



Narragansett Bay Commission  
Pawtucket Tunnel Project

Emergency Response Under  
Extreme Storm Events



An aerial photograph of Narragansett Bay, showing a large dam structure extending across the water. The surrounding land is a mix of green fields, brown autumn foliage, and urban areas with buildings. The water is a deep blue color.

# Agenda

1. Get to Know Us
2. Narragansett Bay Commission (NBC)
3. Phase III InfoWorks ICM Model
4. Modeling Complex Structures in ICM & CFD
5. Modeling Tunnel Performance in ITM

# Get to know the Presenters



**Lila Gillespie**



**Grace Huson**

# Narragansett Bay Commission (NBC)

- Provides Wastewater Collection and Treatment (Two Treatment Facilities)
- Ten Communities – Mostly Providence, Pawtucket and North Providence
- Serves 360,000 Residents
- Serves 7,800 Businesses



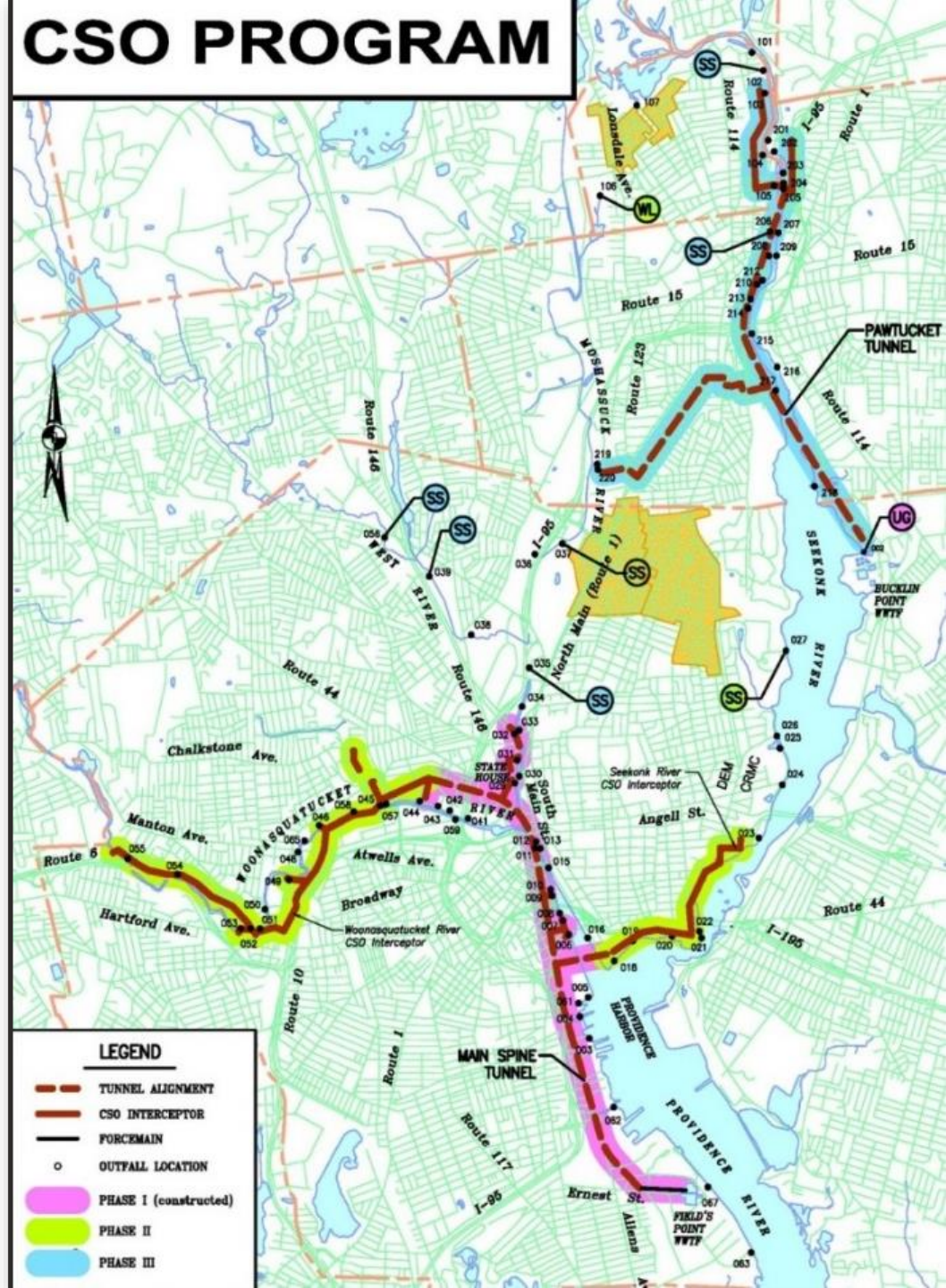
# NBC CSO Control Program

1992: NBC commenced development of a CSO Control Program

1998: NBC Defined Three Phase CSO Control Program

Program Goals for Narragansett Bay:

- 98% reduction of annual CSO volumes
- 98% reduction of fecal coliform loading
- 95% reduction in number of annual overflows
- <4 overflows per year
- 75% and 80% reduction in TSS and BOD loadings, respectively
- 80% reduction in shellfish bed closures.



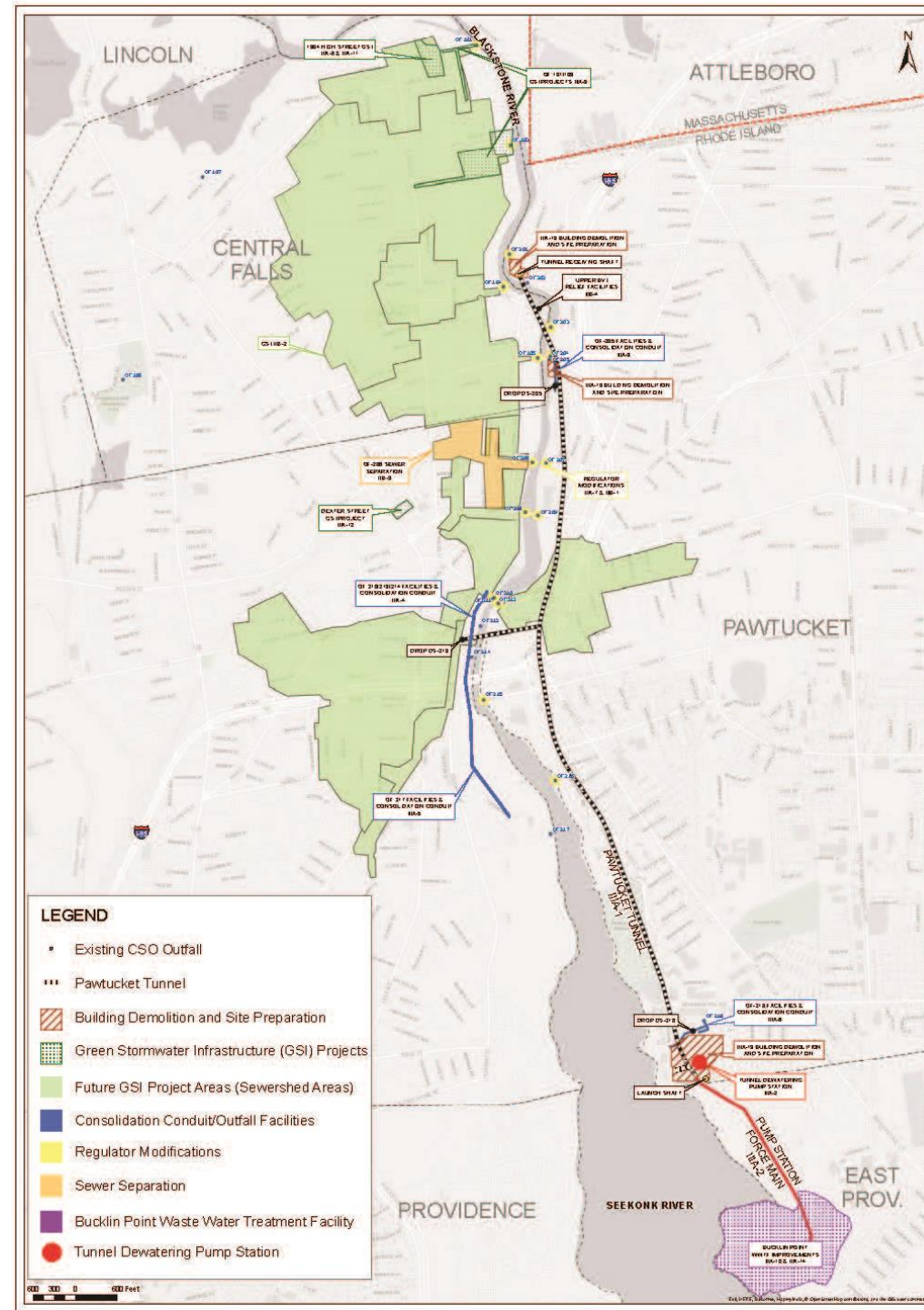
# NBC CSO Control Program

## Phase III (Bucklin Point Service Area)

NBC Commenced a Reevaluation of Phase III in 2014

### Phase III Reevaluation & Optimization Strategy:

- Provide confidence in model output
  - Model expansion
  - Model calibration, focus on regulators
- Reevaluate and optimize design approach to address remaining outfalls
  - Tunnel, consolidation conduits, and regulators' design
  - Tunnel with Stub Tunnel
  - Dewatering Pump Station
- Real Time Controls (RTC)
- Green Infrastructure (GSI)



# Resiliency

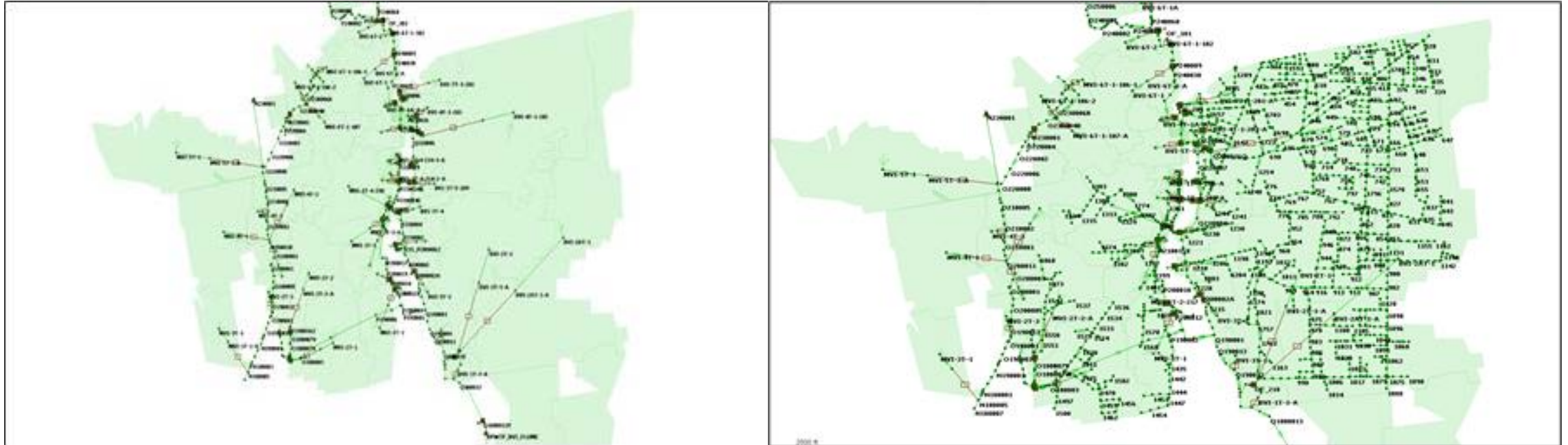
**Storm Events:** 3-month, 2-year, and 25-year

**Guidelines:**

- Tunnel volume: 3-month storm volume
- CSOs: 3-month storm
- Conveyance: 2-year storm
- Level of Service: 25-year storm
- Real Time Control: 25-year storm
- Drop shafts: 25-year storm



# Improving Model Confidence



## Calibrations

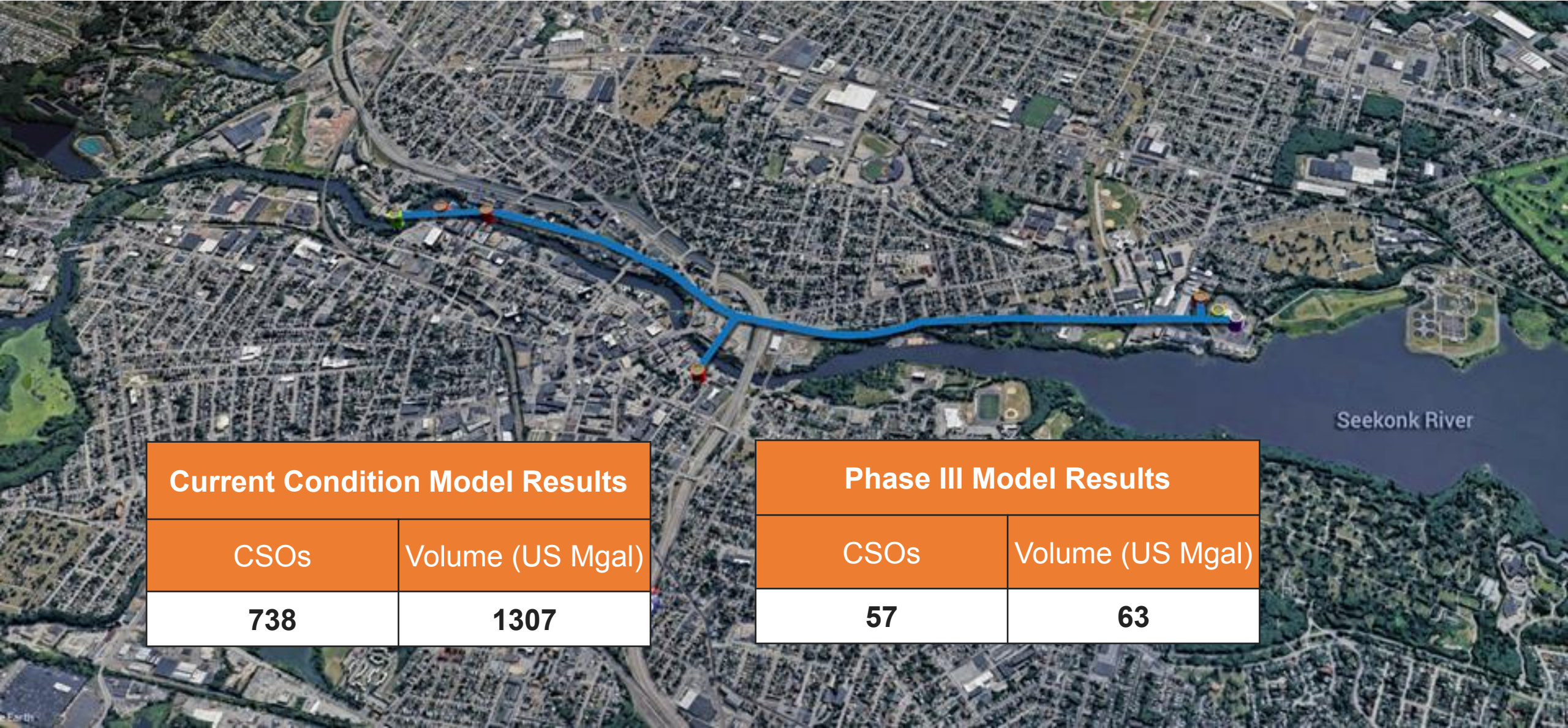
- 3 rounds; 53 meters
- CIWEM Guidelines

Dry Weather	CIWEM Criteria
Peak Flow	+/- 10%
Volume	+/- 10%

Wet Weather	CIWEM Criteria
Peak Flow	-15% to +25%
Volume	-10% to +20%
Surcharge Depth	-0.32-ft to +1.64-ft
Unsurcharged depth	+/-0.33-ft



# Phase III Design CSO Reduction



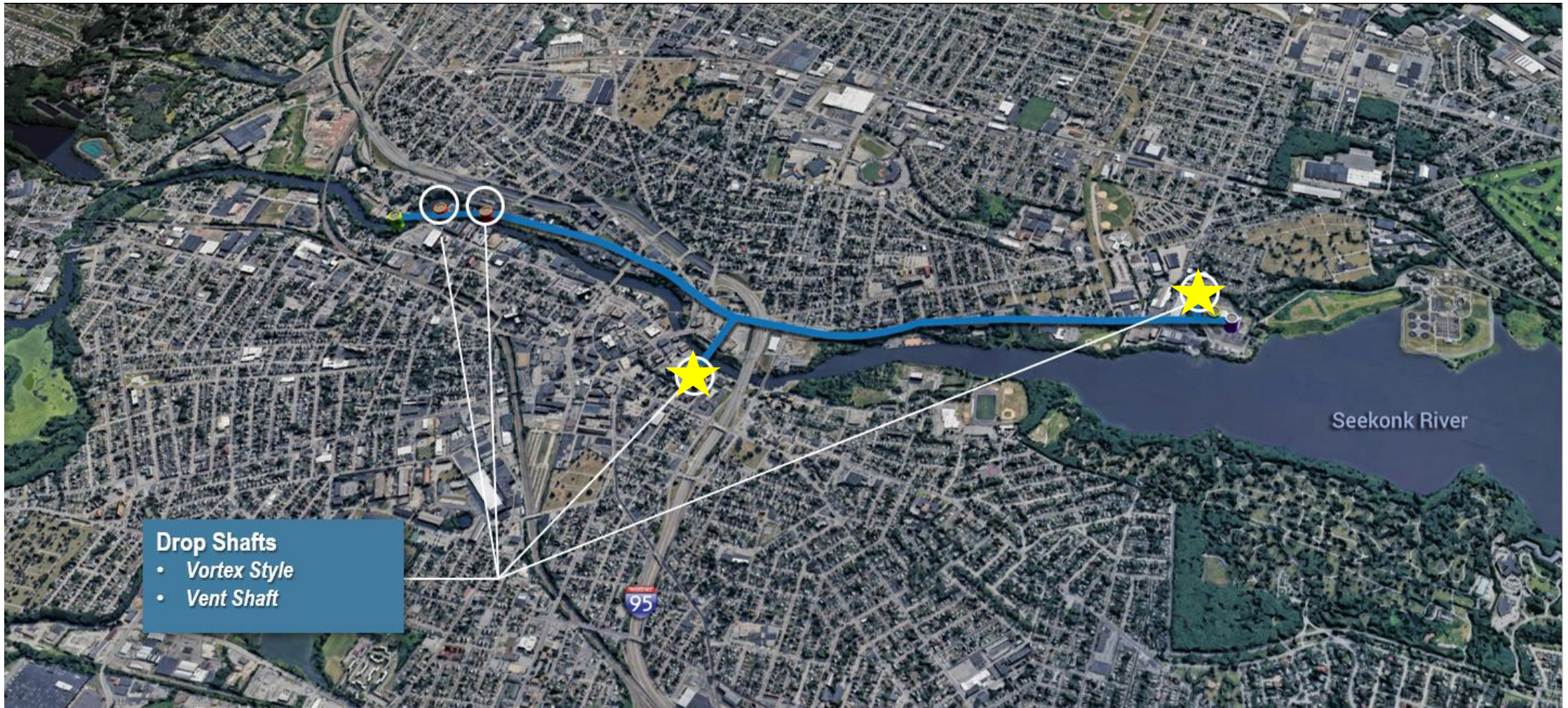
Seekonk River

Current Condition Model Results	
CSOs	Volume (US Mgal)
<b>738</b>	<b>1307</b>

Phase III Model Results	
CSOs	Volume (US Mgal)
<b>57</b>	<b>63</b>

# Regulators of Interest

★ Regulators with notable improvements using CFD

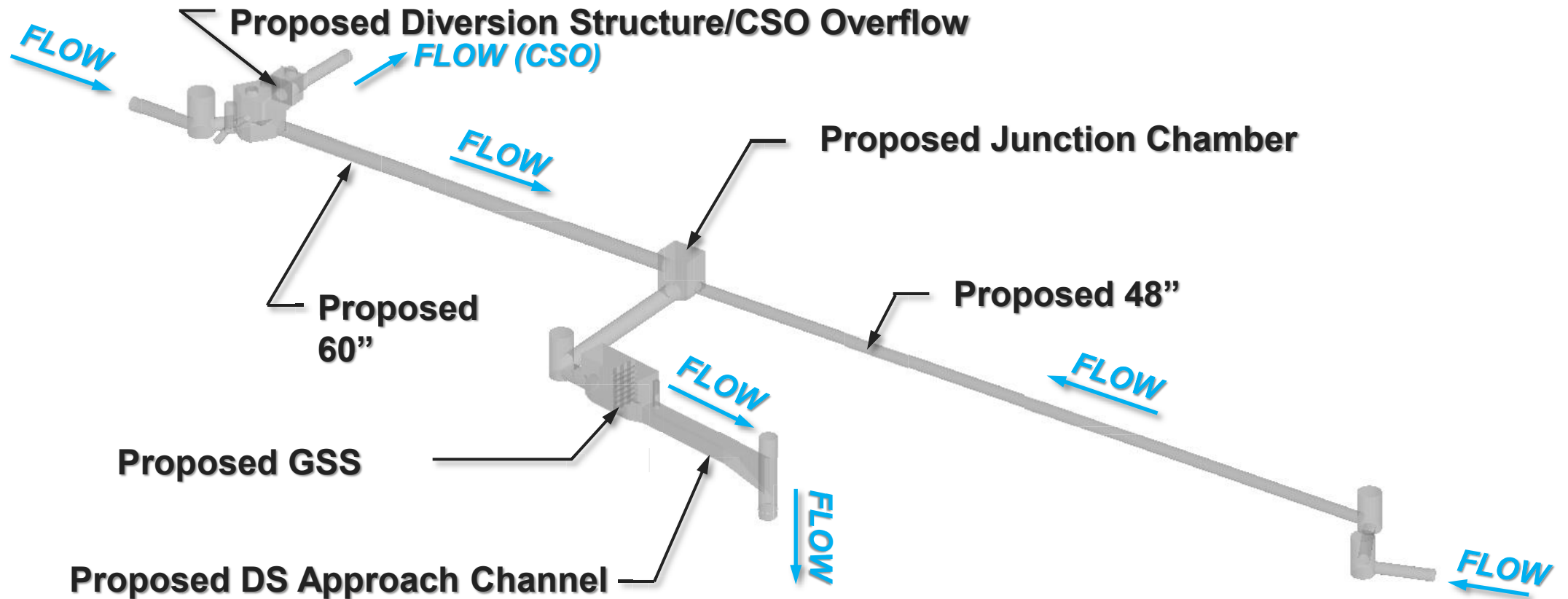


# Consolidation Conduit and Drop Shaft Design

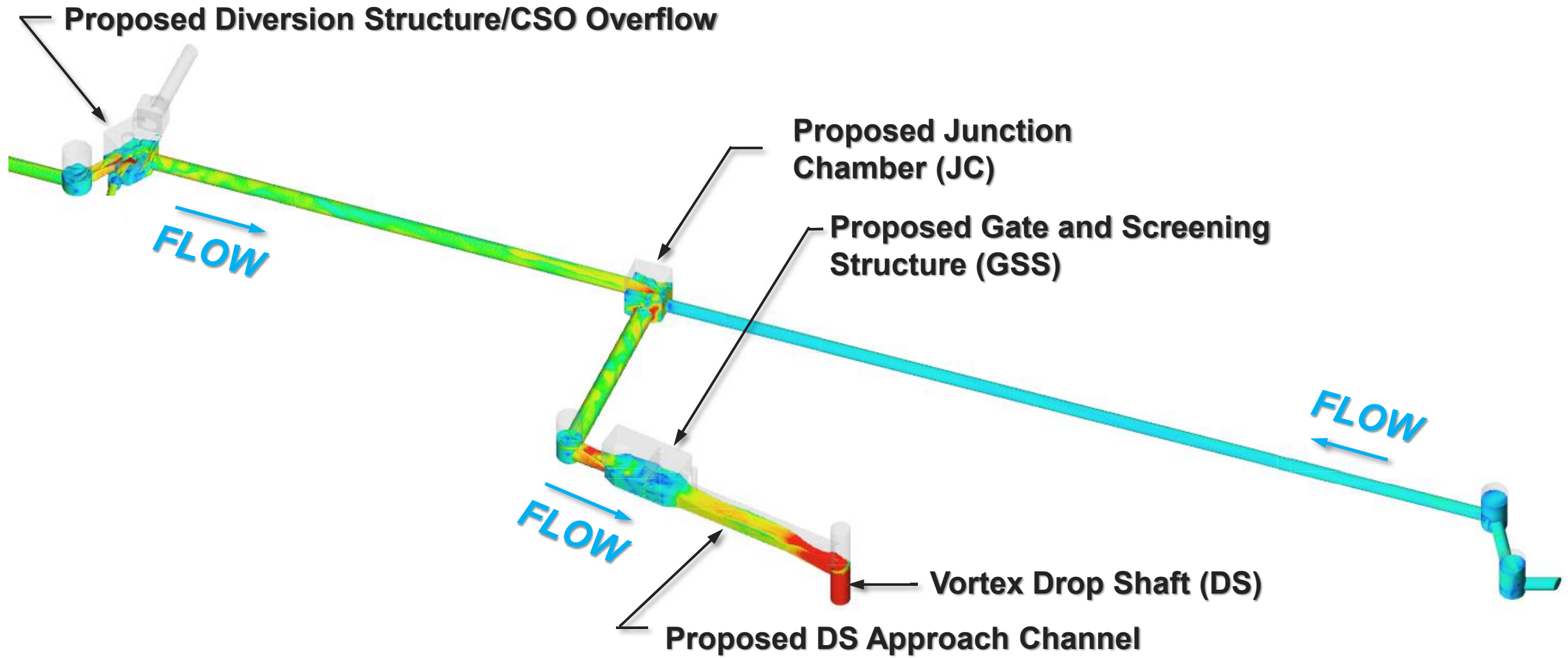


# Regulator 1: CFD Modeling

- Used Flow 3D to optimize structure sizes, piping alignments, and piping depths (improve constructability). Hydraulically proved all the proposed changes to the design.
- Used CFD model to calibrate the ICM model to flowrate and water surface elevation at key locations.



# Regulator 1: CFD Modeling



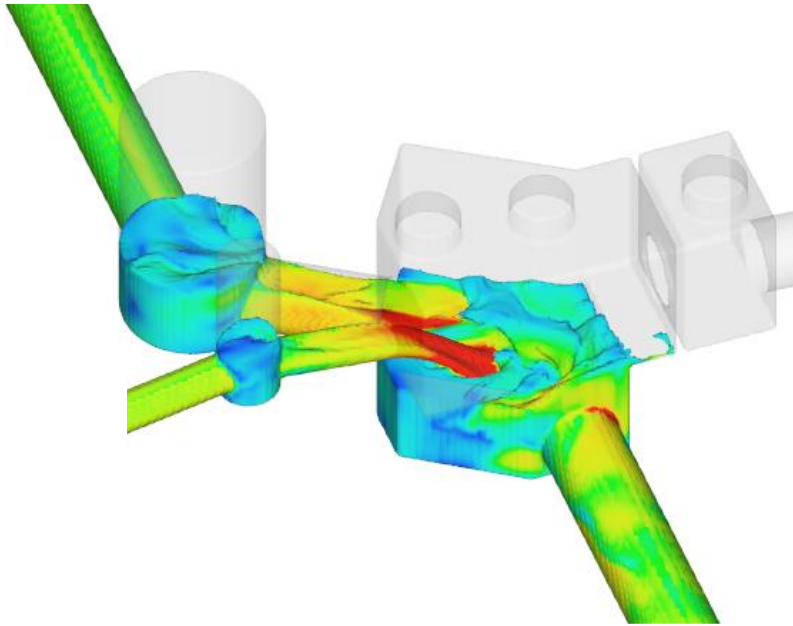
0.0

Velocity (ft/s)

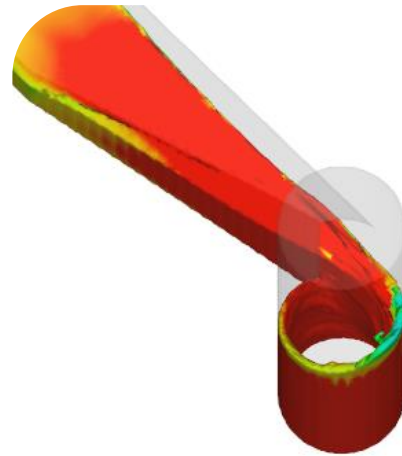
15.0 +

# Regulator 1: CFD Modeling

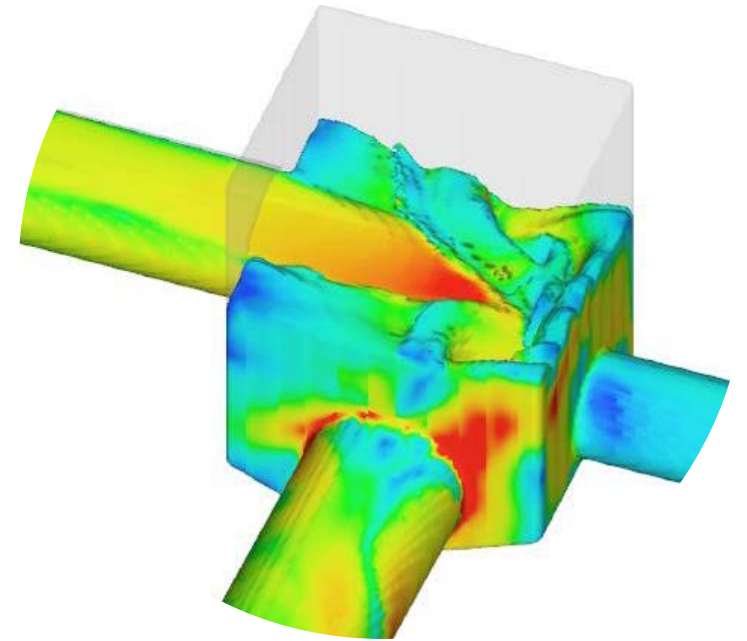
**OVERFLOW DETAIL**



**DS DETAIL**



**JUNCTION CHAMBER DETAIL**

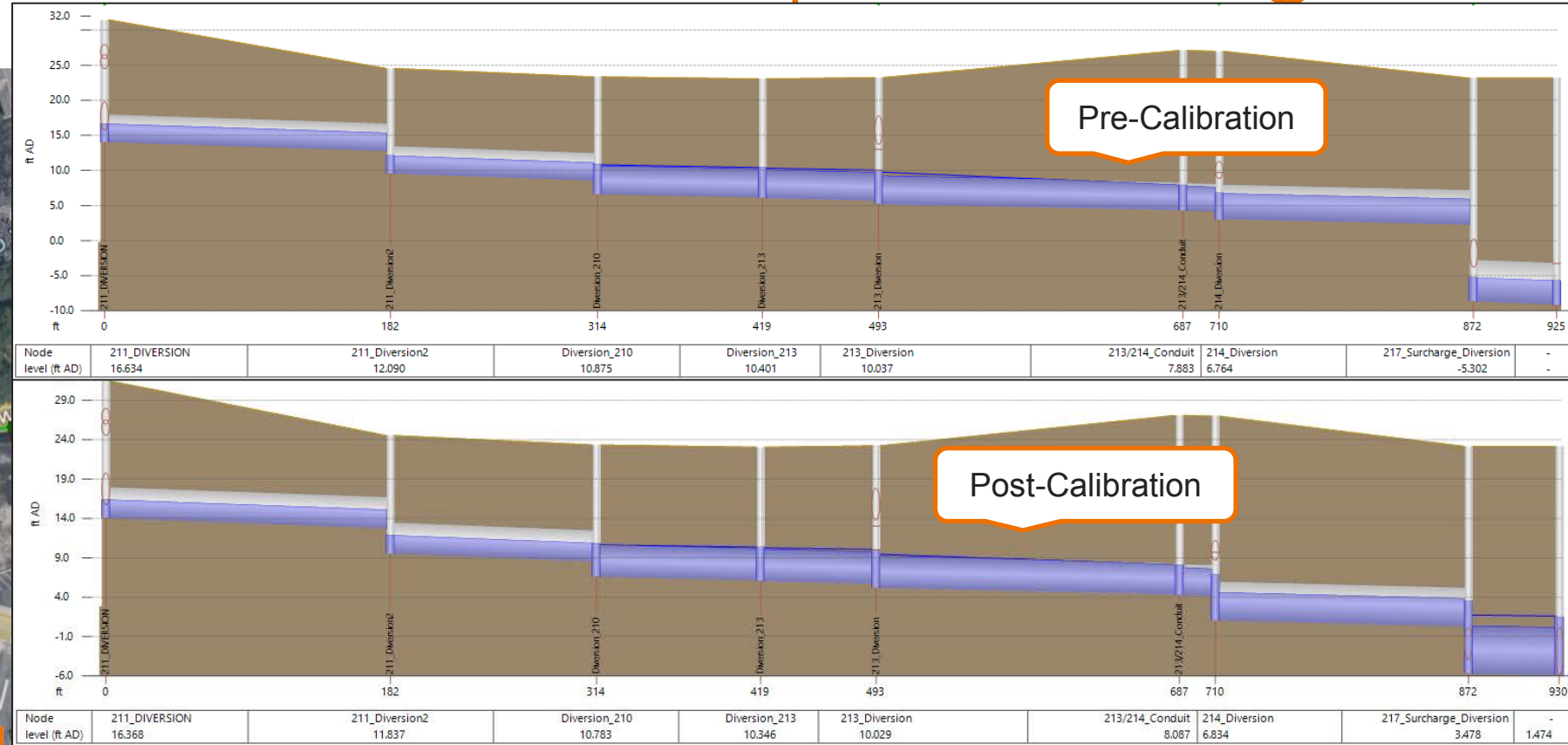
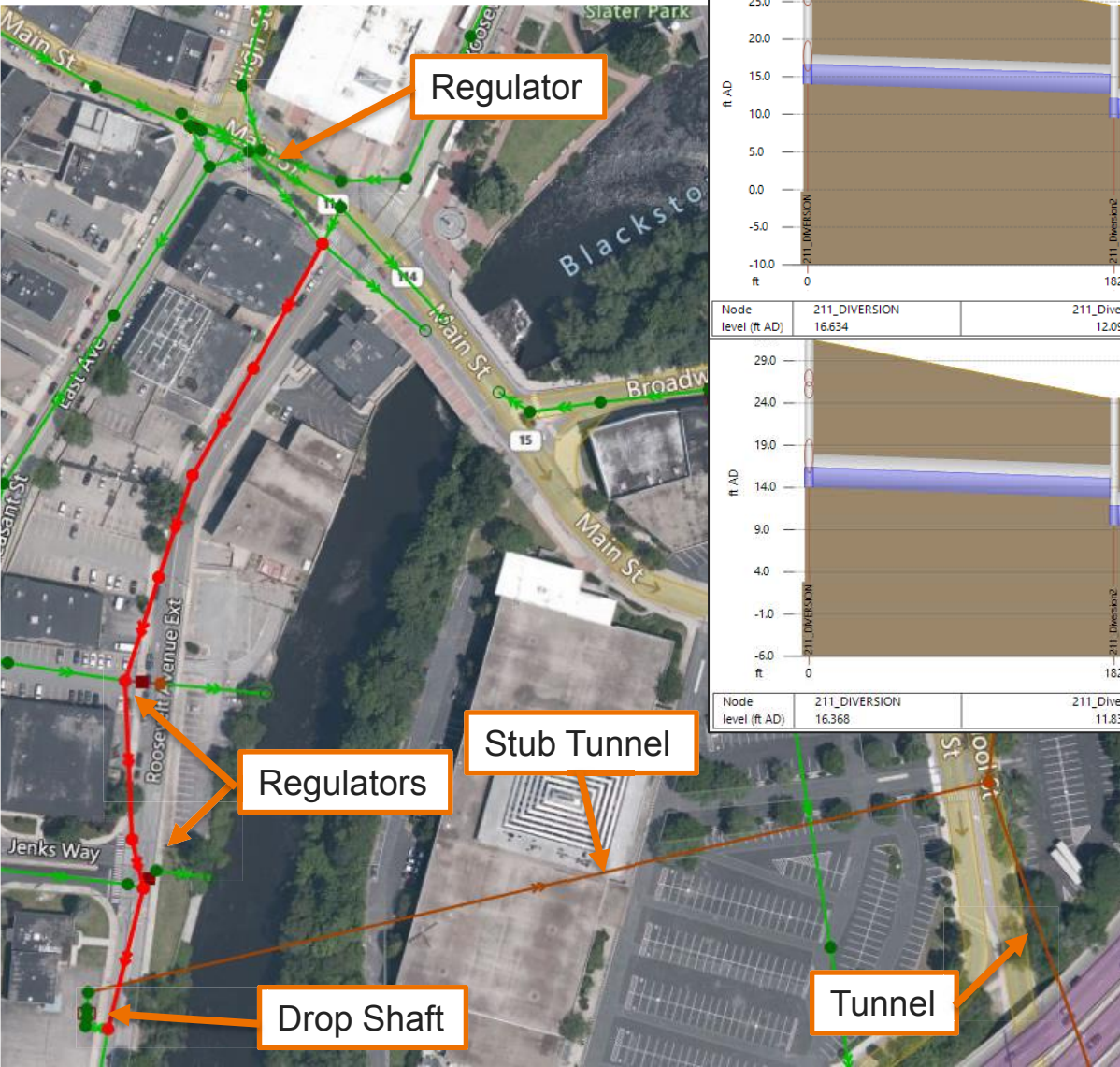


0.0

Velocity (ft/s)

15.0 +

# Consolidation Conduit and Drop Shaft Design



# Regulators of Interest

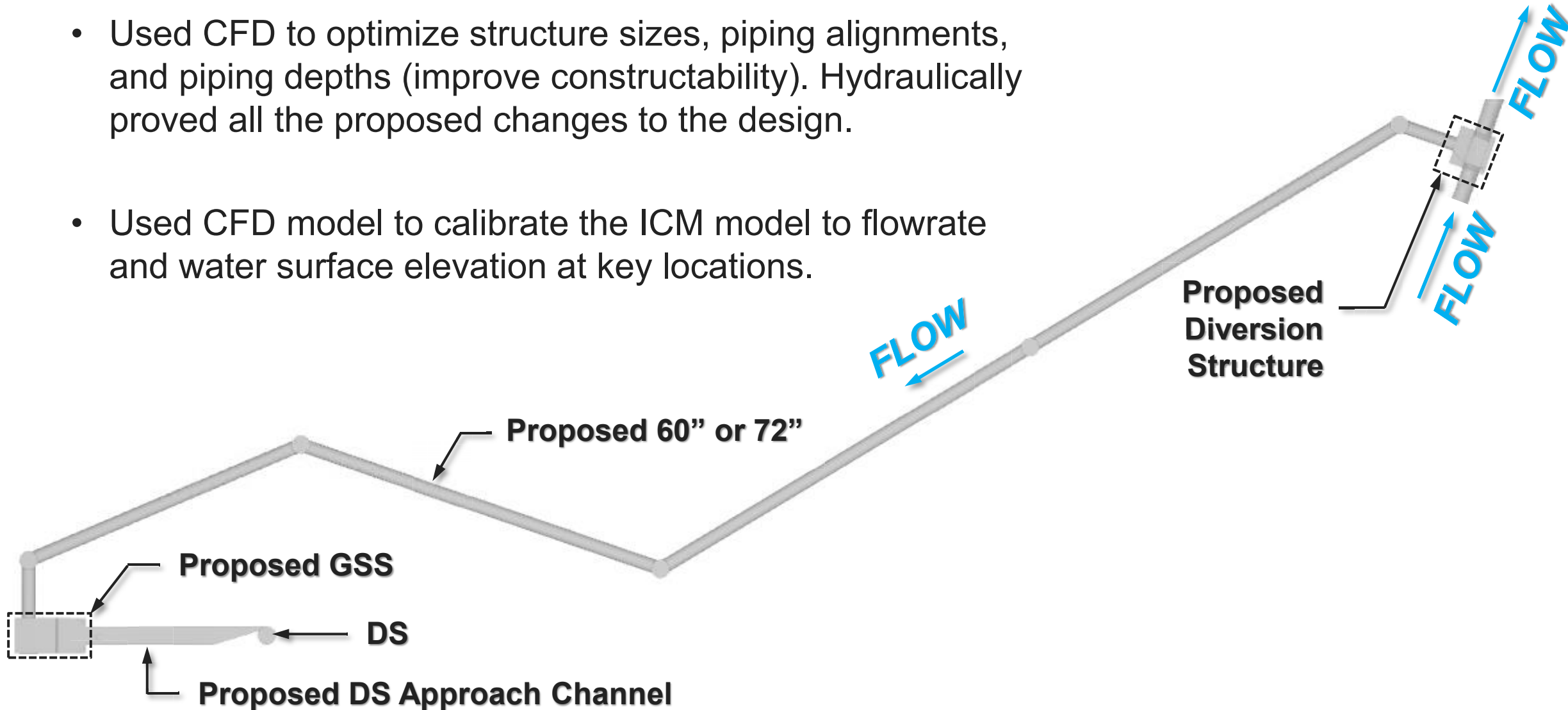
- 60-in relief consolidation conduit based on emperical calculations





# Regulator 2: CFD Modeling

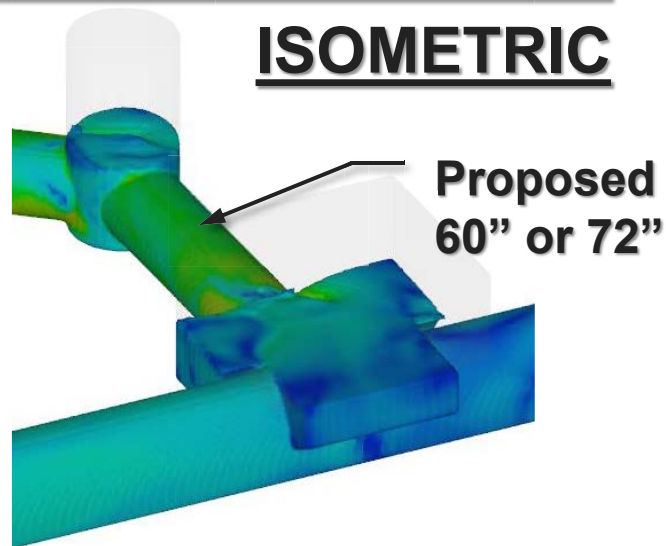
- Used CFD to optimize structure sizes, piping alignments, and piping depths (improve constructability). Hydraulically proved all the proposed changes to the design.
- Used CFD model to calibrate the ICM model to flowrate and water surface elevation at key locations.



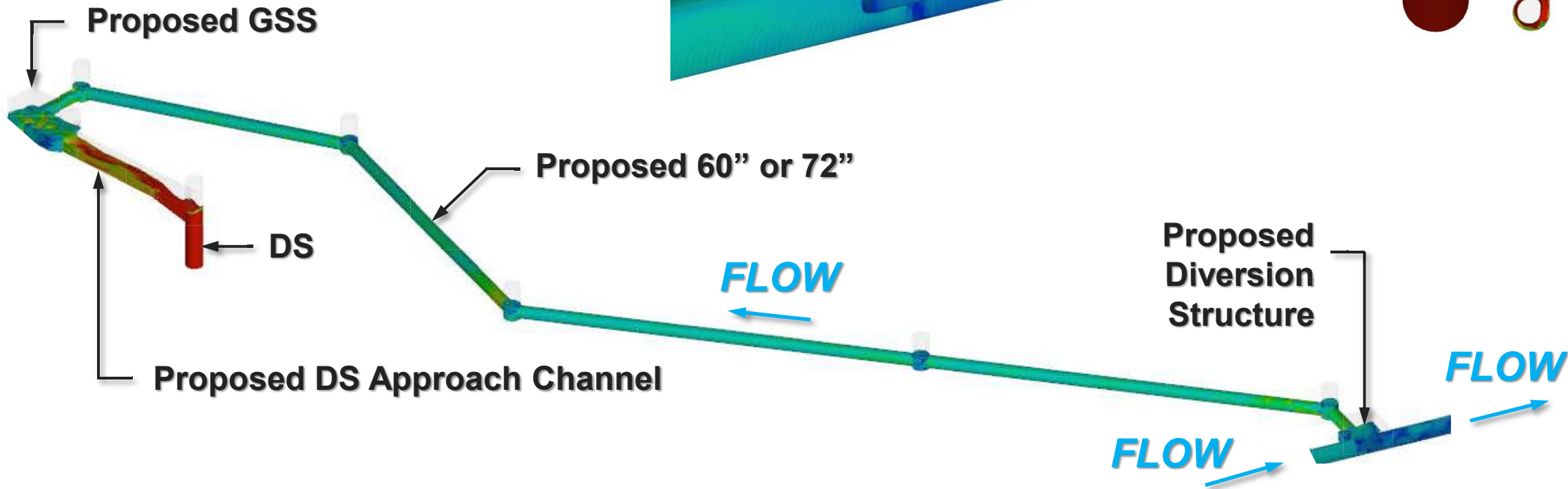
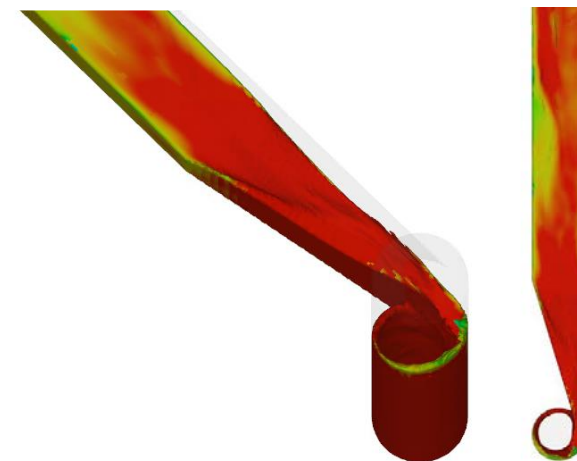
# Regulator 2: CFD Modeling

## DIVERSION STRUCTURE

### ISOMETRIC



## DS DETAIL



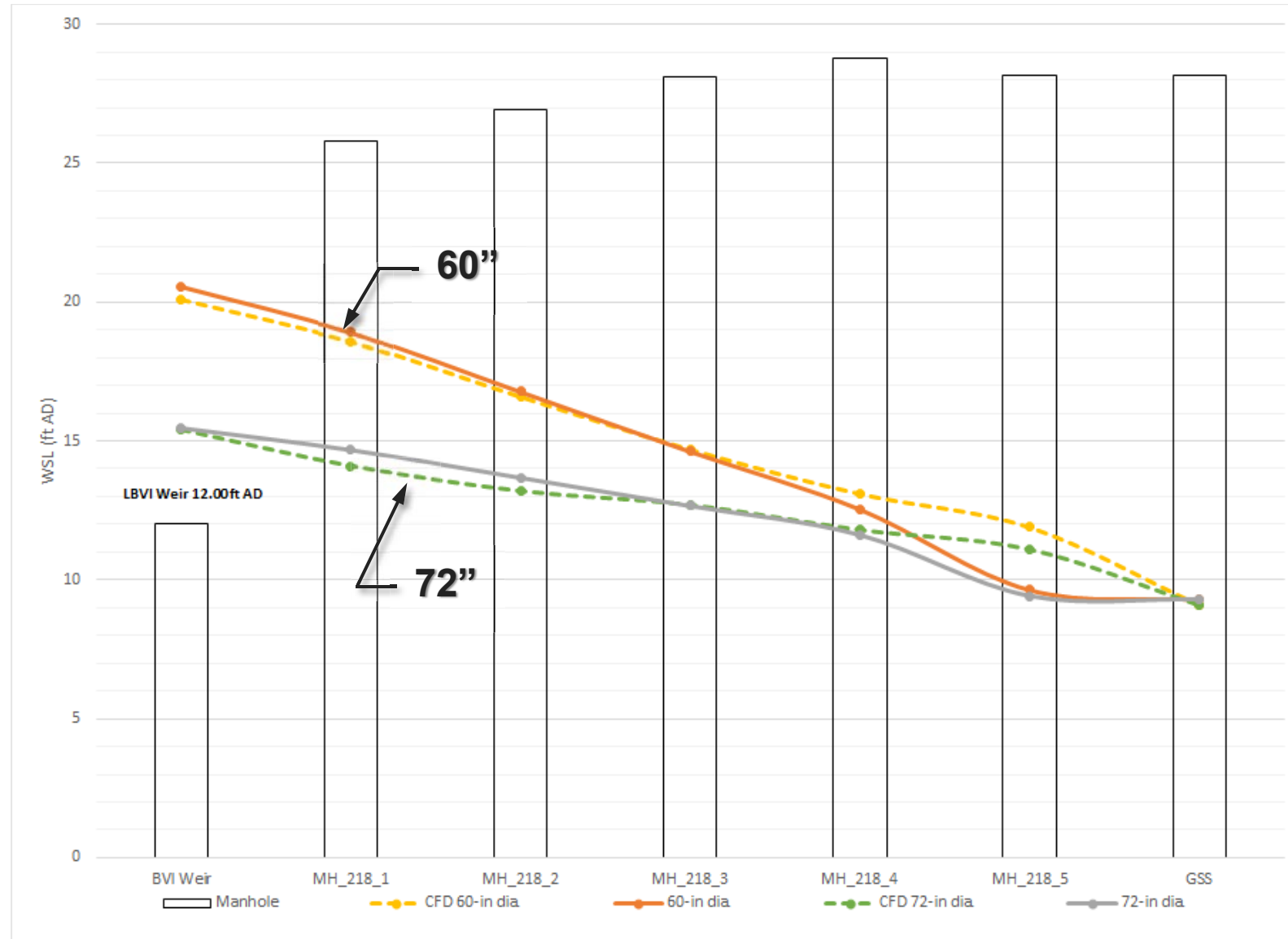
0.0

Velocity (ft/s)

15.0 +

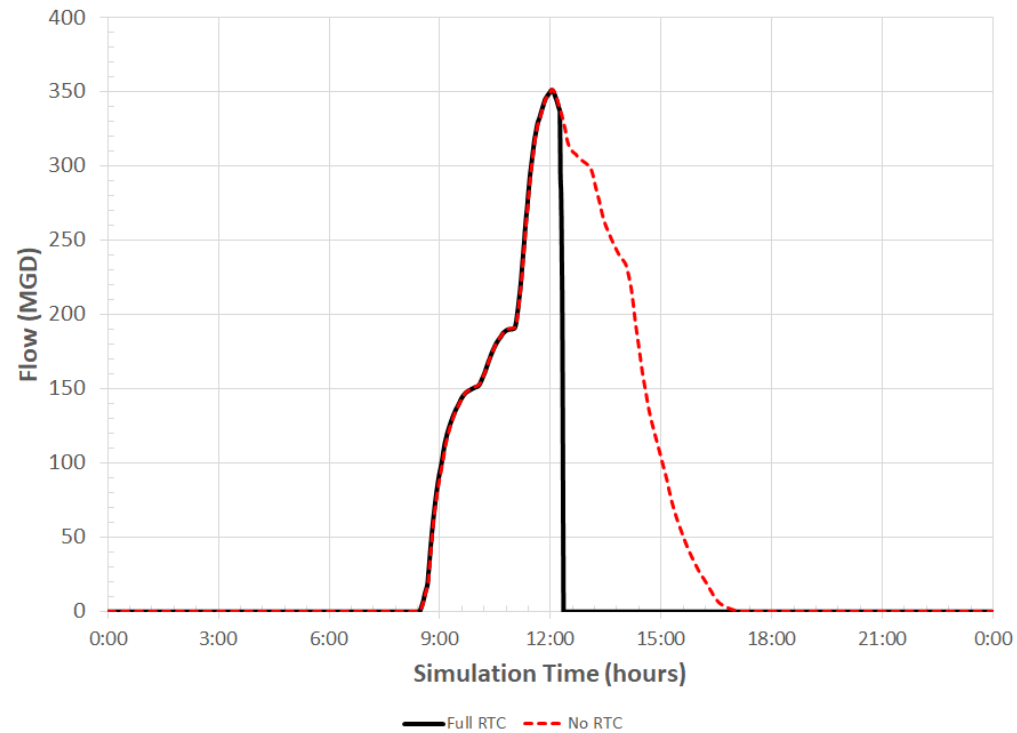
# Regulator 2: Modeling Outcomes

- 60-inch diameter to 72-inch diameter
- ICM losses adjusted based on CFD results
- Reduced CSO risk
- Improved confidence in design

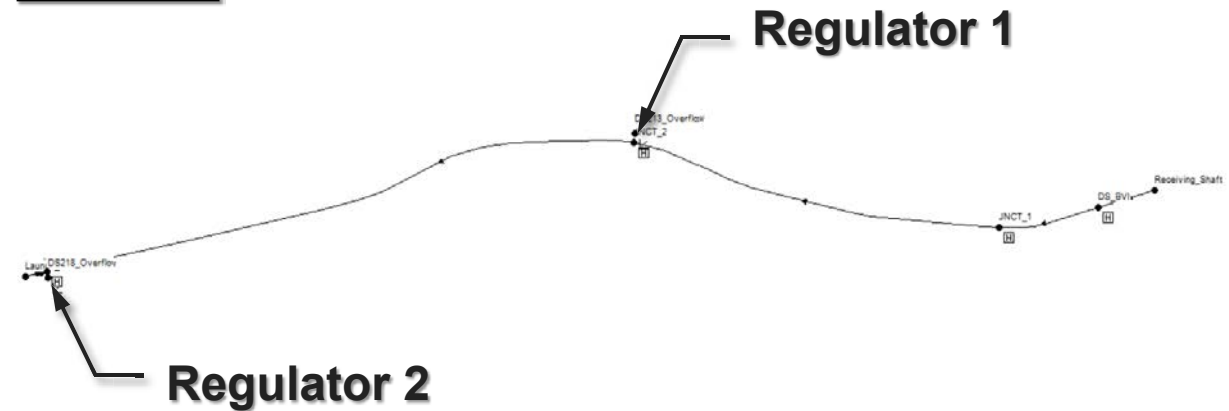


# Illinois Transient Modeling (ITM)

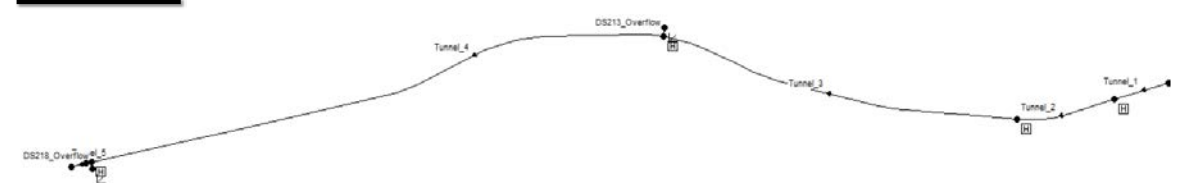
- An Illinois Transient Model (ITM) was completed to identify the potential risk of “geysering” that can occur as the tunnel fills
- Design of emergency overflow facilities during potential gate failure at the GSS’s



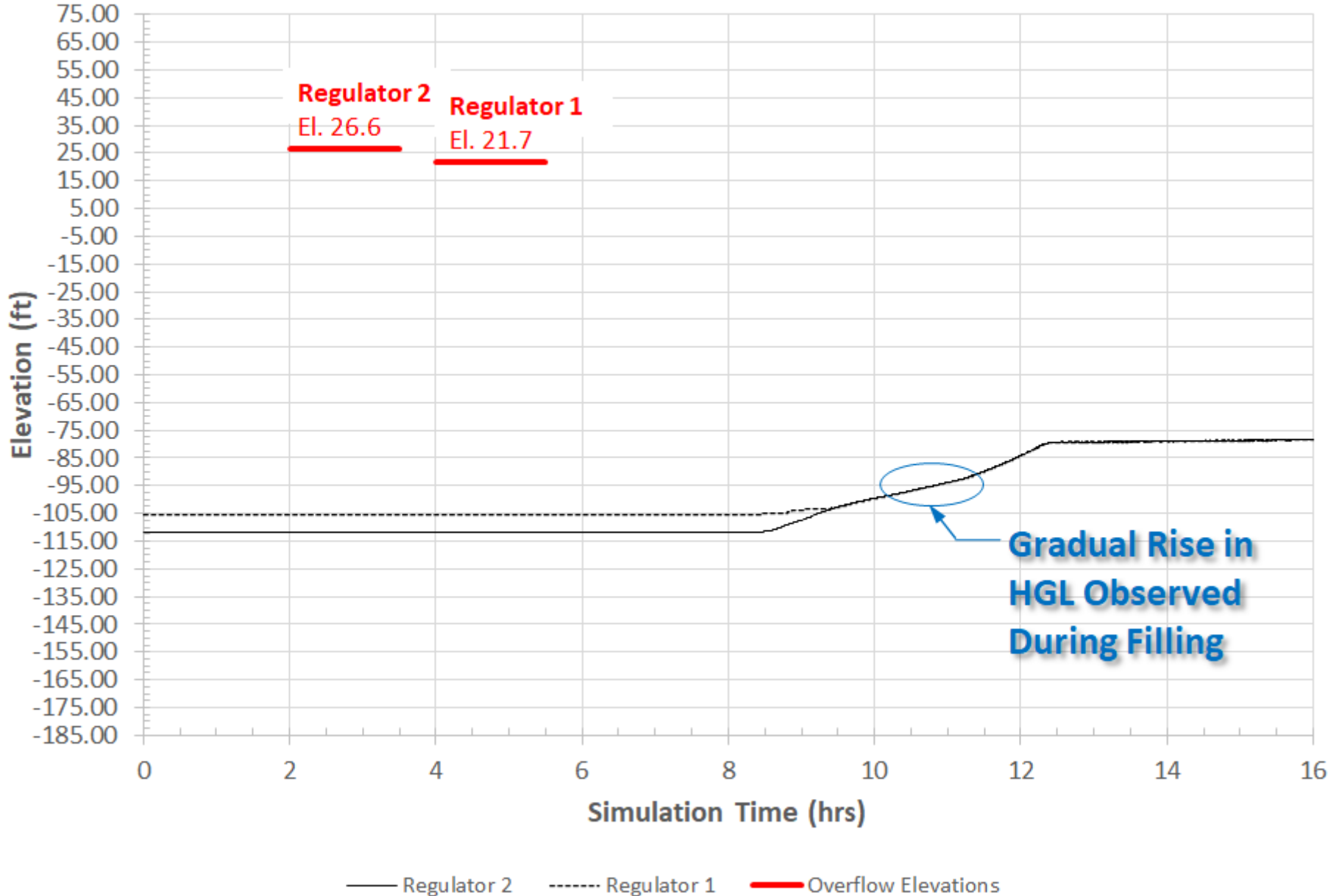
## NODES



## LINKS



# ITM Model Results



# Illinois Transient Modeling (ITM)

● Drop shaft

⊗ Gate remains open

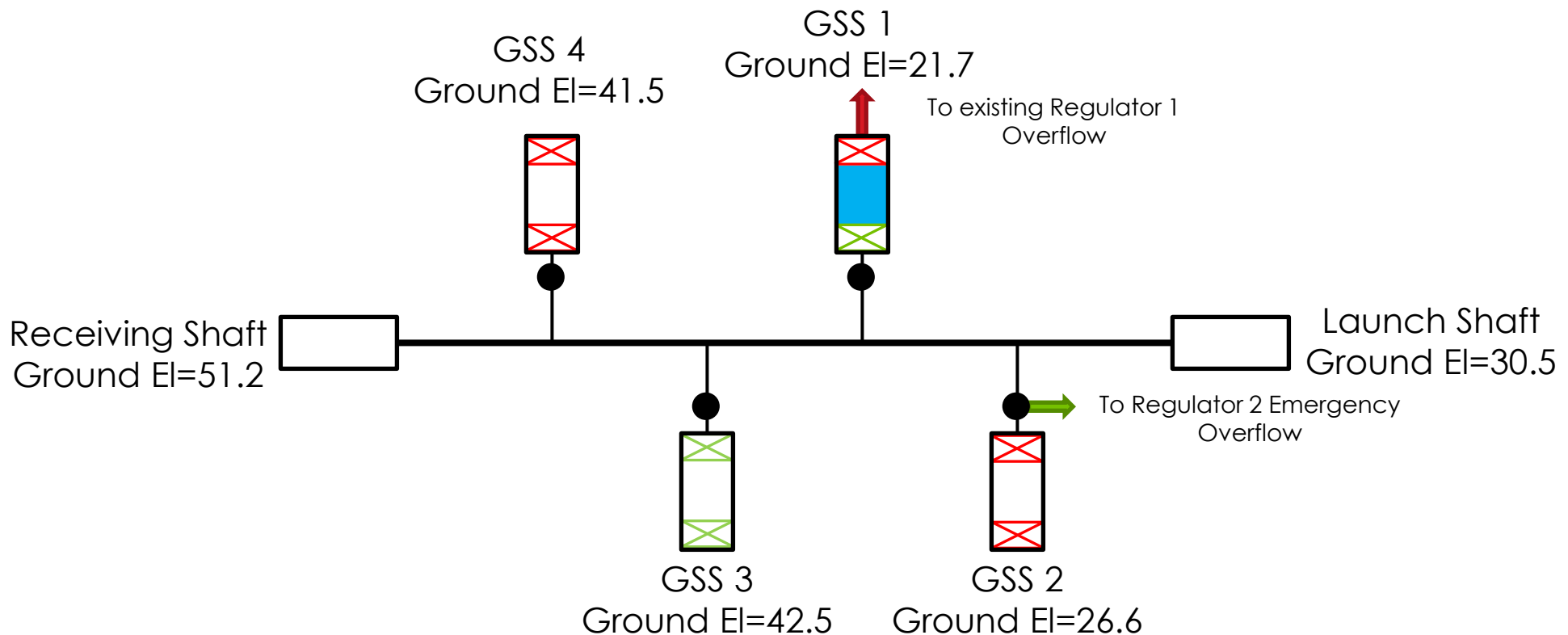
⊗ Gate remains closed

➔ No flow out of overflow

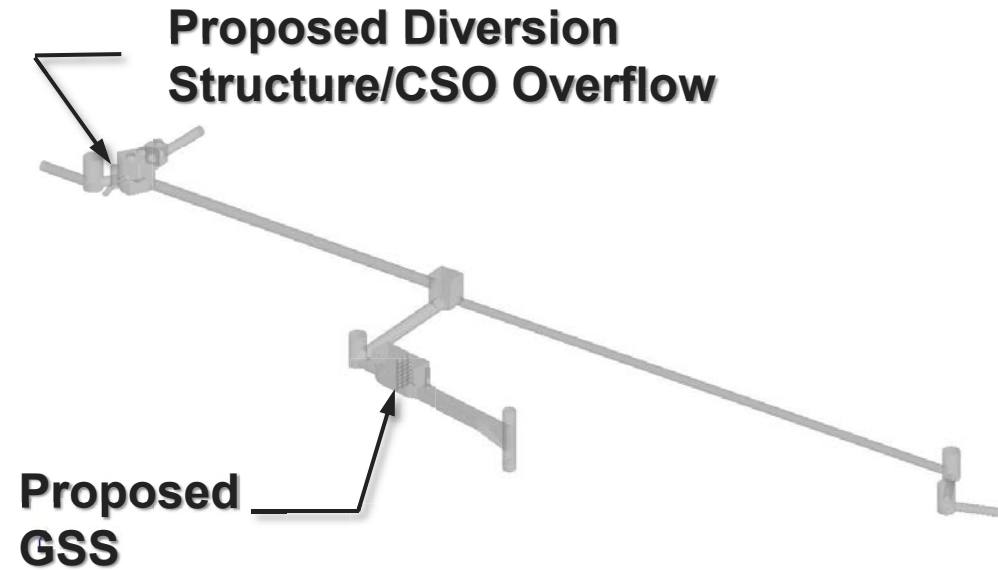
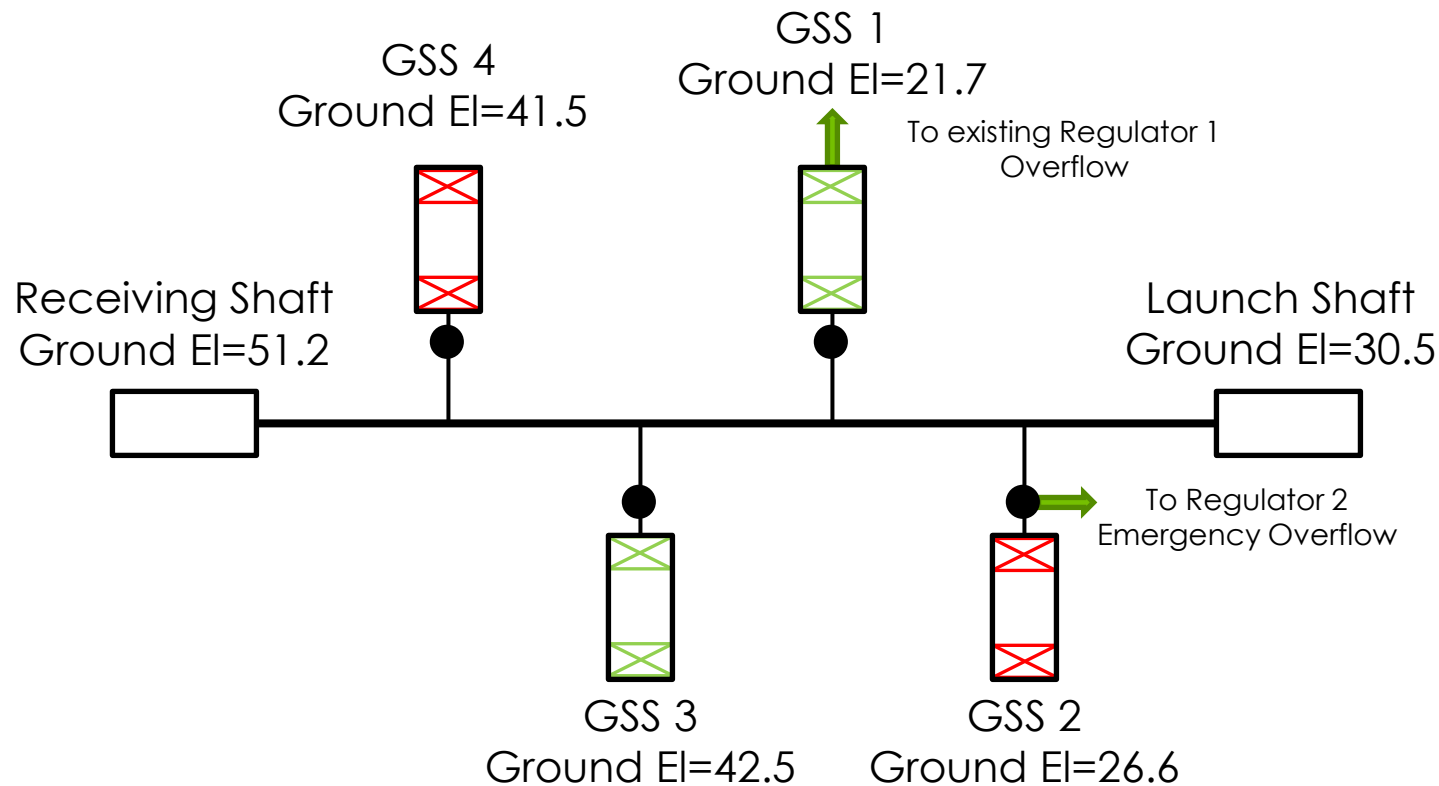
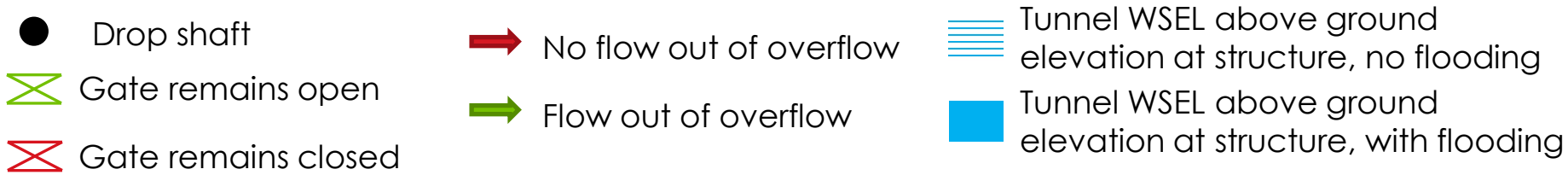
➔ Flow out of overflow

▬ Tunnel WSEL above ground elevation at structure, no flooding

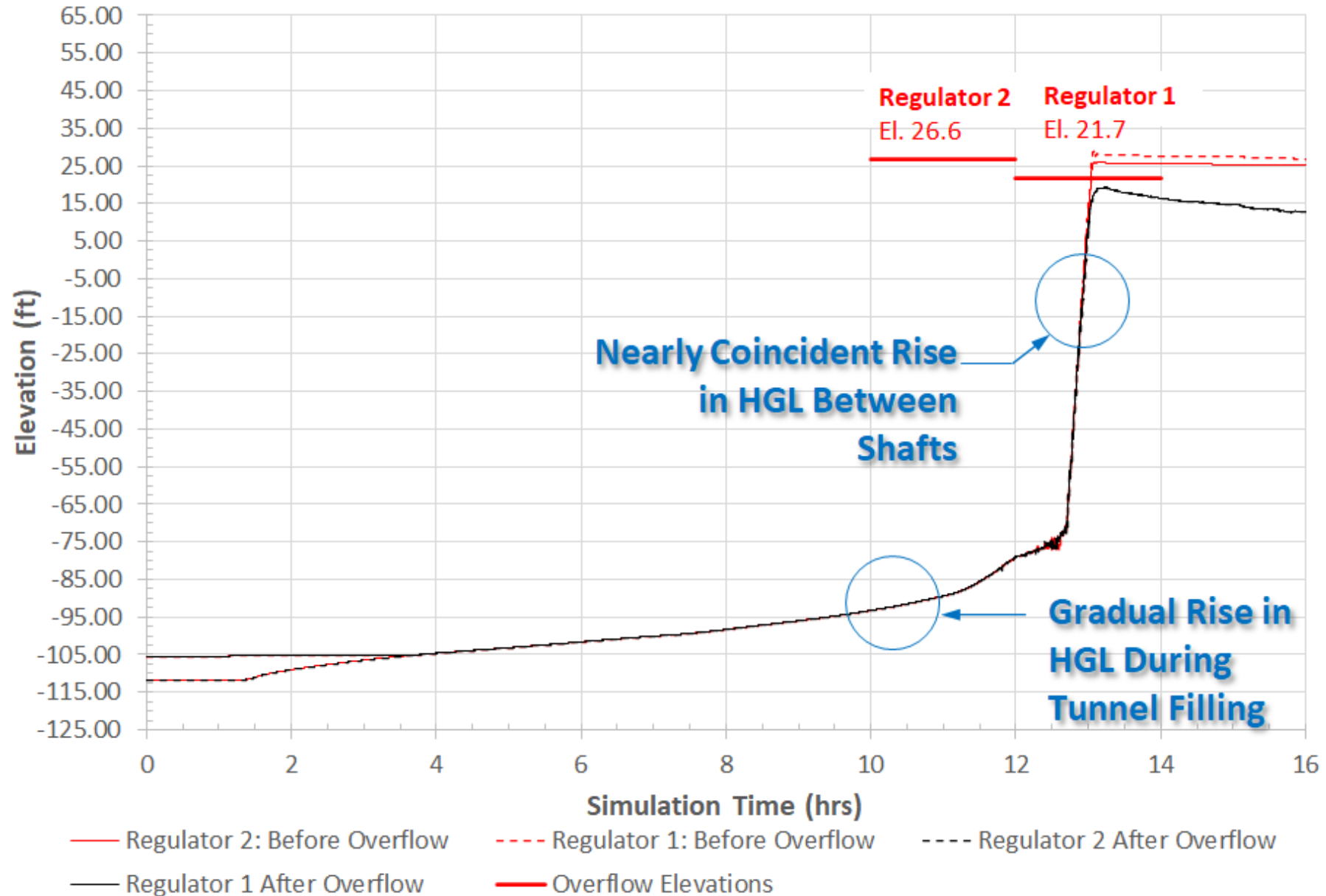
■ Tunnel WSEL above ground elevation at structure, with flooding



# Illinois Transient Modeling (ITM)

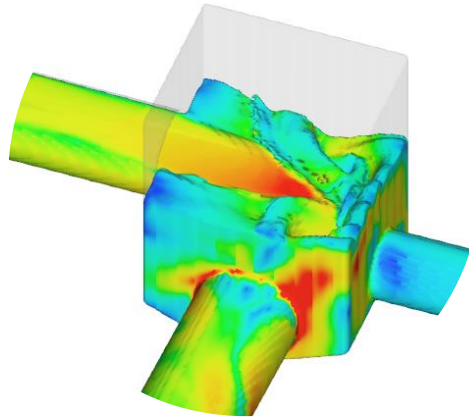


# ITM Model Results

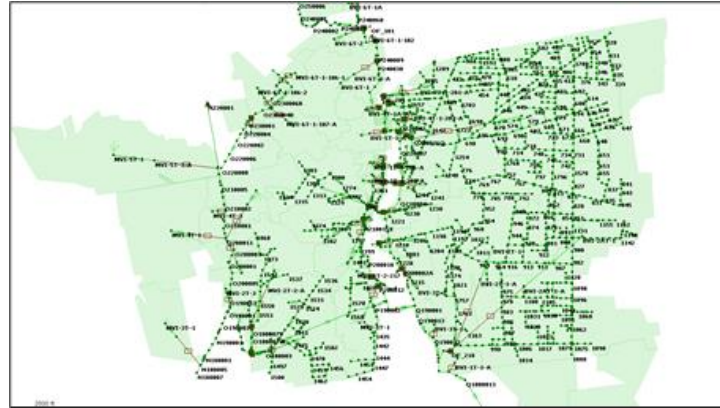
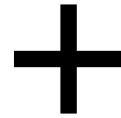




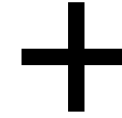
# Conclusions



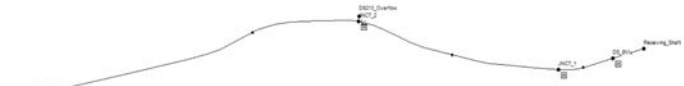
CFD: Complex Structures



ICM: Conveyance Modeling



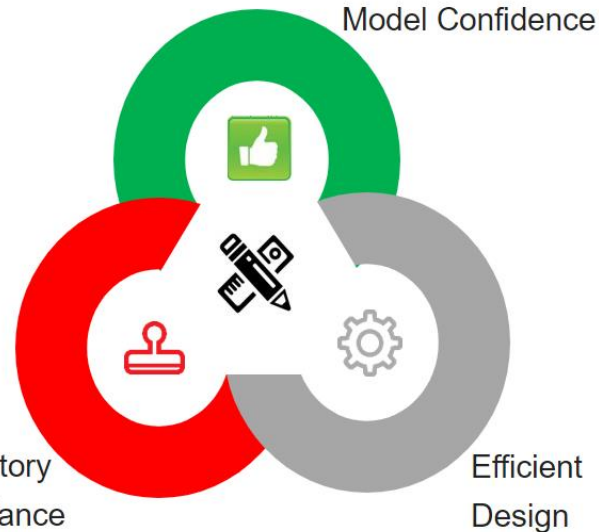
NODES



LINKS



ITM: Tunnel Modeling





Narragansett Bay Commission  
Pawtucket Tunnel Project

Emergency Response Under  
Extreme Storm Events

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