



Trinity River Authority of Texas  
*Enriching the Trinity basin as a resource for Texans*



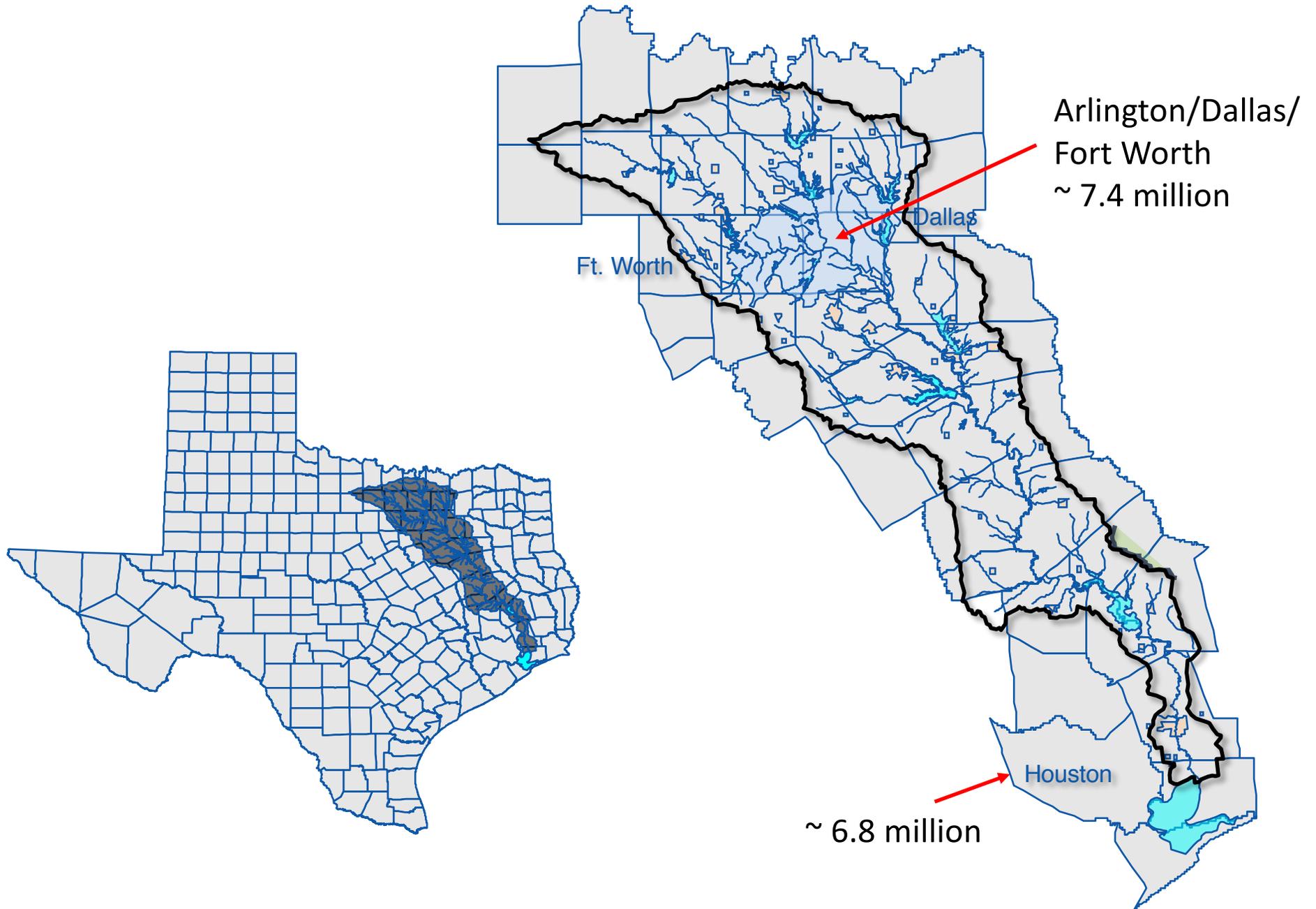
**Joint TWDB-UTA-NIDIS Workshop on  
Forecast-informed Reservoir Operation  
(FIRO) and Water Resources Management in  
the States of TX and OK**

**TRA's Experience with Hurricane Harvey**

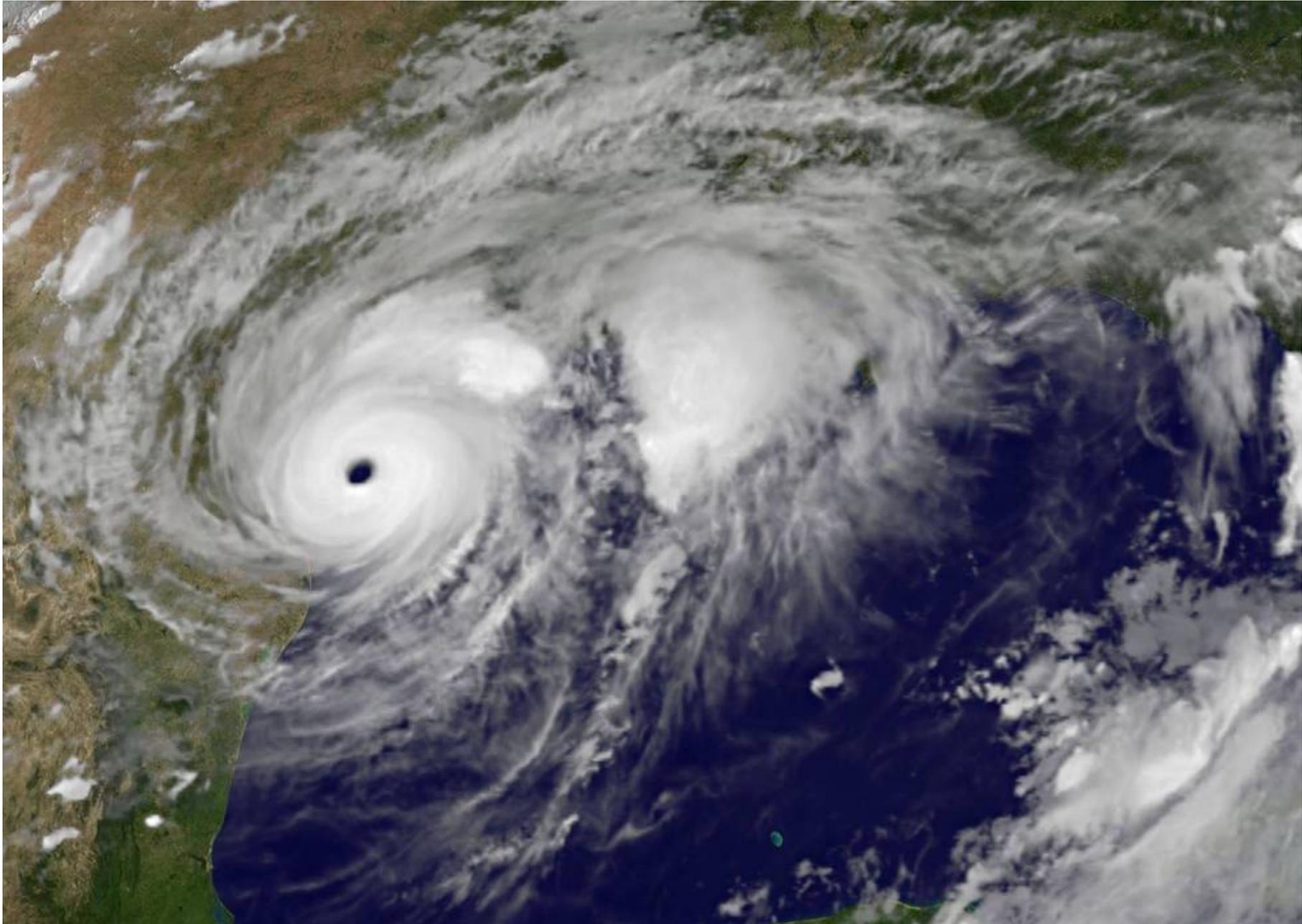
Wastewater Treatment • Water Treatment • Water Storage • Lake Livingston • Recreation

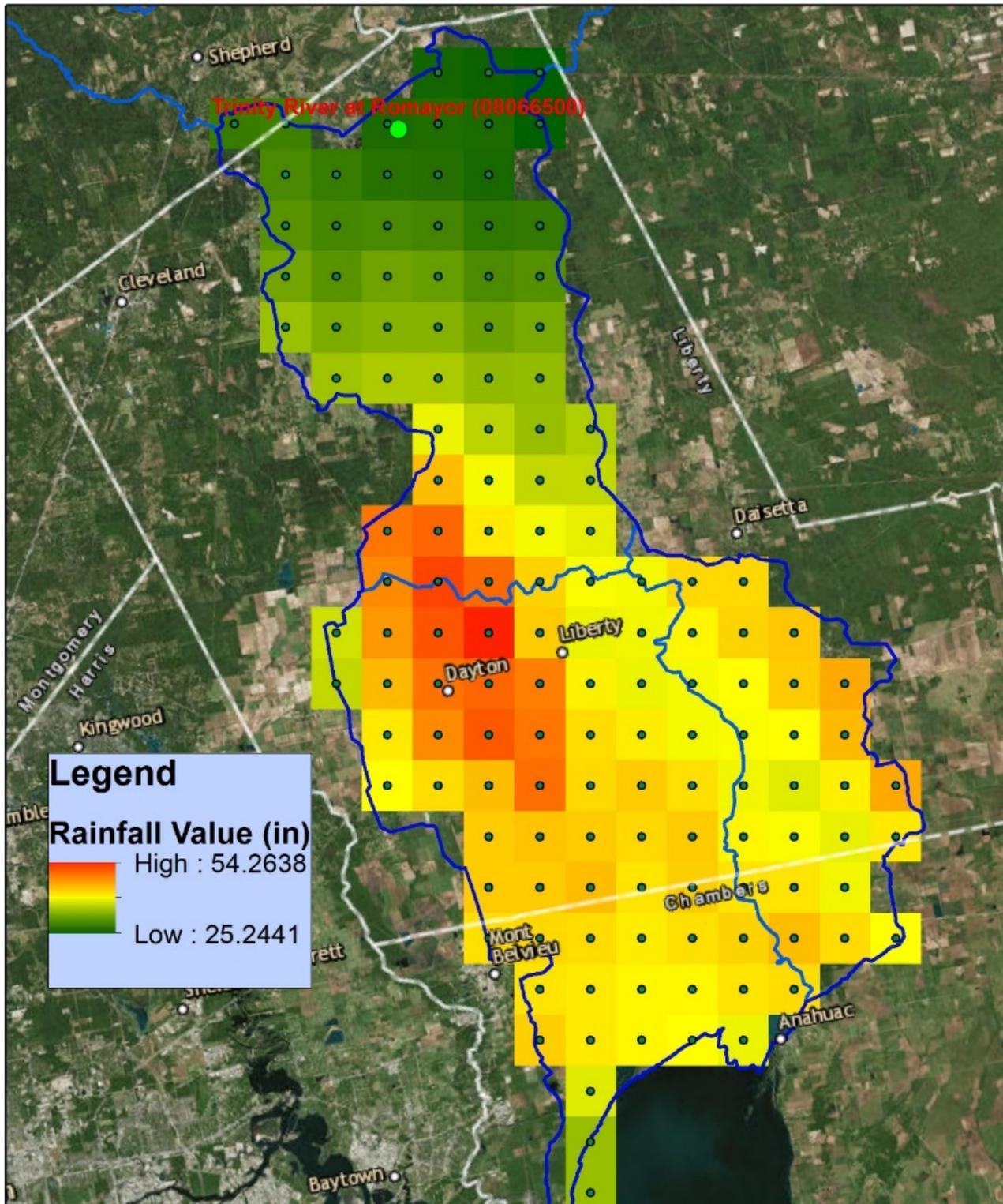


# Trinity River Basin and TRA



# Harvey



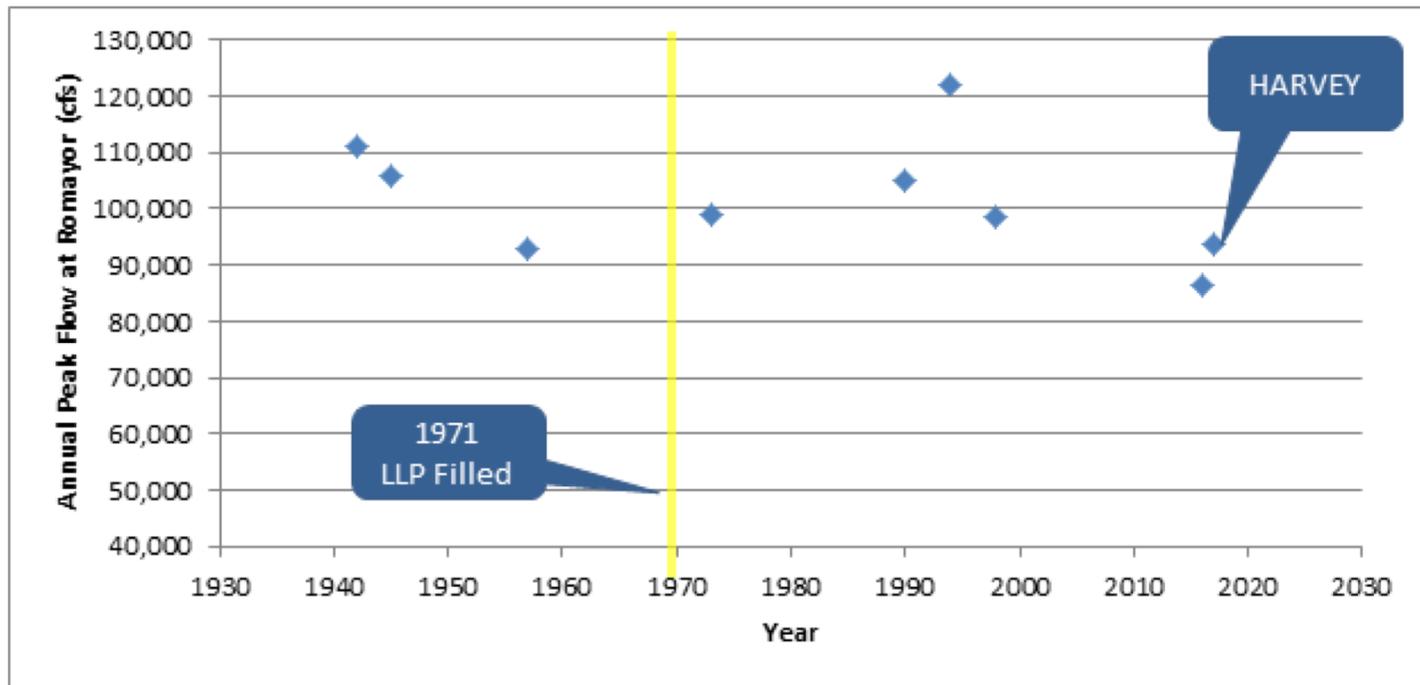


Harvey Rainfall Distribution in Trinity Basin

# Dayton and Liberty, Texas







Year	Annual Peak at Romayor
1994	122,000
1942	111,000
1945	106,000
1990	105,000
1973	99,000
1998	98,600
1917	93,900
2057	93,000
2016	86,300
1992	85,300

# What Could We Have Done?

Lower Lake Levels (permanently maintain additional storage in Livingston for flood control)

**Permanent loss of water supply**

Pre-Release (temporarily create storage in advance of major storms)

# Lower Lake Levels

Harvey dumped an estimates 2,800,000 AF in Trinity basin

Livingston passed approximately 900,000 AF

Only 32% of total runoff from Harvey in the Trinity fell above the dam.

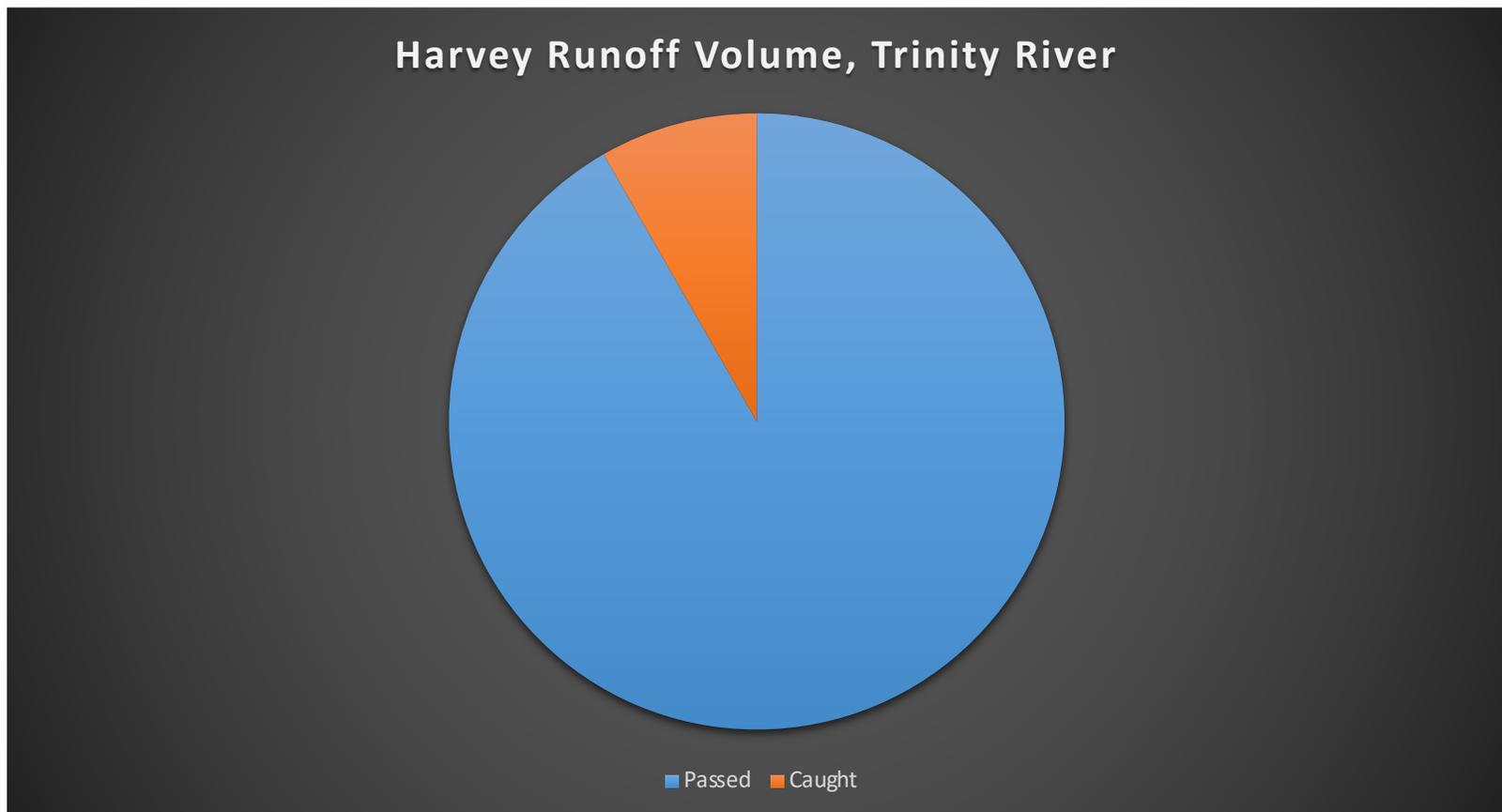
# Lower Lake Levels

Lowering 3' frees-up 232,000 AF  
\$22 million worth of water  
Of 900,000 could have caught 25.7%

So we would have mitigated:  
 $25\% \text{ of } 30\% = 7.5\% \text{ of flows}$

# Lower Lake Levels

...Said another way, 92.5% of Harvey Trinity flows would have remained.



# Release Times to Free 3ft of Reservoir Space

Lowering Livingston by 3' = 231,652 AF

LLP			Romayor Gage			Runoff					
Release Rate cfs	af/day	# Days	Stage	% Action Stage	% Flood Stage	2" Rain (cfs)	Stage & Flood Category	3" Rain (cfs)	Stage & Flood Category	4" Rain (cfs)	Stage & Flood Category
2,000	1,967	118	11.86	40%	30%	27,771	64%	36,359	72%	40,656	75%
5,000	7,917	29	14.15	47%	35%	30,771	67%	39,359	74%	43,656	77%
10,000	17,834	13	17.32	58%	43%	35,771	71%	44,359	78%	48,656	81%
15,000	27,751	8	19.99	67%	50%	40,771	75%	49,359	81%	53,656	84%
20,000	37,668	6	22.37	75%	56%	45,771	79%	54,359	84%	58,656	87%
30,000	57,502	4	26.47	88%	66%	55,771	85%	64,359	90%	68,656	93%

*Assumes "best case scenario" --- inflow = 1,040 CFS*

# Pre Releases

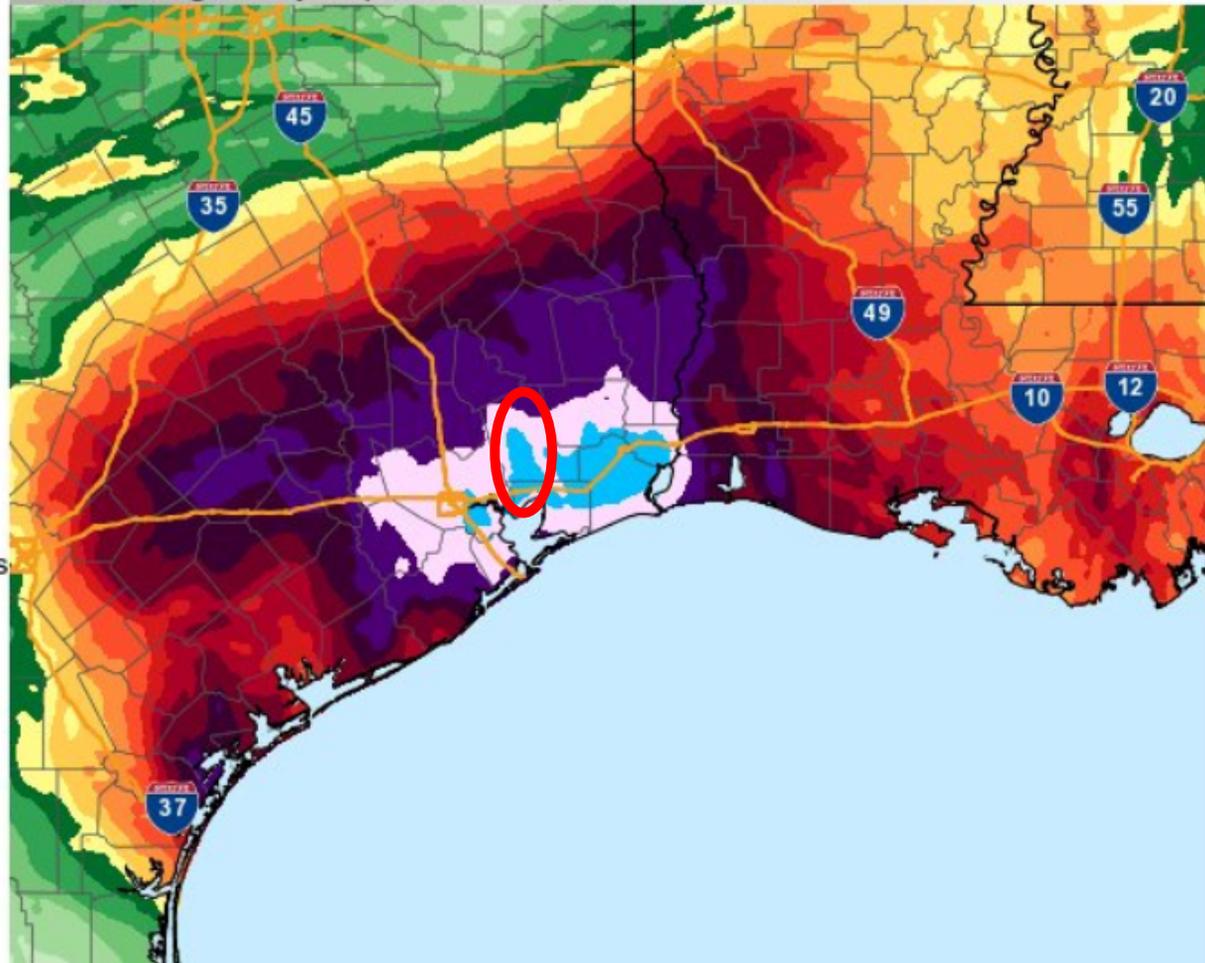
Harvey – 7 Day Precipitation through 9/1/17

## Observed Precipitation



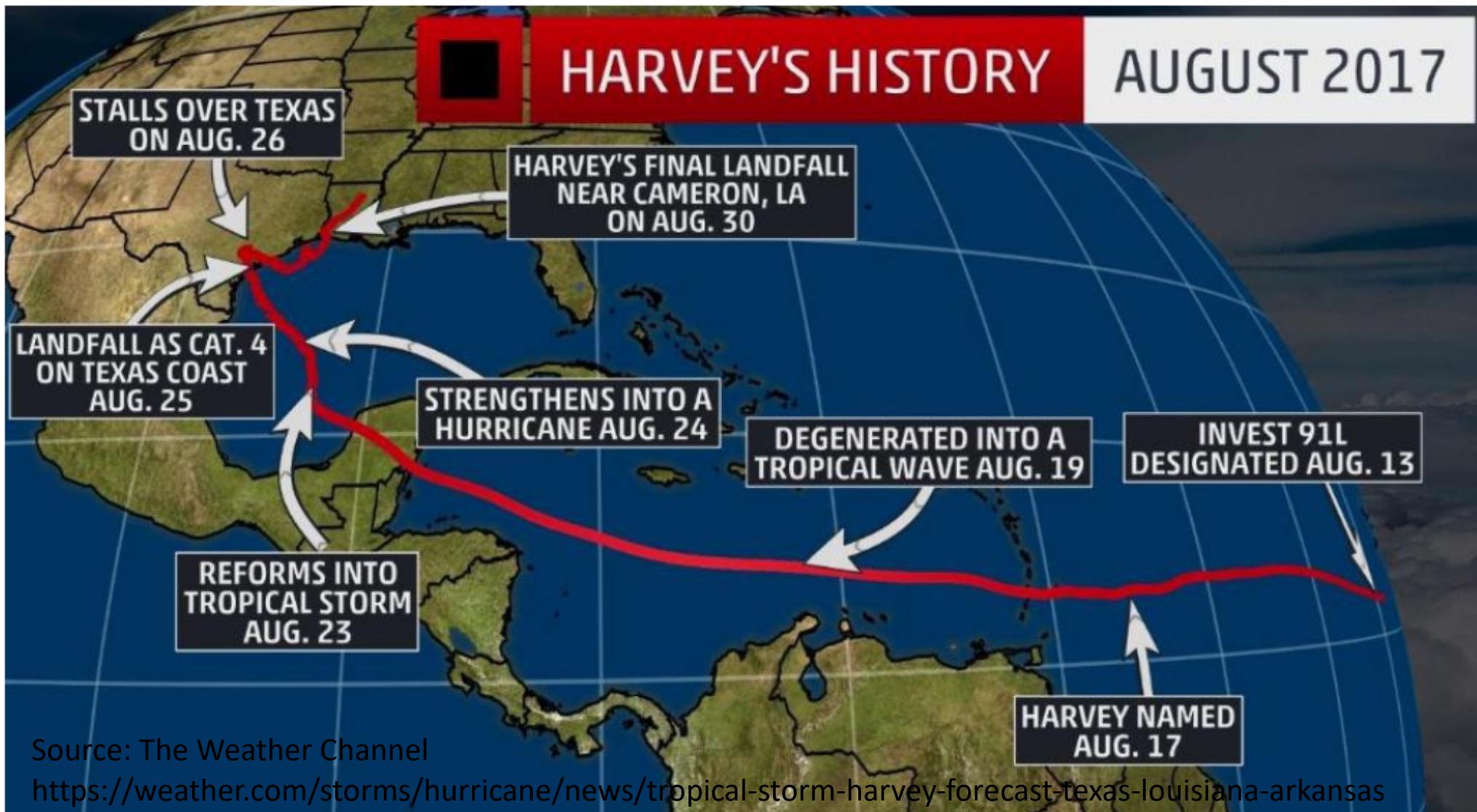
Valid Ending Friday September 1st, 2017 at 3 PM CDT

- Up to 0.1 inch
- 0.1 to 0.25 inches
- 0.25 to 0.5 inches
- 0.5 to 1.0 inches
- 1.0 to 1.5 inches
- 1.5 to 2.0 inches
- 2.0 to 3.0 inches
- 3.0 to 4.0 inches
- 4.0 to 6.0 inches
- 6.0 to 8.0 inches
- 8.0 to 10.0 inches
- 10.0 to 15.0 inches
- 15.0 to 20.0 inches
- 20.0 to 30.0 inches
- 30.0 to 40.0 inches
- Greater than 40 inches



Graphic Created  
September 1st, 2017  
3:59 PM CDT

# Tropical Storm to Major Hurricane in ~40 hours



Source: The Weather Channel

<https://weather.com/storms/hurricane/news/tropical-storm-harvey-forecast-texas-louisiana-arkansas>

# Role of Weather Forecasts in Lake Operations

What could we have done [in terms of Livingston operations] if we had known Harvey was coming?

From a gate operating procedure, very little.

Water Supply Reservoirs are:  
GREAT at supplying water  
TERRIBLE at mitigating flooding



# Role of Weather Forecasts in Lake Operations

May be scenarios where pre-releasing makes sense:

Intense storm of short duration in upper portion of basin with following properties –

1. Known quantity of water in channel
2. Known arrival time
3. Confidence in precipitation forecasts

# Analysis of Flow Trends at Crockett



	Flow in cfs (Greater Than)	Slope (Increasing or Decreasing)	Statistically Significant*
	0 (All flow values)	Increasing	Yes
	10,000	Increasing	Yes
	20,000	Increasing	Yes
<b>Near flood (action level)</b> →	30,000	N/A	No
<b>Minor flooding</b> →	40,000	N/A	No
<b>Moderate flood</b> →	50,000	N/A	No

**\*95% confidence**