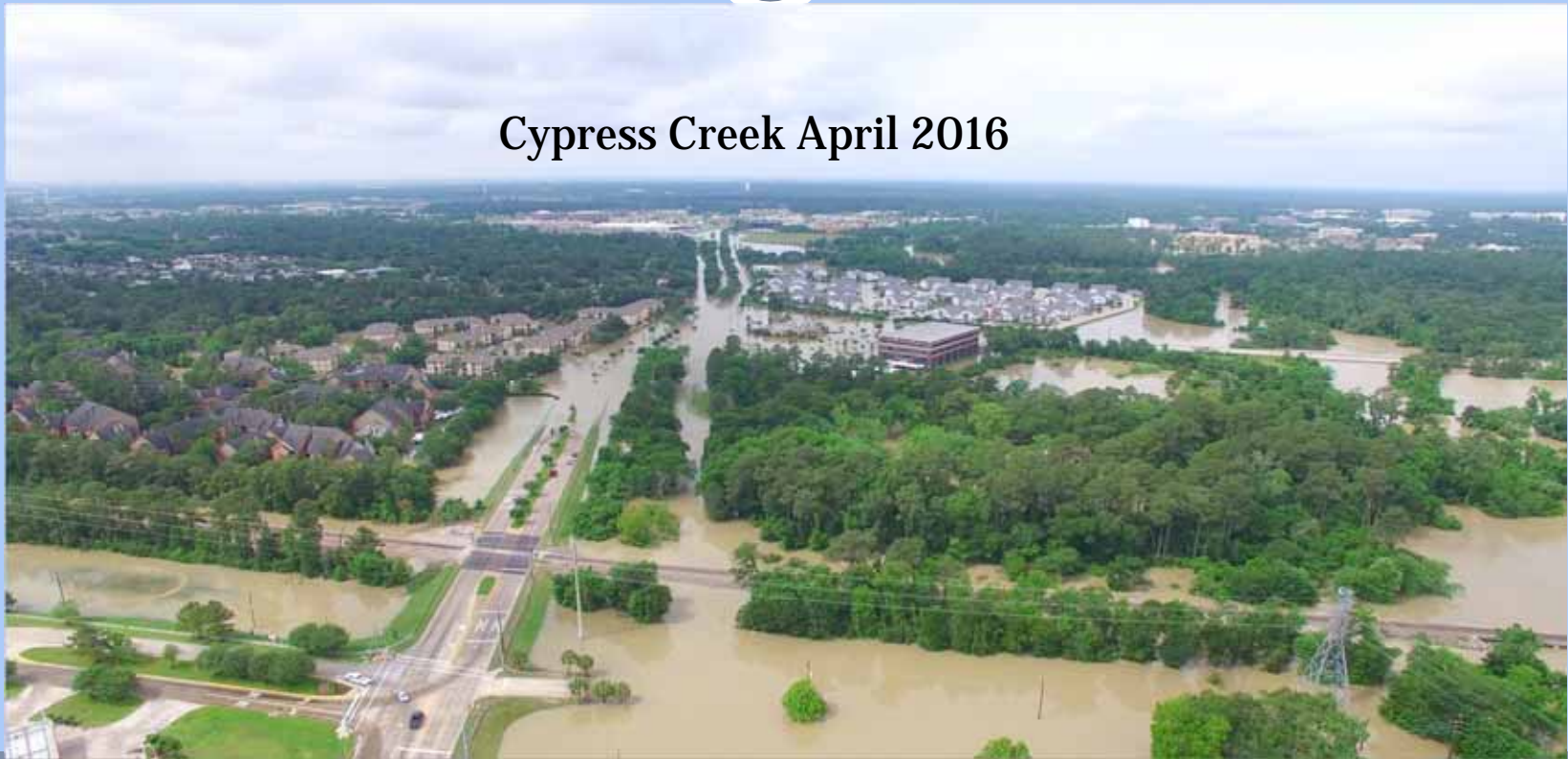


Urban Flooding in Houston: A Disaster in the Making

Dr. Phil Bedient
Herman Brown Professor of Engineering



Cypress Creek April 2016



TS Allison (2001) and May 2015 Floods



Brays during Memorial Day Flood – May 2015



Factors Affecting Flooding



Rapidly expanding development as well as natural hydrologic/topographic factors make Houston extremely vulnerable to flooding

Frequency of Houston Floods:

- ❖ 1976, 1983, 1989, 1992, 1994, 1998
- ❖ 2001, 2007, 2008, 2009, 2012, 2015, 2016

Houston's Flood Issues



Flat topography

Intense rainfalls

Clay soils

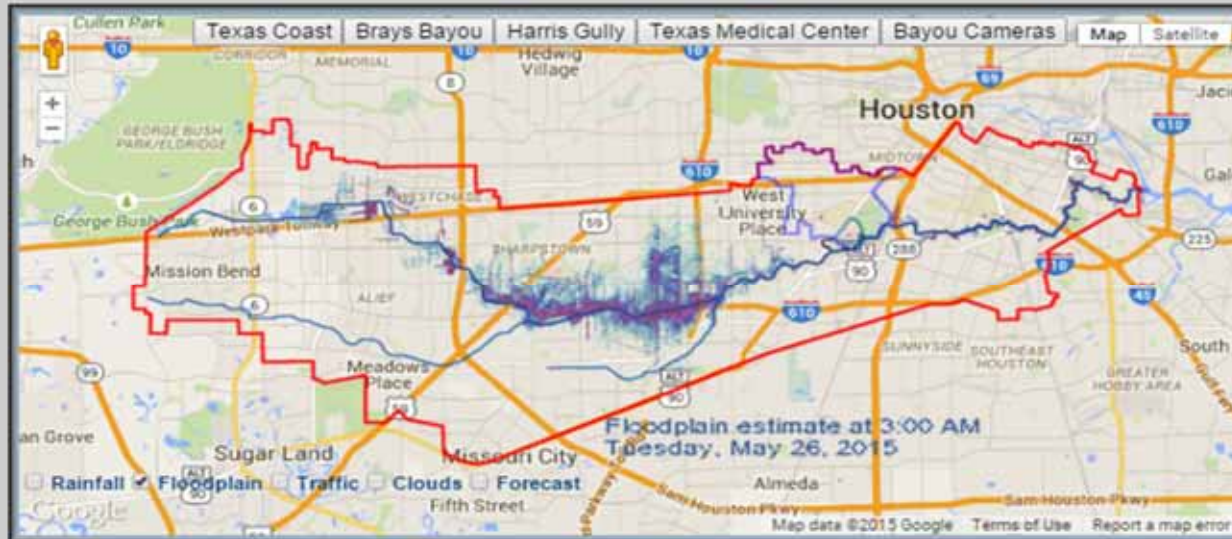
Impervious area

Urbanization

THE RICE UNIVERSITY AND TEXAS MEDICAL CENTER FLOOD ALERT SYSTEM



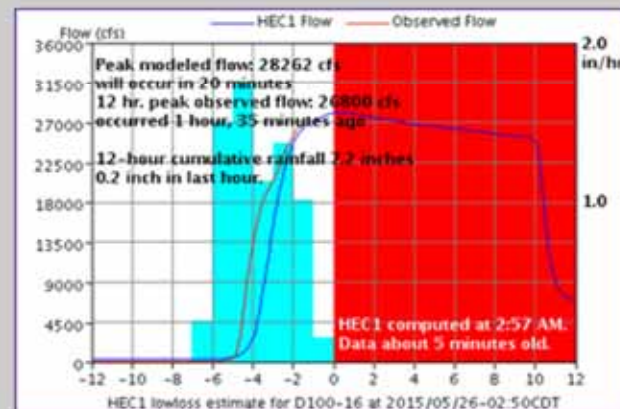
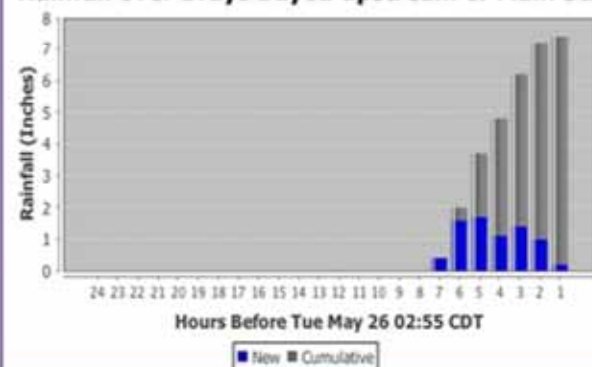
Home Radar Rainfall Bayou Cam Hydrology Case Studies



SubBasins Intensity: ☒ 1-Hour ☐ 3-Hour ☐ 6-Hour
MajorBasins Intensity: ☐ 3-Hour
Total: ☐ 3-Hour ☐ 6-Hour

The map overlay depicts rainfall intensity (inches per hour) in SubBasins from the most recent 1-Hour cumulative rainfall estimate. The legend from the radar page is also used here.

Rainfall over Brays Bayou upstream of Main St.



Your browser retrieved this information Tuesday at 3:03 AM.

The Rice University and Texas Medical Center Flood Alert System is an integrated system utilizing radar, rain gage information, bayou stage data, and hydrologic modeling for the purpose of issuing flood warnings and forecasts for the Rice University / TMC Complex.



28211 CFS, Rising at 2:55 AM

System Status

Last Data Retrieved: 3:03 AM
Next Data Check: 3:03:36 AM
Rain Data: Current
Look for new data

Bayou Cam One

2015-05-26 03:01:14



Bayou Cam Two

2015-05-26 03:01:13



Gulf Activity



Rainfall Estimate



URBANIZATION

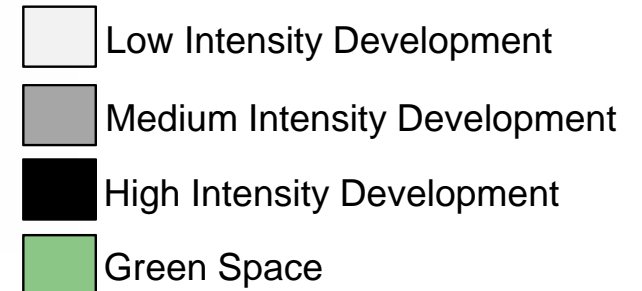
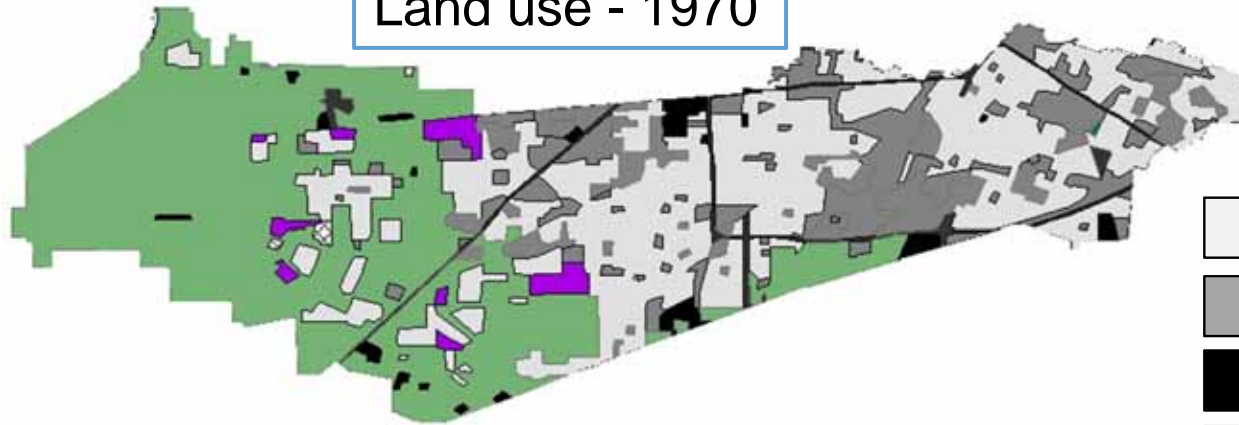
Nearly 500,000 people moved to Houston between 1990 and 2010.



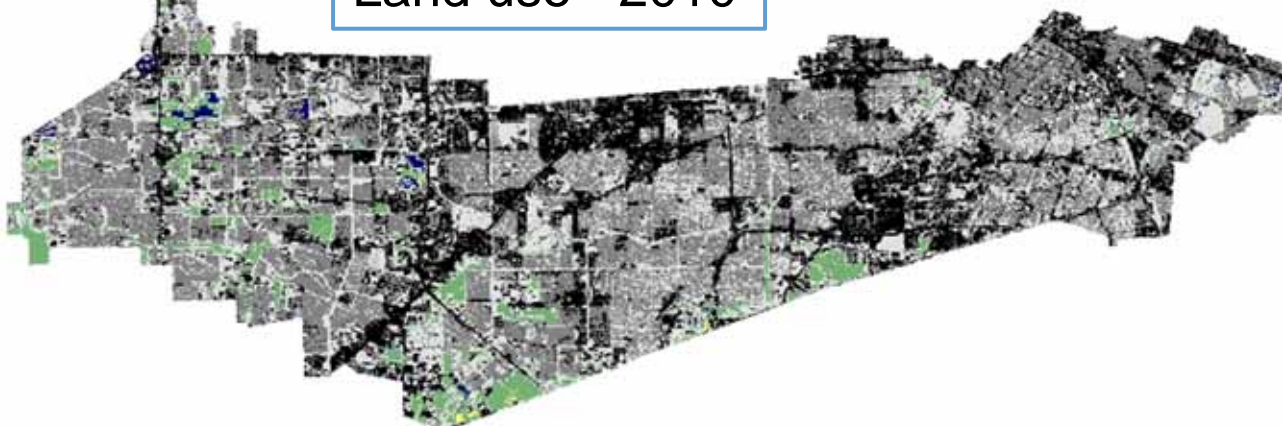
Land Use Changes in Brays Watershed



Land use - 1970



Land use - 2010



Brays Bayou

Meyerland



0 0.25 0.5 1 Miles

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, IGP, swisstopo, and the GIS User Community, Esri, HERE, DeLorme, Mapbox, and the GIS user community

Sugar Land Ft Bend

Sugar Land



0 0.75 1.5 3 Miles

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, Aero
Gridding, Aerogrid, IGN, IGP, swisstopo, and the GIS User community, Esri, HERE, DeLorme,
Mapbox, OpenStreetMap contributors, and the GIS User community

Sugar Land



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, 19F, Swire, and the GIS User Community. Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community.

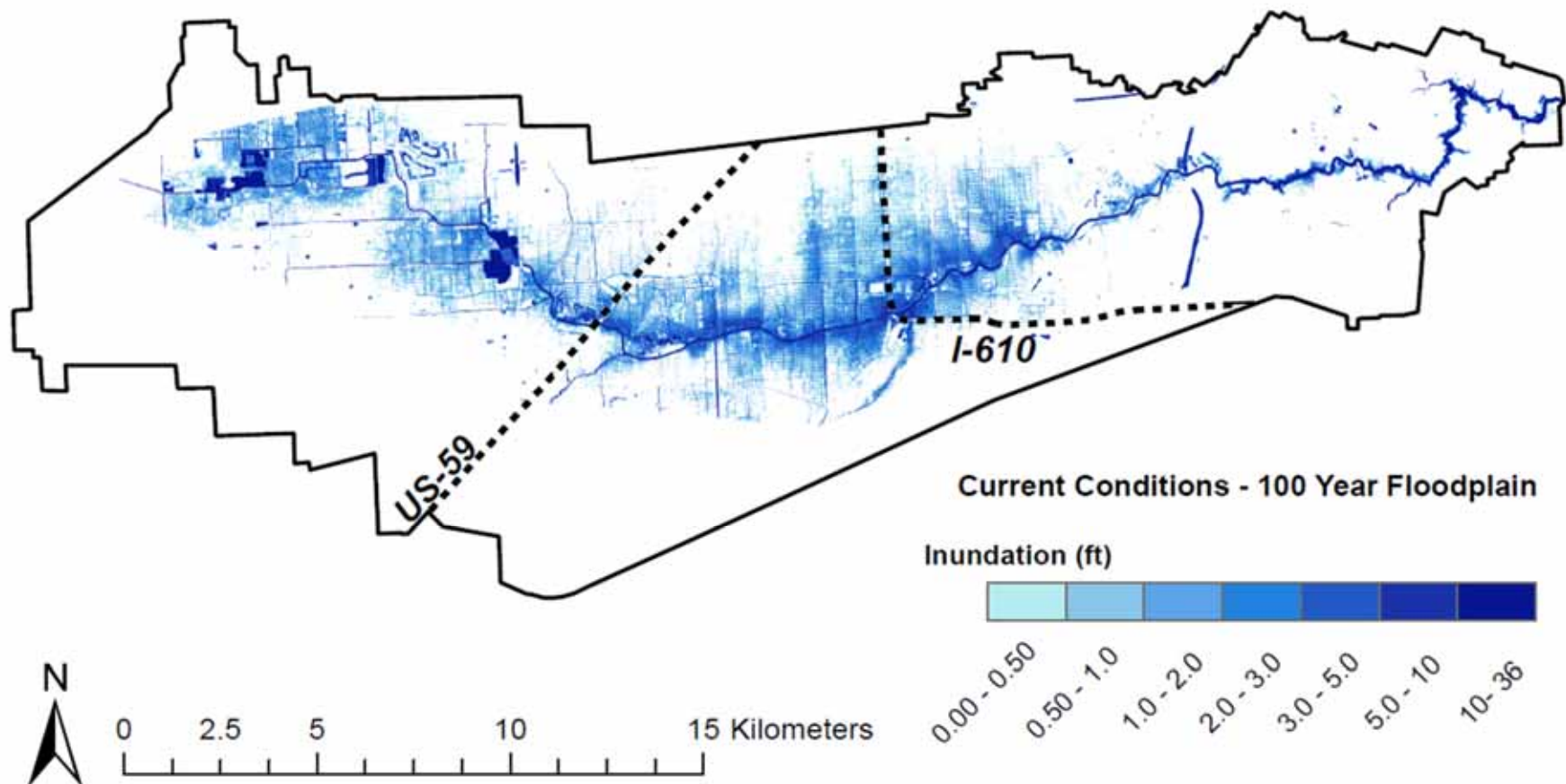
FLOODPLAIN MANAGEMENT



Areal Extent of 100-Year
Floodplains



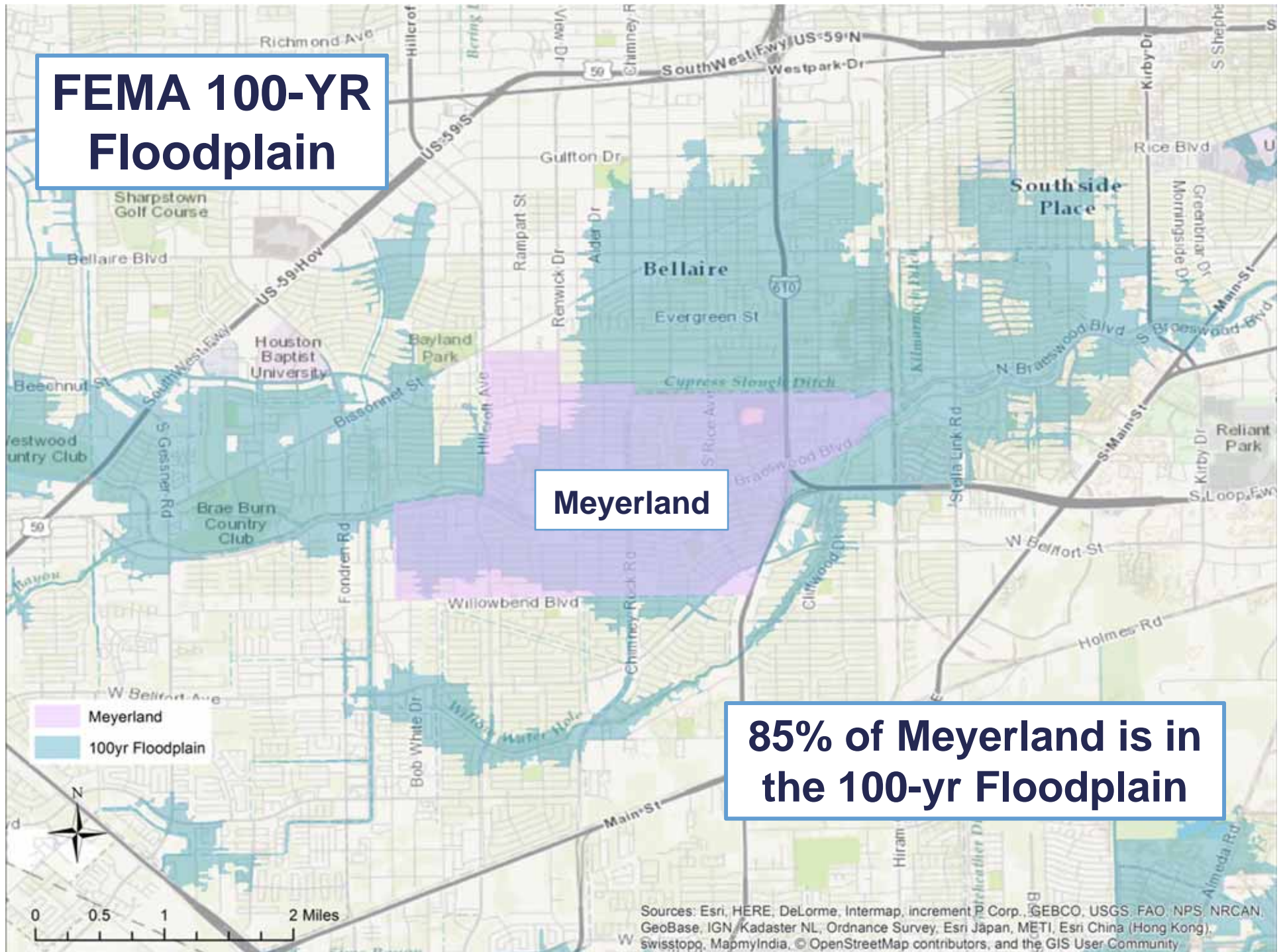
Current Brays Bayou Watershed 100-yr Floodplain



FEMA 100-YR Floodplain

Meyerland

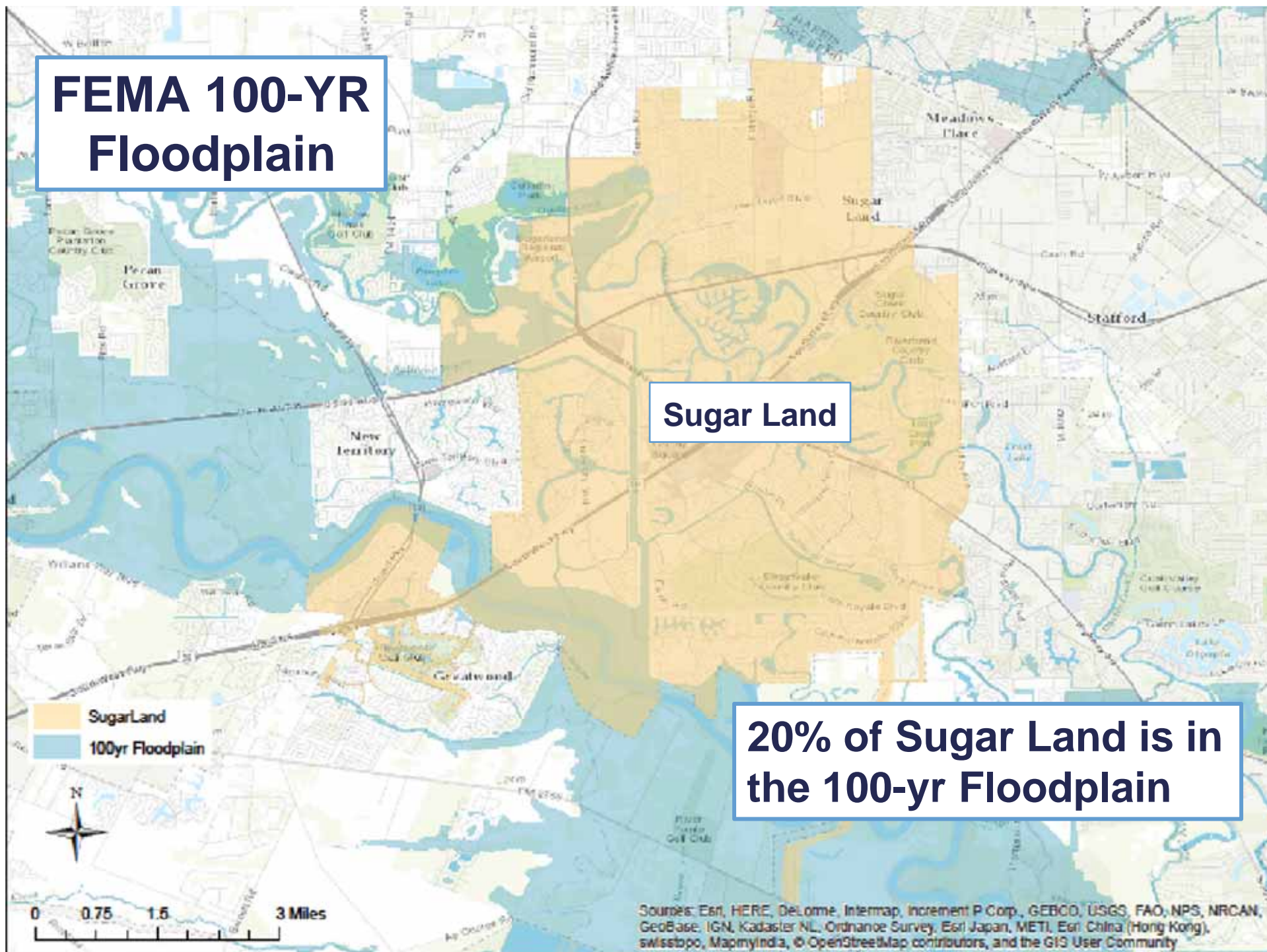
85% of Meyerland is in
the 100-yr Floodplain



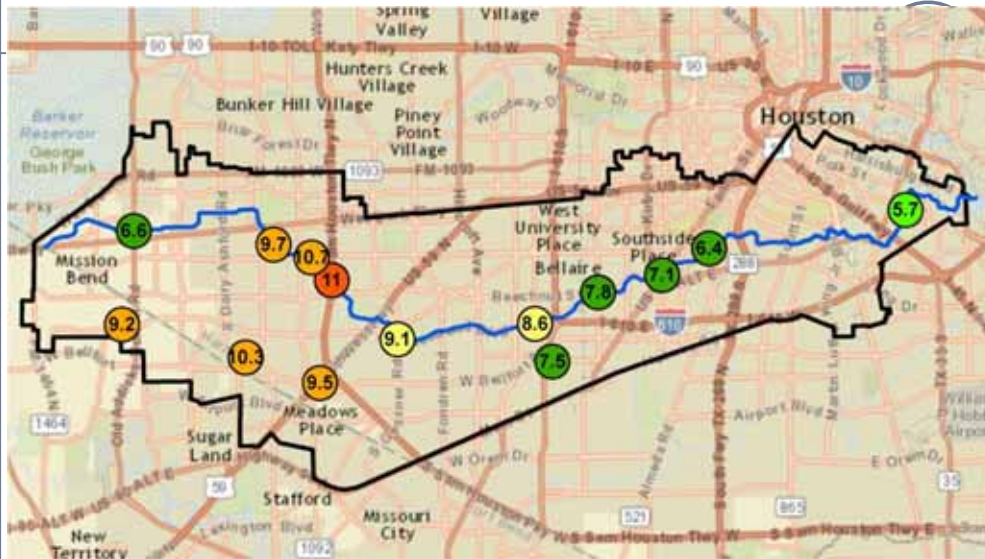
FEMA 100-YR Floodplain

Sugar Land

20% of Sugar Land is in
the 100-yr Floodplain



Memorial Day Flood 2015 (May 25-26, 2015)



12-hr Rainfall at USGS Gages

- Brays Bayou Watershed received 11 inches of rain in 12 hrs (equivalent to 100-yr return period storm)
- Storm fueled by jet stream positioned directly over central and east Texas and moisture originating from the Gulf of Mexico
- Estimated 2,600 residential damages in Houston (1,185 in Brays Bayou watershed)

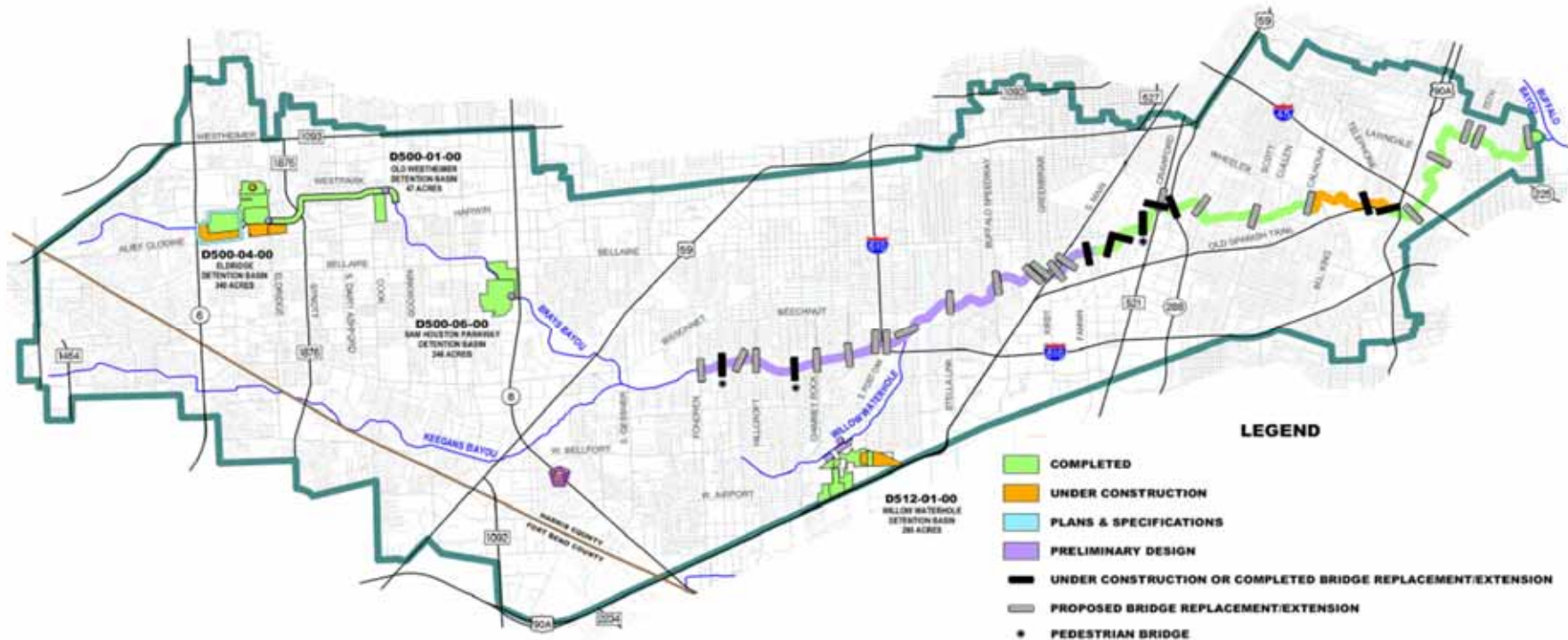


I-45 and Main St.



S. Gessner and Bissonett (Photos from Houston Chronicle)

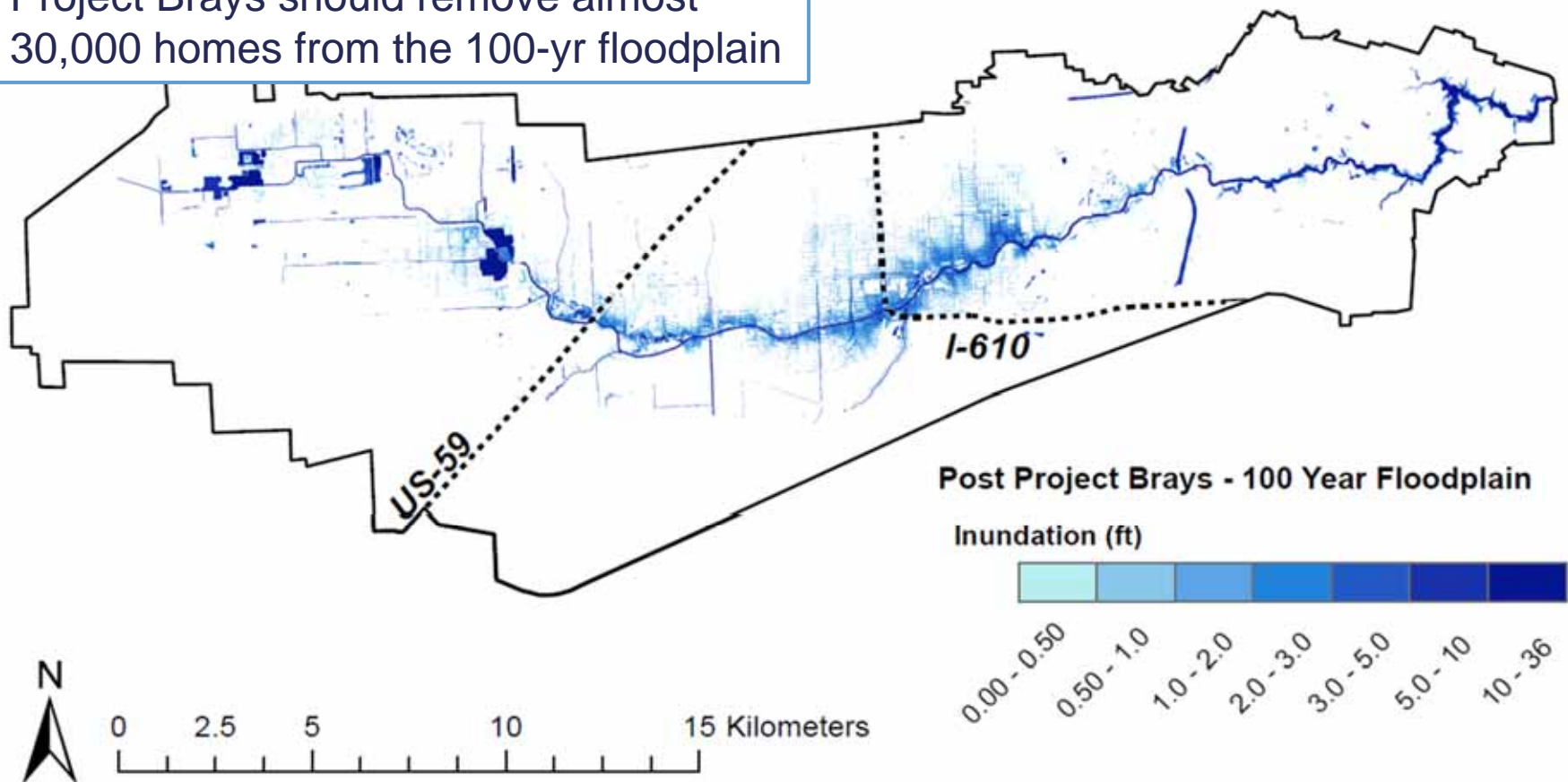
Project Brays



- \$550 million federal funded flood control project (began in early 2000s, original completion date 2014, now expected completion in 2021) to mitigate flooding in Brays Bayou Watershed
- Project consists of large detention basins along upper reach, bridge and channel modifications along middle and lower reaches

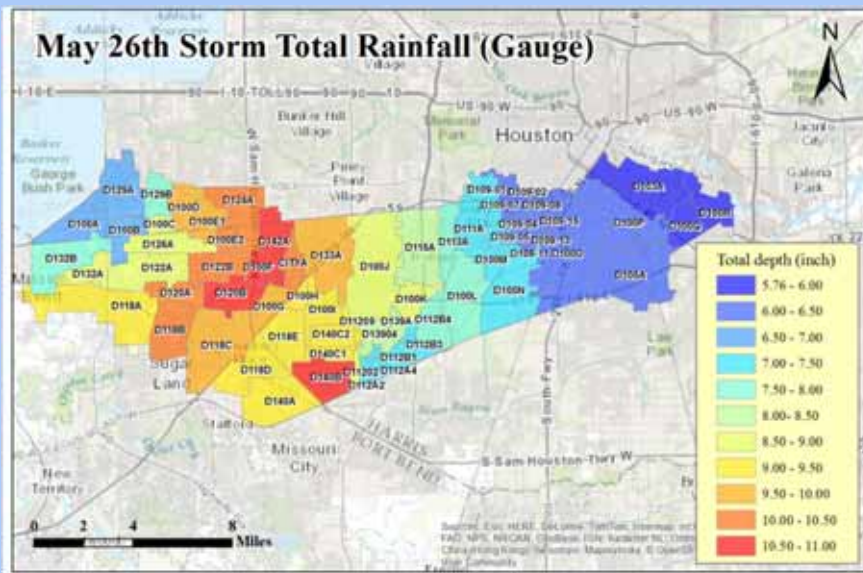
Projected 100-yr Floodplain in 2021

Project Brays should remove almost 30,000 homes from the 100-yr floodplain

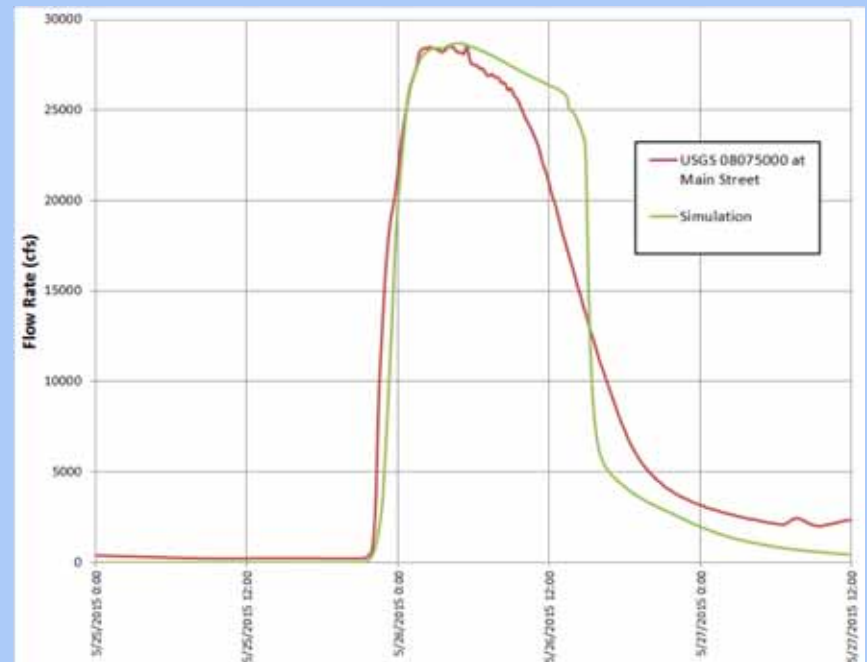


Meyerland Flood Vulnerability - 2015

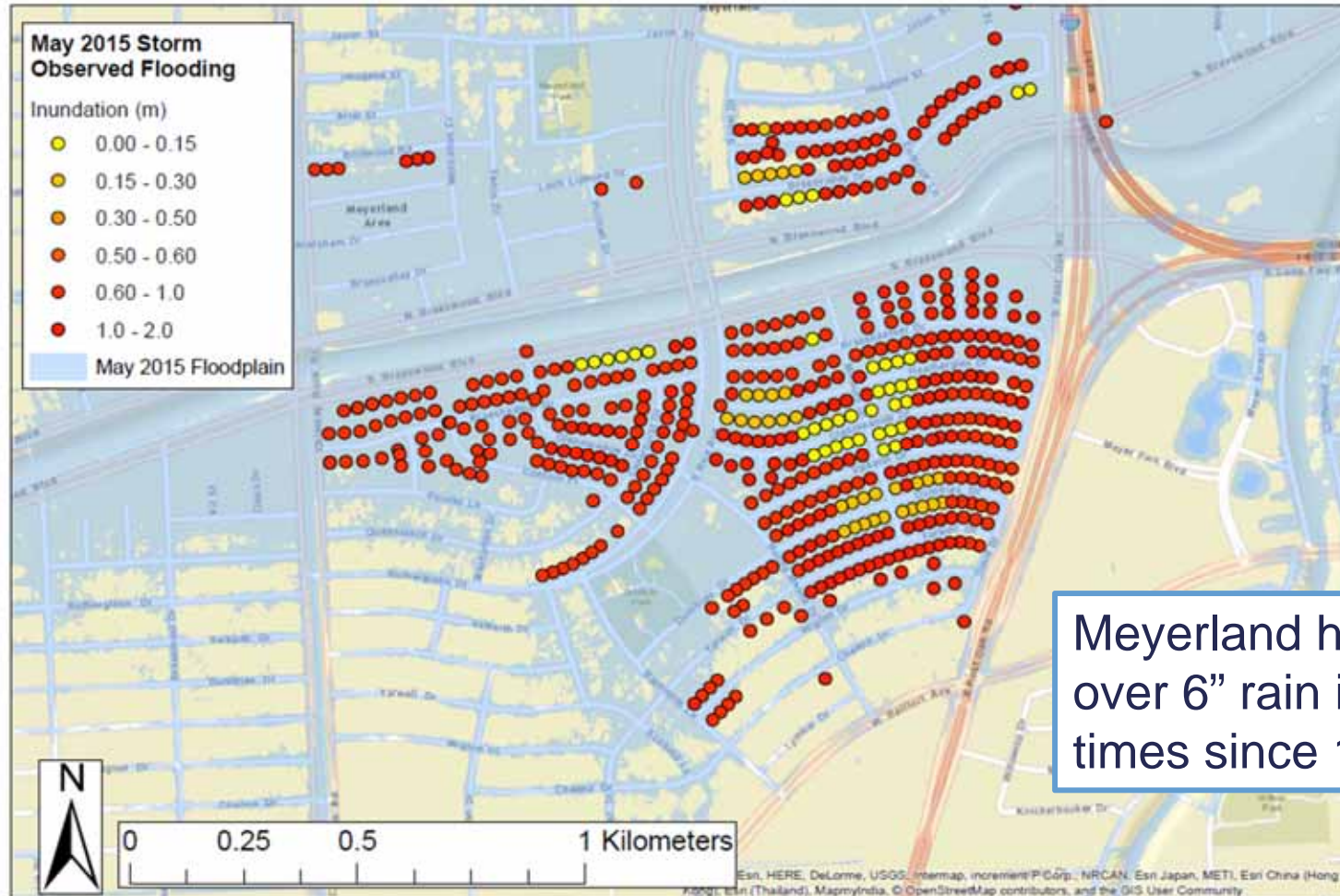
- ❖ The Memorial Day storm dropped massive amounts of precipitation just upstream of Meyerland



- ❖ Resulted in major over-topping of Brays Bayou in Meyerland area – HEC-HMS Model.

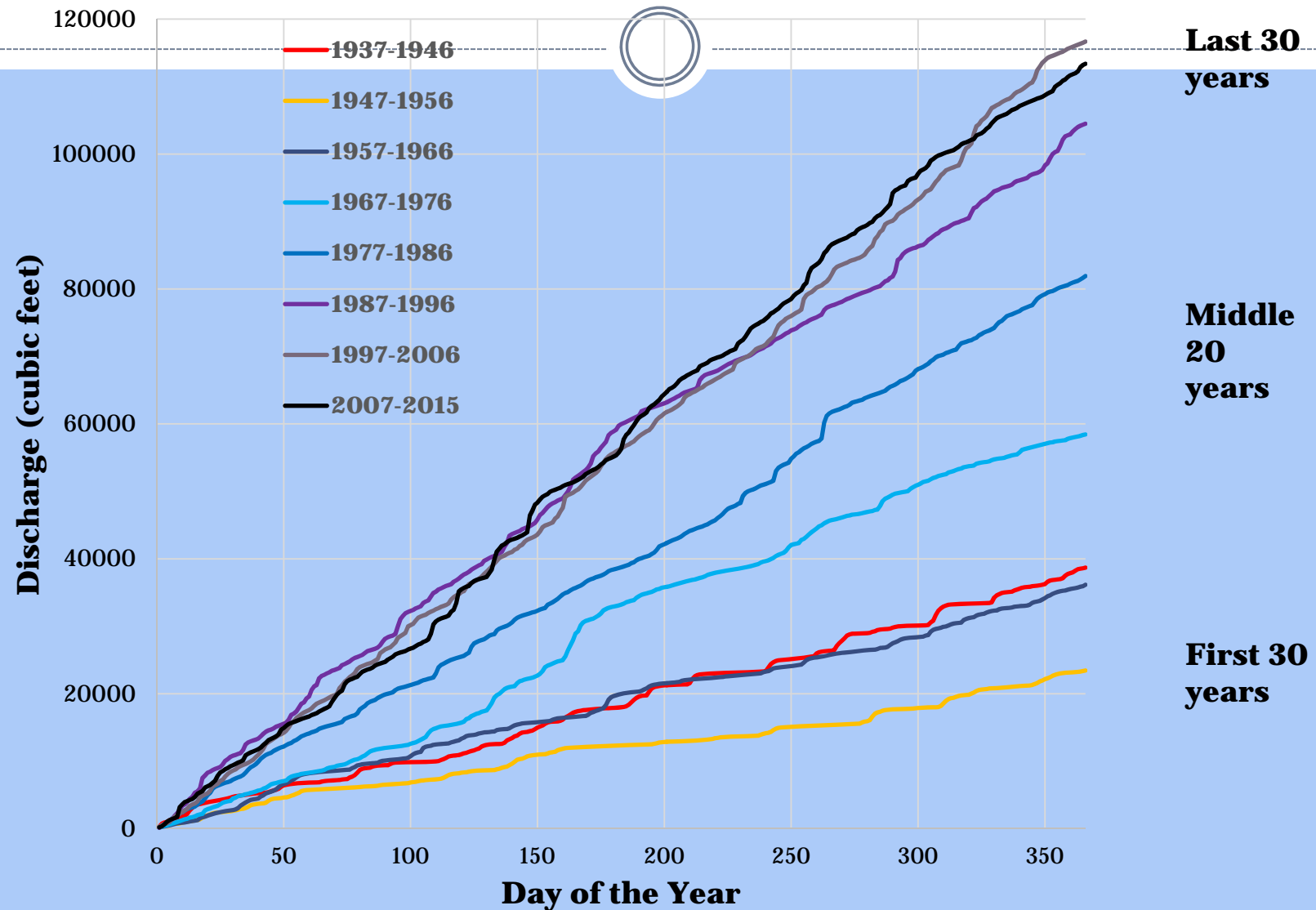


Memorial Day Storm Damages - 2015



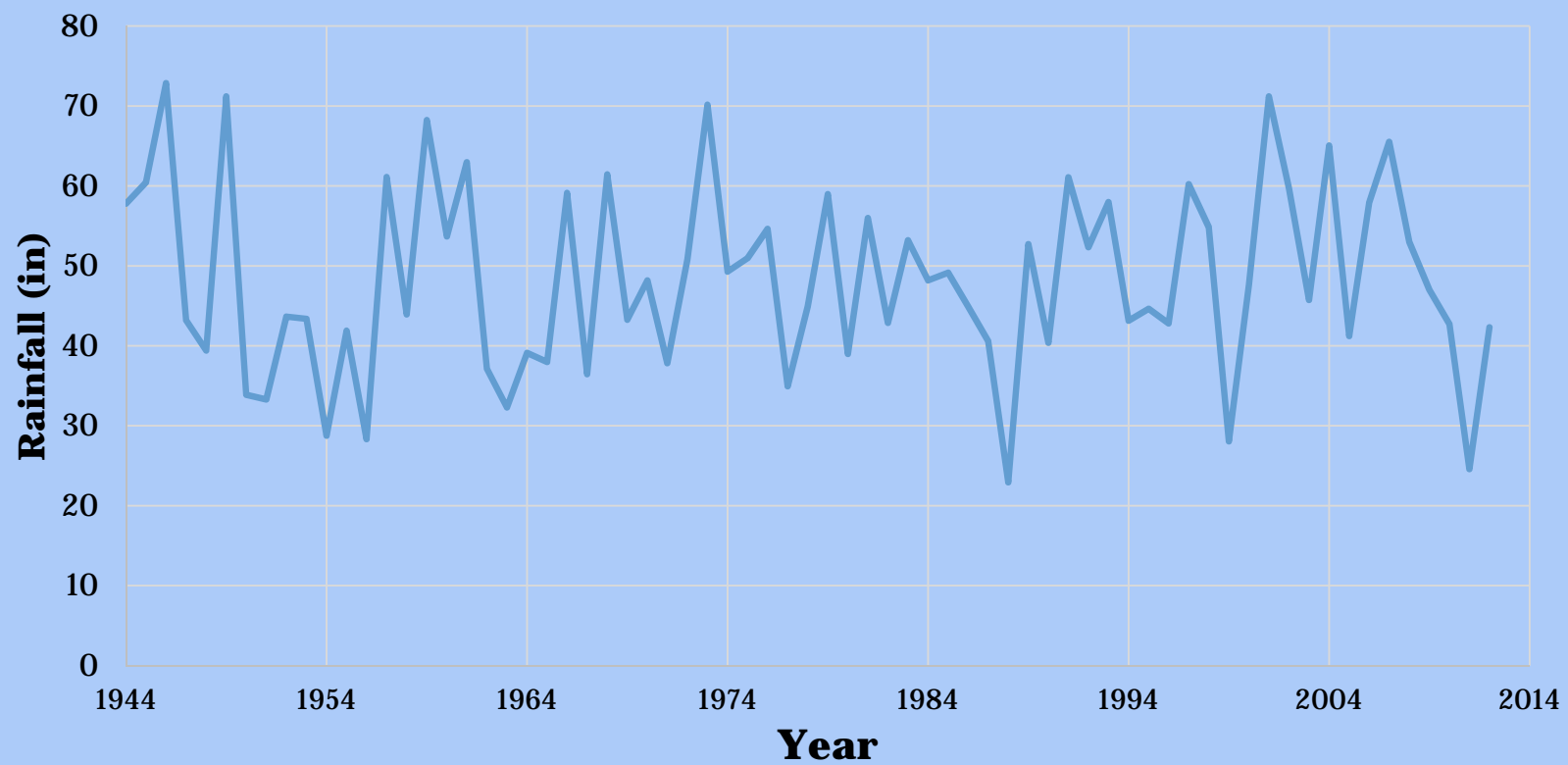
Meyerland has received over 6" rain in 24hr six times since 1986

Average Cumulative Runoff in Brays Bayou by Decade (1937 to 2015)





Houston Annual Rainfall (in)



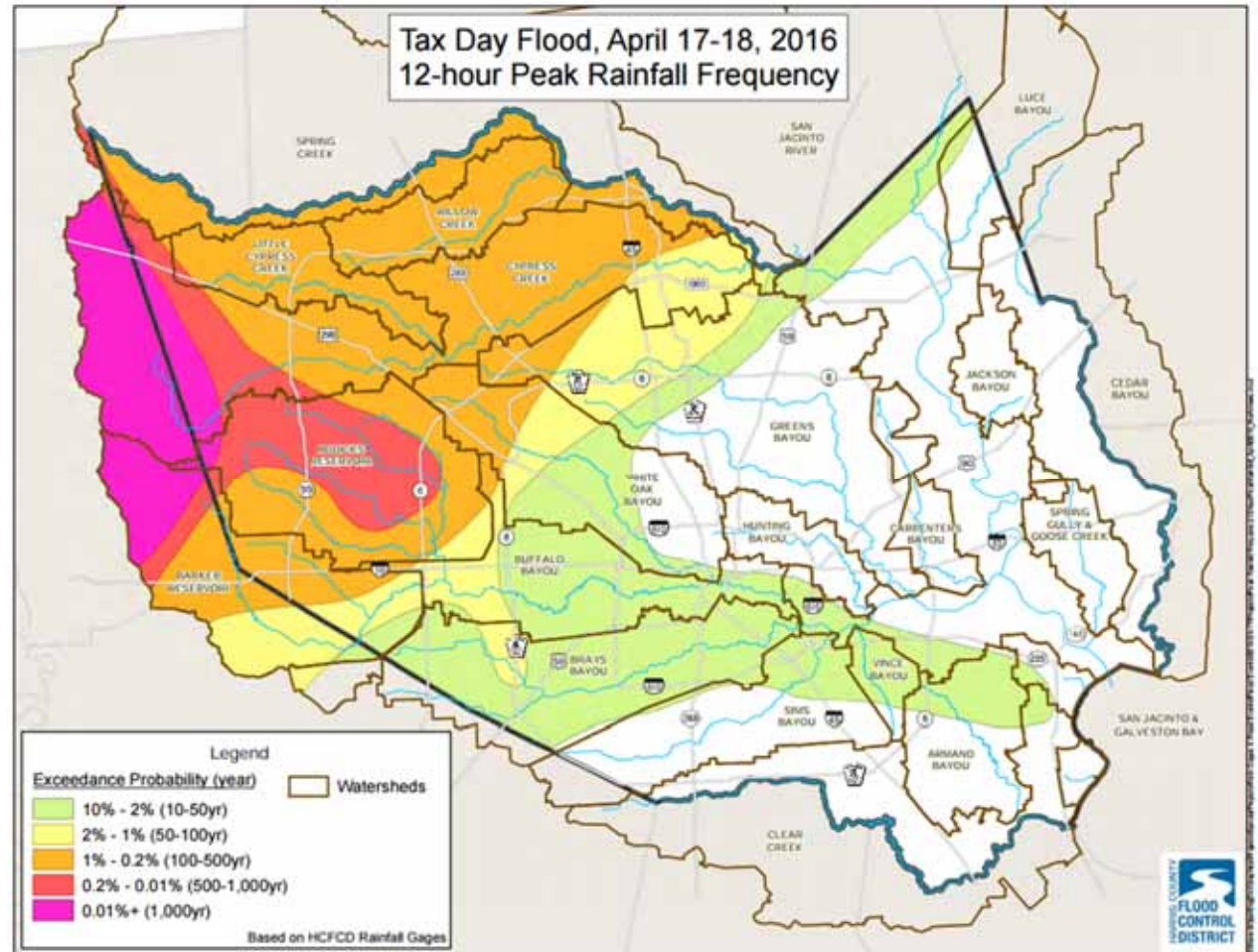
Flood Control Options in Meyerland



- ❖ Hydrologic and Hydraulic computer modeling conducted to understand nature of flooding in Meyerland
 - ❖ How does urbanization, land cover, soil type and topography affect patterns of flooding?
- ❖ Alternate/Additional designs being evaluated and modeled
 - ❖ New detention areas
 - ❖ Pump storage
 - ❖ Buyouts of most vulnerable homes

Cypress Creek and Katy Prairie – April 2016

During the April 17th storm event, parts of **northwest Harris County** received up to **17in of rainfall in a 12-hr period**, corresponding to a return period between 100-yr and 500-yr.



April 2016 Storm Residential Flooding



- ❖ Major riverine flooding occurred in White Oak Bayou, Cypress Creek, Brays Bayou, as well as many other streams in the Houston region
- ❖ **In total 9,840 homes and 2,700 apartments were flooded**
- ❖ The Tax Day flood resulted in the 2nd most number of damaged homes (after TS Allison)

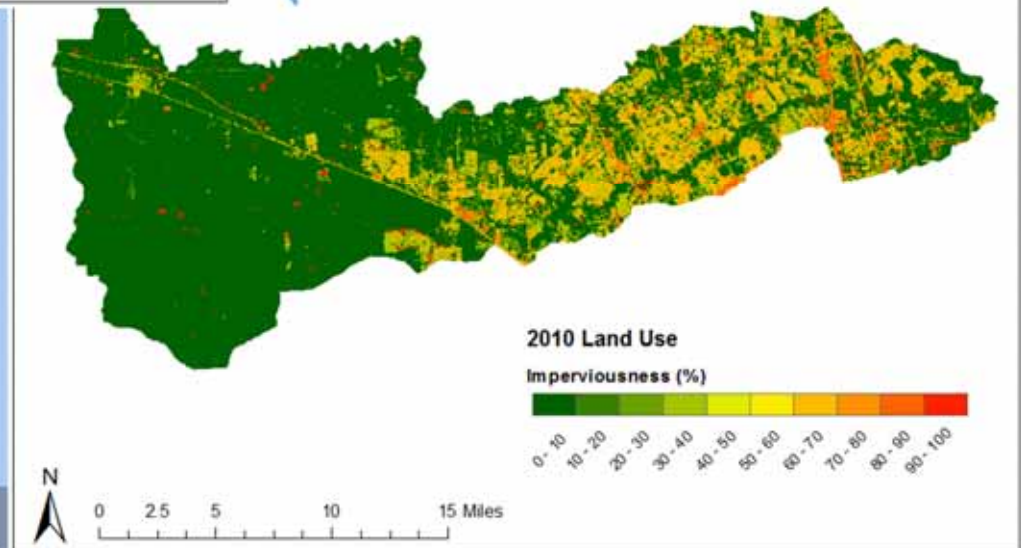
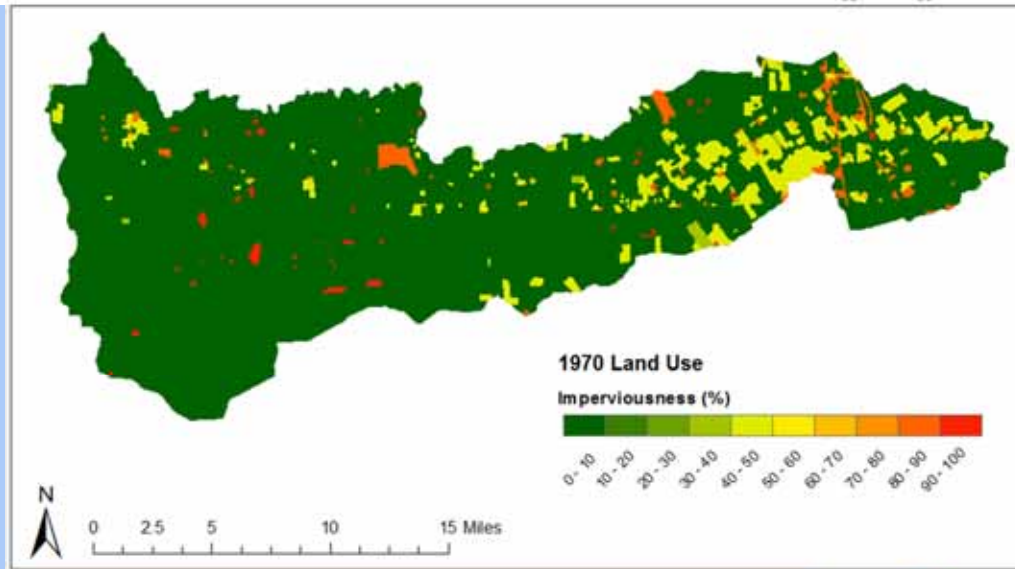
Watershed	House Flooding
White Oak Bayou	2,080
Cypress Creek	1,680
Brays Bayou	1,380
Buffalo Bayou	950
Langham Creek	810
Greens Bayou	600

Flooding Issues in Cypress Watershed



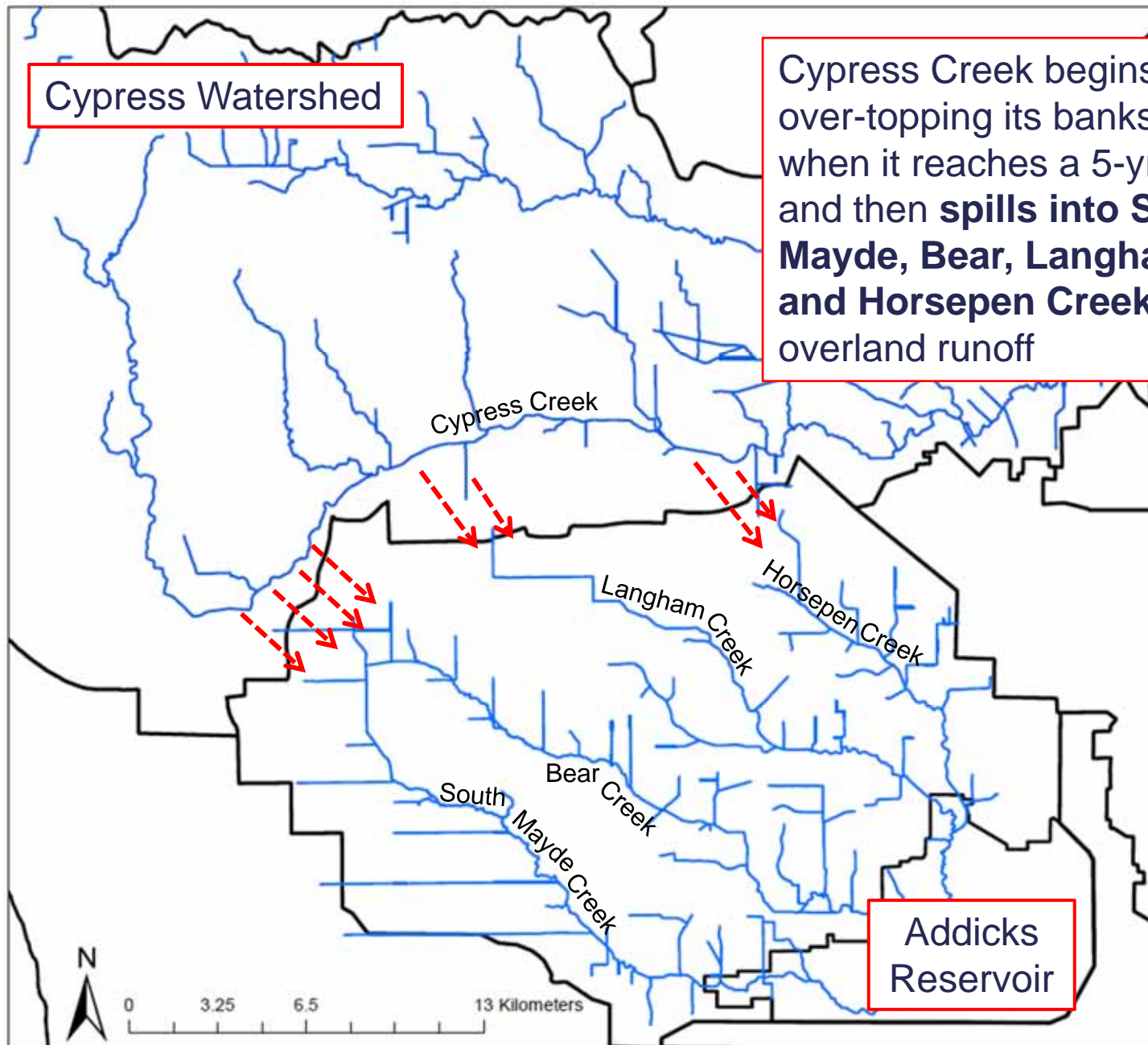
- ❖ Massive runoff into Cypress Creek causes overflow into Addicks watershed (limited storage capacity)
- ❖ Limited downstream channel capacity causes overbank flooding throughout Cypress Creek
- ❖ Land use changes in recent decades exacerbate flooding issues all around the NW sector

Cypress Cr. 1970 vs 2010 Land Use



Cypress Watershed

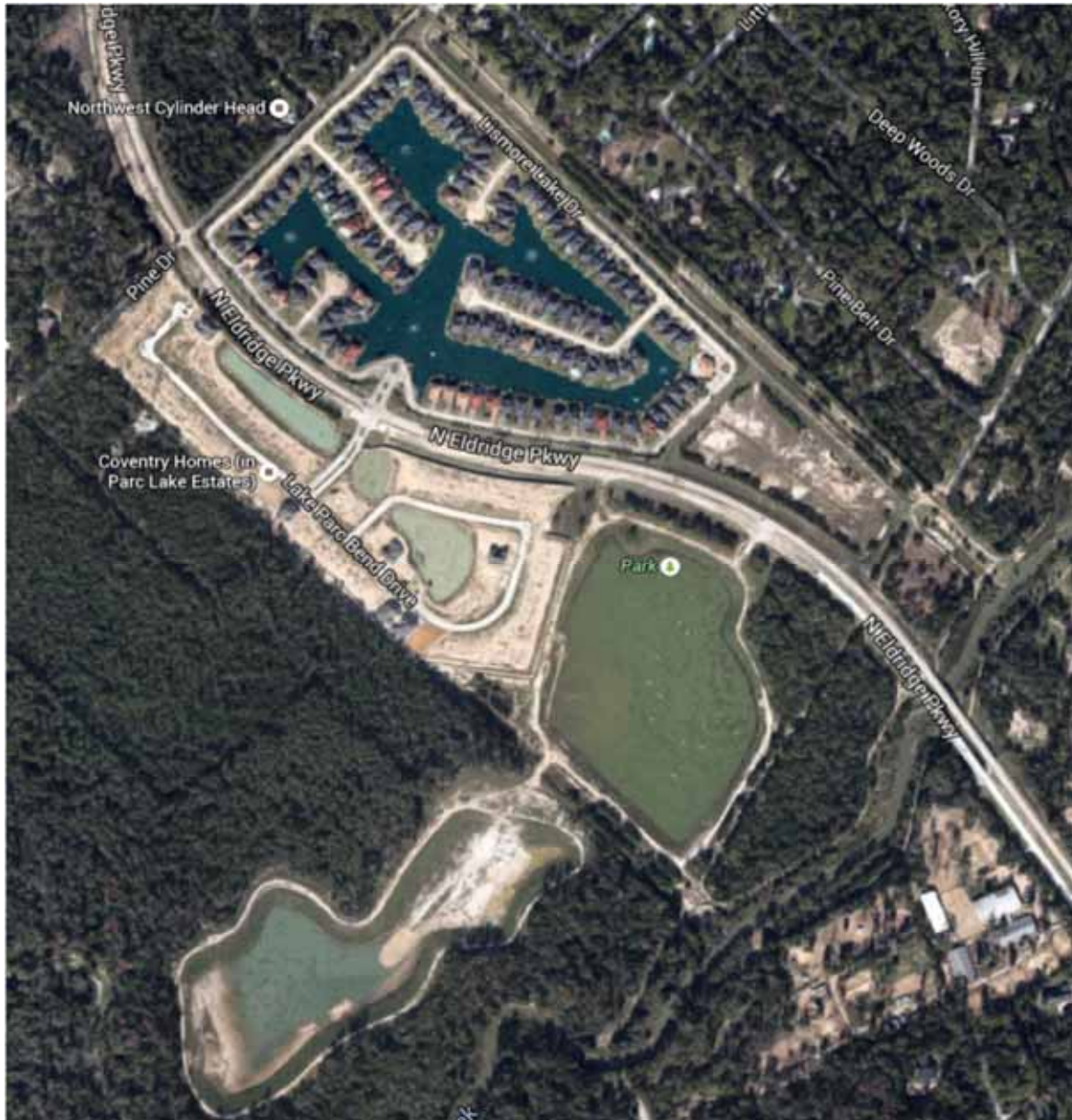
Cypress Creek begins over-topping its banks when it reaches a 5-yr flow and then **spills into South Mayde, Bear, Langham, and Horsepen Creeks** via overland runoff



Addicks
Reservoir



Typical Detention Pond for Flood Control



The Future of Floods – Avoid Disasters



- ❖ Better evaluate overland flow in low relief areas
- ❖ Large % flooded houses are simply not in the floodplain
- ❖ Better Manage Developed Land Use and Green Infrastruct.
- ❖ Large Regional and Local Detention/Retention Ponds
- ❖ Native Wetland Restoration – preserve open space
 - ❖ Katy Prairie Conservancy
- ❖ Strengthen Drainage Policies -- protect downstream areas