Bassam Aldhafari
San Francisco Department of Public Works, Hydraulic Engineering Section

BS (2007) and MS (2009) in Civil and Environmental Engineering
University of California – Davis

Grew up in SF Bay Area – Some activities hiking/camping, travel, music…and training for the marathon

Using FLOW-3D Hydro to Improve Collection System Model

March 6, 2025

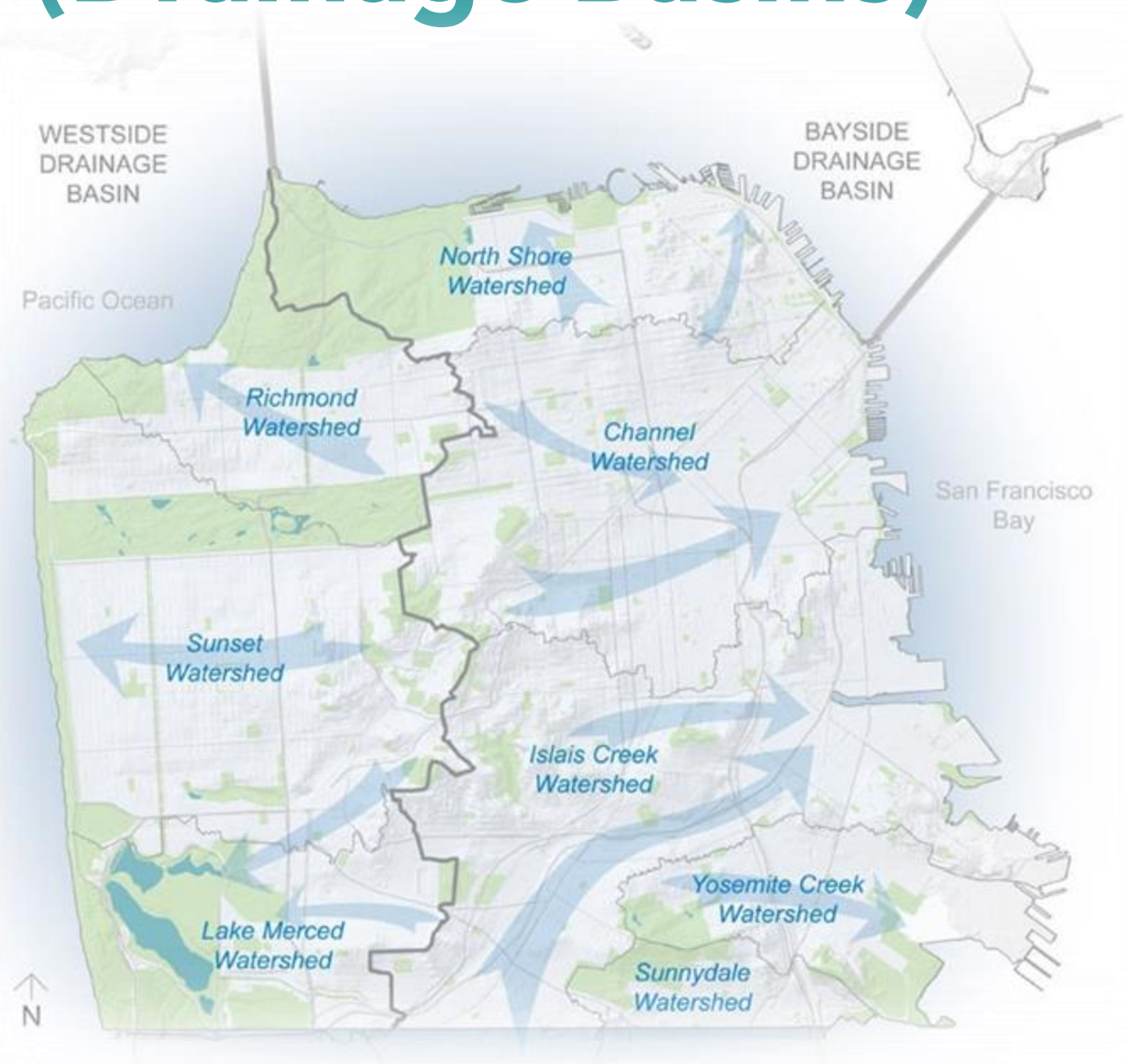
Outline

- Background of Collection System Model
- Description of Problem Area and Current Project to Reduce Flooding
- Using Flow3D-Hydro to Model Major Junction Structures
- Updating Collection System Model
- *Future Use of Flow3D-Hydro for Collection System Modeling*

Collection System

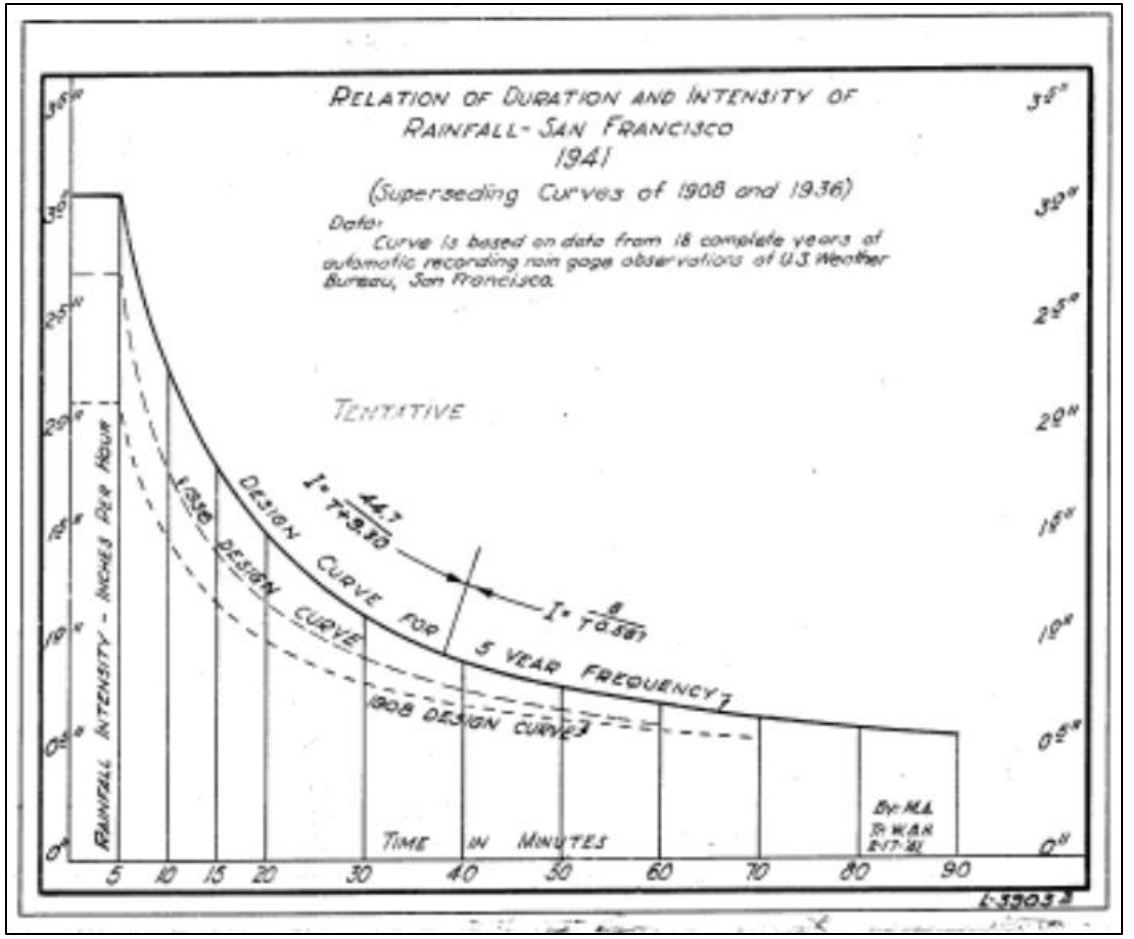
Collection System (Drainage Basins)

- Natural division between bayside and westside drainage
- 8 major watersheds
- Very short time of concentration with peak flows reaching lower areas of the city within 15-20 minutes



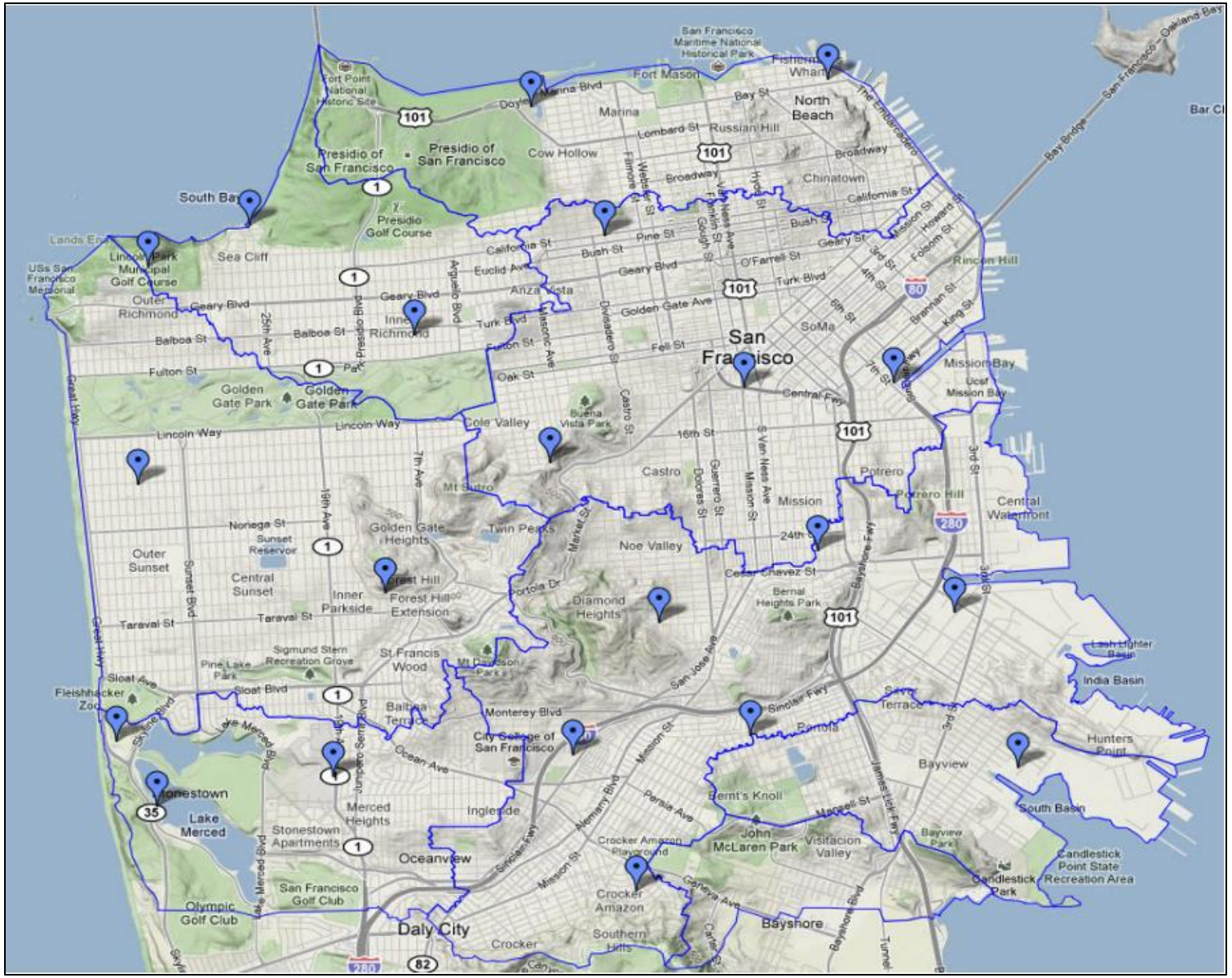
Rainfall and Design Storms

- Average rainfall of 22 inches/year but varies widely
- Sewer system designed to convey runoff from 5yr return period storm
- Excess runoff up to 100yr storm to be conveyed overland by street network

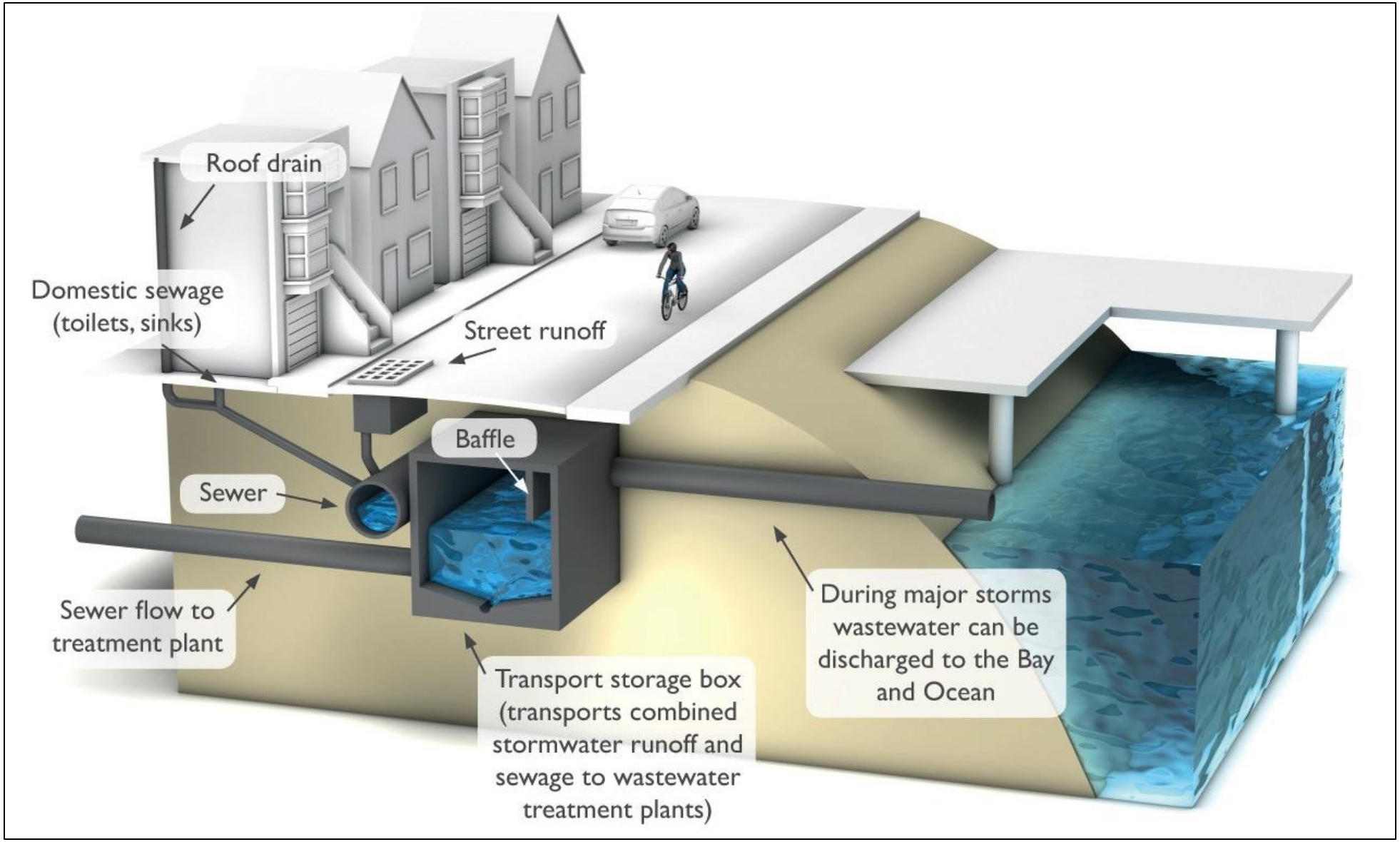


Rainfall and Design Storms

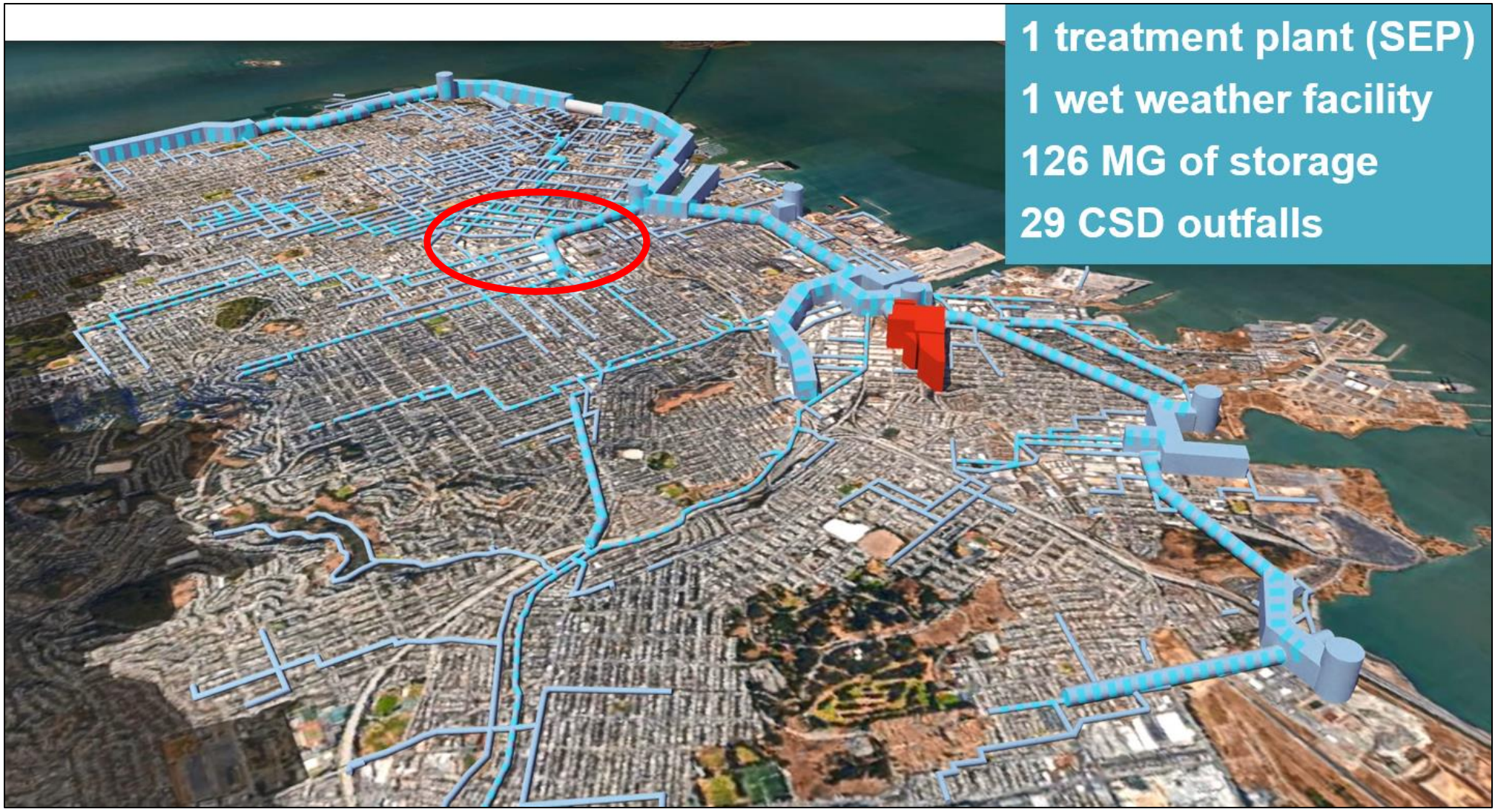
- Network consists of 21 rain gauges
- Data is collected and used to determine various storm characteristics (duration, intensity, return period, etc.)



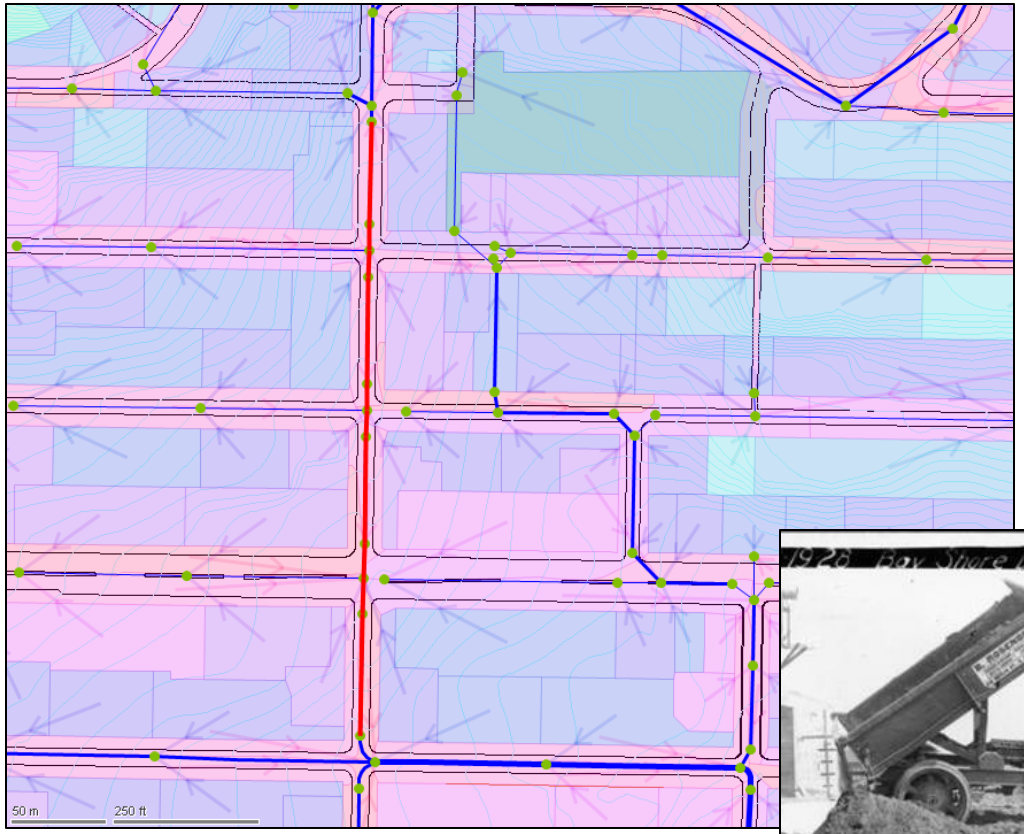
Collection System Network

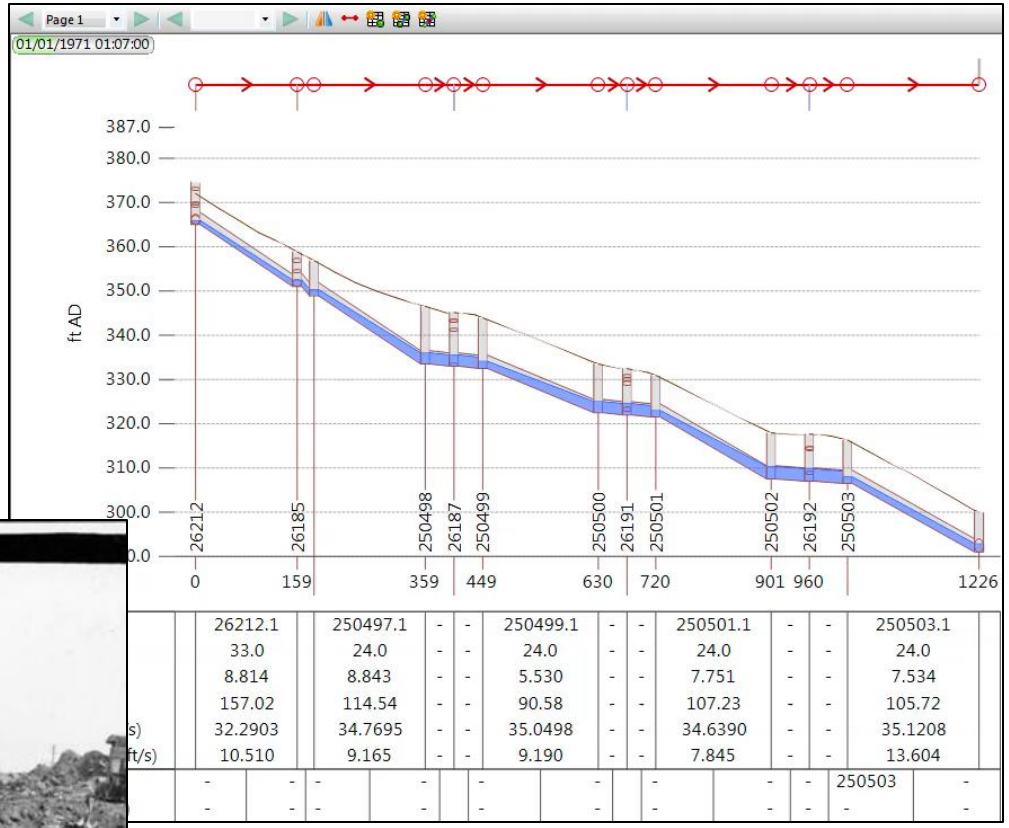


Collection System Network (Bayside)

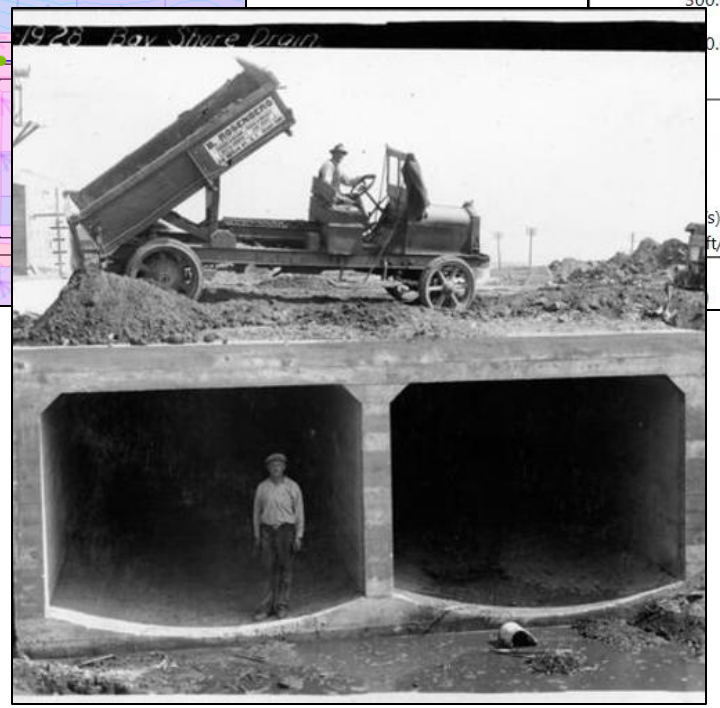


Pipe Network (1D Model)

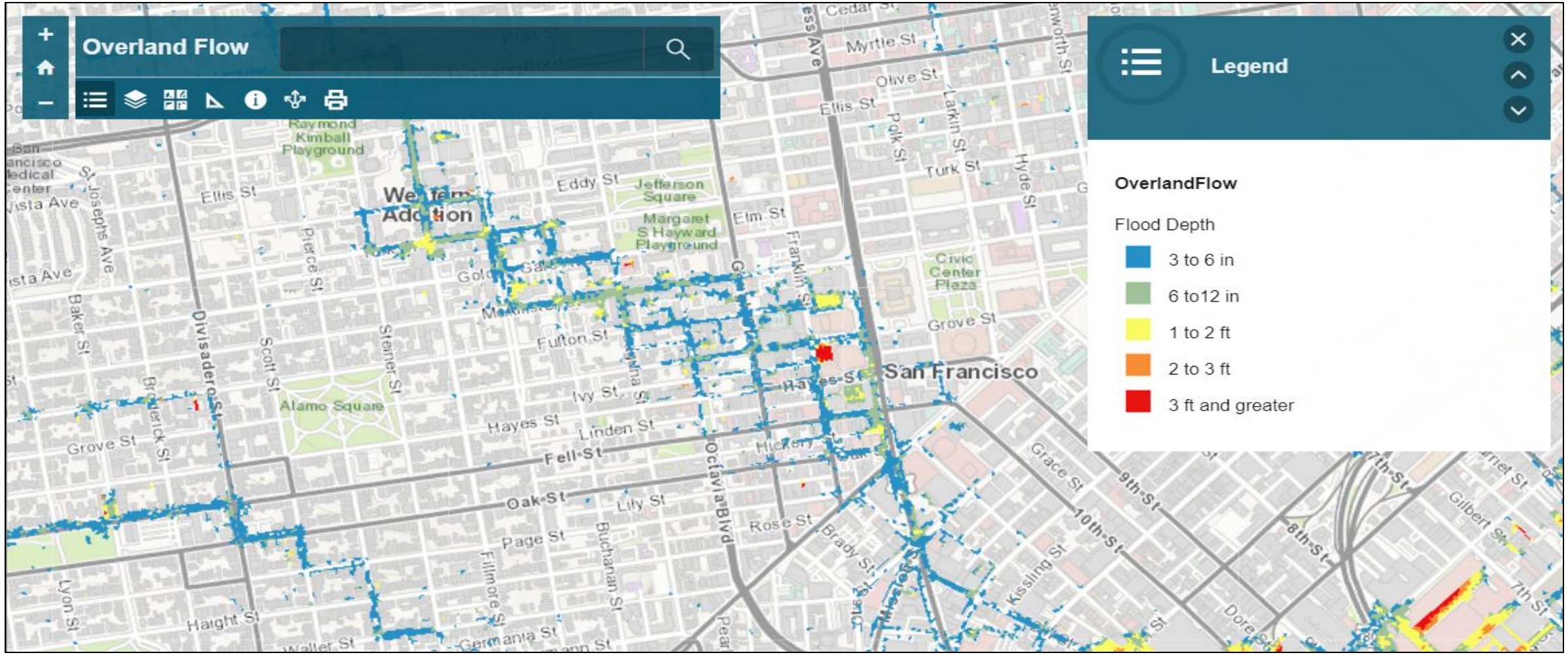




	26212.1	250497.1	-	-	250499.1	-	-	250501.1	-	-	250503.1
	33.0	24.0	-	-	24.0	-	-	24.0	-	-	24.0
	8.814	8.843	-	-	5.530	-	-	7.751	-	-	7.534
	157.02	114.54	-	-	90.58	-	-	107.23	-	-	105.72
s)	32.2903	34.7695	-	-	35.0498	-	-	34.6390	-	-	35.1208
ft/s)	10.510	9.165	-	-	9.190	-	-	7.845	-	-	13.604
	-	-	-	-	-	-		-	-	-	250503	-
	-	-	-	-		-	-		-	-	-	-	-



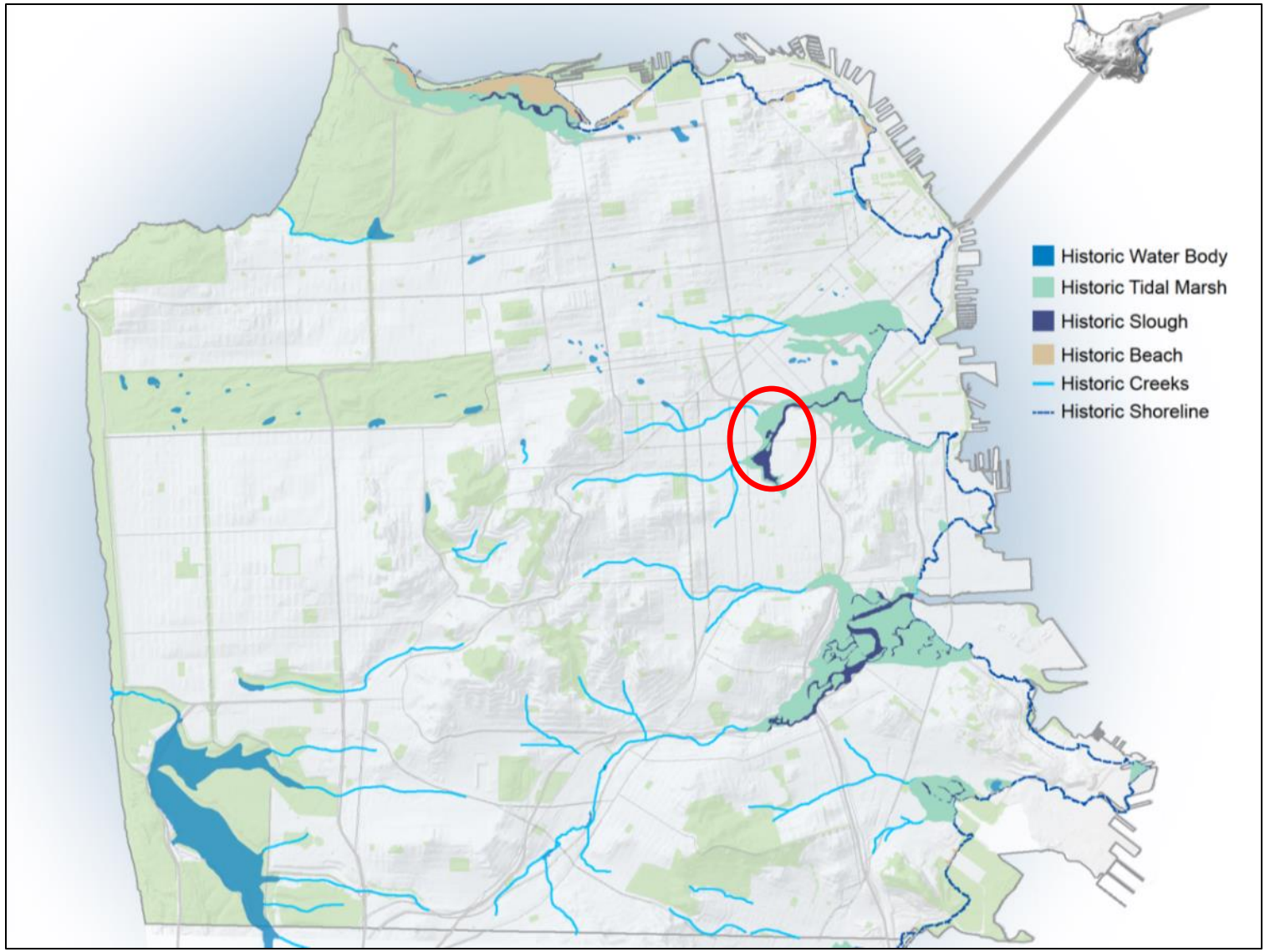
Surface Flow (Coupled 1D-2D Model)



2D Surface Flow

Flooding Area/Project Description

Flooding Area Background



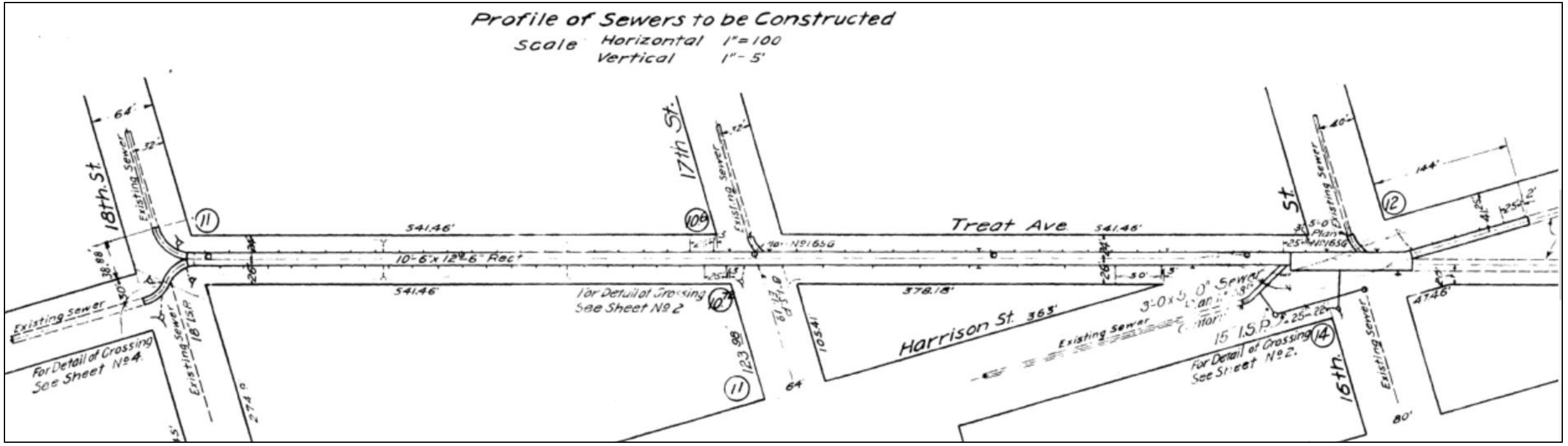
Project Background

- Properties have been subject to stormwater inundation during moderate to heavy storms. Lower-lying areas in the vicinity can experience up to several feet of flooding during rain events
- Challenging area that is part of a major flow path for both underground sewers and overland flow
- Historical creek/marshland that has subsided significantly since original street grades were set
- Area is mixed use with residential and commercial use

Project Background

- Major sewers were constructed with different upstream conditions
- Significant change to quantity of runoff generated from contributing catchment areas

DEPARTMENT OF PUBLIC WORKS
CITY AND COUNTY OF
SAN FRANCISCO, CALIFORNIA
PLANS FOR SEWERS
CONTRACT No. 45
FOR THE CONSTRUCTION OF SEWERS AND APPURTENANCES IN SECTION "G" OF THE
NORTH POINT MAIN
PREPARED BY MARSDEN MANSON CITY ENGINEER
UNDER DIRECTIONS FROM THE BOARD OF PUBLIC WORKS.
SAN FRANCISCO, CALIFORNIA-FEBRUARY-1911.
4 SHEETS
SHEET-No 1.



Project Background

- Several feet of flood depth within private properties
- Shutdown of businesses to clean up post storm

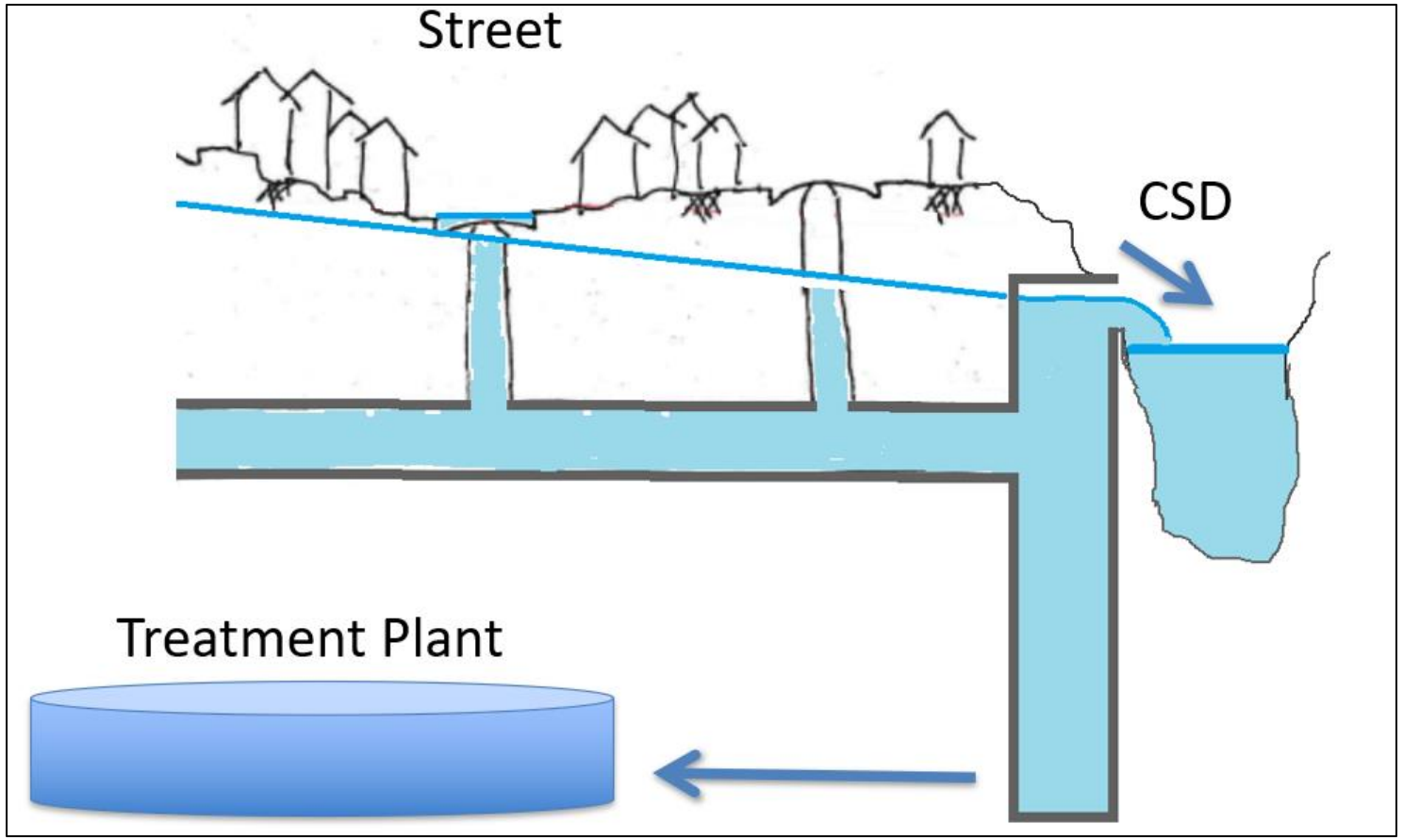
Project Background

- Distribution of sandbags/barriers to reduce runoff from street to the properties

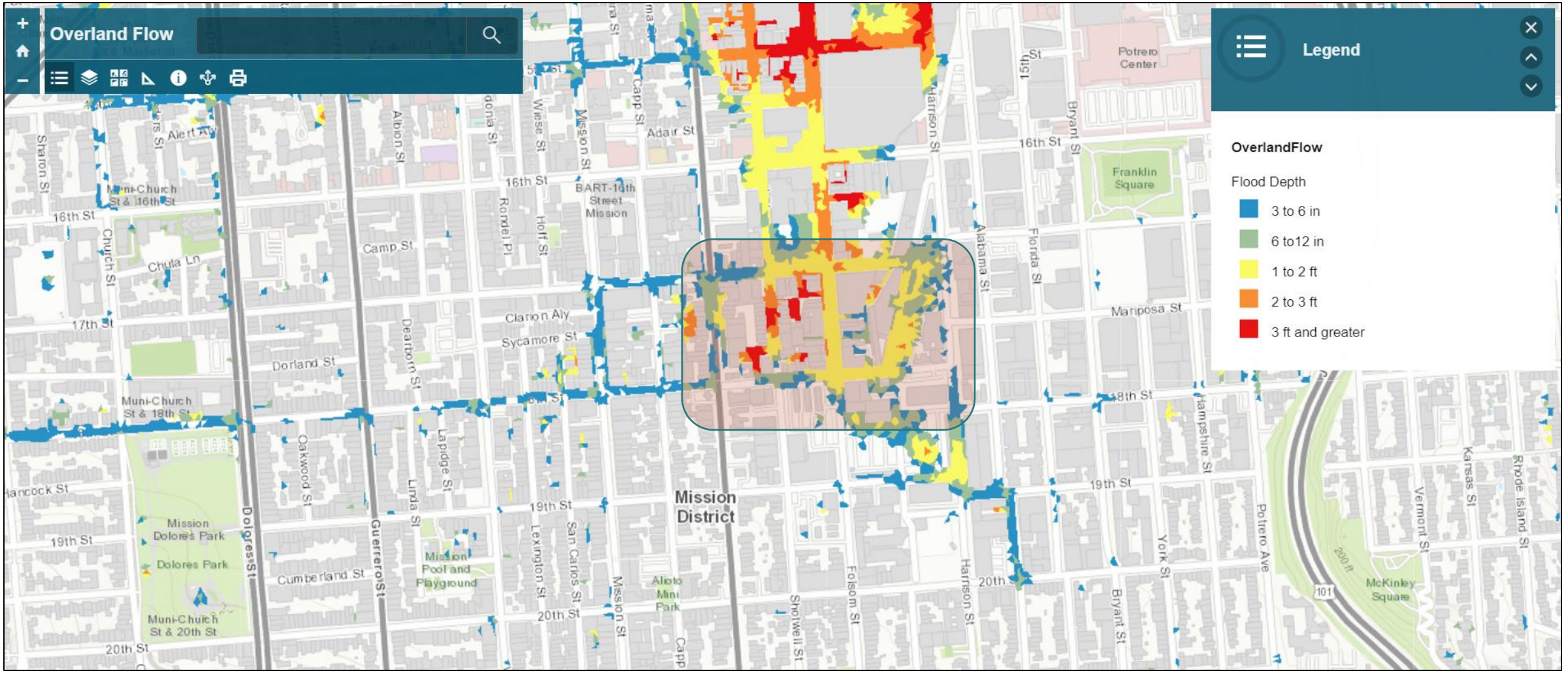
- Helped reduce surface flow but properties still connected to the collection system

System Performance

- Flooding is caused by rise in hydraulic gradeline within the collection system
- Conveyance, discharge, and treatment are limited in capacity
- Low street/property elevations cause more flood damage due to higher depths



Overland Flow



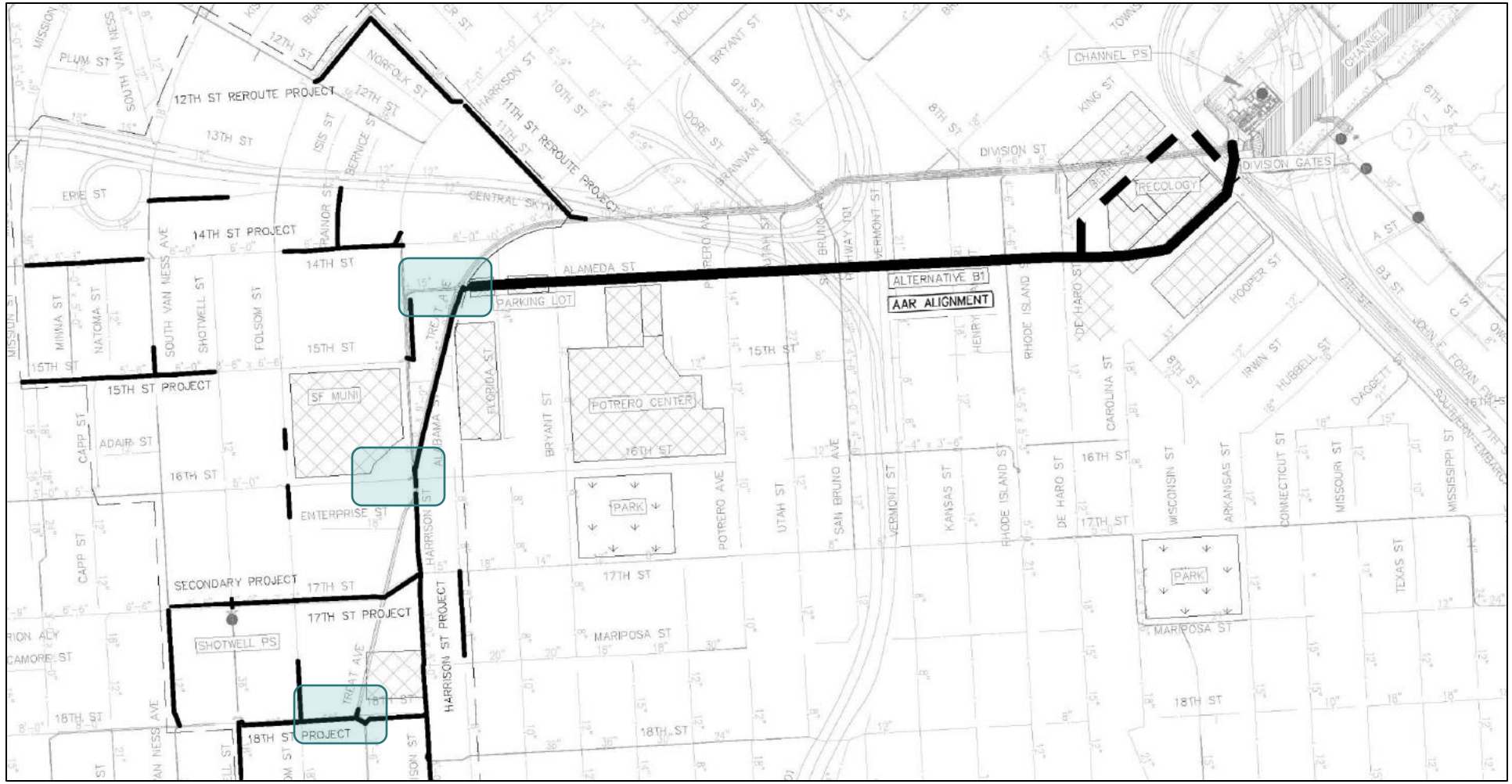
Project Focus Area

Project Hydraulic Performance

- Some drainage improvements were done in the past but limited in scope focusing on single city blocks
- Project will manage stormwater to meet the level of service 5-year storm
- Design to reduce the hydraulic gradeline in the sewer to be at minimum 2 feet below street grade for level of service storm

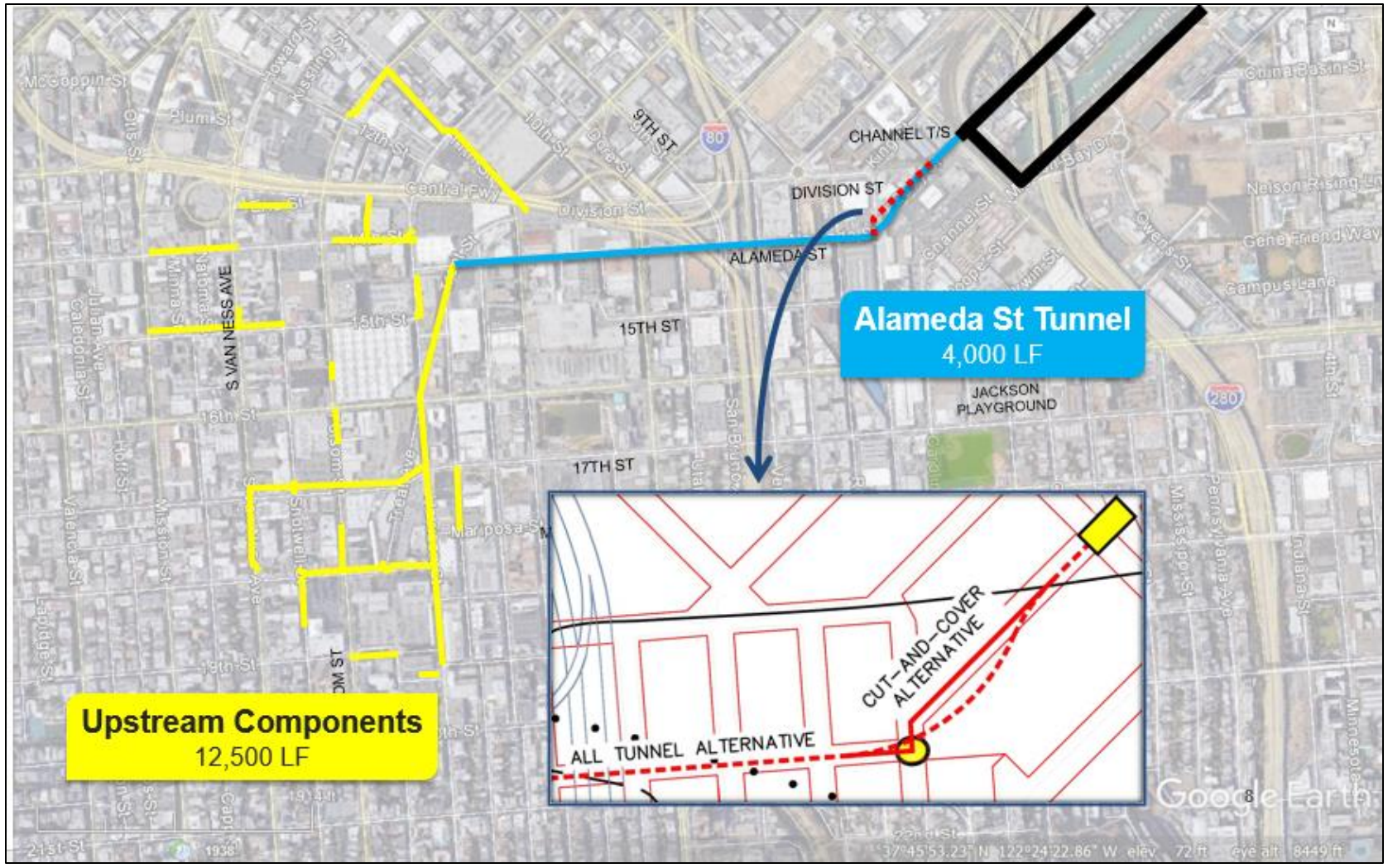
Project Constraints

- Challenging area due to historical subsidence
- Constraints underground due to existing infrastructure
- Coordination with various agencies and disciplines



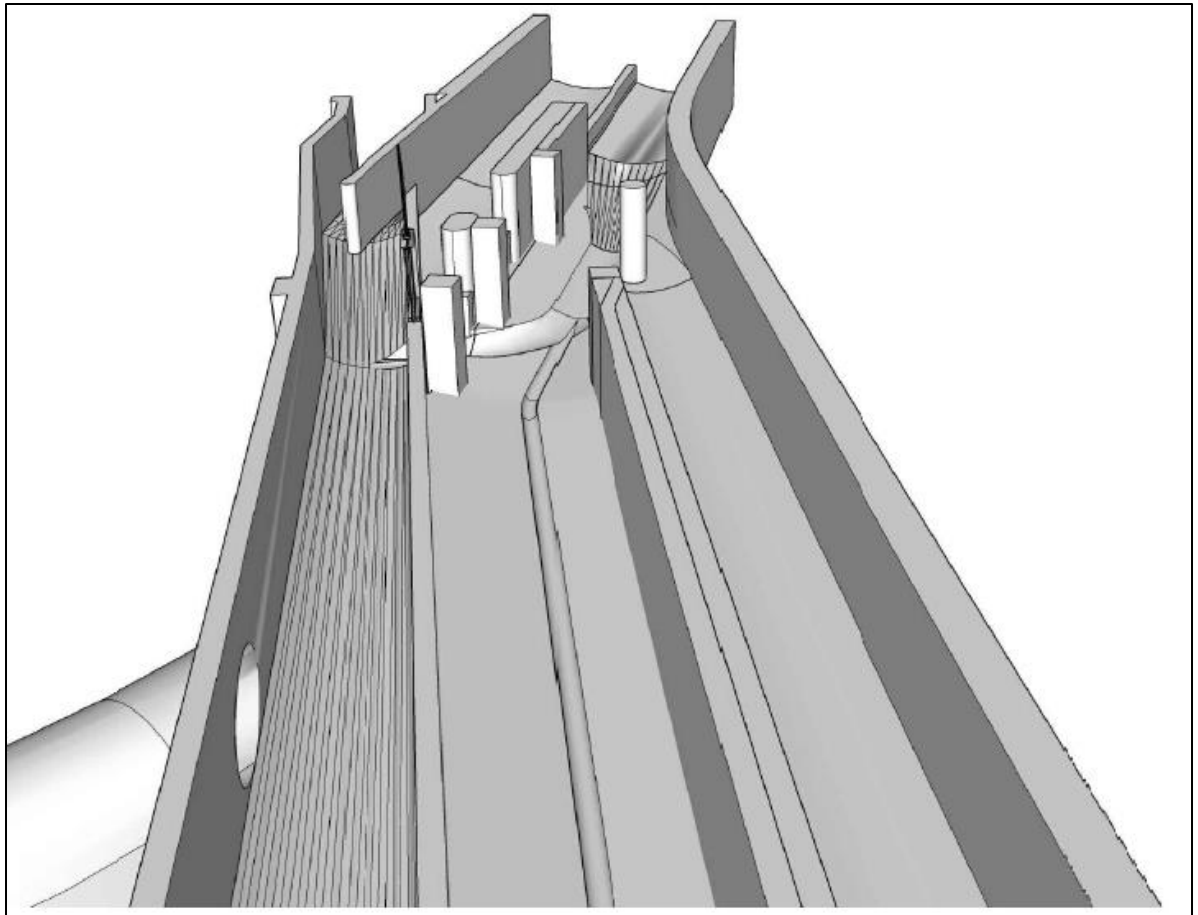
Project Components

- Project divided into two tiers
- First tier addresses upstream hydraulic inadequacies
- Second tier to convey resulting flows to a new 12-ft tunnel and discharged to existing outfall



Modifying Existing Structures

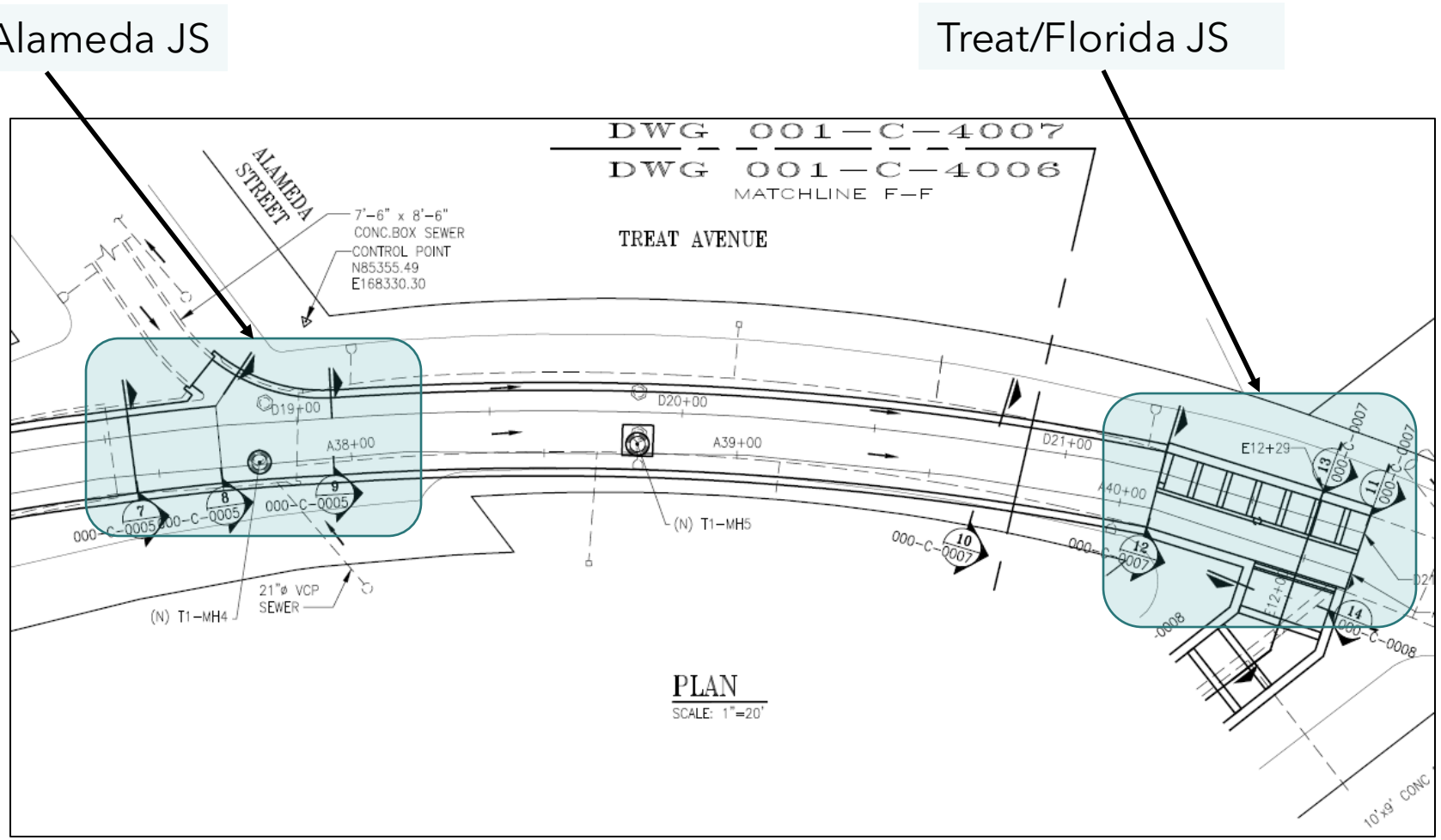
- Maintaining Existing Junction at 16th/Harrison
- Modify Structure to Accept New Box and Reduce Water Surface Elevations
- Difficult Area to Construct New Junction Structure due to Traffic Needs
- Modify Internal Weir/Walls to Reduce Head Losses



16TH ST. JUNCTION STRUCTURE
(LOOKING NORTH FROM ABOVE)

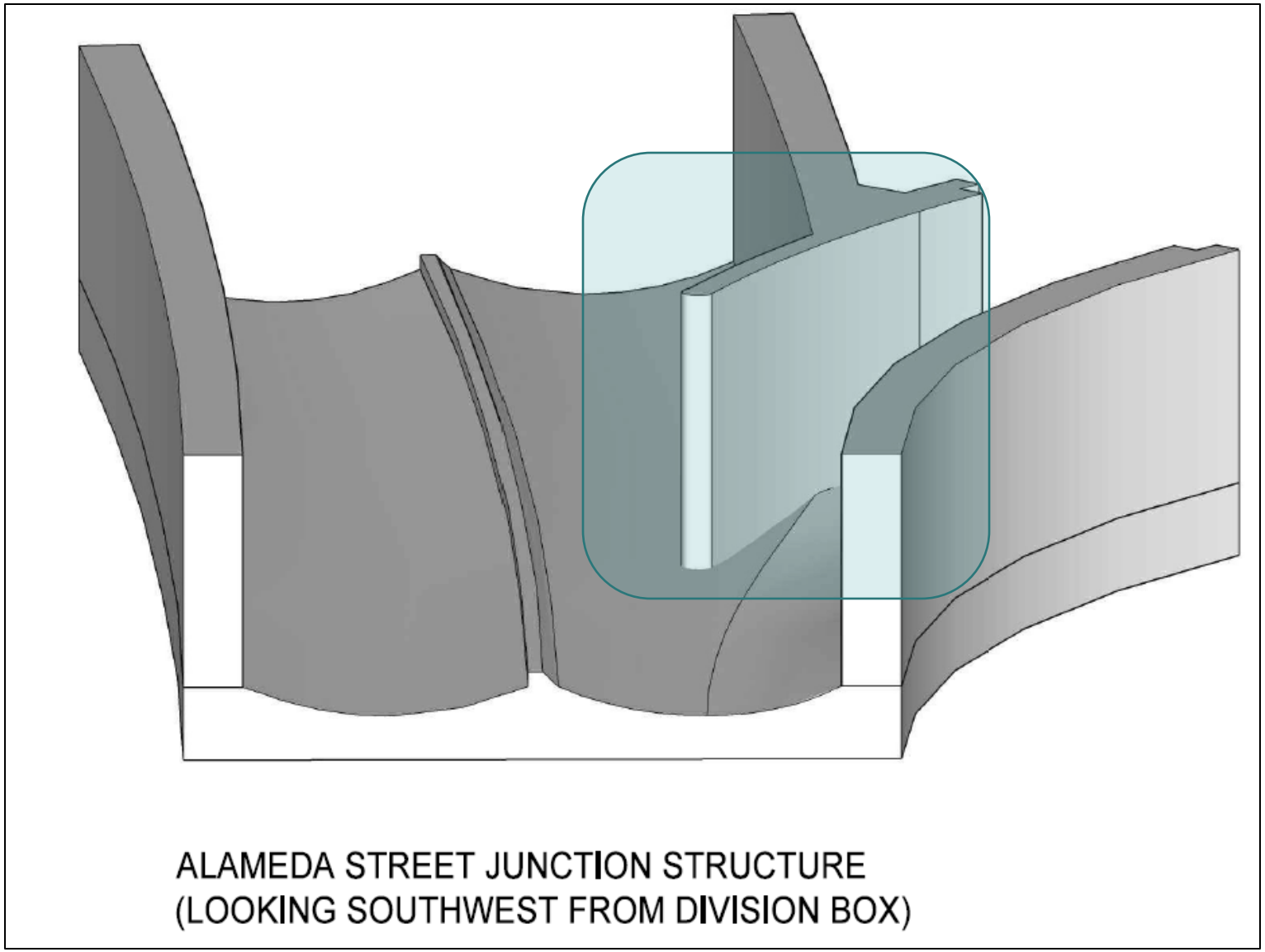
New Junction Structures

- Constructing new box and junction structure
- Add baffle walls to control flow diversion to new tunnel
- Structural modifications to reduce box depths



New Junction Structures

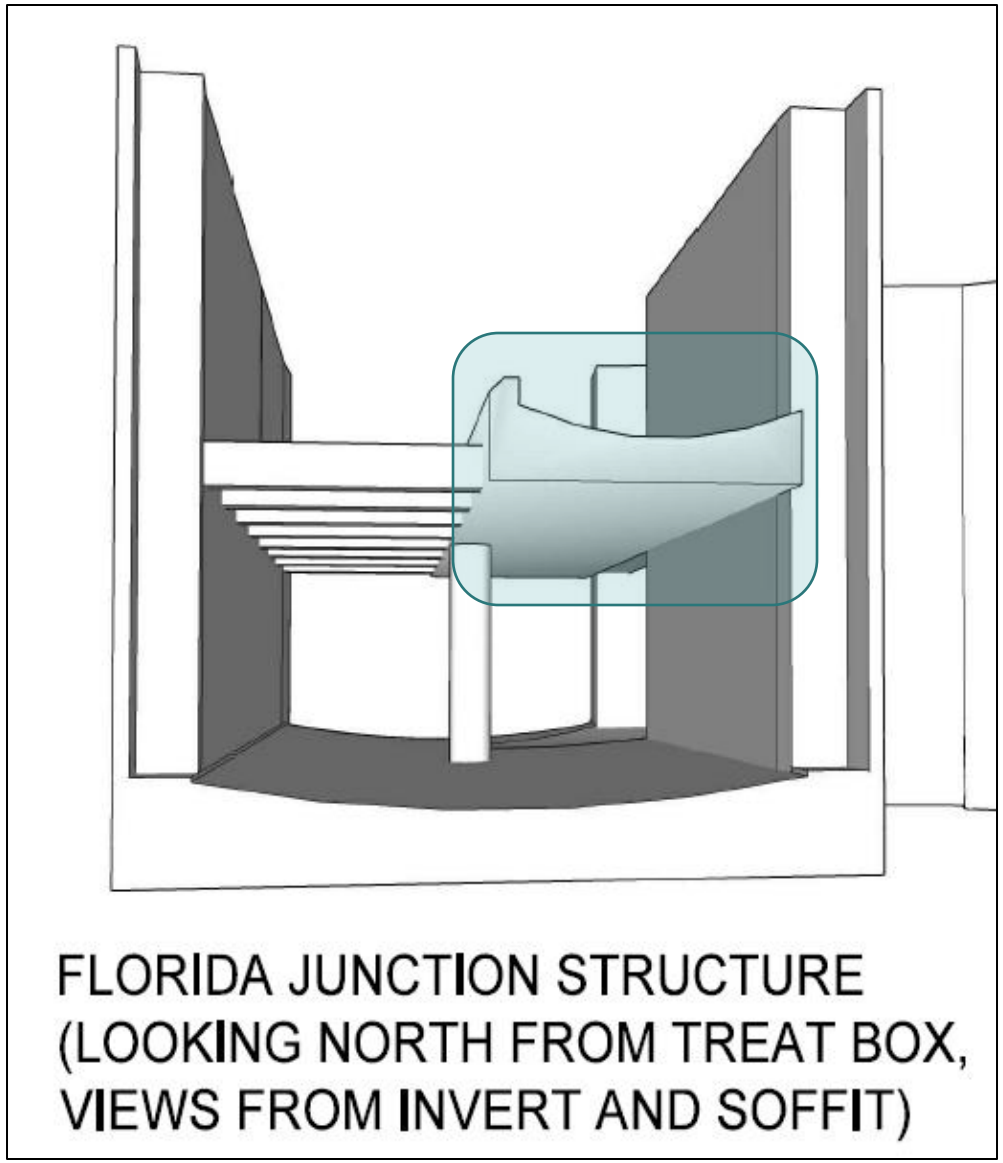
- Maintain dry weather flow channel within new box section
- Added guidewall to divert flow from Alameda Street to Treat Avenue to reduce impact on dry weather flow
- Reduced headlosses at transition structure



ALAMEDA STREET JUNCTION STRUCTURE
(LOOKING SOUTHWEST FROM DIVISION BOX)

New Junction Structures

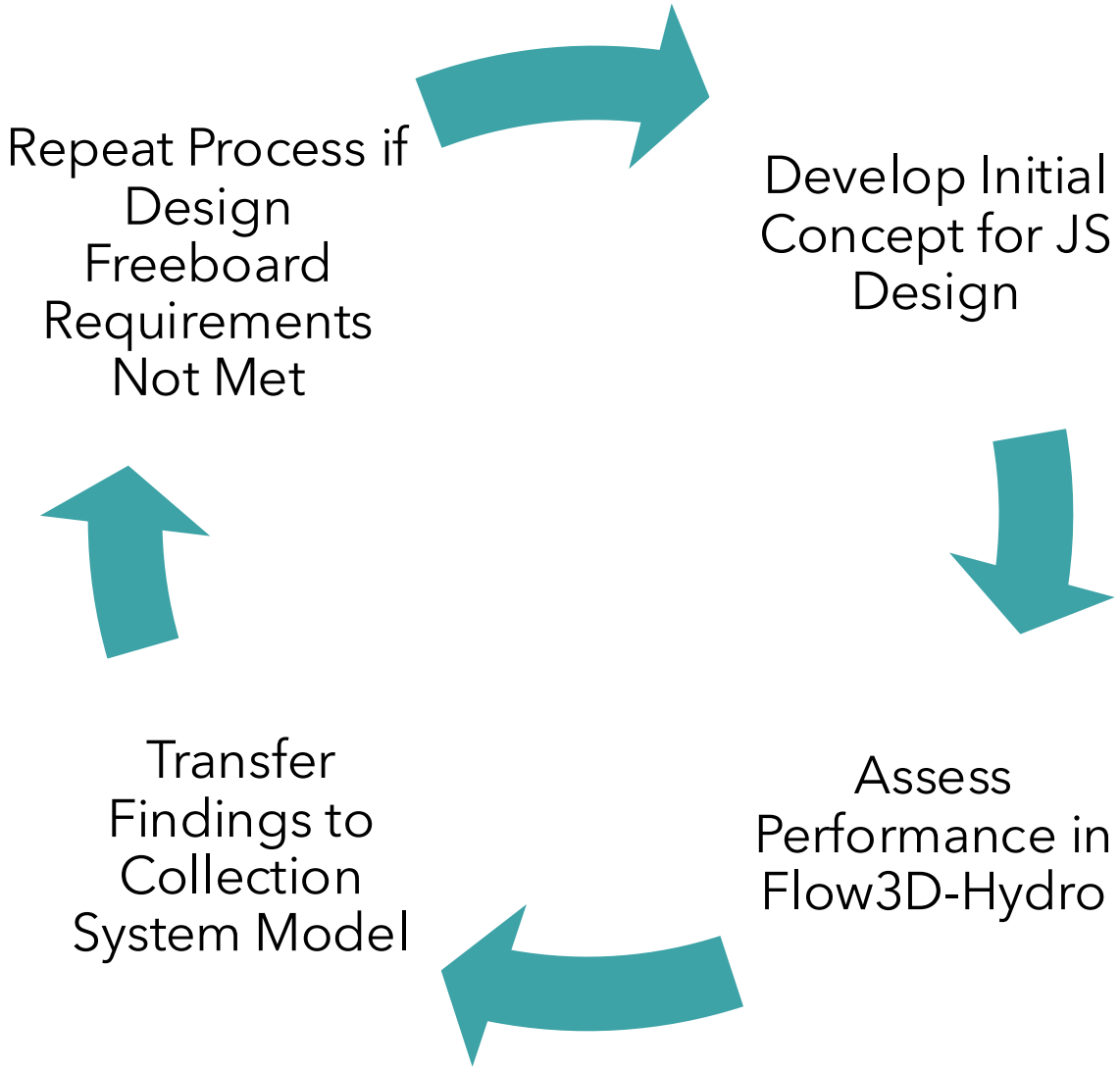
- Shallow box on Treat Ave connecting to deeper box on Florida St
- Need to maintain dry weather flow channel in higher elevation
- Reduced structural elements and maintain adequate freeboard



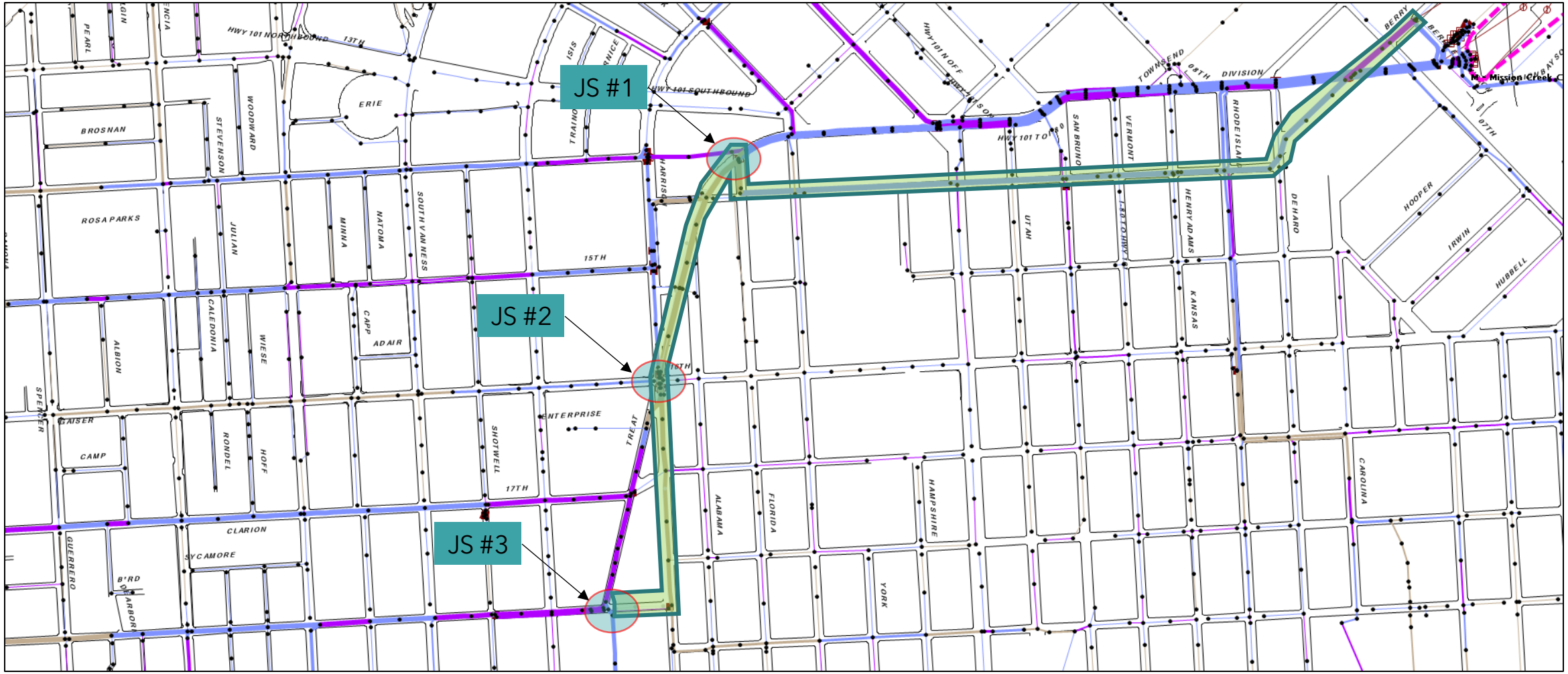
FLORIDA JUNCTION STRUCTURE
(LOOKING NORTH FROM TREAT BOX,
VIEWS FROM INVERT AND SOFFIT)

Application of Flow3D-Hydro

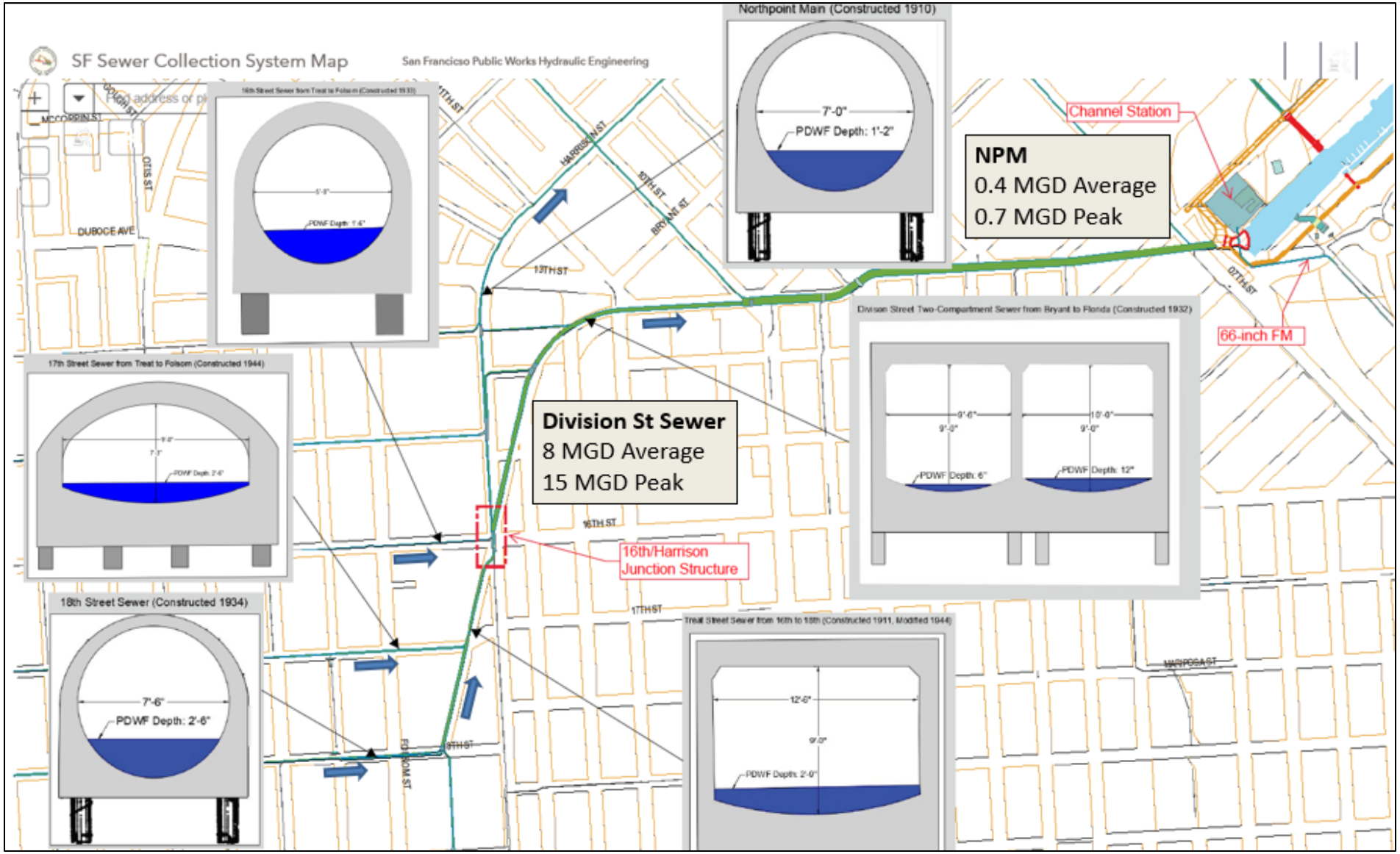
Junction Structure Design Process



Junction Structure #1 at Treat/Florida

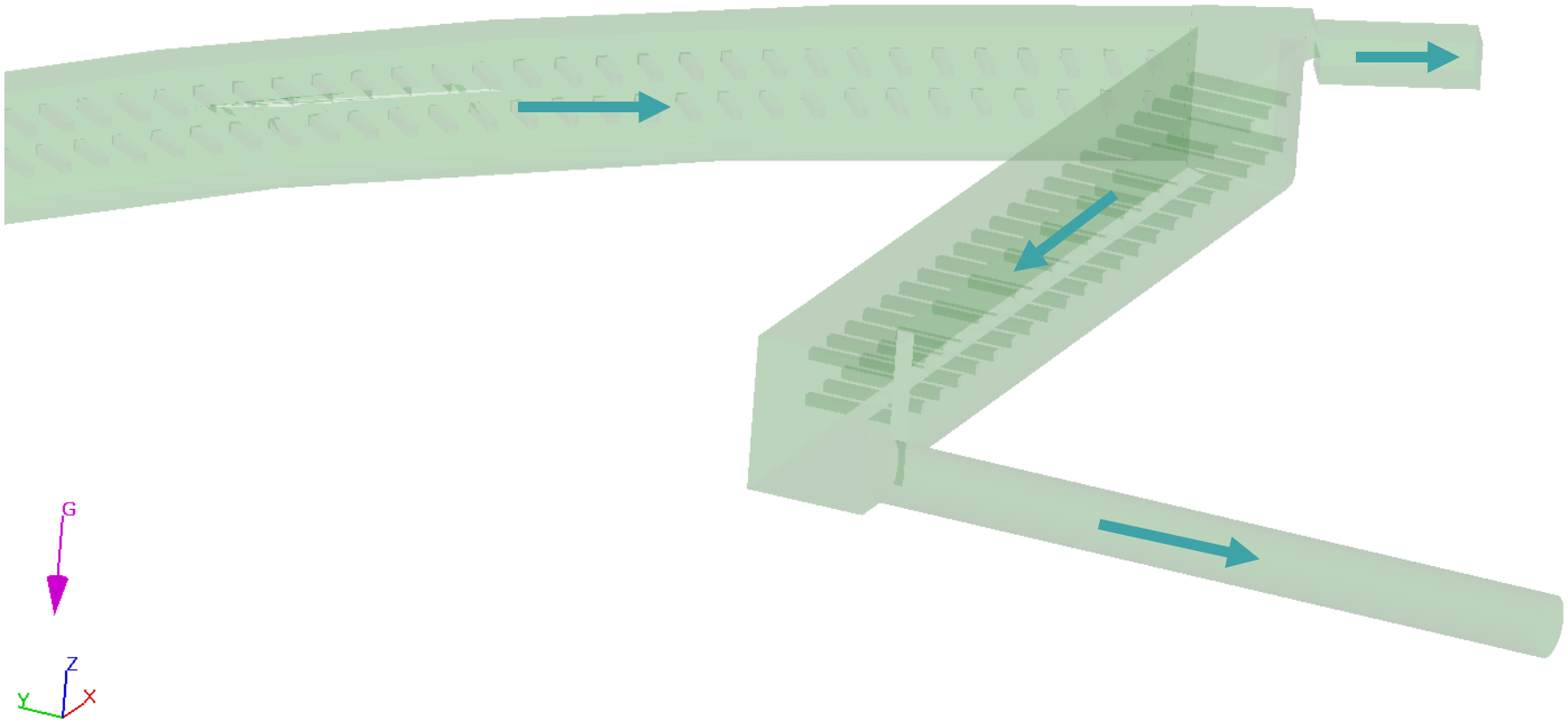


Normal Flow Conditions

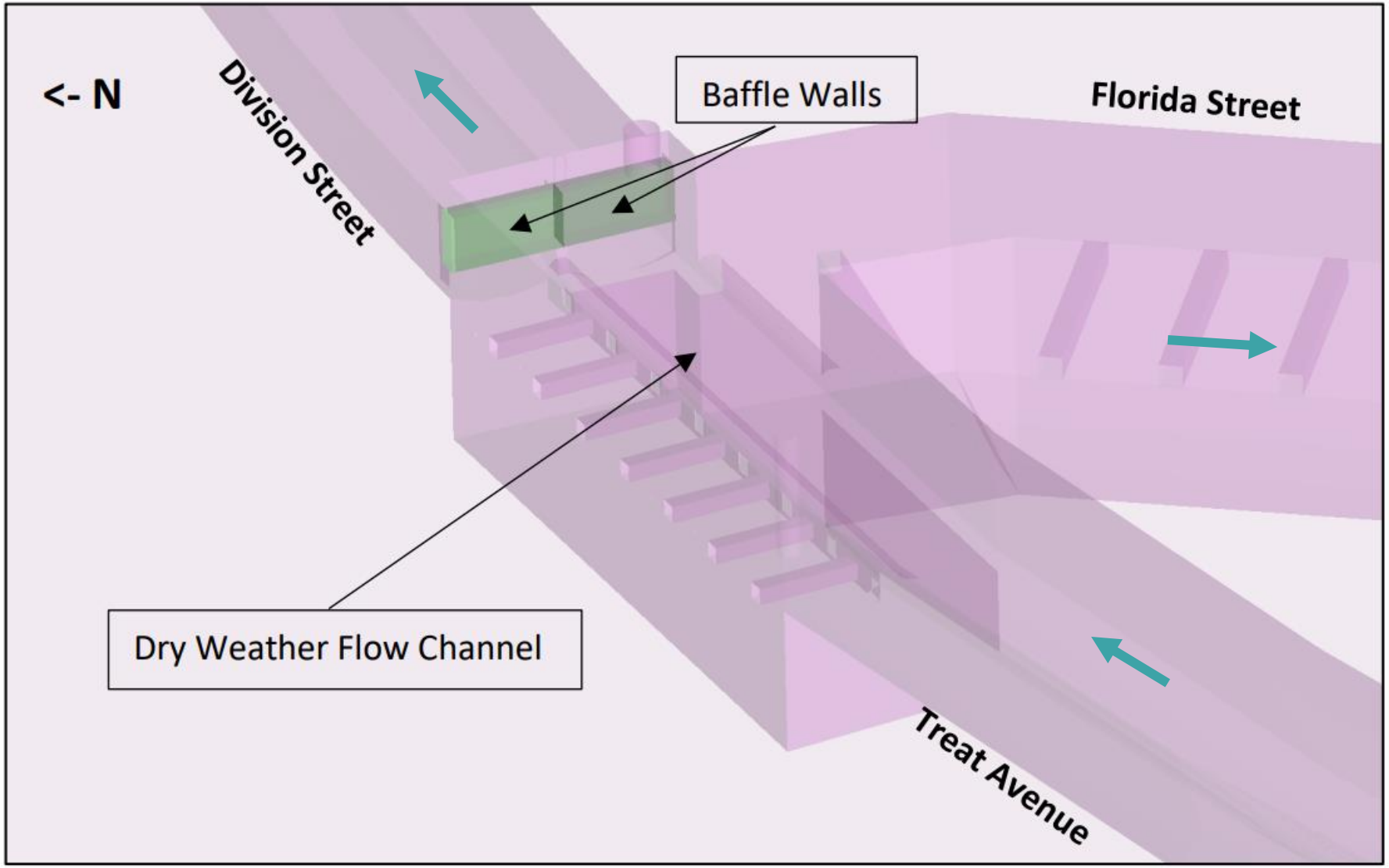


Junction Structure #1 at Treat/Florida

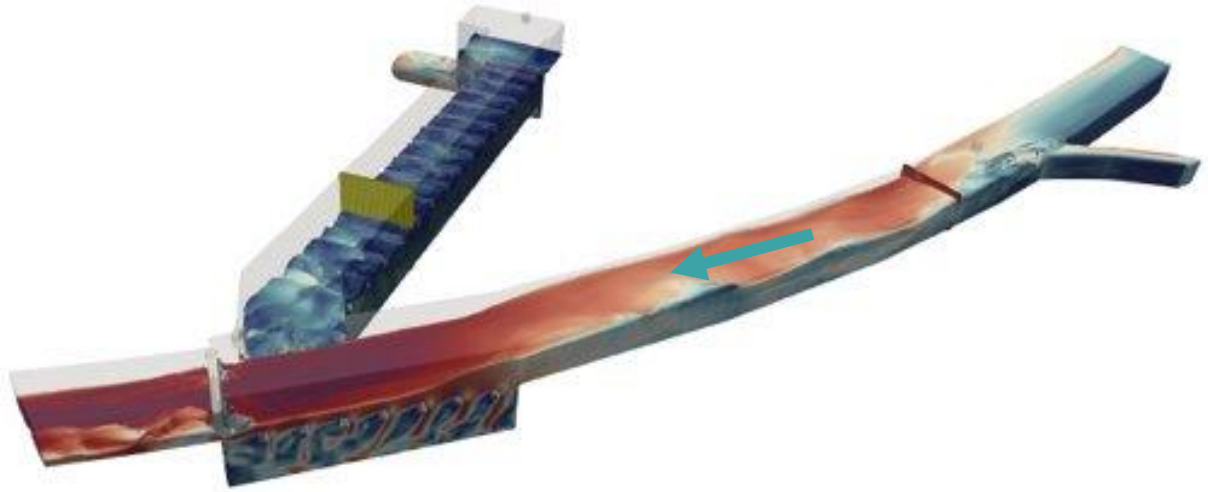
- Needed to model several conceptual designs for effectiveness in short turnaround time
- Use of flux surfaces and water surface elevations to determine adequate flow diversions and updating HGL Profile in 1D model

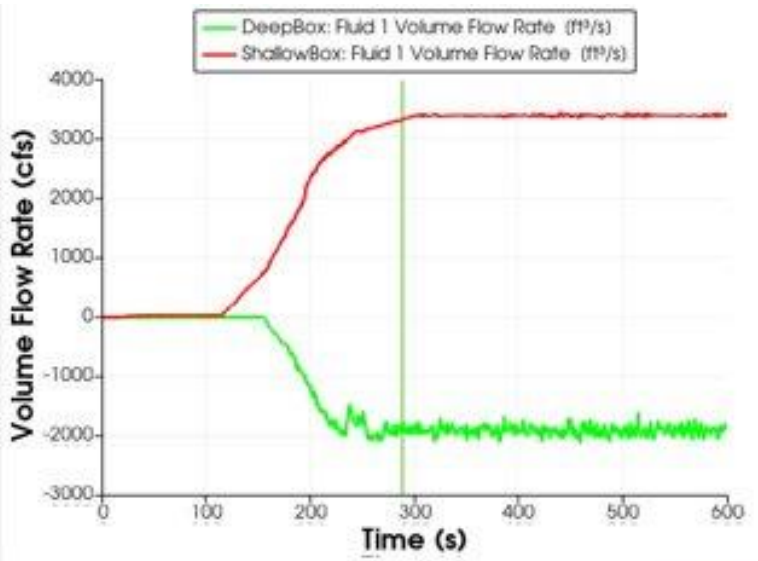


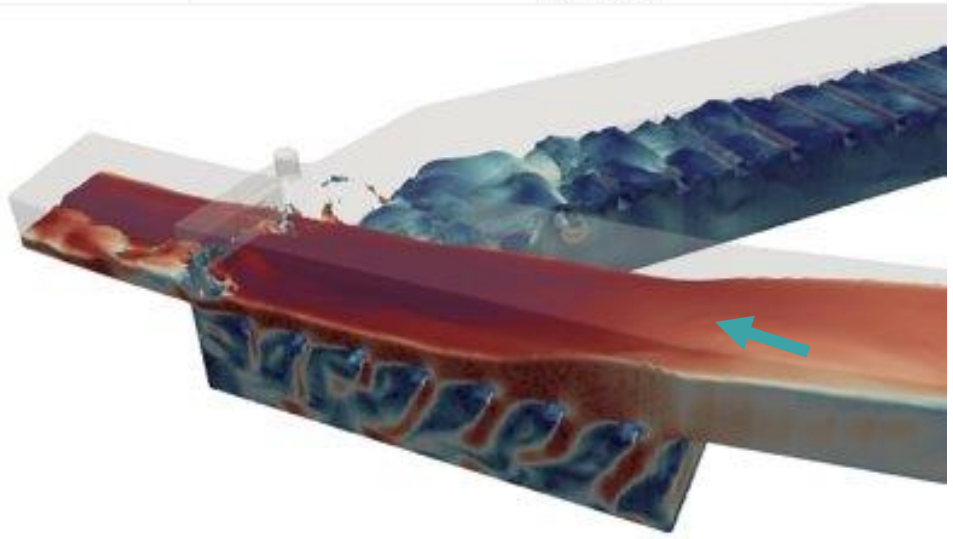
Junction Structure #1 at Treat/Florida



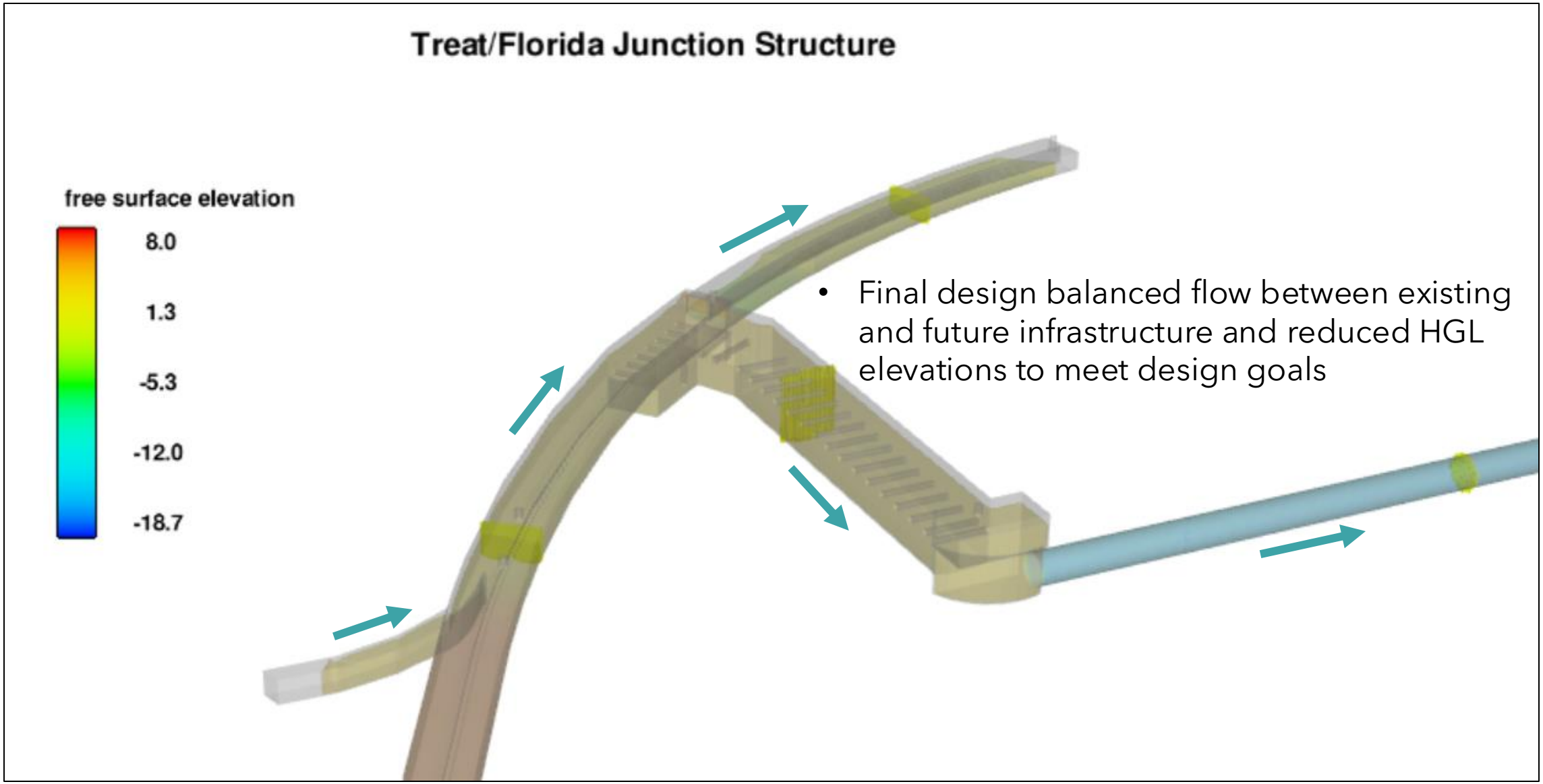
Junction Structure #1 at Treat/Florida







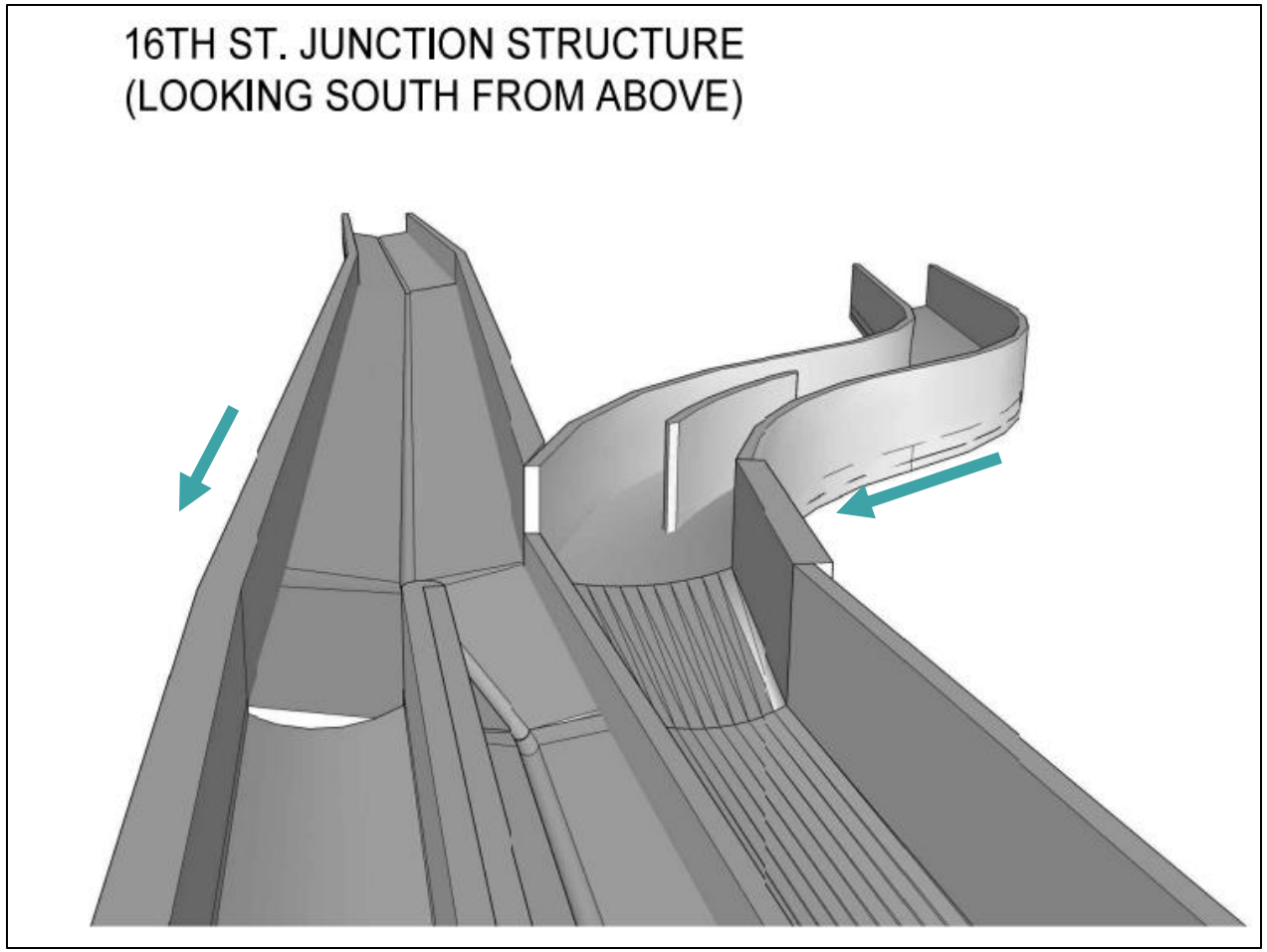
Junction Structure #1 at Treat/Florida



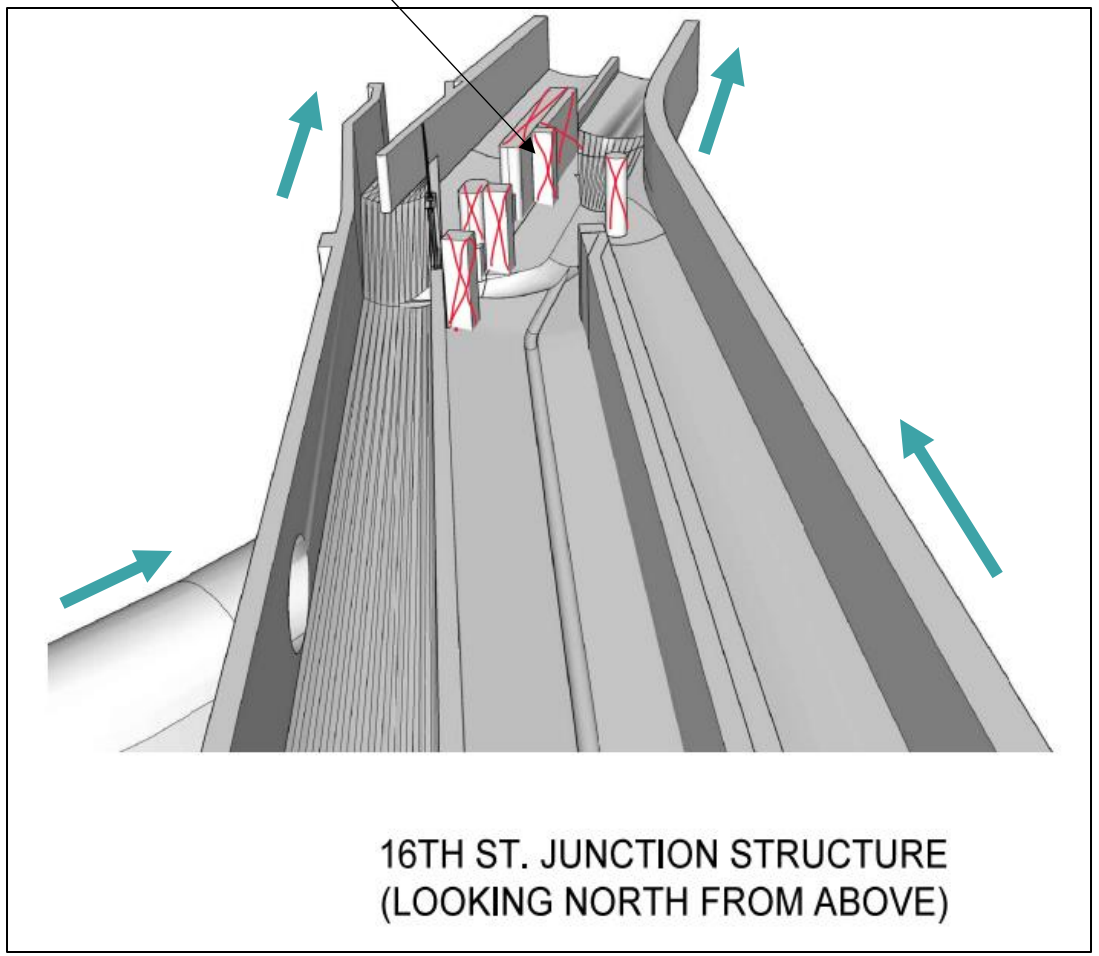
- Final design balanced flow between existing and future infrastructure and reduced HGL elevations to meet design goals

Junction Structure #2 at 16th/Harrison

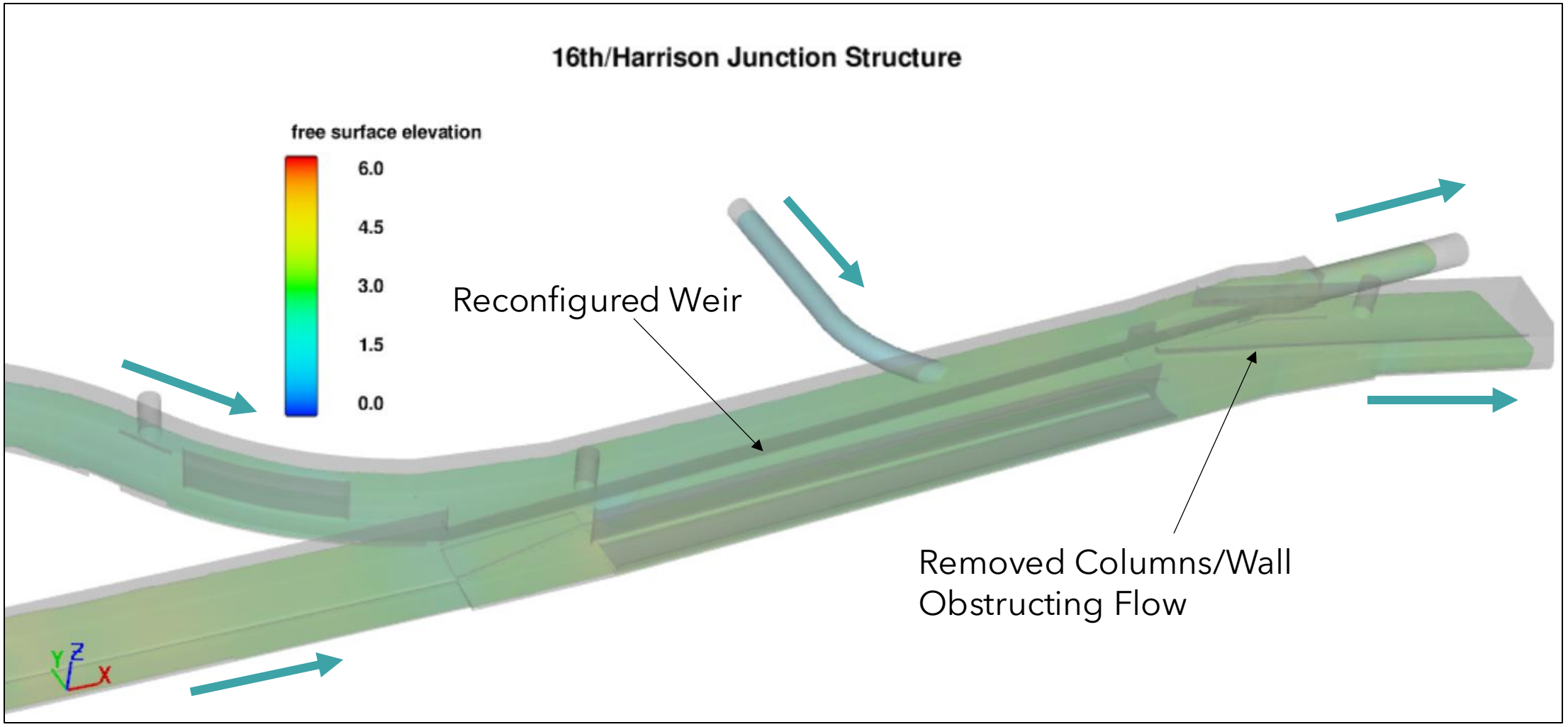
Junction Structure #2 at 16th/Harrison



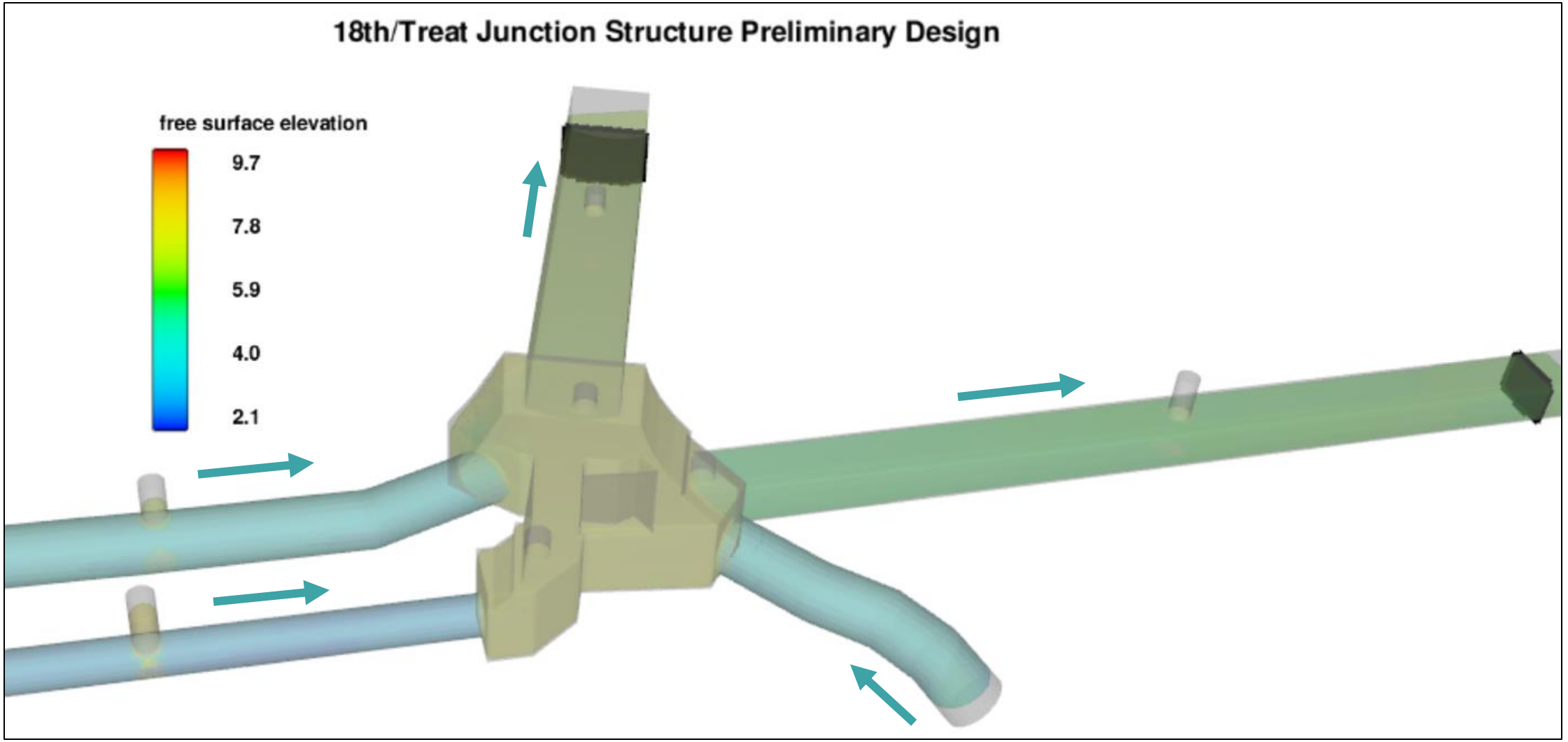
Columns/Wall Obstructing Flow



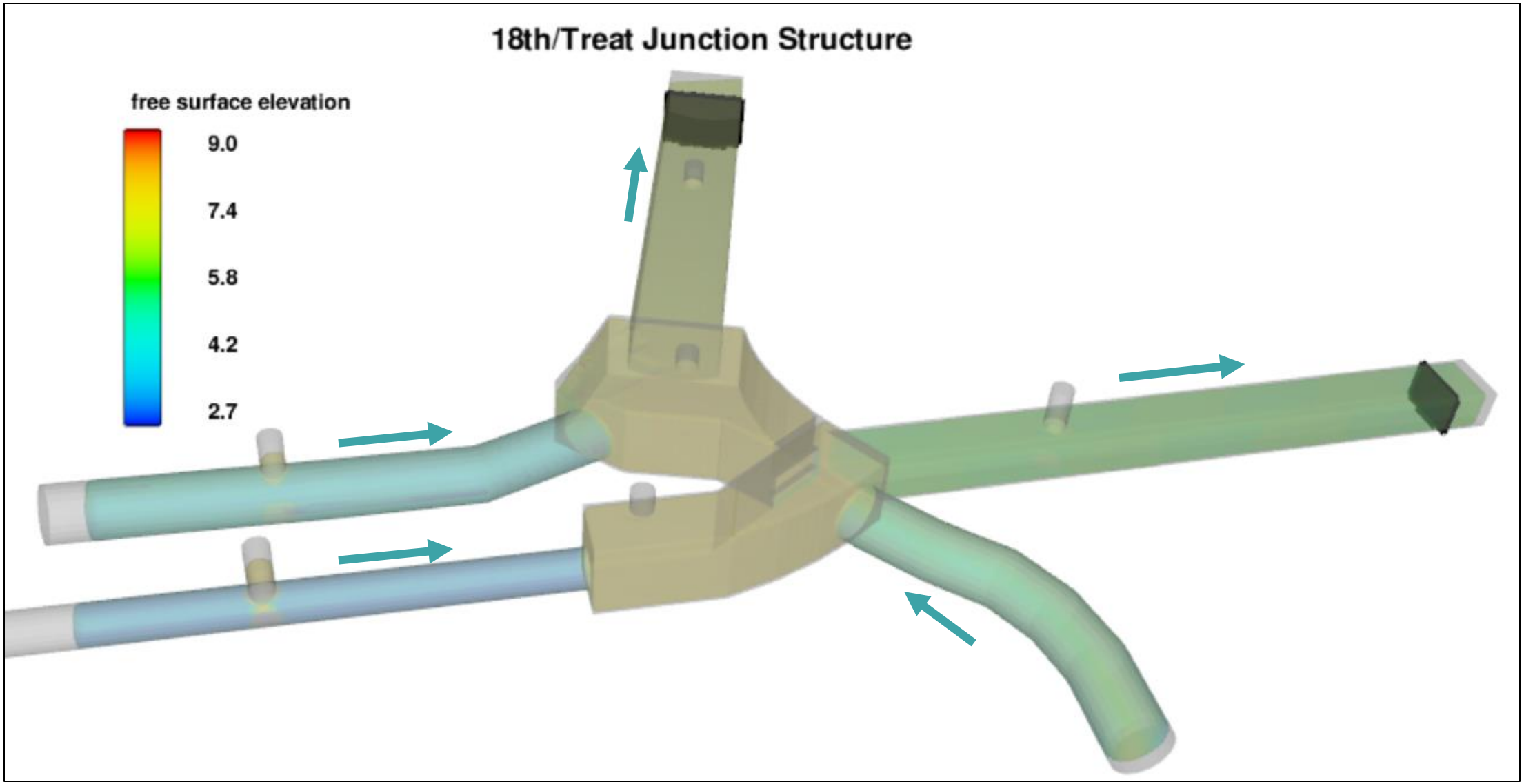
Junction Structure #2 at 16th/Harrison



Junction Structure #3 at 18th/Treat



Junction Structure #3 at 18th/Treat



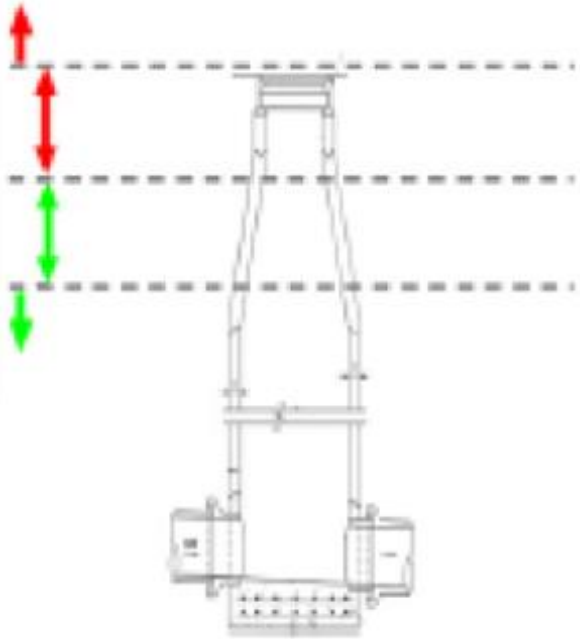
Updating Collection System Model with Results from Flow3D-Hydro

Hydraulic Gradeline Profile Updates

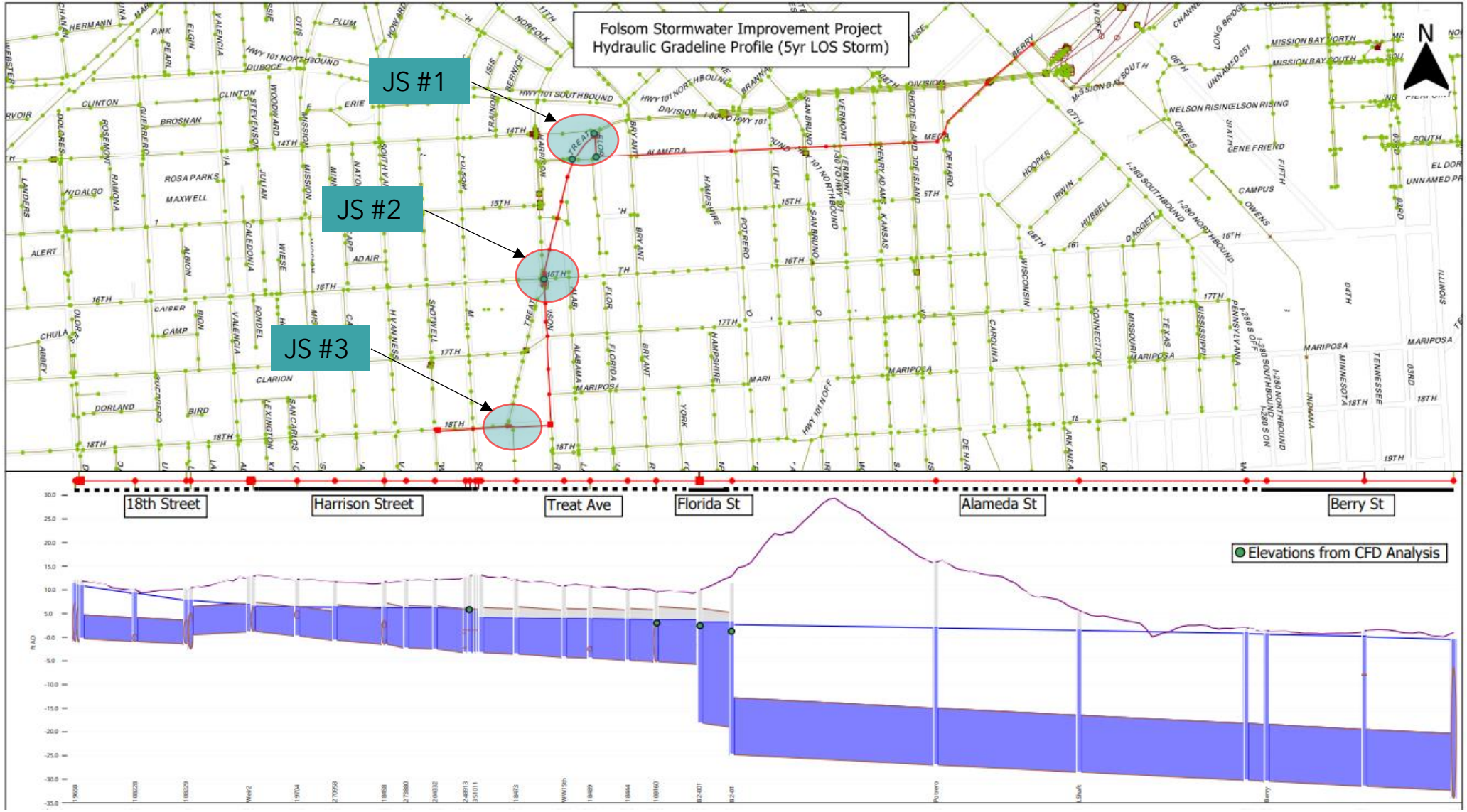
- Locations within study area met the minimum 2-feet of freeboard
- Eliminated surface flooding with proposed improvements for 5-Year design storm

Categories for Freeboard Count

	Freeboard	# of Nodes
Freeboard Not Met	Negative	
	0-2 feet	
Freeboard Met	2-4 feet	
	+4 feet	



Hydraulic Gradeline Profile Updates



Thank You, Questions?

Email: Bassam.Aldhafari@sfdpw.org