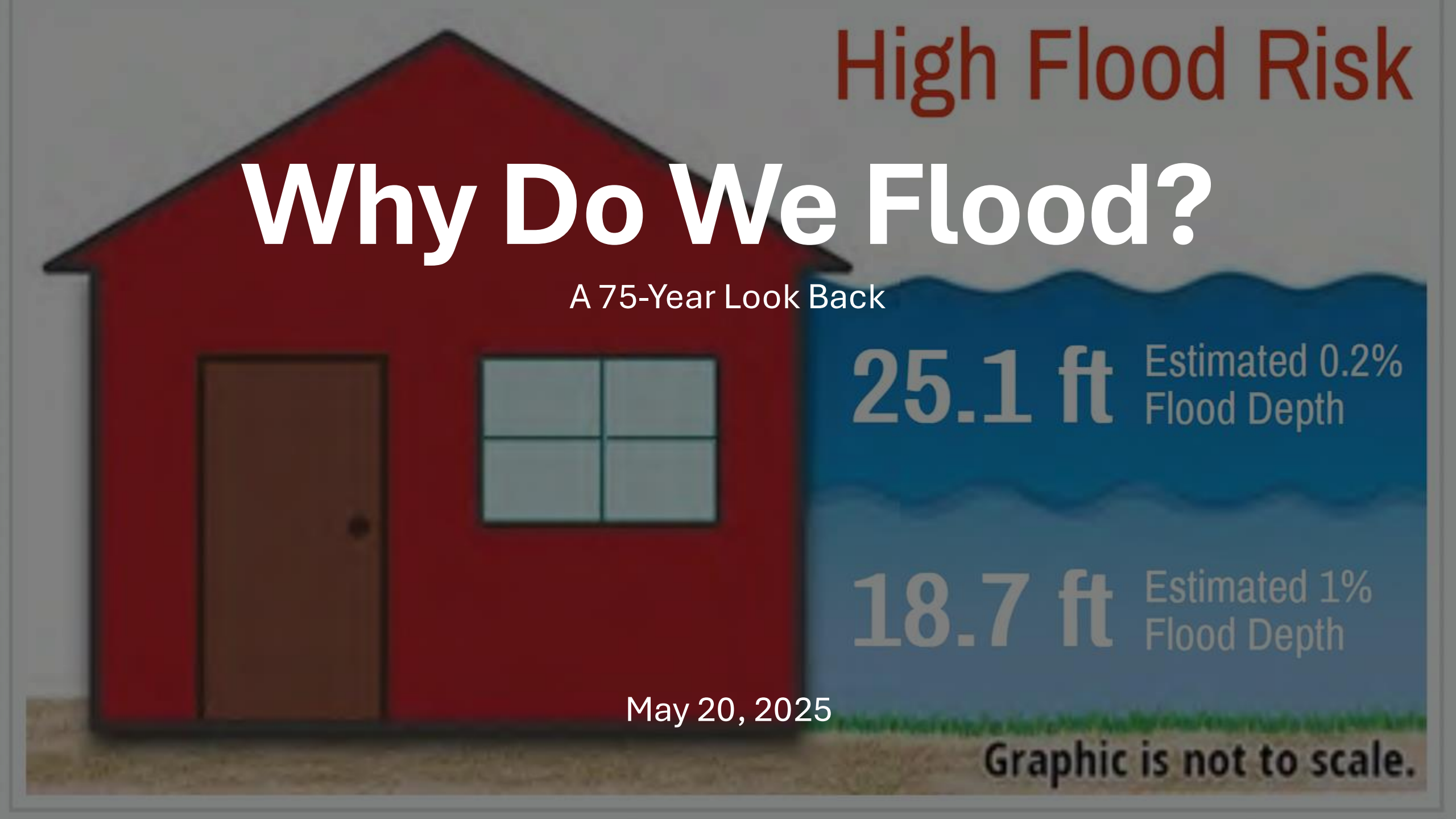
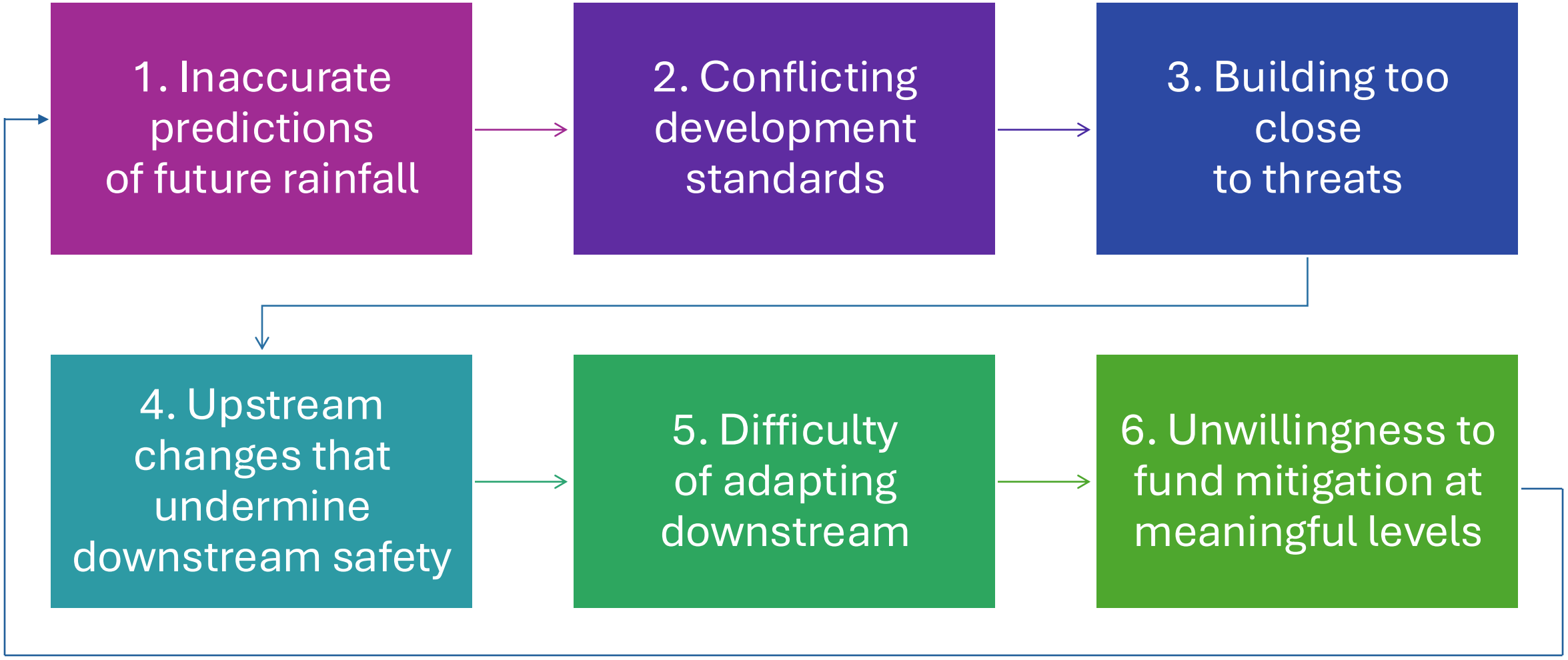


Why Do We Flood?

A 75-Year Look Back

May 20, 2025

Doom Loop


1. Inaccurate predictions of future rainfall
2. Conflicting development standards
3. Building too close to threats
4. Upstream changes that undermine downstream safety
5. Difficulty of adapting downstream
6. Unwillingness to fund mitigation at meaningful levels

1. Inaccurate Predictions of Future Rainfall

Homes built above 1% annual-chance flood

Extreme Value Analysis (EVA)

Small data sets

Revise after major disasters

Harvey 25-30% > Allison, 50% > Carla

Iterations of Design Rainfall Depth Statistics

1961 Carla – Technical Paper 40 (TP-40) – 12 inches

2004 Allison – 13.5 inches

2018 Harvey – Atlas 14 – 18 inches

Some places in region still using TP-40

What Designs Change As Consequence?

- Floodplain boundaries
- Building requirements
- Detention basin sizing
- Subdivision drainage plans
- Bridge design
- Culvert sizes
- Channel widths

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.495 (0.375-0.653)	0.584 (0.446-0.763)	0.729 (0.556-0.958)	0.851 (0.638-1.13)	1.02 (0.740-1.40)	1.15 (0.812-1.62)	1.28 (0.884-1.86)	1.42 (0.956-2.12)	1.62 (1.05-2.49)	1.77 (1.12-2.80)
10-min	0.784 (0.593-1.03)	0.927 (0.707-1.21)	1.16 (0.883-1.52)	1.36 (1.02-1.81)	1.63 (1.18-2.23)	1.84 (1.30-2.60)	2.05 (1.41-2.97)	2.26 (1.52-3.37)	2.54 (1.65-3.92)	2.76 (1.75-4.36)
15-min	0.998 (0.756-1.32)	1.17 (0.897-1.54)	1.46 (1.11-1.92)	1.70 (1.28-2.27)	2.03 (1.48-2.79)	2.29 (1.62-3.22)	2.54 (1.76-3.69)	2.82 (1.90-4.20)	3.20 (2.08-4.93)	3.50 (2.21-5.53)
30-min	1.43 (1.08-1.89)	1.68 (1.28-2.19)	2.07 (1.58-2.73)	2.40 (1.81-3.21)	2.86 (2.07-3.91)	3.20 (2.26-4.51)	3.56 (2.45-5.16)	3.96 (2.66-5.90)	4.53 (2.95-6.99)	5.00 (3.17-7.90)
60-min	1.89 (1.43-2.49)	2.23 (1.70-2.91)	2.78 (2.12-3.65)	3.24 (2.43-4.32)	3.88 (2.81-5.31)	4.37 (3.08-6.14)	4.88 (3.37-7.08)	5.49 (3.69-8.18)	6.38 (4.15-9.85)	7.13 (4.51-11.3)
2-hr	2.29 (1.74-3.02)	2.81 (2.13-3.60)	3.60 (2.74-4.69)	4.30 (3.24-5.71)	5.31 (3.87-7.25)	6.13 (4.35-8.61)	7.03 (4.87-10.2)	8.10 (5.46-12.0)	9.71 (6.33-14.9)	11.1 (7.04-17.4)
3-hr	2.52 (1.92-3.30)	3.17 (2.38-4.00)	4.12 (3.15-5.35)	5.00 (3.78-6.63)	6.32 (4.62-8.62)	7.41 (5.28-10.4)	8.65 (6.00-12.5)	10.1 (6.82-14.9)	12.3 (8.04-18.9)	14.2 (9.05-22.3)
6-hr	2.91 (2.23-3.81)	3.80 (2.84-4.72)	5.05 (3.86-6.51)	6.25 (4.74-8.25)	8.09 (5.96-11.0)	9.67 (6.94-13.6)	11.5 (8.01-16.5)	13.6 (9.24-20.1)	16.9 (11.1-25.8)	19.7 (12.6-30.8)
12-hr	3.36 (2.58-4.37)	4.46 (3.33-5.47)	6.00 (4.61-7.70)	7.51 (5.72-9.87)	9.84 (7.29-13.4)	11.9 (8.57-16.7)	14.3 (9.99-20.4)	17.1 (11.6-25.0)	21.4 (14.0-32.5)	25.0 (16.0-39.0)
24-hr	3.82 (2.95-4.96)	5.17 (3.85-6.27)	7.02 (5.40-8.95)	8.86 (6.77-11.6)	11.7 (8.74-15.9)	14.3 (10.4-20.0)	17.3 (12.1-24.6)	20.7 (14.1-30.2)	25.8 (17.0-39.2)	30.2 (19.4-46.9)
2-day	4.27 (3.31-5.52)	5.91 (4.38-7.05)	8.09 (6.25-10.3)	10.3 (7.93-13.5)	13.9 (10.5-18.9)	17.1 (12.5-24.0)	20.9 (14.7-29.6)	24.8 (17.0-36.0)	30.4 (20.1-45.8)	35.0 (22.6-54.1)
3-day	4.62 (3.59-5.96)	6.41 (4.76-7.63)	8.80 (6.81-11.1)	11.2 (8.64-14.6)	15.1 (11.4-20.5)	18.7 (13.7-26.1)	22.7 (16.0-32.1)	26.8 (18.4-38.9)	32.6 (21.6-49.0)	37.1 (24.0-57.4)
4-day	4.95 (3.85-6.36)	6.80 (5.08-8.13)	9.31 (7.23-11.8)	11.8 (9.13-15.4)	15.8 (12.0-21.5)	19.5 (14.3-27.2)	23.6 (16.7-33.3)	27.8 (19.1-40.2)	33.6 (22.3-50.5)	38.3 (24.8-59.0)
7-day	5.76 (4.49-7.38)	7.70 (5.82-9.27)	10.4 (8.10-13.1)	13.0 (10.1-16.9)	17.1 (13.0-23.1)	20.8 (15.3-28.9)	25.0 (17.7-35.2)	29.3 (20.2-42.2)	35.3 (23.5-52.8)	40.0 (26.0-61.5)
10-day	6.44 (5.04-8.24)	8.44 (6.43-10.2)	11.3 (8.80-14.2)	14.0 (10.8-18.0)	18.1 (13.8-24.4)	21.9 (16.1-30.2)	26.0 (18.5-36.6)	30.3 (20.9-43.7)	36.3 (24.2-54.3)	41.1 (26.8-63.1)
20-day	8.51 (6.68-10.8)	10.6 (8.22-13.0)	13.7 (10.8-17.2)	16.5 (12.9-21.3)	20.8 (15.8-27.8)	24.5 (18.0-33.6)	28.5 (20.3-39.9)	32.7 (22.7-46.9)	38.5 (25.8-57.3)	43.1 (28.2-65.8)
30-day	10.3 (8.10-13.1)	12.5 (9.76-15.4)	15.8 (12.4-19.8)	18.7 (14.6-24.0)	23.1 (17.5-30.6)	26.7 (19.7-36.5)	30.6 (21.9-42.7)	34.6 (24.1-49.6)	40.2 (27.0-59.7)	44.5 (29.2-67.9)
45-day	13.0 (10.3-16.5)	15.4 (12.2-19.2)	19.1 (15.2-24.1)	22.3 (17.5-28.6)	26.9 (20.4-35.5)	30.5 (22.5-41.5)	34.2 (24.5-47.8)	38.0 (26.6-54.5)	43.1 (29.1-64.0)	47.0 (30.9-71.6)
60-day	15.5 (12.3-19.6)	18.1 (14.4-22.7)	22.3 (17.7-28.1)	25.7 (20.2-32.9)	30.5 (23.1-40.2)	34.1 (25.2-46.3)	37.7 (27.1-52.6)	41.3 (28.9-59.1)	46.0 (31.0-68.0)	49.4 (32.5-75.1)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Estimates from the table in CSV format: Precipitation frequency estimates ▾ Submit

2. Conflicting Development Standards

Higher building codes reduced flood damage 20X.

But people want to develop cheap land in floodplains

Science meets politics

Some areas use lower standards/regulation to attract new development

Lobbying, grandfathering, delays, property-rights lawsuits, board appts.

3. Building Too Close to Threats

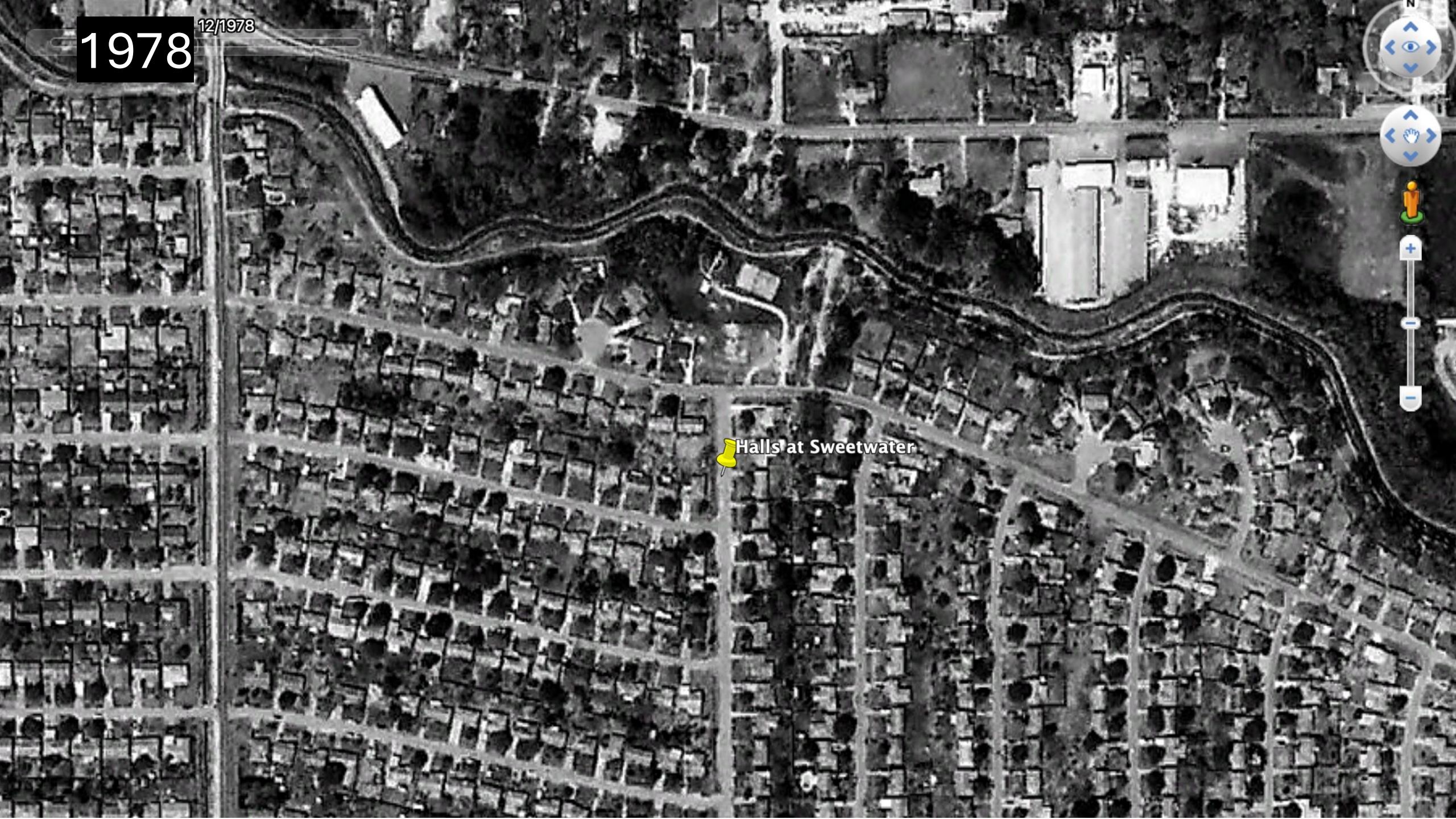
Love of living near water

Poor understanding of risk

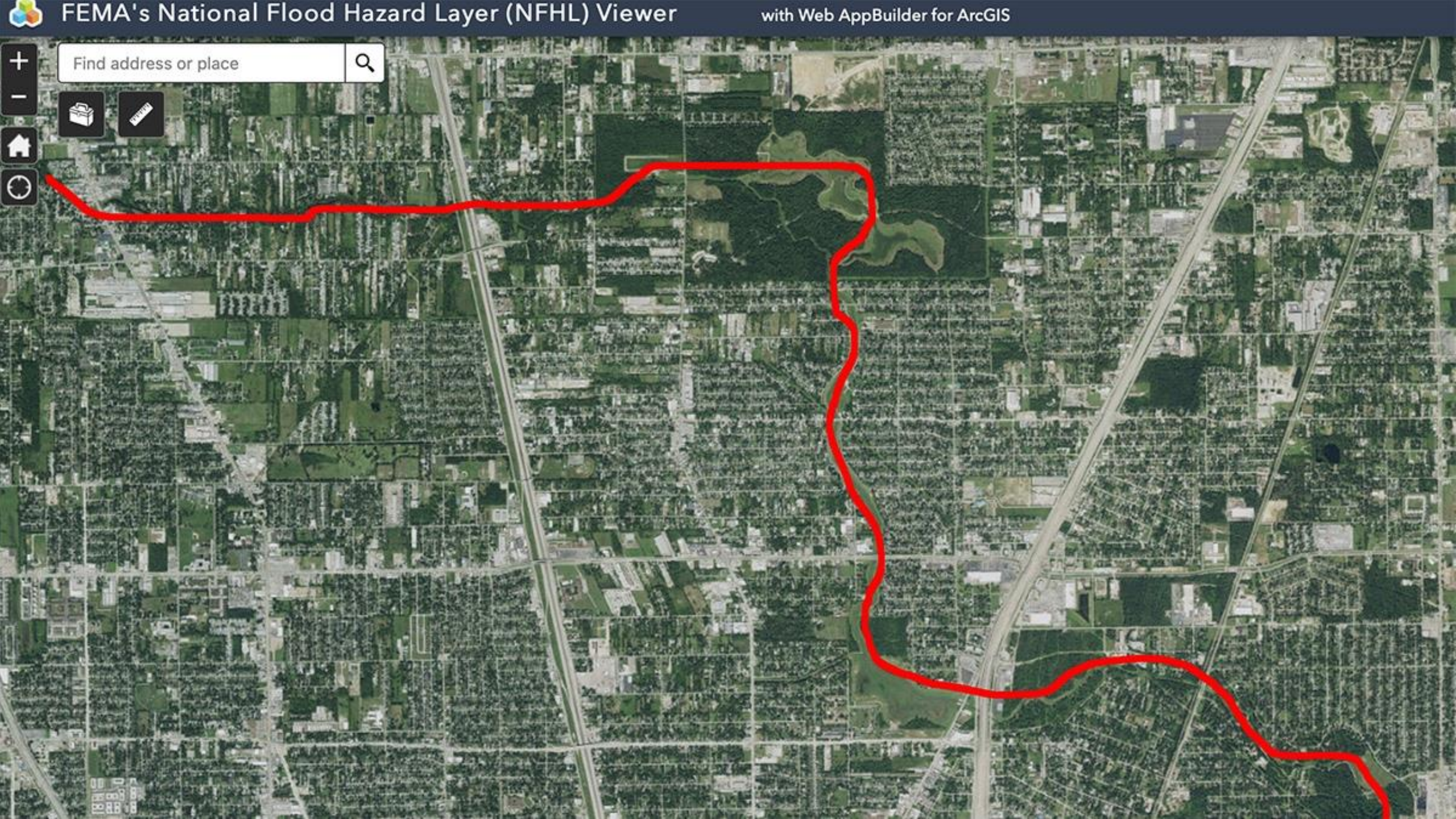
Low cost/high profit for developers

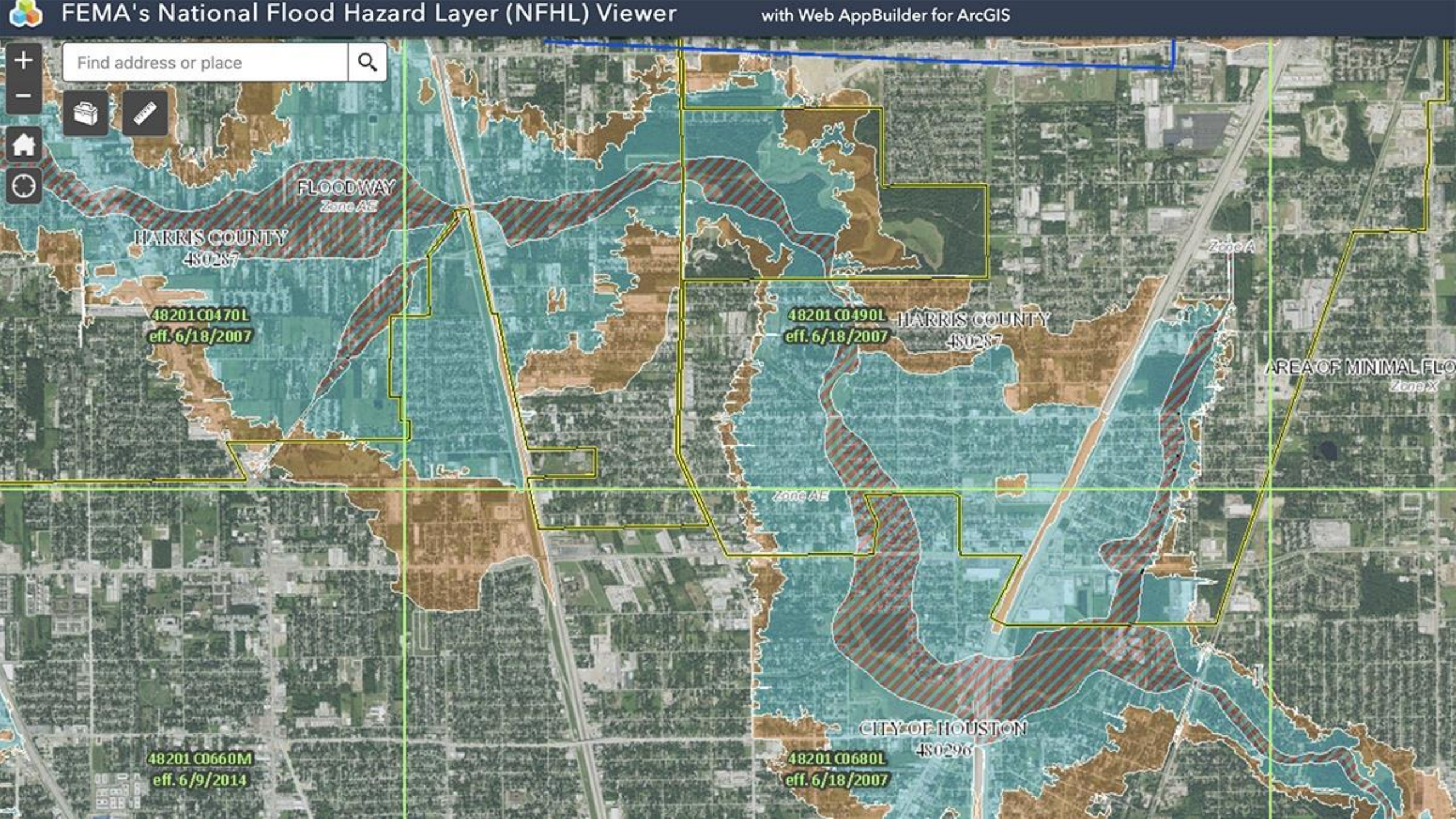
Buyers must ALWAYS look out for themselves.
Governments represent MANY interests.


1944
1953
2021
Halls at Sweetwater


1978
12/1978
Halls at Sweetwater


Today
Footbridge
Zone AE
78
79
78.7
78.3
77.9
HARRIS COUNTY
UNINCORPORATED AREAS
480287
Zone AE


FEMA's National Flood Hazard Layer (NFHL) Viewer
with Web AppBuilder for ArcGIS
Find address or place

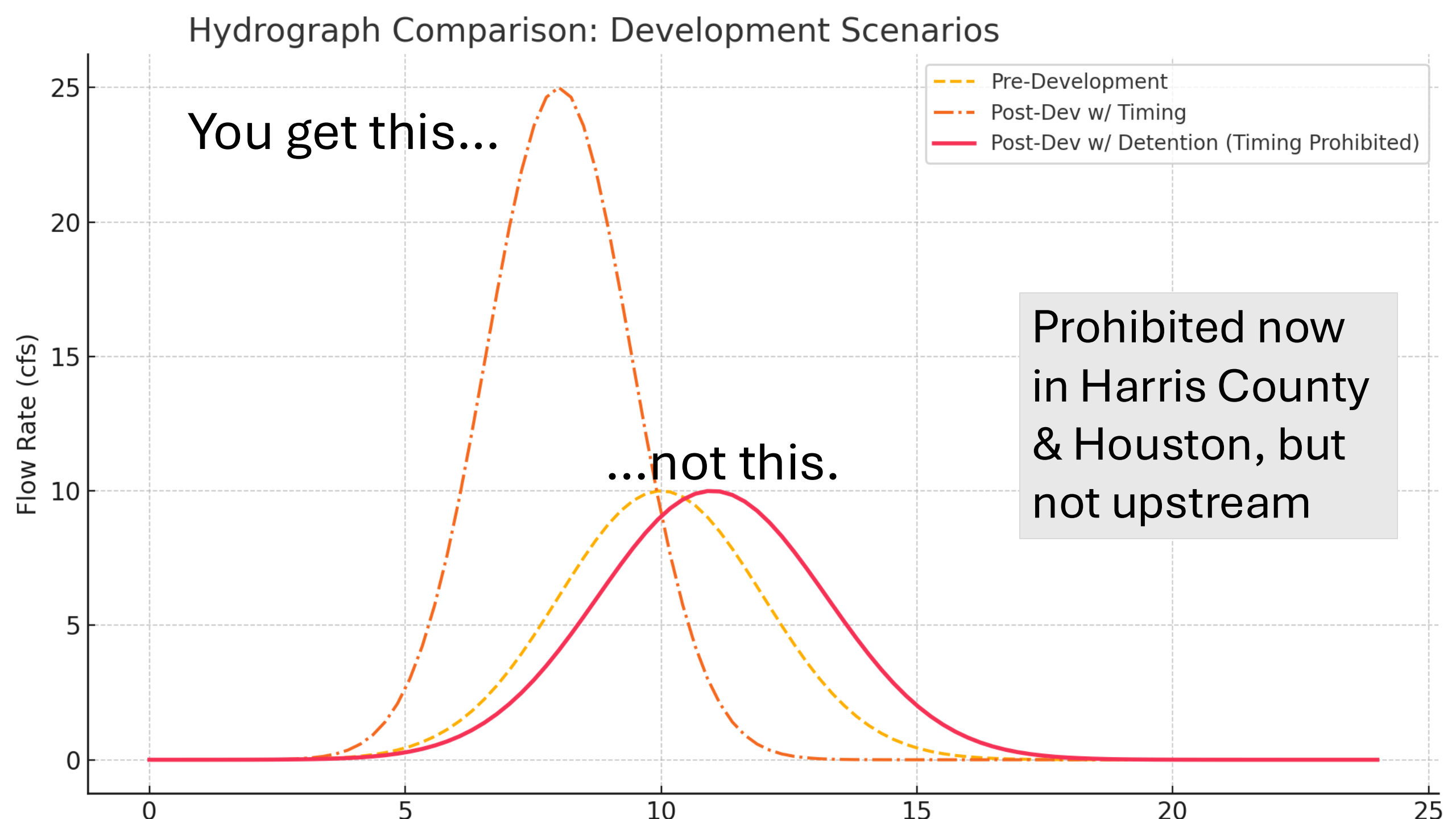

FEMA's National Flood Hazard Layer (NFHL) Viewer
with Web AppBuilder for ArcGIS
Find address or place
FLOODWAY
Zone AE
HARRIS COUNTY
480287
48201C0470L
eff. 6/18/2007
48201C0490L
eff. 6/18/2007
HARRIS COUNTY
480287
Zone A
AREA OF MINIMAL FLO
Zone X
Zone AE
CITY OF HOUSTON
480296
48201C0660M
eff. 6/9/2014
48201C0680L
eff. 6/18/2007

4. Upstream Development that Undermines Downstream Safety Margins

Insufficiently mitigated

100-year floods on 10-year rains

Hydrologic timing studies


Hydrograph Comparison: Development Scenarios
Pre-Development
Post-Dev w/ Timing
Post-Dev w/ Detention (Timing Prohibited)
You get this...
...not this.
Prohibited now in Harris County & Houston, but not upstream
Flow Rate (cfs)
0
5
10
15
20
25

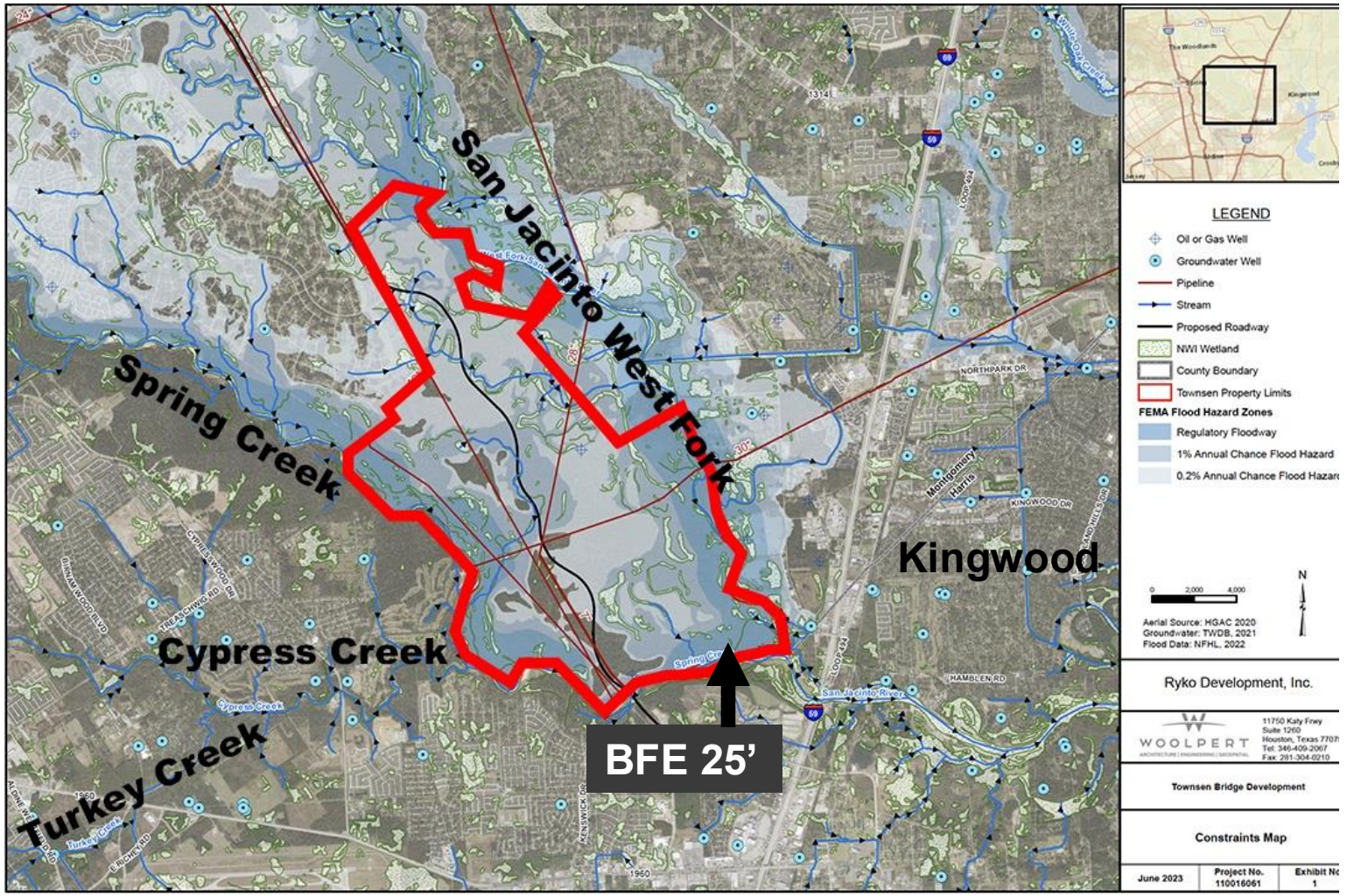
5. Difficulty of Adapting Downstream

Infrastructure, homes, businesses in place
No room to mitigate
Must buy out whole neighborhoods
Expensive, disruptive, often unpalatable
Puts leaders in “double-bind”

6. Historical Unwillingness to Fund Flood Mitigation at Meaningful Levels

- Before 2018 flood bond, HCFCD had $60mm/year for capital improvements
- Sometimes saved for years to build one detention basin
- But motivation gradually diminishes after major floods
- State Flood Infrastructure Fund
  - ~ $1 billion in funds
  - ~ $54 billion in projects
- FEMA, HUD uncertainty

Conclusion: Process Repeated Over and Over as Houston Expands Outward in Concentric Circles



Ryko proposes building 7,000 homes in Montgomery County floodplains

Numerous Other Examples

Colony Ridge

Commons of Lake Houston

Romerica

Texas has more people living in floodplains than the entire populations of 30 states.