Prepared for

NEWEA

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Lessons Learned from Long-Term Monitoring, Metering and Modeling A Springfield Case Study

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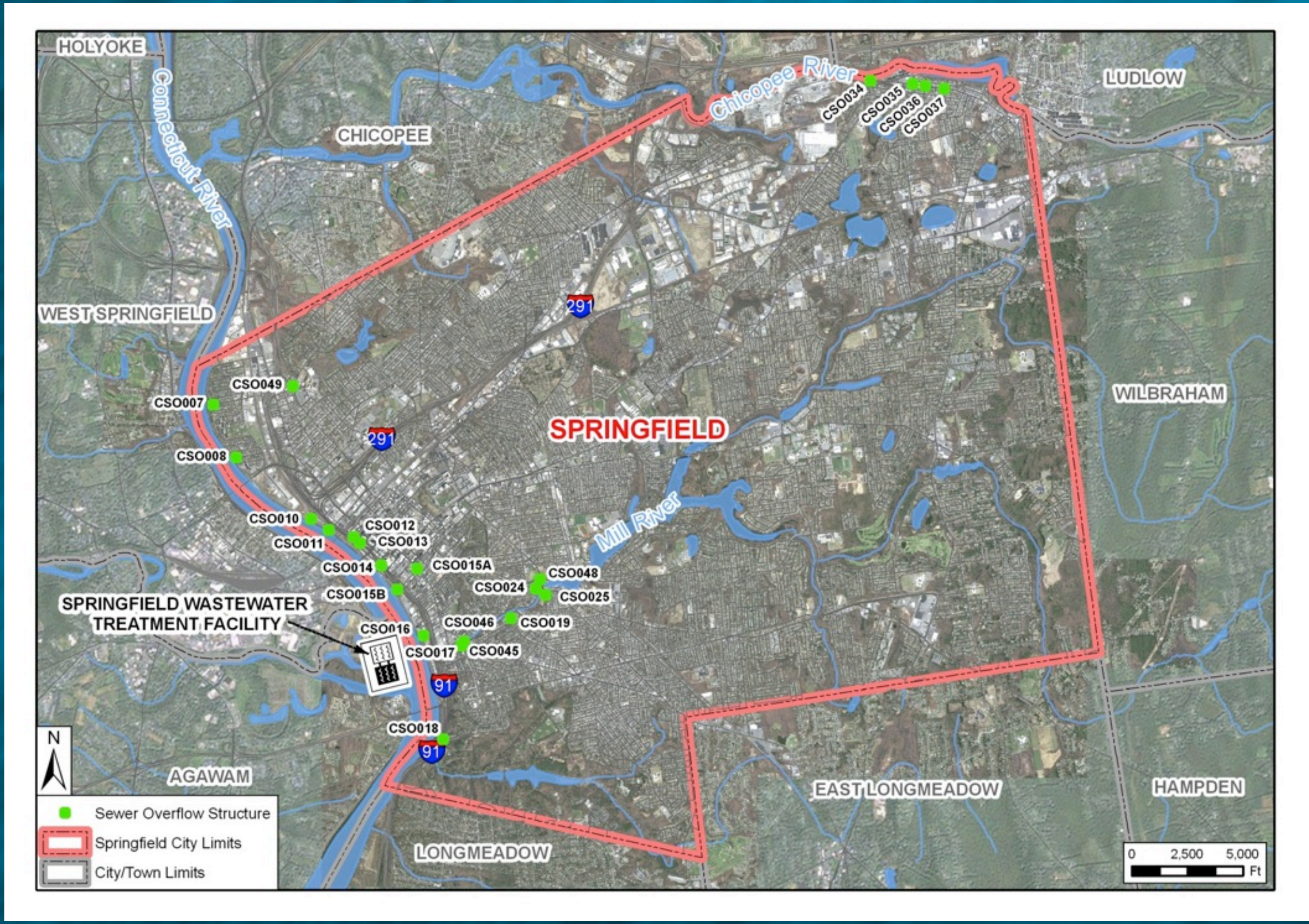
Topics Covered

1. Background
2. Benefits and Limitations of Permanent Metering
3. Temporary Metering to Support Model and Project Development
4. Impact of Temporal and Spatial Distribution on Model Predictions
5. Evolution of Criteria for Project Development
6. Relationship Between Reporting and Compliance
7. Closing

Background: The Springfield System



Key Facts

Population Served: 250,000

450 miles of sewer with 138 miles of combined sewer and 220 miles of storm drains

23 CSO regulator structures with meters and 4 rain gages

7 Flood Control pump stations

26 Sanitary pump stations

Bondi Island SRWTF: Serving Springfield and 7 Satellite Communities, ADF of 40 MGD

Background: Evolution of the Metering and Monitoring Program through the Years

	2000	2005	2010	2015
Permanent Meters	0	25	23	23
Temporary Meters	28	17	44	28
Rain Gages	2	4	4	16
Model	MOUSE	InfoWorks 6.0	InfoWorks 8.5	InfoWorks ICM

* Post Construction Monitoring Performed as Well

- Early stages of the program had limited data
- Programs have been designed to support planning and design
- Most recent focus has been on filling gaps in rainfall data

Benefits and Limitations of Permanent Metering and Monitoring: Velocity, Depth and Float Switch

Benefits:

- Impact of system maintenance and construction changes
- Supports continuous model refinement and trending
- Year-round data that supports reporting

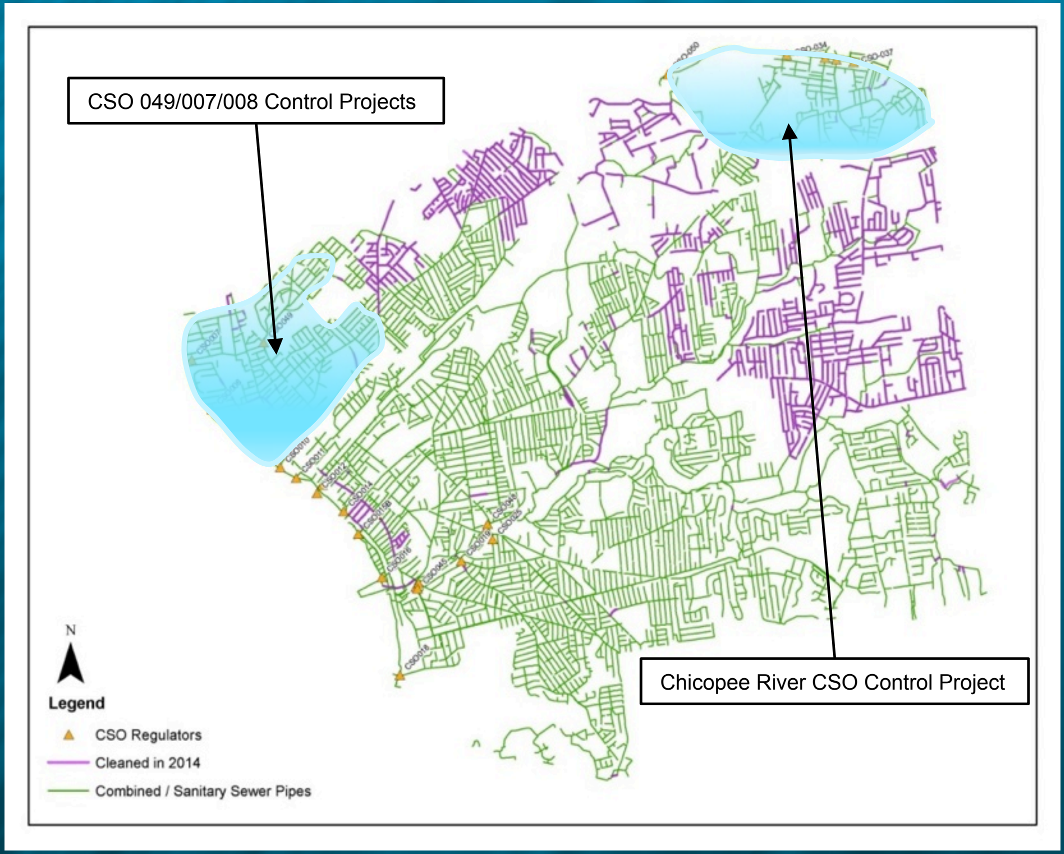
Limitations:

- System anomalies can skew outputs
- Data gaps are a significant impact to the model.

Benefits of Permanent Metering and Monitoring:
Continuous monitoring during system improvements

System Improvements:

- 3 major CSO control projects – 15% reduction in baseline overflows
- Comprehensive six year cleaning and assessment program
- 90% of system cleaned with preliminary indication of a reduction in baseline overflows



Major System Changes

Benefits of Permanent Metering and Monitoring:
Model Refinement and Trending

1976 v 2014								
Data Set	**Total Rainfall (inches)**	**Total No. of Storms**	**Number of Storms by Total Precipitation (inches)**					
			0.01 to 0.13	**0.14 to 0.25**	**0.26 to 0.50**	**0.51 to 1.0**	**1.01 to 2.0**	**> 2.0**
Typical year	42.2	82	28	15	11	14	11	3
2014 Avg	44.6	79	28	11	10	13	13	4
ADS RG01	48.6	80	29	8	12	10	17	4
ADS RG02	38.4	75	26	14	10	13	8	4
ADS RG03	45.4	81	30	11	9	15	12	4
ADS RG04	45.9	78	28	9	10	14	13	4

Trends:

- Recent years have had higher total rainfall on average
- Smaller events have remained consistent
- A shift towards larger more intense events
- Net impact on CSO has been mixed with higher activations at lesser total volume

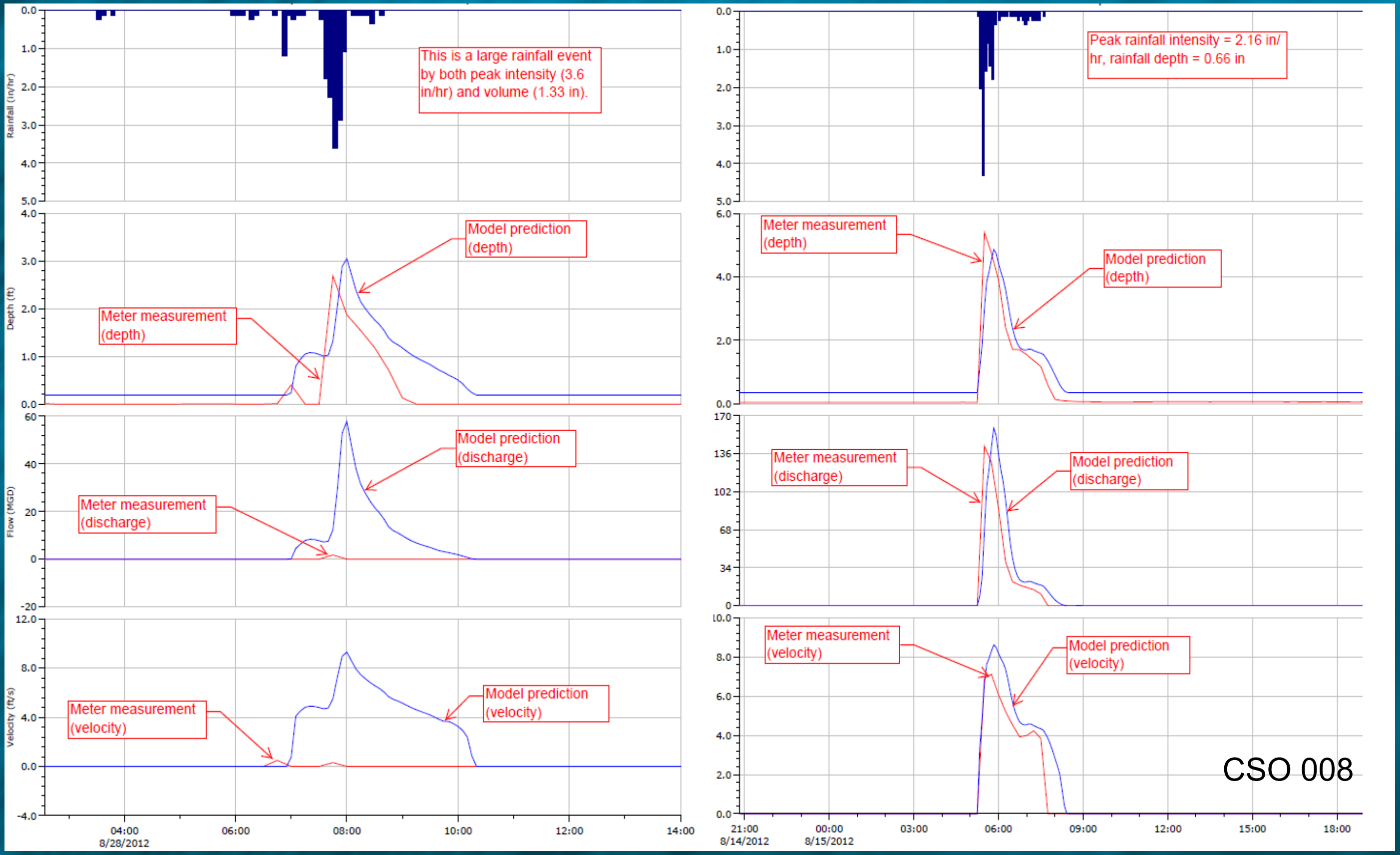
Benefits of Permanent Metering and Monitoring:
Higher Confidence and Accuracy with Predictions

Year	Observed Data		Model Predictions	
	Activations #	Volume (MG)	Activations #	Volume (MG)
2011	190	262	164	271
2012	451	356	326	373
2013	349	312	280	411
2014	**340**	**352**	**352**	**351**

Annual Reporting:

- Earlier results had significant discrepancies – data gaps, application of criteria, system understanding
- Trend toward better correlation over time and higher confidence in the comparison of observed vs predicted

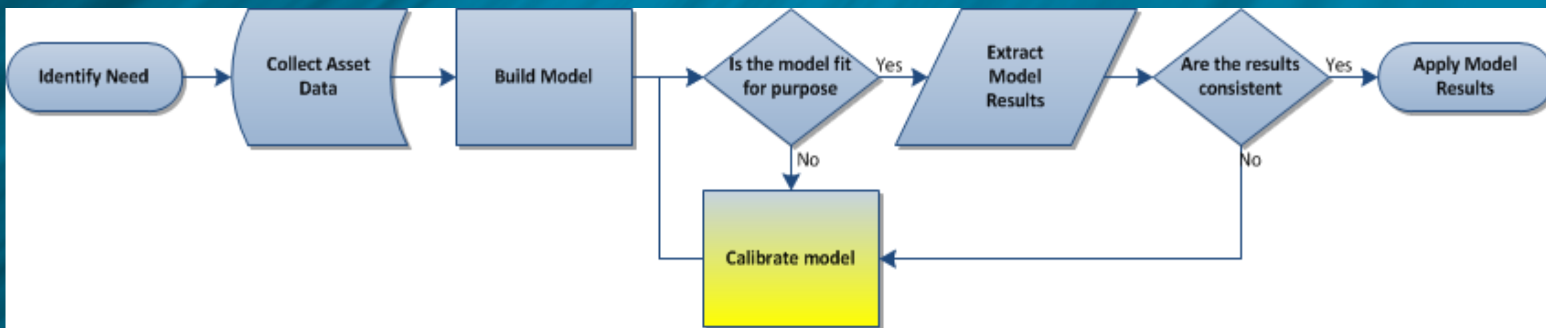
Limitations of Permanent Metering and Monitoring:
Example of CT River Influences on the System

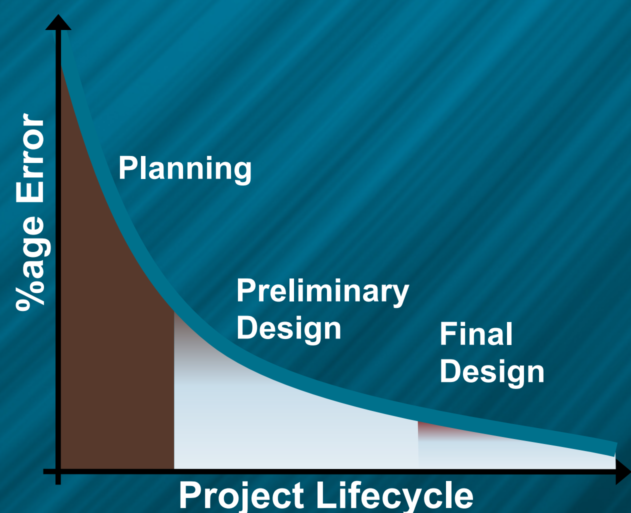


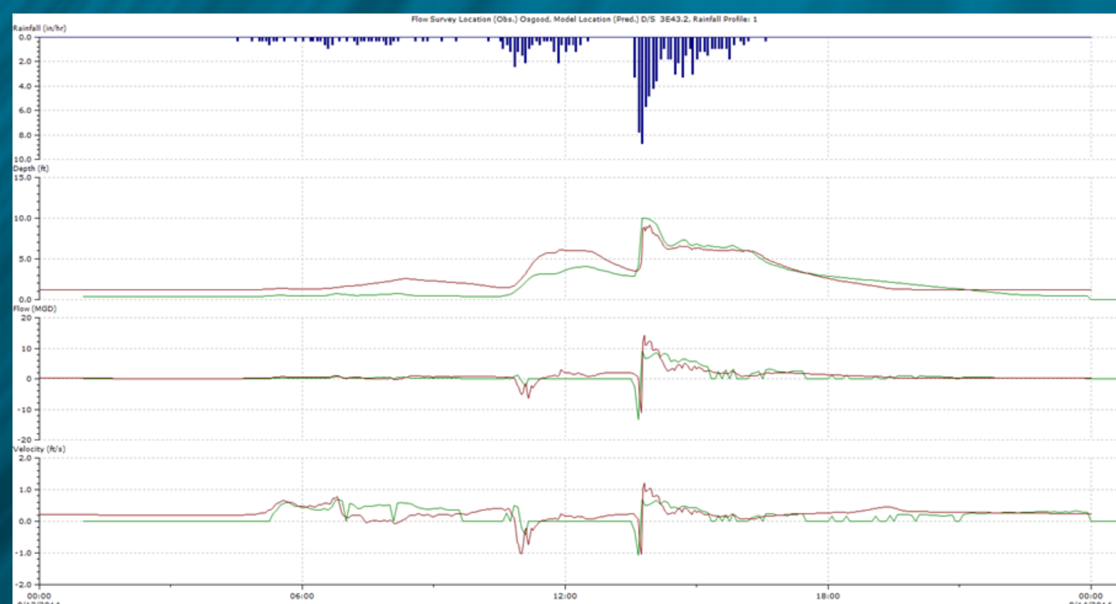
High River

Low River

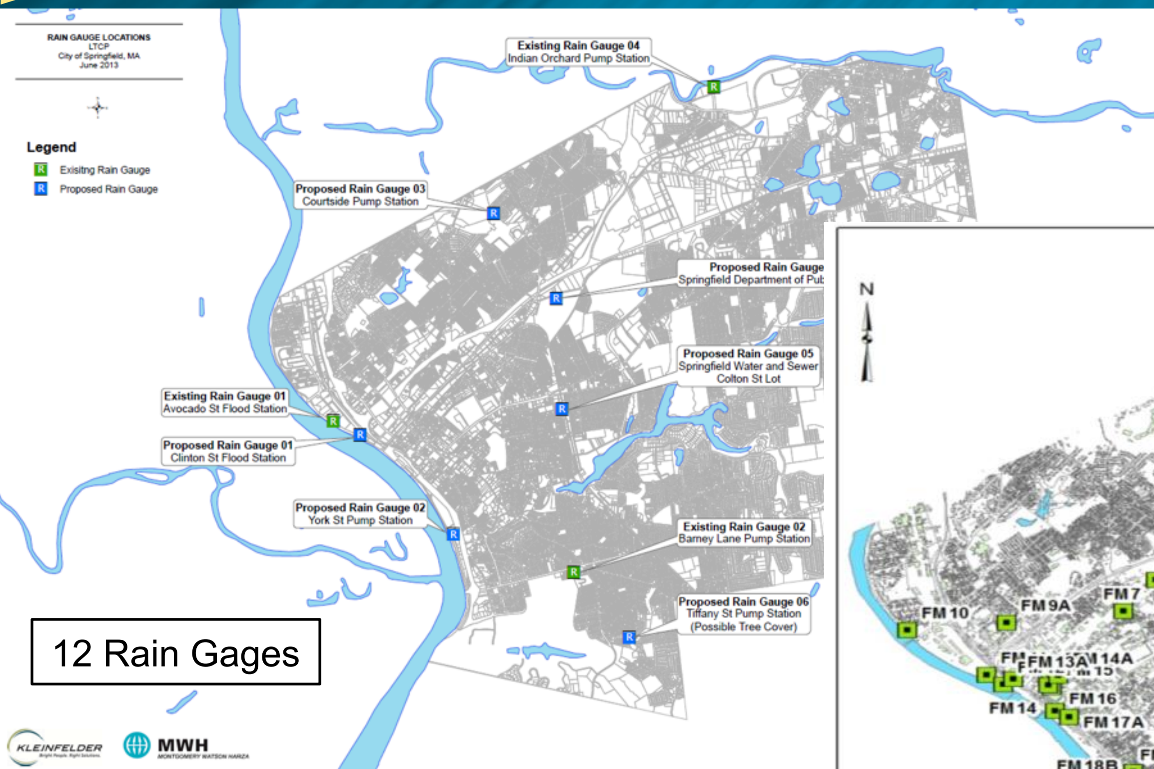
Temporary Metering to Support Model and Project Development: Fit for Purpose





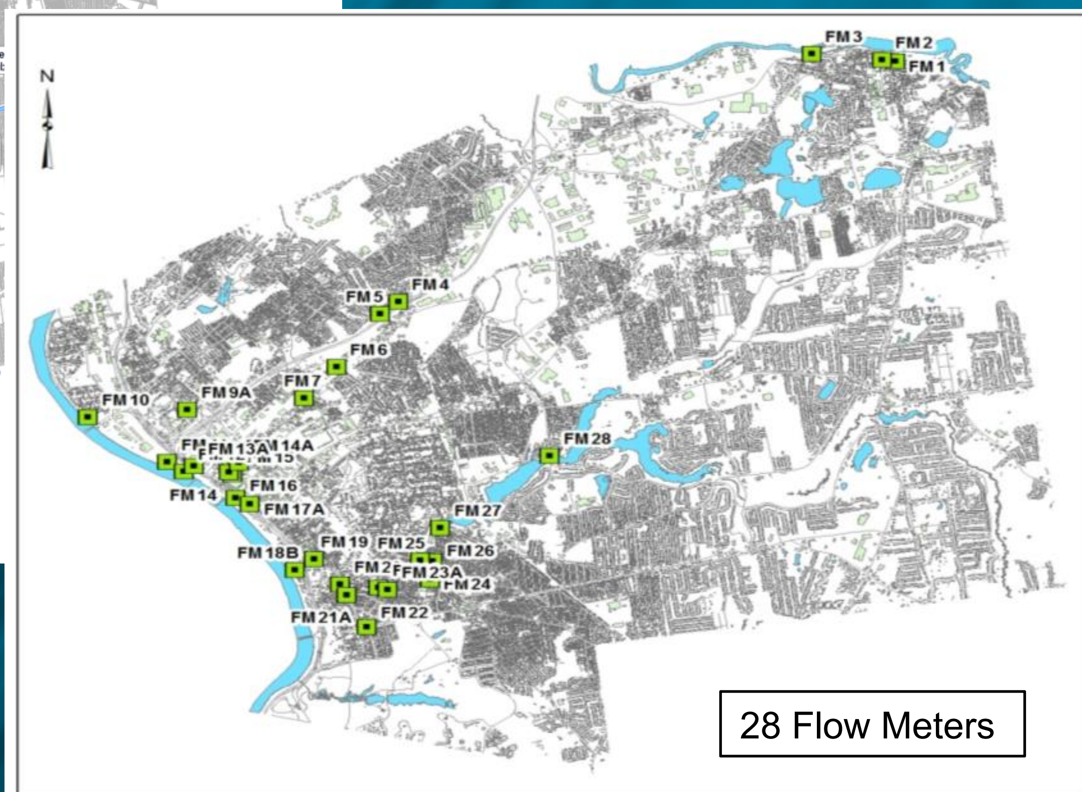


Temporary Metering to Support Model and Project Development: Approach has Evolved Over Time

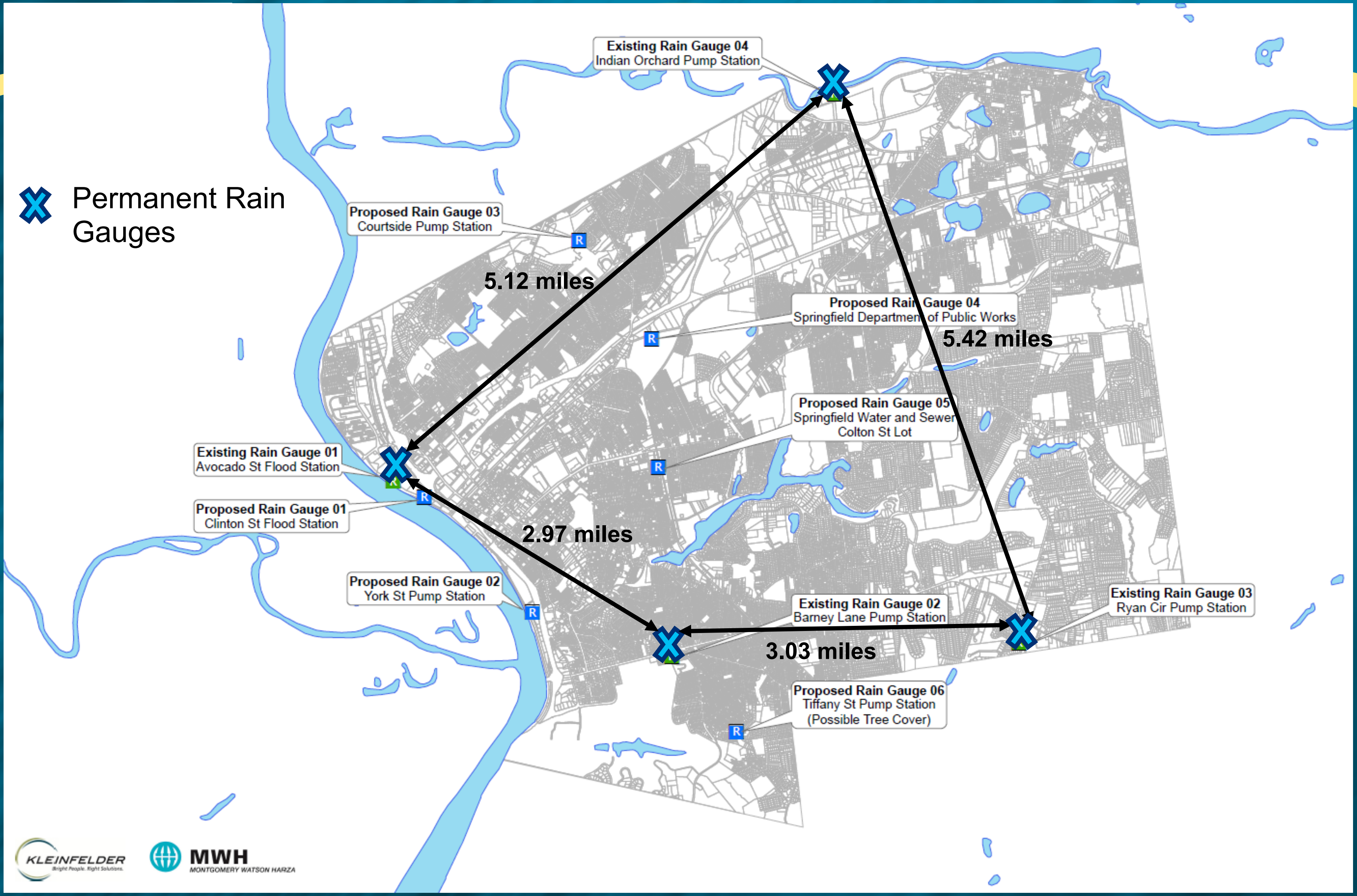


More delineation aligned with catchments around rain gage placement

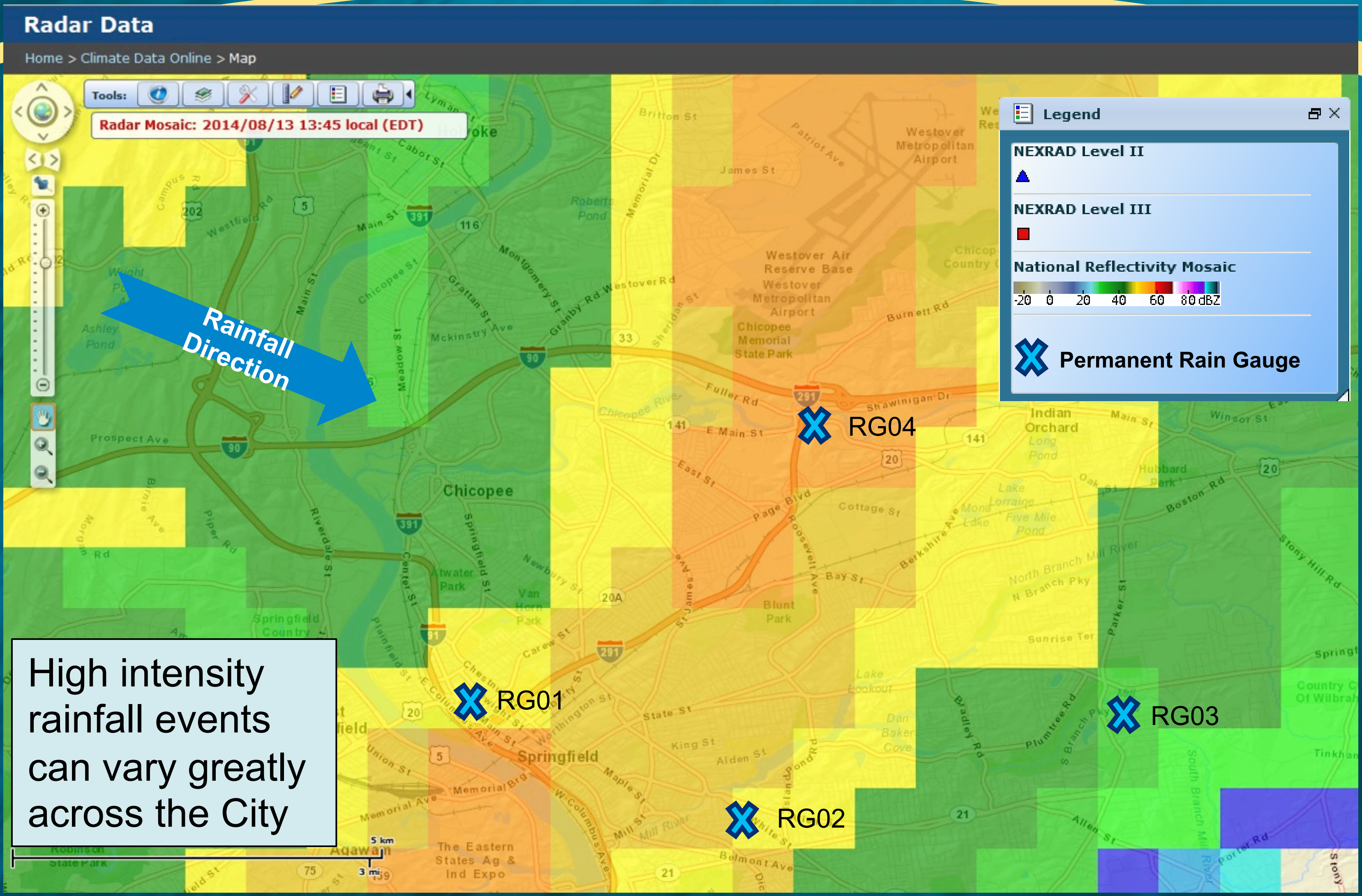
Temporary Meter Placement to Compliment Permanent Meters and Support Design Objectives



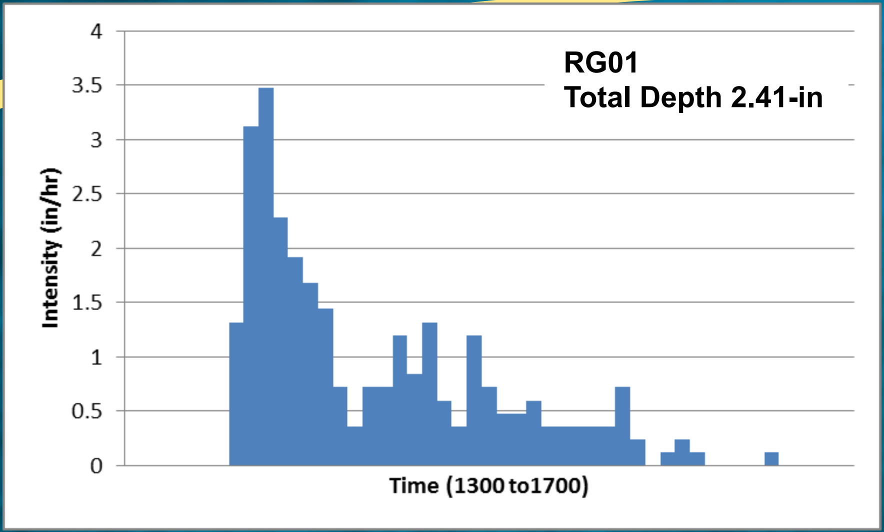
Impact of Spatial Distribution on Model Predictions:
Correlation of Rain Gages to Catchments

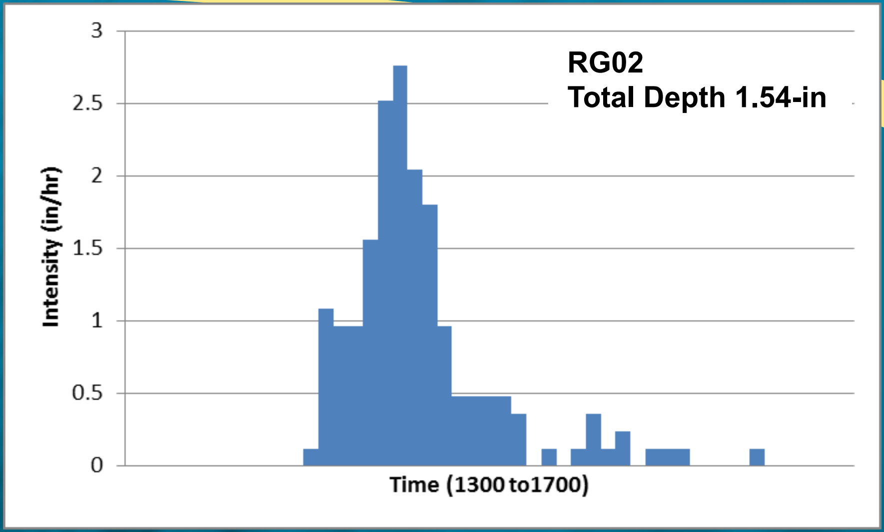


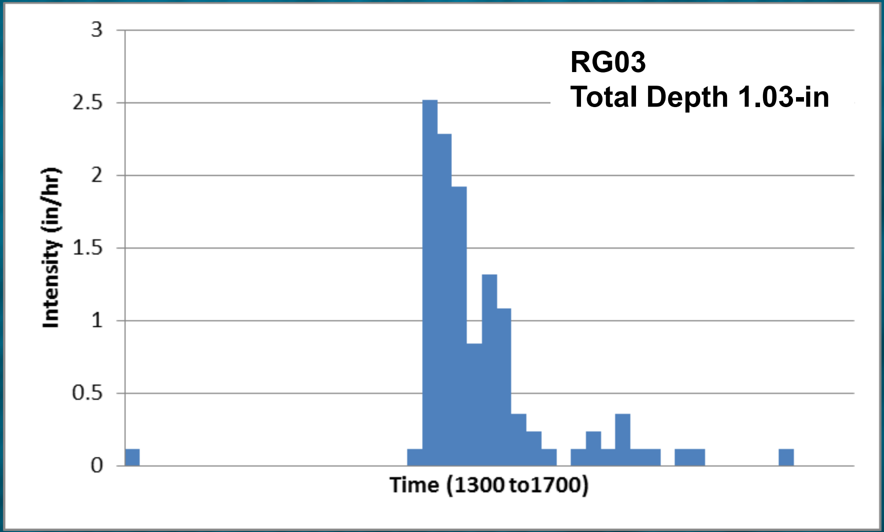
Impact of Temporal and Spatial Distribution on Model Predictions: Rainfall Variability and Gage Placement

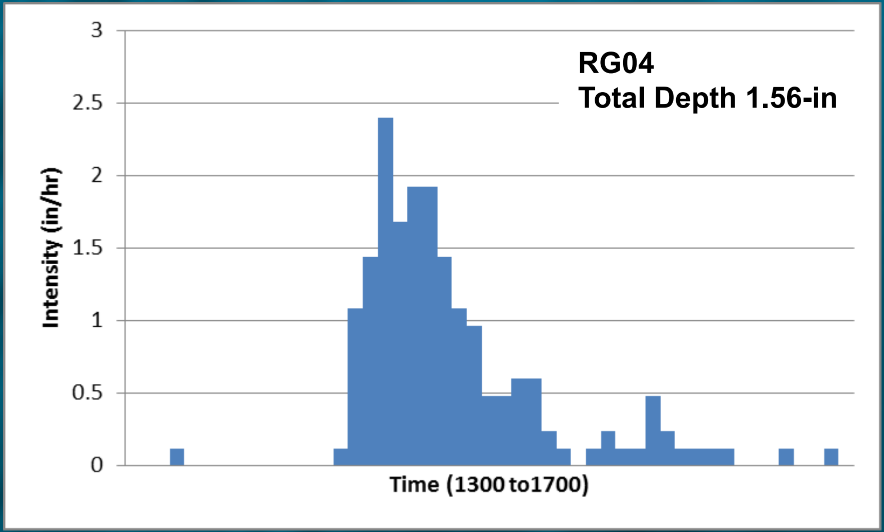


Impact of Temporal and Spatial Distribution on Model Predictions: Hyetographs for the 4 Gages









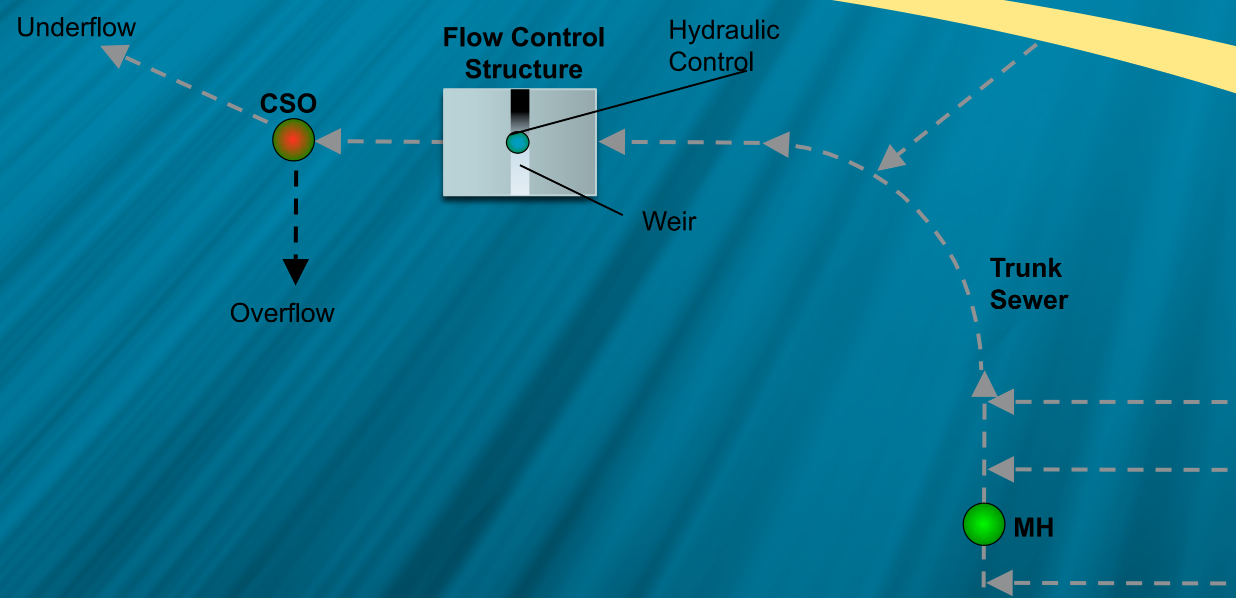
Impact of Temporal and Spatial Distribution on Model Predictions: CSO 008 Model Predicted Output by Rain Gage

Key Points:

1.5 MG variation in volume prediction

Model inputs can significantly skew predictions

Data collection needs to be scaled to better measure natural variability



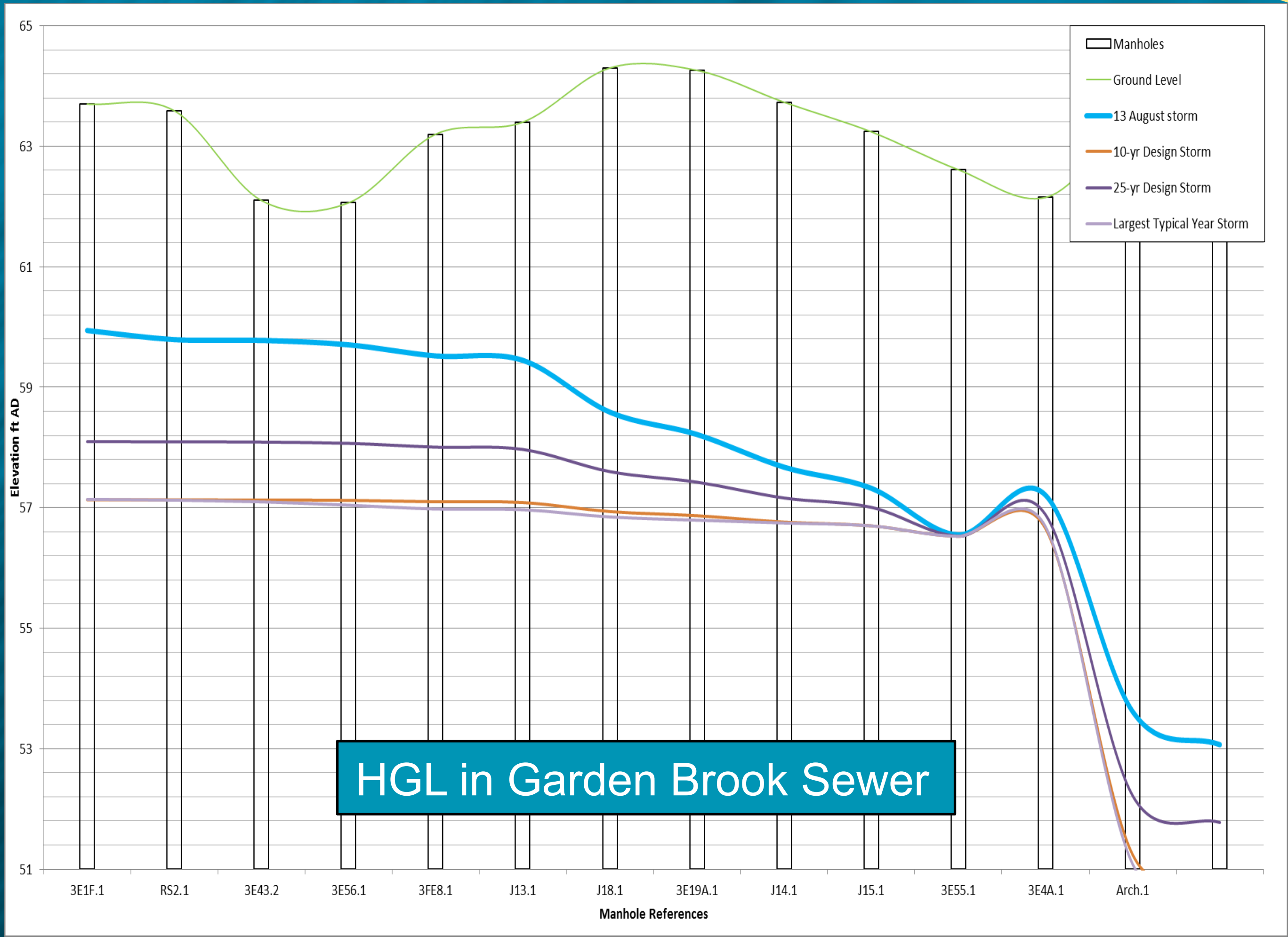
	Overflow		Hydraulic Control
	Peak Q (MGD)	Volume (MG)	Depth over Weir (in)
RG1	51.3	4.96	24
RG2	47.9	3.94	20
RG3	34.7	3.44	13
RG4	41.3	3.87	12

Evolution of Criteria for Project Development:
Example of Unexpected Impacts from Real Events

Changing Criteria:

Old: Typical year series for CSO control, 10 and 25-yr Design Storm for LOS checks

New: Old criteria plus high intensity real world storms, CFD analysis and continuous simulations where required

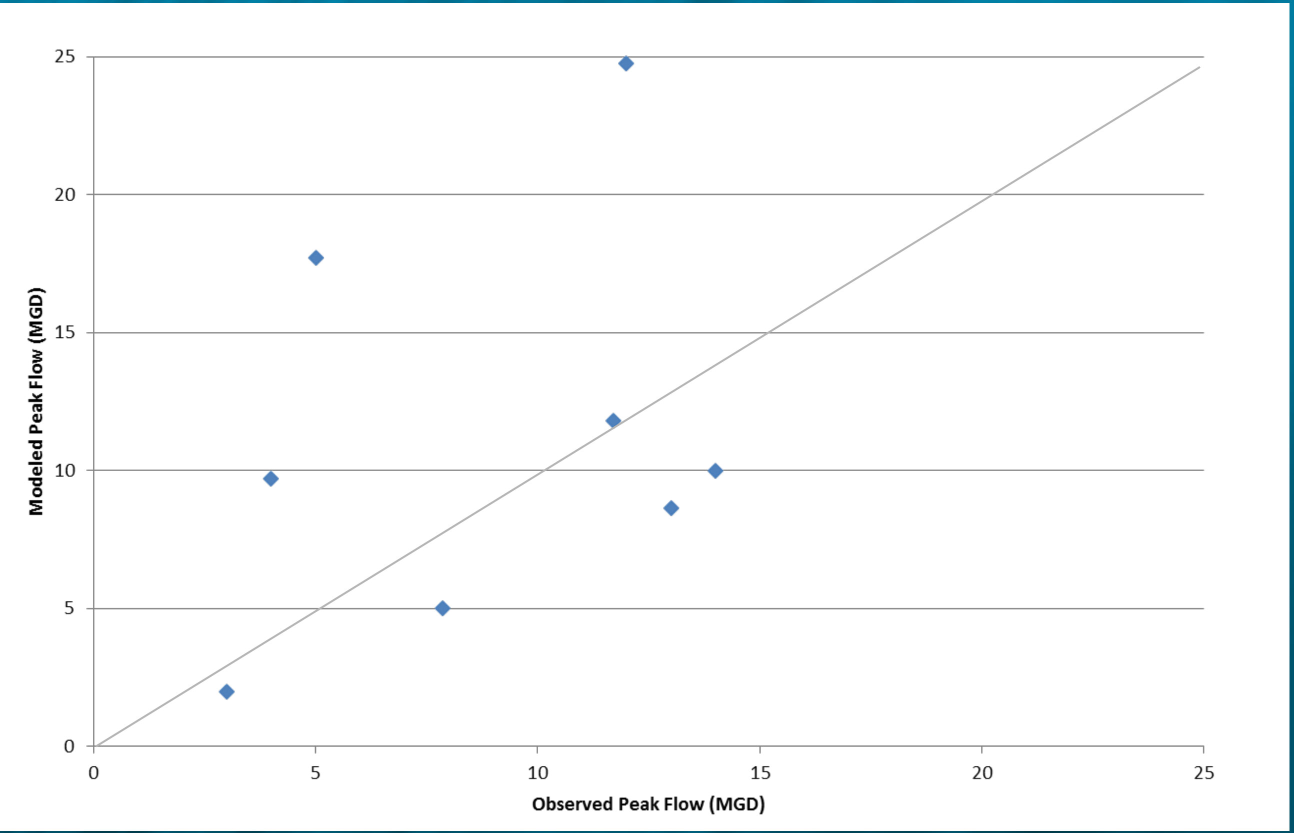


Relationship Between Reporting and Compliance: Predicted vs Observed at CSO 008

Limited Data Set:

Too few data points can lead to incorrect conclusions

Trends need to be evaluated over time



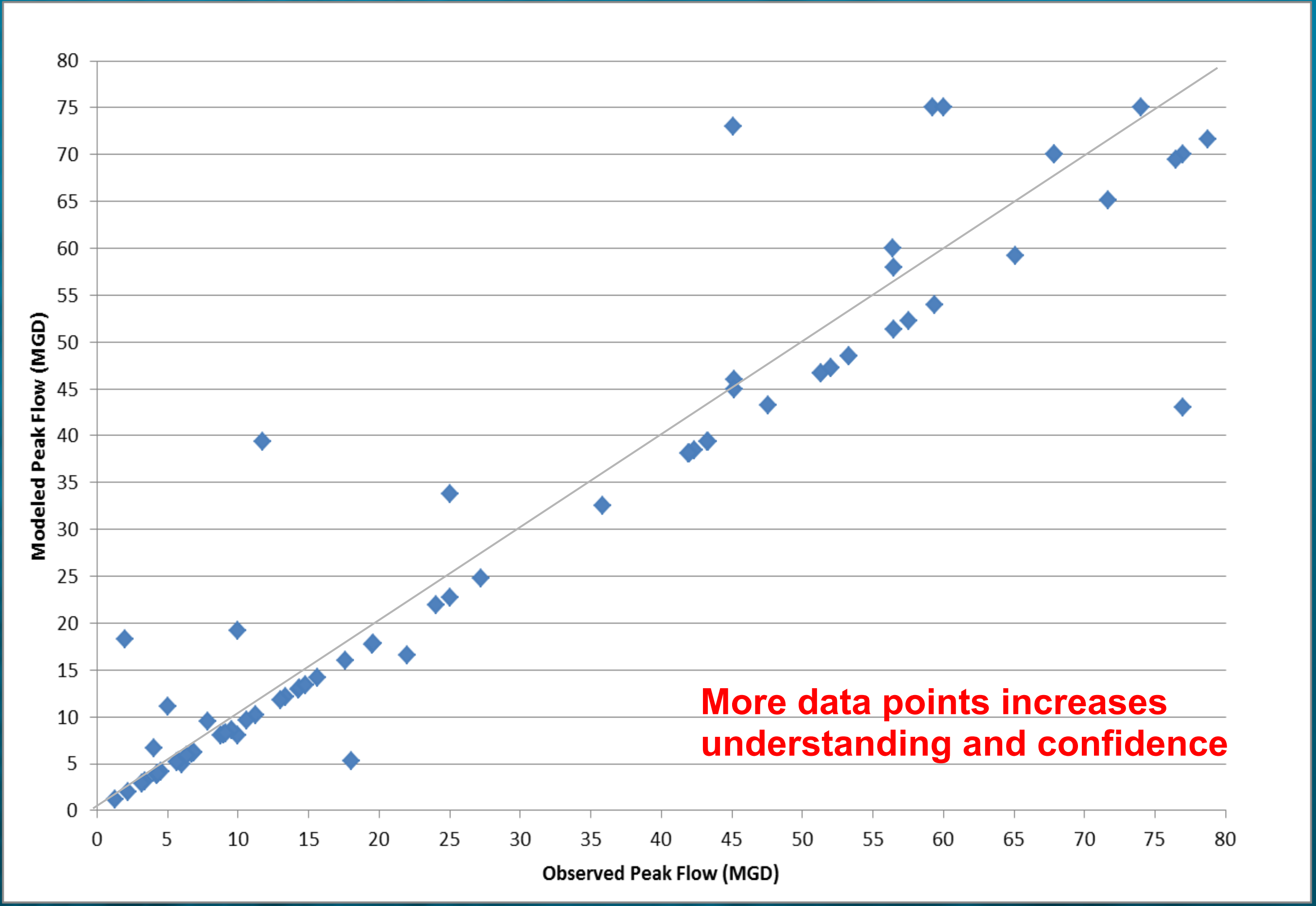
Relationship Between Reporting and Compliance: Predicted vs Observed at CSO 008

Larger Data Set:

Over time trends can become more apparent

Allows for evaluation and refinement

Compliance should to be measured against past performance



Relationship Between Reporting and Compliance: Lessons Learned Over Time

Lessons Learned:

1. Initially, compliance was evaluated against the Typical Year and the Commission just reported metered overflows

2. However, there are limitations to the value of just metered overflows (+/-) and the assumption that every year is the Typical Year

3. You need to look at actual rainfall and system performance relative to baseline compliance requirements (Current Year vs. Typical Year)

4. Metered overflow, measured rainfall, and model alignment are all married to compliance

Closing

1. Metering and monitoring programs need to be scaled to the objectives of the project and support “fit for purpose” modeling

2. Trends can only be identified with adequate periods of evaluation and with enough data points due to variability in natural systems

3. Criteria for evaluating projects can be expected to evolve over time as system understanding improves

4. Reporting needs to account for current conditions and how they stack up against design or compliance standards

Acknowledgements

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Thank You

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