
Master Drainage Concept Plan

City of
Bellaire



Master Drainage Concept Plan

Partners

1. Harris County Flood Control District - \$351,000 (50%)
2. City of Bellaire – \$221,832 (31.6%)
3. Texas Department of Transportation - \$129,000 (18.4%)

Engineering Project Team

1. ARKK Engineers, LLC.
2. Costello, Inc.
3. Freese & Nichols, Inc.

Scope

- Determine Drainage Improvements for 10 and 100-year storm events using Atlas 14
- Determine 3 concepts for improvements
- Evaluate open channels, storm sewers, detention ponds, and flood tunnels
- Determine estimated mitigation volume to mitigate peak flows along Brays Bayou
- Review and analyze potential overflows coming in to the City
- We have also developed a website for the purpose of inform all about our progress and answering questions that we are receiving.

<https://www.bellairemdcp.com/>

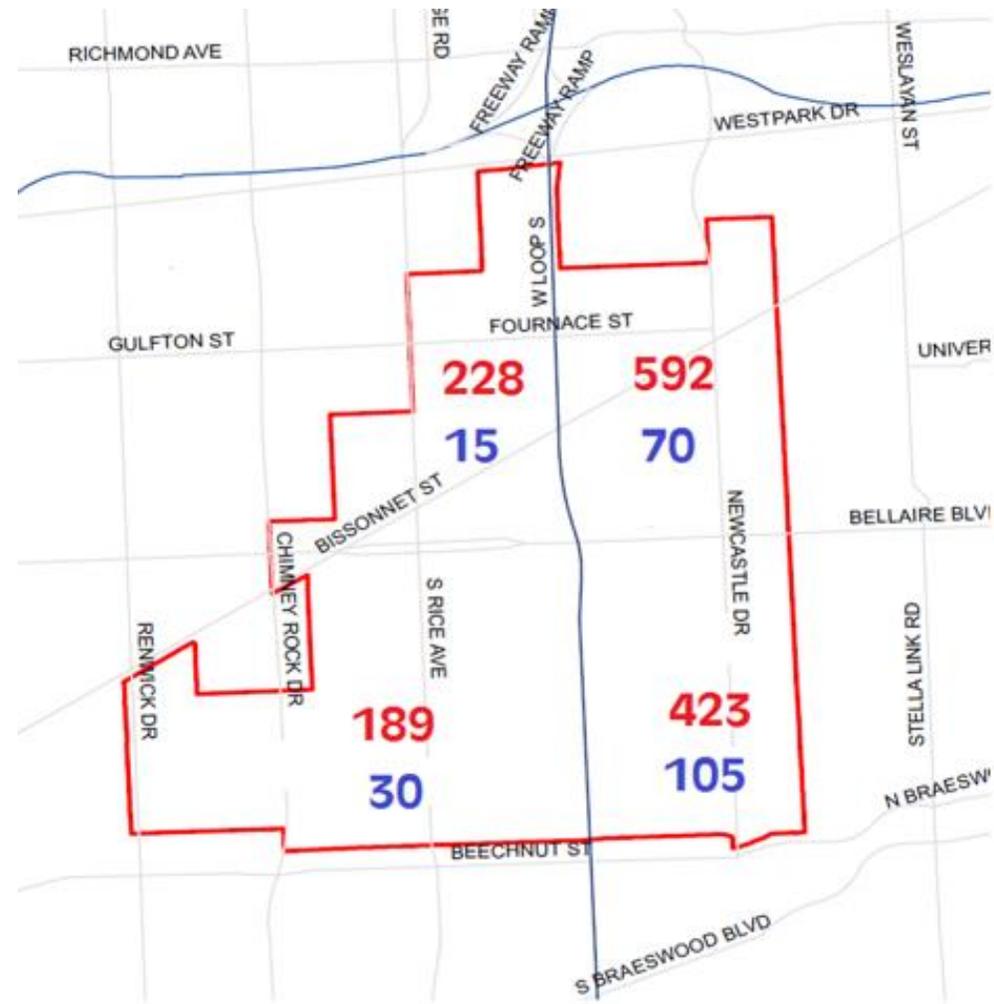


Flooding in the area is not new

Flooded structures by area during Tropical Storm Allison & the May 2015 storm

Public Works Service Center flooded in both Storms

No access across Loop 610



Reported Structures Flooded

Allison 2001

May 2015

1432

220



IH 610 at Bellaire Blvd. May 2015

Local Rainfall Highs

Table 2 - Rainfall Highs per Time Period Brays Bayou at Stella Link Road (HCFWS Gauge 430)

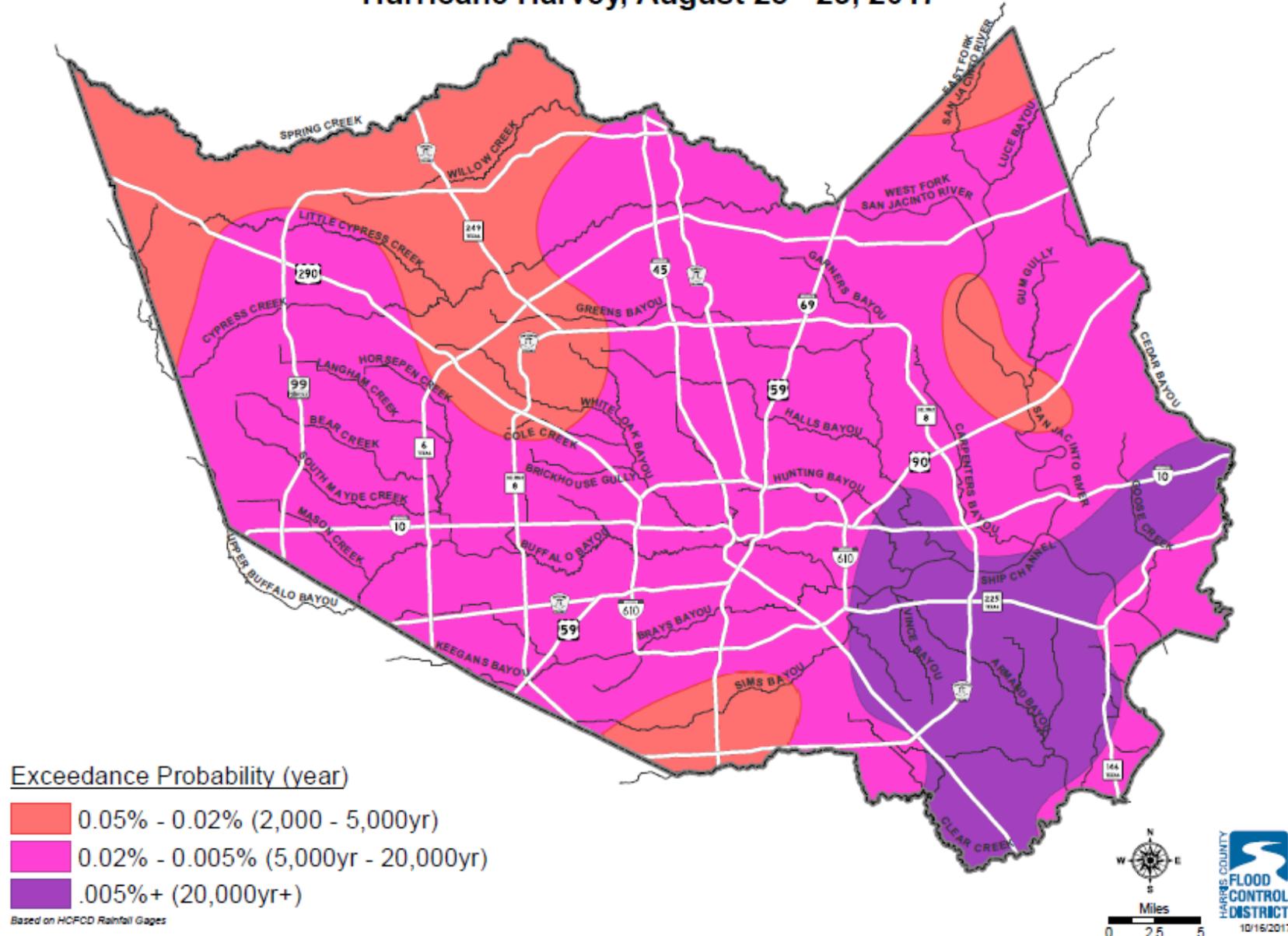
Rainfall Highs (inches)							
Time	May 25	Ike (Sept. 2008)	Allison (June 2001)	Event			
				2-yr	25-yr	50-yr	100-yr
1 hour	1.84	1.30	3.43	2.50	3.80	4.25	4.60
2 hour	3.24	1.73	6.02	3.00	4.90	5.50	6.20
6 hour	7.08	3.42	9.24	3.90	7.00	7.90	8.90
12 hour	7.76	4.76	11.42	4.50	8.50	9.60	10.90
24 hour	7.80	4.83	11.58	5.25	10.00	11.50	13.00



Hurricane Harvey

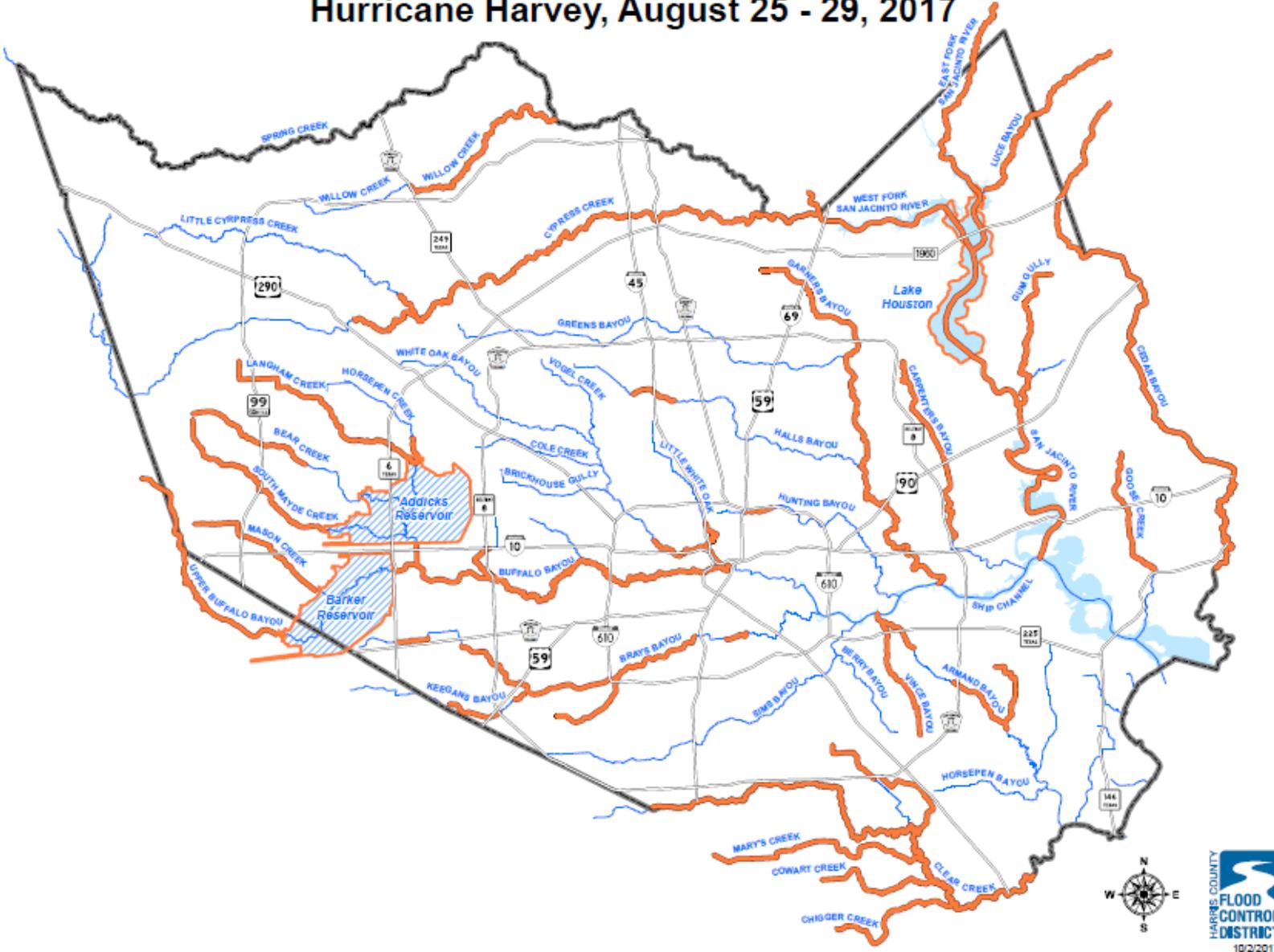
Four Day Peak Rainfall Frequency

Hurricane Harvey, August 25 - 29, 2017



Record Flood Levels

Hurricane Harvey, August 25 - 29, 2017



HARRIS COUNTY
FLOOD CONTROL
DISTRICT
10/2/2017

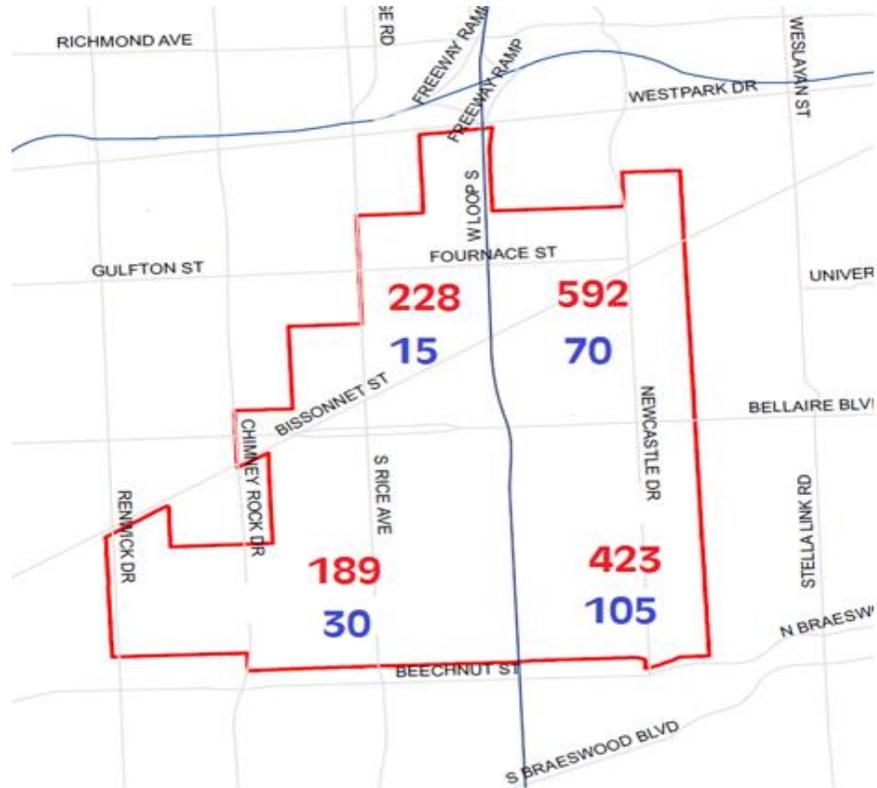
Structures Flooded May 2015 vs Harvey 2017

SUMMARY

Description		Existing Homes	<u>May 2015 Flood</u>		<u>August 2017 Flood</u>		Flooded in Both Storms
			Structural Flooding	% Flooded Homes	Structural Flooding	% Homes w/Structural Flooding	
Tier I	Pre 1980	2313	122	5%	1039	45%	80
Tier II	1980-1993	1087	32	3%	291	27%	12
Tier III	1994-2007	2348	56	2%	554	24%	30
Tier IV	2008-Present	739	16	2%	47	6%	5
	Year Build Unknown	201	2	1%	5	2%	0
TOTAL		6688	228	3%	1936	29%	127

Allison May 2015 Harvey

Structures Flooded



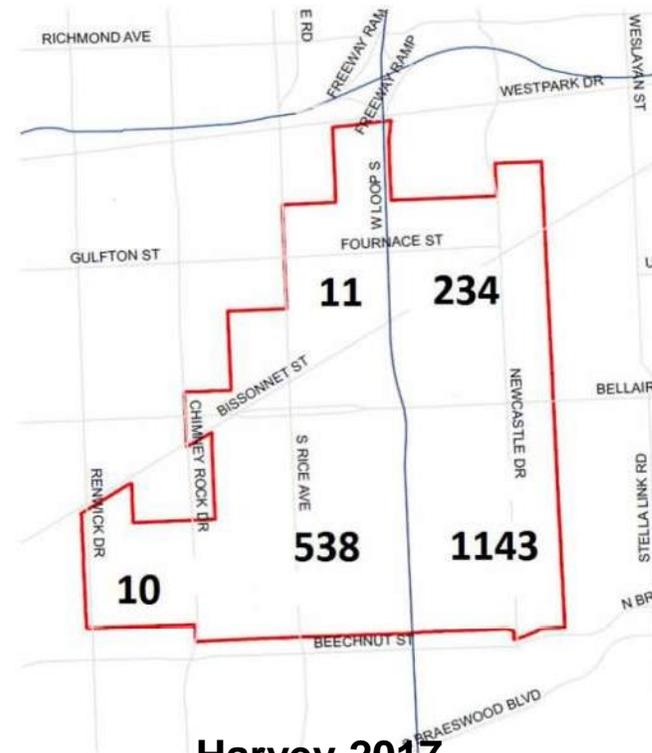
Reported Structures Flooded

Allison 2001

May 2015

1432

220

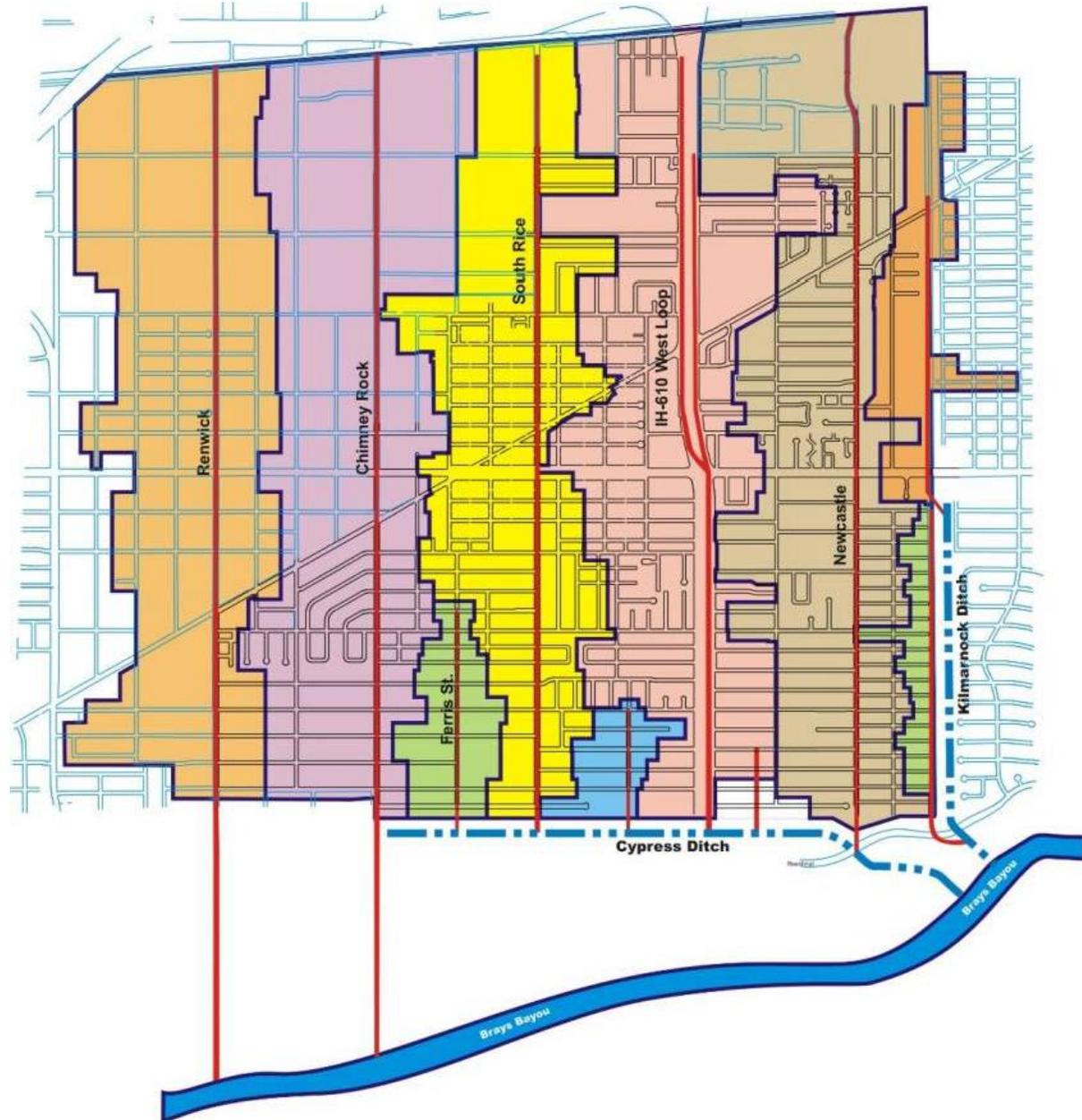


Harvey 2017

Homes Flooded
not including garages
1936



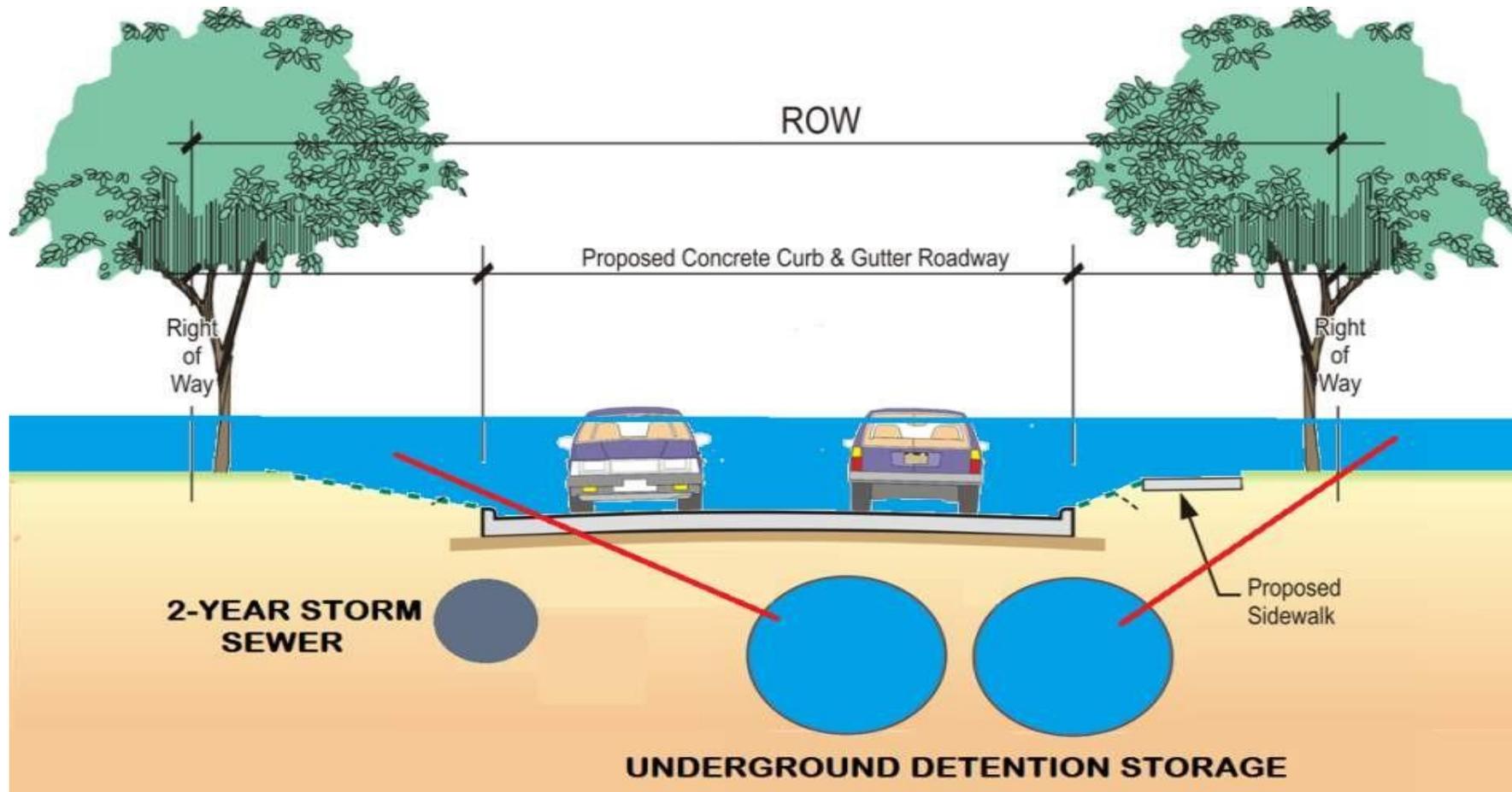
- Brays Bayou – HCFCD & US Army Corps of Engineers
- Cypress Ditch – HCFCD & Houston
- Renwick Drainage System – Houston
- Alder, Chimney Rock, S. Rice – Houston and City of Bellaire
- Ferris, Englewood, Ave. B, Newcastle and Baldwin – City of Bellaire
- IH 610 – TxDOT
- 96-inch Monolithic Pipe in railroad right-of-way – City of Houston and City of West University
- Railroad Ditch – City of Houston and Harris County
- Kilmarnock Ditch – City of West U



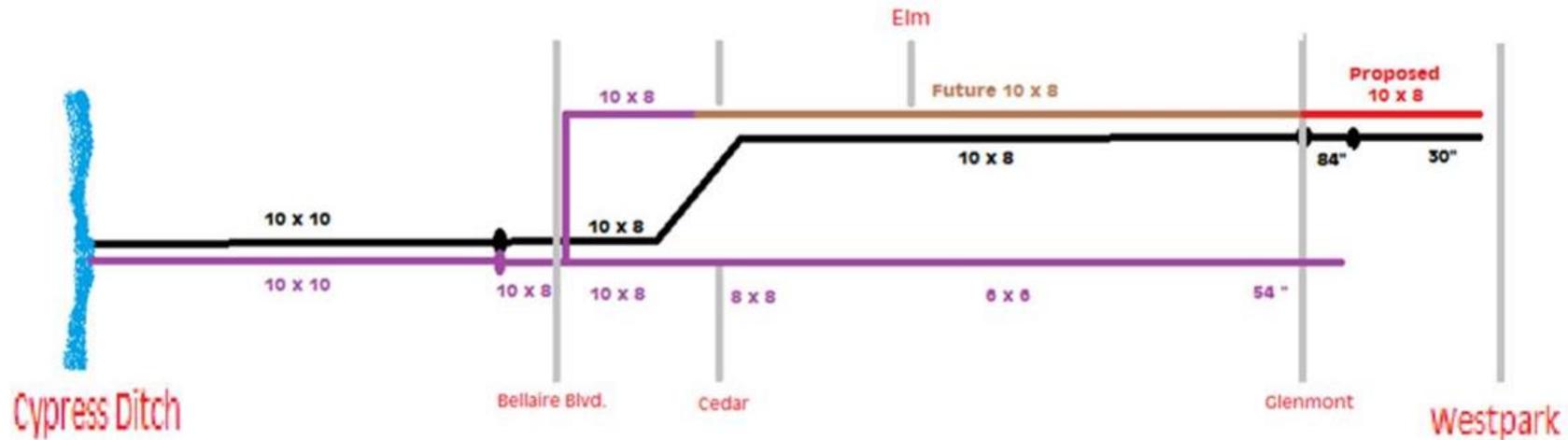
Regulatory Requirements Finished Floor Elevations



Local Storm Drainage Improvements

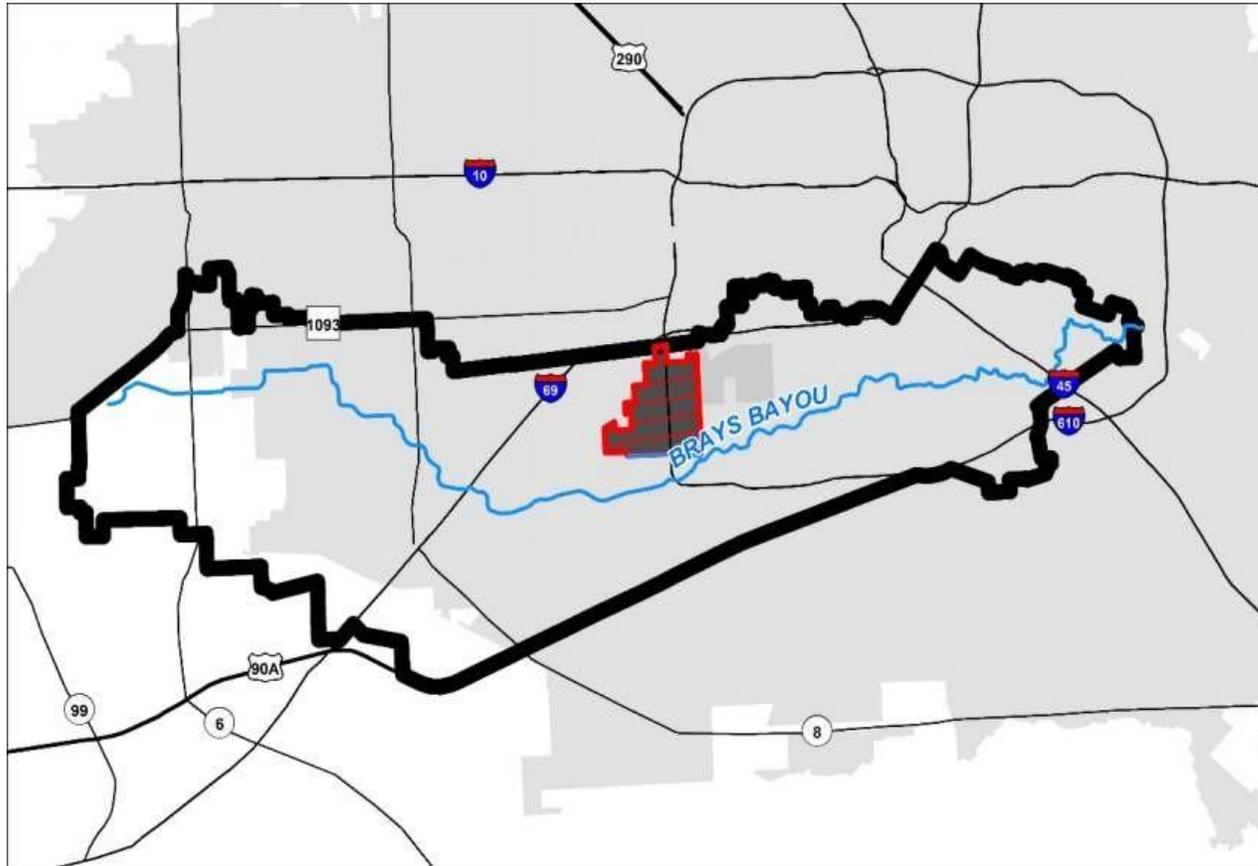


IH 610 Drainage Systems



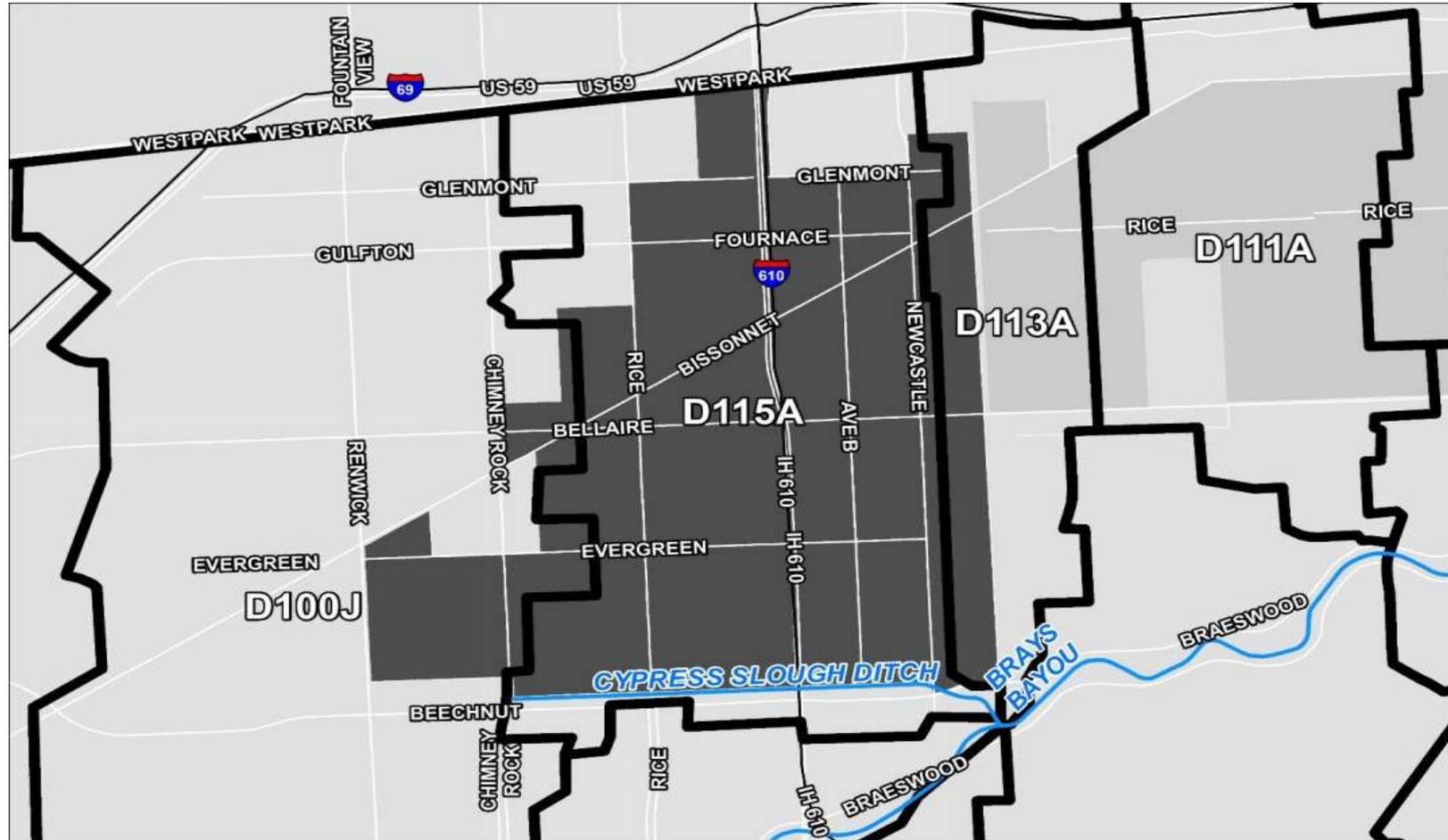
- Existing prior to 2000 improvements
- Constructed in 2000
- Proposed Now
- Future

Existing Conditions – Watershed

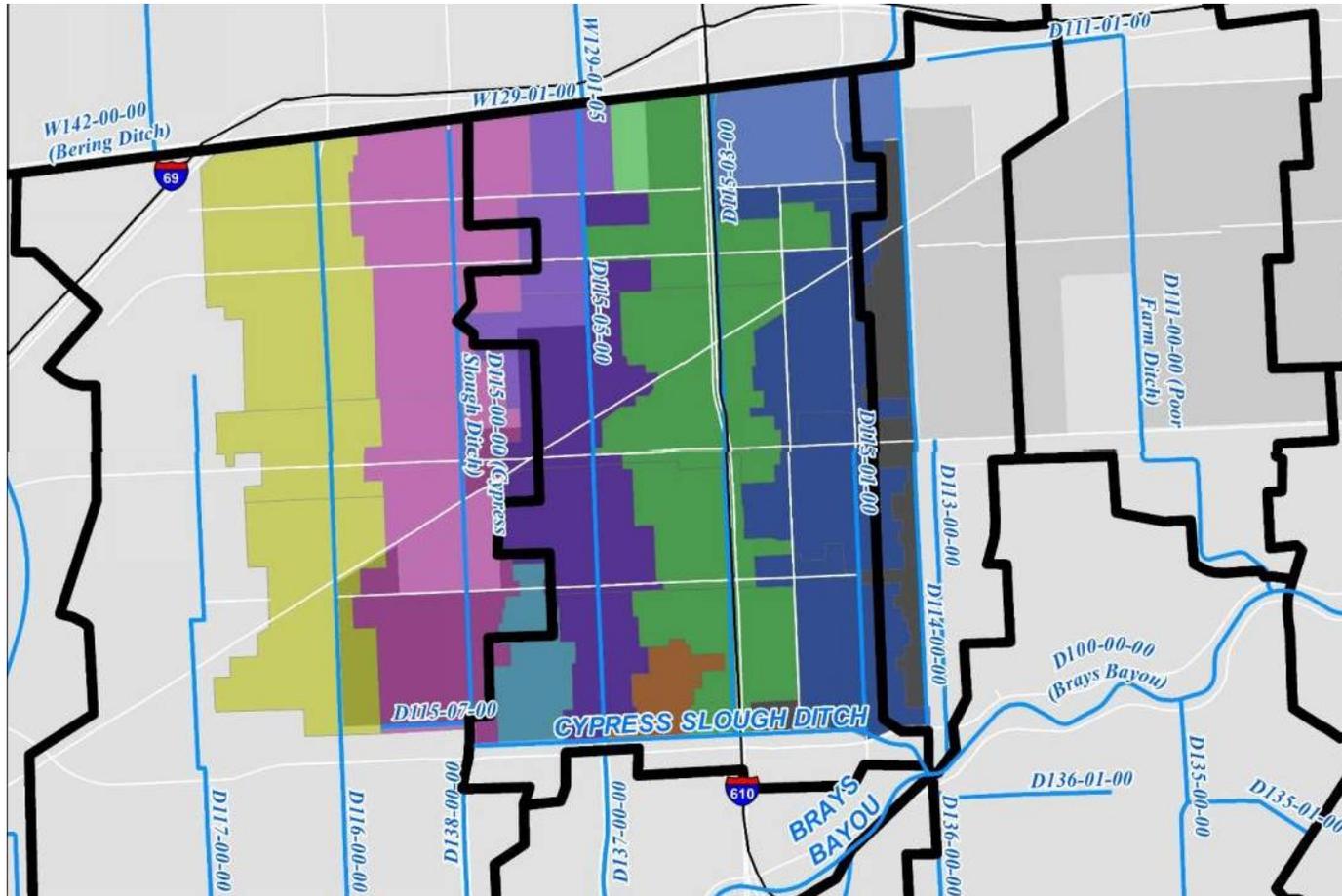


- Approximate 2,317 acres in Bellaire City Limits
- 52,850 acres upstream of the City of Bellaire

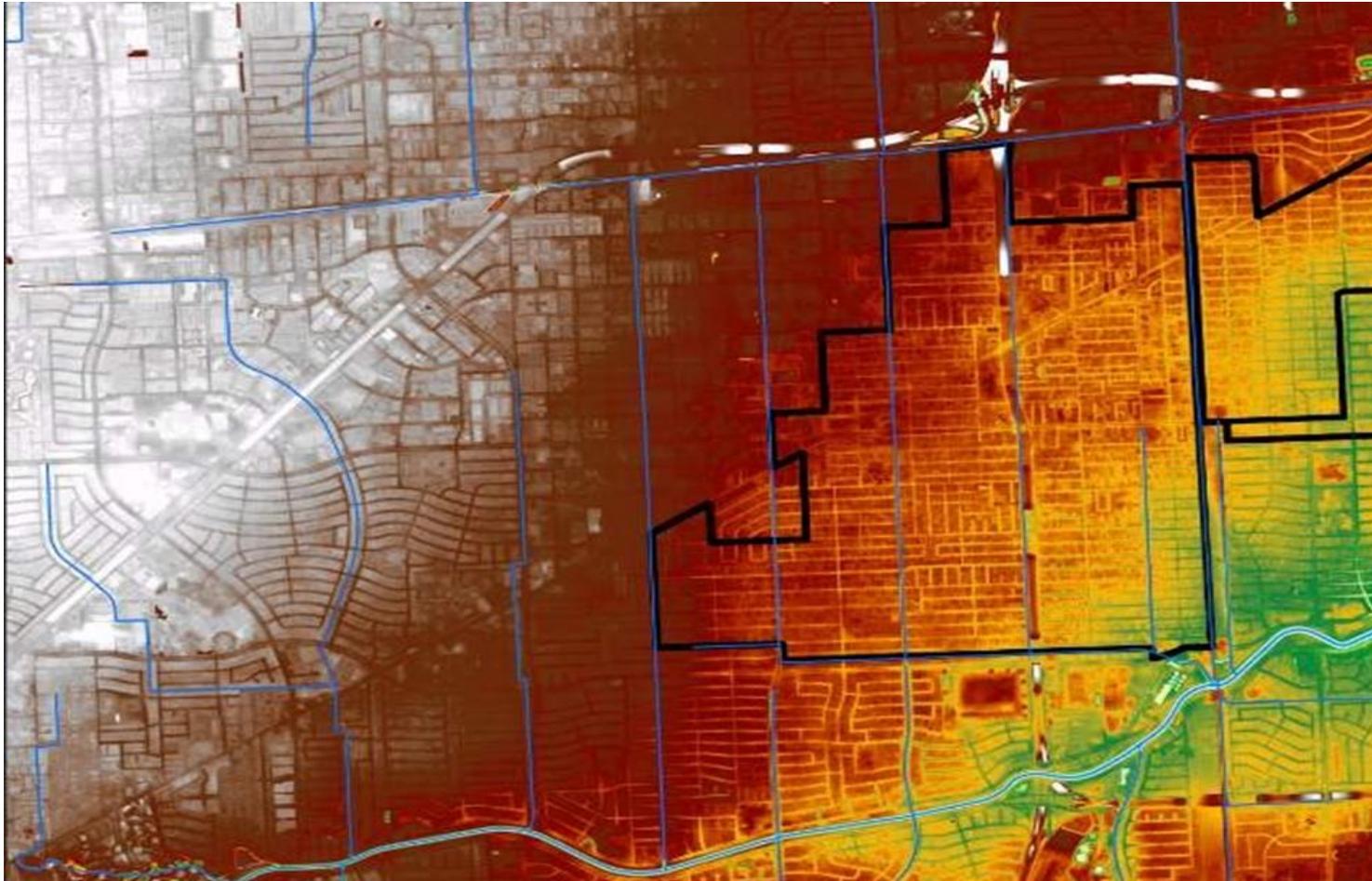
Existing Conditions – D115 Sub-Basin



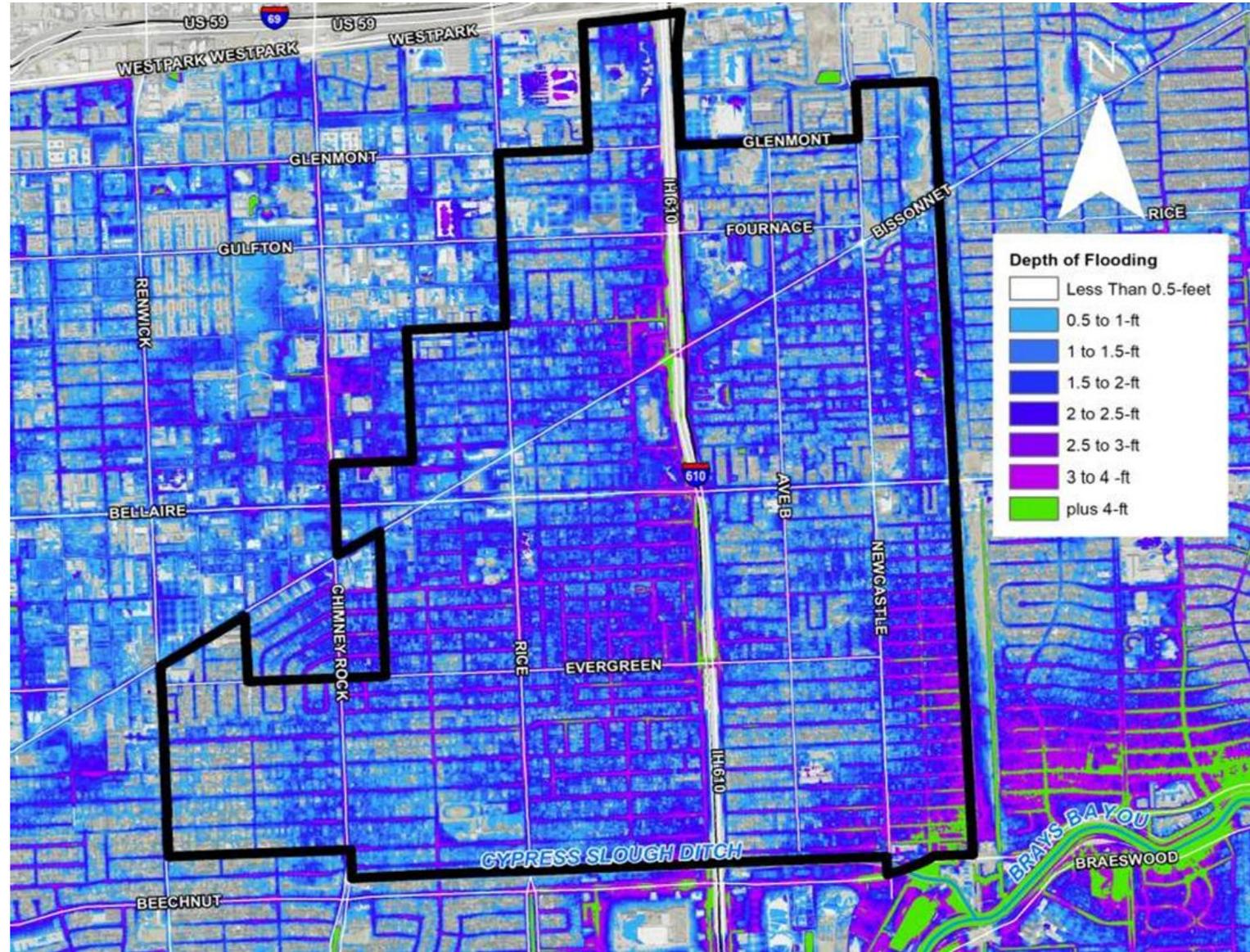
Existing Conditions – Local Drainage (Sub-Watersheds)



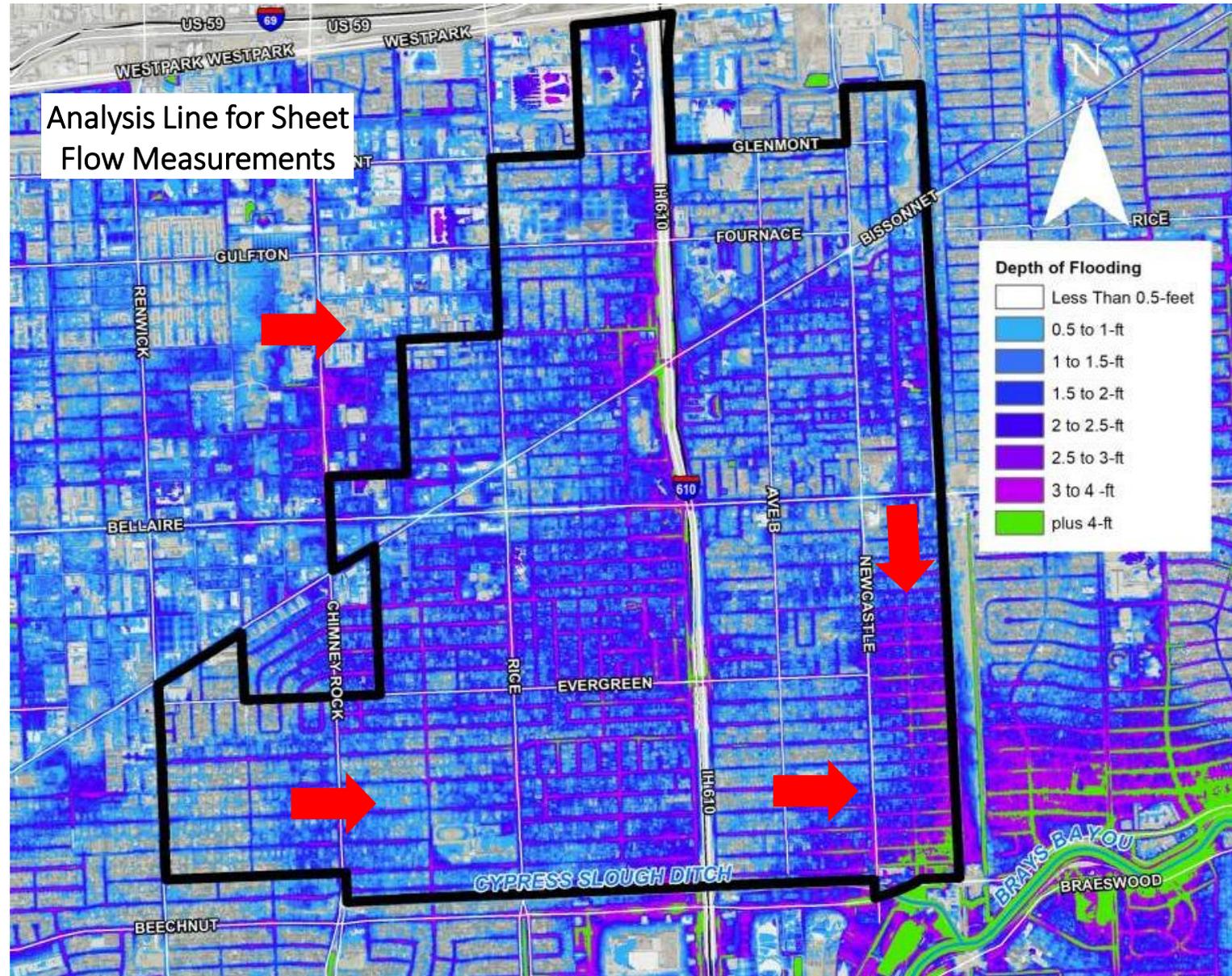
Existing Conditions – Sheetflow Intensity Map



Existing Conditions – Sheetflow



Existing Conditions – Sheetflow



Drainage Improvement Types



Detention Pond



Drainage Channel



Flood Tunnel

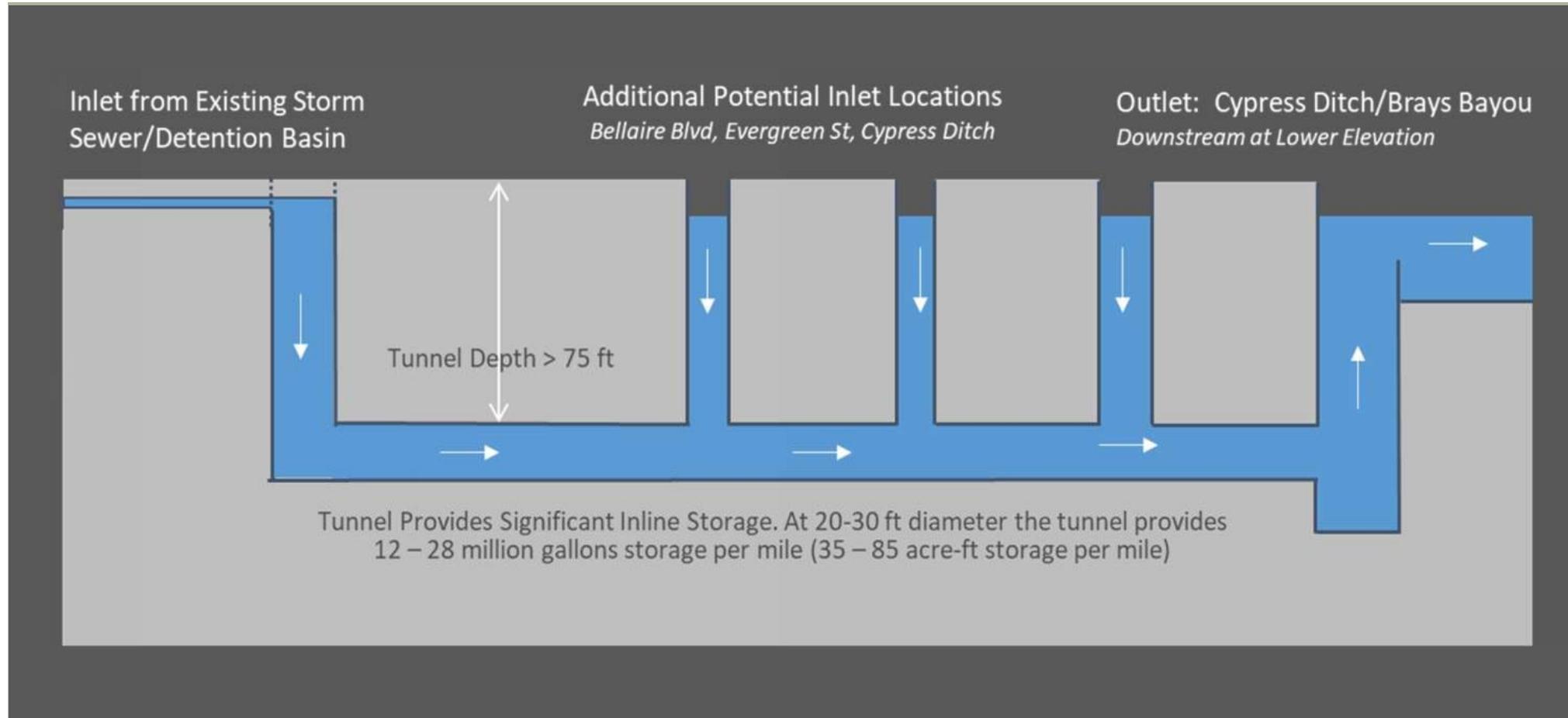


Pump Station



Storm Sewers

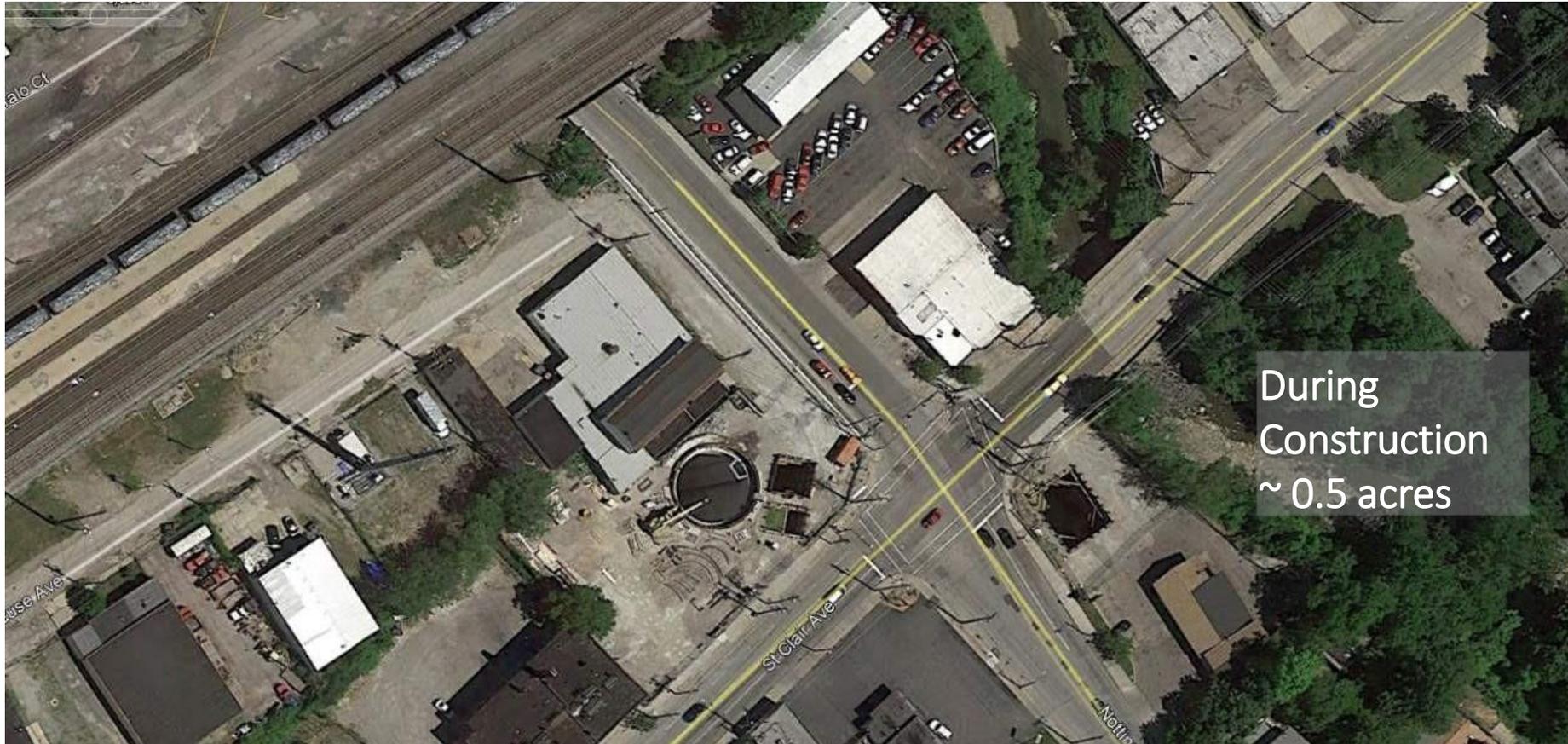
Inverted Siphon Tunnel Concept



Precast Concrete Tunnel



Tunnel Shaft Work Area



Euclid Creek Tunnel, Northeast Ohio Regional Sewer District,
Cleveland, Ohio

Tunnel Shaft Restoration



Euclid Creek Tunnel, Northeast Ohio Regional Sewer District, Cleveland, Ohio

Tunnel Shaft Restoration

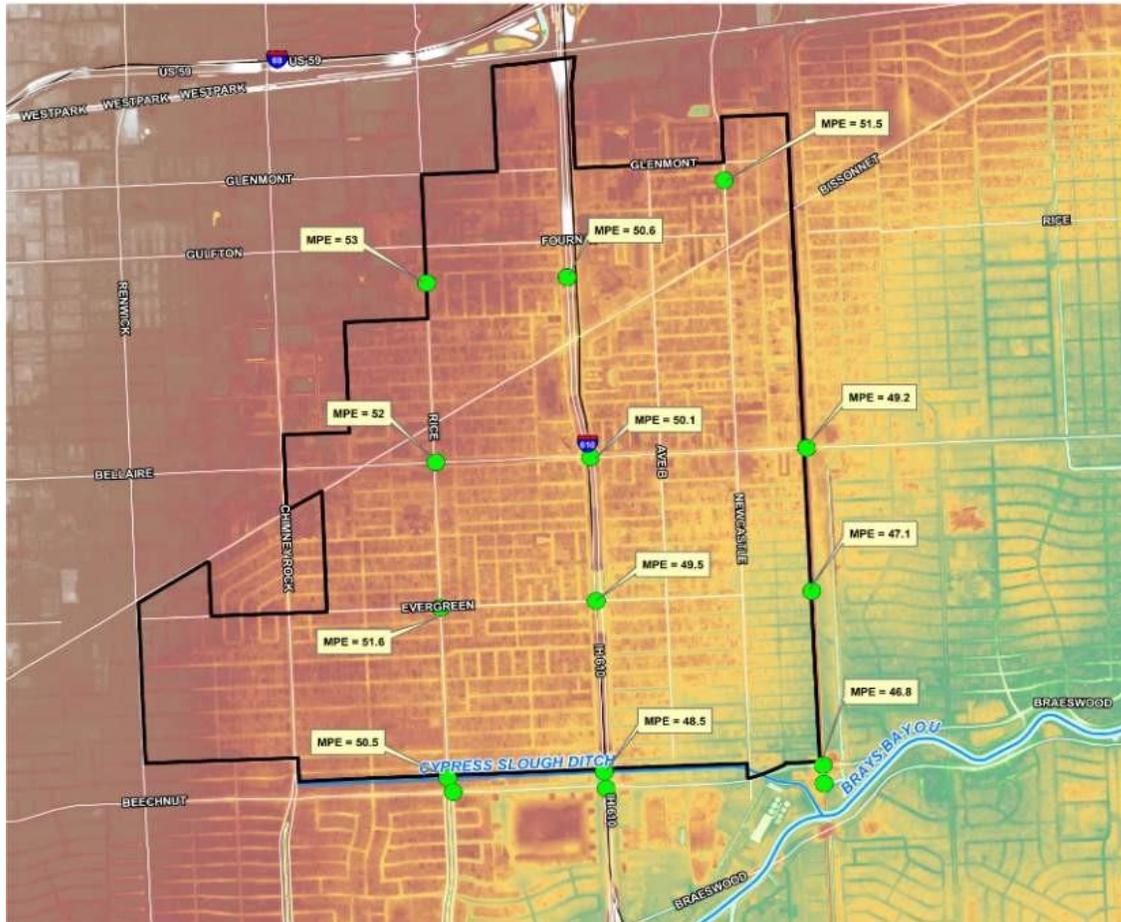


Euclid Creek Tunnel, Northeast Ohio Regional Sewer District,
Cleveland, Ohio

Concept Design Storm Events

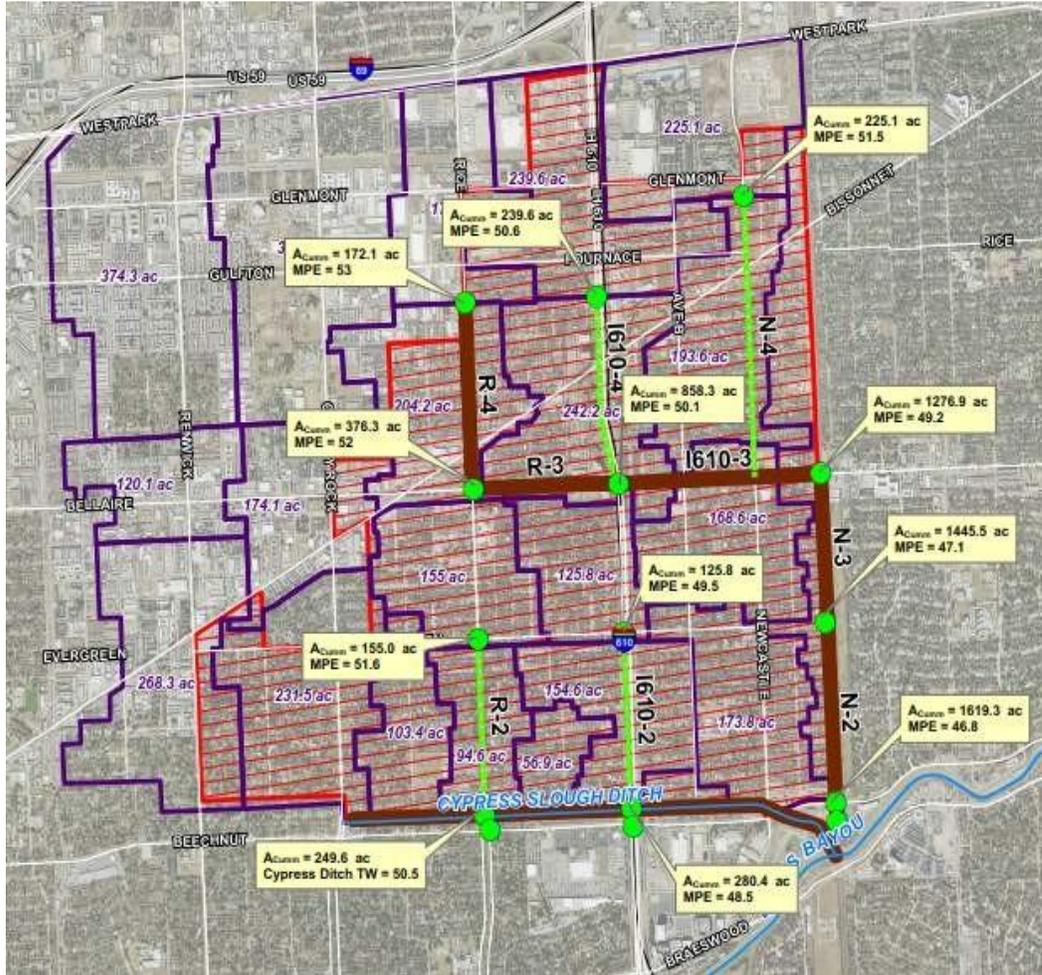
- Compute Peak Flows for the 10 and 100-year Atlas 14 Storm Event (additional storm events to be evaluated during detailed modeling phase)
- Determine Maximum Ponding Elevation (MPE) for review of topographic data. No flooding outside of right-of-way
- Sheetflow Assumptions from Preliminary Model
 - 100-YR 1,200 cfs
 - 10-YR 600 cfs
 - COH Chimney Rock Study identified 600 cfs

Maximum Ponding Elevation



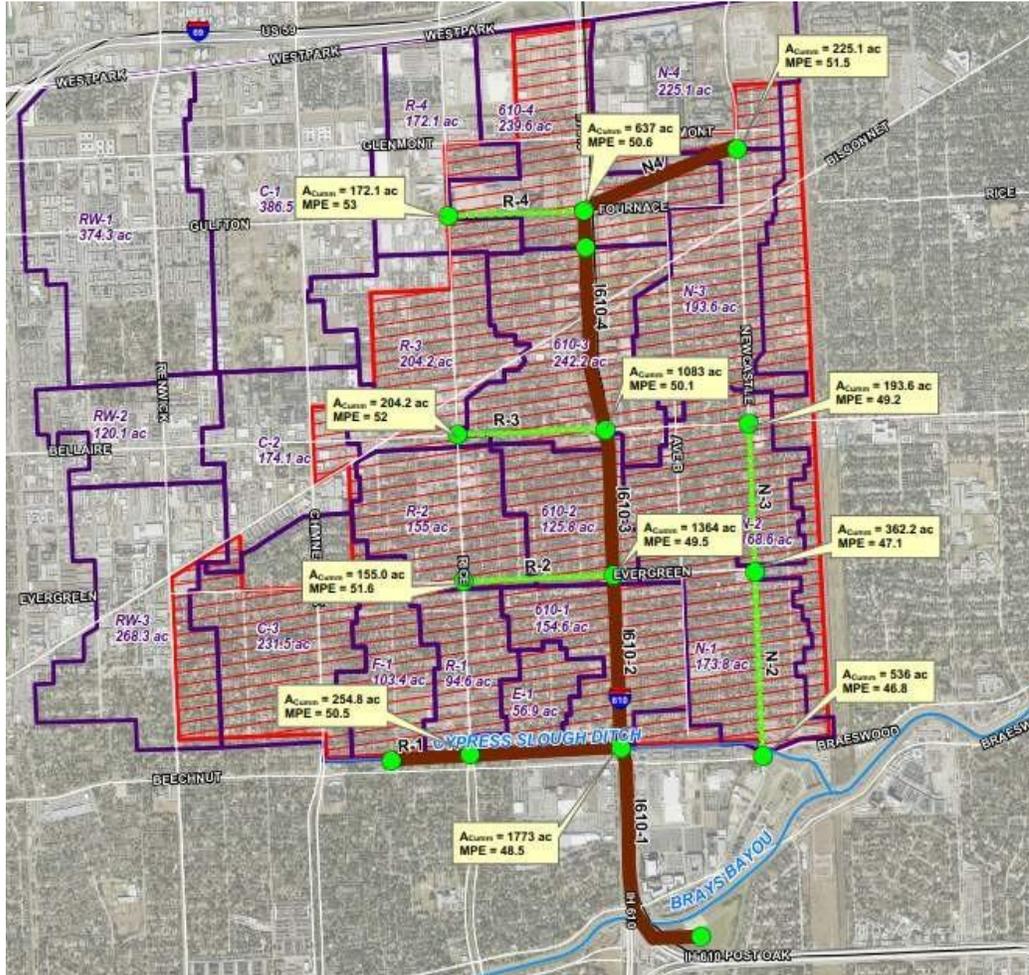
- Based on Natural Ground at right-of-way line
- Set for key locations of flow collection throughout city
- Generally represents the lowest locations within each localized drainage area

Concept A



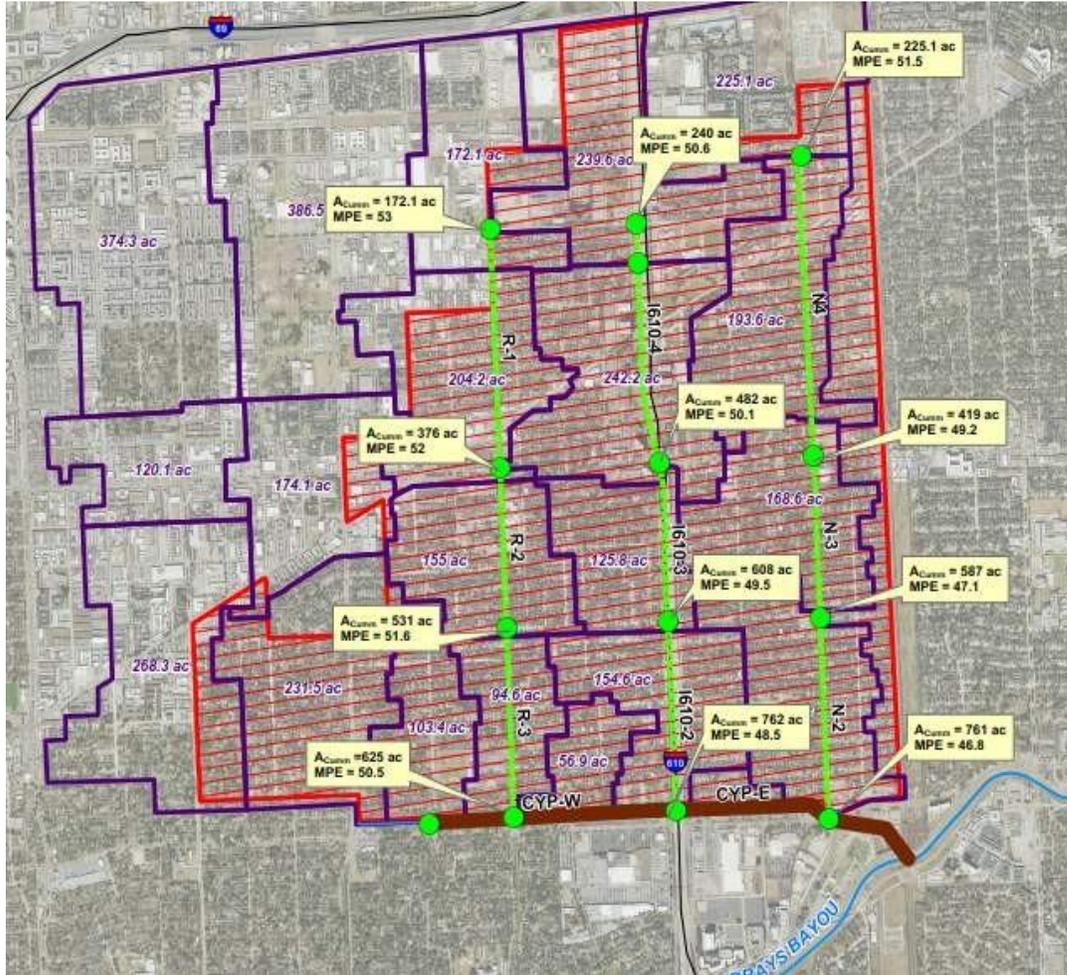
- Mimics topography and locates major systems in lowest portions
- Utilizes Bellaire Blvd to Capture and convey sheetflow from West
- Diverts majority of water from Cypress Ditch improving capacity
- Locates a major systems along railroad track to capture sheetflows

Concept B



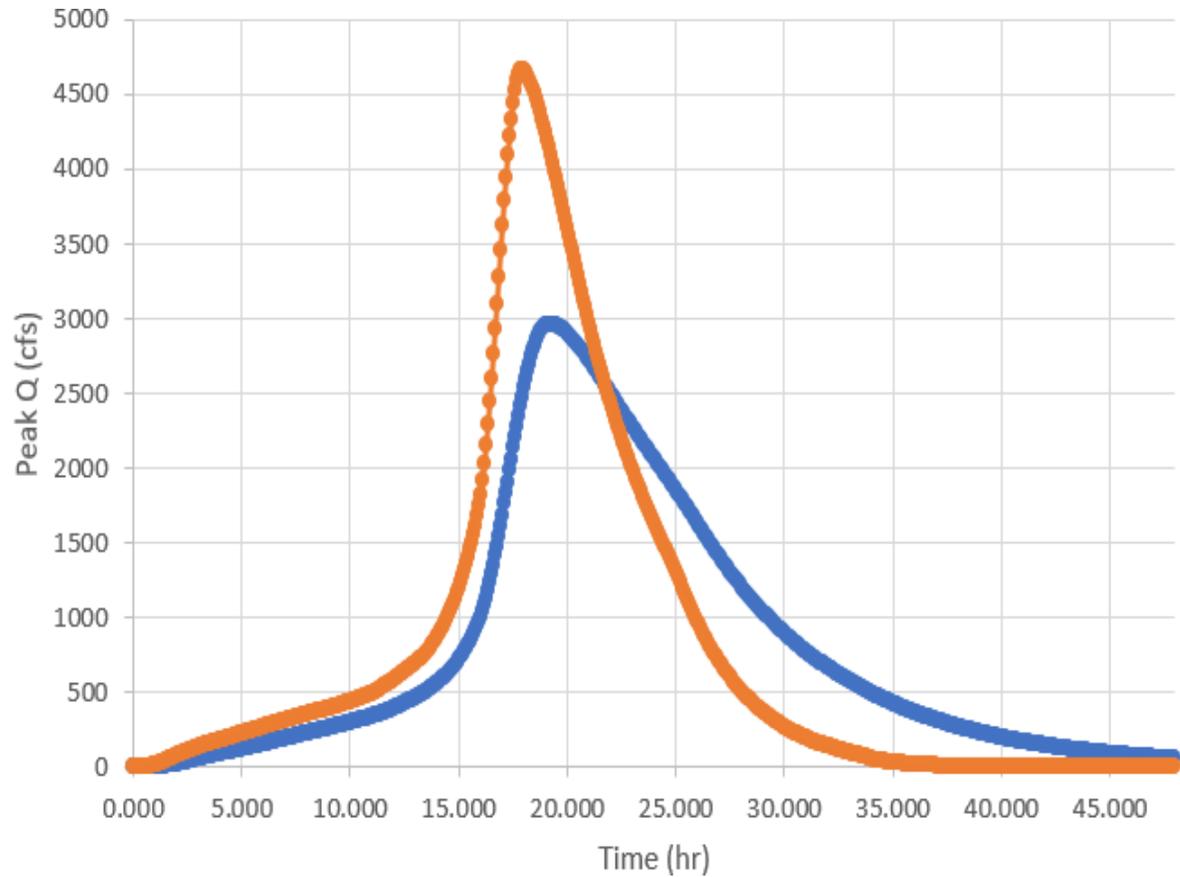
- Places Major Collection system along I610 west frontage road where majority of existing sheetflow ponds
- Diverts Rice localized drainage directly to major drainage system
- Keeps east side drainage out of west side of City
- Diverts significant drainage area off of Cypress Ditch
- Utilizes existing HCFCD/COH pond for

Concept C



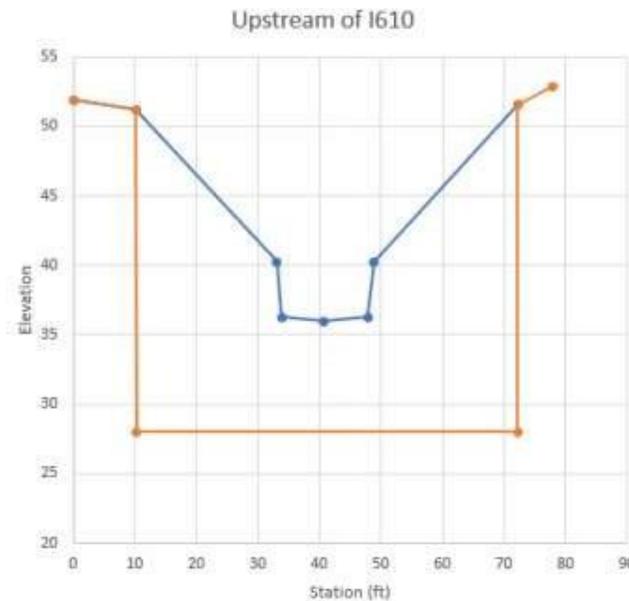
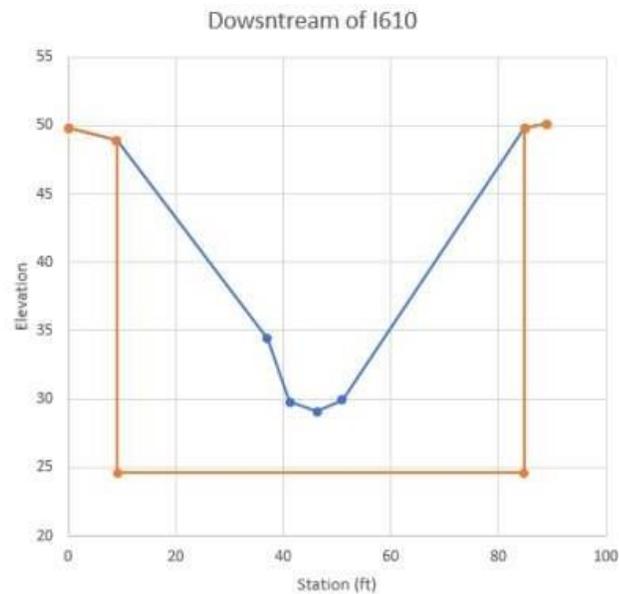
- Maintains Existing Drainage Paths
- Upsizing of the existing systems
- Rice System Sized to collect sheetflow from west (Chimney Rock, Renwick)
- Will require improvements to Cypress Ditch

No Adverse Impact to Brays



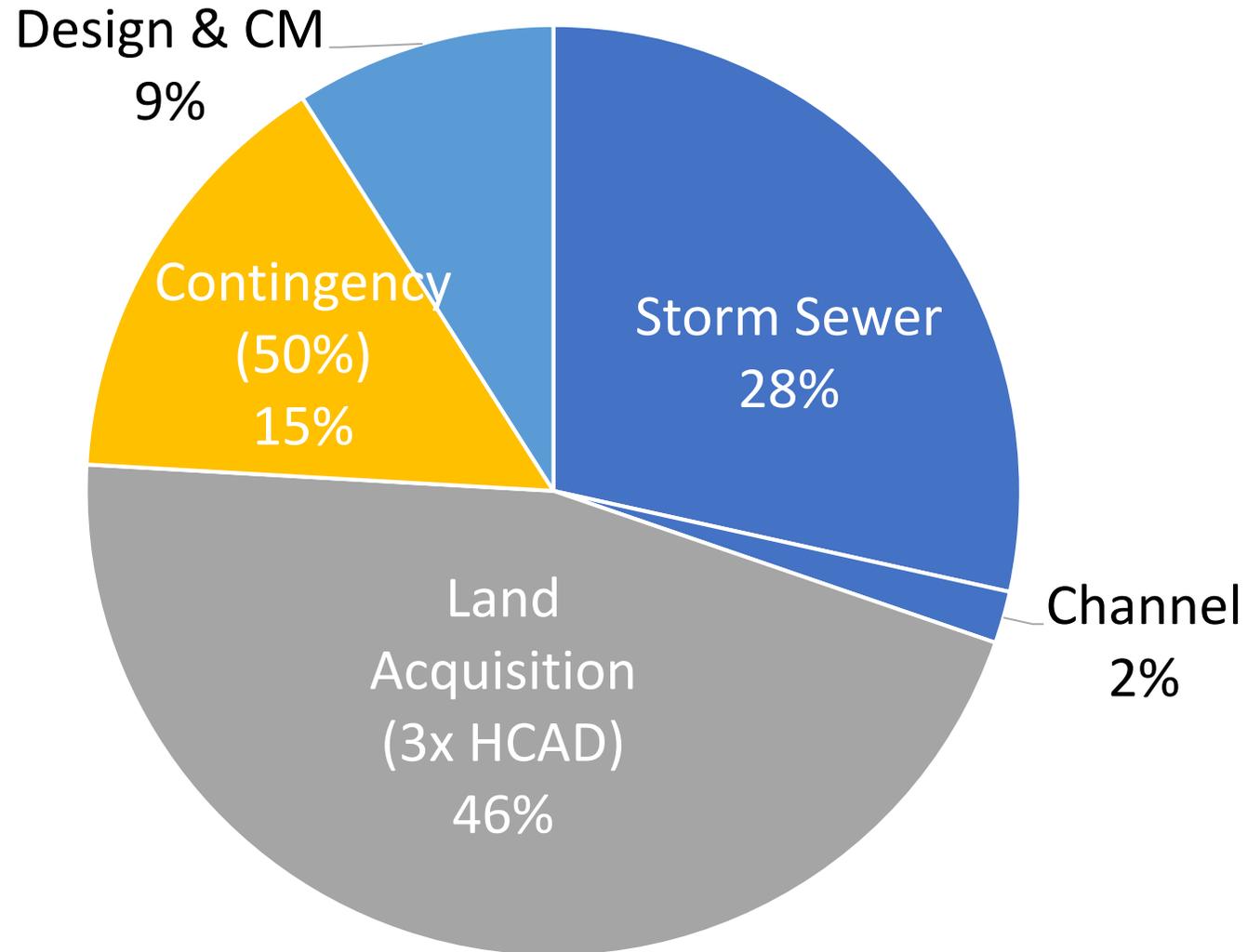
- No impact to Brays Bayou due to internal localized improvements
- Compare Pre and Post D115 hydrographs based on improved conveyance for design storm events
- Utilized HCFCD Basin Development Factor Methodology to simulate improvements.
- Estimate 333 acre-feet for 10-year level of service
- Estimate 783 acre-feet for 100-year level of service

Cypress Ditch Improvements and Mitigation

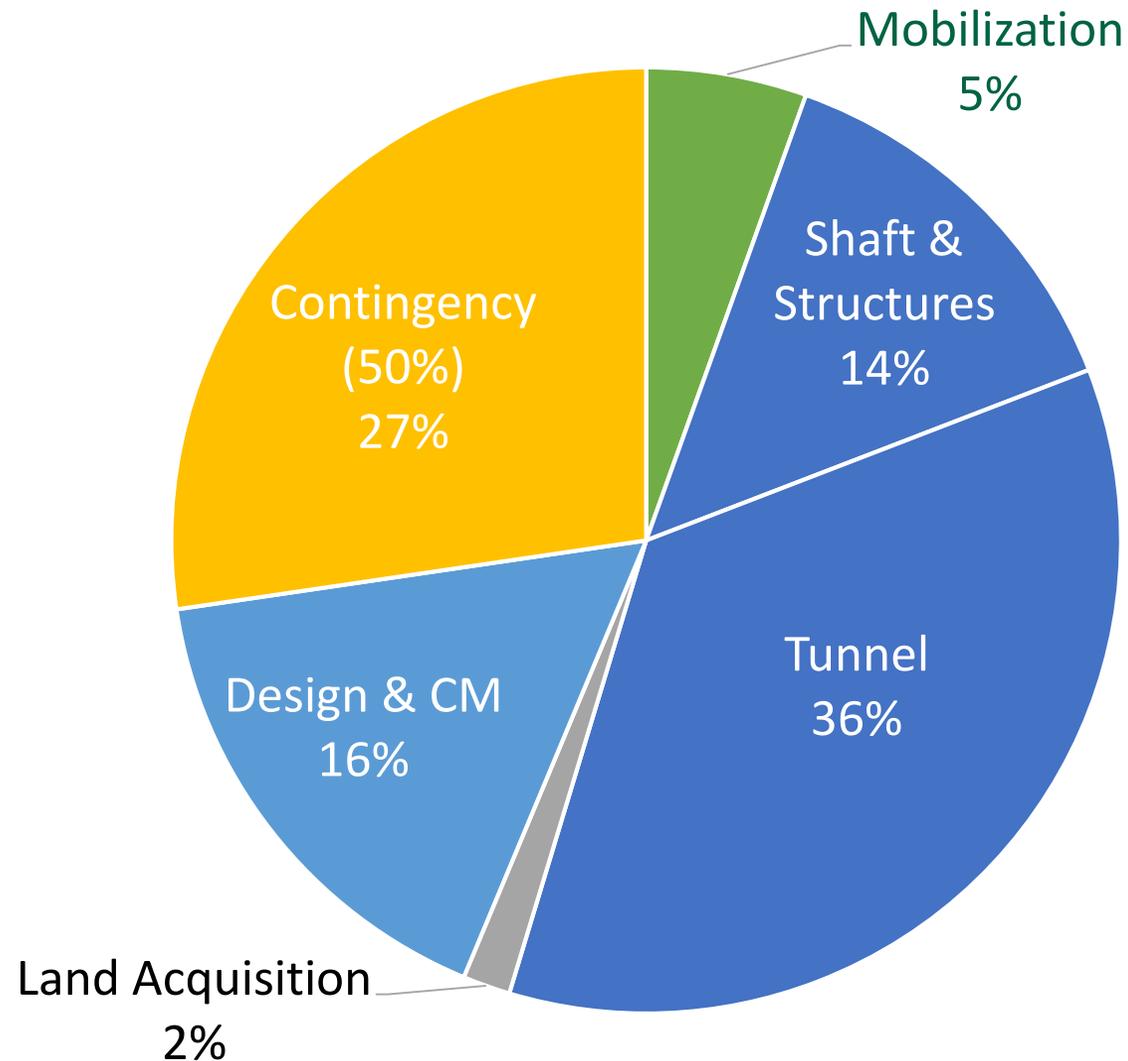


- Requires improvements under all bridges including I610
- Approximately 110 ac-ft Upstream of I610 and 93 ac-ft Downstream of I610

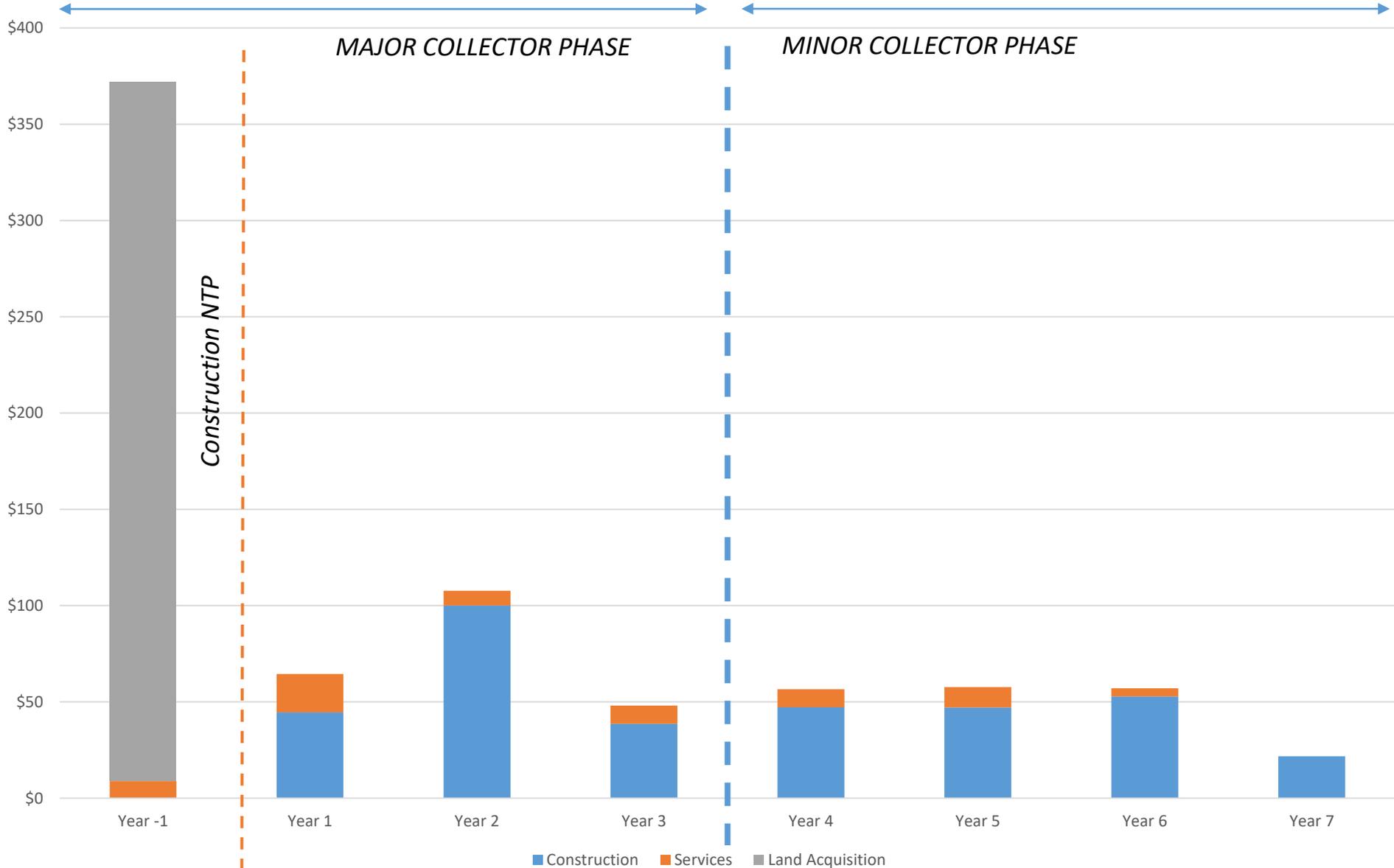
Concept A Channel & Storm Sewer Tunnel 100 YR w/ Overflow (~\$770M)



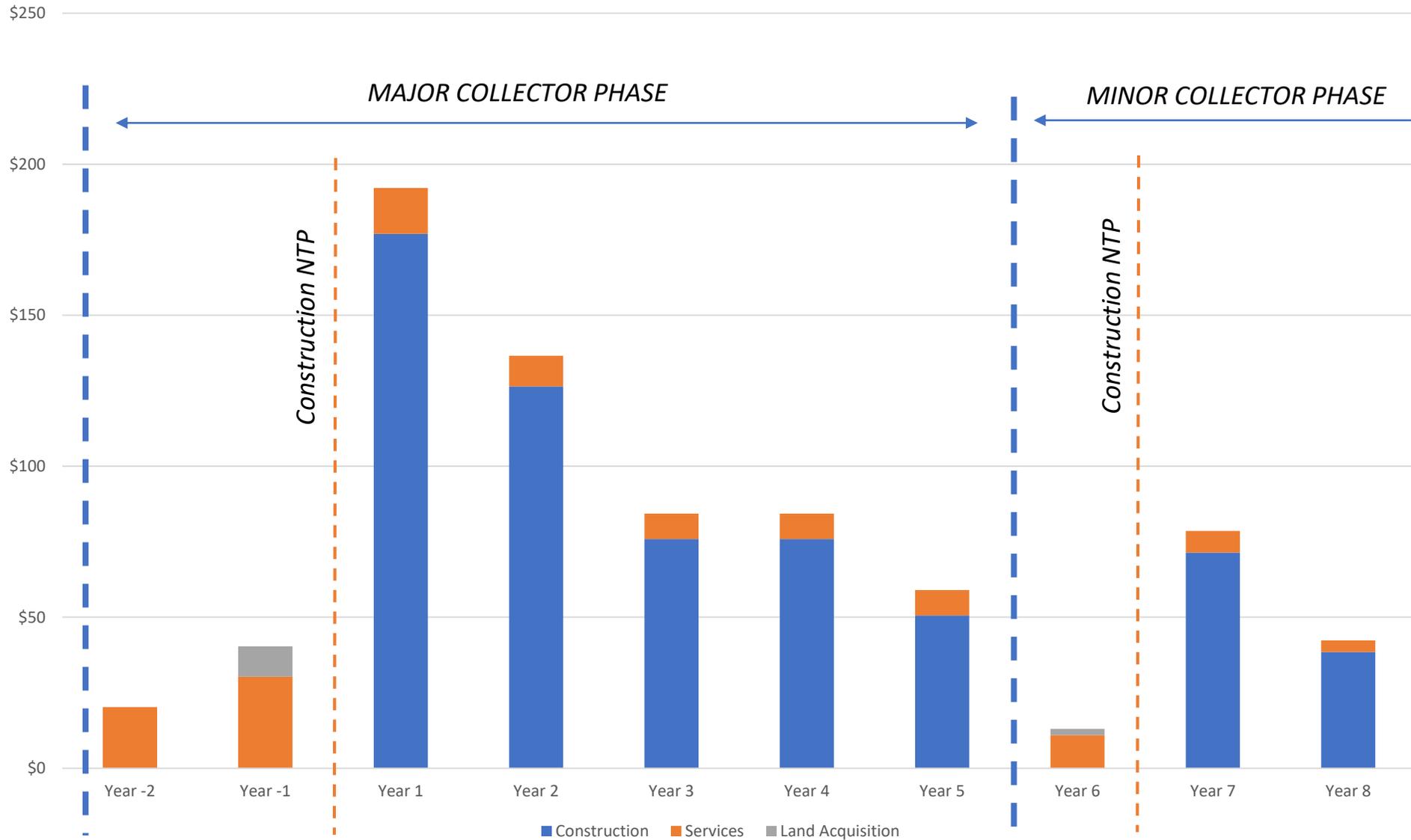
Concept B Tunnel 100 YR w/ Overflow (\$750M) Major & Minor Collectors



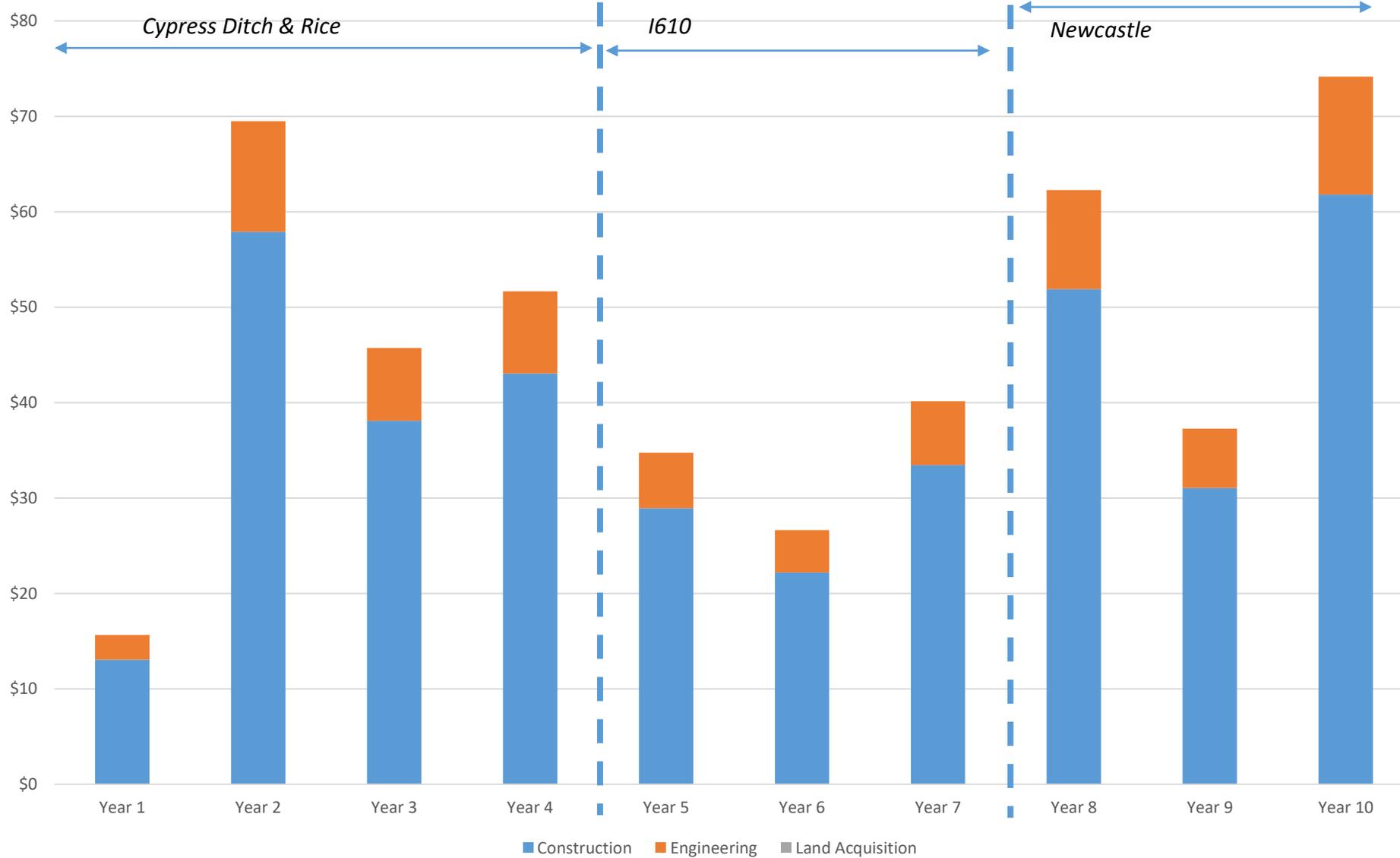
ANNUAL EXPENDITURES - Concept A Channel 100 YR w/ Overflow (~\$780M)



ANNUAL EXPENDITURES - Concept B Tunnel 100 YR w/ Overflow (~\$750M)

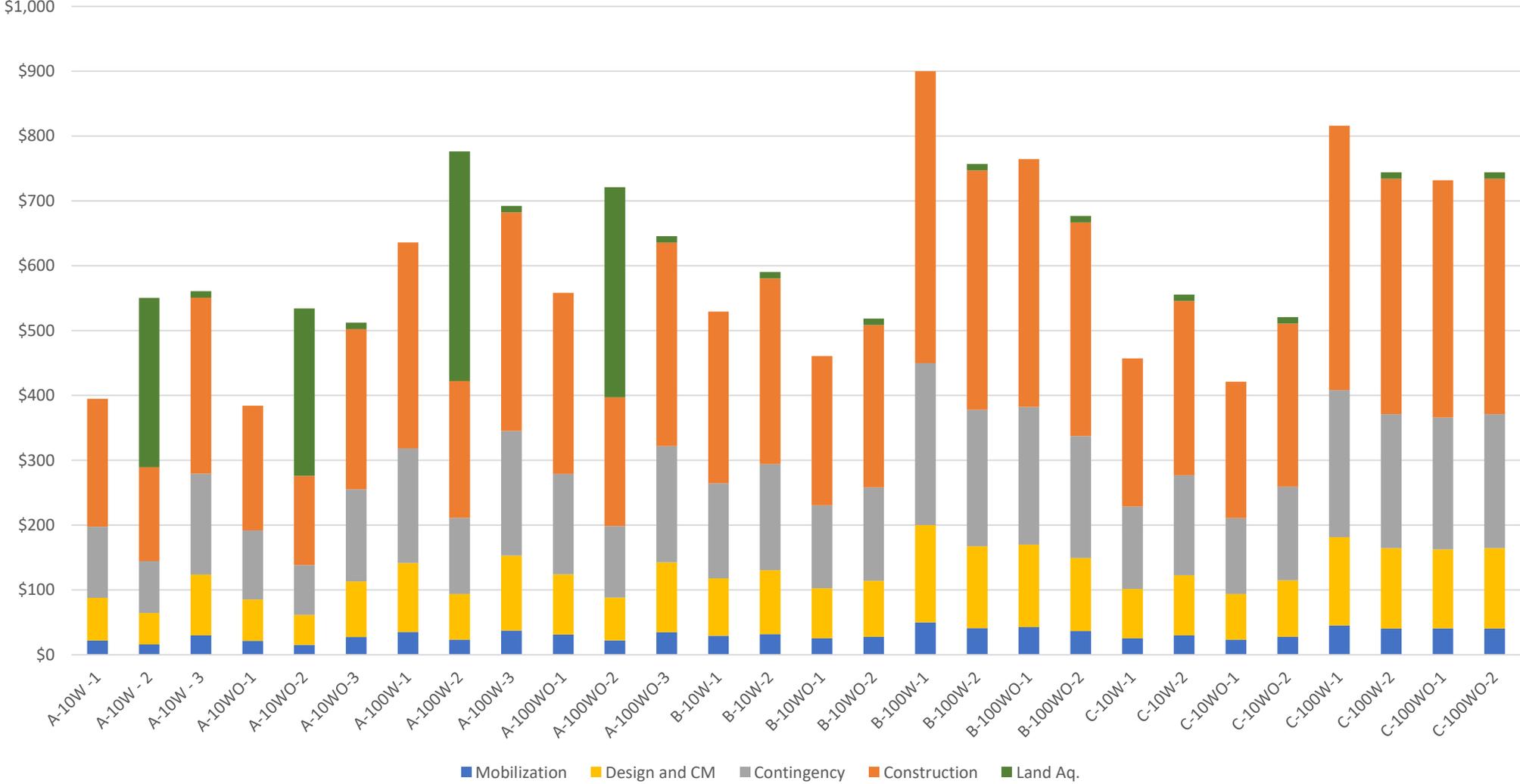


ANNUAL EXPENDITURES - Concept C 100 YR w/ Overflow (~\$460M)



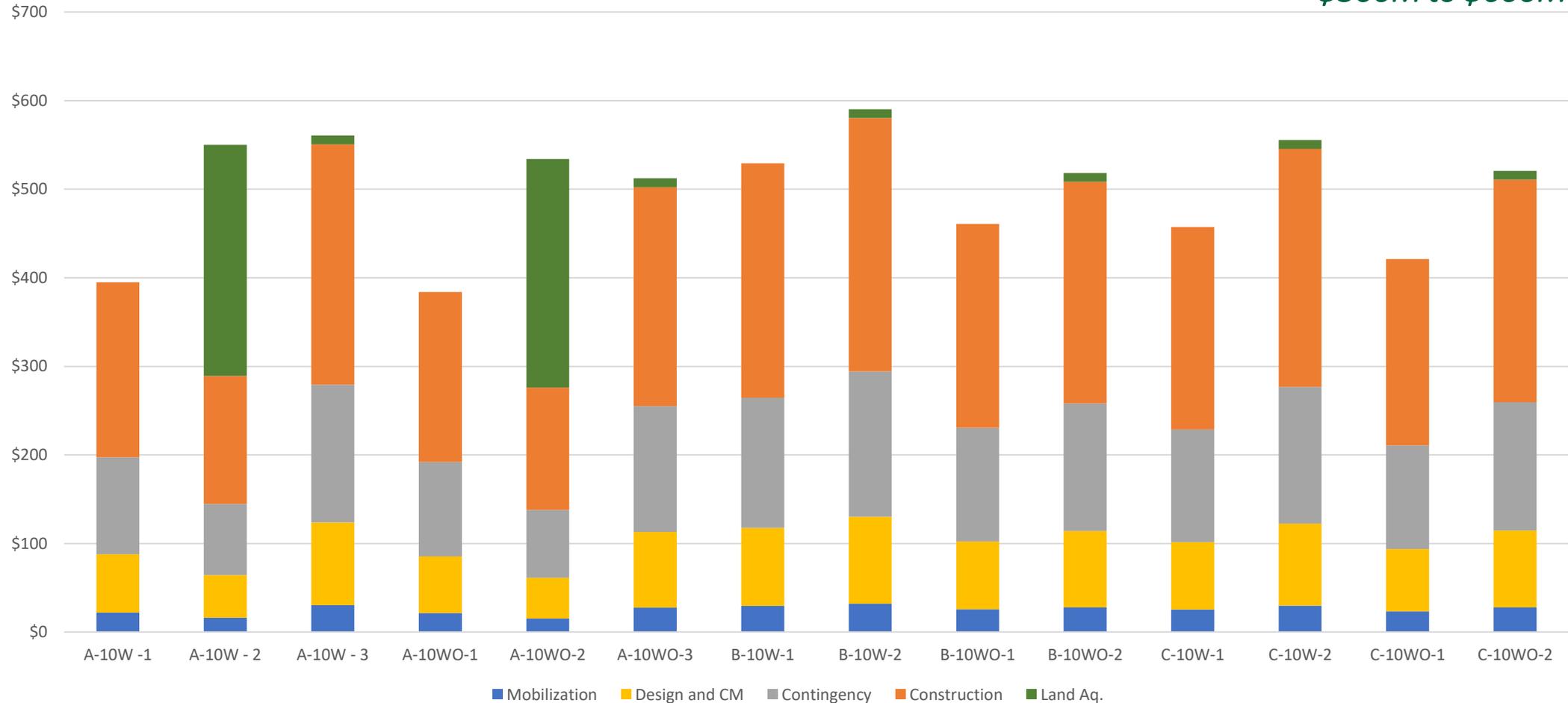
All Concepts

Cost Range:
\$300M to \$800M



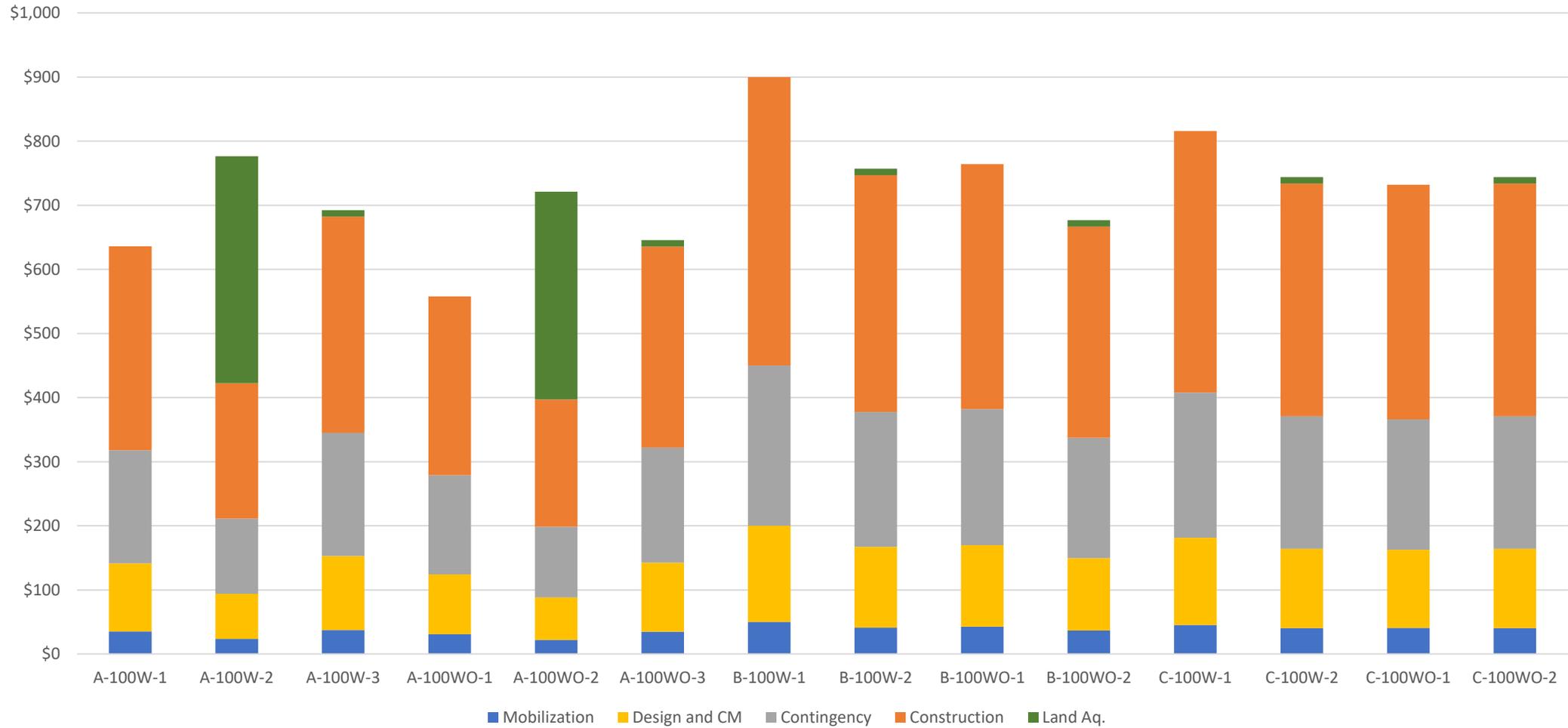
10 YR Concepts

Cost Range:
\$300M to \$600M



100 YR Concepts

Cost Range:
\$500M to \$800M



Concept Summary and Comparison

Concept A

- Can provide 100-year LOS but requires significant upfront financial investment and disruption due to land acquisition.
- Once land is acquired, construction can be better phased.
- Diverts flow directly to Brays Bayou which allows avoiding improvements to Cypress Ditch

Concept Summary and Comparison

Concept B

- Can provide 100-year LOS but requires significant upfront financial investment and construction for the main tunnel.
- This option does avoid major disruption with improvements being most sub-terrain.
- Bypasses Cypress Ditch and does not require improvements to Cypress Ditch.

Concept Summary and Comparison

Concept C

- Not enough existing Right-of-way to construction 100-year LOS but would still provide substantial flood reduction as compared to existing system.
- Individual projects would require construction work within existing rights-of-ways and would be disruptive during construction.
- Can be phased based on funding availability. This would occur from downstream to upstream with initial projects focused on Cypress Ditch improvements.

Initial Observations/Next Steps

- Value engineering of design concepts
- Identify “low-hanging fruit”/smaller projects consistent with findings
- Develop phasing plan(s)
- Quantify benefits for each concept and level of service
 - Number of structures removed from flooding
 - 10-year storm design versus 100-year storm design

Initial Observations/Next Steps

- Identify funding opportunities / partnerships
 - HCFC
 - TXDOT
 - City of Houston
 - TWDB – low interest loans and grants
 - FEMA / GLO / HUD
- December 2020 - Results of Hydraulic Modeling
- March 2021 – Finalization of MDCP Report
- Future – Preliminary Engineering Report of Recommended Projects

Questions and Comments

<https://www.bellairemdcp.com/>

Master Drainage Concept Plan

City of
Bellaire

