HR Wallingford
Working with water

FORT BEND COUNTY, TEXAS
Keeping Sugar Land Dry
LEVEE IMPROVEMENT DISTRICT #2

FBFMA
Fort Bend Flood Management Association

Determining Residual Flood Risk Associated with a Complex Levee System Fort Bend County, TX

4 May 2017

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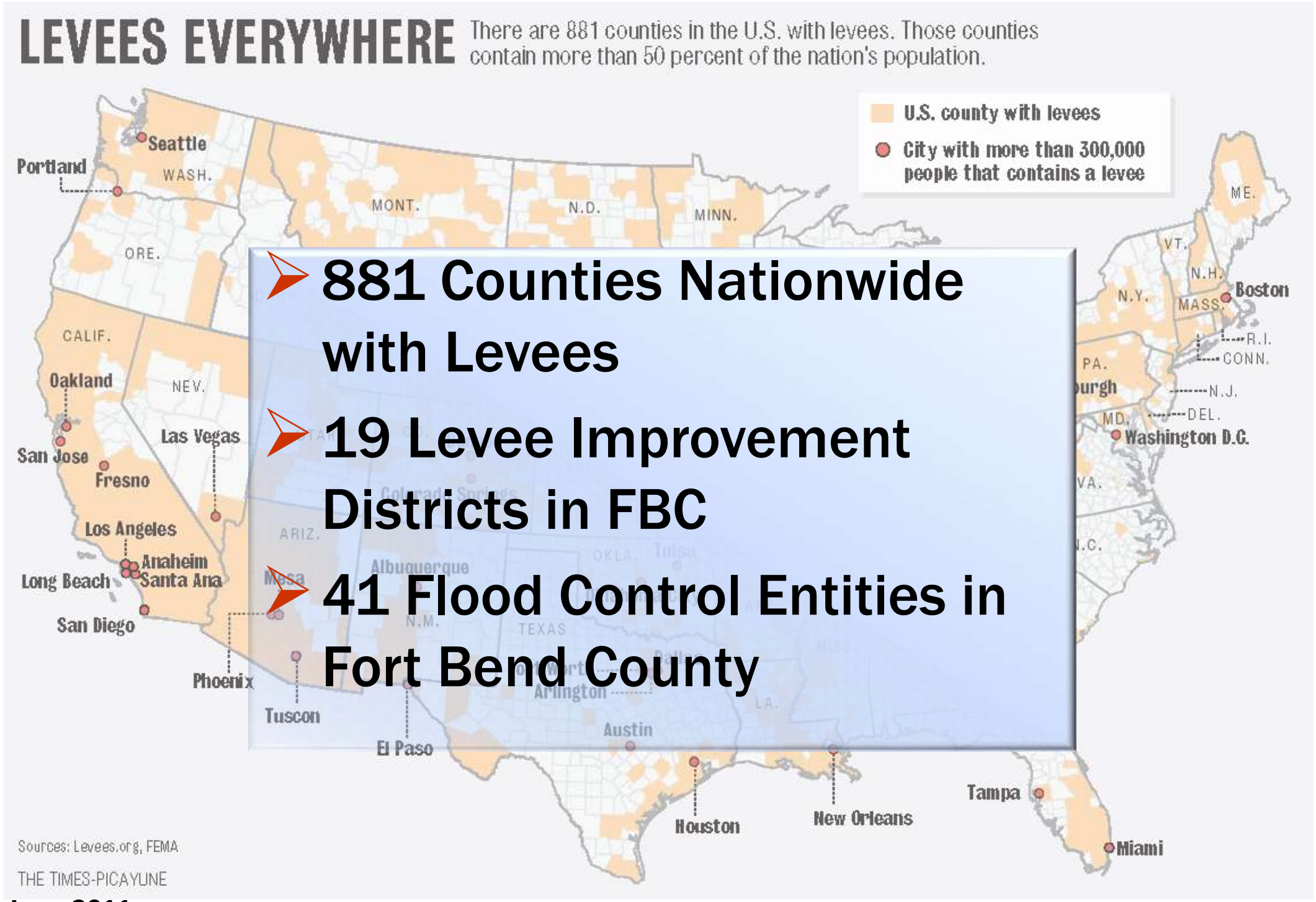
ASFPM 2017

Outline

1. The Fort Bend levee system

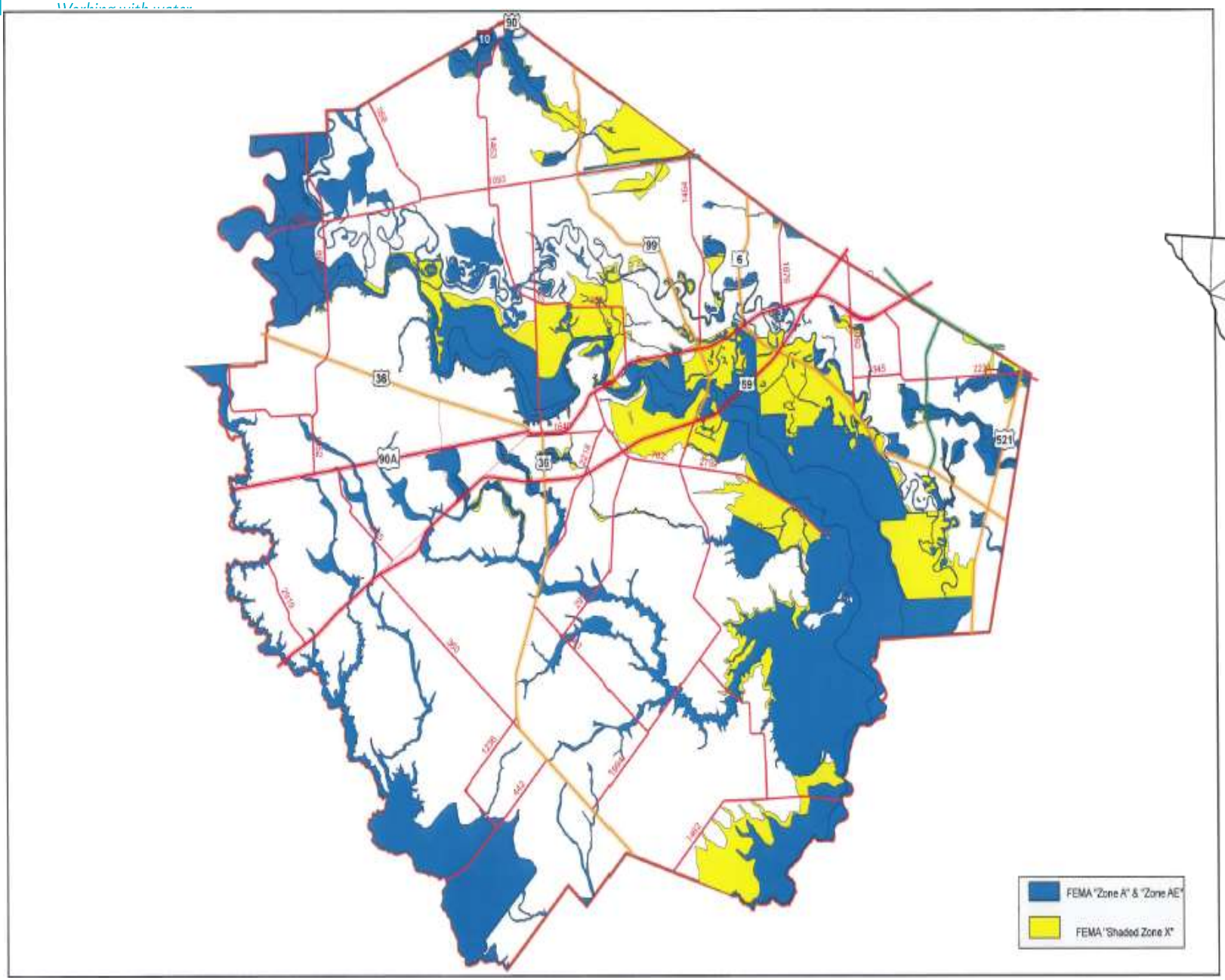
2. Background on system flood risk modelling
   - What is it
   - What is its purpose
   - What does it look like
3. Applying system flood risk modelling to Fort Bend
   - Phase 1 - Levee reliability analysis

4. Next steps


LEVEES EVERYWHERE
There are 881 counties in the U.S. with levees. Those counties contain more than 50 percent of the nation's population.
U.S. county with levees
City with more than 300,000 people that contains a levee
881 Counties Nationwide with Levees
19 Levee Improvement Districts in FBC
41 Flood Control Entities in Fort Bend County
Seattle
Portland
WASH.
ORE.
MONT.
N.D.
MINN.
CALIF.
Oakland
NEV.
Las Vegas
San Jose
Fresno
Los Angeles
Anaheim
Santa Ana
Long Beach
San Diego
Phoenix
Tuscon
El Paso
ARIZ.
Albuquerque
N.M.
TEXAS
Austin
Houston
New Orleans
Tampa
Miami
ME.
VT.
N.H.
Boston
N.Y.
MASS.
R.I.
CONN.
N.J.
DEL.
MD.
Washington D.C.
VA.
Sources: Levees.org, FEMA
THE TIMES-PICAYUNE

June 2011

Fort Bend County Floodplains



Fort Bend County Levees

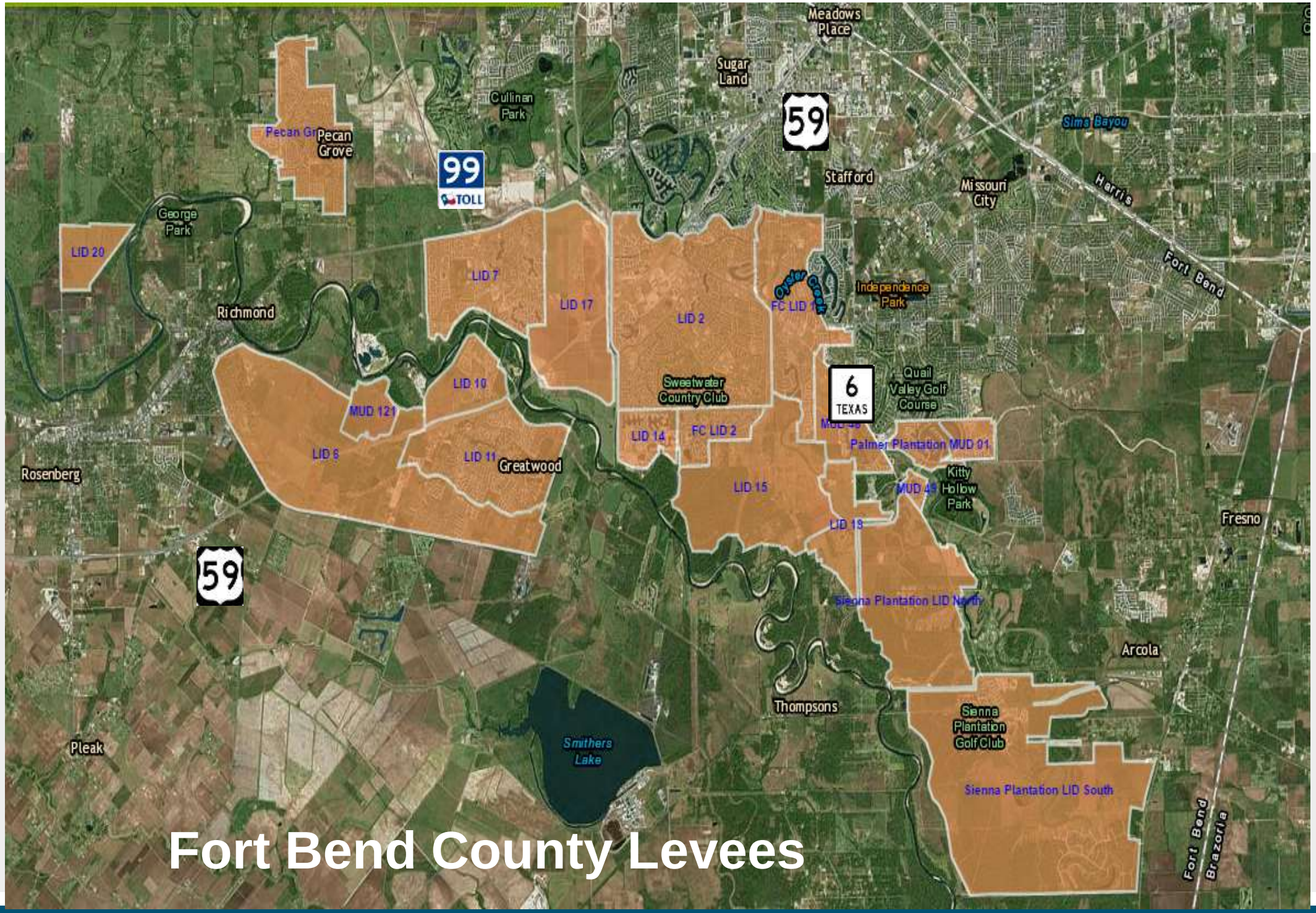
19 Levee Districts in Ft. Bend County

99 miles of levees

27 miles of Brazos River levees

Protect $23+ billion in assessed taxable value

1 in 4 Fort Bend County residents lives behind a levee



Fort Bend County Levees

What does a levee look like?

What are levees? Or rather, what levees are not.

Flood Control Works

NOT JUST SOME BIG MOUND OF DIRT

Not Landscape Berms

Not Parks

Not Hiking Trails

Not Utility Corridors (Sometimes They Are)

Not Power Company Roads

What level of protection do we have?

- FEMA Minimum Height – 3’ Freeboard above 100-yr BFE on Brazos River
- FBC Added an Additional 1-foot of Freeboard (Ft. Bend Foot)
- FEMA Recognizes 100-yr Protection on FIRMs
- Actual Overtopping Protection Above 500-yr Protection
- Some Districts Have Potential For Being Flanked ($^{+/-}$500-yr)
- Internal Drainage Systems Designed for Local 100-yr Rainfall, with River well BELOW Flood Stages
- Pump Stations Designed for Coincidental Event
  - Local Rainfall while River is NEAR Flood Stages

Ft. Bend LID 2 Map

5,313 acres protected by levees

11.3 miles of earthen levee and 8.4 miles of drainage channels

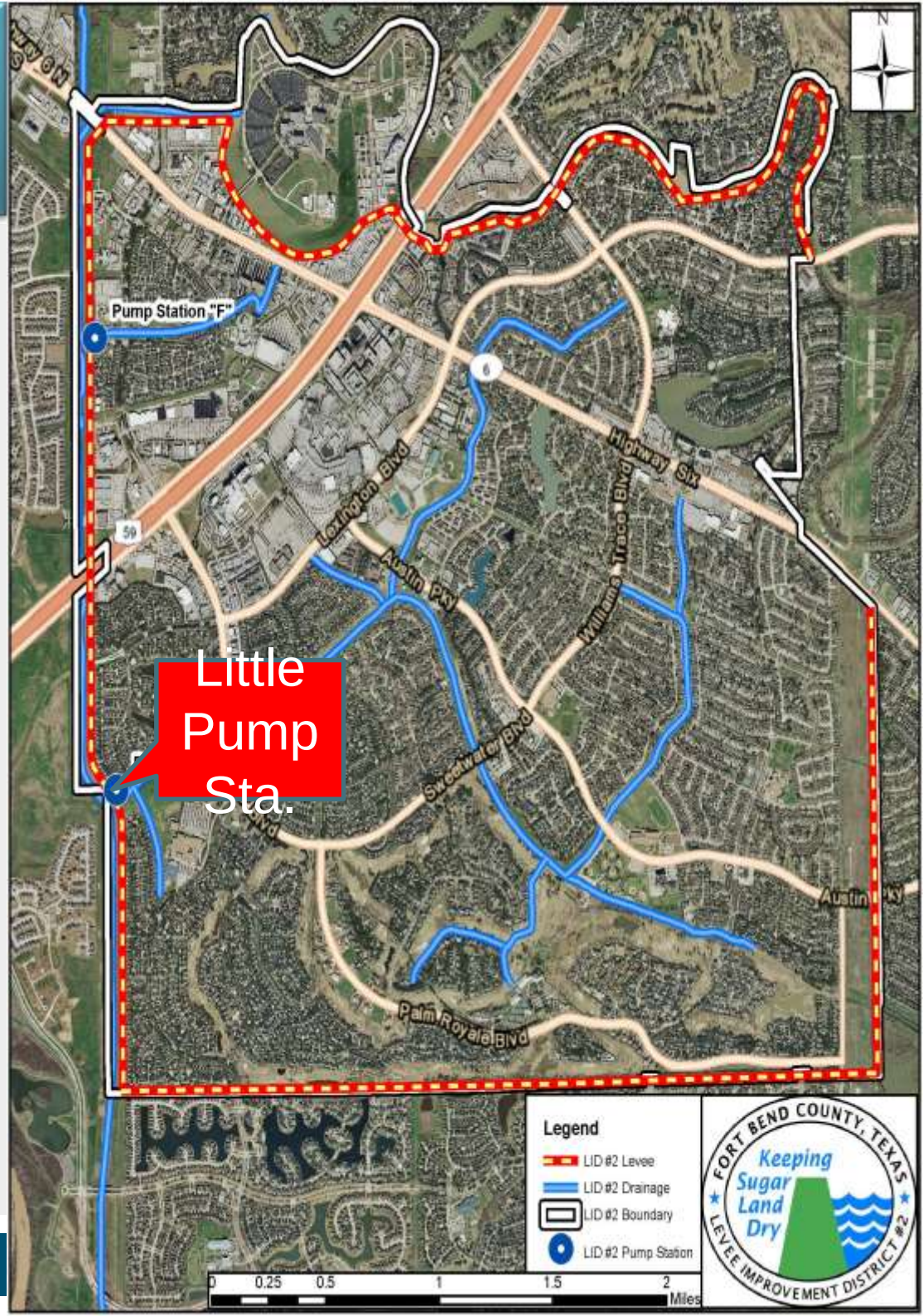
Two storm water pump stations

William “Bill” Little Pump Station

- 4 pumps capable of a combined 240,000 gpm

Pump Station “F”

- 4 pumps capable of a combined 80,000 gpm



Ft. Bend County Levee Improvement District No. 2

Special District established in 1975 to provide flood protection from the Brazos River and to convey storm water out of the District

$4,815,810,202 assessed value of property and structures (2016)

About 10,000 homes and hundreds of business

Major transportation arteries – US 59 and SH 6

Sugar Land City Hall, Police, Fire, and Emergency Operations Center

Multiple hospital complexes

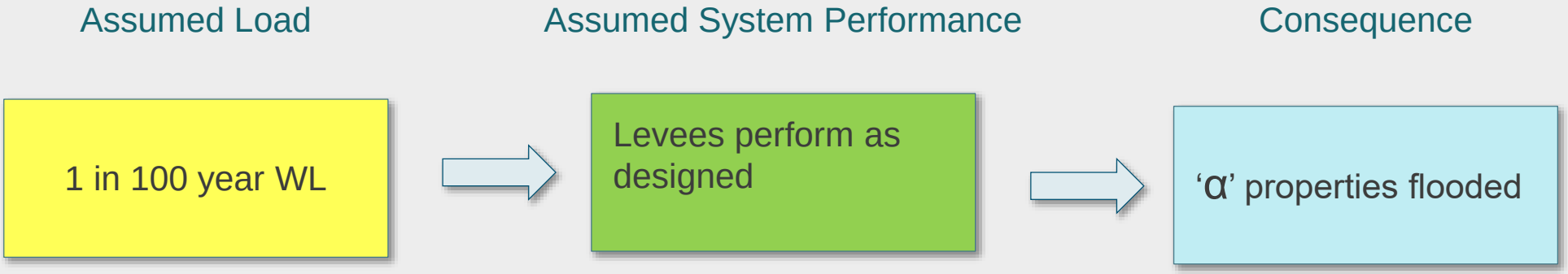
Major retail centers including Sugar Land Town Square and First Colony Mall

What is flood risk?

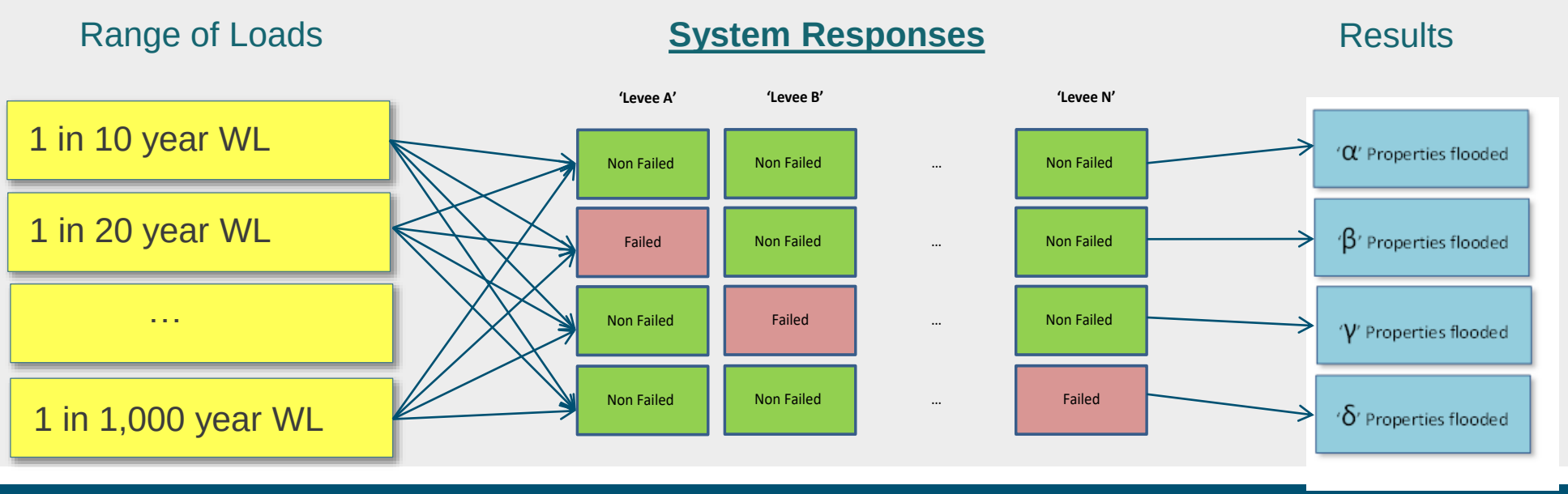
Flood Risk = probability of consequence

Traditional and risk-based approaches for flood systems

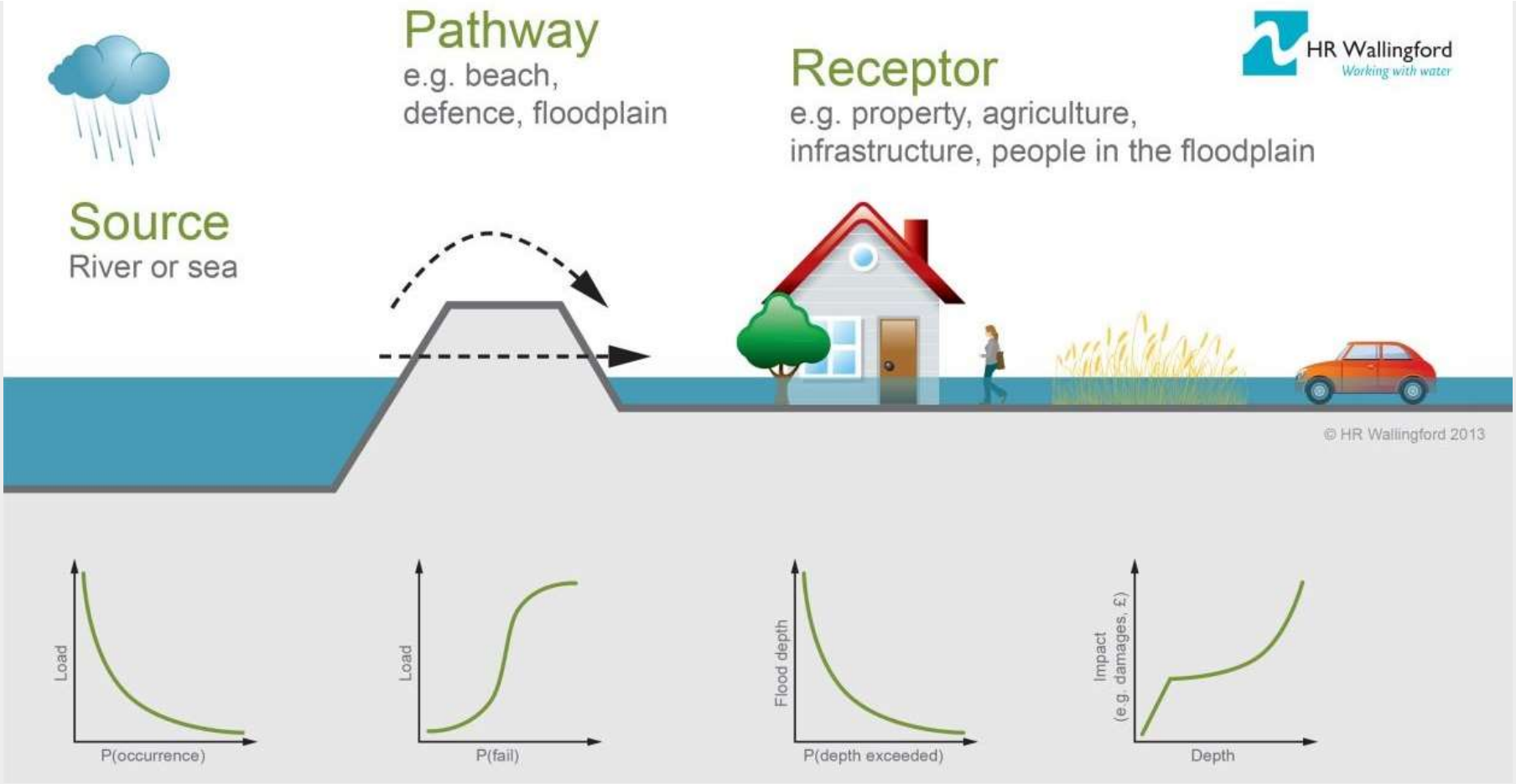
The Traditional (Deterministic) Approach



The Probabilistic (Risk-based) Approach

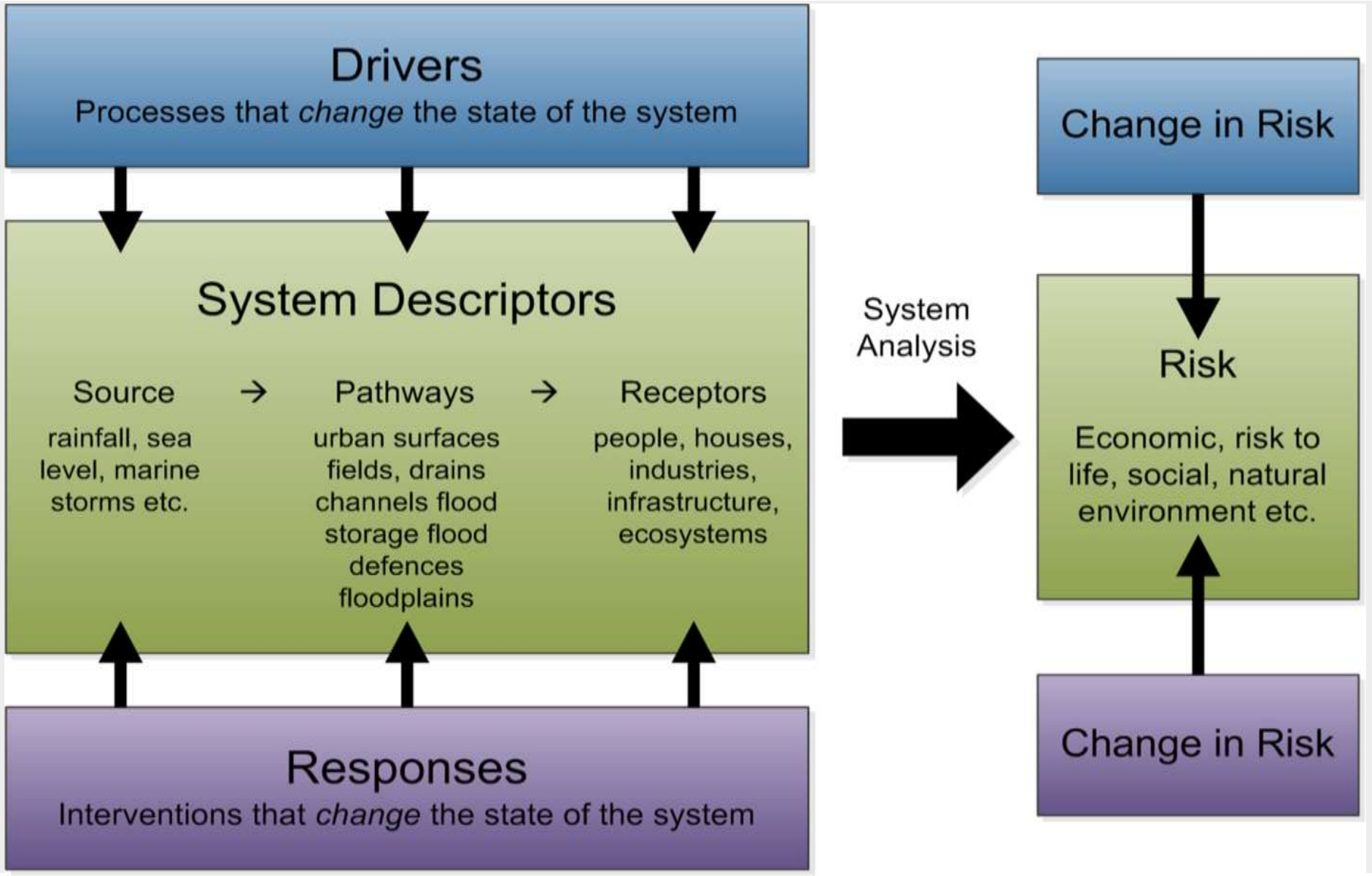


Full risk analysis approach
(addresses both probability components)

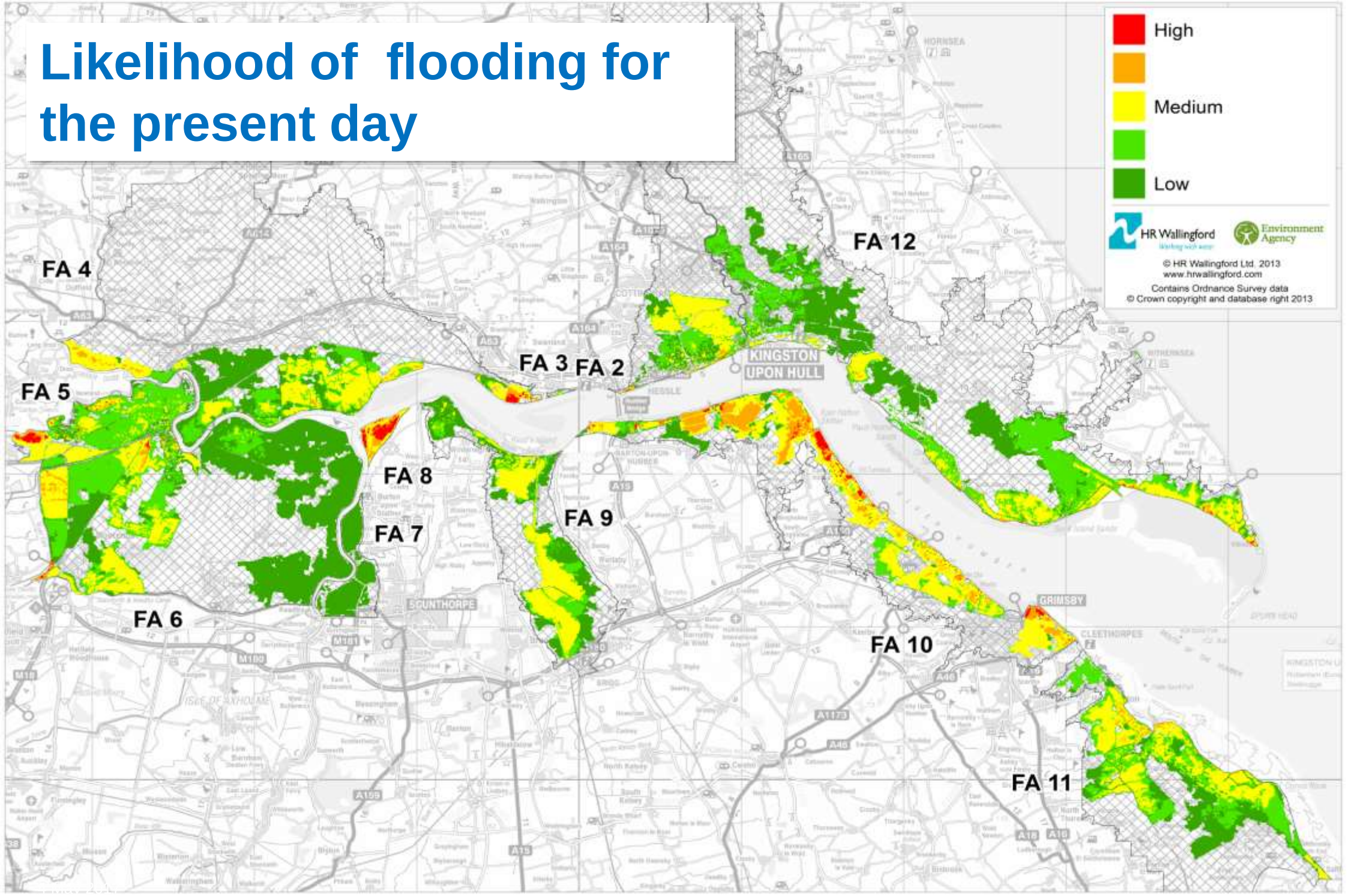


$$Flood\ risk = \left\{ Probability\ (Load) \times Probability\ (Breach \frac{and}{or} overtopping) \times Consequence\ (\$) \right\}$$

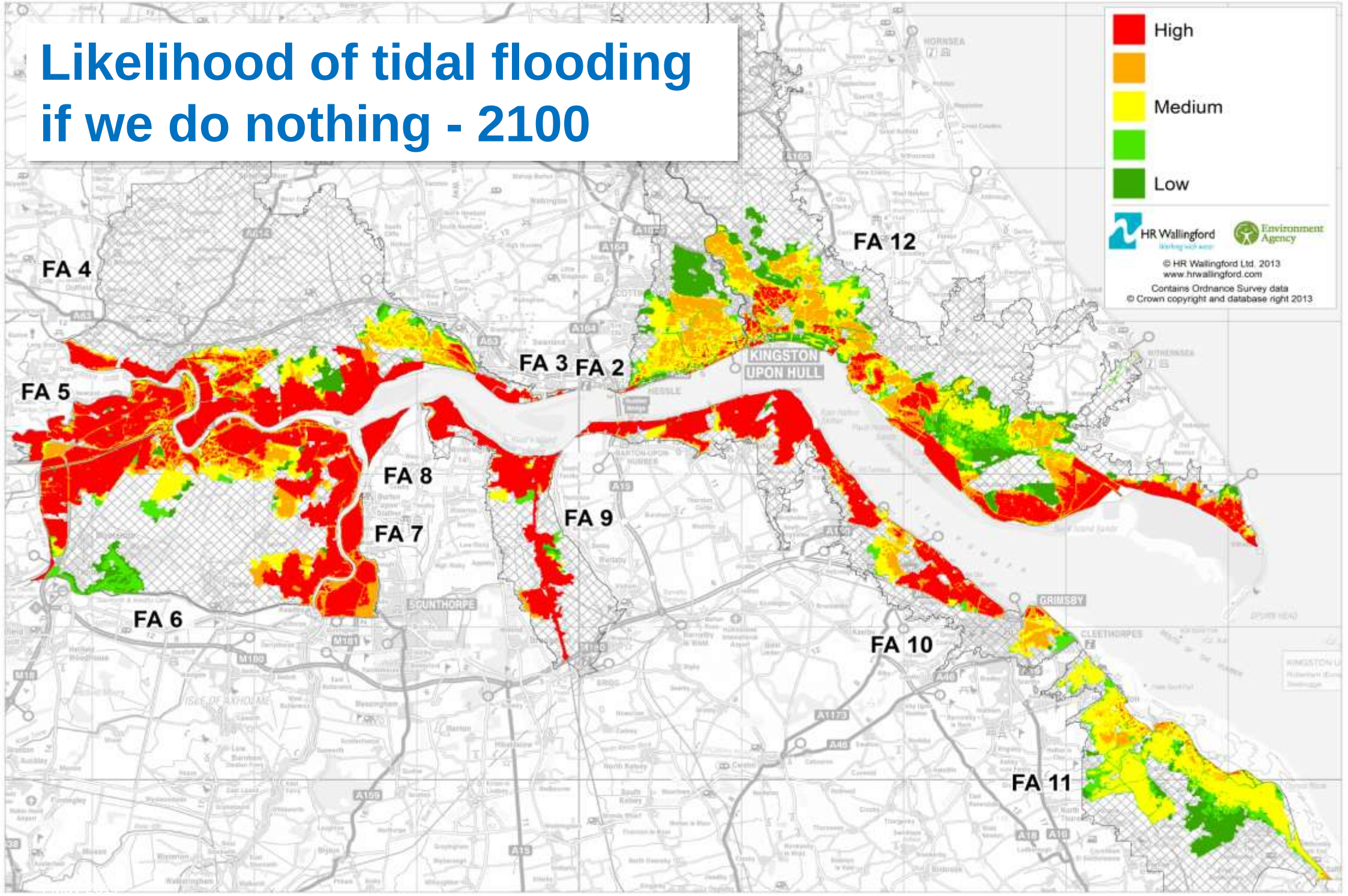
Flood risk is constantly changing



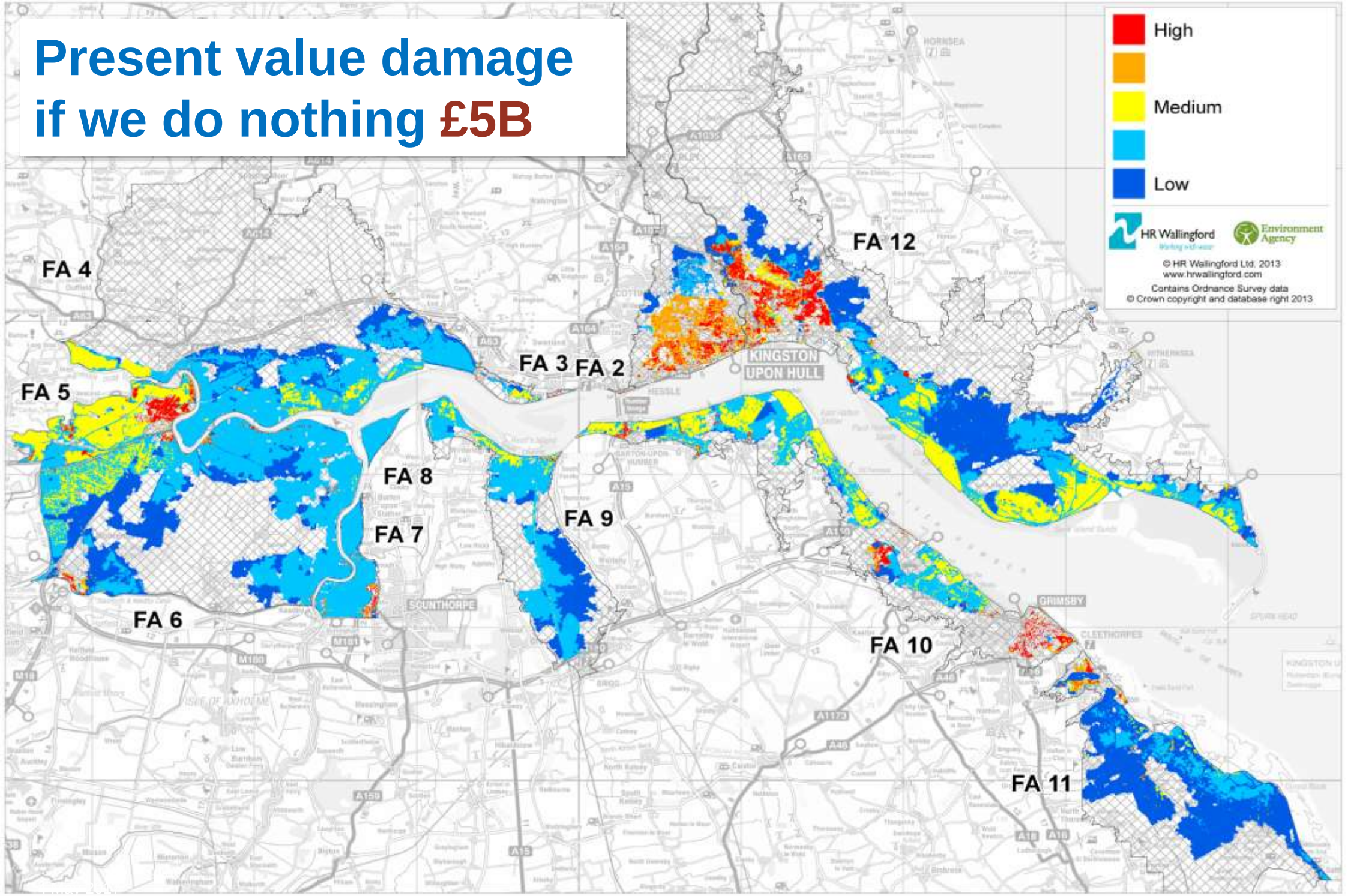
Likelihood of flooding for the present day



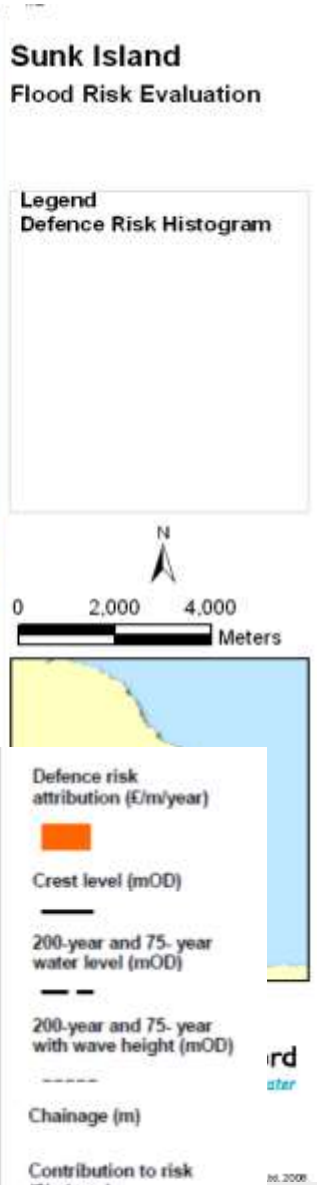
Likelihood of tidal flooding if we do nothing - 2100

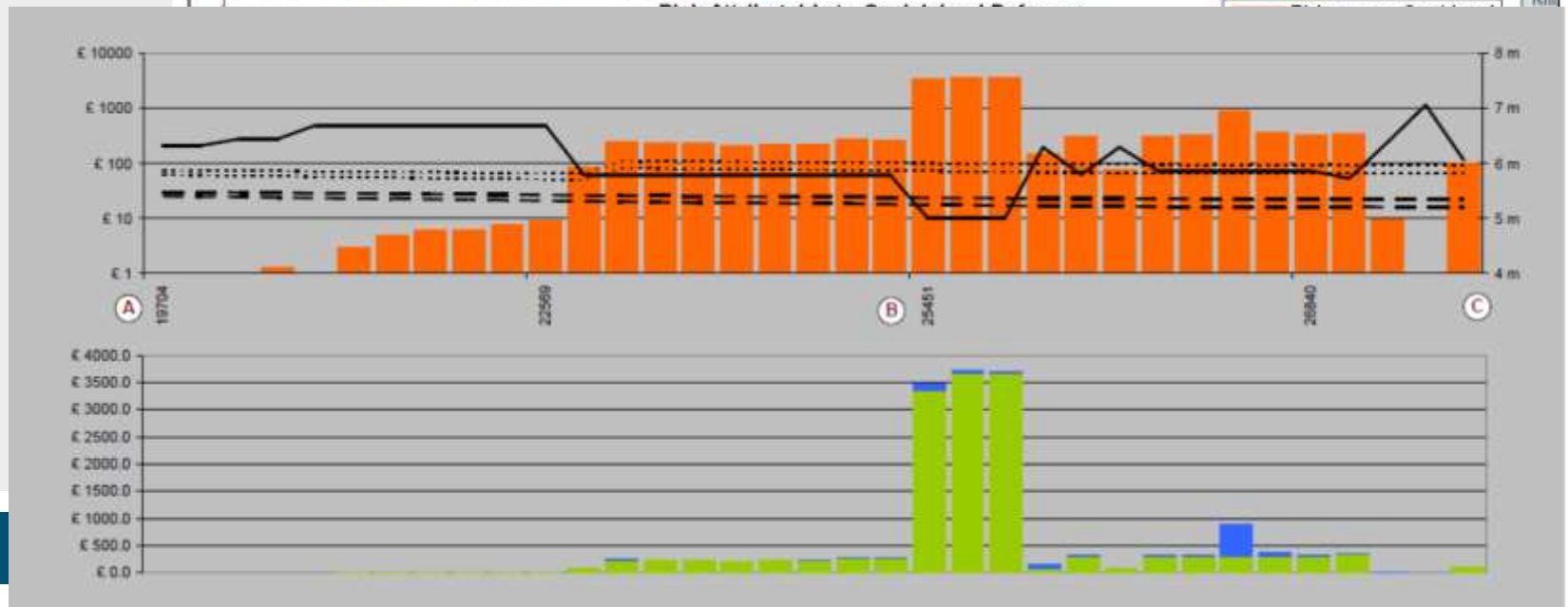


Present value damage if we do nothing £5B

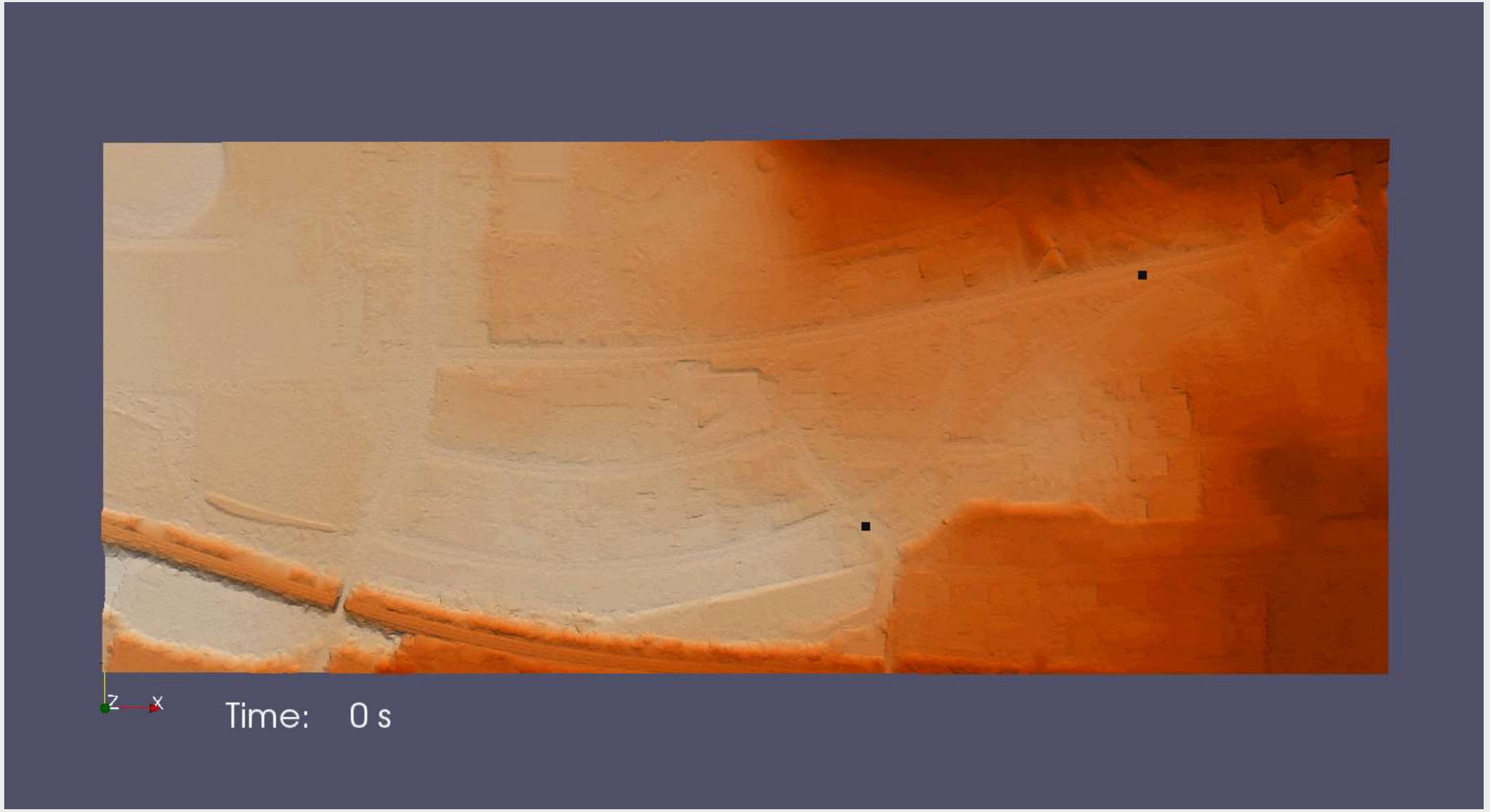


Risk attribution to levees

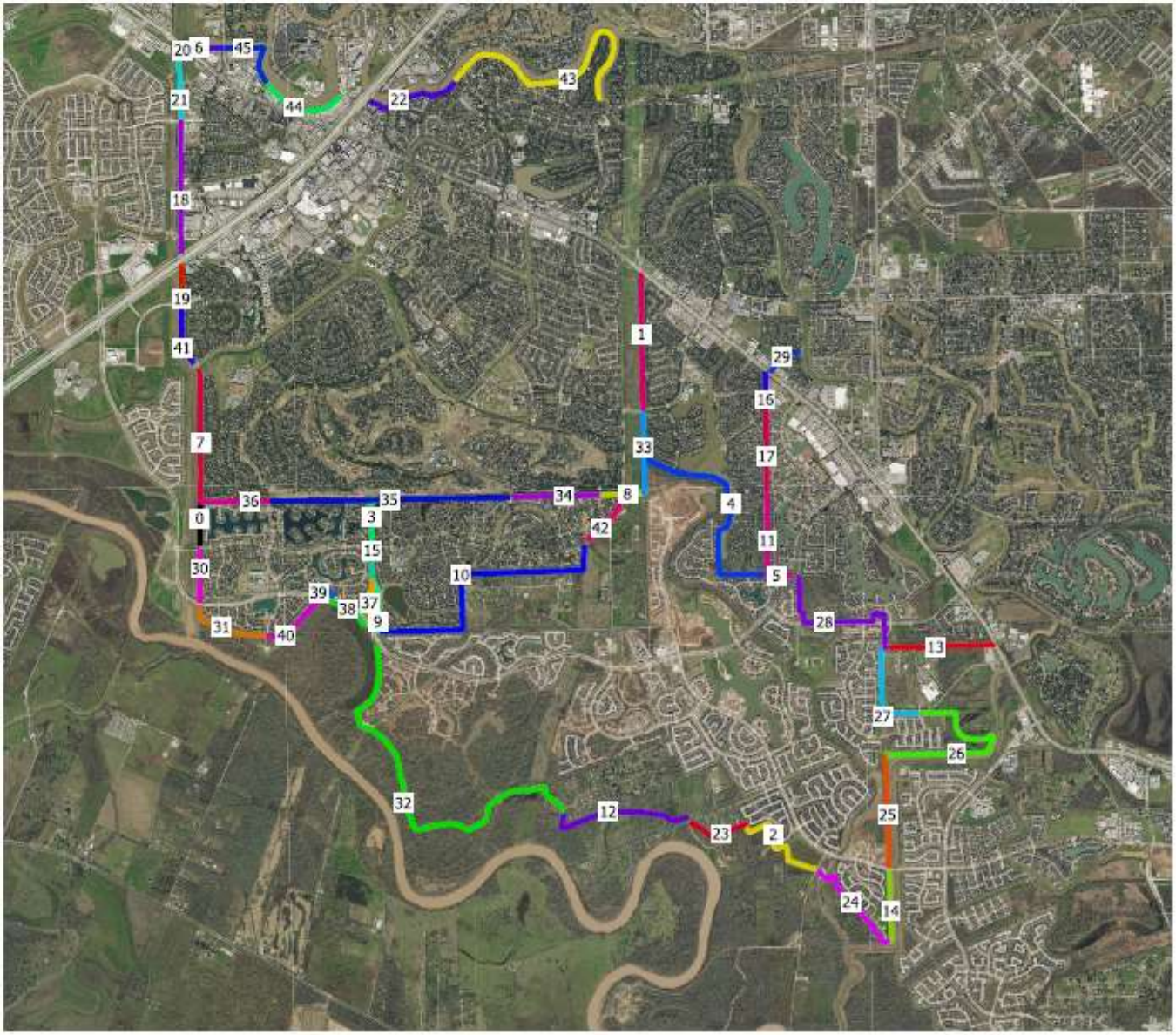




Attributing risk to levee system: Volume Tracking



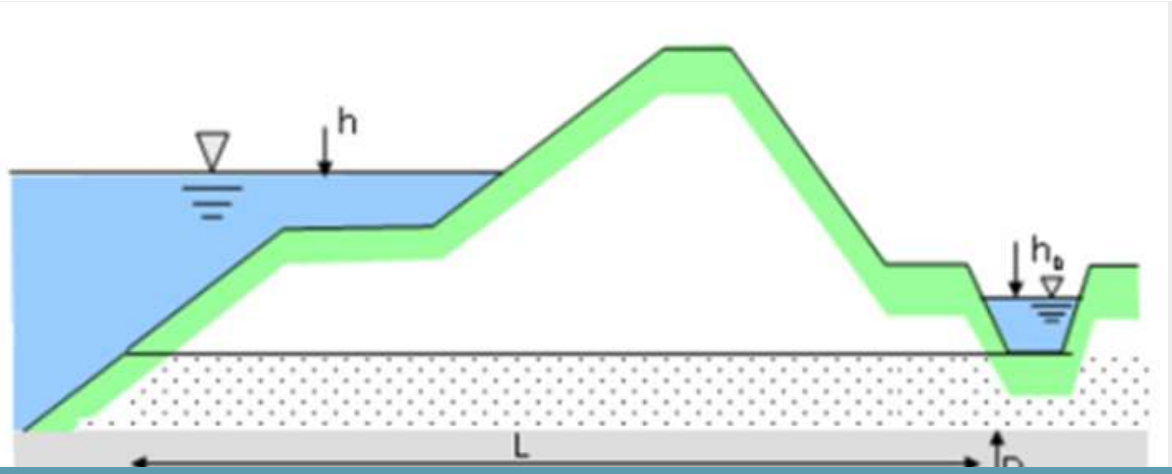
Fort Bend Risk analysis: Levee segments



Segmentation by:

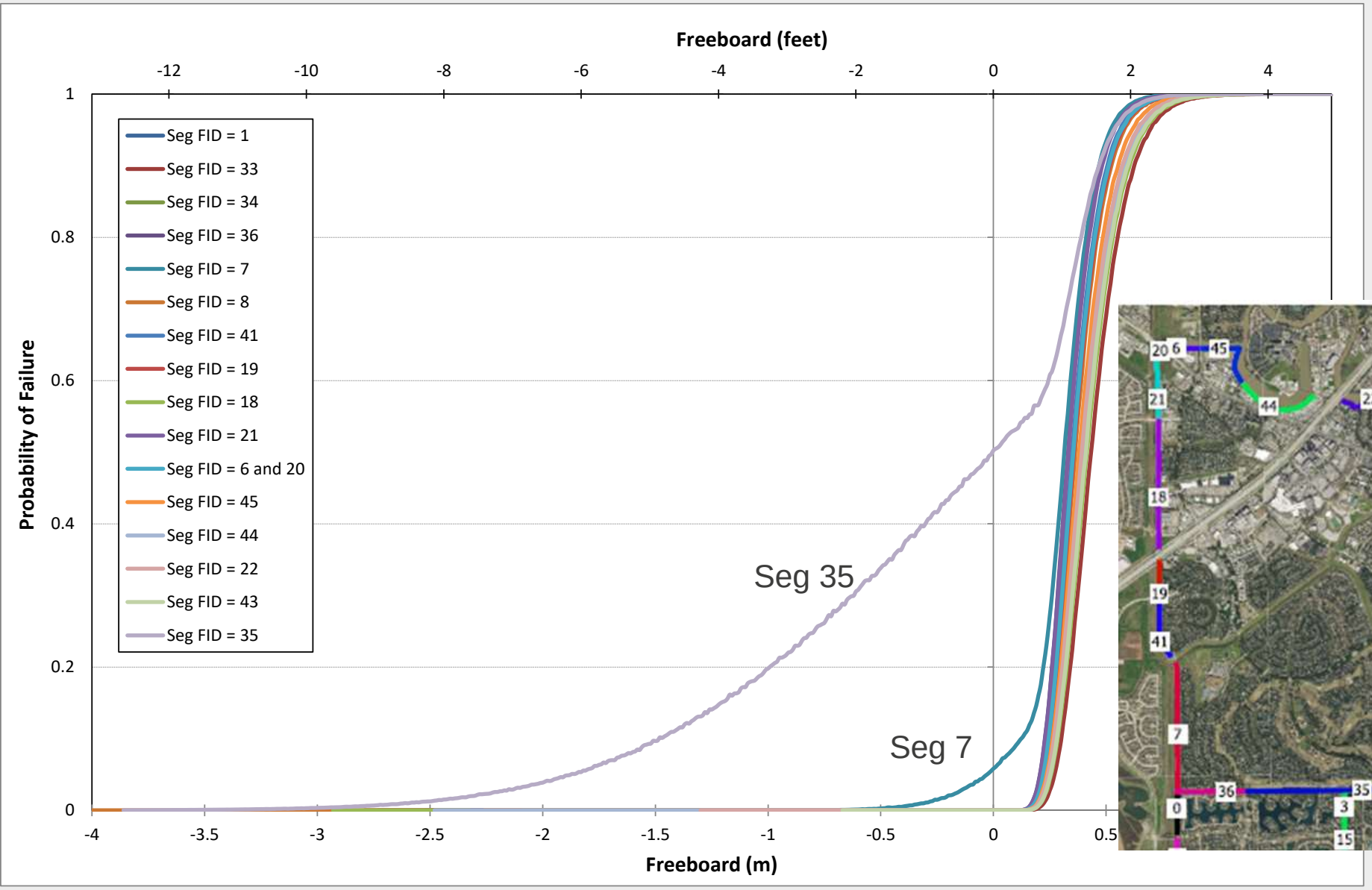
- Geo-technical information (borehole data).
- Crest-level
- Local features.

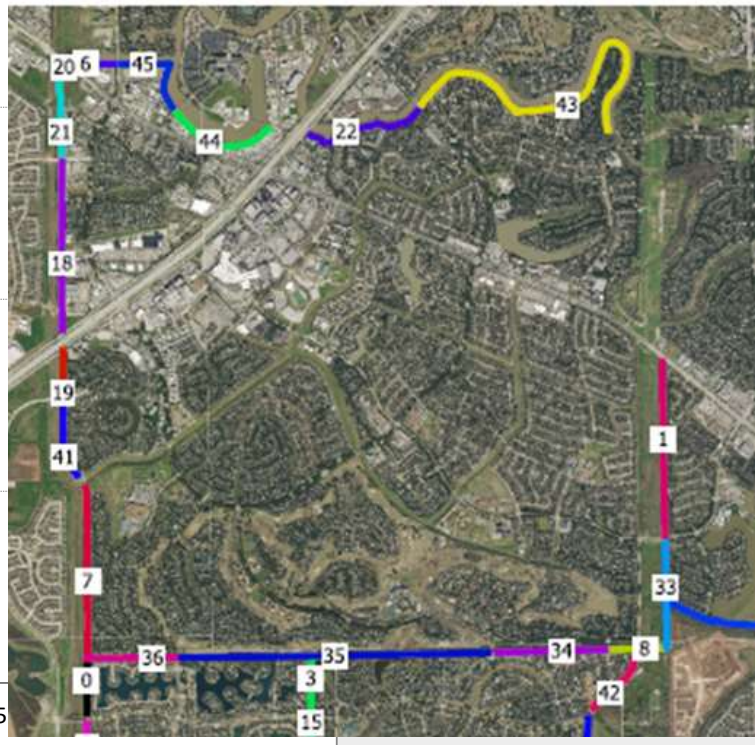
Identification of Limit State Equations (LSE's): RELIABLE Model



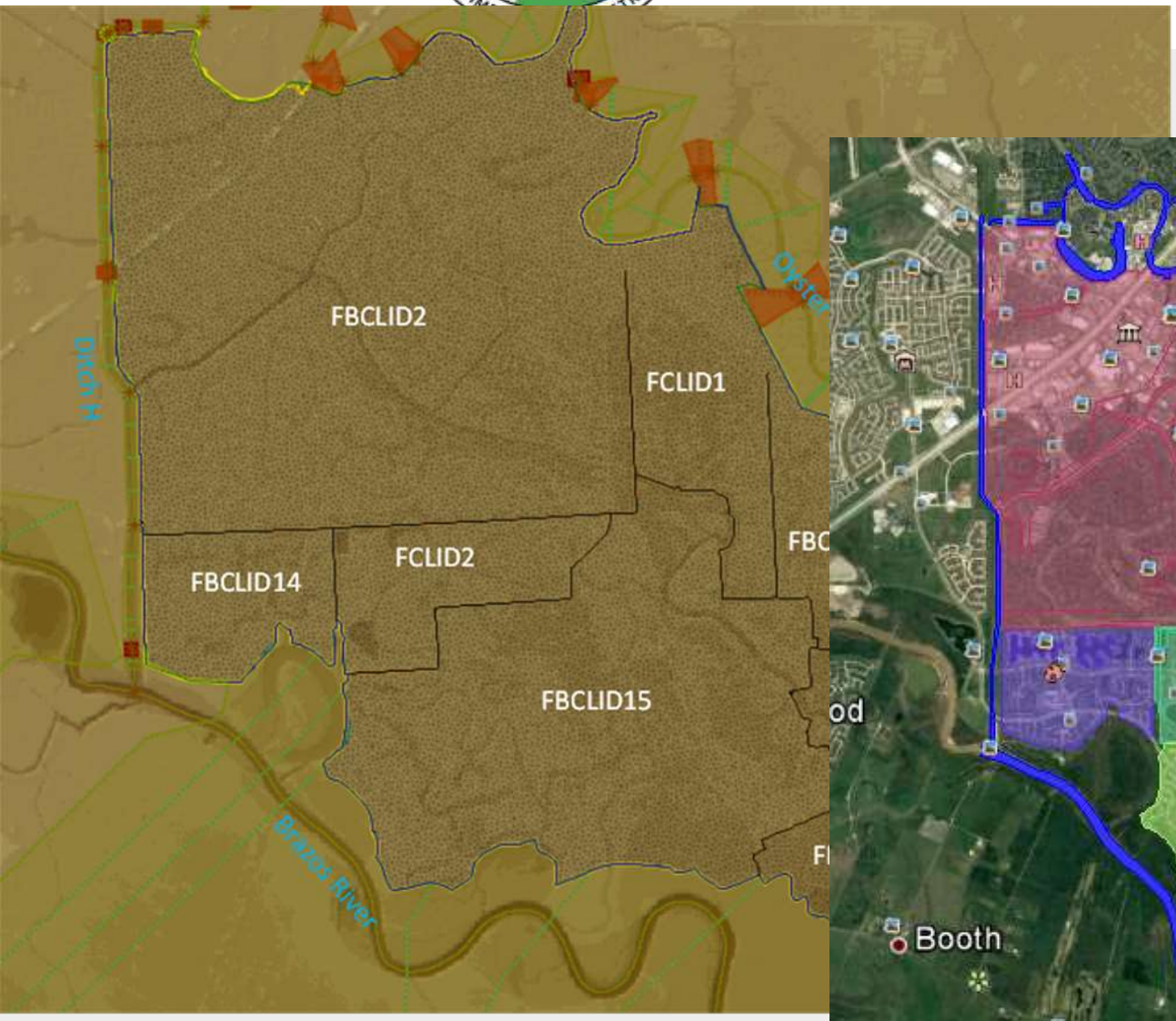
Failure mode	Failure mode description
External erosion	Erosion of rear face of an embankment due to overtopping, leading to down cutting and hence breach
Through-seepage	Seepage through levee in the embankment (based on steady state conditions) which could lead to piping.
Under-seepage	Piping under levee due to under seepage (based on steady state conditions), conditional on the following heave/uplift mechanism
Protected side heave	Heave/uplift behind levee due to under-seepage (based on steady state conditions)

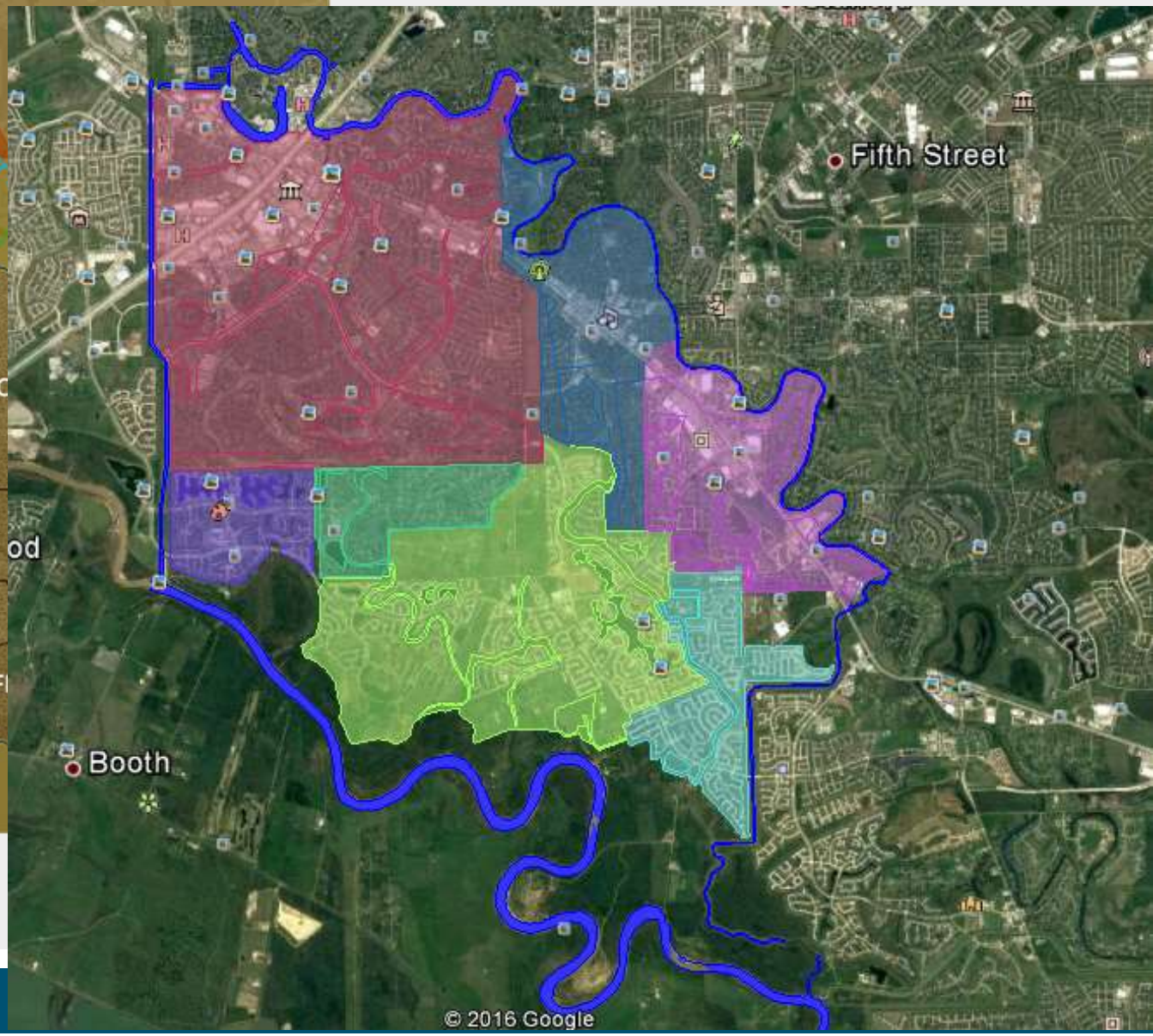
Fragility analysis: LID 2 results





Fort bend system risk modelling



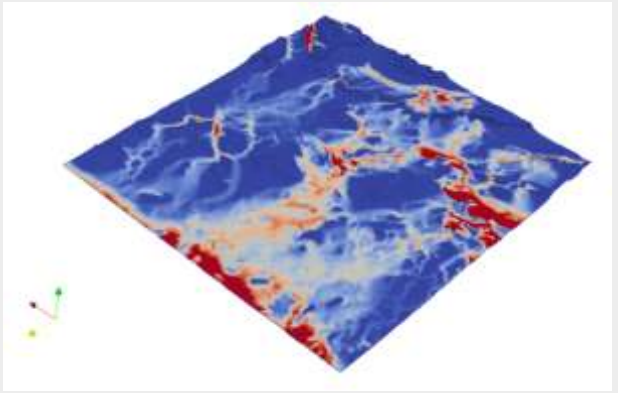


Next steps

- Full dynamic system risk model
  - High resolution (sub-property level), dynamic, FSWE inundation modelling
  - Large numbers of extreme events
  - Large number of breach scenarios
  - Representation of full* probability space
  - Revised levee representation for multiple layers

GPU

Cloud



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"Without flood control, nothing else matters."
- Association of Levee Boards of Louisiana

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