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Public Protection . . . Is the Current Standard Enough?

MAFSM 2008 Conference – Oct. 22 & 23

From the Mountains to the Coast
Floodplain and Stormwater Management in Maryland

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October 23, 2008

From the Mountains to the Coast

Floodplain – Georges Creek, Westernport , Maryland

Ocean City

Levees from New Orleans to Prince George County

New Orleans Levee System

Anacostia Levee System

Annual Probability of Exceedance

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The Probability of an Event being exceeded in one year.

Prob [Exceedance] = 1%

There is a One Percent Chance that this event will occur in any one year

Percentile

- A **percentile** is the value of a variable below which a certain percent of observations fall. So the 99 percentile is the value (or score) below which 99 percent of the observations may be found.

Percentile = 1 – Prob [Exceed]

Return Period

Return Period, T_R, is Defined as:

$$T_R = \frac{1}{Prob[Exceed]}$$

$$T_R = \frac{1}{Prob[0.01]} = 100\,year$$

Typical Design Standards in Engineering Practice

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Type	Design Standard
Stormwater Facilities	2 to 5 year
Culverts	10 to 50 year
Bridges	25 to 100 year
Floodplain Insurance	100 year
Levees	100 year
Dams	100 year to PMP

Risk

$$\text{Risk} = \left(1 - \left(1 - \frac{1}{T_R}\right)^{n}\right)$$

Where n is the year you want to evaluate the risk for, i.e., what is the risk of a 100-year event flood occurring within a 30 year mortgage for a home.

Risk

$$\text{Risk} = \left(1 - \left(1 - \frac{1}{T_{100}} \right)^{30} \right)$$

Risk = 26 %

Design Standard for Levees

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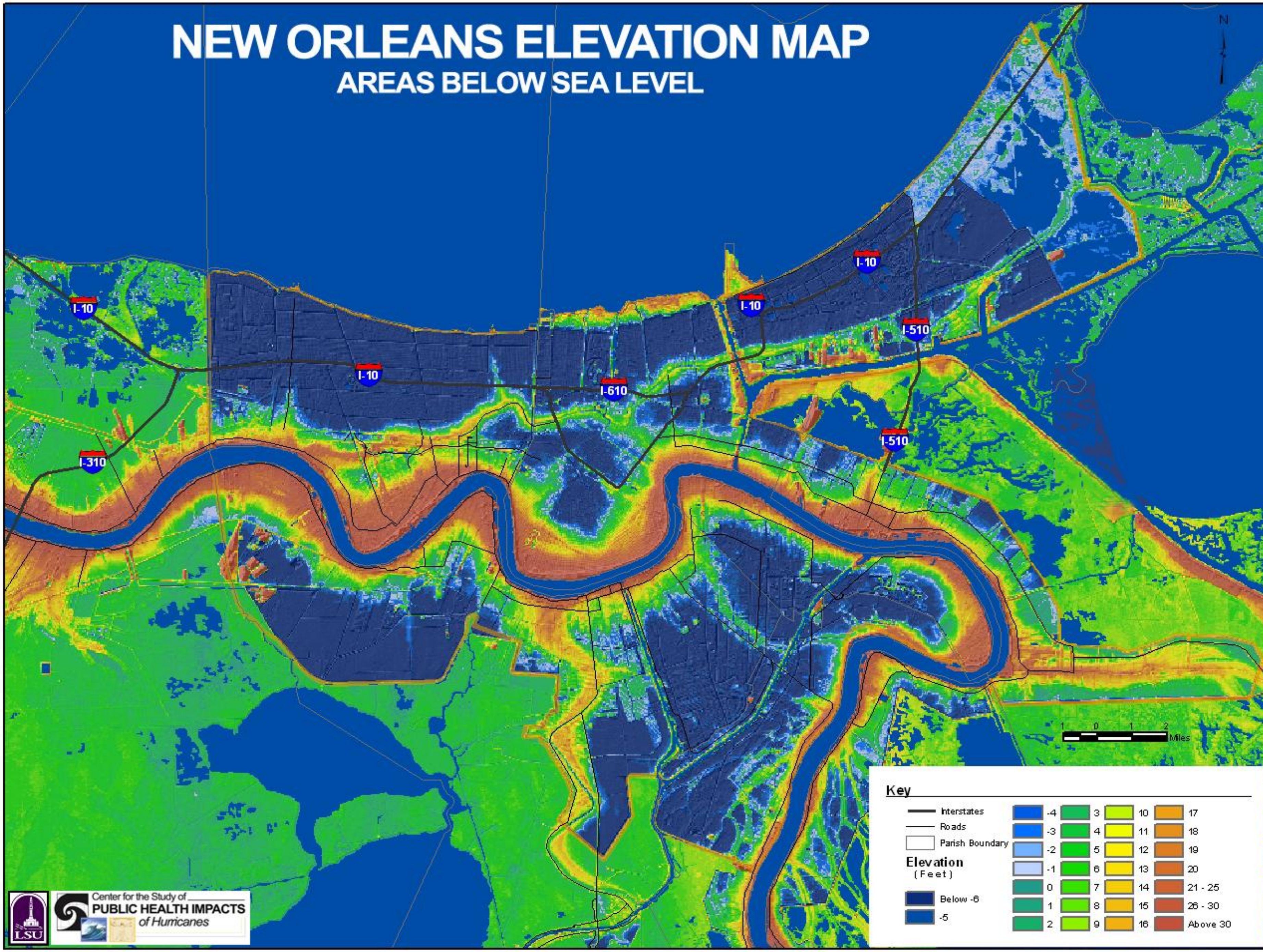
NEW ORLEANS ELEVATION MAP
AREAS BELOW SEA LEVEL
N
I-10
I-10
I-610
I-10
I-10
I-510
I-510
I-310
1 0 1 2
Miles
Key
Interstates
Roads
Parish Boundary
Elevation
(Feet)
Below -6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21 - 25
26 - 30
Above 30
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PUBLIC HEALTH IMPACTS
of Hurricanes

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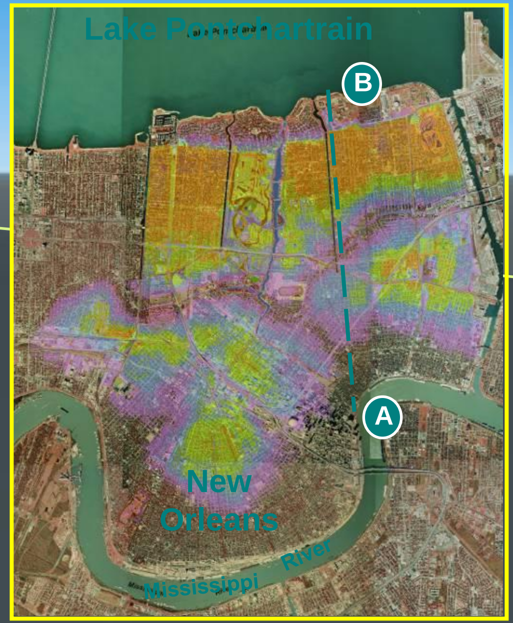
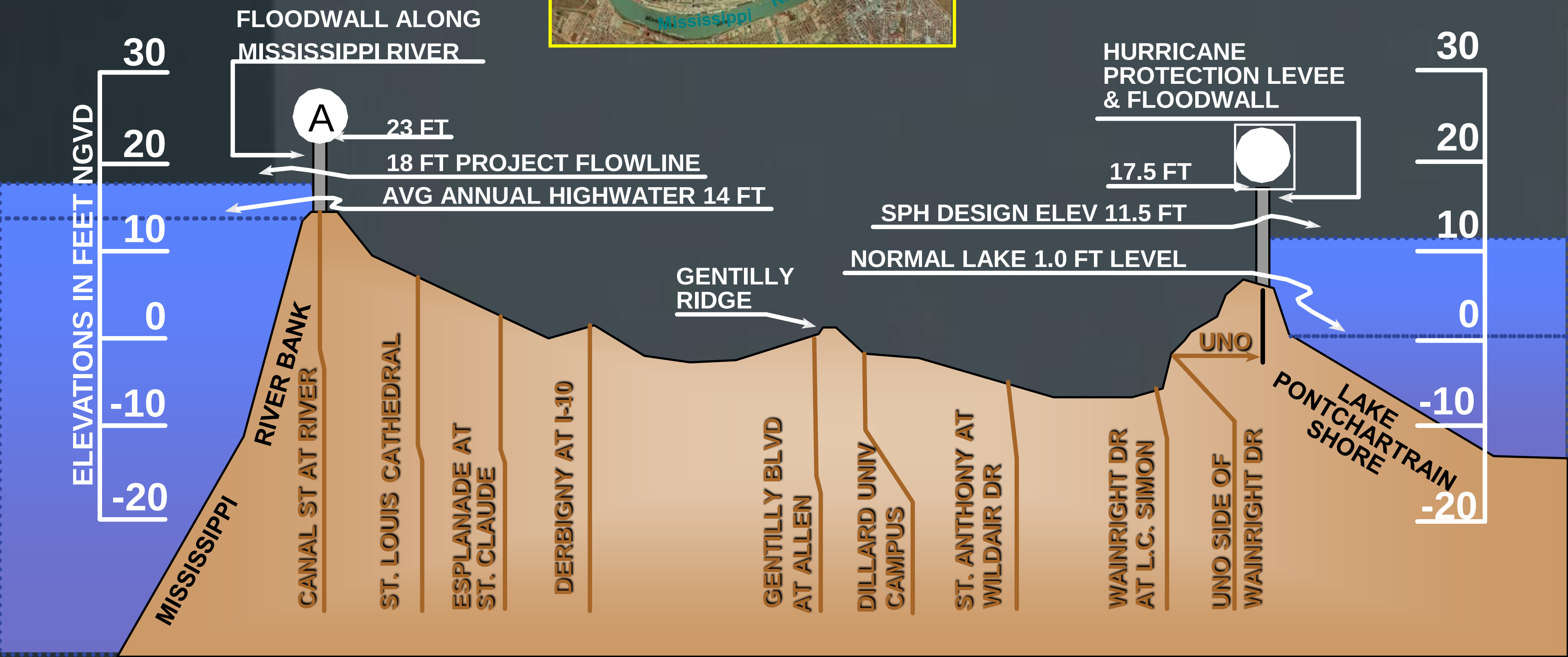
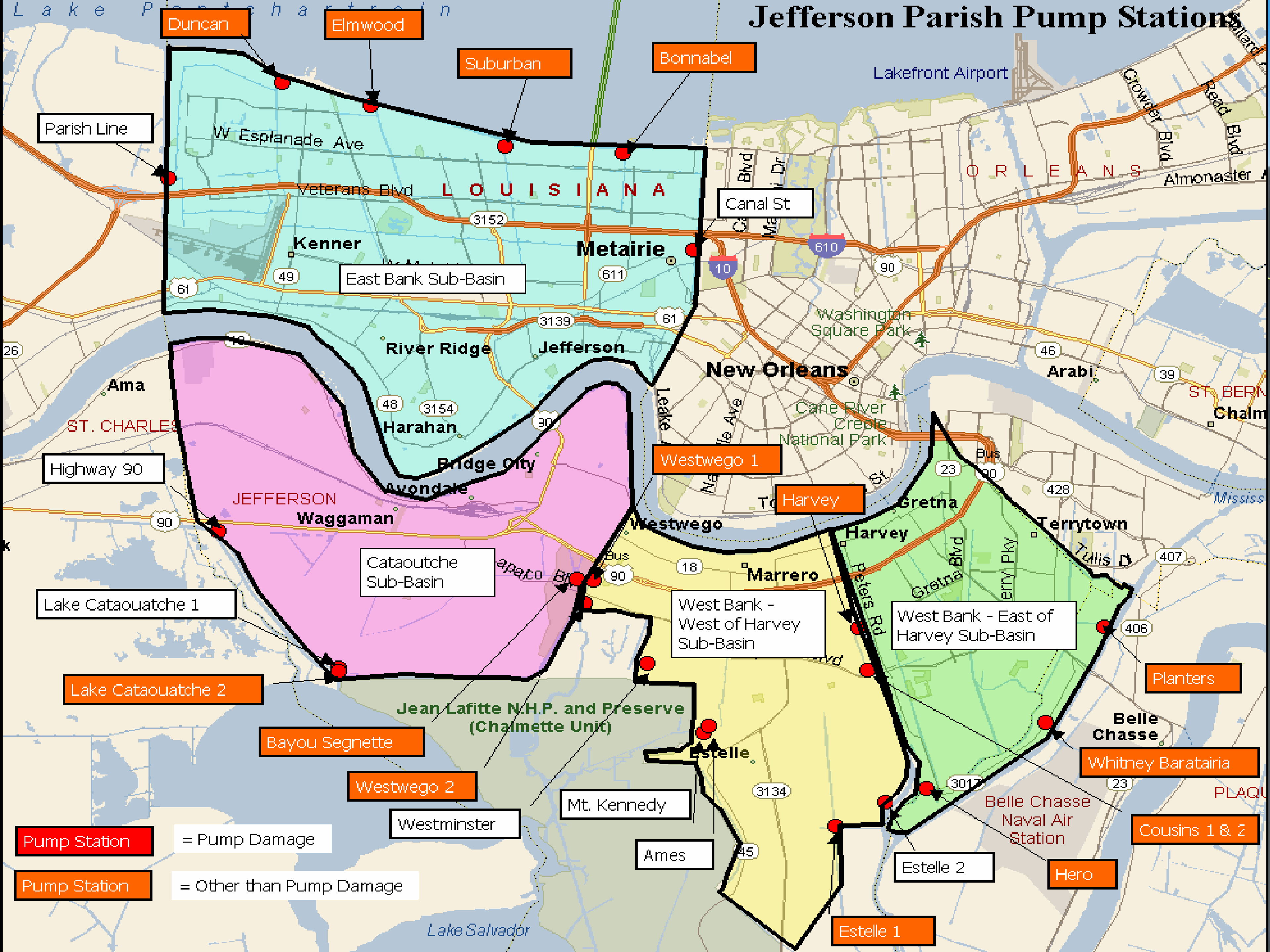
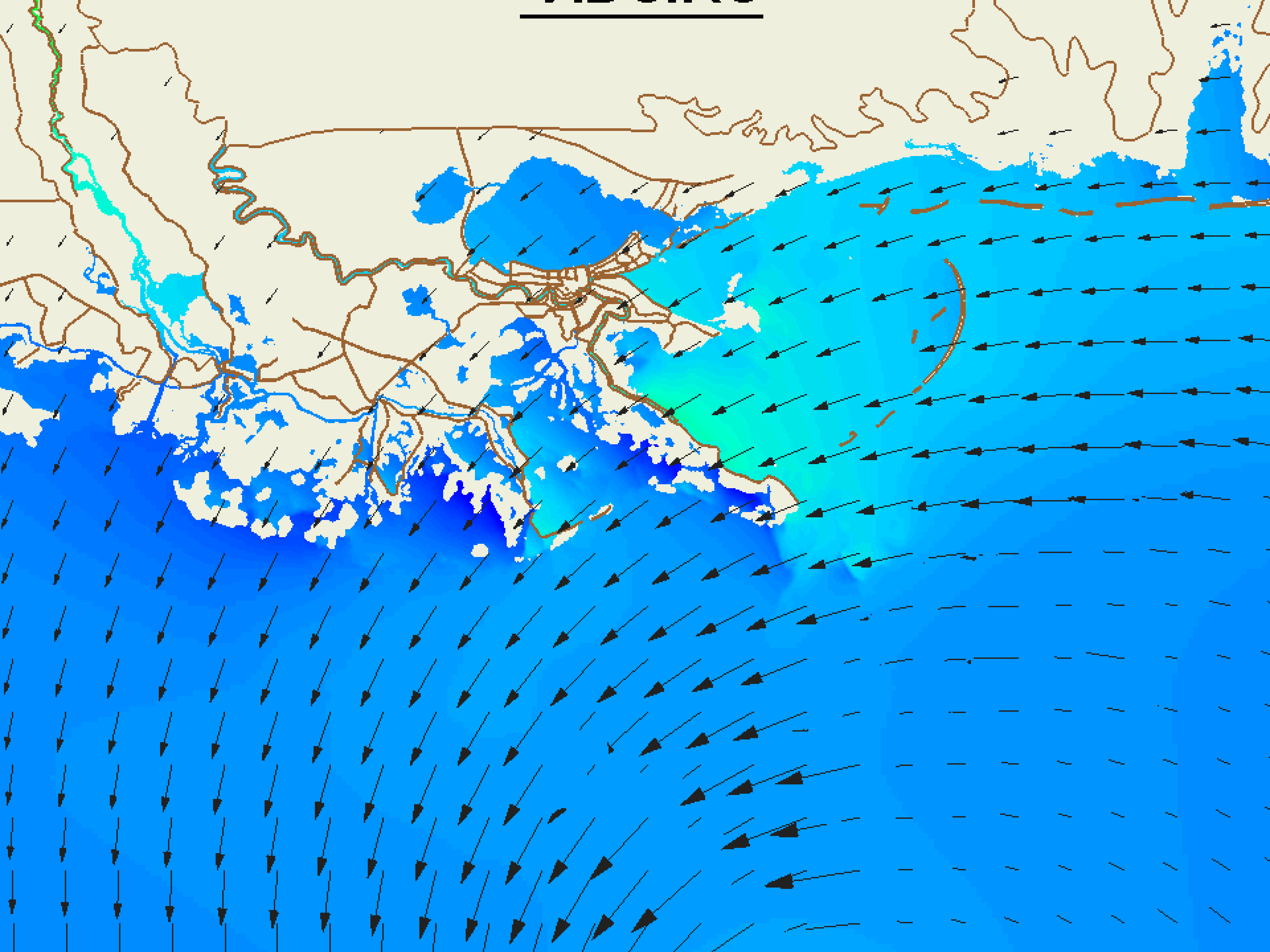
City of New Orleans Ground Elevations

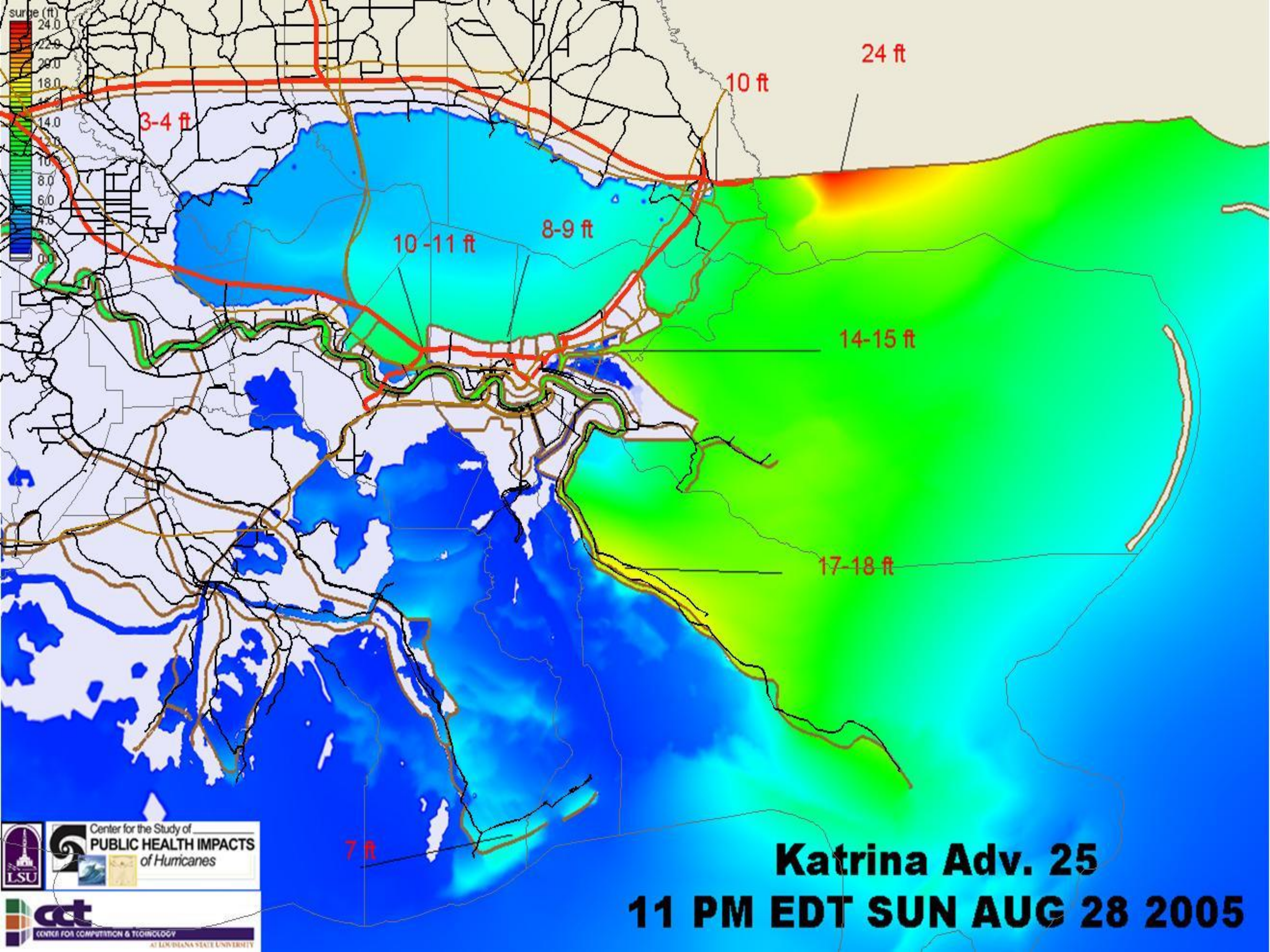


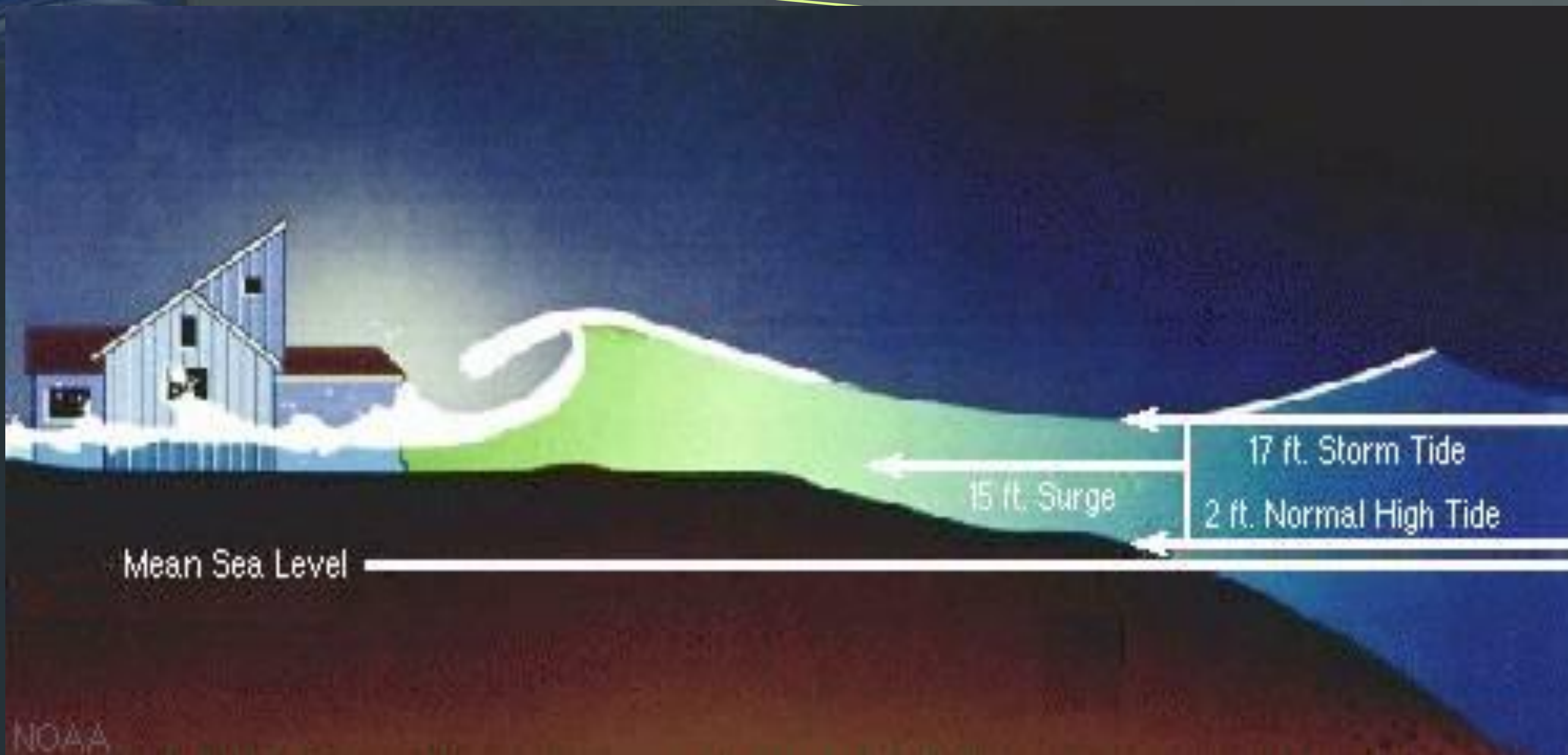
From Canal St. at Mississippi River to the Lakefront at U.N.O.




Jefferson Parish Pump Stations
Lake Pontchartrain
Duncan
Elmwood
Suburban
Bonnabel
Parish Line
Canal St
East Bank Sub-Basin
Cataoutche Sub-Basin
West Bank - West of Harvey Sub-Basin
West Bank - East of Harvey Sub-Basin
Highway 90
Lake Cataouatche 1
Lake Cataouatche 2
Bayou Segnette
Westwego 1
Westwego 2
Harvey
Westminster
Mt. Kennedy
Ames
Estelle 1
Estelle 2
Planters
Whitney Barataria
Cousins 1 & 2
Hero
Pump Station = Pump Damage
Pump Station = Other than Pump Damage
Lakefront Airport
LOUISIANA
ORLEANS
JEFFERSON
ST. CHARLES
Kenner
Metairie
River Ridge
Jefferson
Harahan
Bridge City
Avondale
Waggaman
Ama
New Orleans
Washington Square Park
Cane River Creole National Park
Arabi
Gretna
Harvey
Terrytown
Westwego
Marrero
Estelle
Belle Chasse
Belle Chasse Naval Air Station
Jean Lafitte N.H.P. and Preserve (Chalmette Unit)
Lake Salvador
W Esplanade Ave
Veterans Blvd
Almonaster
Crowder Blvd
Read Blvd
Peters Rd
Gretna Blvd




surge (ft)
24.0
22.0
20.0
18.0
14.0
8.0
6.0
0.0
3-4 ft
10 ft
24 ft
10 -11 ft
8-9 ft
14-15 ft
17-18 ft
7 ft
Center for the Study of
PUBLIC HEALTH IMPACTS
of Hurricanes
CENTER FOR COMPUTATION & TECHNOLOGY
AT LOUISIANA STATE UNIVERSITY
Katrina Adv. 25
11 PM EDT SUN AUG 28 2005


17 ft. Storm Tide
15 ft. Surge
2 ft. Normal High Tide
Mean Sea Level
NOAA

New Orleans

If you would expect the life of a city such as New Orleans to be a minimum of 200 years, what is the risk of a 100 year event (Category 3 Hurricane) occurring within the next 200 years?

Risk

$$\text{Risk} = \left(1 - \left(1 - \frac{1}{T_{100}}\right)^{200}\right)$$

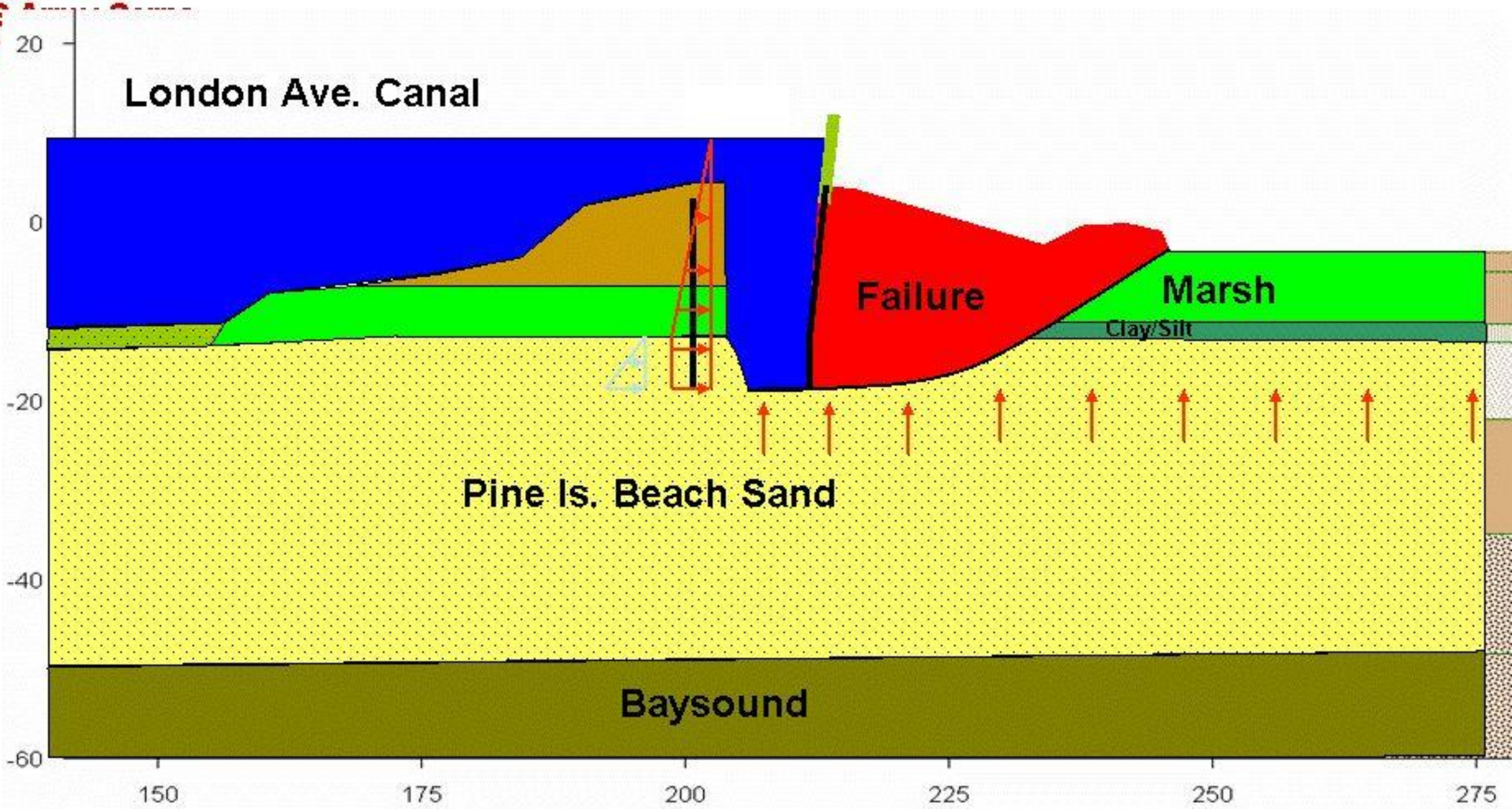
Risk = 87 %

Large Hurricanes of US

Hurricane	Year	Location	Category	Winds
Labor Day	1935	Florida Keys	5	200
Camille	1969	Miss.	5	190
Andrew	1992	SE FL	5	165
Charley	2004	Punta Gorda, FL	4	150
Katrina	2005	LA, MS, AL	4-5	140

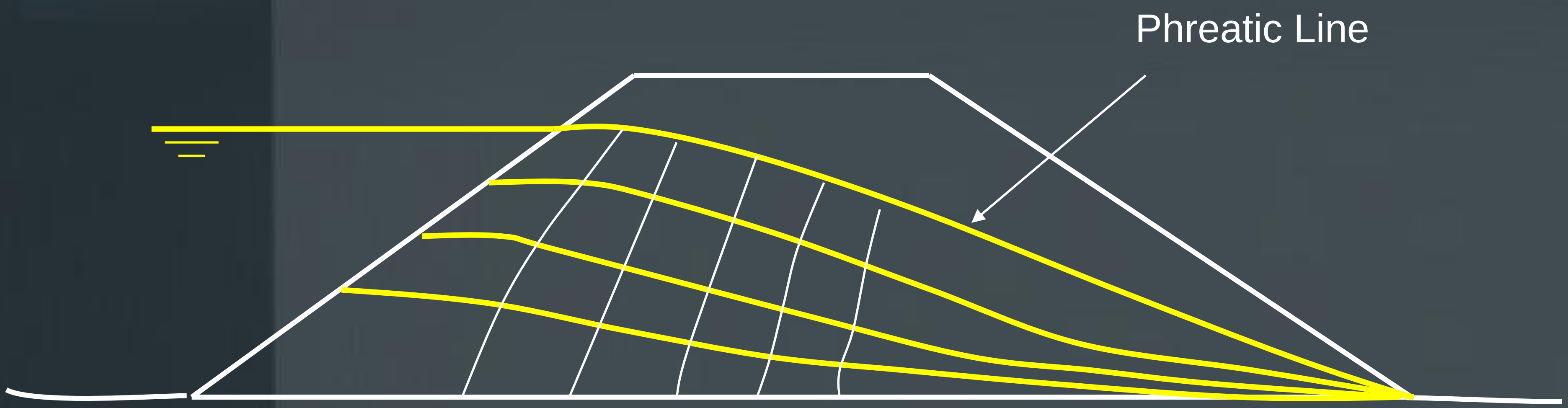
London Ave. Canal – North Breach

US
of



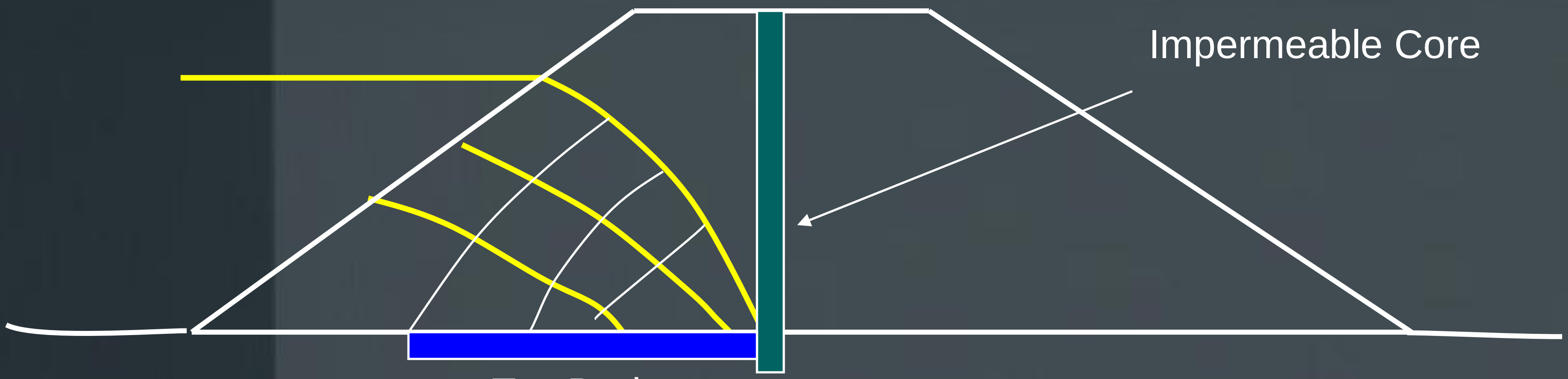
Floodwalls and levees

Levee Design



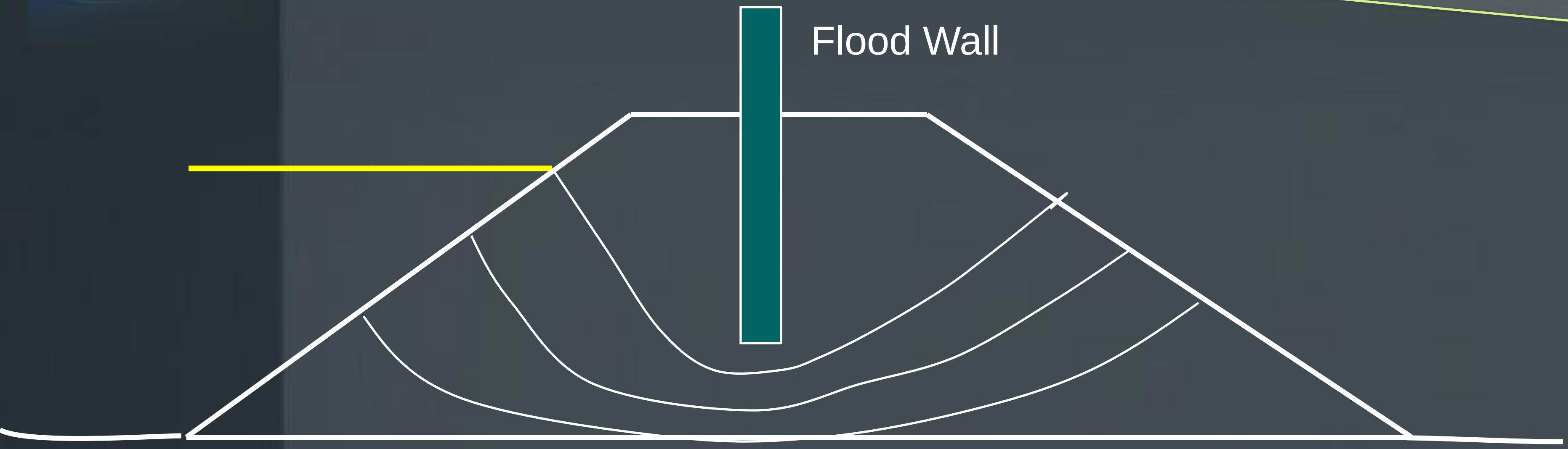
Seepage Pattern Through and Earth Embankment

Levee Design



Seepage Pattern Through and Earth Embankment

Levee Design



Levee system in New Orleans

- design of post-Betsy levees and floodwalls
  - –based on rudimentary storm surge models
  - –design hurricane is fast-moving category 3
    - even category 3 storm could swamp system if storm stalled over New Orleans
    - predicted that N.O. could be under as much as 20 ft water
  - –16 ft and higher levees, floodwalls
  - –along Mississippi River, levees designed for the 200-year storm from inland
  - –New Orleans described as bowl
  - –as of 2003, Army Corps of Engineers reassessing levees

Problems caused by levees

- creates ecosystem problems since no flooding and limited access to the river
  - nutrients, debris, sand bars, …
- when levees fail, creates far more dramatic flood
  - housing in locations where none would be without levees
- once flooding occurs, keeps flood waters from returning to river

Predictions of 2006 disaster

- Army Corps of Engineers, LA district
- Greg Brouwer, Civil Engineering—ASCE, Vol. 73, No. 6, June 2003, pp. 46-55
- Mark Fischetti, Scientific American, October, 2001, 76-85
- modeling efforts
  - –Louisiana State University
    - Category 4 would drive surge 30 miles inland, surging water would fill Lake Pontchartrain, overflow, pour into city, flood city up to 20 ft.
  - –Corps

Predictions

- flooding up to 20 ft
  - shut down city's power, water, and sewage plants
  - pumps clogged
  - levees will hold water in the city
- American Red Cross predicted 25,000-100,000 could die
- water not the only problem
  - wind forces can rip rooftops off
- evacuation predicted to be difficult
  - 100,000 people in N.O. do not have easy access to cars
  - major evacuation routes over water
  - I-10 could be covered with water during Category 5

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Compare to Netherlands

- Much of Netherlands also below sea level
- Flooding protection needed from North Sea and major rivers

Compare to Netherlands

- 1953 – North Sea storm surge at high tide destroyed the dykes, killing 1,800 people
- Rebuilt flood protection system
  - 10,000-year event for sea
  - 1,250-year event for rivers
- $620 million spent annually on maintaining the current system

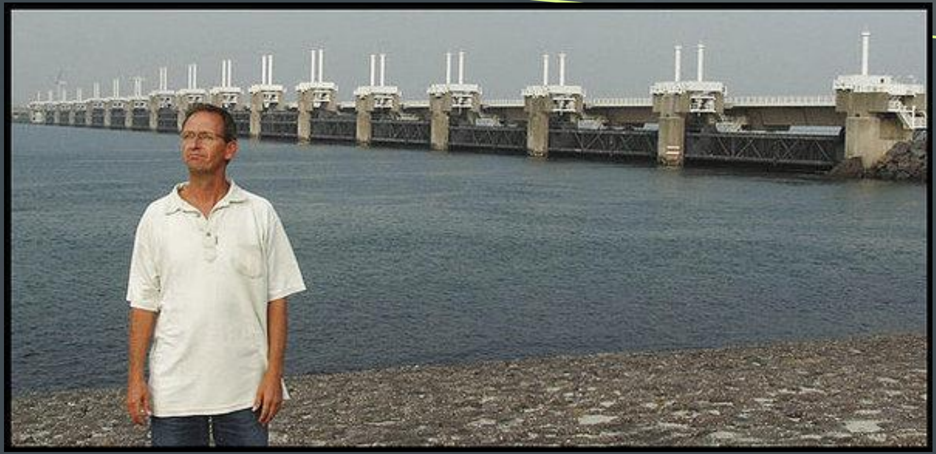
Risk of 10,000 year food occurring in 200 years

$$\text{Risk} = \left(1-\left(1-\frac{1}{T_{1000}}\right)^{200}\right)$$

Risk = 2 %

Netherlands

- hydraulic sea wall 130 feet high by six miles long
  - giant steel curtain that can be opened or closed, depending on the water level
- flood gates
  - 1 1/2 -mile stretch of 62 gates to control the entry and exit of North Sea waters
  - close as soon as the water rises 6 feet
- large dams across rivers



Netherlands
Storm surge barrier at Rotterdam

Netherlands

- Anti-flood measures will be reviewed in all Dutch regions following Katrina disaster
- complications
  - climate change
    - sea level rise significant, 23-39 inches per century
    - most engineering design life ≈ 75-100 years
  - land sinking like New Orleans, not as fast


9 1 '96


9 7 96

The Current Standard

- Does the 1 percent standard effectively contribute to achieving the goals of the National Flood Insurance Program (NFIP) ?
- In reality the 1 percent flood represents a range of discharge and elevation values – Uncertainty

The Current Standard

- The 1 percent standard and many supporting NFIP regulations were designed to strike a balance between promoting economic growth and preventing flood damages in the development of floodplains; however, this perceived balance might be significantly different if the economic value of the natural and beneficial functions of floodplains is considered.

The Current Standard has lead to:

- The concentration of development in land areas protected by the 1 percent flood.
- Development outside the 1 percent floodplain. (The magnitude of the property damage in the 0.2 percent floodplain may be two to three times larger than in the 1 percent floodplain)

The Current Standard

- The need for a Federal standard does not mean, that one standard should limit floodplain management at the state and local levels. (States and their communities should exercise their responsibility to impose higher standards, where the health and safety of the population merits a higher standard for land use regulations)

The Current Standard

- The 1-percent standard is too low for removal of NFIP land use and insurance requirements for population centers behind levees.
- What should be the standard?
- Prob [Exceed] = ?? 0.2 (500-year)