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“Smart” Stormwater Management

Village of Carol Stream’s Kimberly North Stormwater Study

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September 2, 2022

Outline

- Background
- Methodology (EPA SWMM)
- “Smart” Stormwater Management
- Conclusions

Background

- History of Stormwater Management in Village
- Klein Creek Watershed / Study Area
- May 2020 Flood Event
- Water Level Loggers

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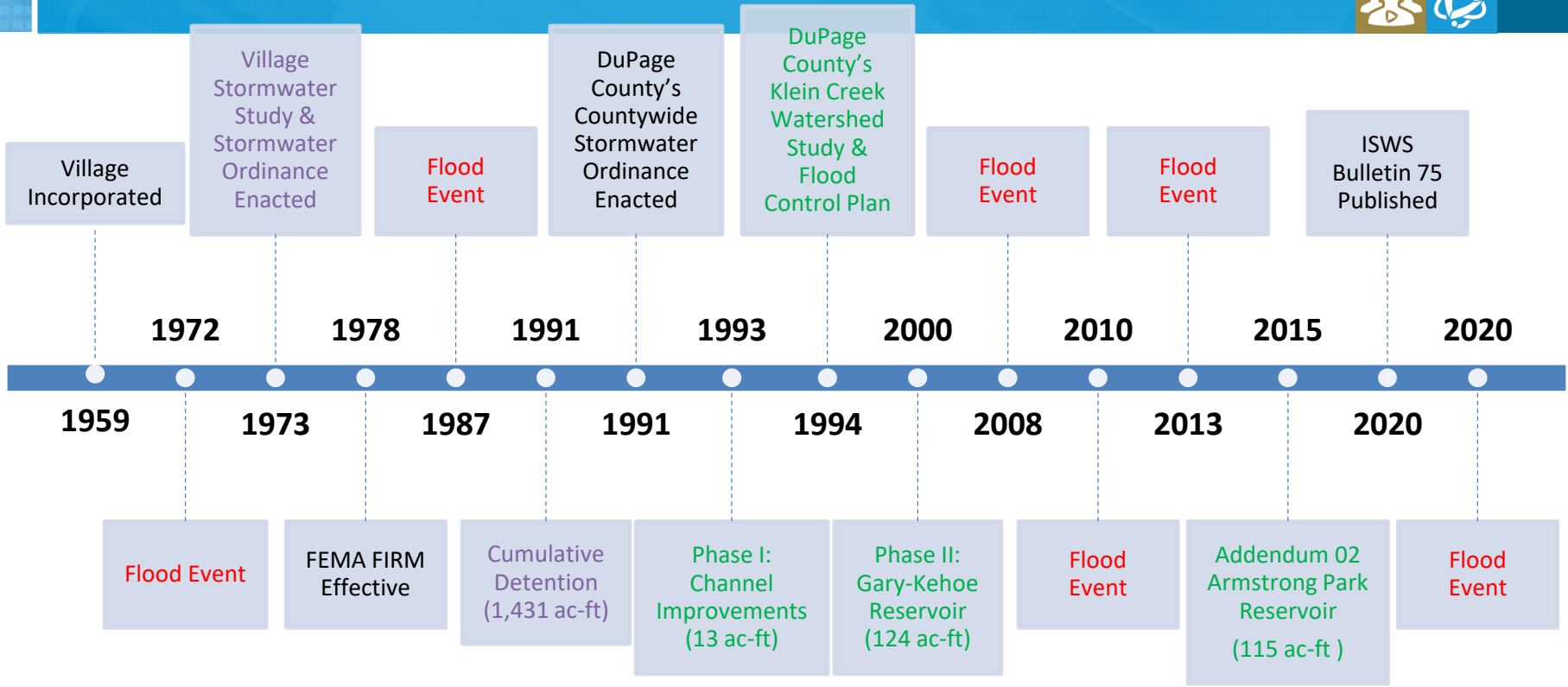
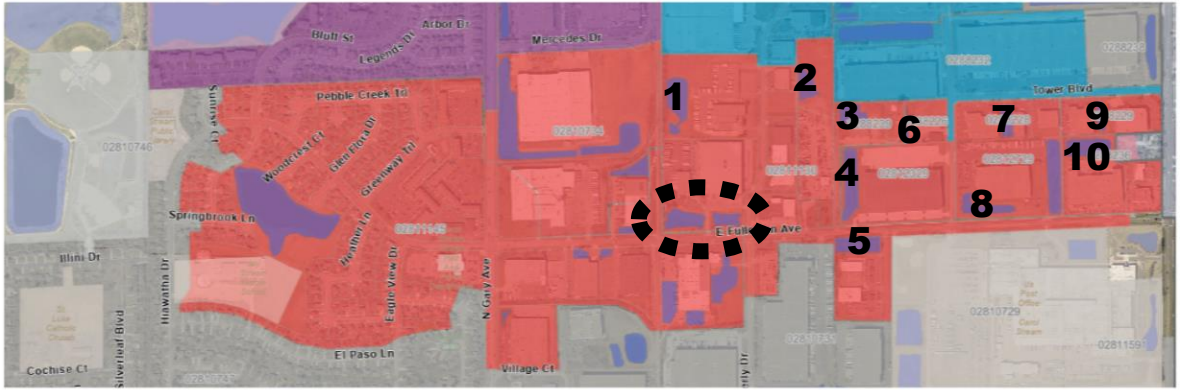
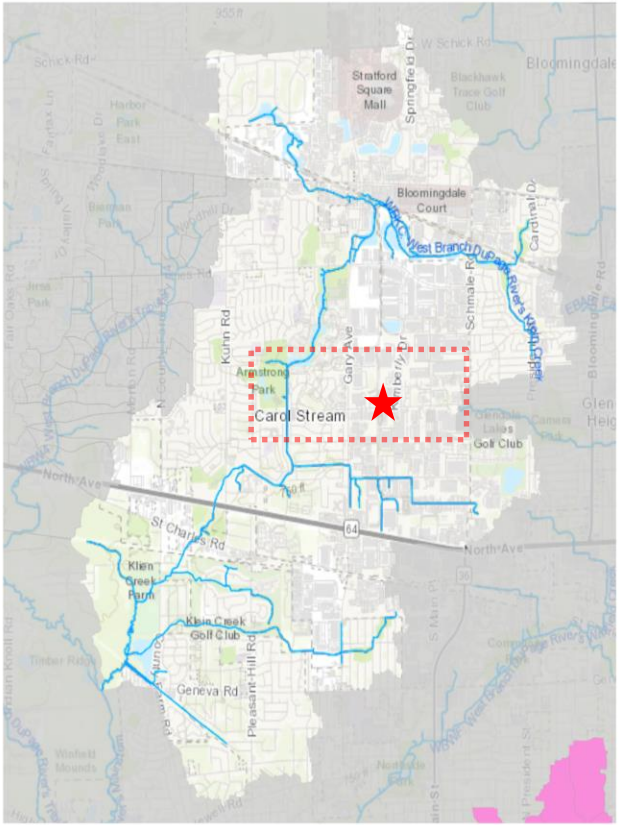
History

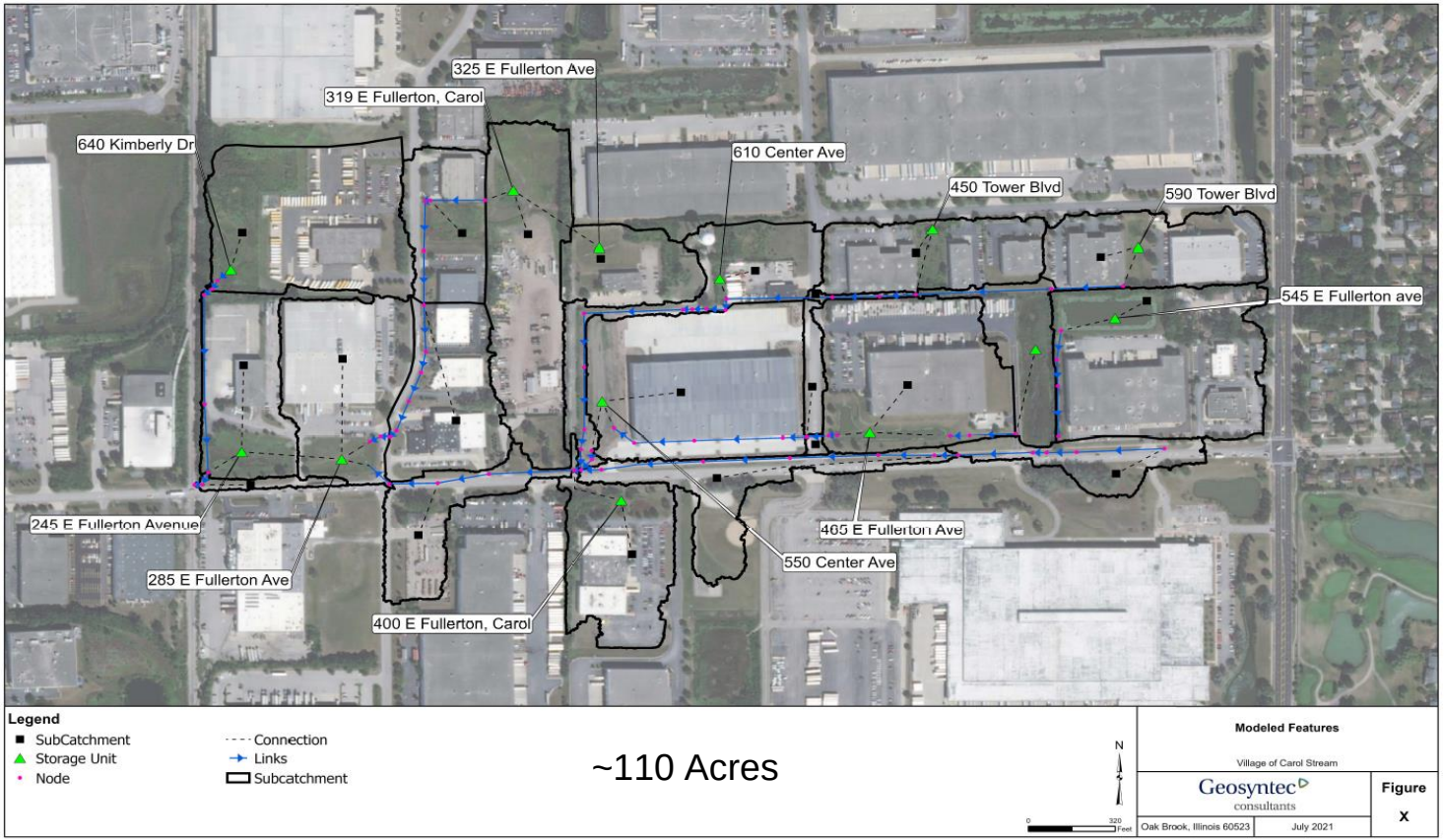

Village Incorporated
Village Stormwater Study & Stormwater Ordinance Enacted
Flood Event
DuPage County's Countywide Stormwater Ordinance Enacted
DuPage County's Klein Creek Watershed Study & Flood Control Plan
Flood Event
Flood Event
ISWS Bulletin 75 Published
1959
1972
1978
1991
1993
2000
2010
2015
2020
Flood Event
FEMA FIRM Effective
Cumulative Detention (1,431 ac-ft)
Phase I: Channel Improvements (13 ac-ft)
Phase II: Gary-Kehoe Reservoir (124 ac-ft)
Flood Event
Addendum 02 Armstrong Park Reservoir (115 ac-ft)
Flood Event
1973
1987
1991
1994
2008
2013
2020

Klein Creek Watershed



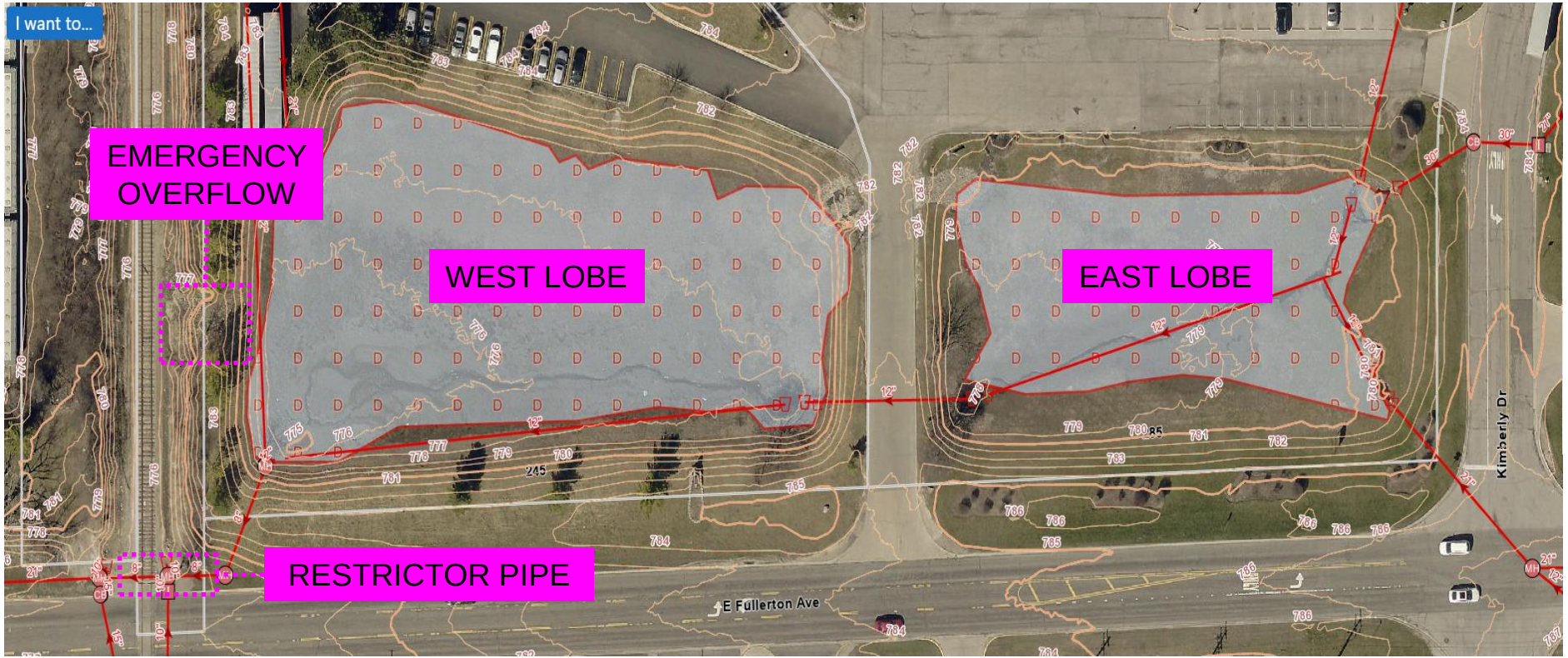


Study Area



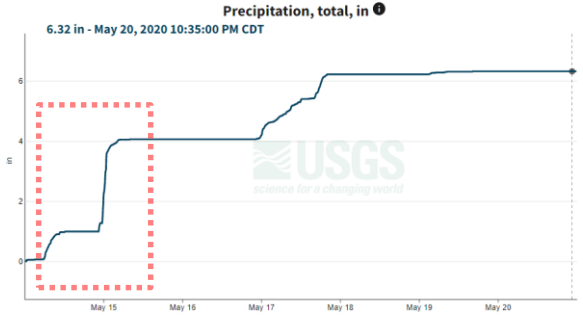
~110 Acres

Kimberly North Detention Basins

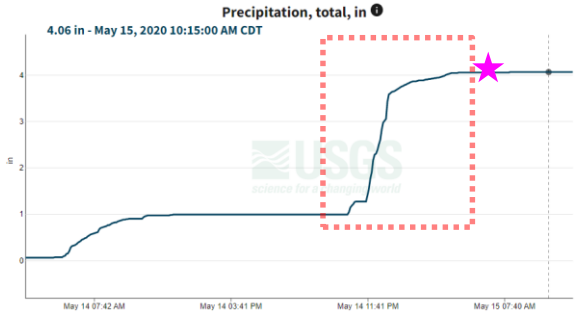


May 2020 Flood Event

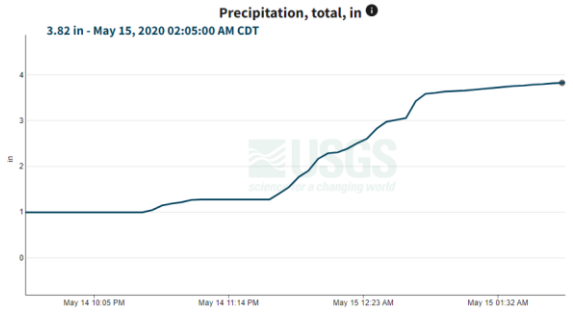
May 2020 Flood Event



72 hours –> 6.3 in –> 10 yr

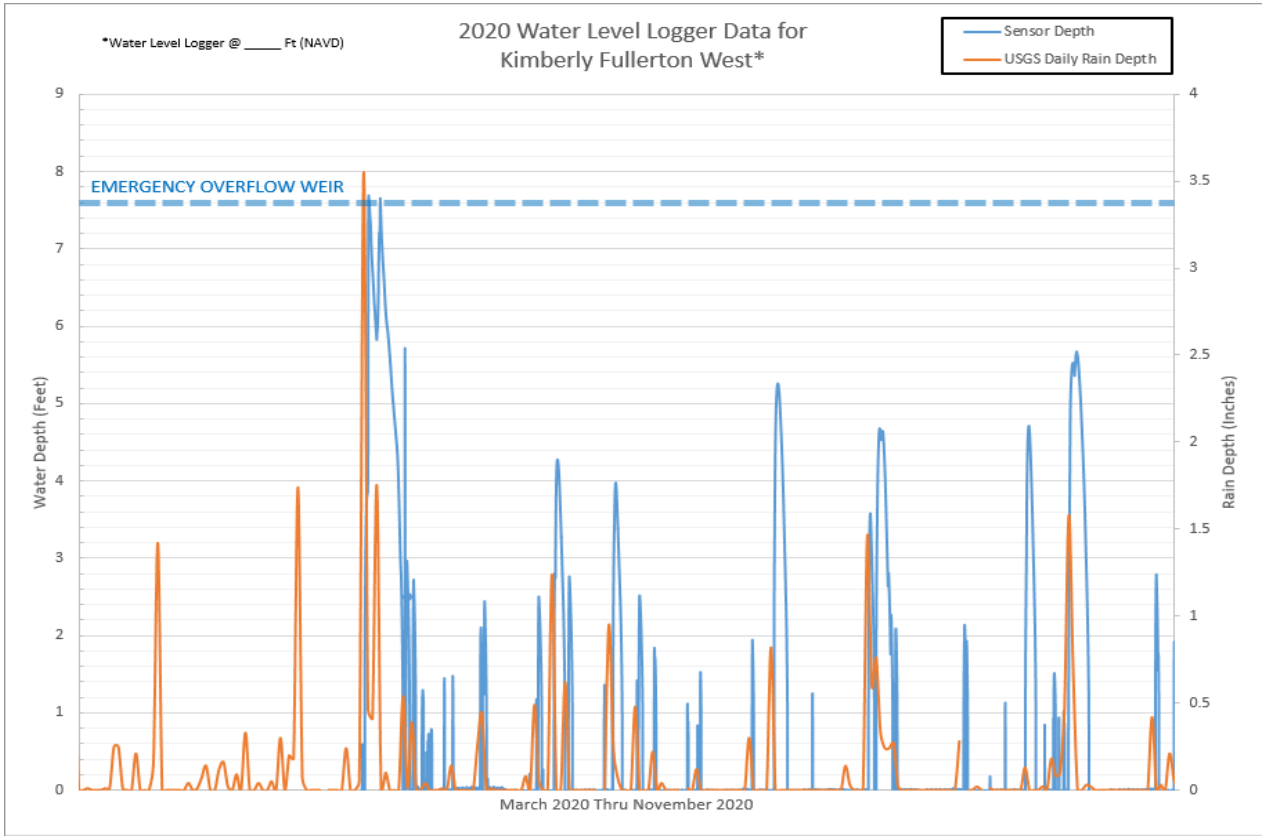


24 hours –> 4.0 in –> 5 yr



2 hours –> 2.8 in –> 10 yr

Water Level Loggers



Methodology (EPA SWMM)

- **Model Framework**
- **Model Development**
- **Model Calibration**
- **Alternative Analysis**

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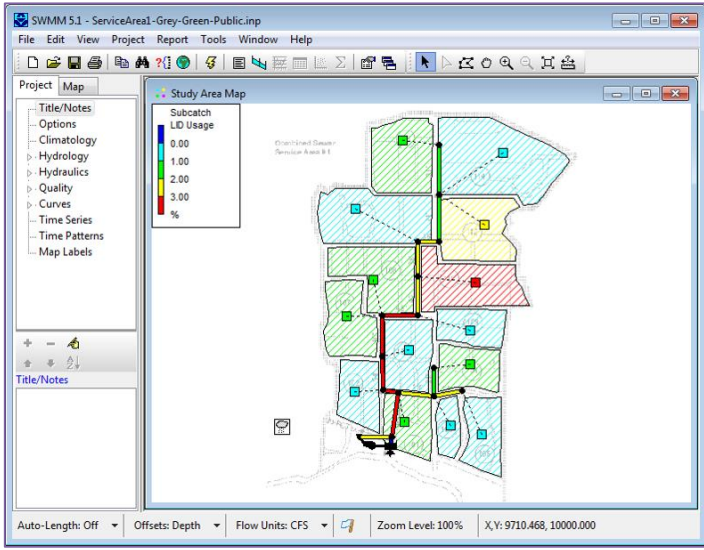
Modeling Framework

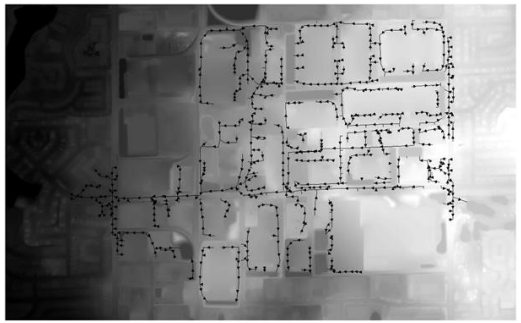
- Developed a Storm Water Management Model (SWMM) to simulate existing conditions
  - Continuous Simulation
  - Hydrology
  - Hydraulic
  - Real-Time Controls



- Calibrated model to measured data

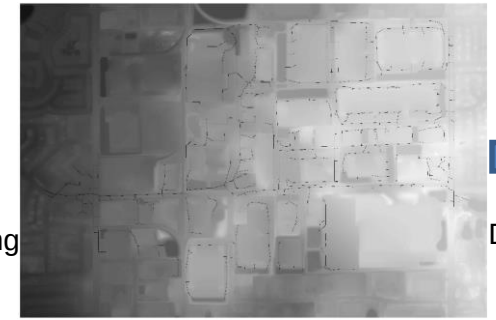
- Used the model to evaluate alternatives to mitigate flooding

Model Development



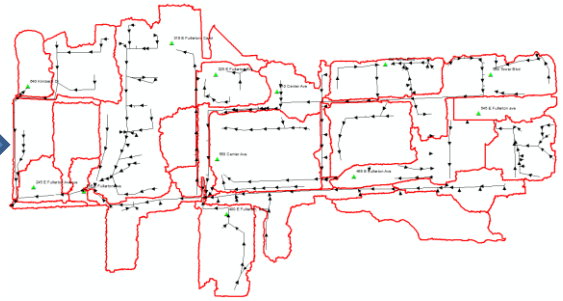
Bare Earth DEM with sewer network overlaid

DEM Reconditioning



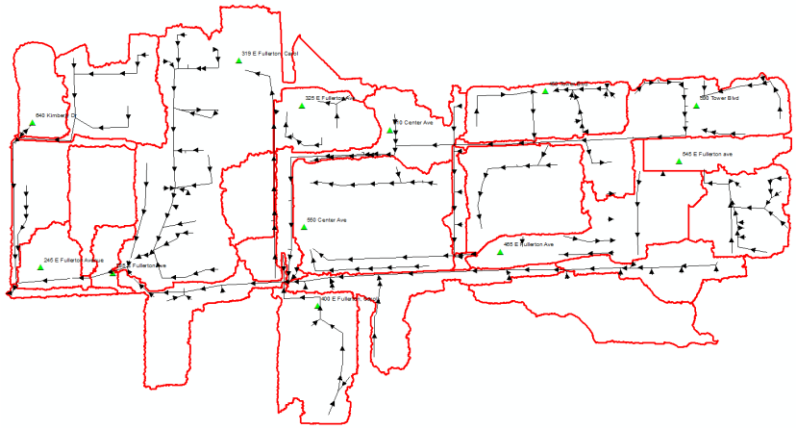
DEM with sewer network burned

Delineation



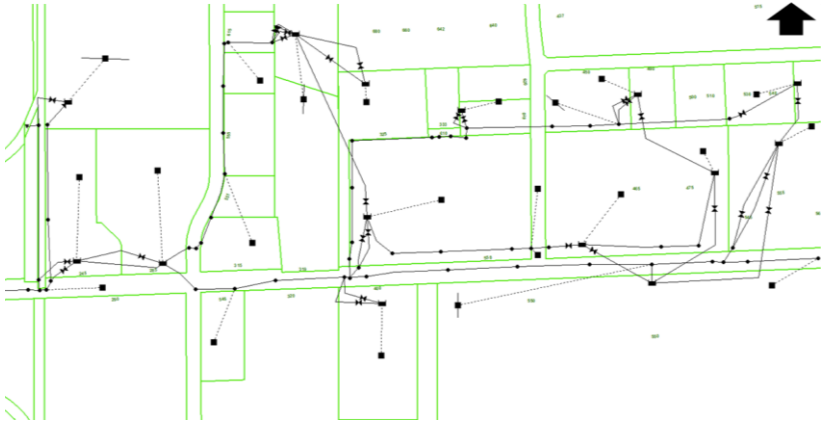
Delineated subwatersheds with storm sewer network in GIS

Model Development



Delineated subwatersheds with storm sewer network in GIS

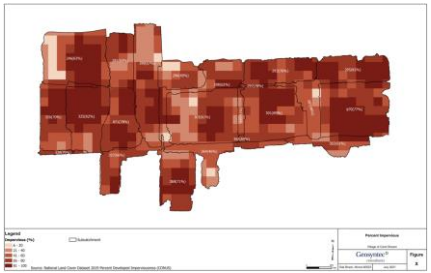
Open Source Python Scripts (PySWMM)



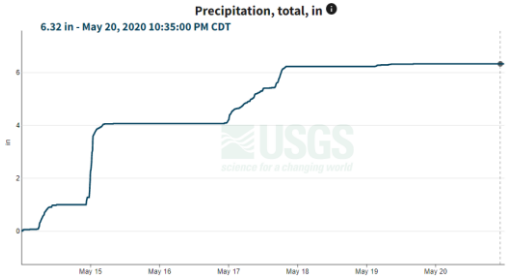
SWMM Model

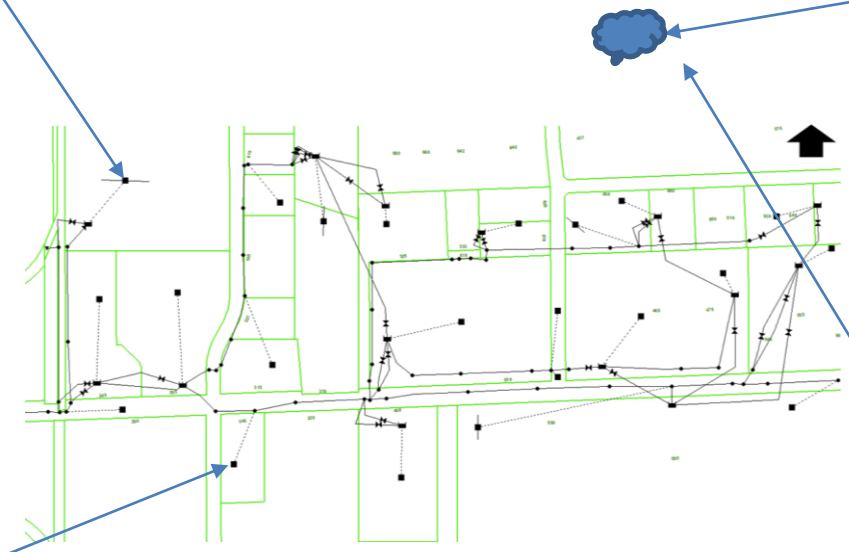
Model Development

Subwatershed Imperviousness

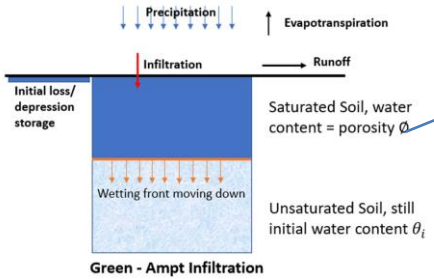


May 2020 storm



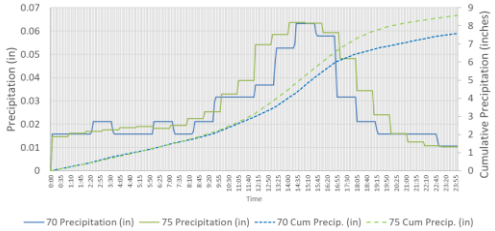


Infiltration Parameters

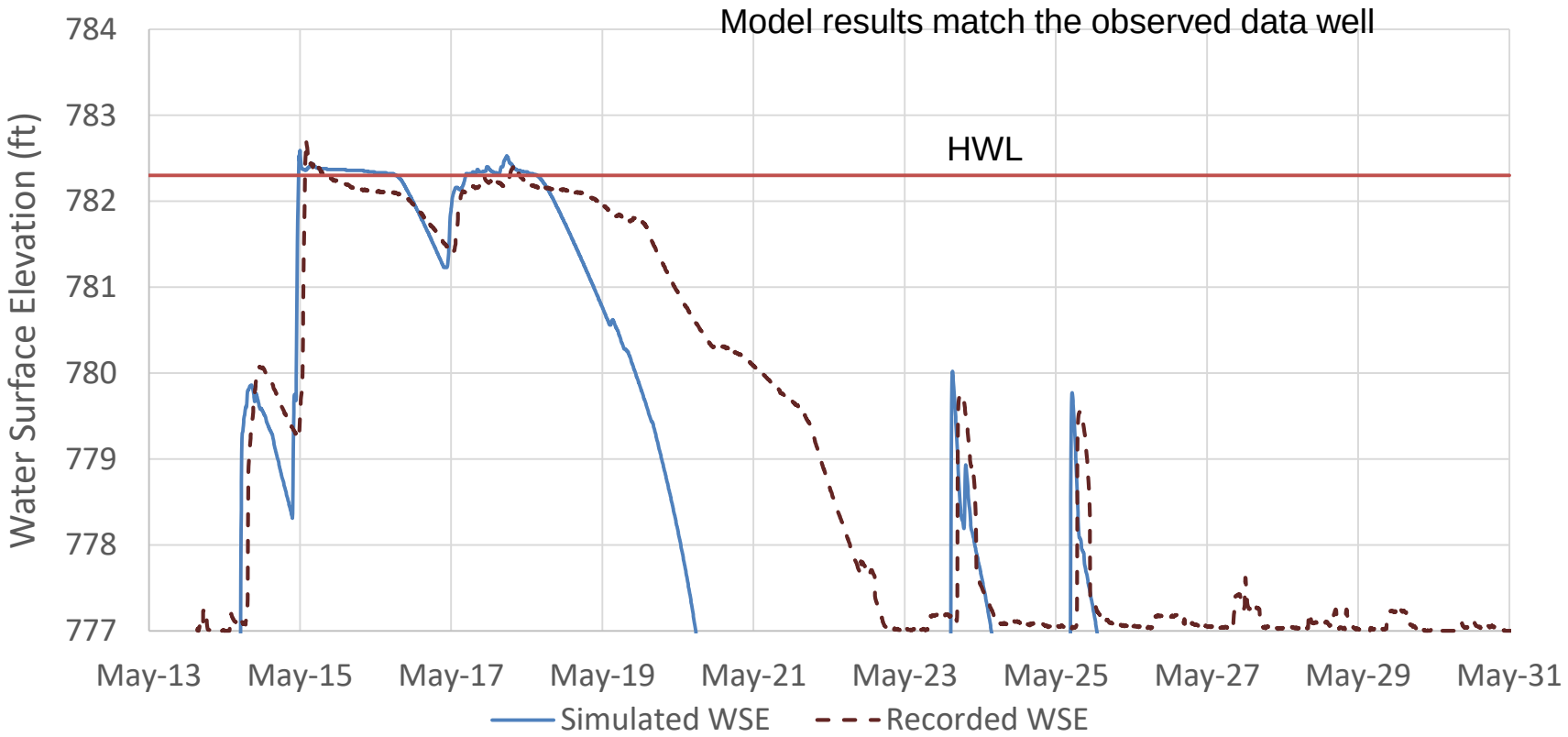


SWMM Model

Bulletin 70 and 75, 100-yr 24-hr storms

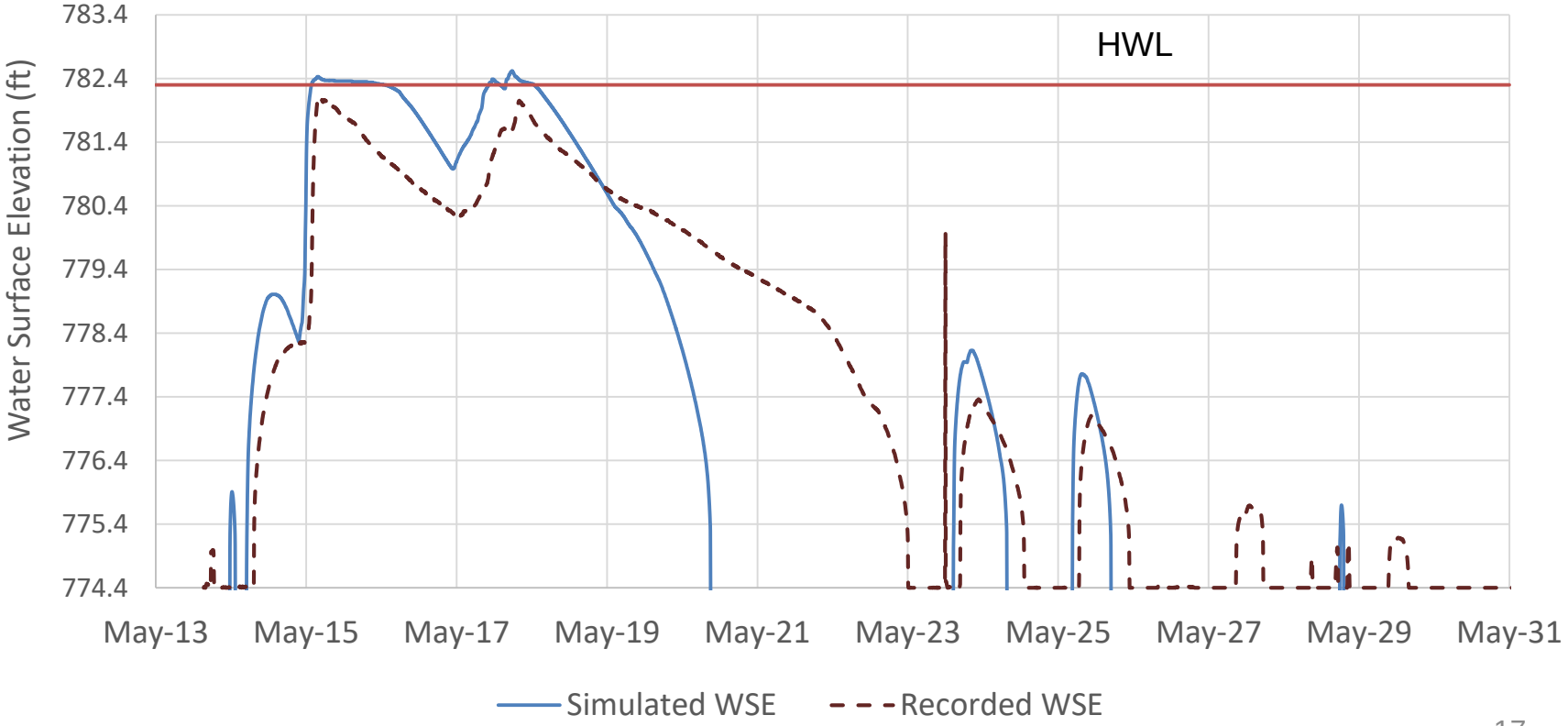


Model Calibration – 285 E Fullerton



Model Calibration – 245 E. Fullerton

Model results match the observed data well



Alternative Analysis

Traditional Solutions

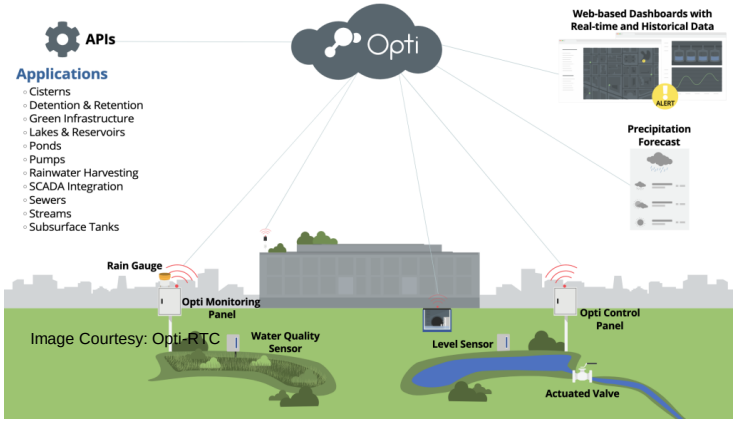


Image Courtesy: Opti-RTC

"Smart" Stormwater Management (aka Real Time Control)

“Smart” Stormwater Management

- EPA SWMM CONTROL RULES
- MAY 2020 STORM SIMULATIONS
- STORAGE UTILIZATION

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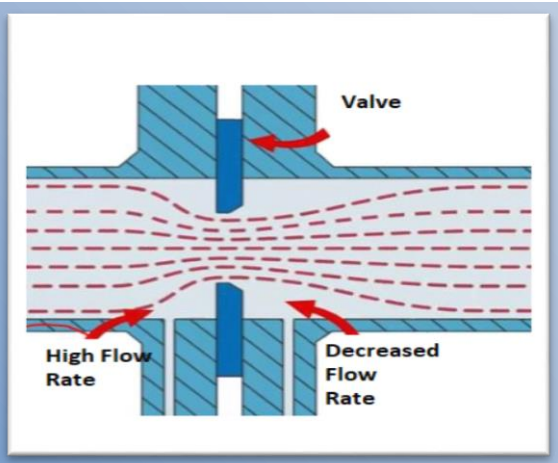
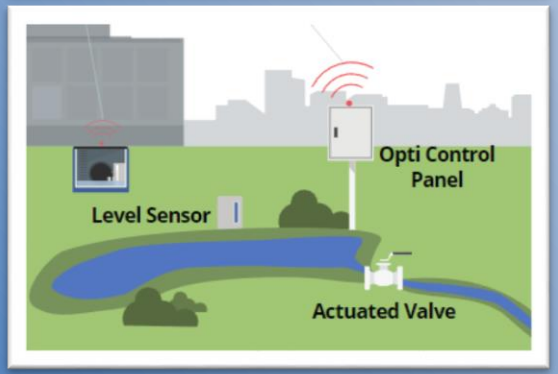
EPA SWMM CONTROL RULES





Rule Format

Each control rule is a series of statements of the form:

```
RULE   ruleID

IF     condition_1
AND    condition_2
OR     condition_3
AND    condition_4
Etc.

THEN   action_1
AND    action_2
Etc.

ELSE   action_3
AND    action_4
Etc.

PRIORITY value
```

Some examples of condition clauses are:

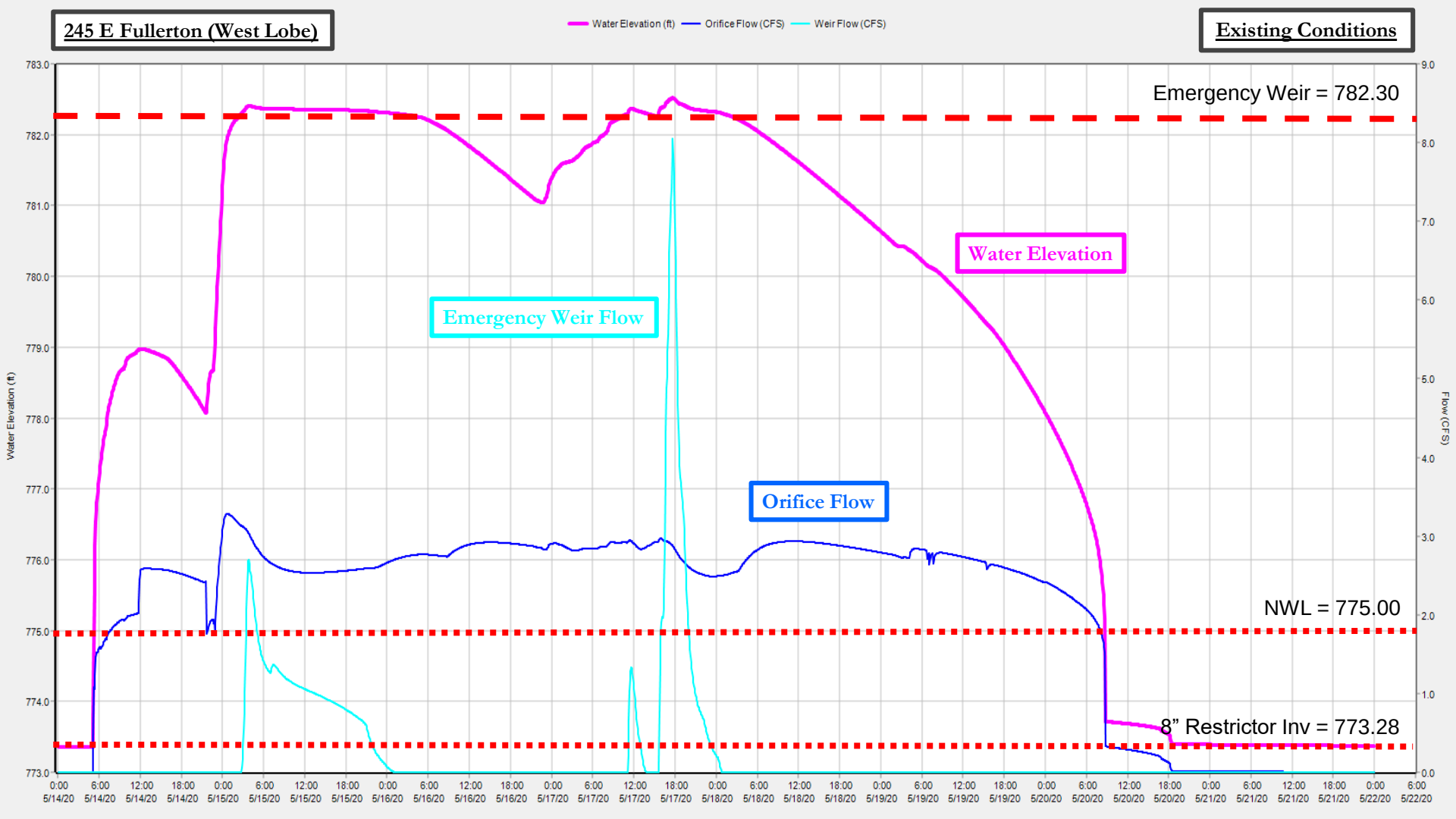
```
NODE   N23   DEPTH   >   10
NODE   N23   DEPTH   >   NODE 25 DEPTH
PUMP   P45   STATUS  =   OFF
LINK   P45   TIMEOPEN >= 6:30
SIMULATION CLOCKTIME = 22:45:00
```

The objects and attributes that can appear in a condition clause are as follows:

Object	Attributes	Value
NODE	DEPTH	numerical value
	HEAD	numerical value
	VOLUME	numerical value
	INFLOW	numerical value
LINK	FLOW	numerical value
	DEPTH	numerical value
	TIMEOPEN	decimal hours or hr:min
	TIMECLOSED	decimal hours or hr:min

Control Rules Editor

```
RULE 245A
IF SIMULATION DATE <= 05/15/2020
THEN ORIFICE 245_0283600 SETTING = 0.3
ELSE ORIFICE 245_0283600 SETTING = 1.0

RULE 319A
IF NODE 319 HEAD > 790
THEN ORIFICE 319_02885669 SETTING = 1.0
ELSE ORIFICE 319_02885669 SETTING = 0.0

RULE 319B
IF SIMULATION DATE >= 05/19/2020
THEN ORIFICE 319_02885669 SETTING = 1.0
PRIORITY 5

RULE 319C
IF SIMULATION DATE >= 05/14/2020
THEN WEIR 319_INTERNALWEIR1 SETTING = 0.0
PRIORITY 5

RULE 319D
IF SIMULATION DATE >= 05/14/2020
THEN WEIR 319_INTERNALWEIR2 SETTING = 0.0
PRIORITY 5


RULE 465A
IF NODE 465 HEAD > 800.5
THEN ORIFICE 465_02865709 SETTING = 0.1
ELSE ORIFICE 465_02865709 SETTING = 0.0
PRIORITY 1
```


245 E Fullerton (West Lobe)
Existing Conditions
Water Elevation (ft)
Orifice Flow (CFS)
Weir Flow (CFS)
Emergency Weir = 782.30
Water Elevation
Emergency Weir Flow
Orifice Flow
NWL = 775.00
8” Restrictor Inv = 773.28
Water Elevation (ft)
Flow (CFS)
783.0
782.0
781.0
780.0
779.0
778.0
777.0
776.0
775.0
774.0
773.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0:00 5/14/20
6:00 5/14/20
12:00 5/14/20
18:00 5/14/20
0:00 5/15/20
6:00 5/15/20
12:00 5/15/20
18:00 5/15/20
0:00 5/16/20
6:00 5/16/20
12:00 5/16/20
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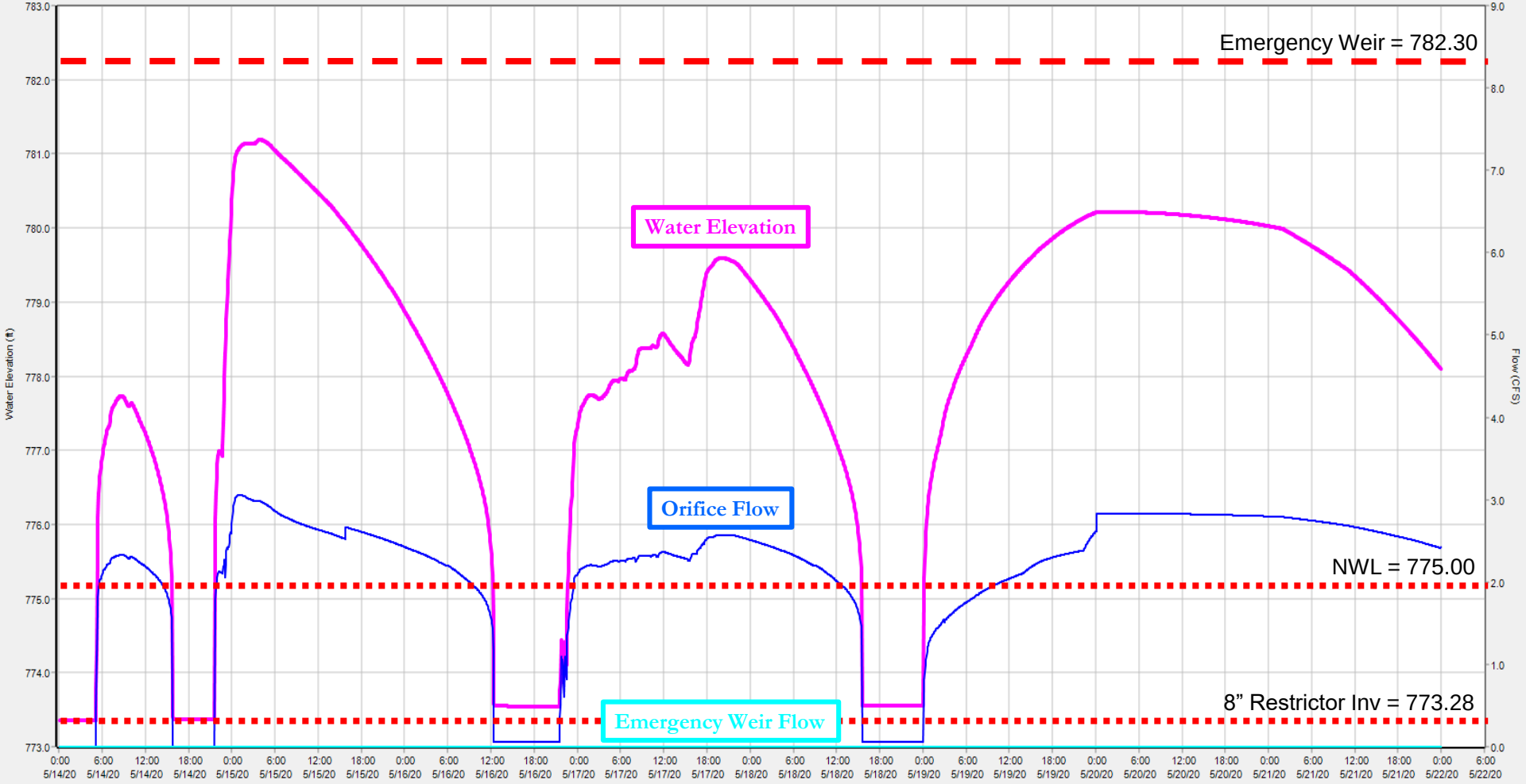
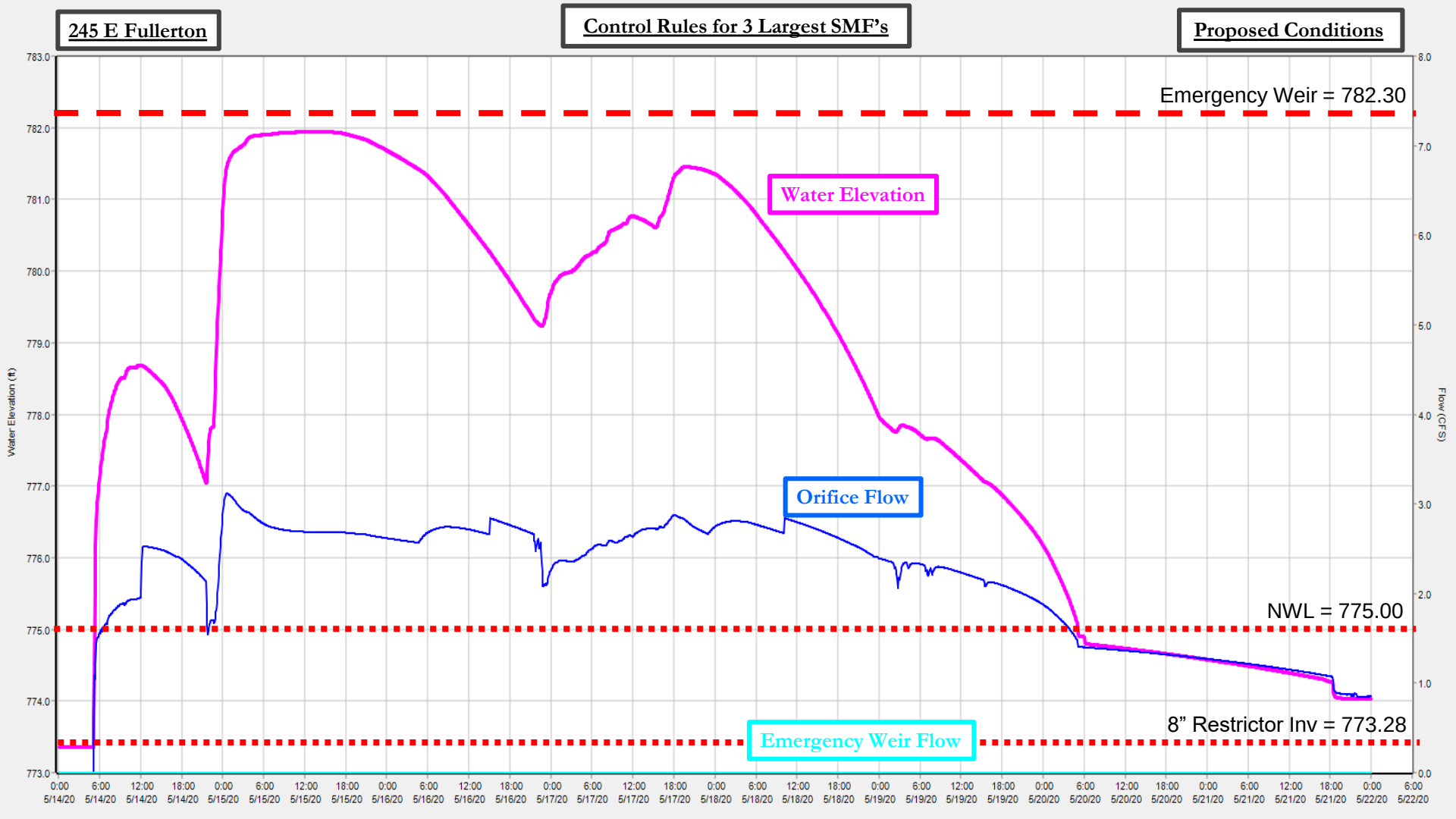
245 E Fullerton

Control Rules for All 10 SMF's

Proposed Conditions




245 E Fullerton
Control Rules for 3 Largest SMF's
Proposed Conditions
Emergency Weir = 782.30
Water Elevation
Orifice Flow
NWL = 775.00
Emergency Weir Flow
8" Restrictor Inv = 773.28
Water Elevation (ft)
Flow (CFS)
783.0
782.0
781.0
780.0
779.0
778.0
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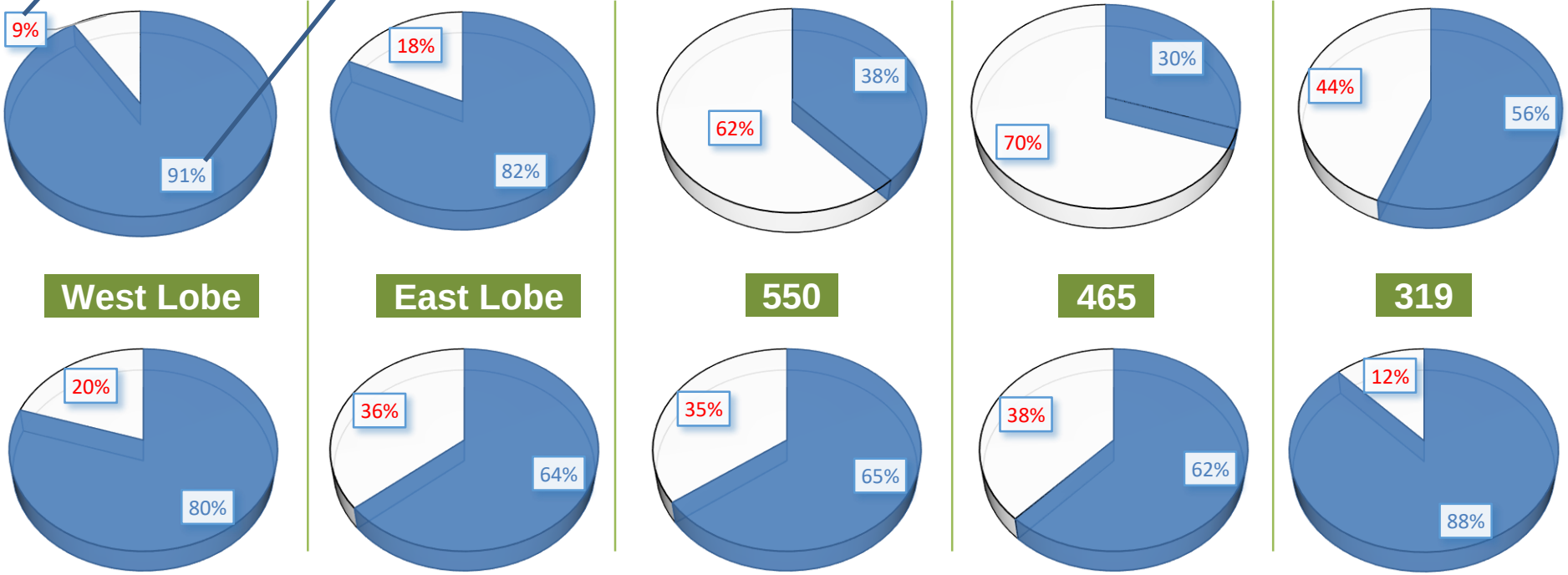
STORAGE UTILIZATION

UNUSED STORAGE

MAX. STORAGE*

EXISTING



*Emergency weir flow occurs @ >80%

CONTROL RULES

Conclusions

- **Using EPA SWMM's Control Rules is "easy"!**
- **"Smart" Stormwater Management (aka Real Time Controls) could have eliminated flooding on May 15, 2020 (10-Year Recurrence Interval).**
- **Existing storage and conveyance infrastructure does not change; just need to retrofit the restrictors.**
- **The utilization rate (by volume) of the existing stormwater management facilities nearly doubled.**
- **Maximum effectiveness is most likely to be in the recurrence intervals between 10 and 25 years.**

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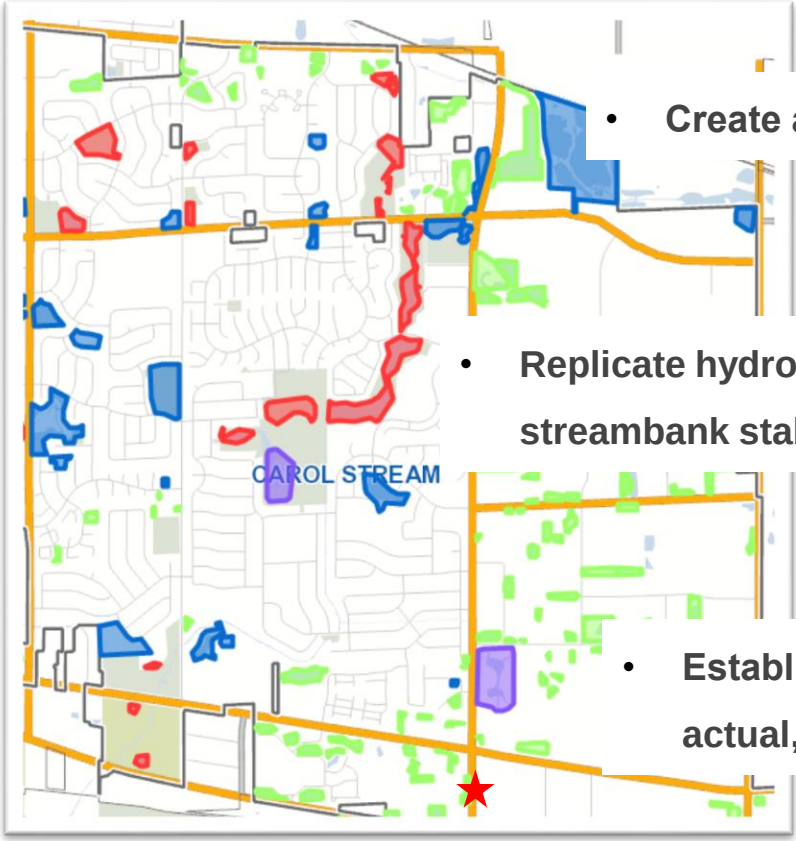
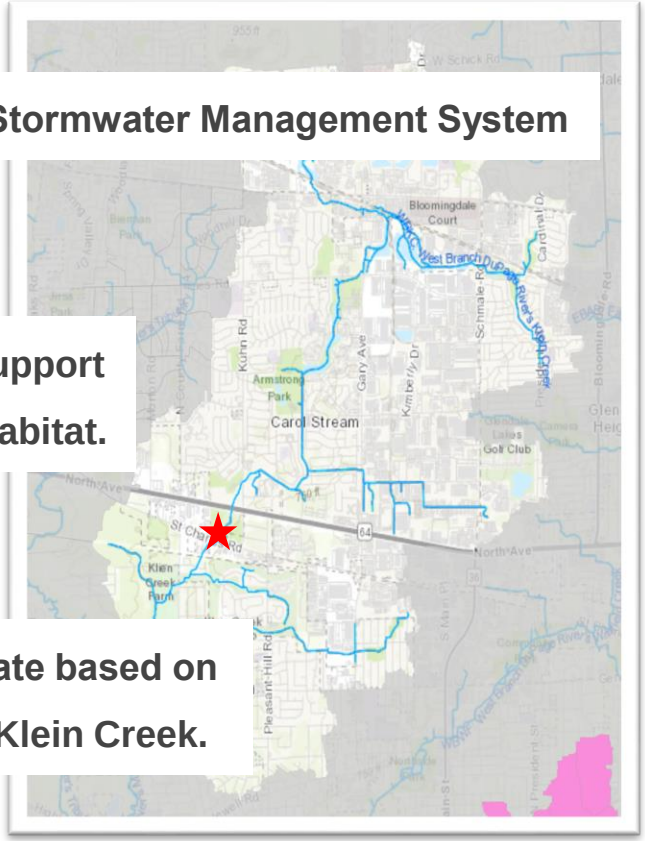
Long-Term Projects



- Create a “Digital Twin” of the Stormwater Management System
- Replicate hydrologic modification to support streambank stabilization and aquatic habitat.
- Establish a “single” release rate based on actual, real-time flows within Klein Creek.



Contact Info

PRESENTATION & EPA SWMM FILES
https://nextcloud.carolstream.org/index.php/s/LYJecpzWQwfRCKb

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UIC Senior Design Project Presentation
https://engineeringexpo.uic.edu/news-stories/cme-05-kimberly-north-detention-system-optimization/