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Digging Deep Into Non-Revenue Water Reduction Beyond Water Audits

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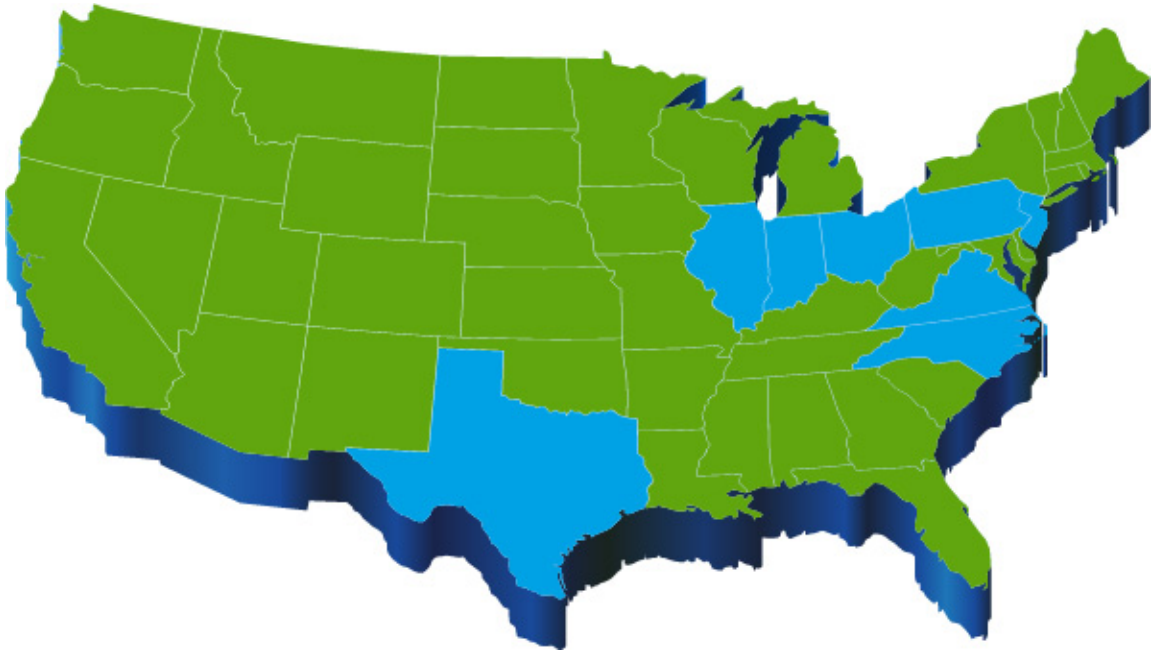
Outline

- Aqua Pennsylvania Background
- NRW Trends Evaluation
- Business Cases
    - Prioritization
    - Findings and Results
- Next Steps

Aqua Pennsylvania Background

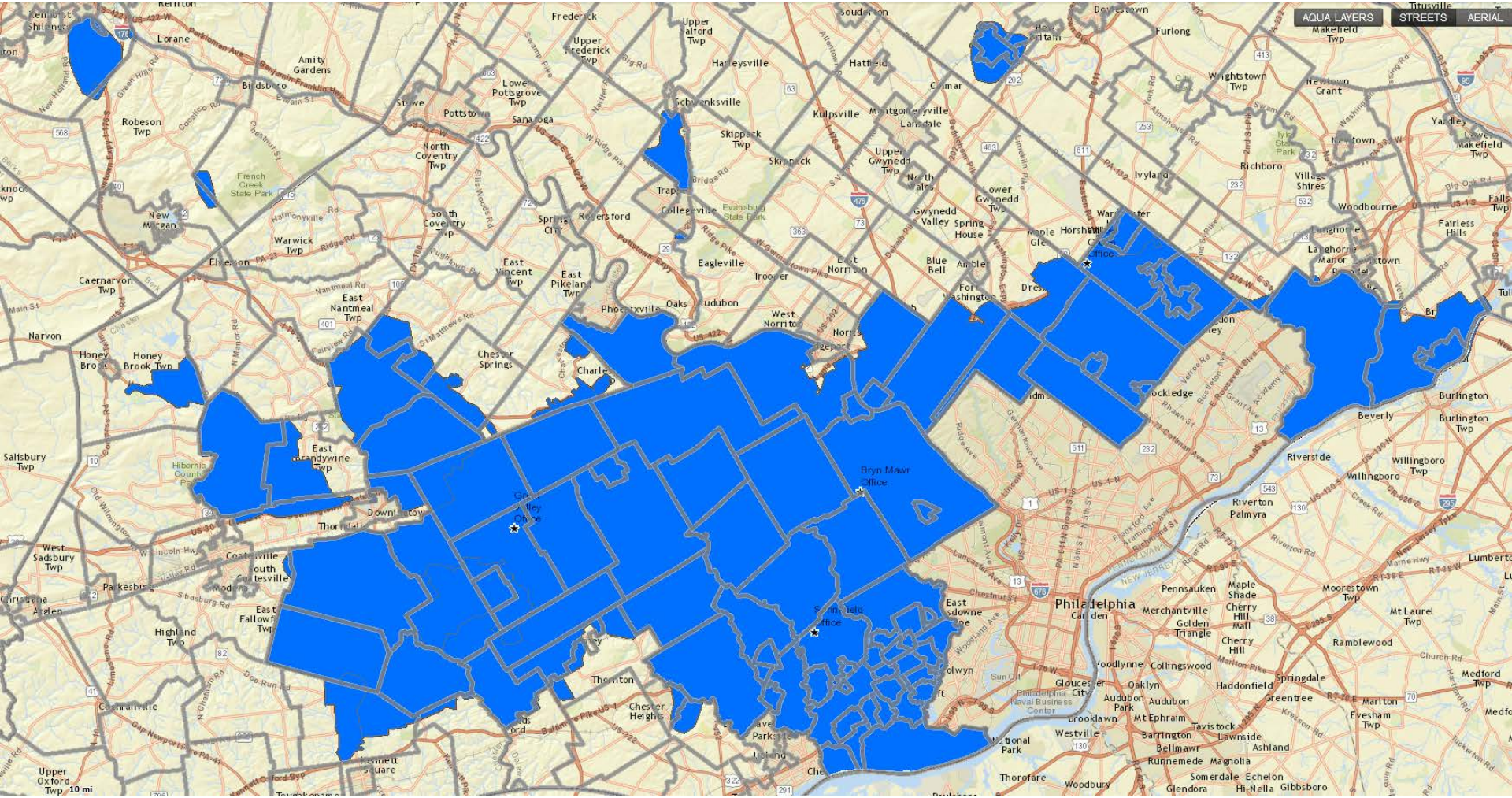
Aqua America Overview

- **Aqua America**
  - Investor owned water and wastewater utility
  - 3 million people served across 8 states
- **Aqua Pennsylvania, Inc.**
  - Largest operating company
  - Southeast PA surrounding Philadelphia and smaller systems throughout PA



Aqua PA Systems

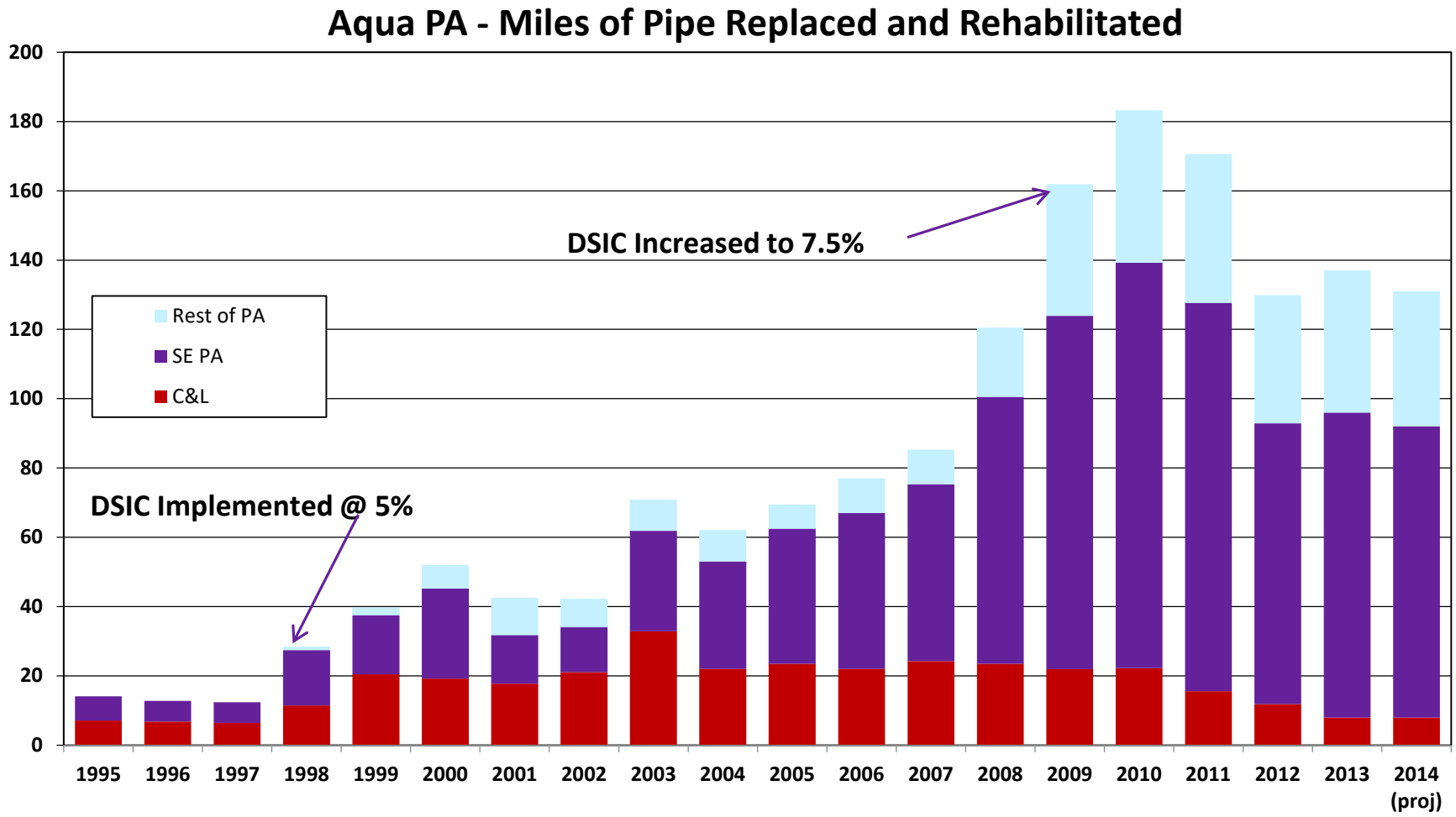
Southeast PA territory



- **5 Counties surrounding Philadelphia**
- **114 municipalities**
- **4,400 miles of pipe**
- **8 Surface Water Treatment Plants**
- **109 Wells**
- **11 Interconnections with Others**
- **Average Daily Demand = 109 MGD**

NRW Trends Evaluation

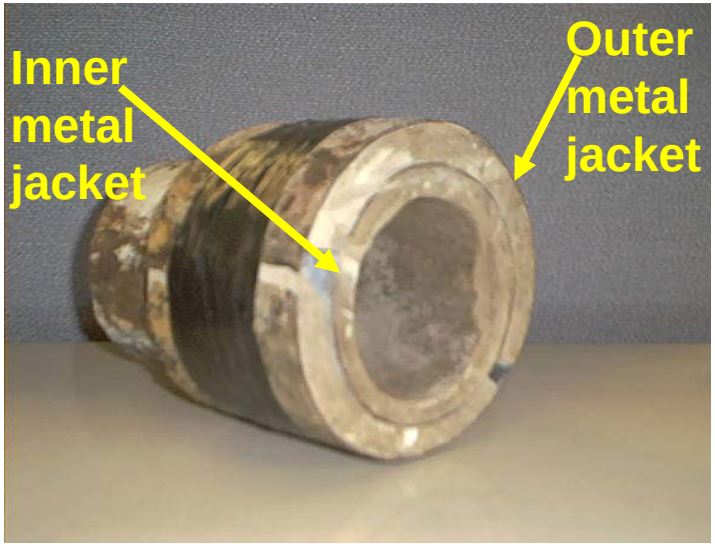
Renewal Program History



1,643 Miles (2.7%) Replaced and Rehabilitated over 20 Years

Current Renewal Rate – 2.5% of System per Year

Cement Stovepipe



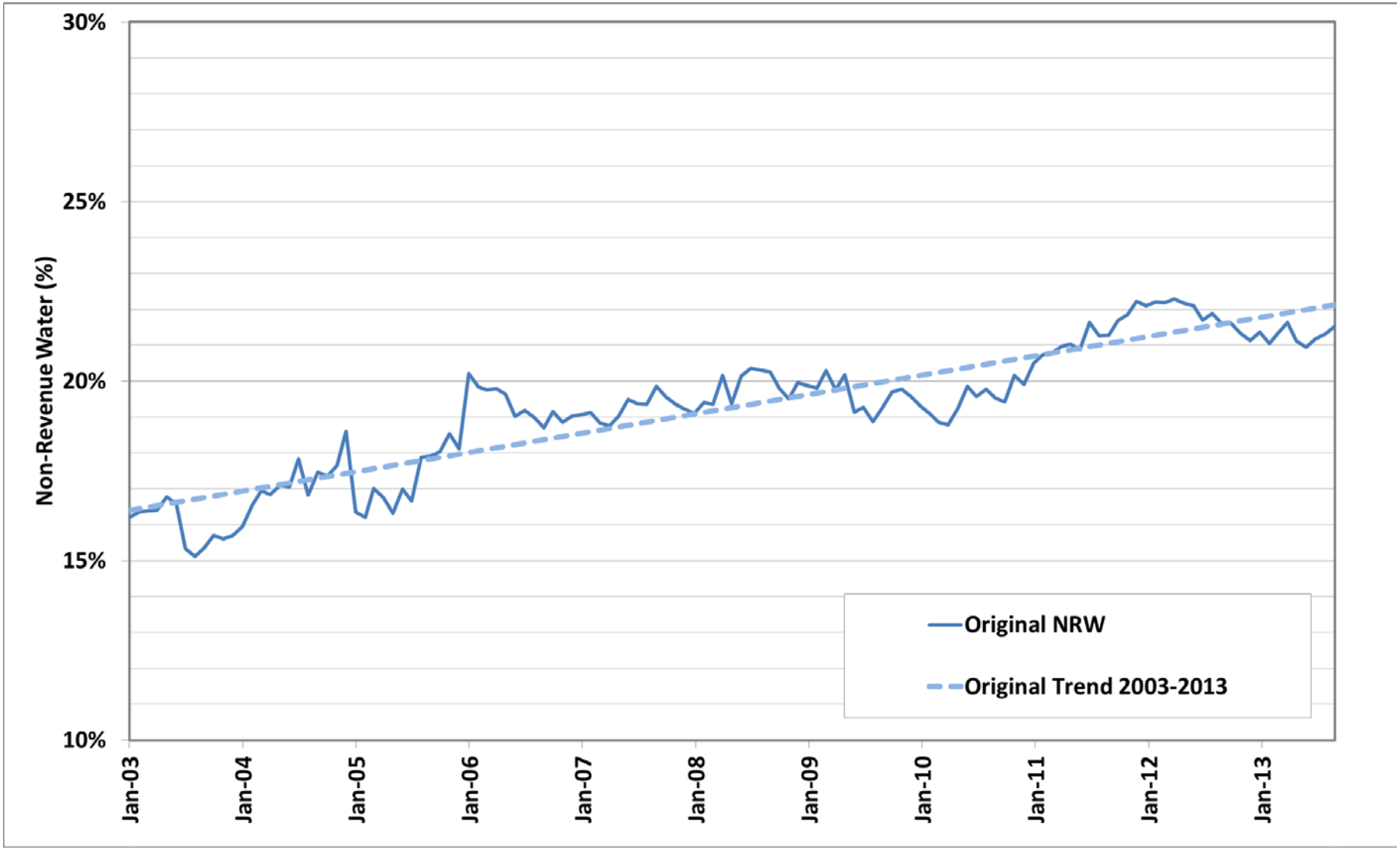
- Unique to Southeast PA
- "Sandwich" of cement materials and galvanized iron jacket
- Hundreds of miles installed pre-1920
- Highest % of main breaks and often severe
- Roughly 50 miles remain

Thin-Walled Unlined C.I.P.

- Installed in the 1930s and 1940s
- Approximately 100 miles was cleaned and lined before analysis showed pipe was problematic
- Very high break rate, especially in winter

Main Break History

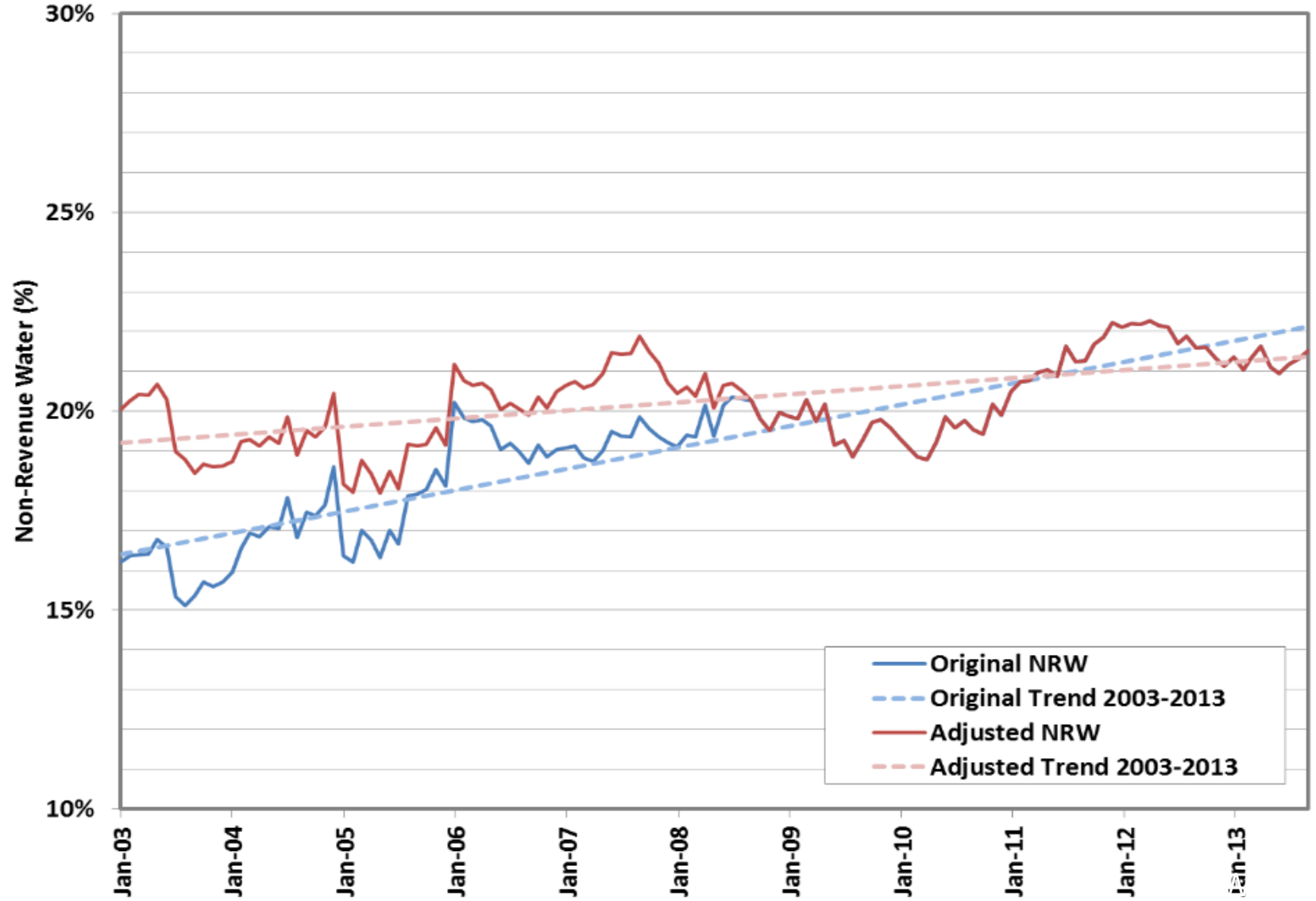
NRW Increasing Trend



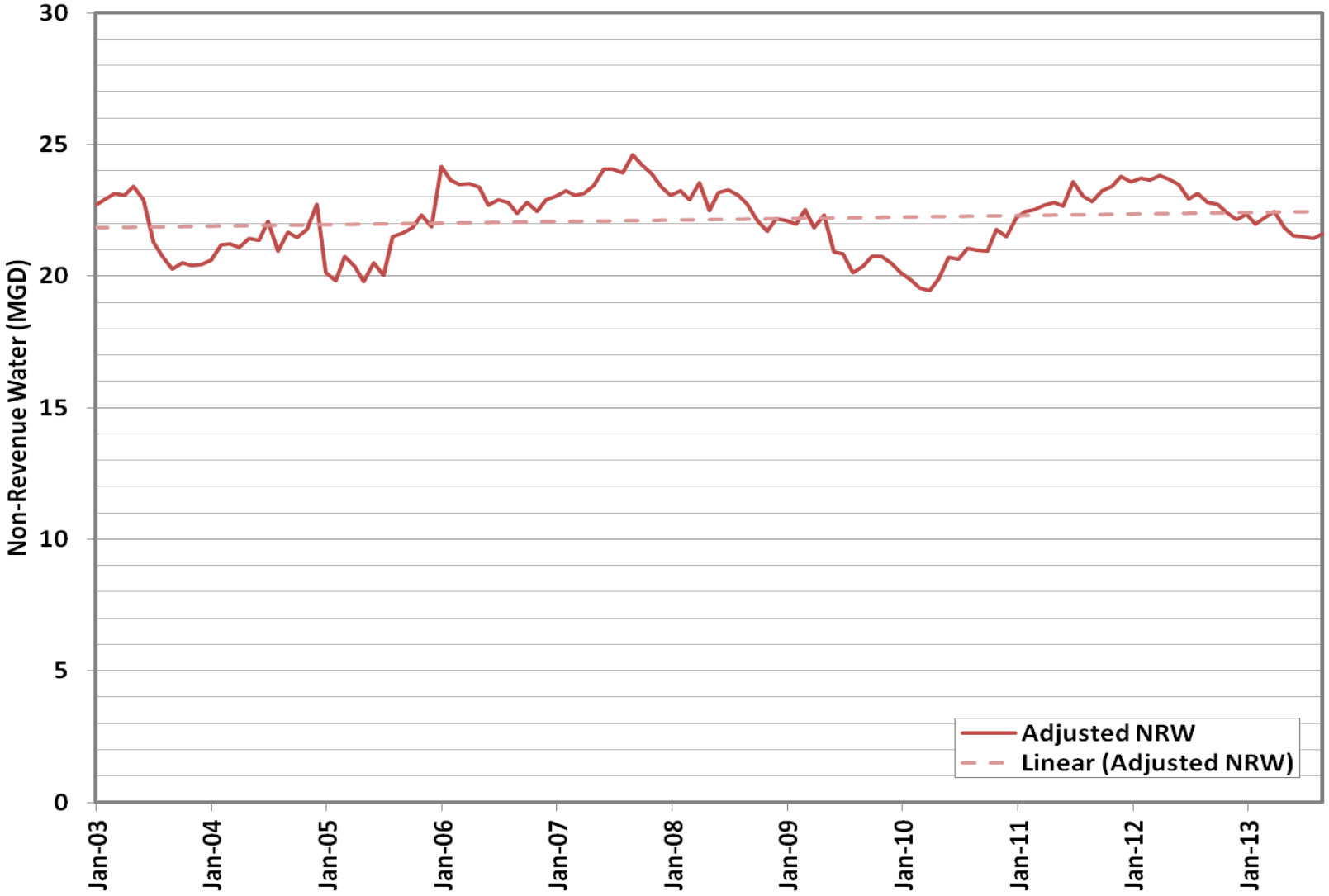
Phase 1 NRW Investigations

- Data Reliability
  - Production sendout meter accuracy – assessment needed
- Real Losses
  - Pressure – has increased 3 psi over last 10 years
  - Service line leakage – possible source of recoverable losses
  - Breaks – going down, but ALC program assessment needed
- Apparent Losses
  - Customer meters – testing, but needs assessment
  - Theft potential – old project, needs review
  - Billing and accounting – Found errors in “historical” reporting on customer usage data

NRW Percentage Calculations Updated



Adjusted NRW by Volume



Spawning of Business Cases

- ~~Business Case 1~~: System-wide Pressure Reduction Study
- **Business Case 2: Leak Detection Form Standardization**
- **Business Case 3: Leak Detection Practices**
- ~~Business Case 4~~: Large Diameter Pipeline Condition Assessment and Leak Detection Pilot
- ~~Business Case 5~~: Tap Card Form Standardization
- **Business Case 6: Moving Customer "Meters –to-Curb" Study**
- **Business Case 7: Production Meter Calibration**
- **Business Case 8: Customer Meter Testing Standardization**
- Business Case 9: Advanced Metering Infrastructure Study
- **Business Case 10: Theft Reduction Techniques**
- **Business Case 11: AMRA to Banner Comparison**
- **Business Case 12: WTP Process Standardization**
- **Business Case 13: District Metered Area**
- **Business Case 14: NRW Calculation Standardization**

Business Cases

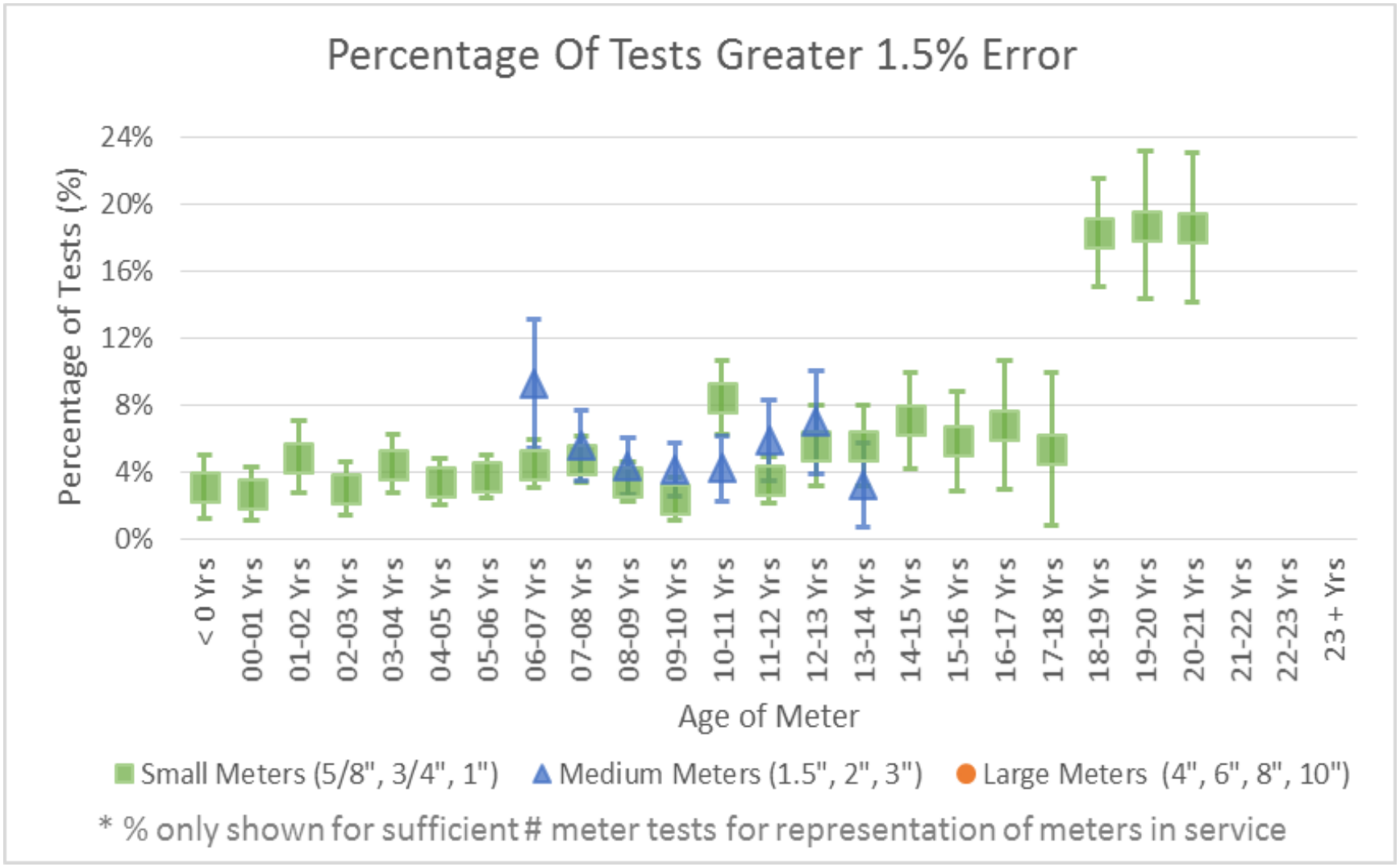
Phase 2 NRW Investigations
Business Cases Selected

- Customer Meter Testing Standardization
- Leak Detection Practice Standardization and Operations Analysis
- District Metered Area (DMA) Selection and Design Pilot
- Production Meter Accuracy Assessment
- Theft Reduction Technique Development
- Flow Monitoring for System Subzone Water Auditing

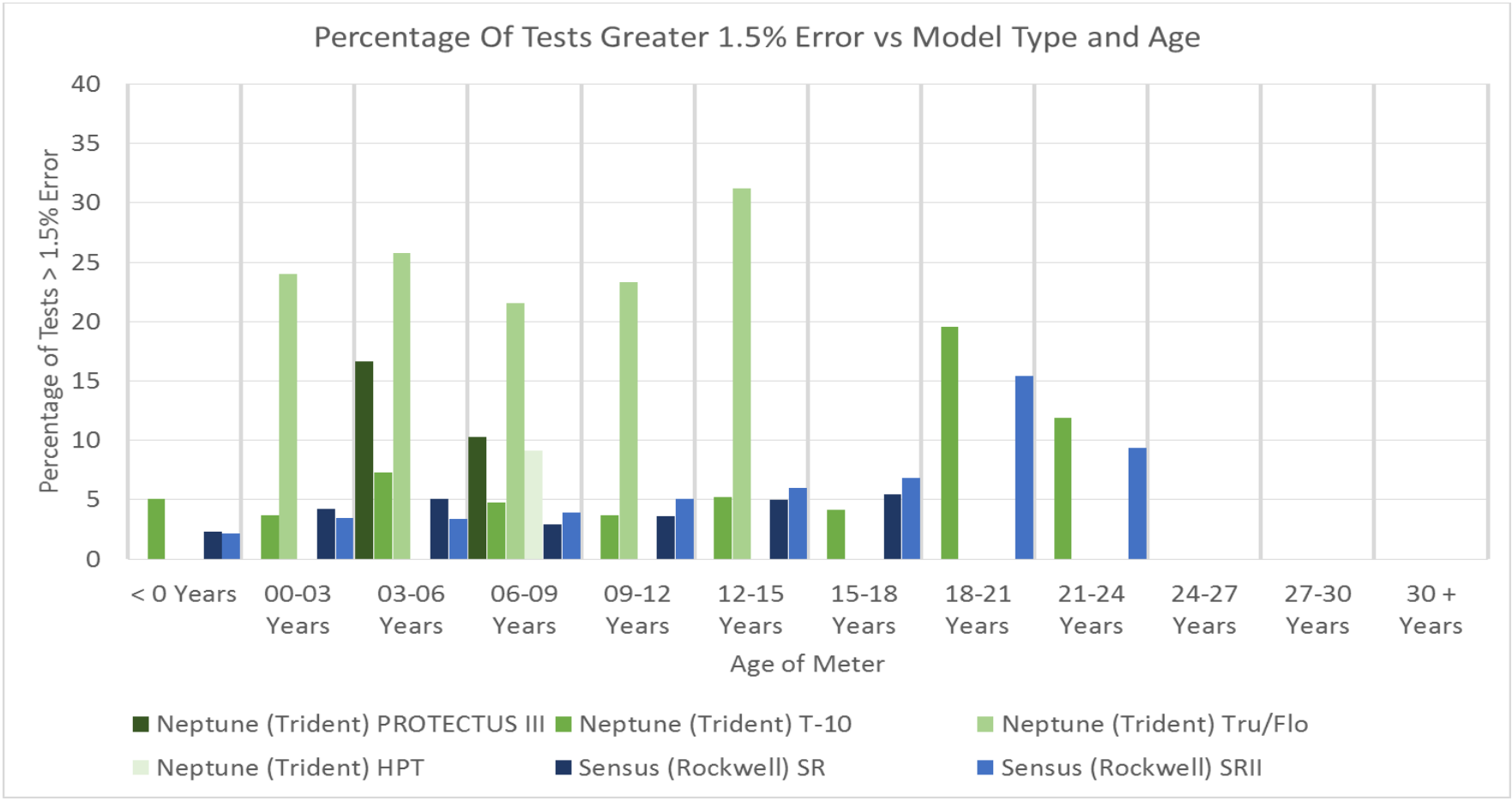
Customer Meter Testing Standardization

- Objective – review testing process and automate results analysis performed in Phase 1
- Analysis performed – Due to imminent system upgrade, review test results, evaluate current testing and replacement practices
  - 8 years of meter testing, 166,000 accuracy tests, 50,000 matched to the meter database, 15,300 individual meter accuracy metrics
  - Meter accuracy results evaluated by size, type, age
- Recommendations:
  - Additional testing is recommended for medium and large meters, across ages
  - Replacement frequency of small meters is validated by testing results.
  - Exporting capabilities from test database (currently proprietary)

Meter Test Accuracy Results



Meter Test Accuracy Results



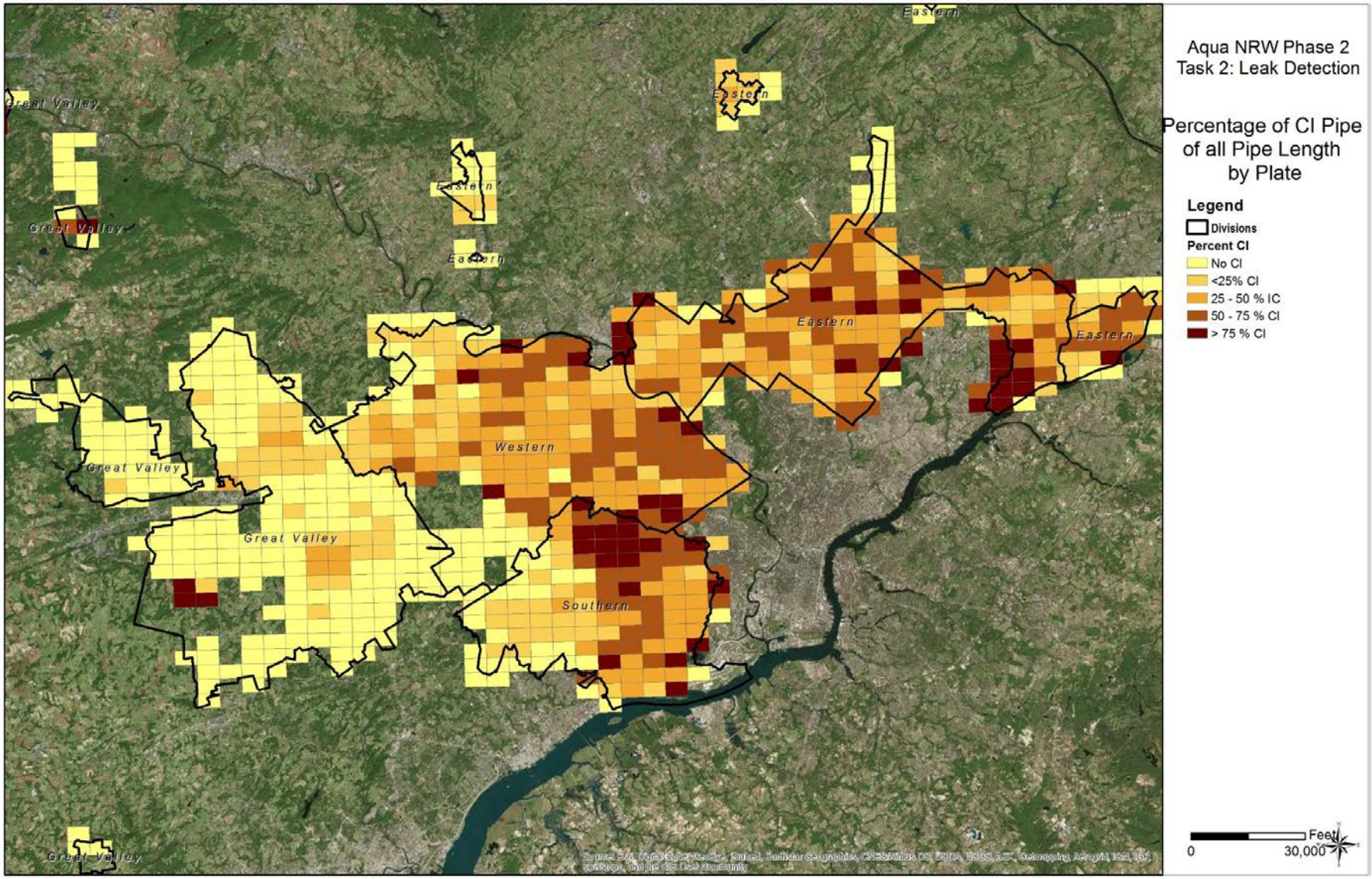
Leak Detection Practice Standardization and Operations Analysis

- Objective – review current practices and recommend improvements
- Analysis performed – interview leak detection personnel, map business process for leak detection and repair, review leak detection survey results, evaluate detected leaks for optimization
- Recommendations
  - Training from manufacturer of equipment
  - Better tracking of leaks in CMMS and GIS
  - Increase frequency of leak detection in areas of high percentage of cast iron piping and limestone soil, based on historic breaks

Risk of Leaks/Breaks by Material Type

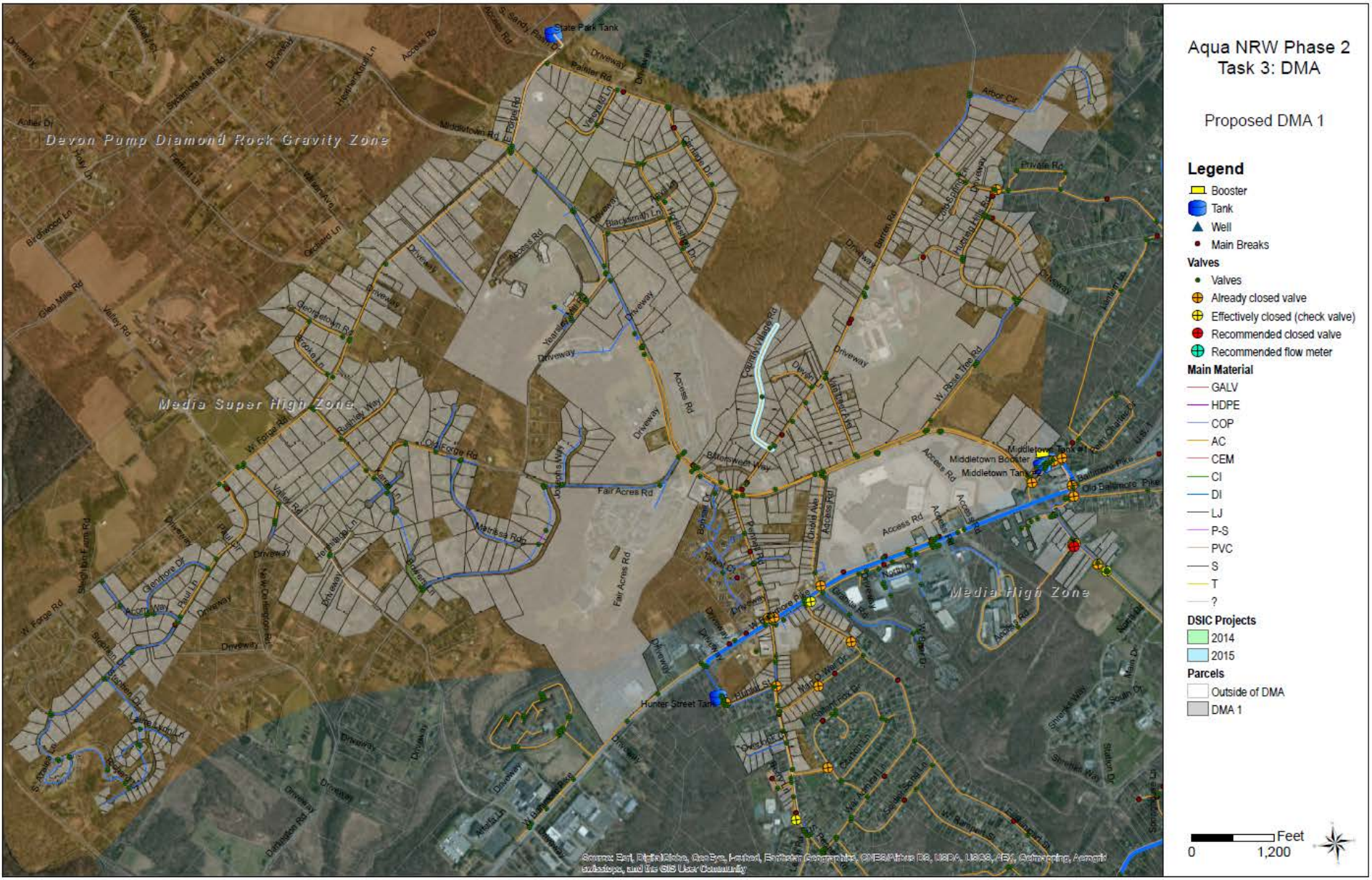
Material	Number of Leak/Break Events	Percentage of Events	Leak/Break Rate (per Mile of adjusted length)	Mileage as Percent of Current System	Risk of Leak/Break as Percentage of System Events
Cast Iron	13,707	63%	6.1	36%	65%
Ductile Iron	1,197	5%	0.9	52%	14%
Asbestos Cement	1,538	7%	4.2	7%	9%
Cement Stovepipe	4,562	21%	21.8	1%	8%
Other/Unknown	927	4%	3.5	4%	4%

Map of Areas of Cast Iron Pipe



District Metered Area (DMA) Selection and Design Pilot

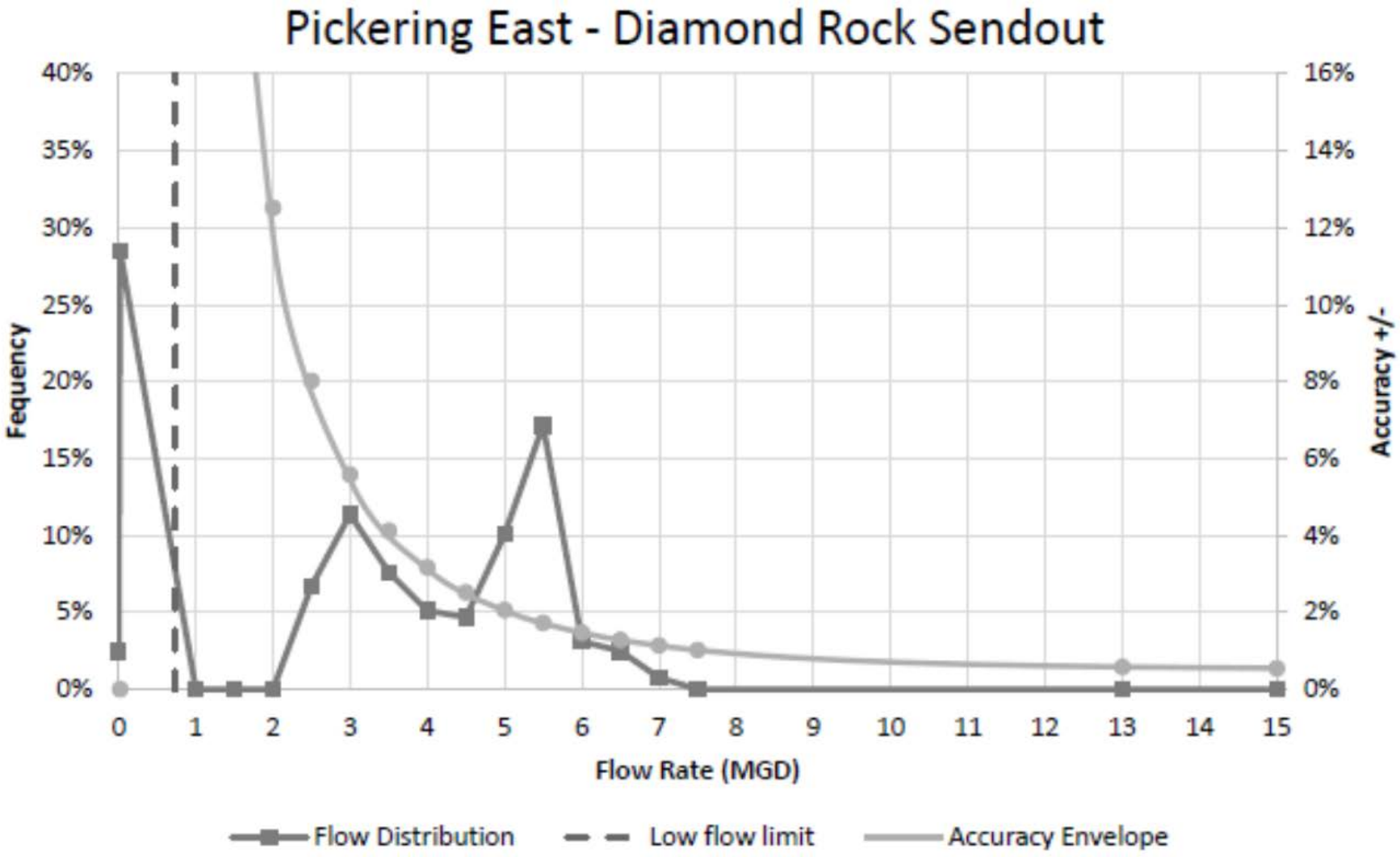
- Objective – review potential locations to implement DMAs and recommend process to implement
- Analysis performed – study 12 potential candidate locations, prioritize them based on ease of implementation, potential value from observations to be extrapolated
- Recommendations
  - Top two DMA candidates identified
  - Specific procedures outlined to implement, monitor, evaluate DMA

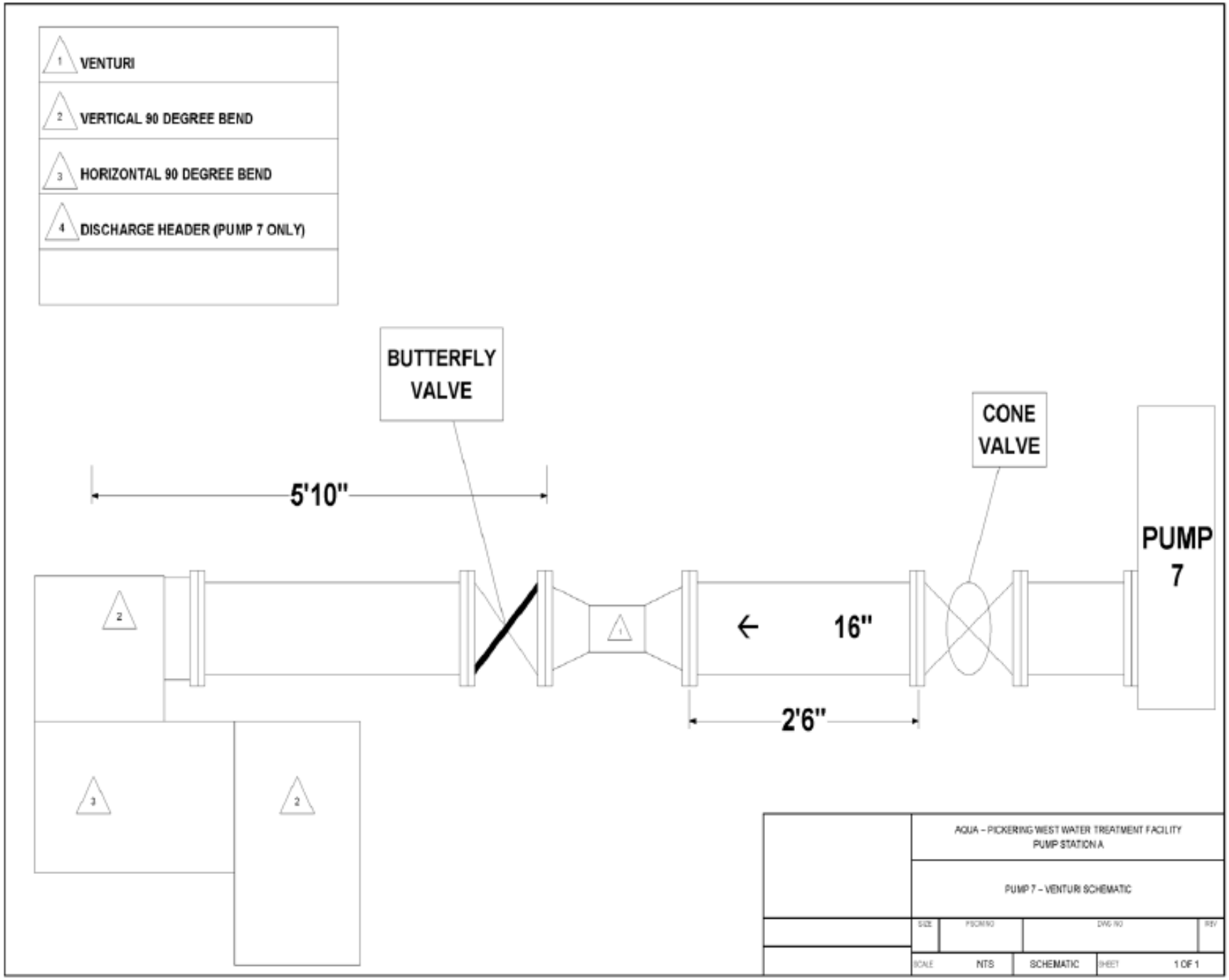

Aqua NRW Phase 2
Task 3: DMA
Proposed DMA 1
Legend
Booster
Tank
Well
Main Breaks
Valves
Valves
Already closed valve
Effectively closed (check valve)
Recommended closed valve
Recommended flow meter
Main Material
GALV
HDPE
COP
AC
CEM
CI
DI
LJ
P-S
PVC
S
T
?
DSIC Projects
2014
2015
Parcels
Outside of DMA
DMA 1
Devon Pump Diamond Rock Gravity Zone
Media Super High Zone
Media High Zone
State Park Tank
Middletown Booster
Middletown Tank #2
Hunter Street Tank
Feet
0
1,200

Production Meter Accuracy Assessment

- Objective – Review design and installation details for all production sendout meters to calculate potential uncertainty volumes and prioritize testing and repair (all venturi meters)
- Analysis performed – review accuracy of each component of flow meter system: primary element, secondary device, and installation conditions, calculate uncertainty volumes based on historical flows. Ranged from 0.5% to 3.7% with a total uncertainty volume of 350 million gallons annually
- Recommendations
  - Improvements to 11 of 23 meter systems (some with multiple improvements), prioritized by uncertainty volume
    - Low flow cutoff
    - Modify calibrated span
    - Upgrade DPT with upgraded technology (improved accuracy)
    - Relocate flow meter to improve flow conditions
    - Replace flow meter

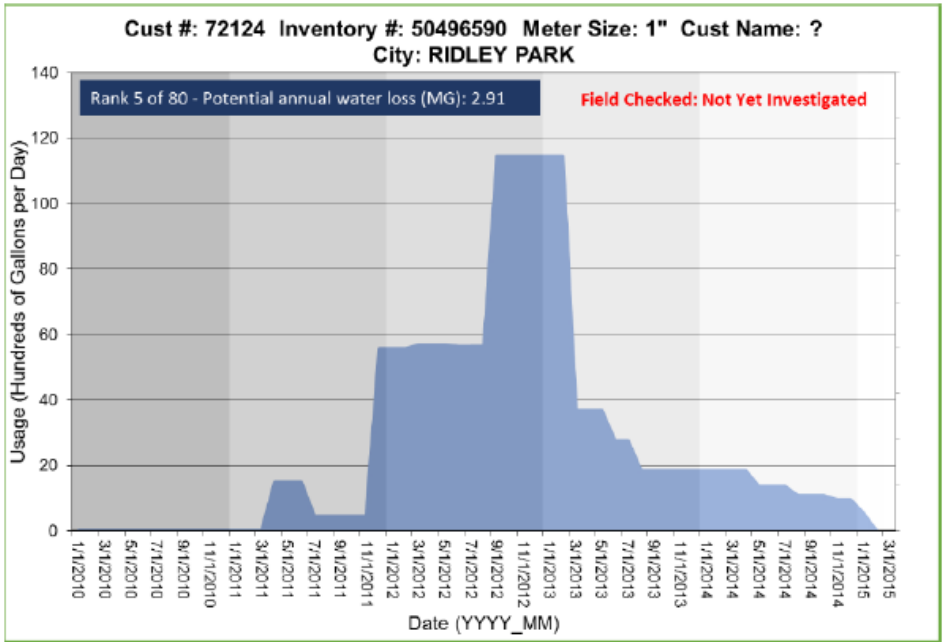
Uncertainty volume evaluation

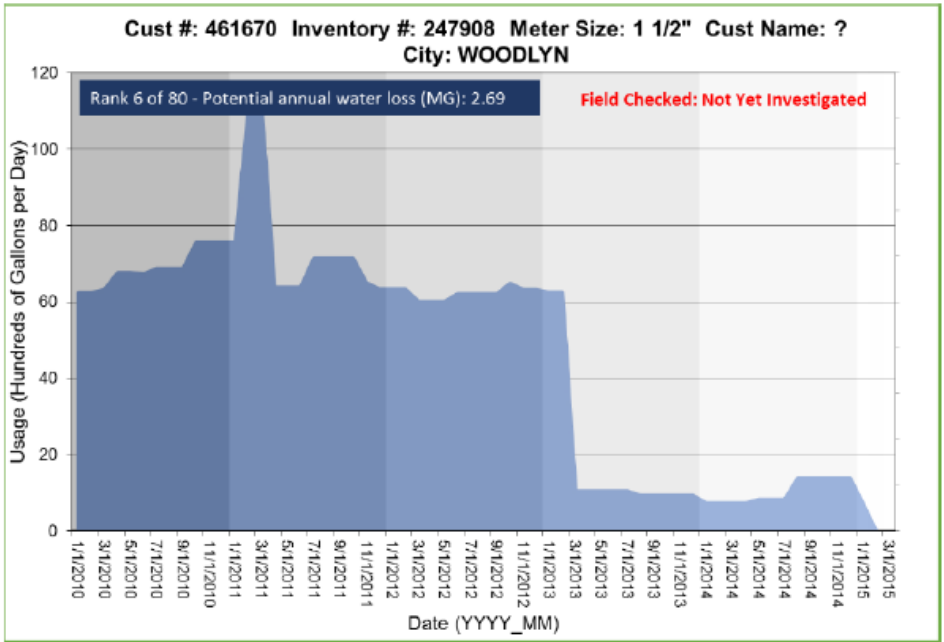


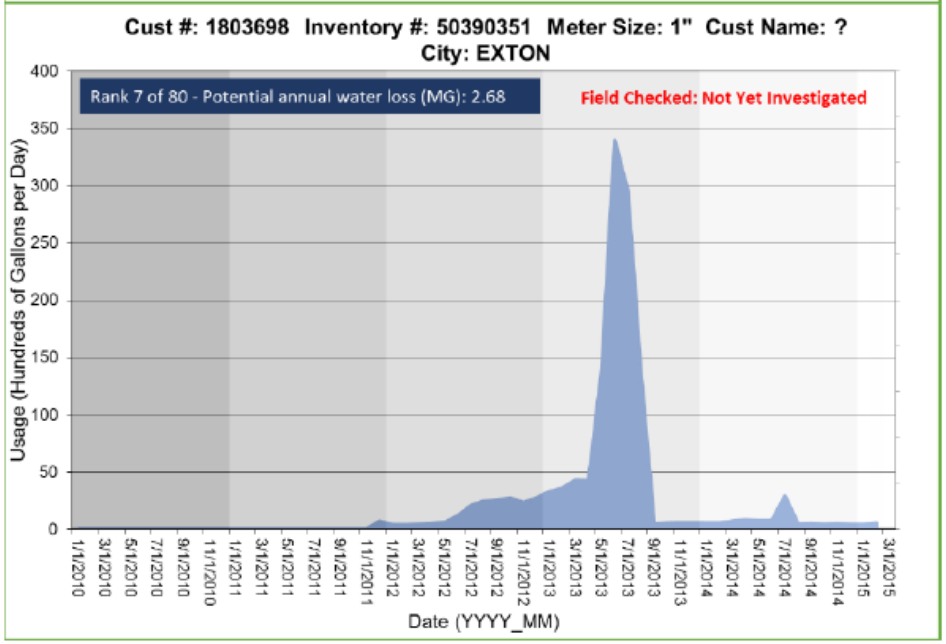

1 VENTURI
2 VERTICAL 90 DEGREE BEND
3 HORIZONTAL 90 DEGREE BEND
4 DISCHARGE HEADER (PUMP 7 ONLY)
BUTTERFLY VALVE
CONE VALVE
PUMP 7
5'10"
16"
2'6"
AQUA – PICKERING WEST WATER TREATMENT FACILITY
PUMP STATION A
PUMP 7 – VENTURI SCHEMATIC
SIZE
P&ID NO
DWG NO
REV
SCALE
NTS
SCHEMATIC
SHEET
1 OF 1

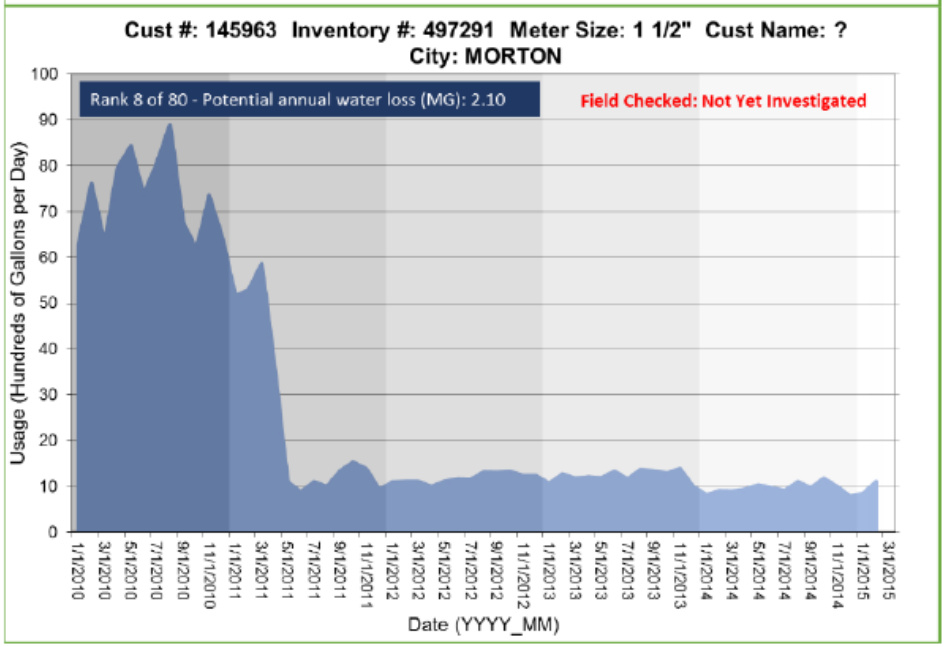
Theft Reduction Technique Development

- Objective – review previously developed algorithm to detect irregular customer usage for theft or deteriorating meter accuracy
- Analysis performed – Developed an algorithm to detect irregular usage activity, beyond normal exception reports in billing system.
- Recommendations
  - Field investigation of 110 customer accounts out of ~350,000 records, with a potential of $960,000 in recoverable revenue
  - Run the meter readings through algorithm annually or semi-annually


Cust #: 72124 Inventory #: 50496590 Meter Size: 1" Cust Name: ?
City: RIDLEY PARK
Rank 5 of 80 - Potential annual water loss (MG): 2.91
Field Checked: Not Yet Investigated
Usage (Hundreds of Gallons per Day)
Date (YYYY_MM)


Cust #: 461670 Inventory #: 247908 Meter Size: 1 1/2" Cust Name: ?
City: WOODLYN
Rank 6 of 80 - Potential annual water loss (MG): 2.69
Field Checked: Not Yet Investigated
Usage (Hundreds of Gallons per Day)
Date (YYYY_MM)


Cust #: 1803698 Inventory #: 50390351 Meter Size: 1" Cust Name: ?
City: EXTON
Rank 7 of 80 - Potential annual water loss (MG): 2.68
Field Checked: Not Yet Investigated
Usage (Hundreds of Gallons per Day)
Date (YYYY_MM)


Cust #: 145963 Inventory #: 497291 Meter Size: 1 1/2" Cust Name: ?
City: MORTON
Rank 8 of 80 - Potential annual water loss (MG): 2.10
Field Checked: Not Yet Investigated
Usage (Hundreds of Gallons per Day)
Date (YYYY_MM)

Flow Monitoring for System Subzone Water Auditing

- Objective – assist with selection and installation of permanent flow meter to create subzone within main system for period water loss auditing on smaller regions
- Analysis performed – recommended and procured insertion electromagnetic flow meter: bidirectional, DC powered and battery backup. Installed and verified flow with secondary temporary flow meter,.
- Recommendations
  - Connect meter to SCADA
  - Develop routines/frequency to calculate zonal water loss analysis

Next Steps

Next Steps

- Continue business case implementation
- Track progress and compare audits
- Share case studies with other Aqua systems (auditing, water loss reduction)

Thank You

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