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Model Forensics: Validating the Performance of a Hydraulic Model against a Design Storm that Actually Occurred

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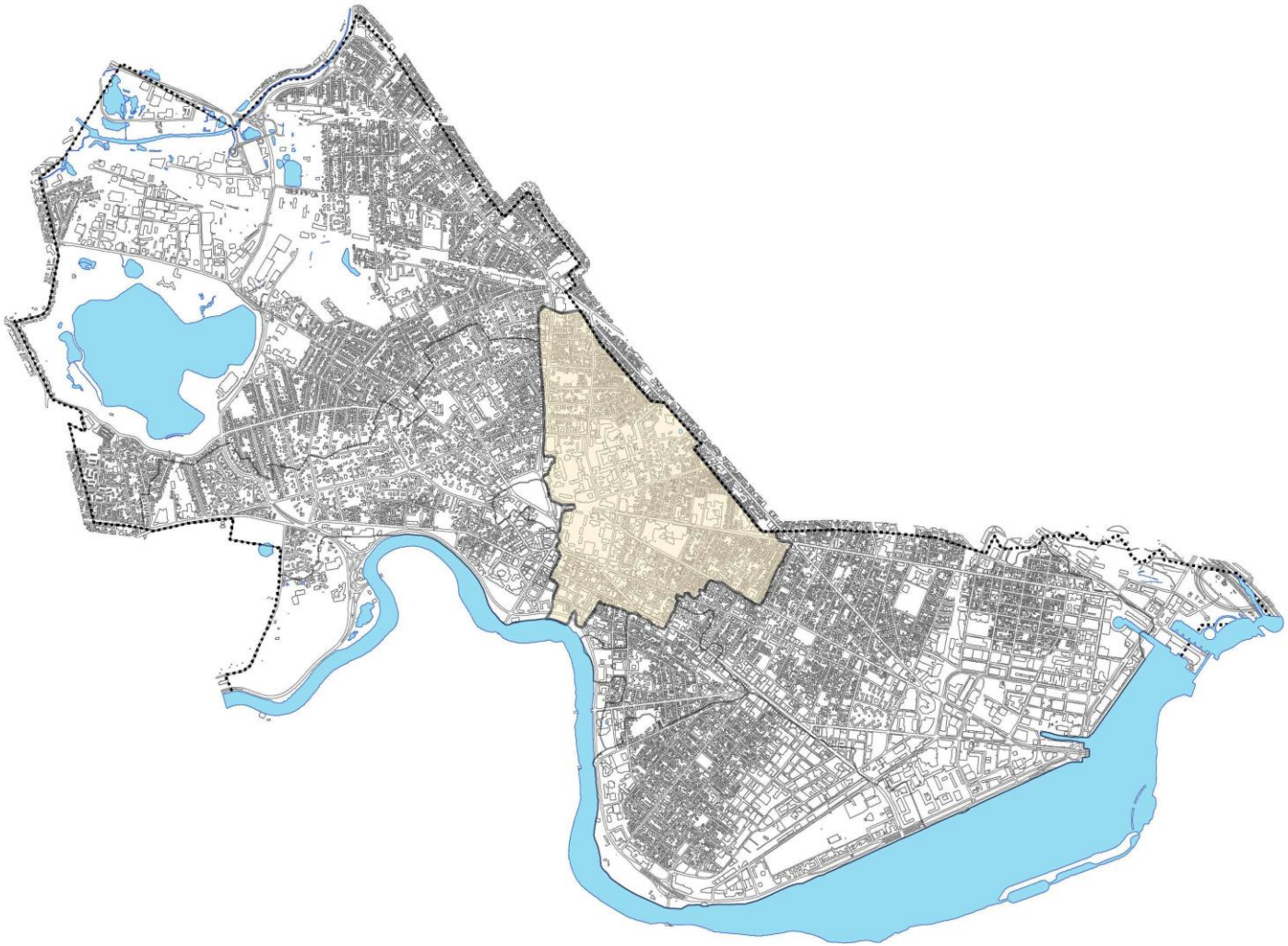
BUILDING A BETTER WORLD

Background: Cambridge's Area 13



Background

- Area 13 is a combination of separated and combined sewer systems
- Long-term area plan includes sequenced sewer separation and flood protection projects around the entire catchment
- Project sequencing resulted in numerous flood protection projects:
  - Crescent/Carver stormwater tanks
  - Scott/Holden stormwater tanks
  - Forest/Frost streets sewer separation
  - Myrtle/Magnolia sewer separation and Hovey Ave tank
  - Roberts Road sewer separation
  - Kirkland Street sewer separation
  - Etc.

Background

Scott/Holden Tanks

Hovey Avenue Tank

Area 13 Hydraulic Design Criteria

- Area 13 Master Plan's goal is to achieve a 25-year level of flood protection once all the projects in the plan are completed.

- One of the conditions of the phased approach is that each individual project had to provide flood protection for the 10-year, 24-hour NRCS storm at a minimum.

- Since this is a flood prone area, conveyance was designed using the NRCS storms with 15-minute time increments (same volume, higher intensities)

Engineers and Design Criteria

The interesting thing about design conditions is that they rarely ever occur!!

Engineers and Design Criteria

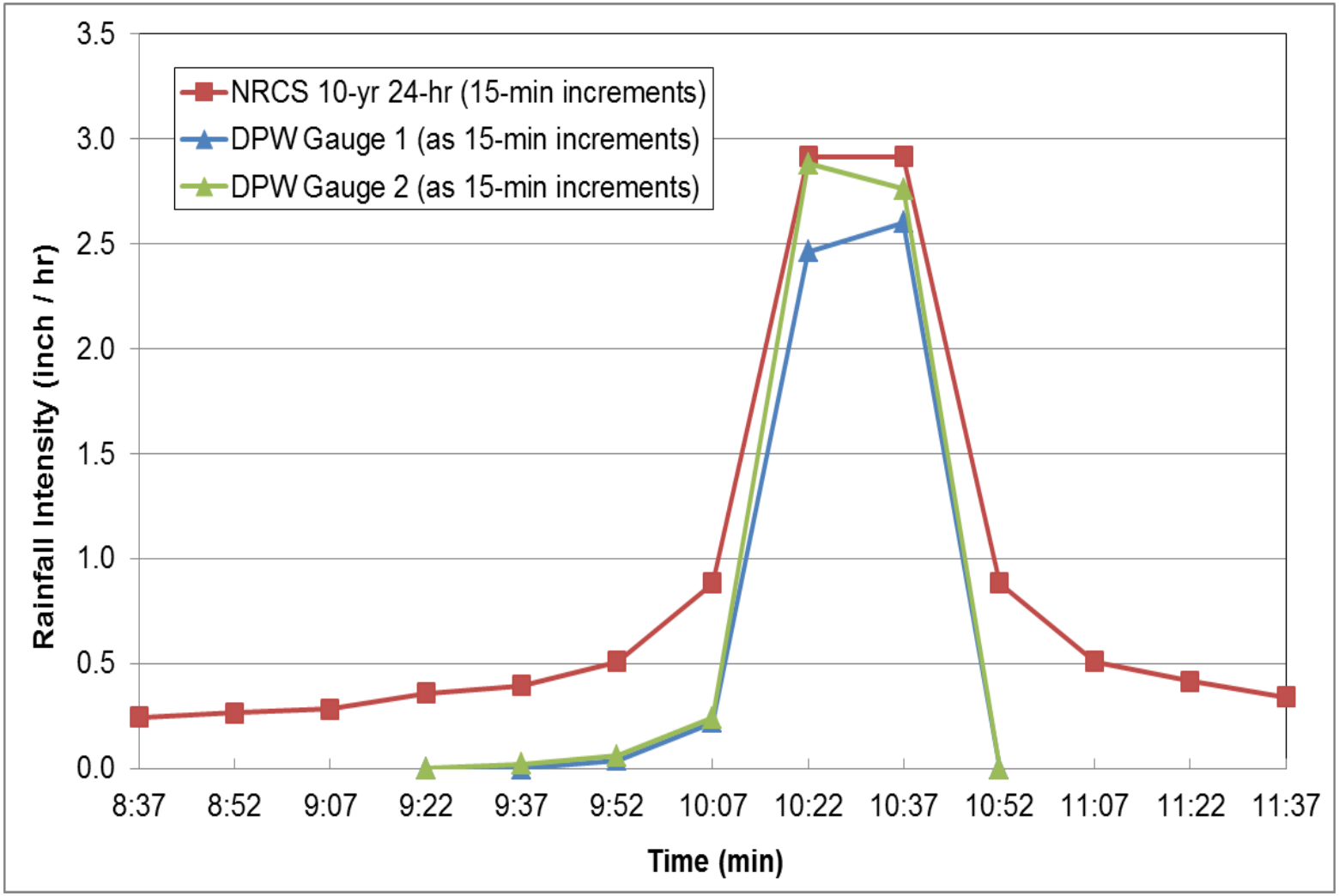
July 28th, 2014

- On July 28th 2014, after a powerful storm hit Area 13
- Several calls from residents with basement backups were received in Magnolia Avenue after the storm
- Several inches of street flooding were observed on Hovey and Magnolia Ave intersection and several complaints were received
- The M&M sewer separation project was completed in 2013 and is part of the Area 13 Master Plan
- CDPW tasked MWH to investigate if the new system performed as expected (was it properly sized?)

Analysis of the Storm Frequency

		STORM DURATION					
		1h	2h	3h	6h	12h	24h
	Jul 28th Max. Rainfall Accumulation (in)-CWD Gauge 2.	1.49	1.49	1.49	1.49	1.49	1.49
RETURN PERIOD	1yr	0.75	1.04	1.27	1.61	2.05	2.62
	2yr	0.94	1.26	1.59	2	2.51	3.15
	5yr	1.18	1.58	2.02	2.54	3.18	3.98
	10yr	1.4	1.87	2.42	3.05	3.81	4.75
	25yr	1.74	2.35	3.06	3.86	4.84	6
	50yr	2.07	2.79	3.68	4.65	5.8	7.17
	100yr	2.46	3.31	4.4	5.57	6.94	8.57
	200yr	2.92	3.93	5.28	6.68	8.33	10.25
	500yr	3.68	4.93	6.71	8.5	10.58	13

Analysis of the Storm's Rainfall Distribution

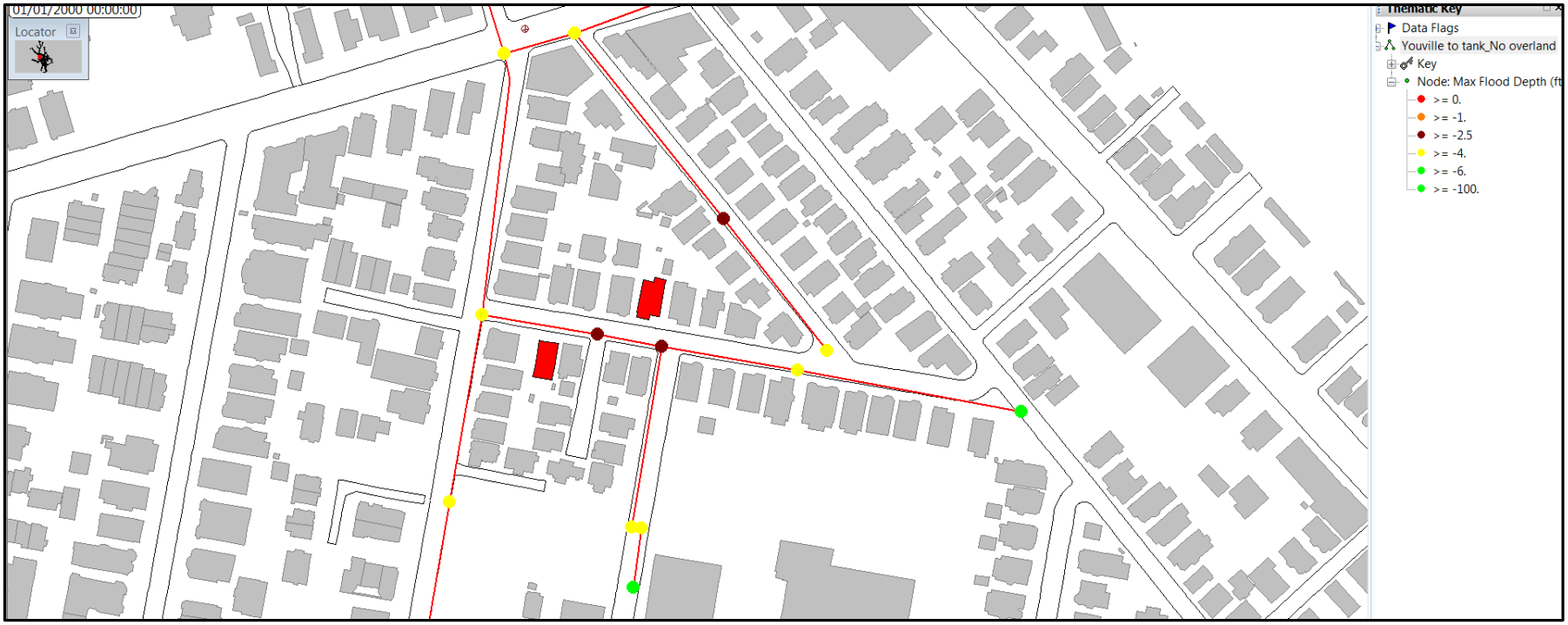


Engineer's Office after Rainfall Analysis

Sanitary System Performance

Sanitary sewer backups were reported at #9 and #20-22 Magnolia Avenue

Sanitary System Modeling



Stormwater System Performance

- The Hovey Ave stormwater tank had 68,000 gallons of storm water post storm

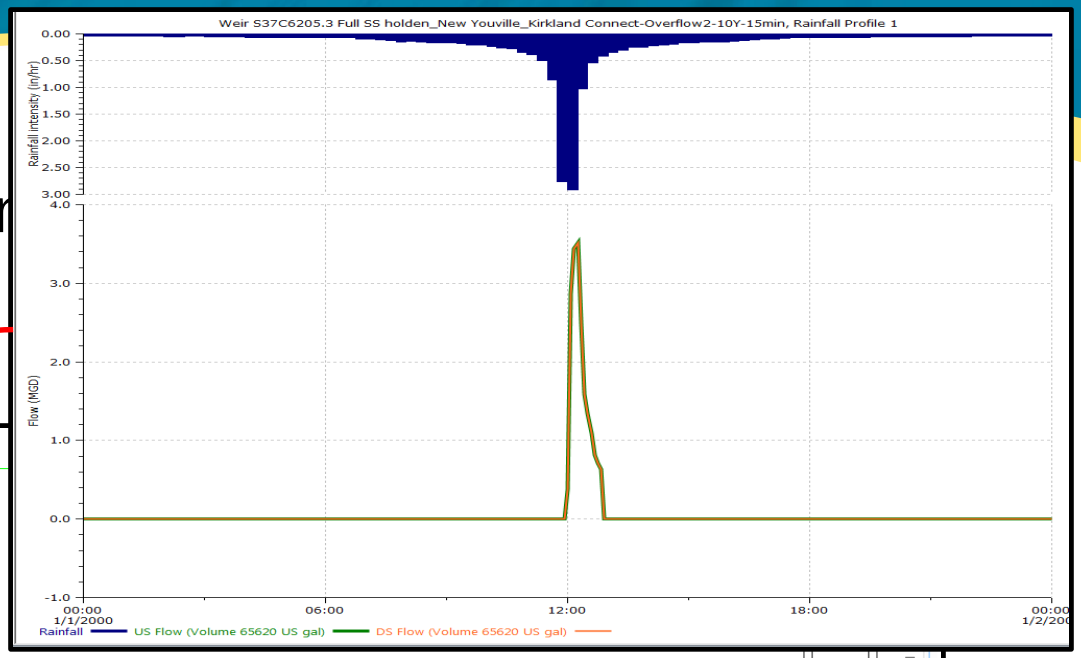
- Stormwater system doesn’t seem to have enough capacity? (surface flooding)

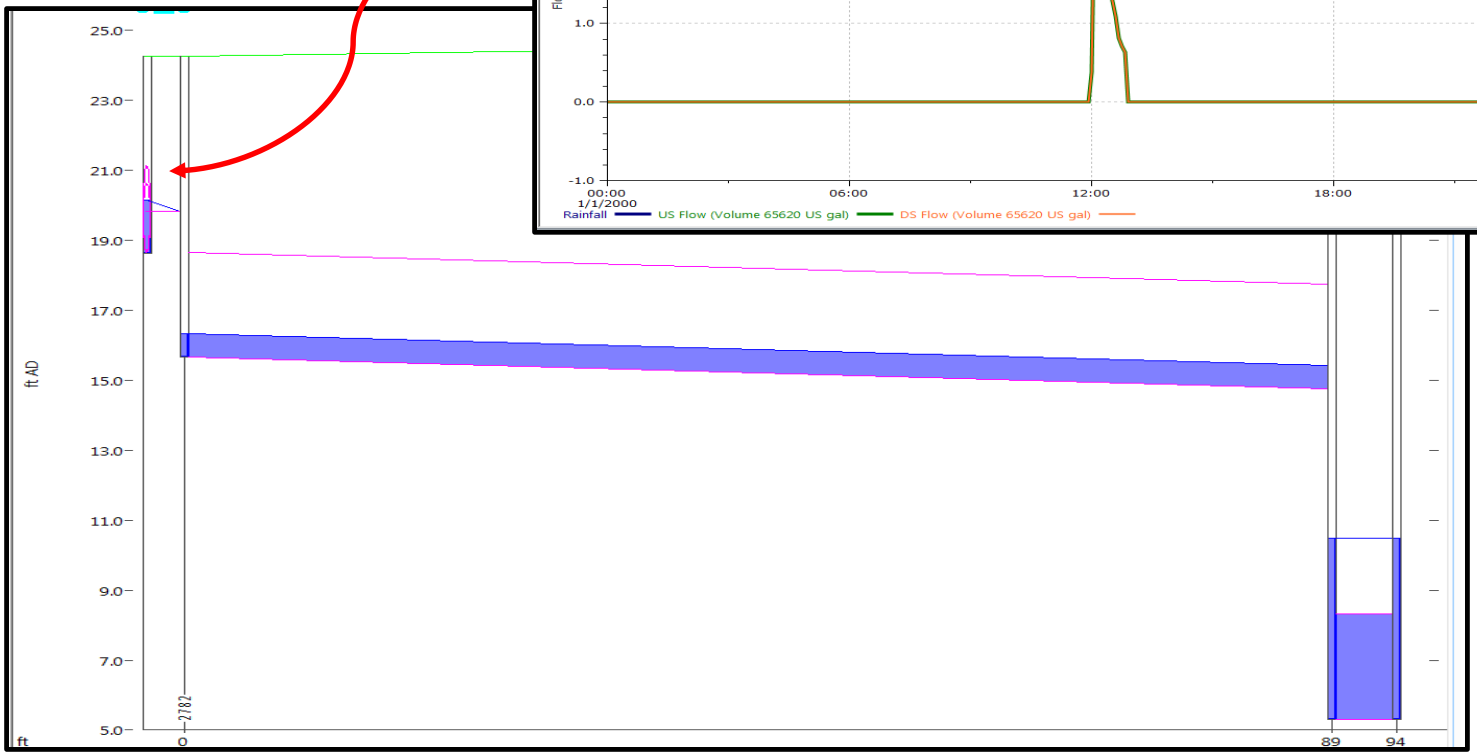
Stormwater Conveyance Modeling

The conveyance system performed well with freeboards of 4’ or more below ground

Stormwater Conveyance Modeling

The Hovey Ave Tar
stormwater



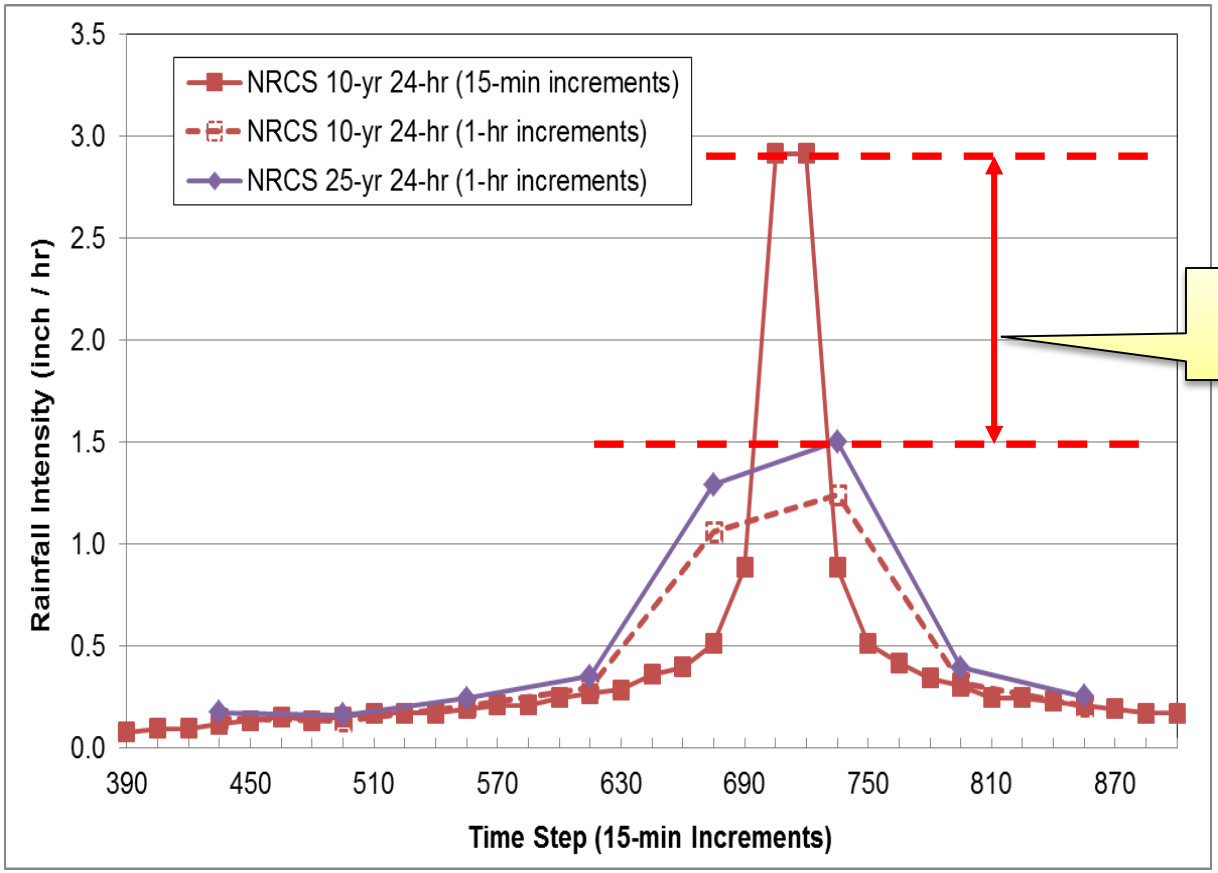


Surface Ponding Performance

- Several inches of ponding in the public ROW were observed at the Hovey Ave and Magnolia Ave intersections
- The model indicated there is enough conveyance capacity

Inlet Design

- Peak intensity criteria for inlet design was 1.50in/h (peak of the 25y, 24hr storm with 1-hour increments)



Surface Ponding and Inlet Design

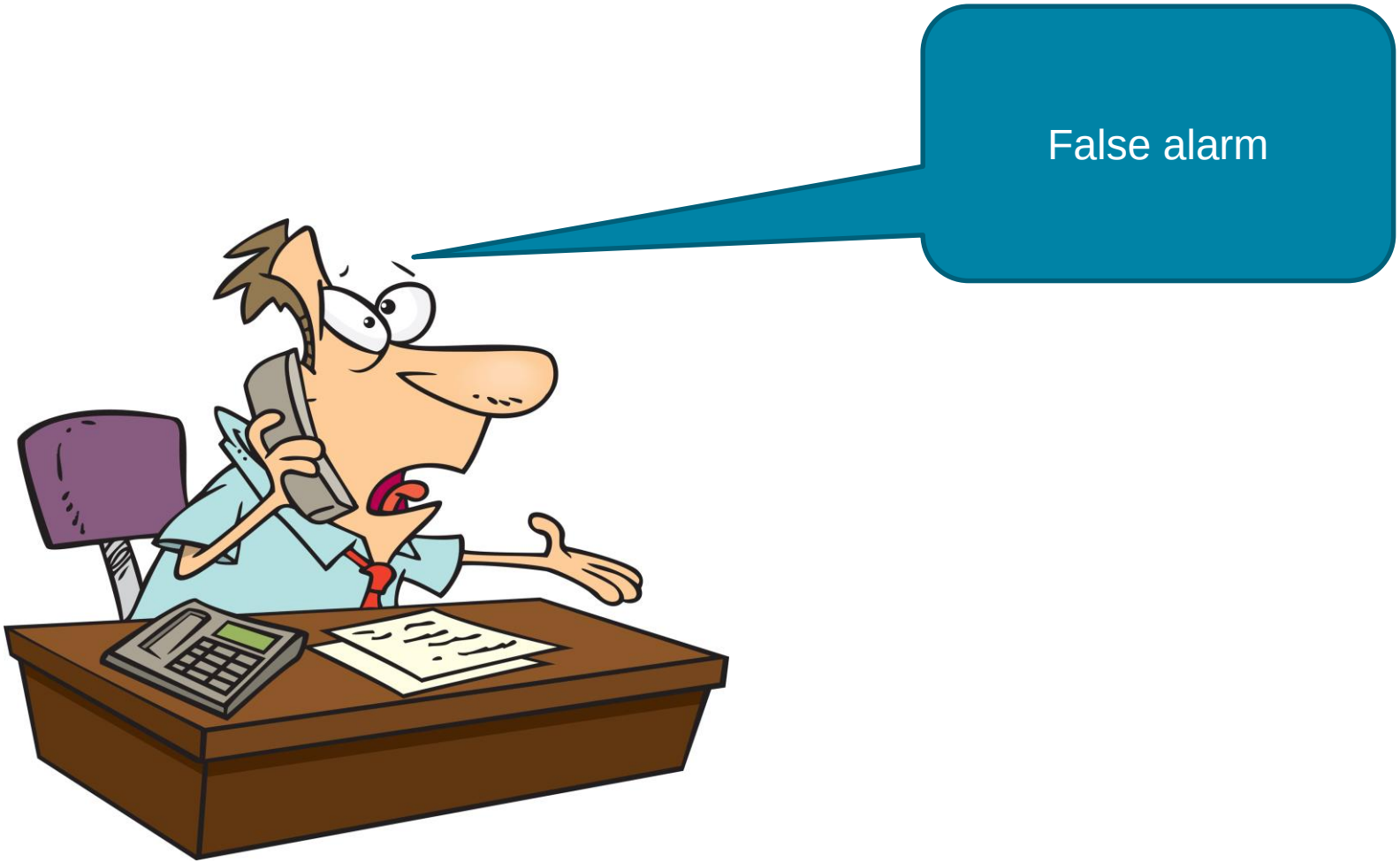
- Usage of public ROW was designed as storage for large storms as significantly increasing inlet capacity to 3in/h would be very costly.

- Surface storage was maximized by reducing the roadway crown in low topographical spots and by increasing curb reveals.

- Flooding occurred only in the public ROW

SO THE SYSTEM PERFORMED AS DESIGNED!

Meanwhile…



Conclusions

- The drain pipelines and Hovey Tank functioned as designed throughout the storm. Storm water conveyance was not an issue.
- The catch basin inlets were over their design capacity for 20+ minutes during a period of intense rainfall.
- The reduced roadway crown along Magnolia Avenue stored potentially damaging flooding during intense rainfall.
- The sewer pipeline surcharged near the ground surface due to area-wide hydraulic limitations.
- The western half of Magnolia Avenue remains prone to basement sewer backups until long-term planned improvements are completed.

THANK YOU!

Questions