular, which helps with documenting results and coordination
    - "Flex Tables" are a customizable quick tool for comparing data sets and creating reports
- **Most importantly**, helps ensure the best alternative is selected and yields successful projects

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# Key Design Successes:

- Bailey Cove Piping Improvements (Properly Sized Transmission Main)
- Cecil Ashburn Upgrades (Pump Station Design and Properly Sized Transmission Main)
- Green Mountain Upgrades (Tank Sizing Analysis, Pump Station Design)

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# System Operation

- Energy Conservation: Pump station optimization and efficiency
- Pressure Zone Boundary Changes
  - Model can add pressure contours and color coding to pipe features for useful visuals
- Tank Sizing and Operation
- Optimize Flushing for Water Quality
- Fire Flow Capacity
- Emergency Scenarios: Line Breaks, Booster Station Outages, and Temporary Needs

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# Notable Successes for System Operation:

- Identify areas of low and high pressure
- Provided recommendations for fire flow improvement within certain areas
- Recommendations for pump station operation within Cummings Research Park West and Mid-City Development
- Recommendations for Improvements to North Huntsville Industrial Park Area

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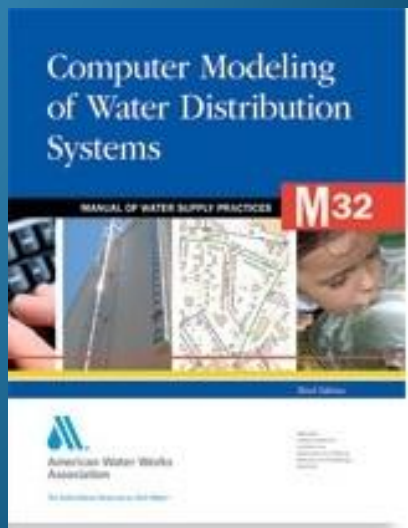
References and Credits:

- Huntsville Utilities:
  - Glen Partlow, PE (Huntsville Utilities)
  - Tim Storey, PE (Huntsville Utilities)
  - Charlie Marlin (Huntsville Utilities)
  - Dave Carden (Huntsville Utilities)
  - The Amazing Julie Brown (Huntsville Utilities), et. al.
- Kevin Mullins, PE (Garver)
- Brian Shannon, PE (Garver)
- Evan Tromble, PhD (Garver)
- AWWA Manual M32
- Bentley

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# Questions?