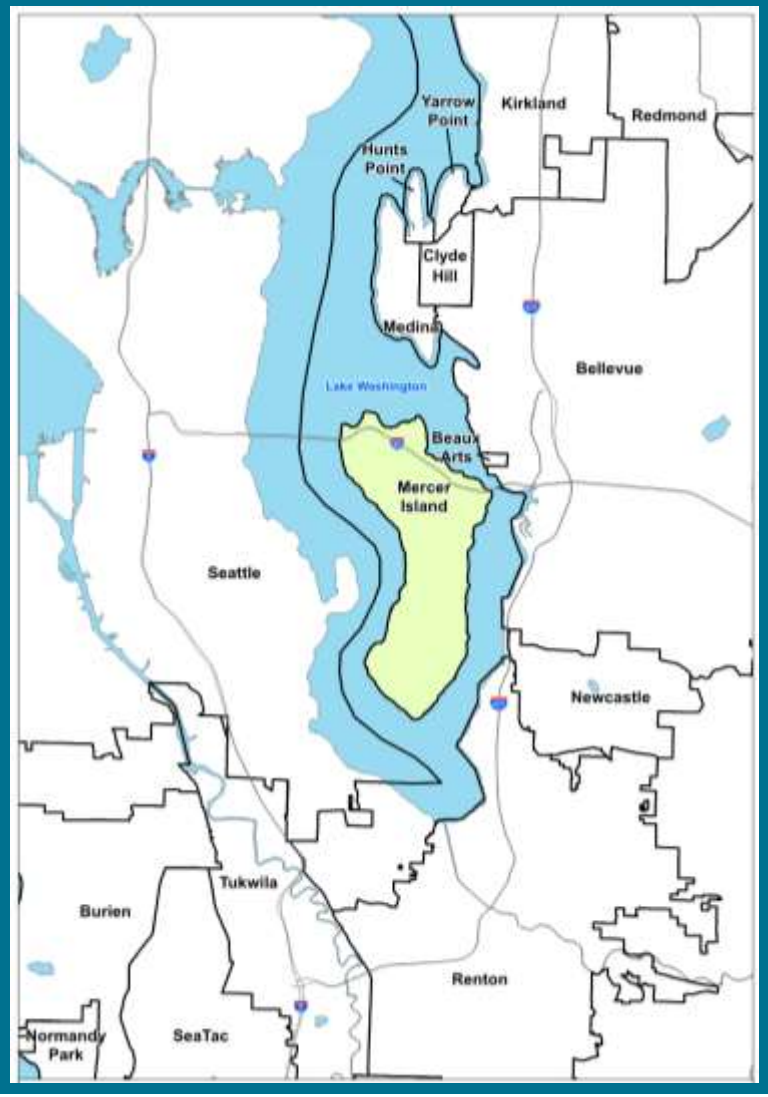

Using Water Quality Risk Management to Support Capital Improvement Planning: Mercer Island Case Study

Anne Tonella-Howe, PE
Assistant City Engineer
City of Mercer Island

Alex Mofidi, PE
Confluence Engineering

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10 Years 2008 - 2018

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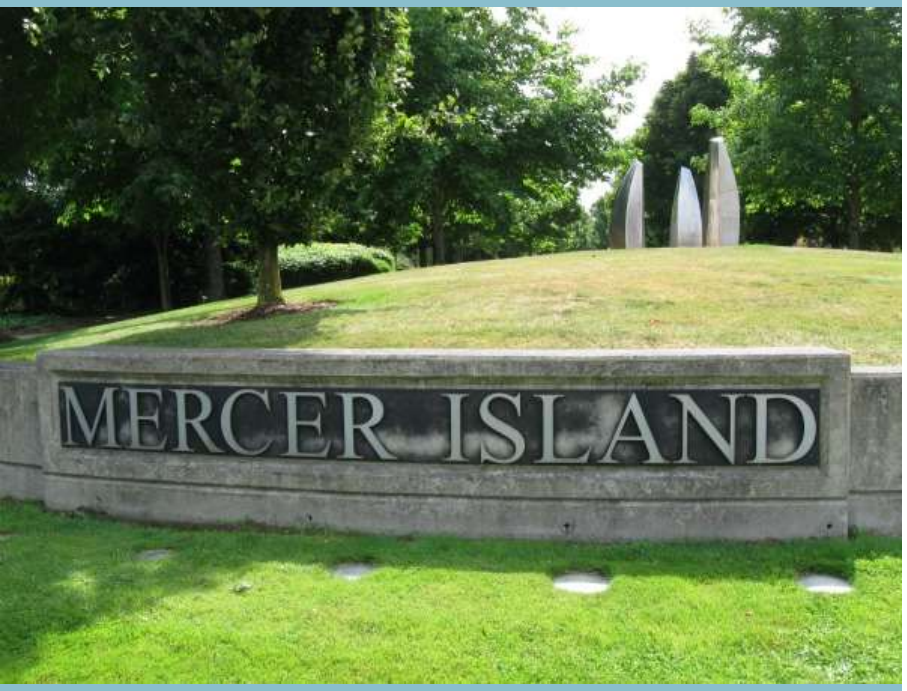
Just Add Water
2018 TACOMA PNWS-AWWA

2018 PNWS-AWWA Annual Conference
Tacoma, Washington



Using Water Quality Risk Management to Support Capital Improvements Planning: Mercer Island Case Study

Additional Acknowledgements:

Mike Helten
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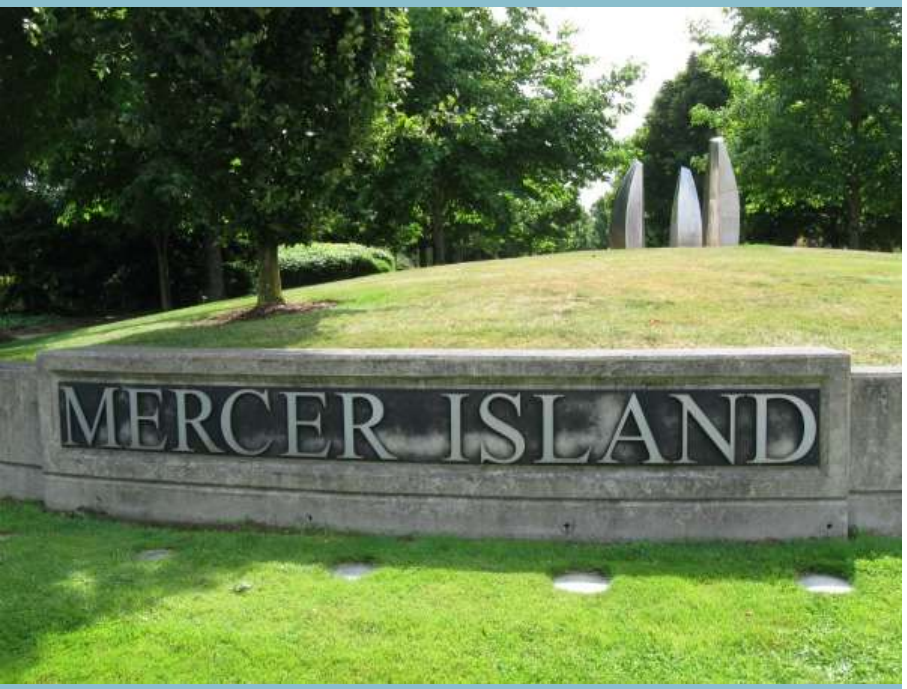
Brian McDaniel

Melinda Friedman
Andrew Hill
Michael Hallett
Amie Hanson



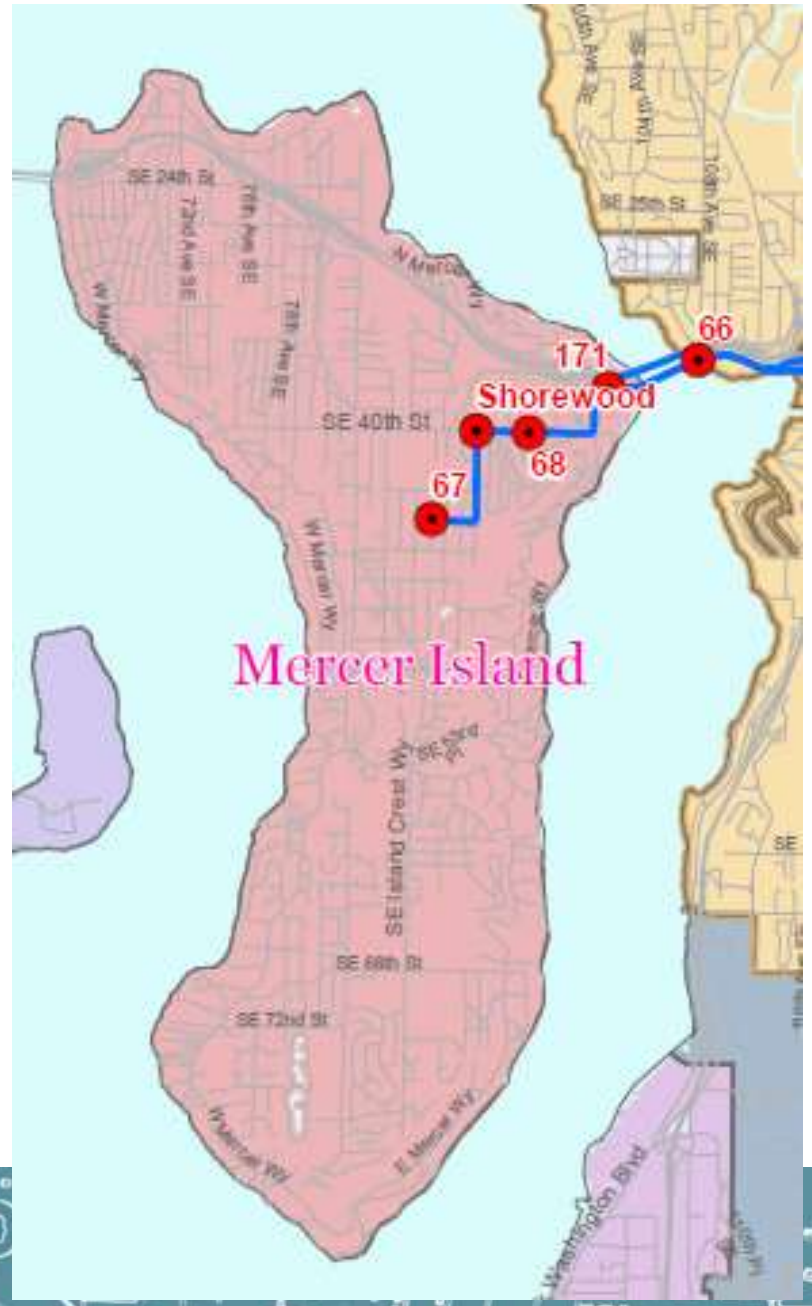
1 Introduction and Project Background

2 Updating the City CIP Program

3 Water Quality CIP Concepts & Integration Findings

4 Results & Next Steps

1 Introduction and Project Background



Mercer Island

- Southern portion of Lake Washington
- 6.3 square miles with a population of 22,700
- Water System
  - Seattle Public Utilities (SPU) wholesale customer
  - Supply can be Tolt or Cedar water or blend
  - Three service connections

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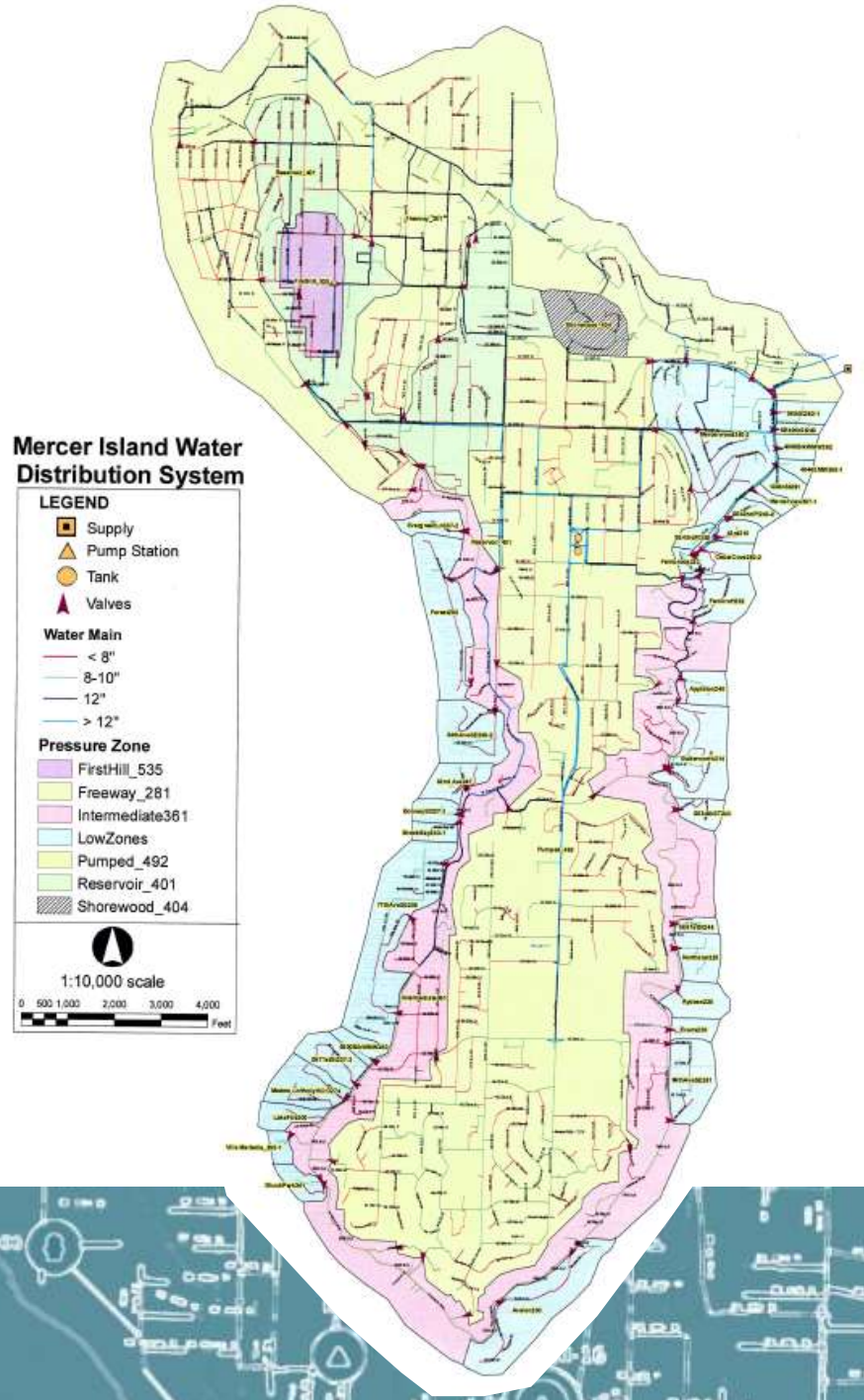

Mercer Island

- Southern portion of Lake Washington
- 6.3 square miles with a population of 22,700
- Water System
  - Seattle Public Utilities (SPU) wholesale customer
  - Supply can be Tolt or Cedar water or blend
  - Three service connections
  - 120 mi of water main (primarily unlined cast iron)
  - 2 x 4 MG reservoir storage
  - 83 pressure reducing stations
  - 30+ small PRV zones along shoreline

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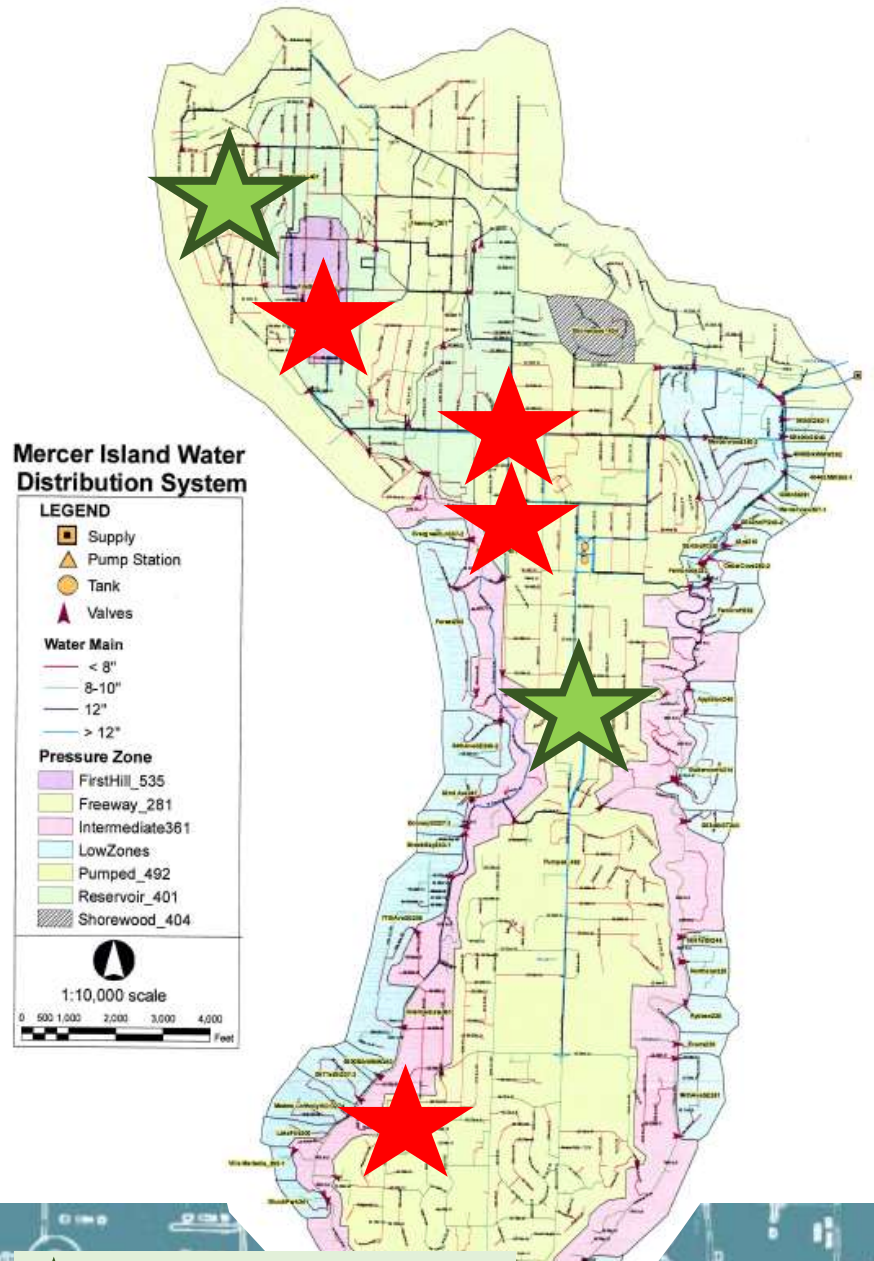

E.coli Event & Response

- 18 samples/month from 5 TCR locations
- September 2014 TC and *E.coli* present

Total Coliform (TC) Absent

TC and E.coli present

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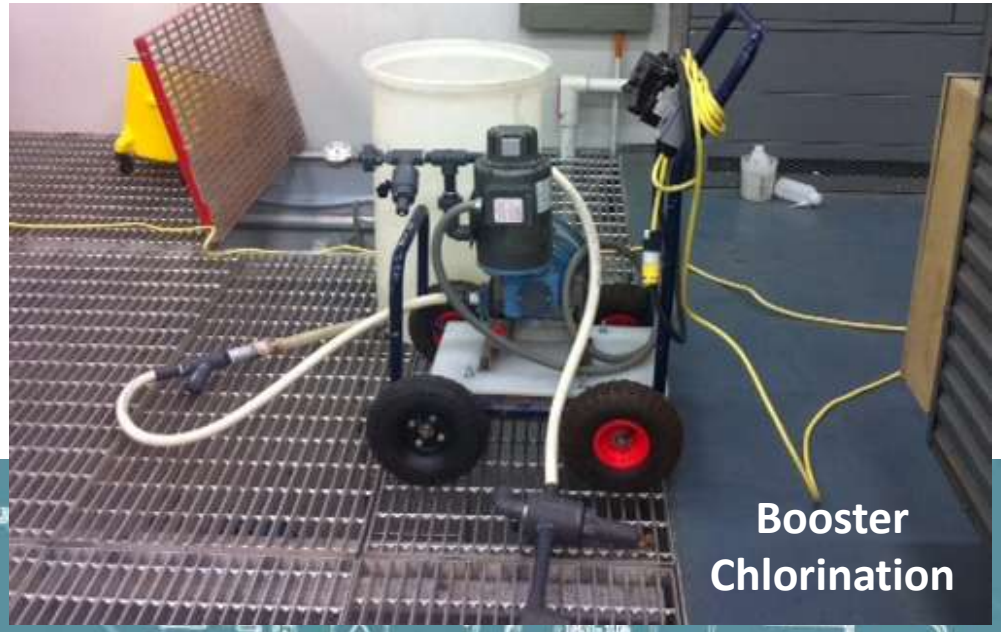

E.coli Event & Response

- 18 samples/month from 5 TCR locations
- September 2014 TC and *E.coli* present
  - Investigation, sampling, flushing, booster chlorine
  - Significant help from SPU and WSDOH
  - Transitory event / no "smoking gun"

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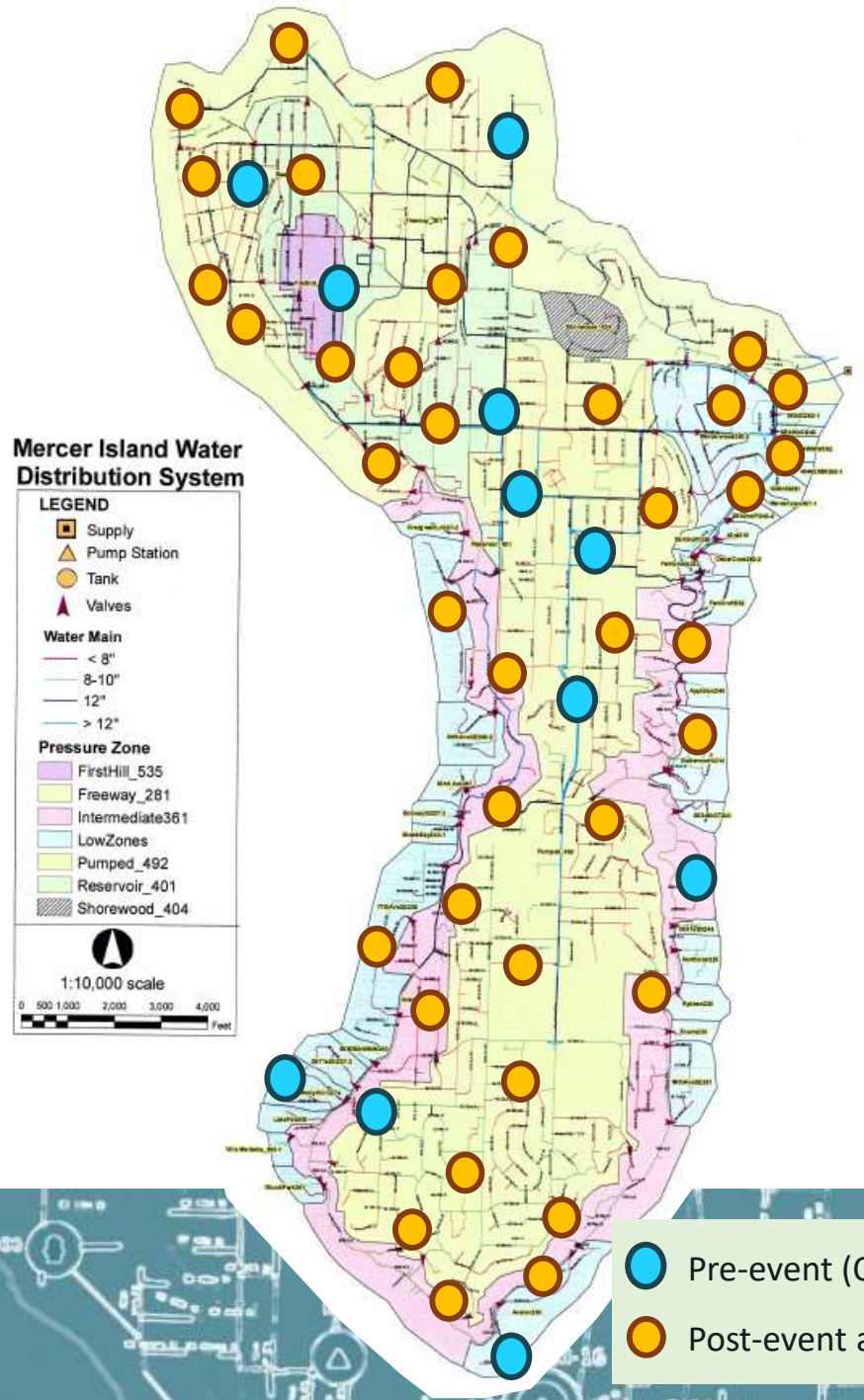
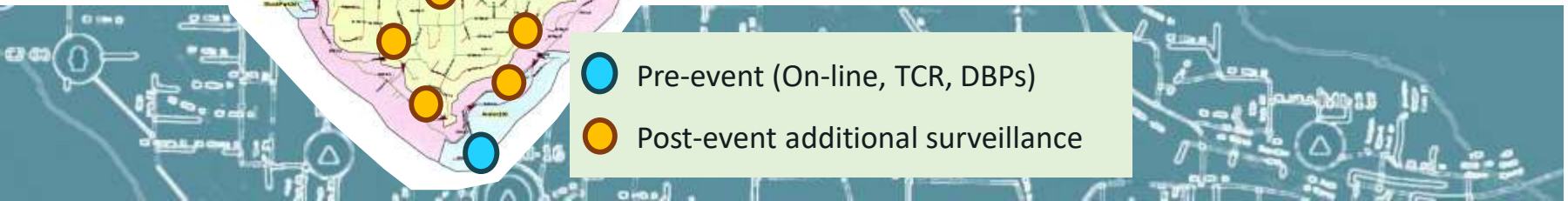


E.coli Event & Response

- 18 samples/month from 5 TCR locations
- September 2014 TC and *E.coli* present
  - Investigation, sampling, flushing, booster chlorine
  - Significant help from SPU and WSDOH
  - Transitory event / no "smoking gun"
- After event: Engaged Confluence
  - Opportunity to modify O&M practices
  - Included increased surveillance monitoring (at left)
  - 4 Key focus areas (next slides)



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Project Focus Areas

Disinfectant Residual Increase and Maintenance

- Booster disinfection
- Flushing to reduce water age
- Evaluate Cl_2 demand
- Main cleaning

Reduce Contamination Risks

- Retrofit PRV vaults
- Cross-connection control program

Operating Procedures and Documentation

- Pressure control
- Develop written SOPs

Water Quality Monitoring

- Event response and transition monitoring
- Cl_2 residual surveys
- Permanent TCR plan
- Surveillance monitoring
- Analyzer upgrades

Integrate water quality into the CIP planning

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2 Updating the City's CIP Program

Current City CIP Planning

- Asset Rankings
  - Fire flow modeling
  - Pipe diameter
  - Service area considerations
- Condition Rankings
  - Frequency of pipe breaks
  - Pipe material
  - Pipe age
- Ranking multi-project coordination/construction
- High number is ‘bad’, low number is ‘good’

City of Mercer Island
2014 CIP Water Projects Ranking Criteria

Points		Weight Factor	Weighted Points
	"FIRE FLOW" FACTORS		
	Fire Flow Availability		
3	Modeling indicates less than 50% of required fire flow	2	6
2	51 to 75% of required fire flow	2	4
1	76 to 99% of required fire flow	2	2
0	100% or greater of required fire flow	2	0
	Pipe Diameter		
3	Pipe diameter 4 inch or smaller	2	6
2	Pipe diameter is 6 inches or smaller (but > 4 inches)	2	4
1	Pipe diameter is 8 inches or smaller (but > 6 inches)	2	2
0	Pipe diameter is larger than 8 inches	2	0
	Benefit Area/Affected Area		
3	Non single-family connections (multi-family, condo, church, and etc)	3	9
2	Large area served (greater than 50 connections)	3	6
1	Medium area served (between 25 and 50 connections)	3	3
0	Small area served (less than 25 connections)	3	0
	"PIPE CONDITION" FACTORS		
	Maintenance/Breaks History		
3	High frequency of breaks (3 or more breaks within recorded years)	4	12
2	Medium frequency of breaks (2 breaks within recorded years)	4	8
1	Low frequency of breaks (a break has occurred)	4	4
0	No maintenance and no history of problems	4	0
	Pipe Material		
2	Asbestos Cement (AC), Galvanized (Gal), Polyvinyl Chloride (PVC), or Steel	3	6
1	Cast Iron (CI)	3	3
0	Ductile Iron (DI)	3	0
	Age of Pipe		
3	Over 50 years	1	3
2	Over 40 years	1	2
1	Over 30 years	1	1

ADDITIONAL CONSIDERATIONS - Extra Weighting Points For Involving Projects.

	Coordination with Other Projects in the Same Area		
5	Other project scheduled next year	2	10
4	Other project scheduled in 2 years	2	8
3	Other project scheduled in 3 years	2	6
2	Other project scheduled in 4 years	2	4
1	Other project scheduled in 5 years	2	2
0	Other project scheduled in 6 years, beyond, or not scheduled	2	0

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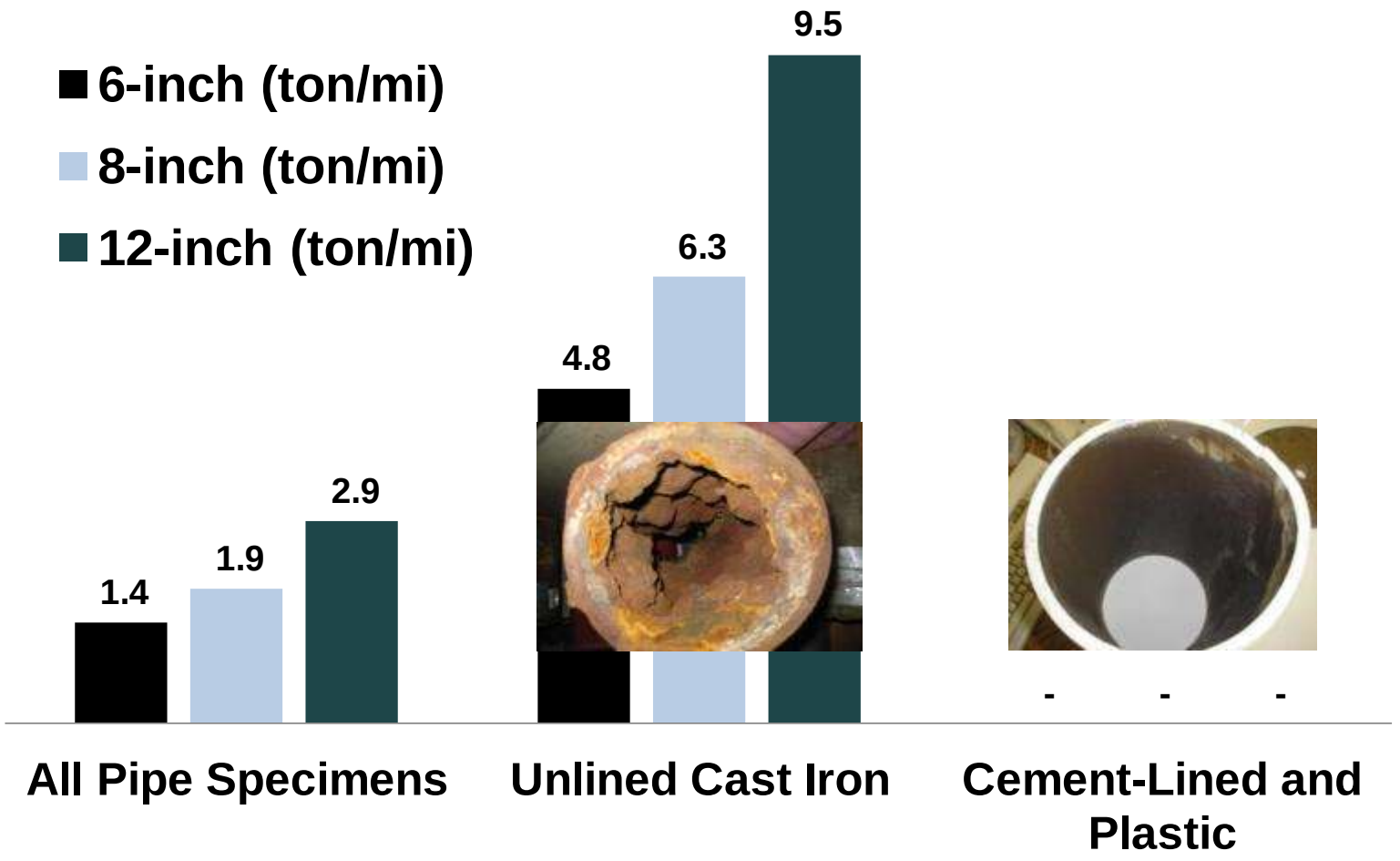
Should Water Quality be A Factor in CIP Decisions?



Median Solids Accumulation Rates (tons per mile)

Source: Friedman and Hill et al., 2010, Water Research Foundation

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Water Quality Should be Considered in CIP Planning!

- Risk increases with time (pipe age) and DS water age
- Low-level loading of iron/manganese
- Pipe materials (unlined cast iron)
- Lack of effective mains cleaning strategy
- Practices that encourage 'release' events
  - Source and/or treatment changes
  - Hydraulic shifts (planned or unplanned)

4-inch Unlined Cast Iron Main

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Goal: Incorporate Water Quality Into City CIP Planning and Decision Making

- Current System
  - Mostly unlined cast iron pipe
  - Main replacement
    - Industry recommendation: >1% / year (AwwaRF 2005)
    - City: 0.4% / year
  - No Main cleaning program

- Develop Water Quality "Tool" Add-On To CIP
  - Identify worst water quality offending areas
  - Consider flushing or replacement with CIP

2-inch service line

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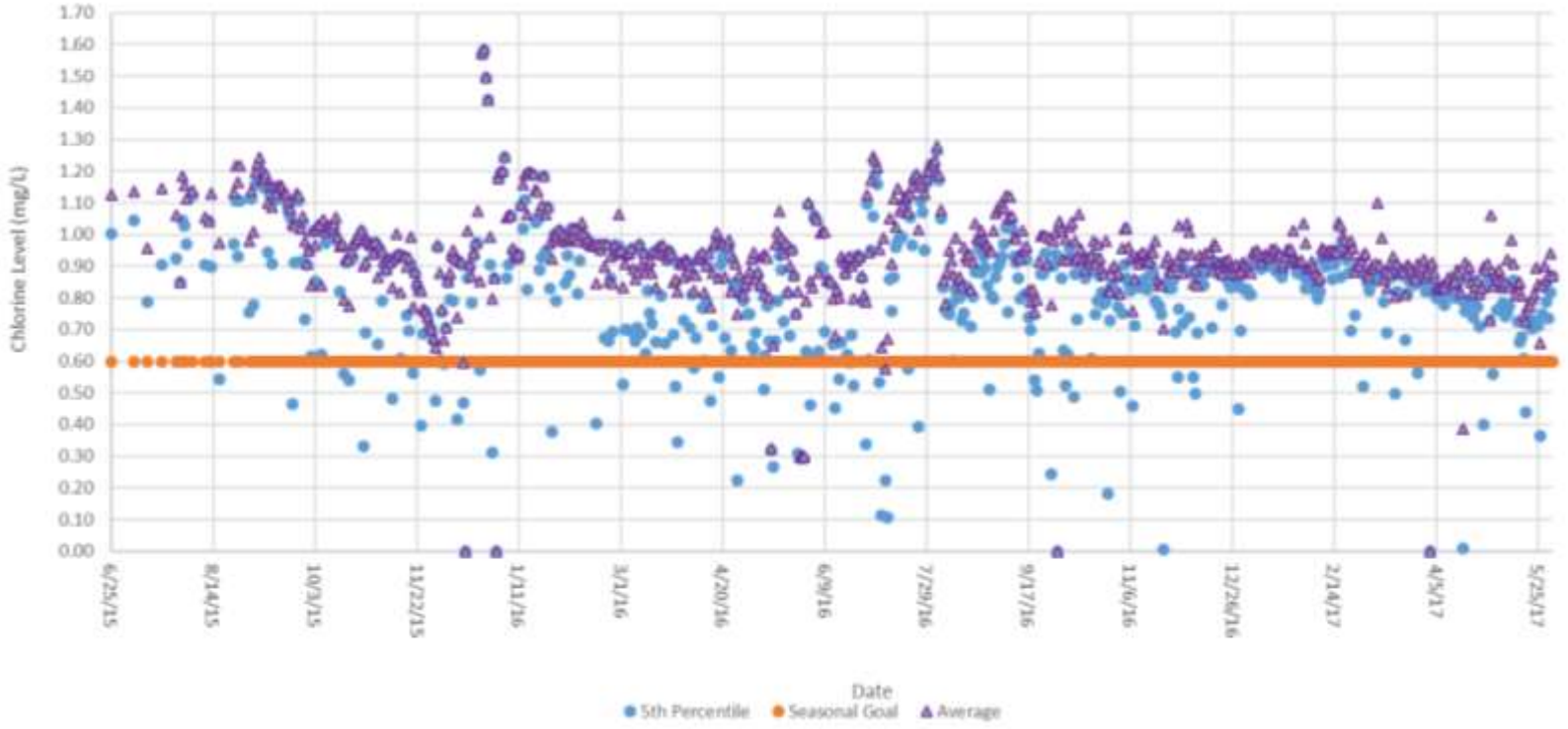
3 Water Quality CIP Concepts & Integration Findings

Developing Water Quality Tool to Assist CIP Planning

- Goal
  - Based on real data
  - Flexible / robust to change
  - Complimentary to current CIP process
- Water Quality Data
  - Chlorine residual
  - R2A HPC bacteria
  - Iron, total
  - Customer complaints
  - Other?



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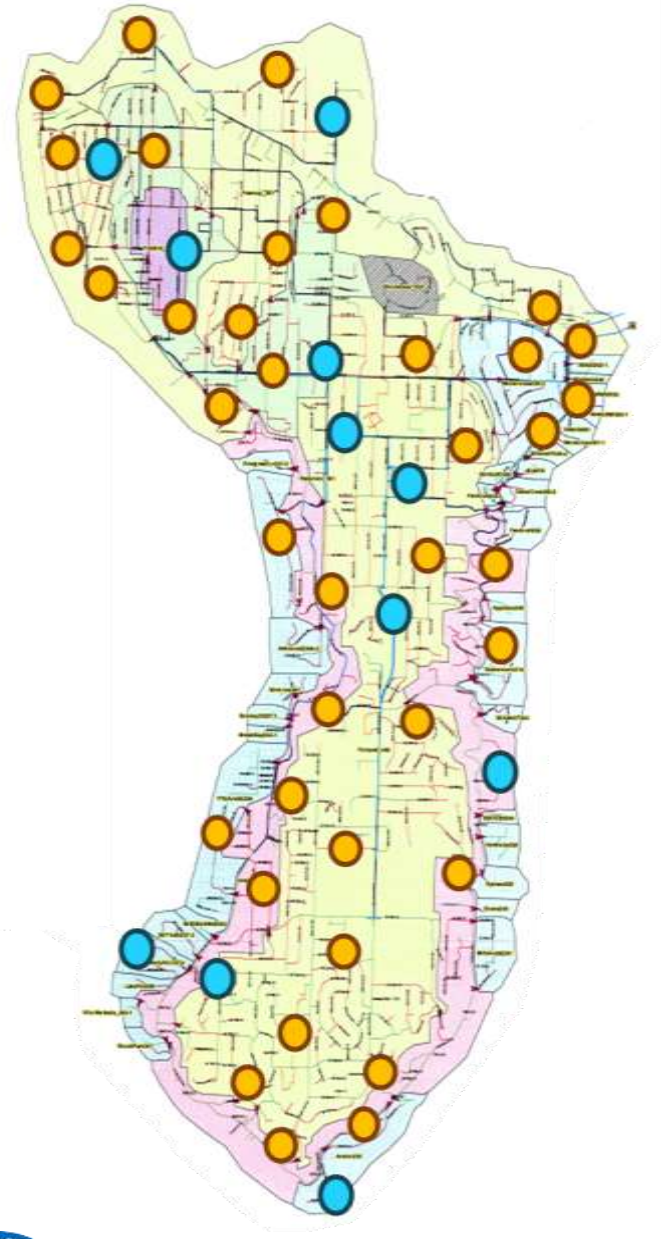
Approach & Qualitative Tool Input Variables

- 3-Step Approach / Application to CIP Process
  - Conduct monitoring
  - Develop method to assign risk levels to pipe assets
  - Manage risk
    - Manage with O&M activities
    - Elevate to CIP / renewals if O&M not appropriate or feasible

- Parameters Included
  - Chlorine Residual
  - R2A HPC bacteria
  - Iron, total
  - Other Parameters May Be Added Later (customer complaints)



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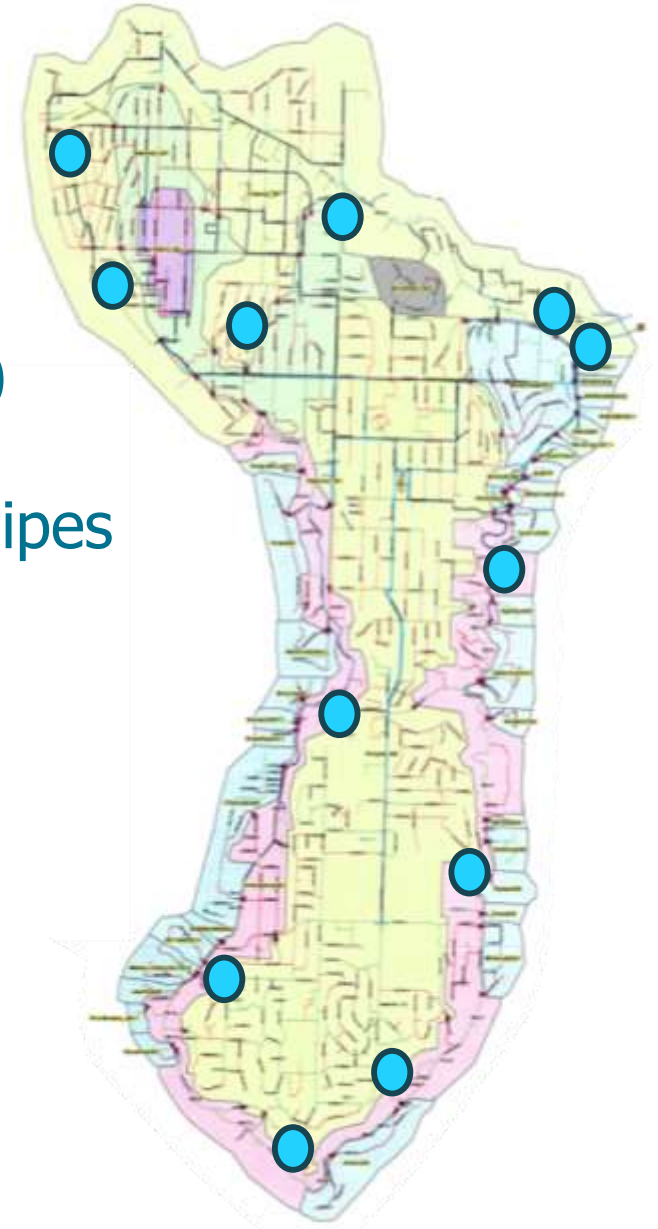
Approach & Qualitative Tool Input Variables

- This is a "First Step" in Tool Development (can be refined later)

- Merge Water Quality Data with City GIS / Apply to All System Pipes
  - Strategic sample locations chosen
    - 12 sites having best historical data
    - Sampled from June 2015 through July 2017
  - City GIS database support

- Assumptions
  - Flow not considered (add later)
  - Quantitative method: Statistical data analysis & characterization
  - Qualitative application: Results summarized in risk levels



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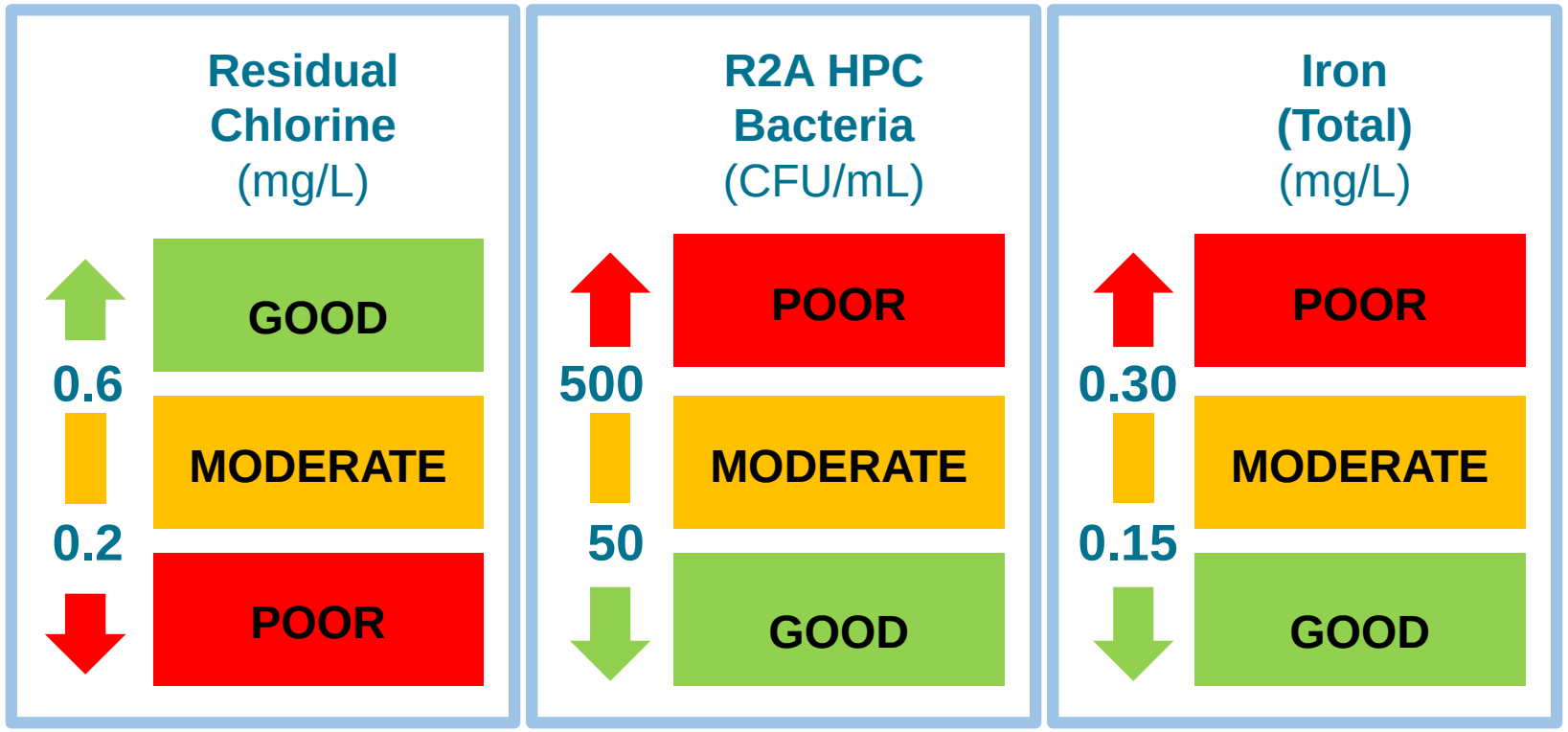
Developing Risk Levels

- Annualized Data
  - 5th percentile (low)
  - 95th percentile (high)
- Interpolate Between Sample Stations
  - Up to 1,000 ft distance
  - No flow direction impact
- Calculation of 'Risk' Level
  - Kept it simple
  - Sensitivity analysis
  - Poor=5, Moderate = 2, Good = 0



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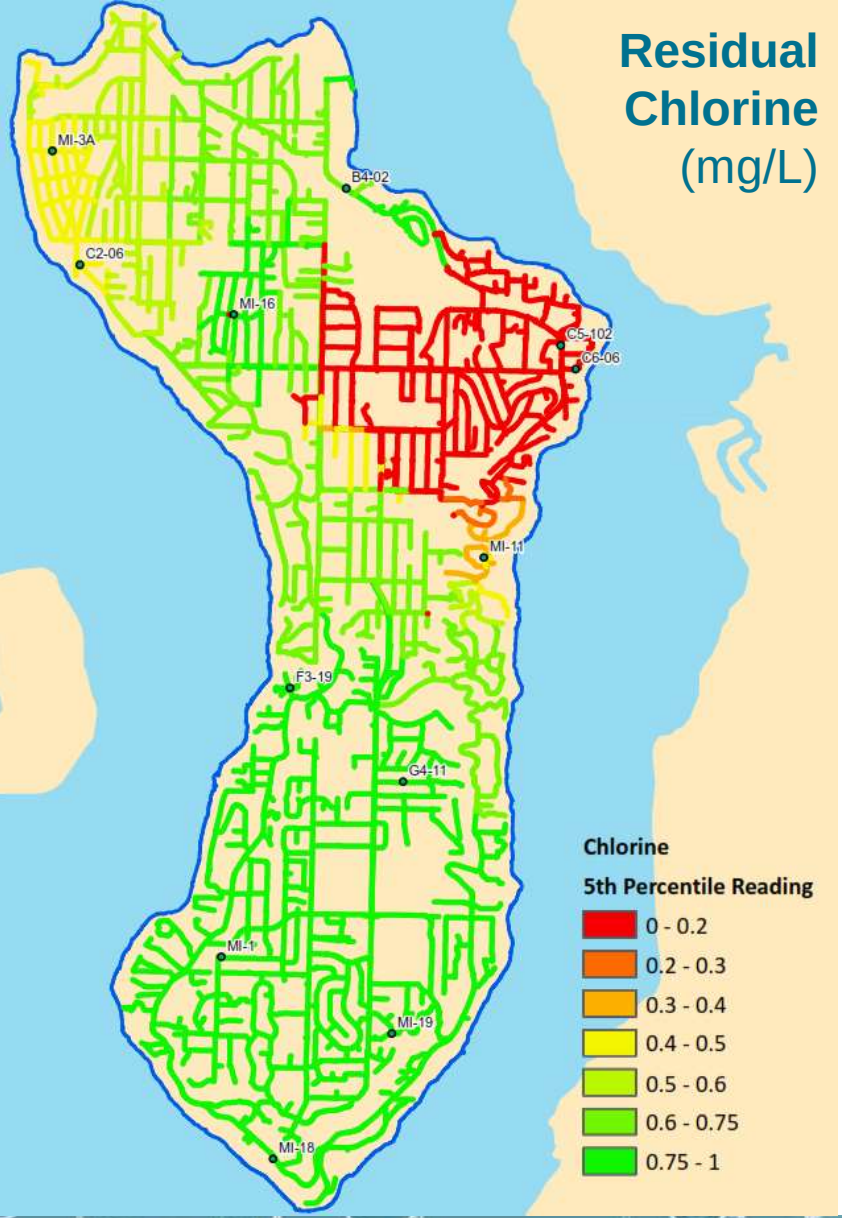

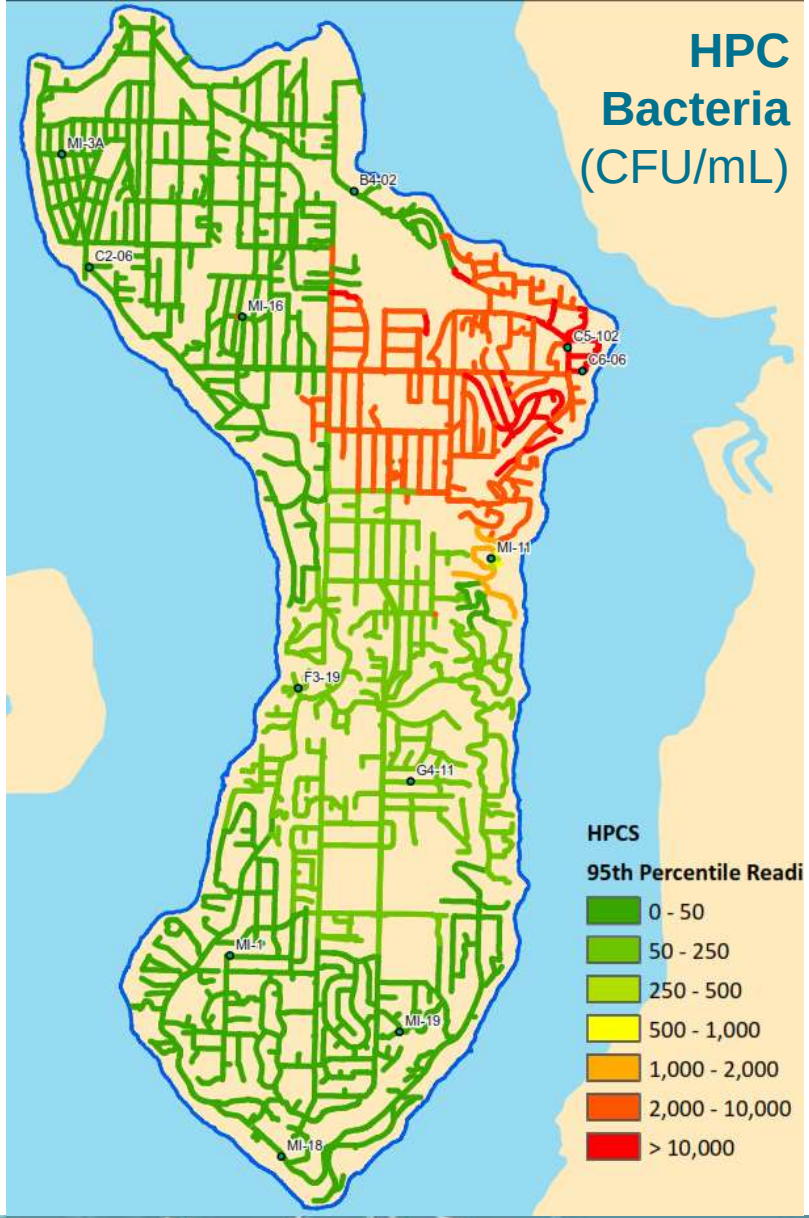

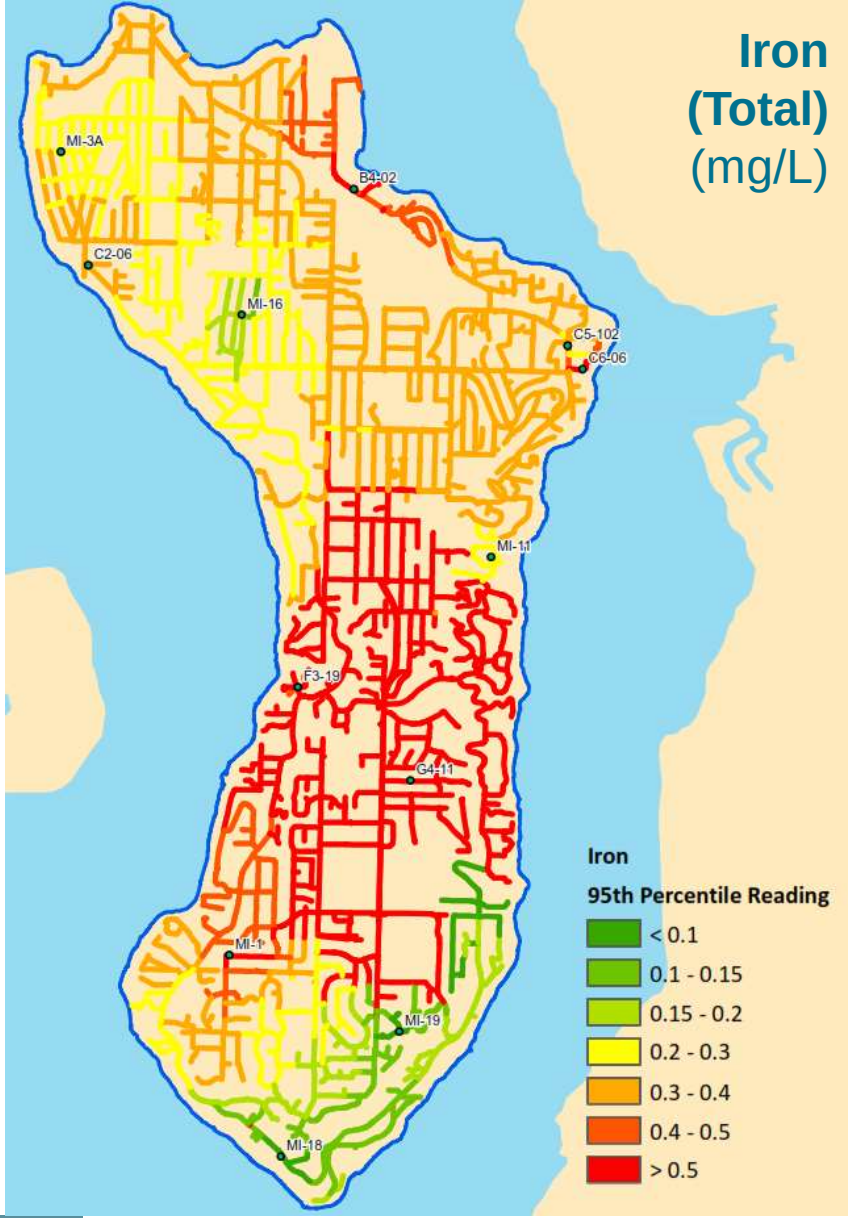

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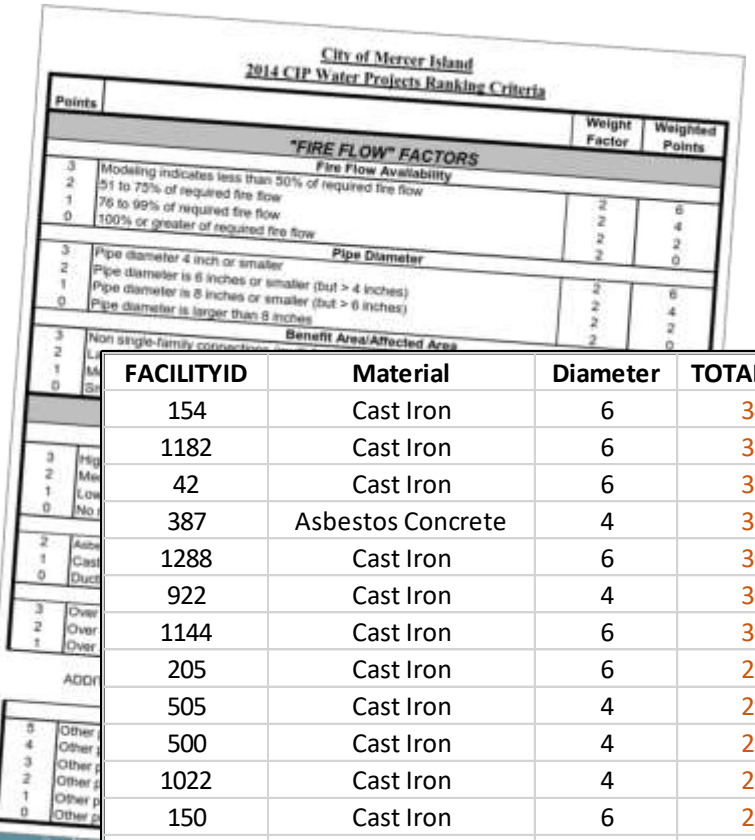
Integrating Water Quality Characterizations to the CIP

- Original Ranking Database
- Water Quality Conditions
- Rankings With WQ Risk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	Benefit Area/Affected Area		
3	Non single-family connections		

FACILITYID	Material	Diameter	TOTAL_SCORE
154	Cast Iron	6	34.05
1182	Cast Iron	6	32.84
42	Cast Iron	6	32.14
387	Asbestos Concrete	4	31.86
1288	Cast Iron	6	30.30
922	Cast Iron	4	30.21
1144	Cast Iron	6	30.13
205	Cast Iron	6	29.57
505	Cast Iron	4	29.34
500	Cast Iron	4	28.53
1022	Cast Iron	4	28.26
150	Cast Iron	6	28.22
139	Cast Iron	8	28.18

Water Quality Condition Assessment

- Chlorine Residual
- R2A HPC Bacteria
- Total Iron
- Customer Complaints

FACILITYID	Material	Diameter	WQ Condition	TOTAL_SCORE
154	Cast Iron	6	Moderate	34.05
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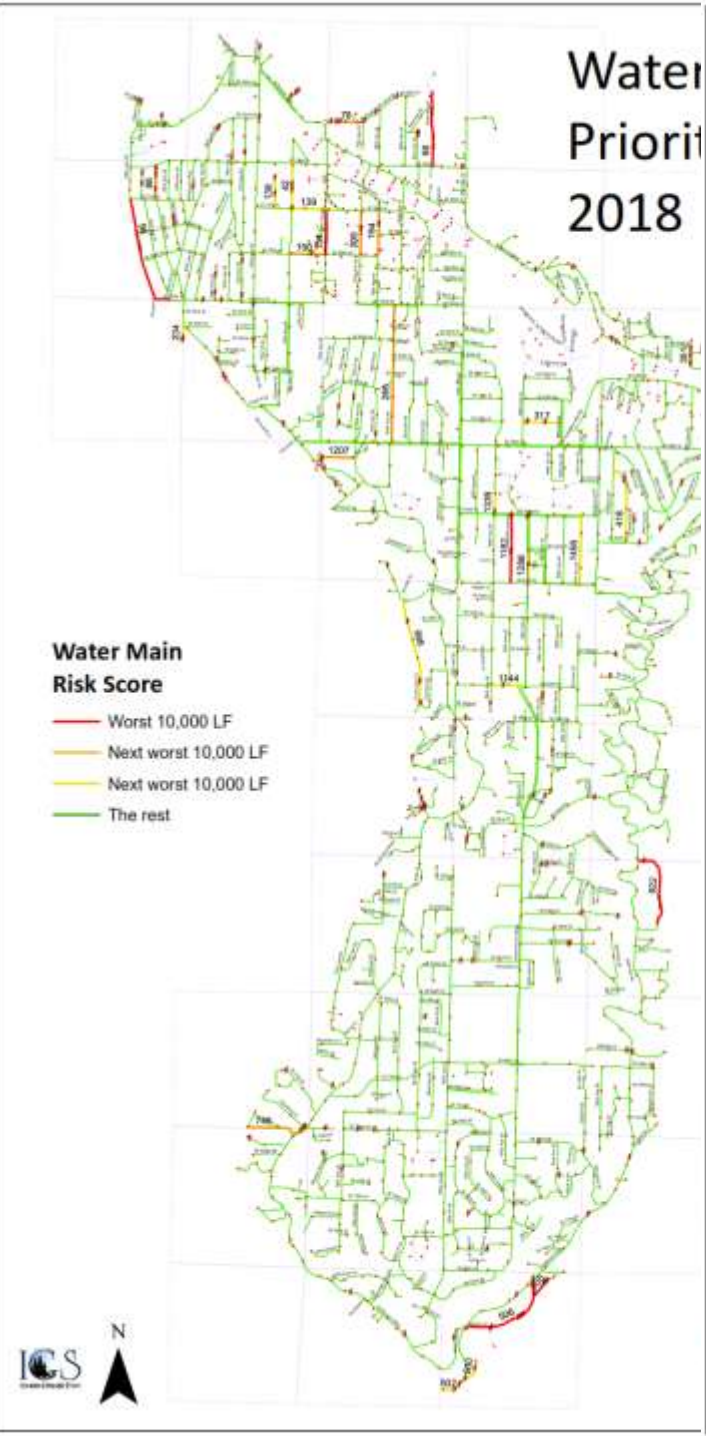
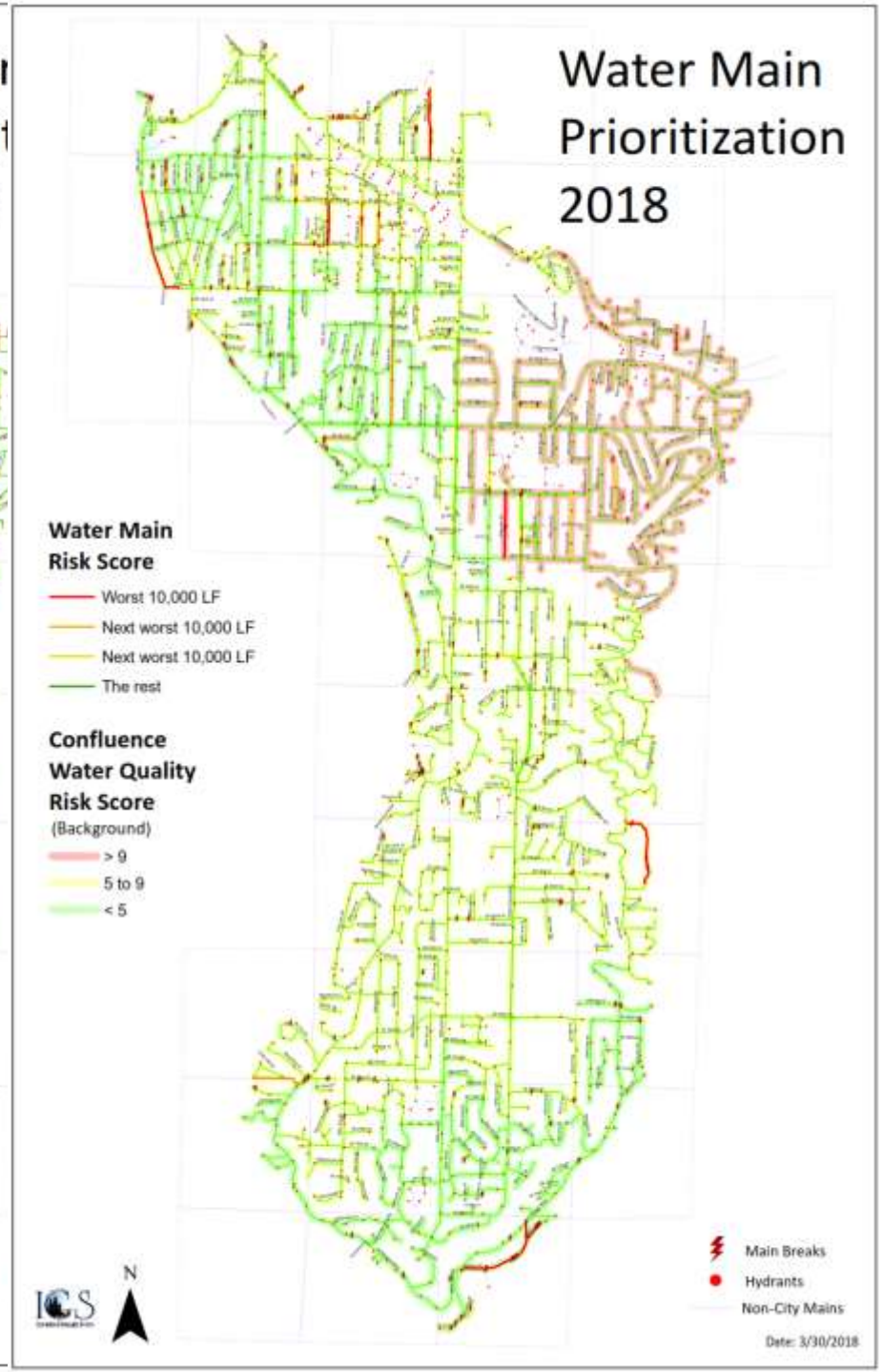
4 Results & Next Steps





Project Results

- Qualitative & Quantitative CIP Evaluation Process
- Concept To Evolve Over Time / Further Development
- Applied to City's pipelines, allowing ability to interpret appropriate response (O&M or CIP)
- Mains Cleaning Response for Selected Poor Water Quality Areas

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Next Steps

- Incorporate hydraulic model results / change from geometric interpolation
- Observe impacts of unidirectional flushing on changing water quality
- Continue to expand/refine water quality monitoring to improve system understanding
- This was a very simplified start: Look toward adjusting statistics and qualitative 'risk' calculations as program and water quality monitoring evolves

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THANK YOU

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10 Years
2008 - 2018

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