Coastal GeoTools 2011

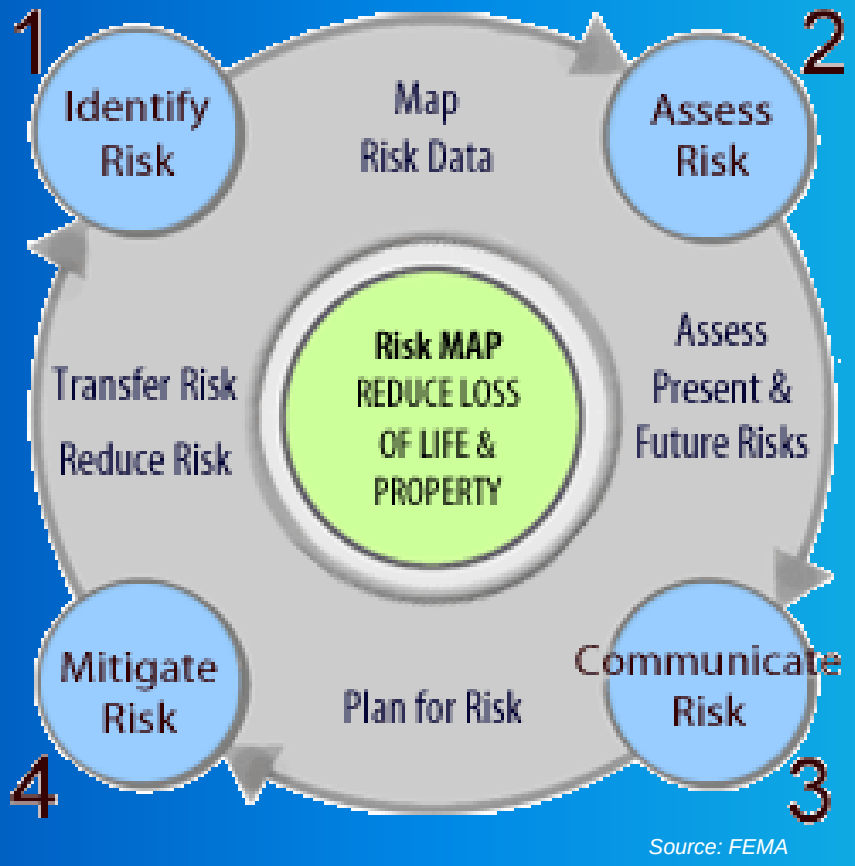
GIS Tools & Technologies for Coastal Flood Studies

Chris Mack

March 22, 2011

AECOM

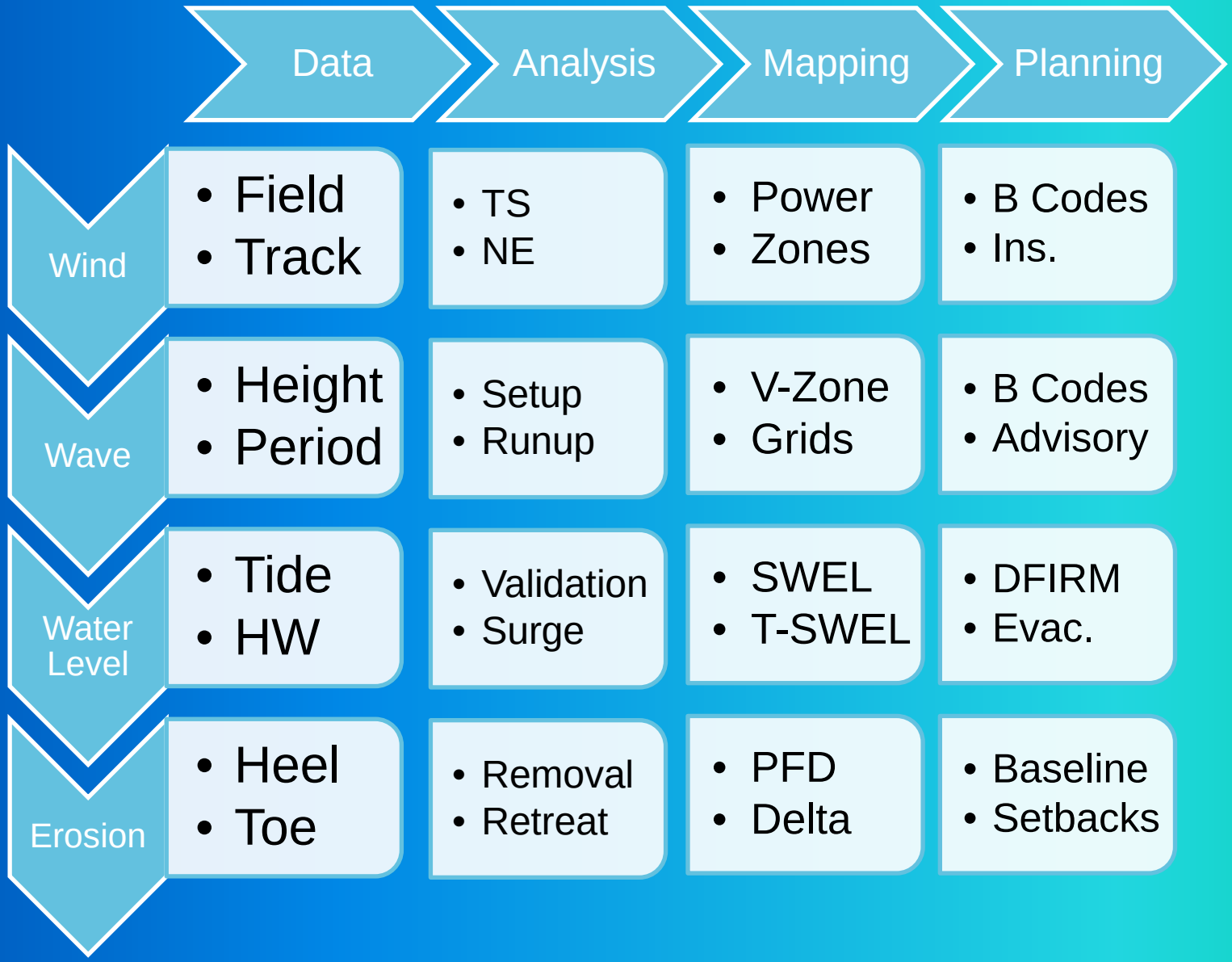
GIS – The Backbone, Foundation, and Integration of it All?



Source: FEMA

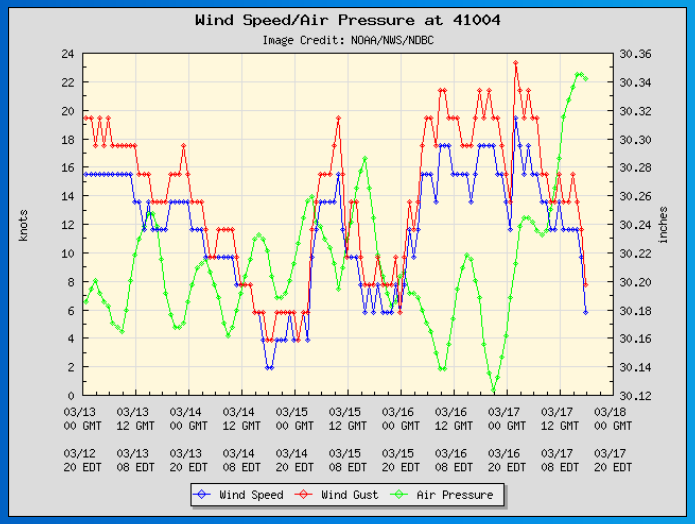
AECOM

GIS Supports Every Phase, Every Element, Every Deliverable….Everything!

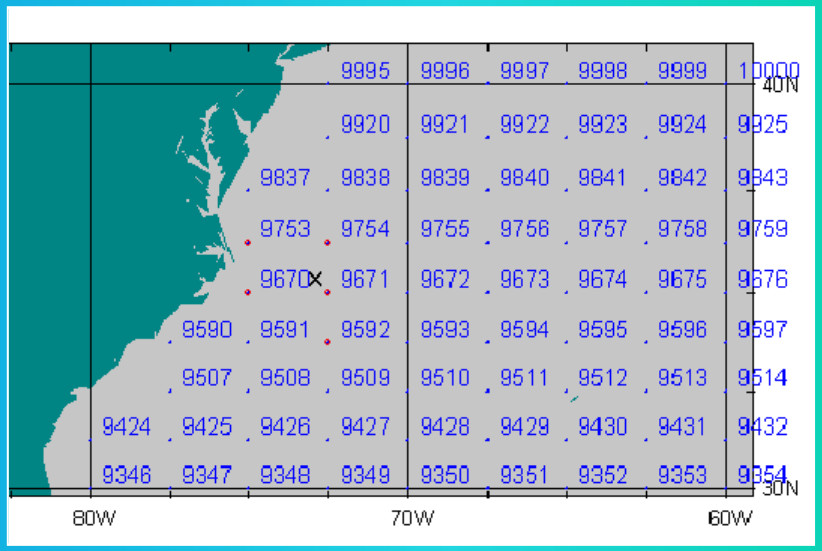


AECOM

Data – Wind



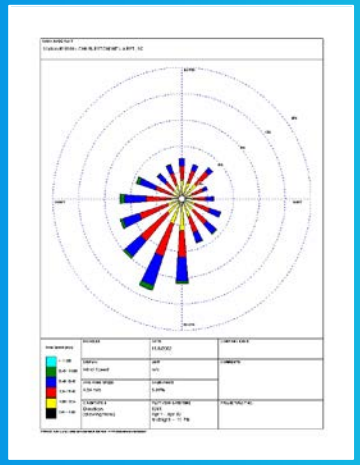
Source: Oceanweather, Inc.



Source: Oceanweather, Inc.

Hindcasted Data Sets
(OSMOSIS, Oceanweather, Inc.)

Historical & Hindcasted:
- Wind Speed
- Wind Direction
- Pressure
- (time series)

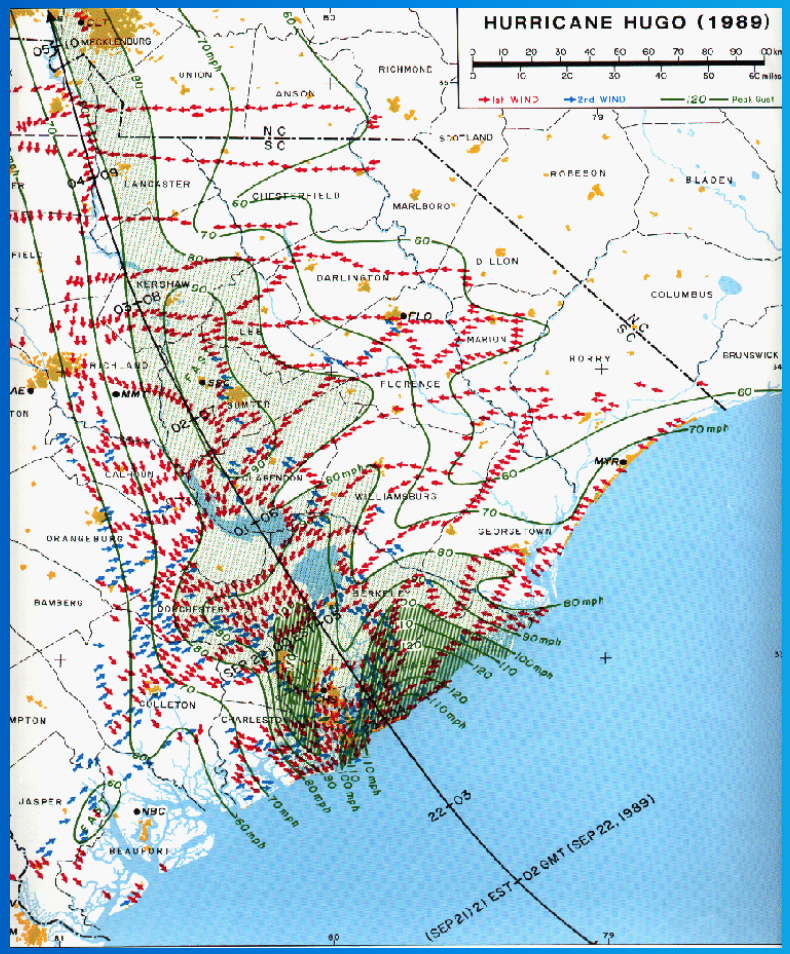


Source: USDA

Wind Rose

AECOM

Analysis – Wind



Source: NHC NOAA

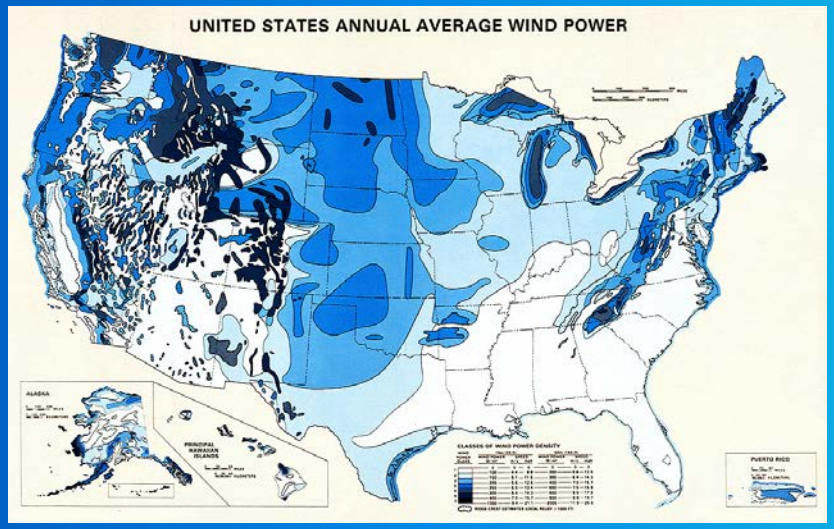
Five primary parameters of interest for coastal modeling reproduced from hindcasted time series per storm track:

- Central pressure deficit
- Radius to maximum wind speeds & direction
- Storm track heading
- Forward velocity
- Shoreline crossing point

Tools & Technologies:
OSMOSIS, Oceanweather, Inc.
HURDAT, NOAA AOML

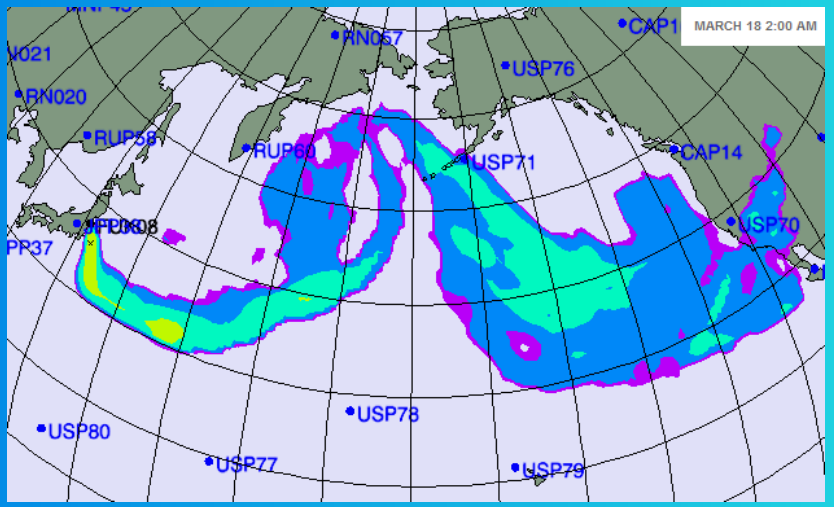
AECOM

Mapping – Wind



Source: NREL

Wind Power



Wind Trajectories

Source: CNTBTO

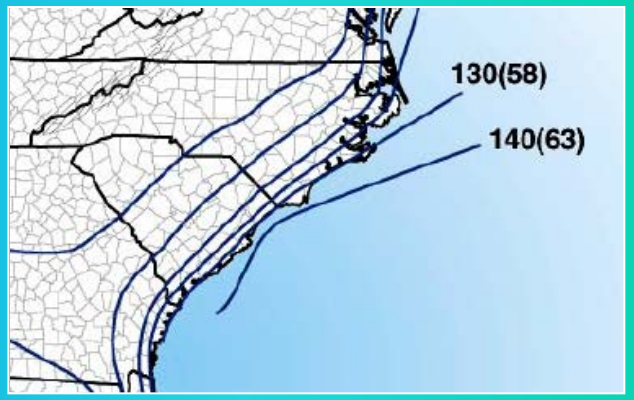
AECOM

Planning – Wind

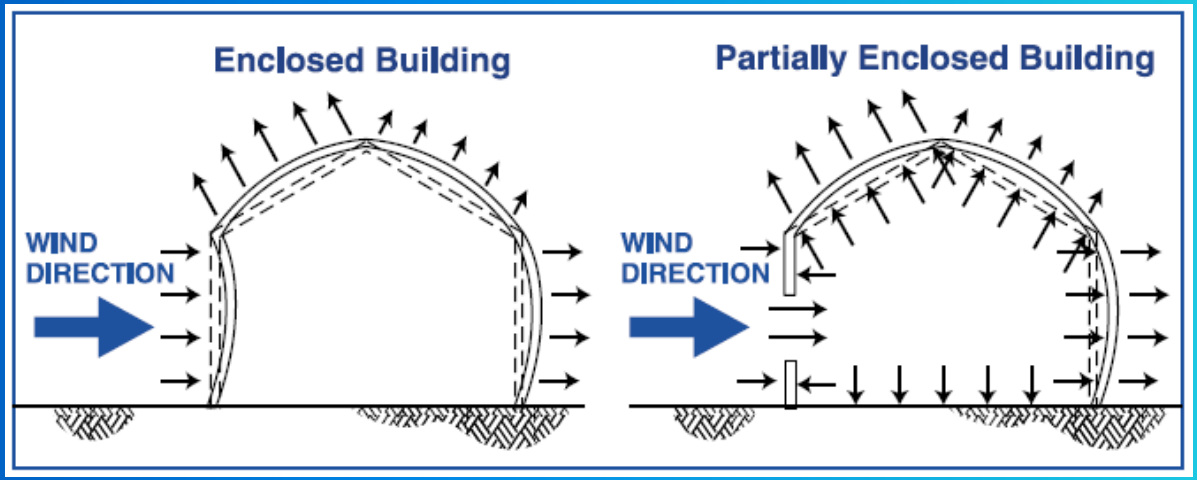
Wind Load Determination Procedure

STEP 1	Determine the wind speed from the map shown in Figure 11-18 on pages 11-38 and 11-39. (More detailed maps for Atlantic and Gulf of Mexico coasts are included in Figures 6.1a through 6.1c of ASCE 7-98.)
STEP 2	Define the building as either open, partially enclosed, or enclosed.
STEP 3	Determine the Exposure Category: A, B, C, or D (see ASCE 7-98).
STEP 4	Determine the Importance Factor I and the topographical influence factor K_{zt}.
STEP 5	Determine the velocity pressure at the appropriate mean roof height.
STEP 6	Select appropriate internal and external pressure coefficients.
STEP 7	Determine the design pressures (all pressures should be net pressure; use + to indicate inward-acting pressure and – to indicate outward-acting pressure).
STEP 8	Apply the design pressure to the appropriate tributary area for the element or assembly under consideration.

Source: FEMA



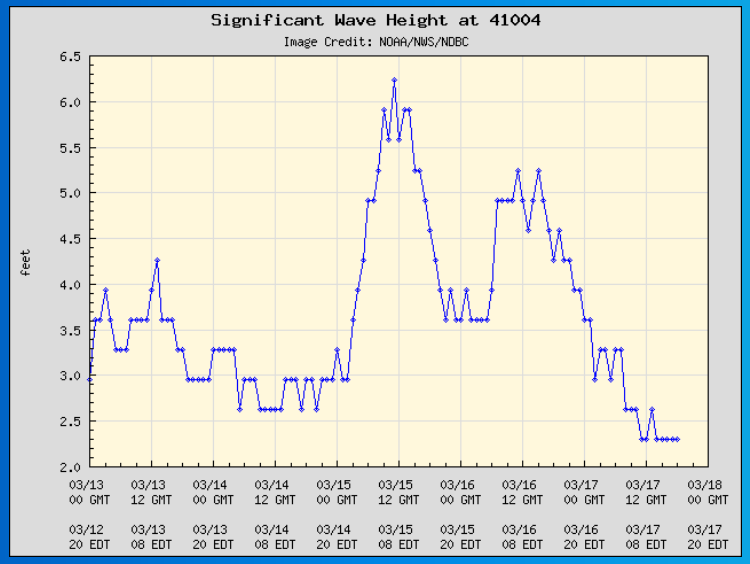
Source: FEMA



Source: FEMA

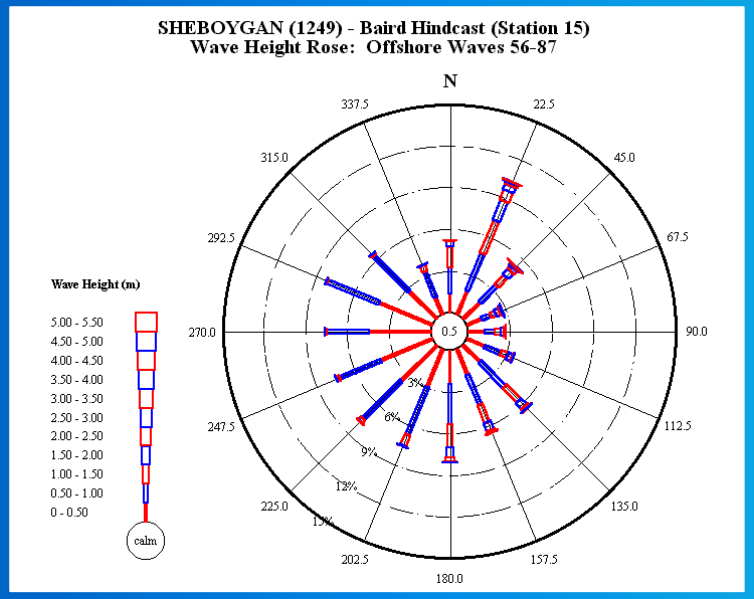
AECOM

Data – Wave



Source: Oceanweather, Inc.

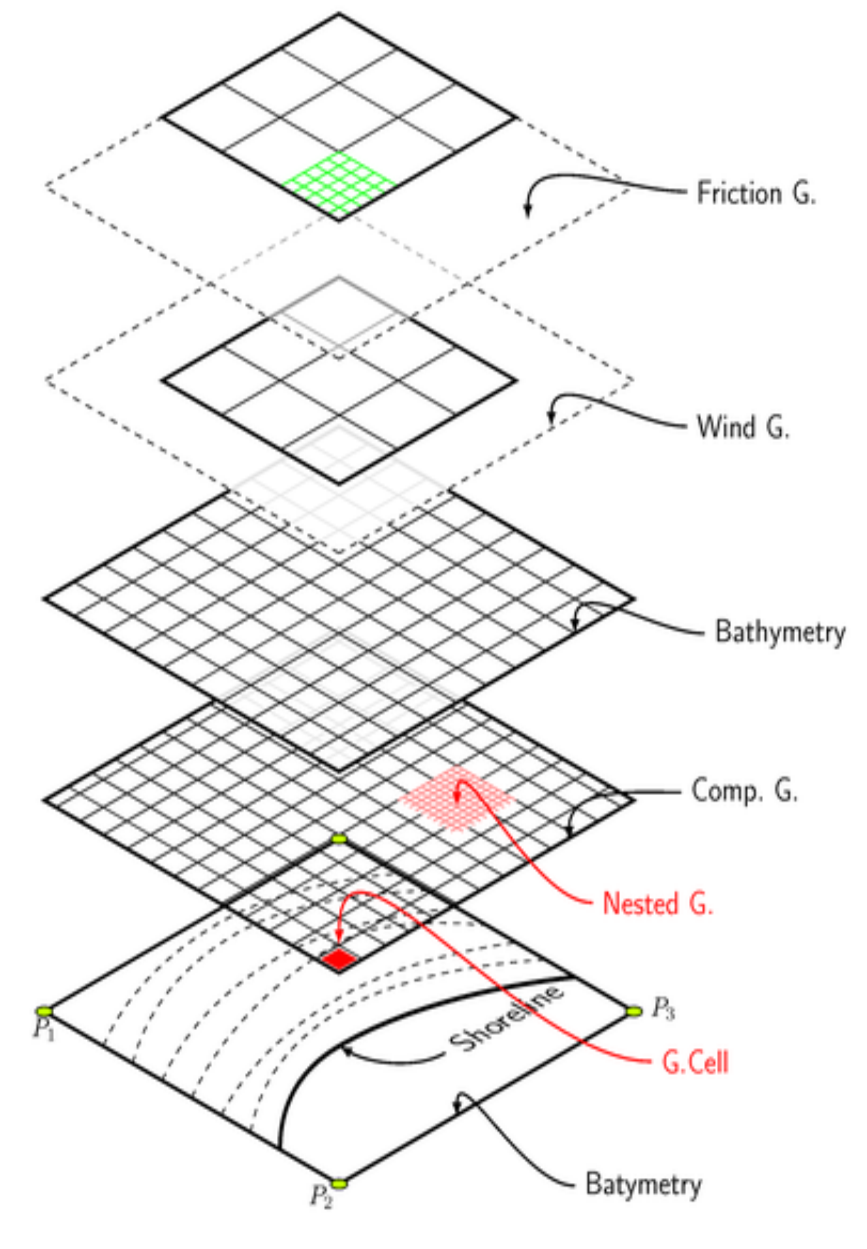
Source: NOAA NODC



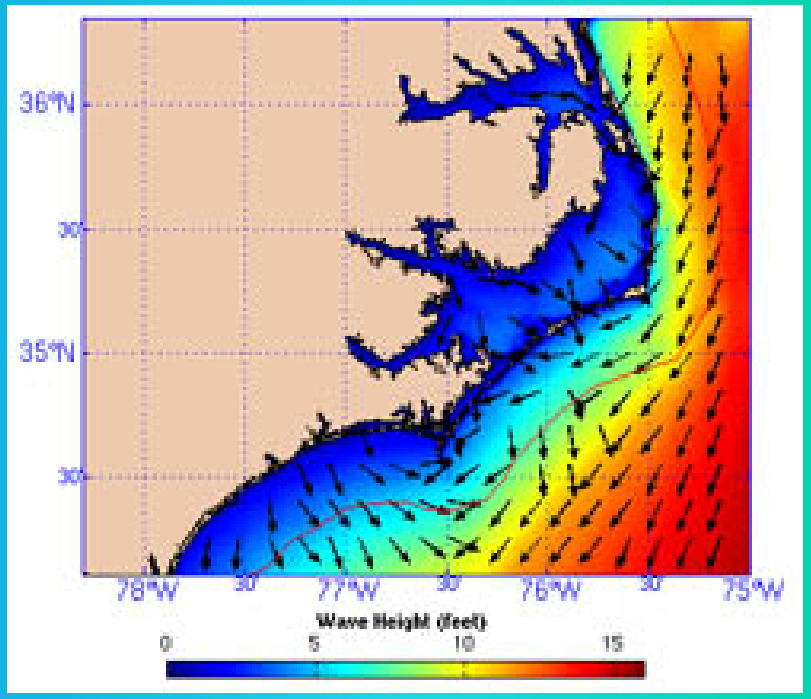
Source: USACE

AECOM

Analysis – Wave



Source: TU Delft

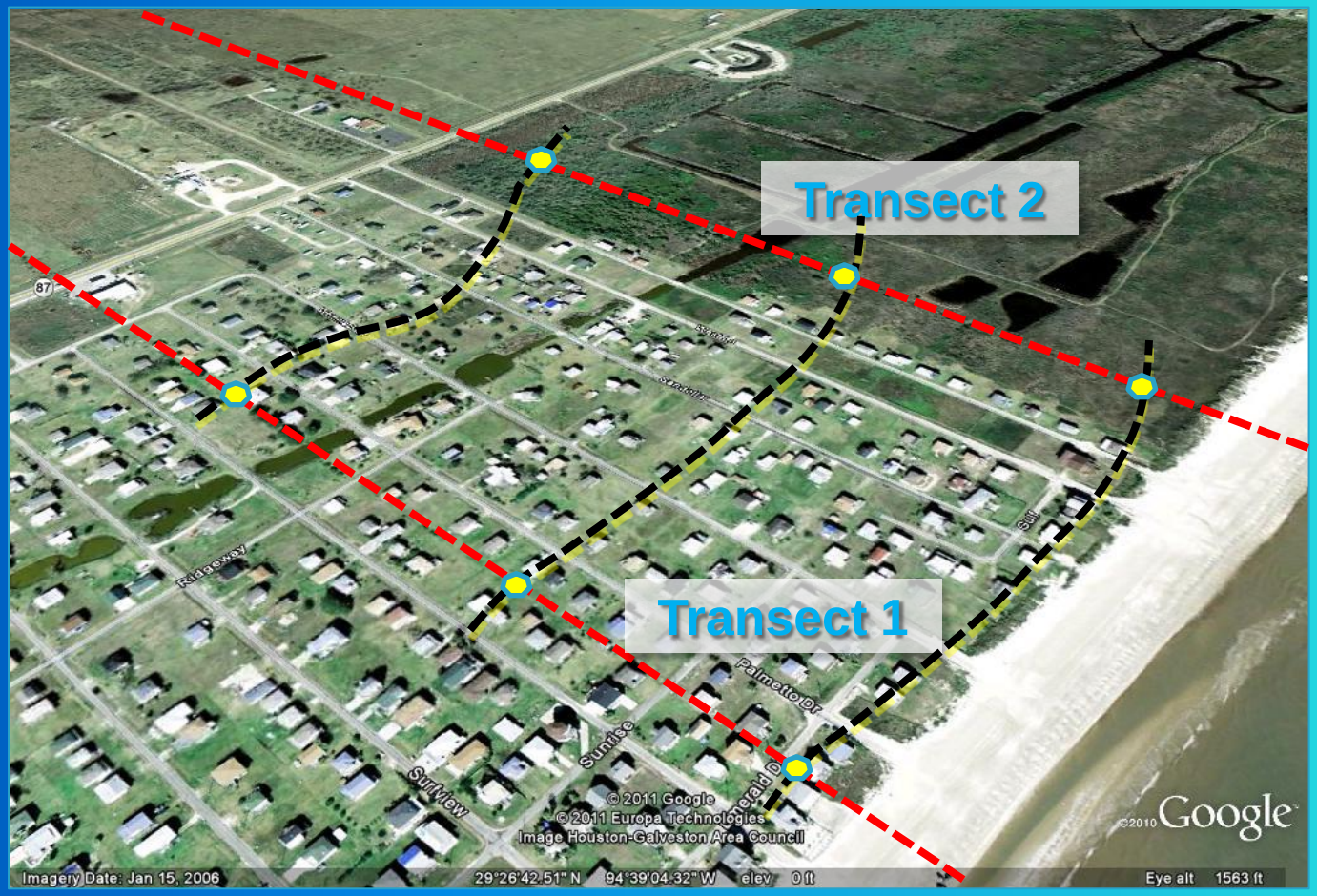


Source: NOAA

Tools & Technologies:
SWAN, TUDelft

AECOM

Analysis – Wave



Source: Google & AECOM

Tools & Technologies:
Coastal WISE
CHAMP (integrated)

AECOM

Mapping – Wave

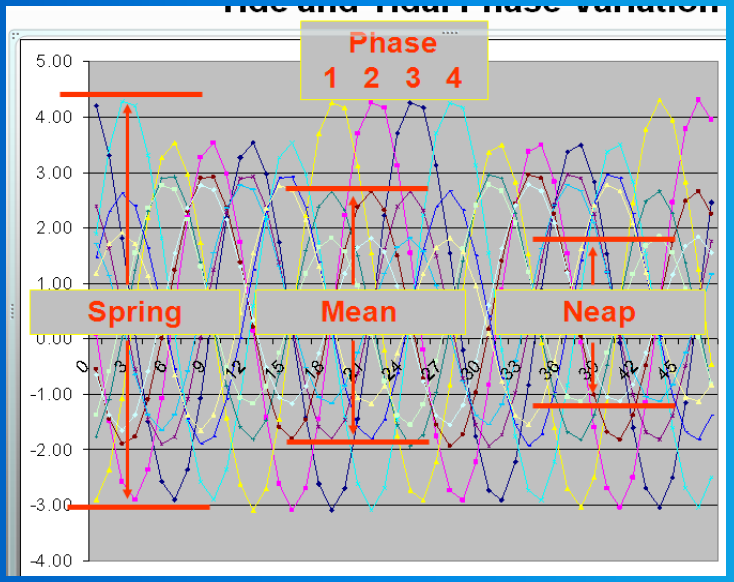
Source: FEMA

AECOM

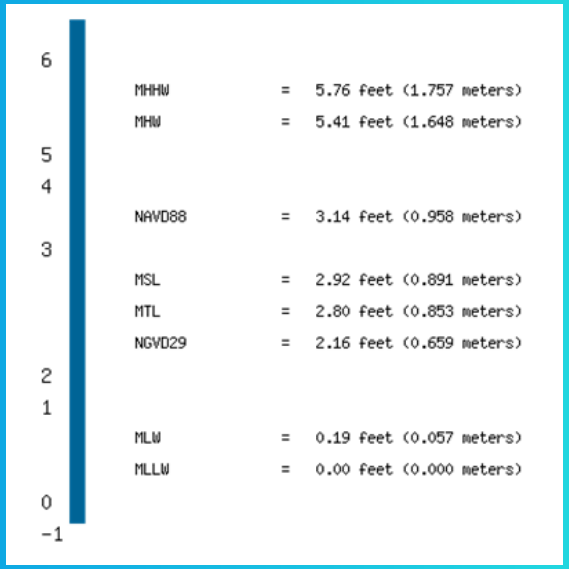
Planning – Wave

AECOM

Data – Water Level



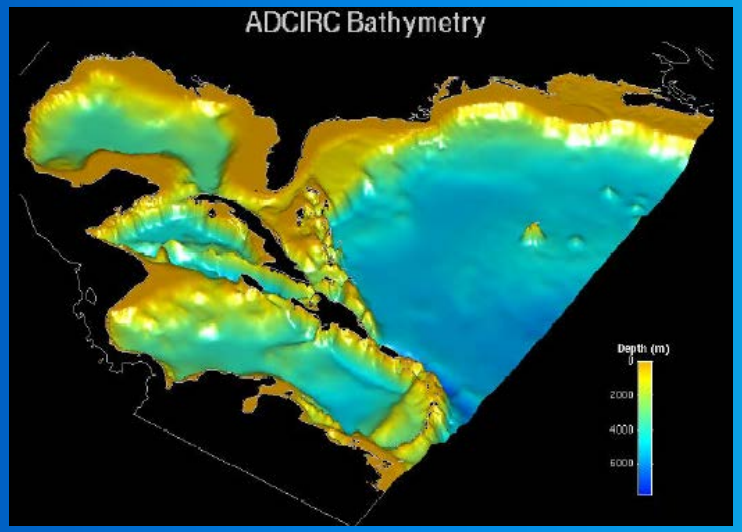
Source: AECOM



Source: NOAA

AECOM

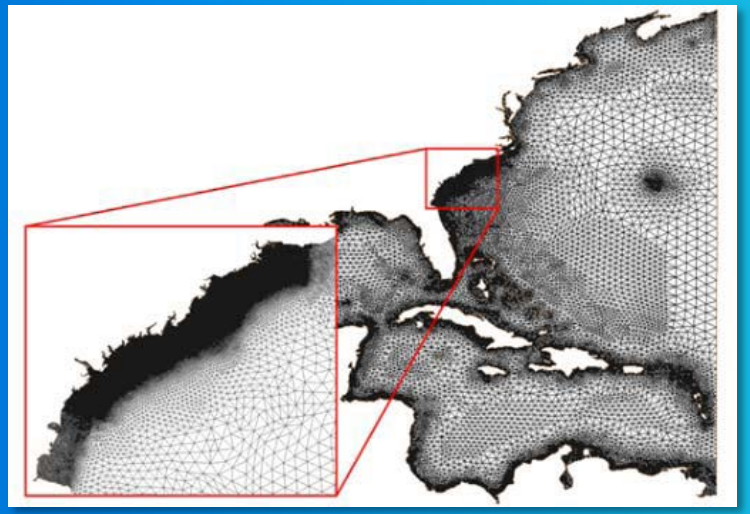
Analysis – Water Level



Source: UNC

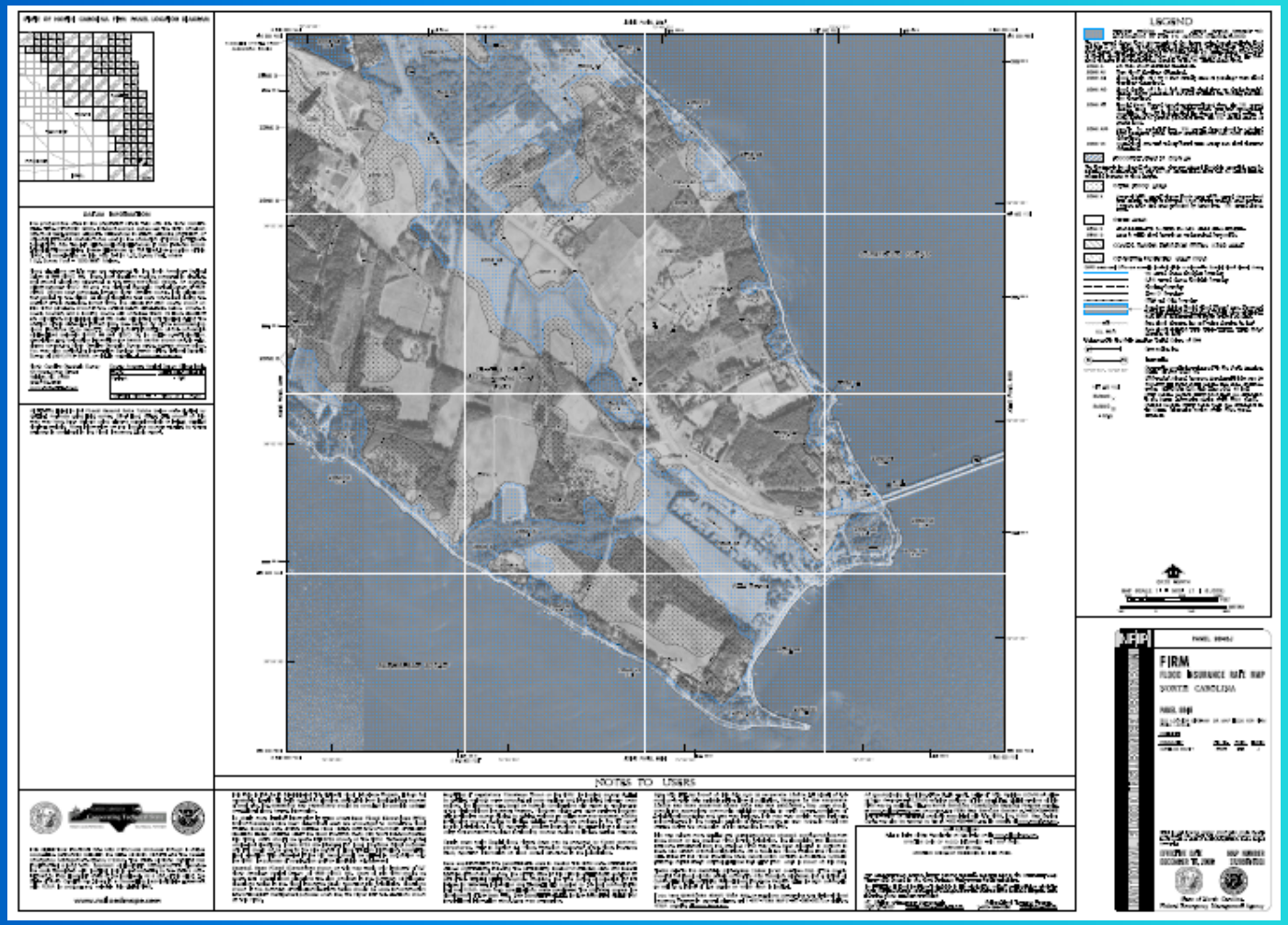
$$\frac{\partial UH}{\partial t}+\frac{1}{R\cos\phi}\left(\frac{\partial UUH}{\partial\lambda}+\frac{\partial UVH\cos\phi}{\partial\phi}\right)-\left(\frac{U\tan\phi}{R}+f\right)VH=$$
$$-\frac{H}{R\cos\phi}\frac{\partial}{\partial\lambda}\left[\frac{p_s}{\rho_0}+g(\zeta-\alpha\eta)\right]+M_\lambda+D_\lambda+\frac{\tau_{s\lambda}}{\rho_0}-\frac{\tau_{b\lambda}}{\rho_0}$$

$$\frac{\partial VH}{\partial t}+\frac{1}{R\cos\phi}\left(\frac{\partial VUH}{\partial\lambda}+\frac{\partial VVH\cos\phi}{\partial\phi}\right)-\left(\frac{U\tan\phi}{R}+f\right)UH=$$
$$-\frac{H}{R}\frac{\partial}{\partial\phi}\left[\frac{p_s}{\rho_0}+g(\zeta-\alpha\eta)\right]+M_\phi+D_\phi+\frac{\tau_{s\phi}}{\rho_0}-\frac{\tau_{b\phi}}{\rho_0}$$



AECOM

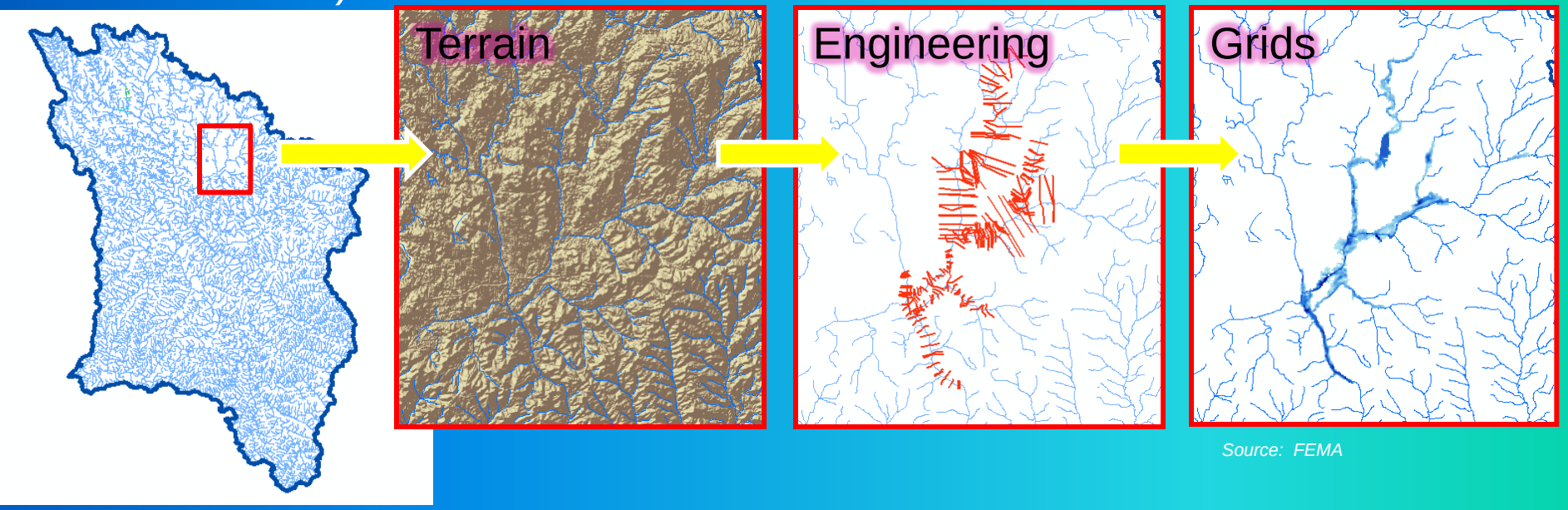
Mapping – Water Level



AECOM

Depth Grids - Introduction

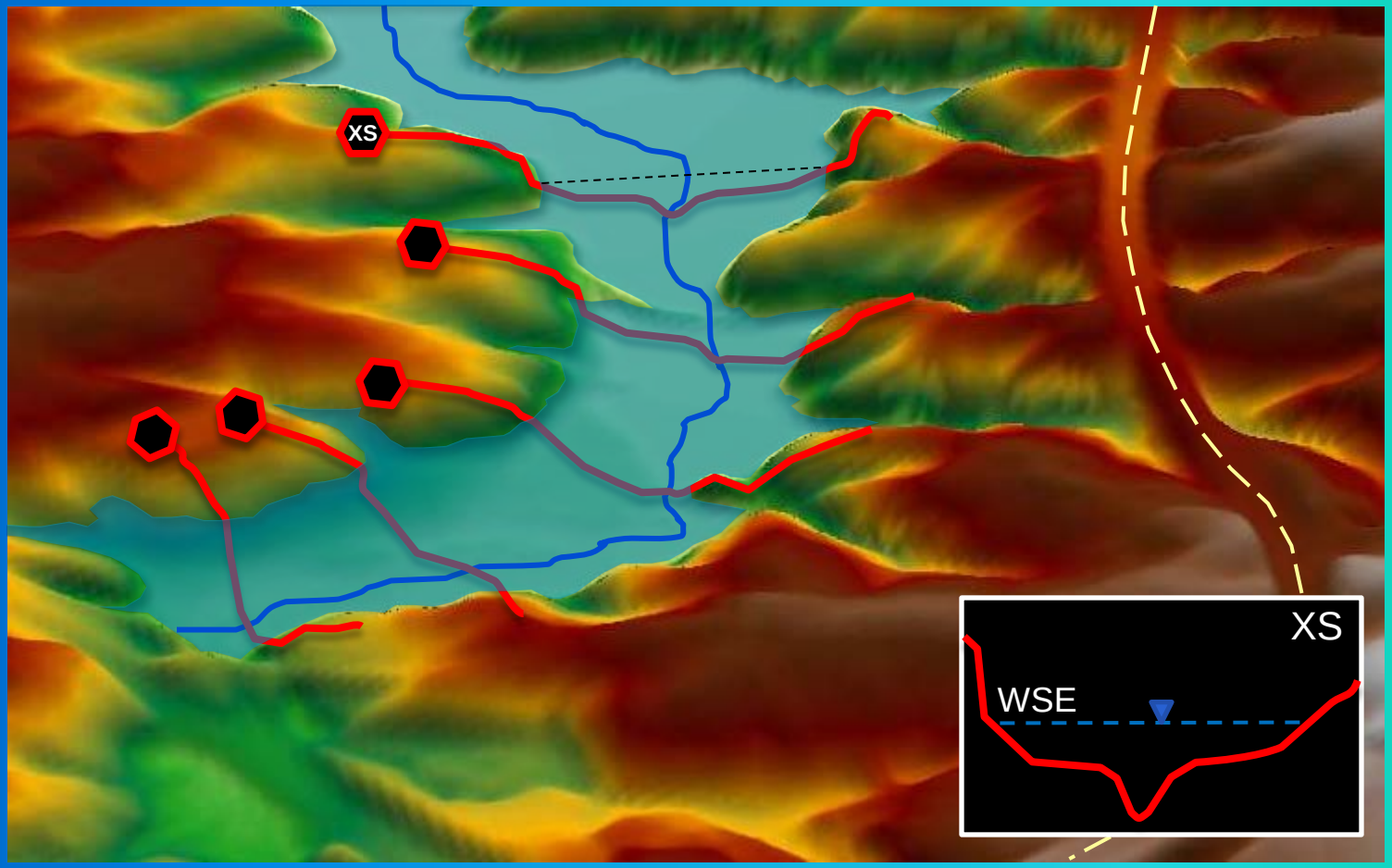
- Reminders/takeaways from the Plenary
- What are the inputs for these grids?
  - Terrain data
  - Modeled Water Surface Elevations (i.e. engineering analysis is available)



Source: FEMA

AECOM

Floodplain Boundary

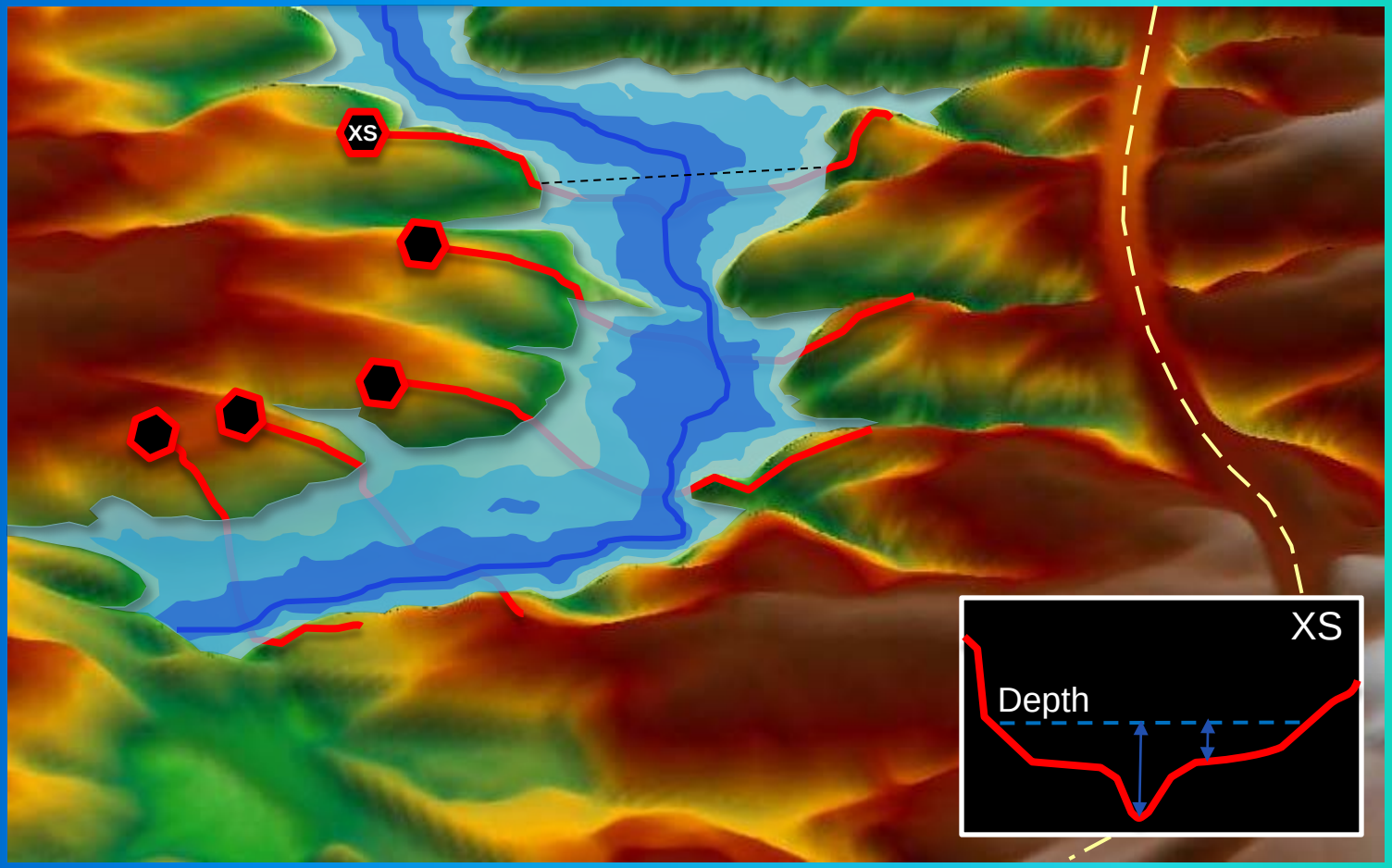


Source: FEMA

AECOM

Flood Depth Grid Development

- Depth Grid Calculated as Difference between WSE and Ground

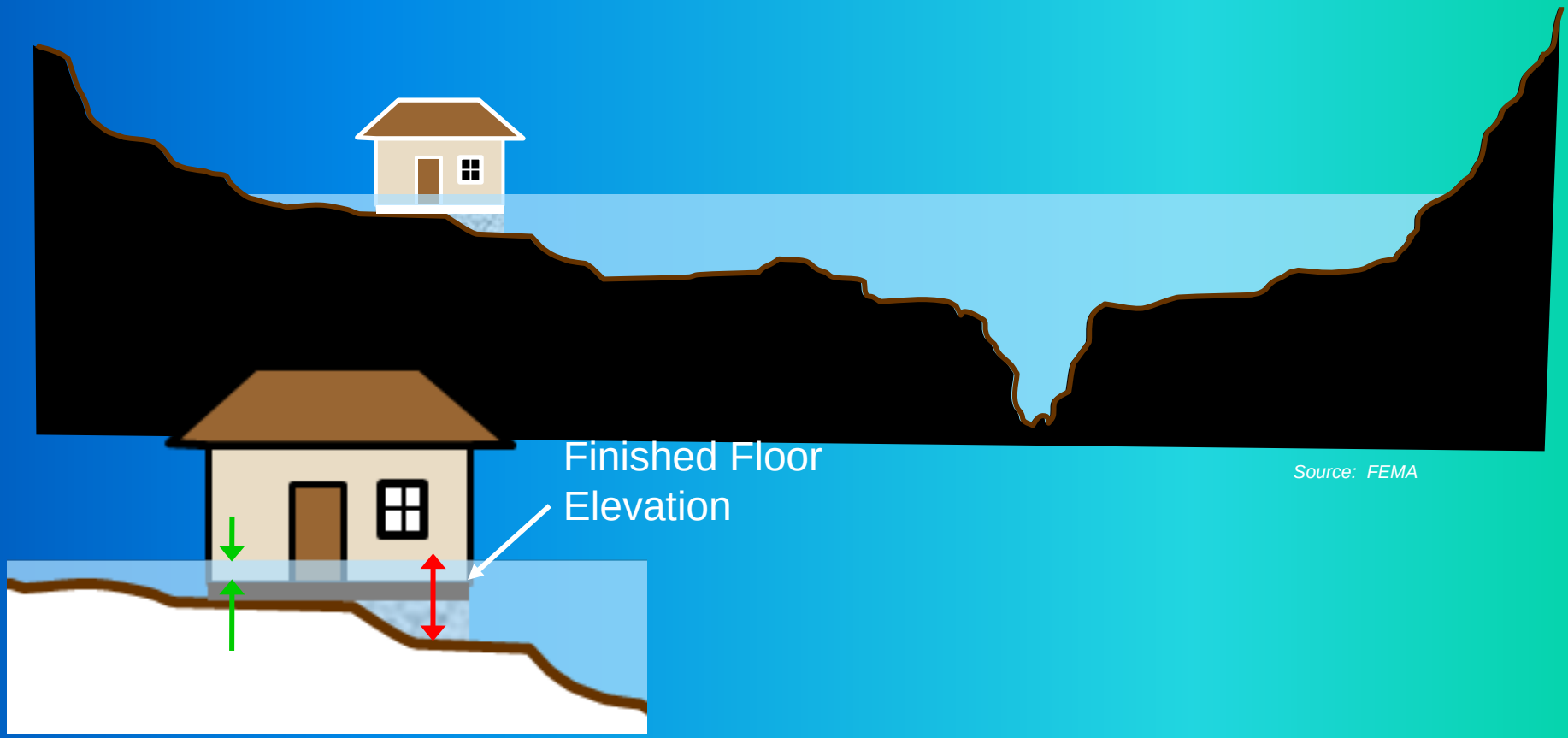


Source: FEMA

AECOM

Flood Depth & Analysis Grids

- Awareness when using at specific buildings/structures



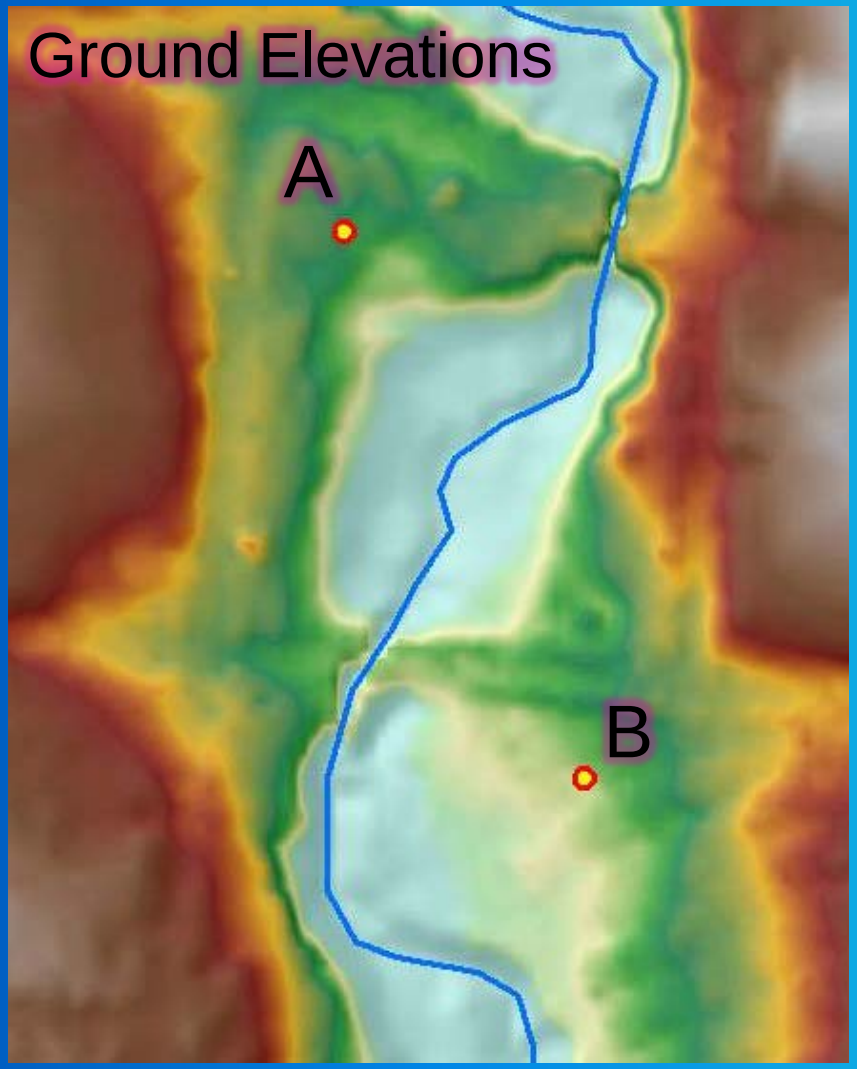
Source: FEMA

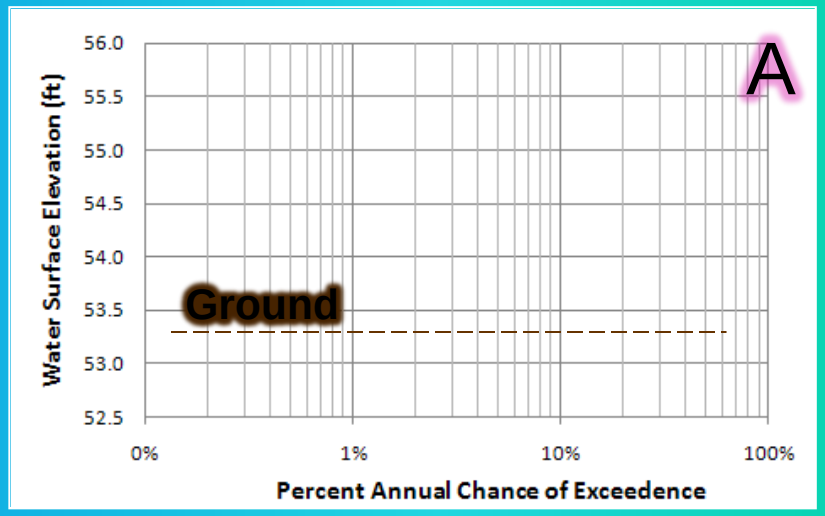
AECOM

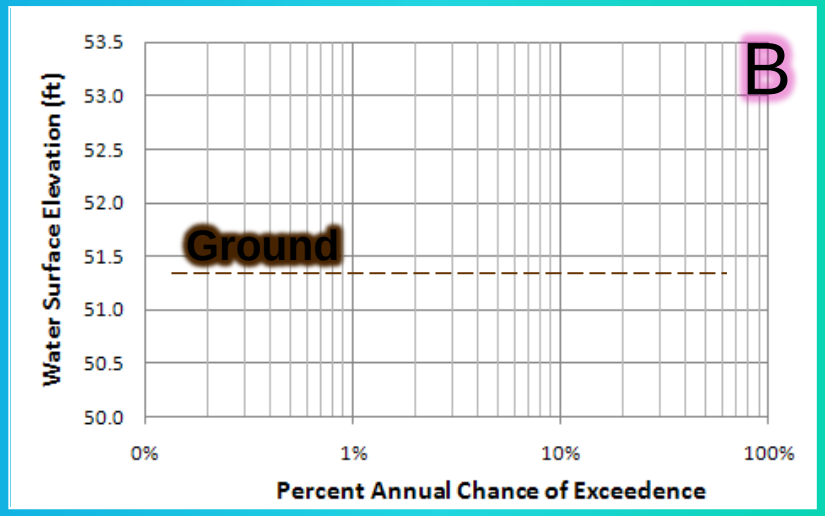
Percent Chance of Flooding Grids

- Definition
  - Digital datasets showing the percent chance of flooding (annual & 30-yr) at various locations within the mapped floodplain
- Purpose
  - Communication that the likelihood of flooding for someone living within the mapped floodplain may actually be higher than a “1% annual chance”, and that the flood hazard (and by extension, risk) varies within the mapped floodplain

Percent Annual Chance Grid Development Process



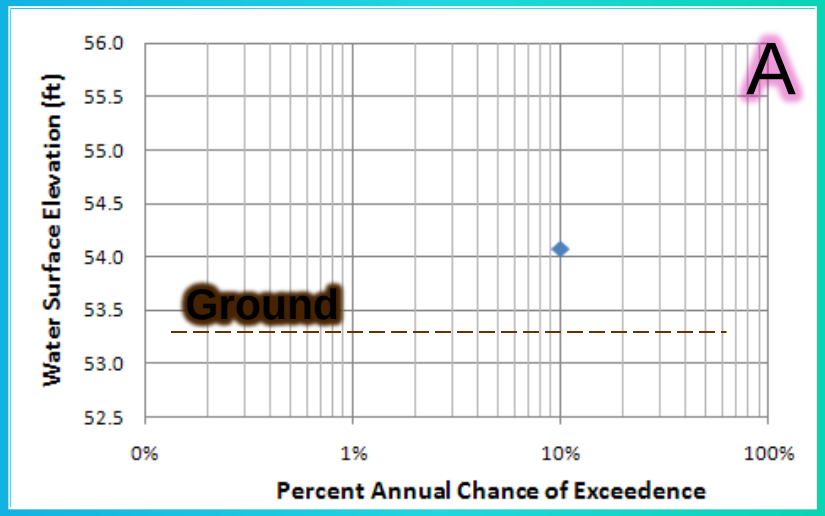


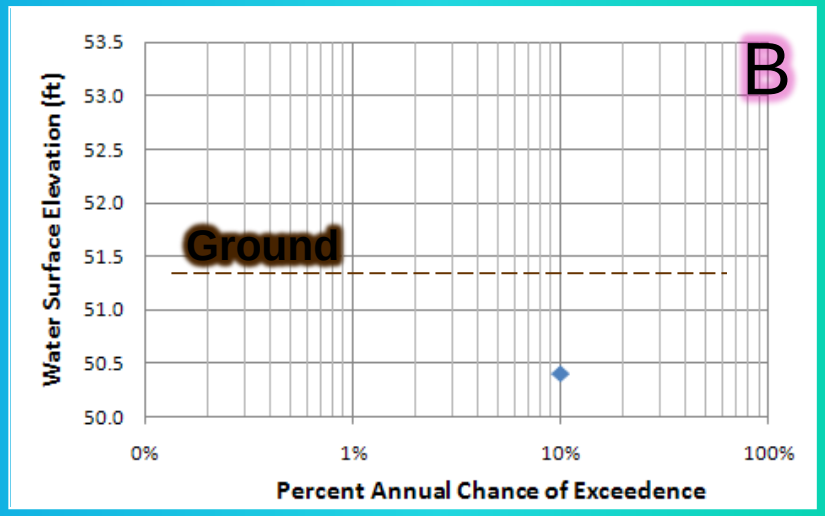


Source: FEMA

AECOM

Percent Annual Chance Grid Development Process

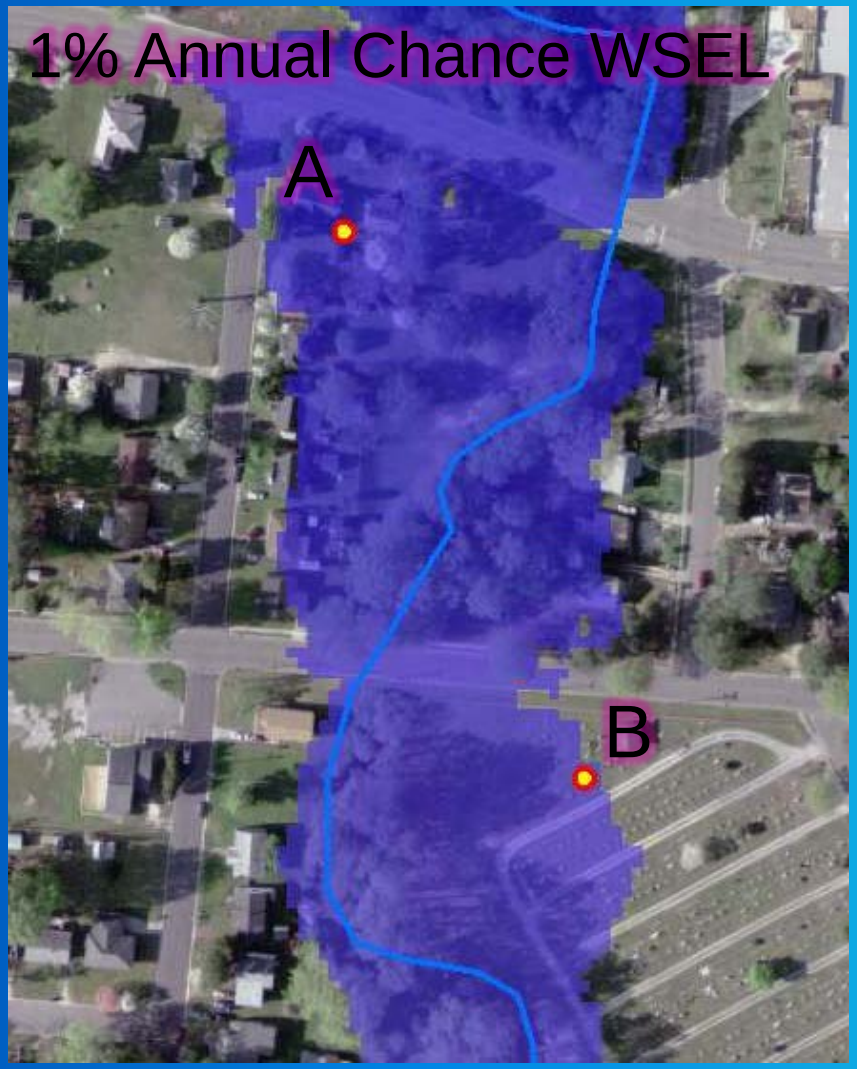


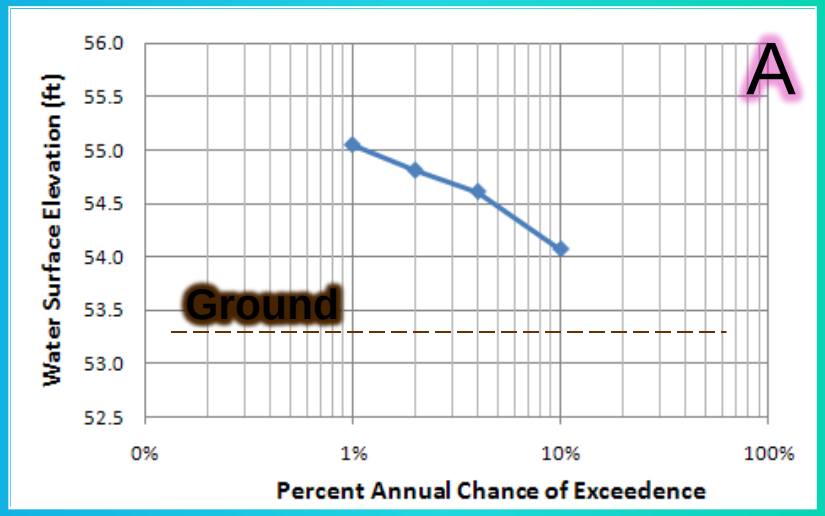


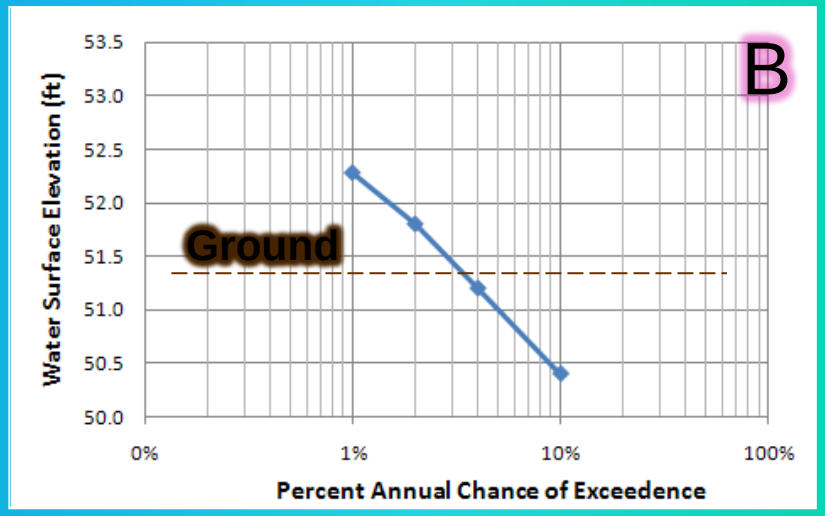
Source: FEMA

AECOM

Percent Annual Chance Grid Development Process



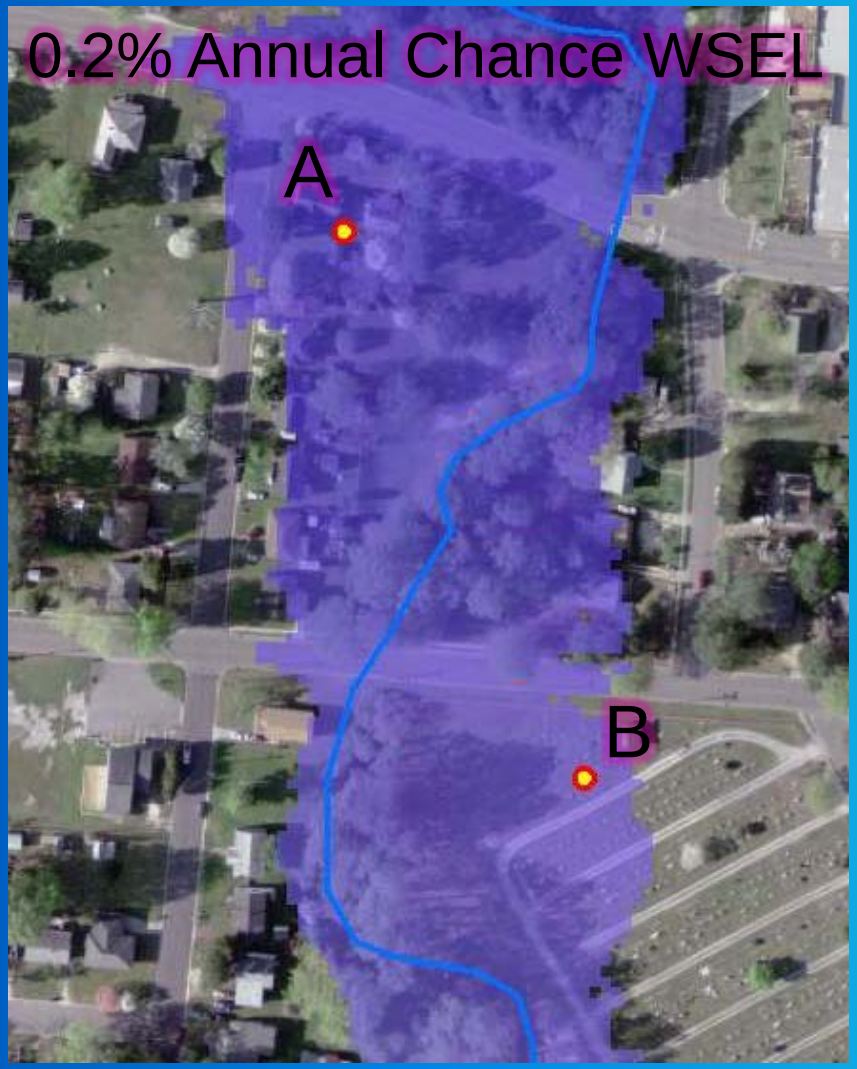


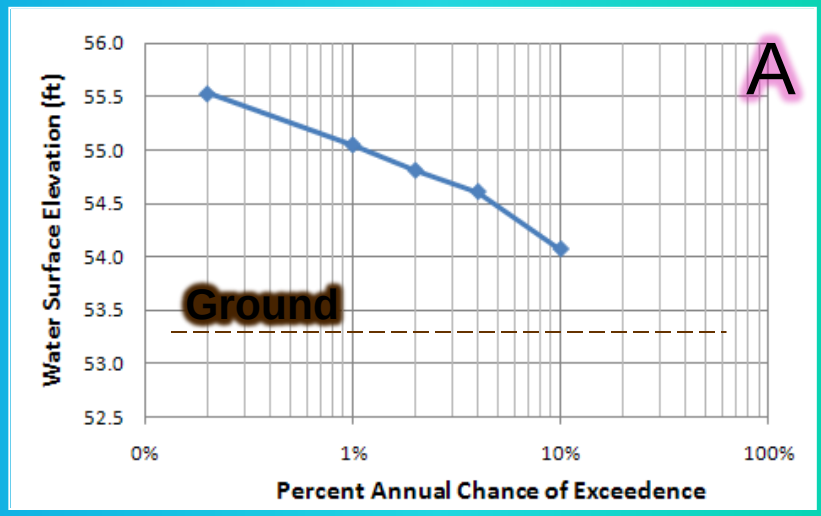


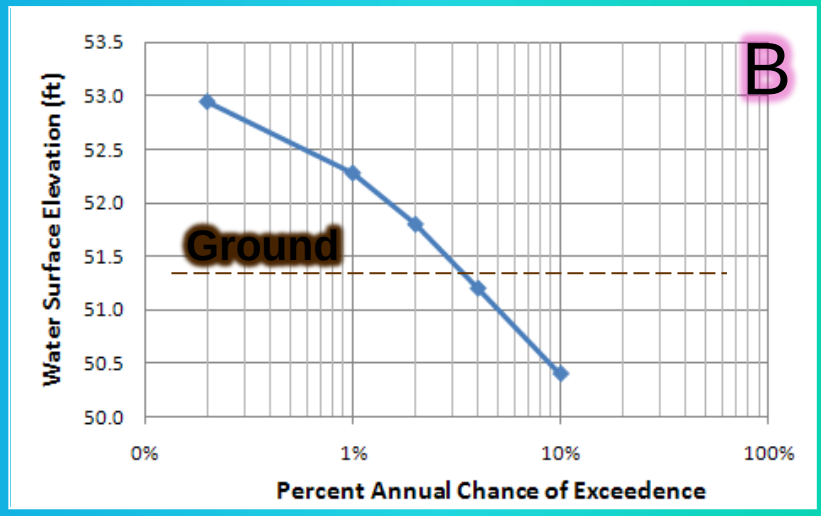
Source: FEMA

AECOM

Percent Annual Chance Grid Development Process



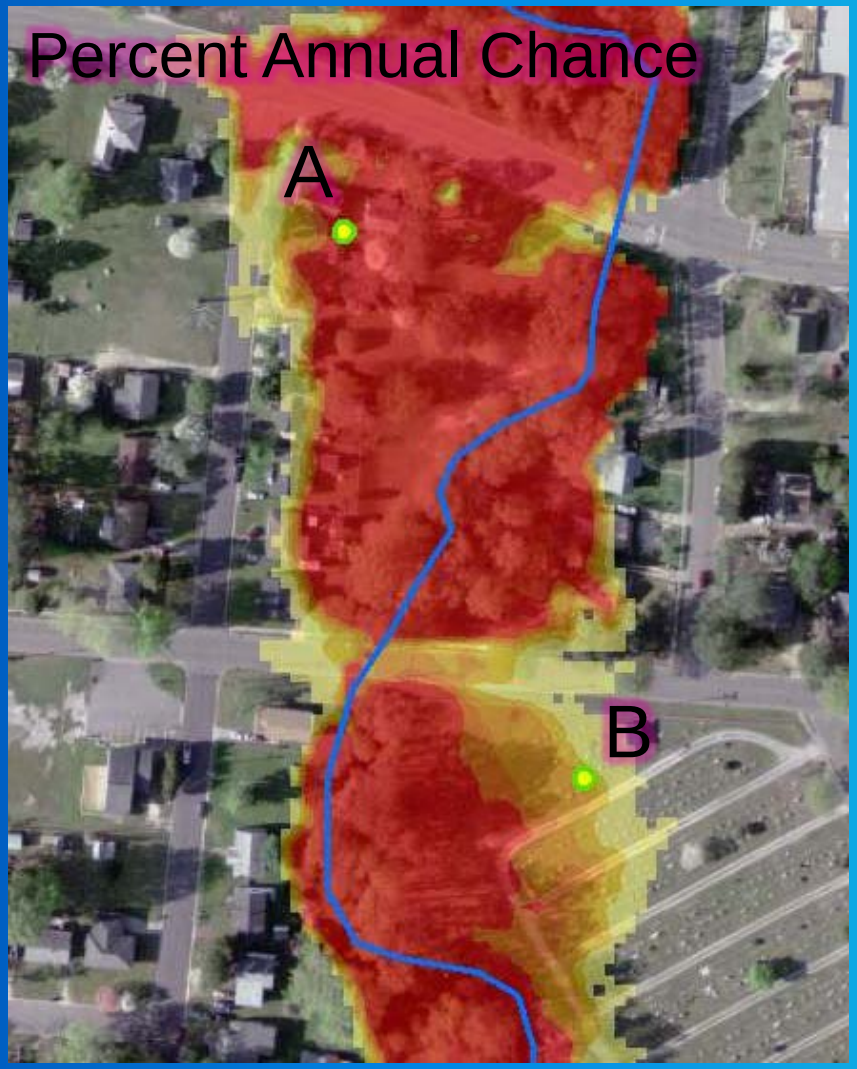


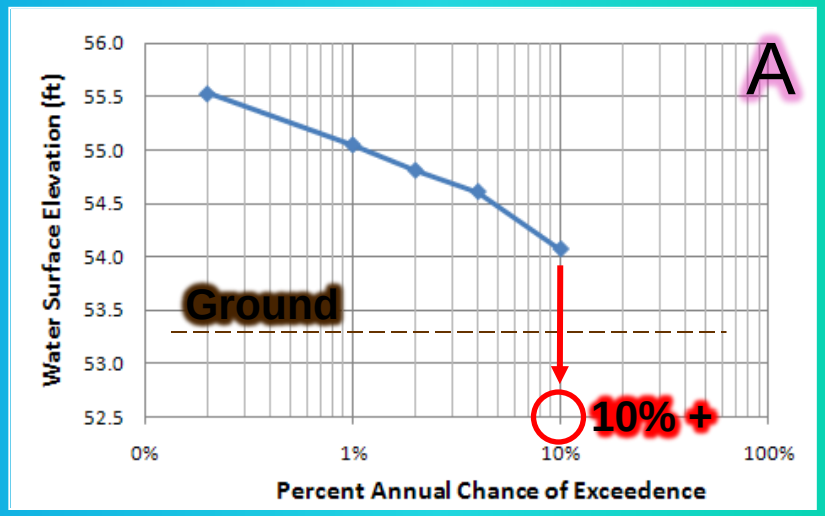


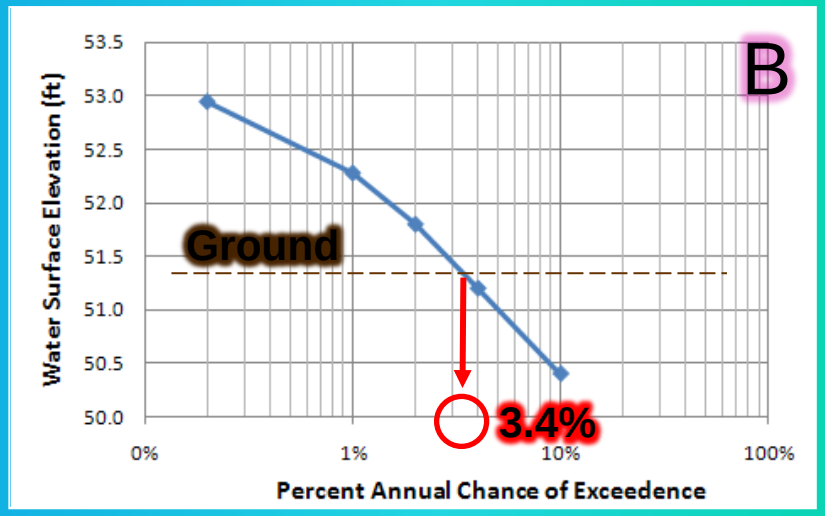
Source: FEMA

AECOM

Percent Annual Chance Grid Development Process







Source: FEMA

AECOM

Percent Chance of Flooding over a 30-yr Period Grid

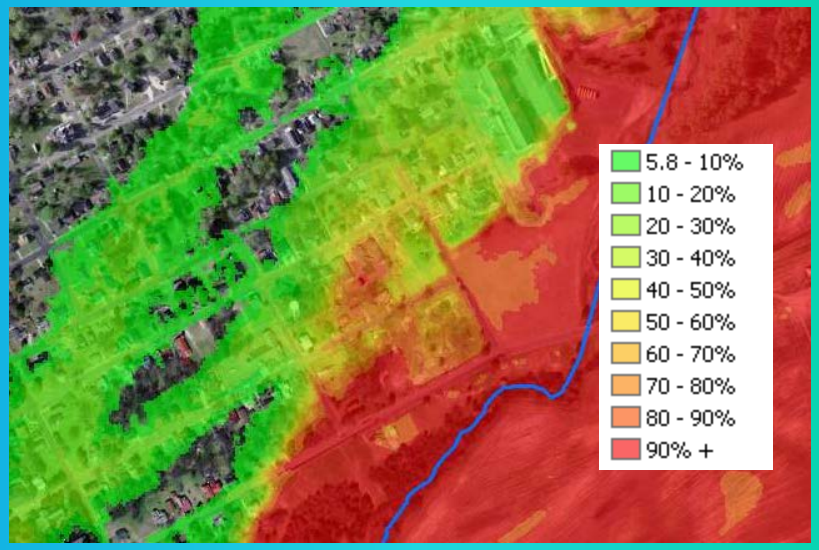
- What is the likelihood that a specific location will flood at least once during a 30-yr period?
- Using the Percent Annual Chance of Flooding Grid as an input, perform the following calculation:

…where “p” = percent annual chance of flooding and “n” = 30

$$1 - (1-p)^n$$

Percent Annual Chance

Percent 30yr Chance



Source: FEMA

Velocity Grids

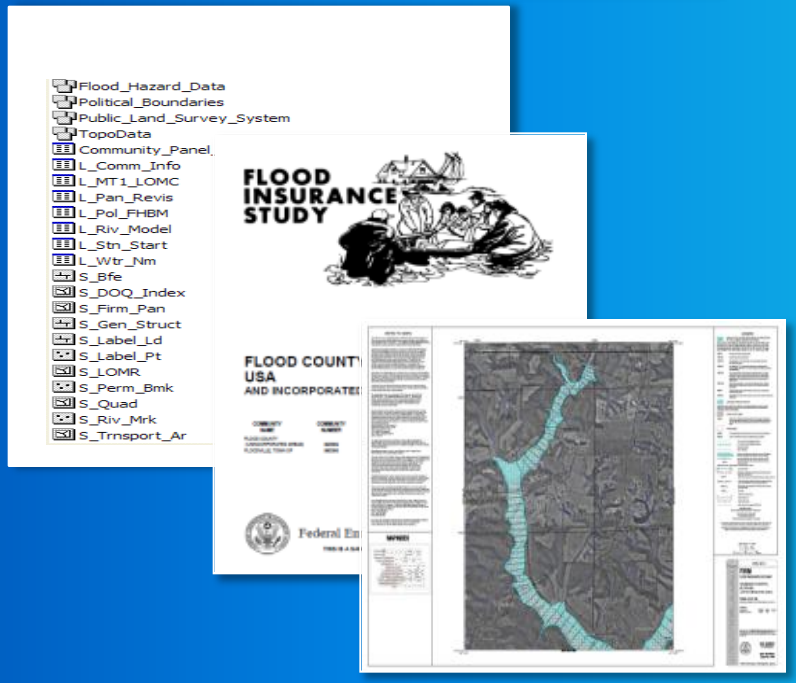
- Velocity Grids can be generated from the results of 1D models (HEC-RAS, etc.) or 2D models in riverine and coastal areas
- Can be combined with depth results (V * D) to communicate impact on structures within the floodplain, assist with human maneuverability applications, help with foundation design, etc.

Source: FEMA

AECOM

Program Product Comparisons

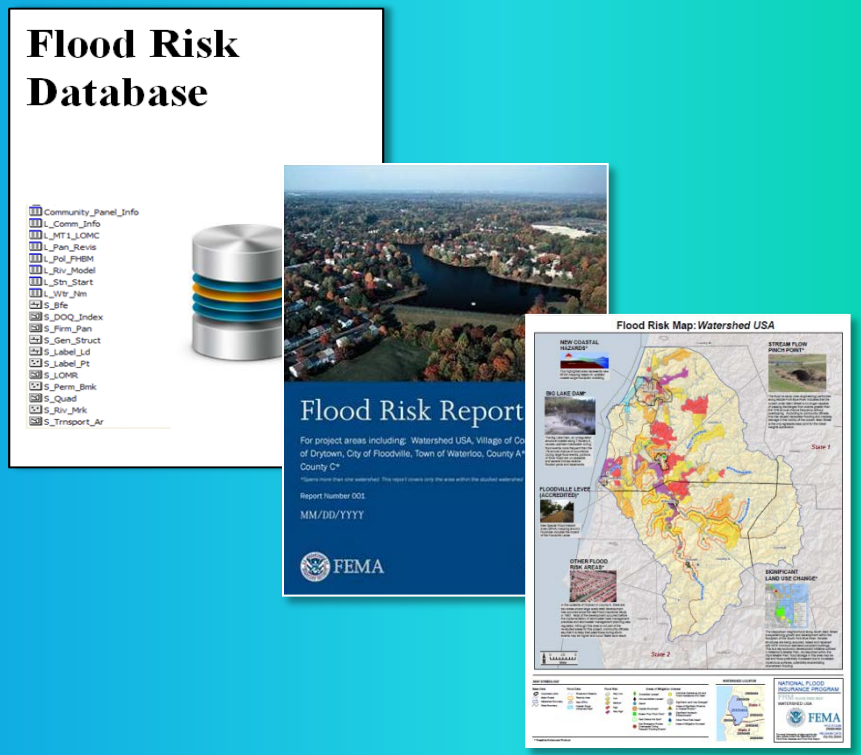
Traditional Regulatory Products



Source: FEMA

Traditional products are regulatory and subject to statutory due-process requirements

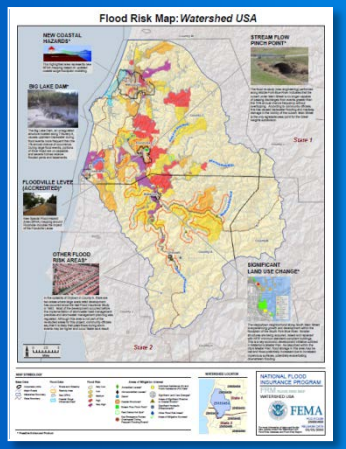
Non-Regulatory Products



Risk MAP products are non-regulatory and are not subject to statutory due-process requirements

AECOM

Flood Risk Products Overview

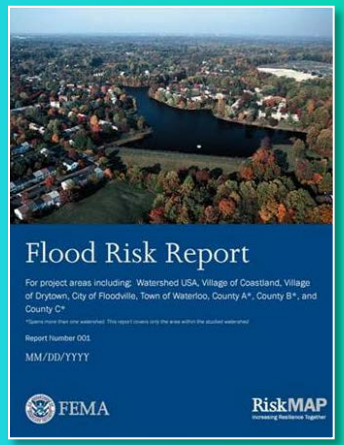


Flood Risk Map

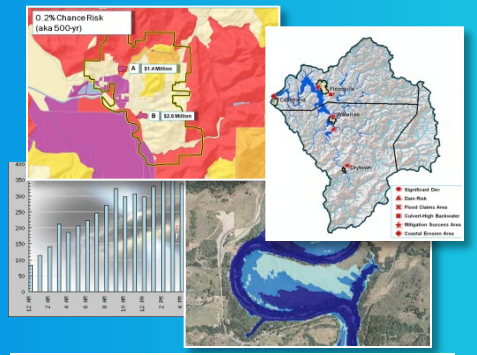
Flood Risk Database

Flood Risk Assessment Data
Flood Depth & Analysis Grids

Changes Since Last FIRM Data
Areas of Mitigation Interest



Flood Risk Report

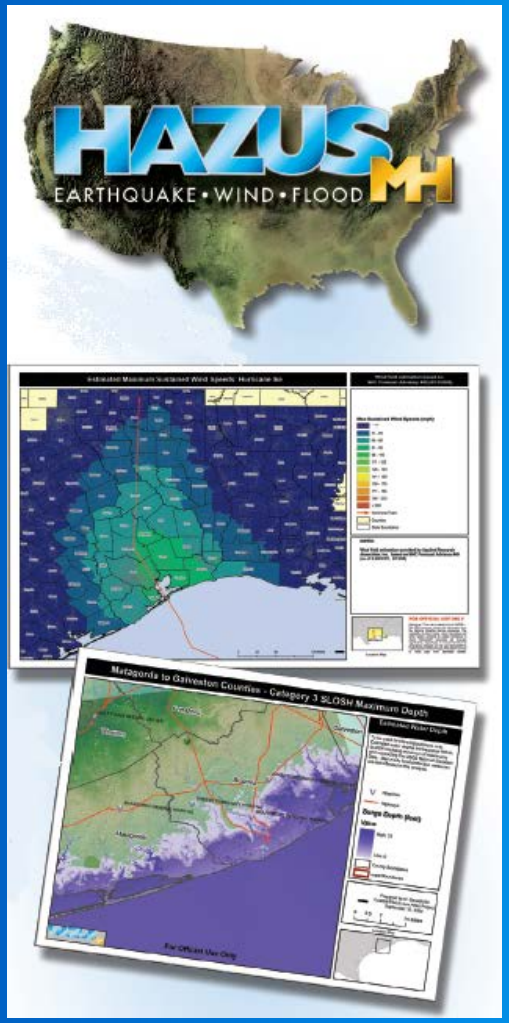


Ad-Hoc Flood Risk Analyses

Source: FEMA

AECOM

Planning – Water Level



Source: FEMA

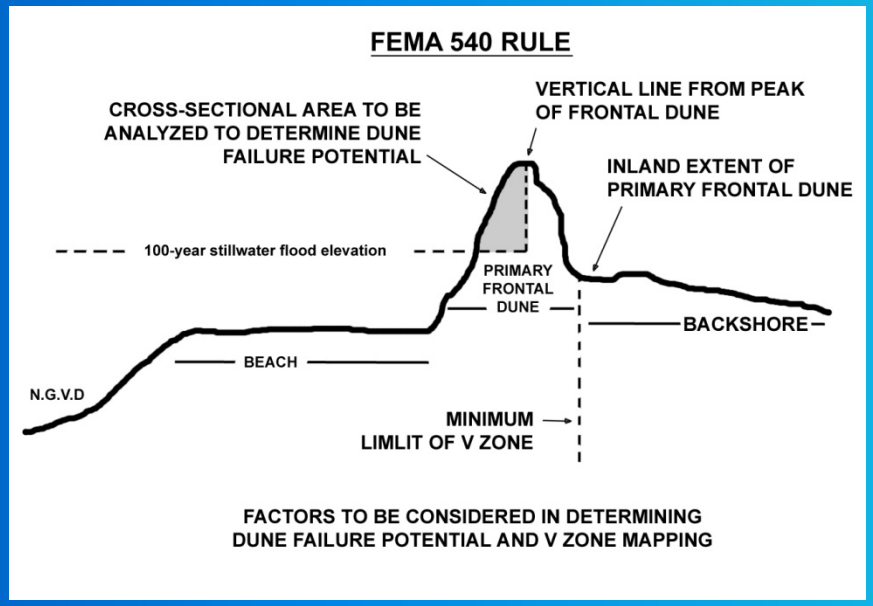
GIS helps us to "see", "tell", and "hear" the story.

AECOM

Erosion – Primary Frontal Dune

Heel

Toe



Source: FEMA

AECOM

Field Reconnaissance

Source: AECOM

Inspect coastal modeling transects

Identify specific field investigation target points

Collect landuse data using an internally designed set of data menus

Develop a landuse shapefile covering the entire modeling domain

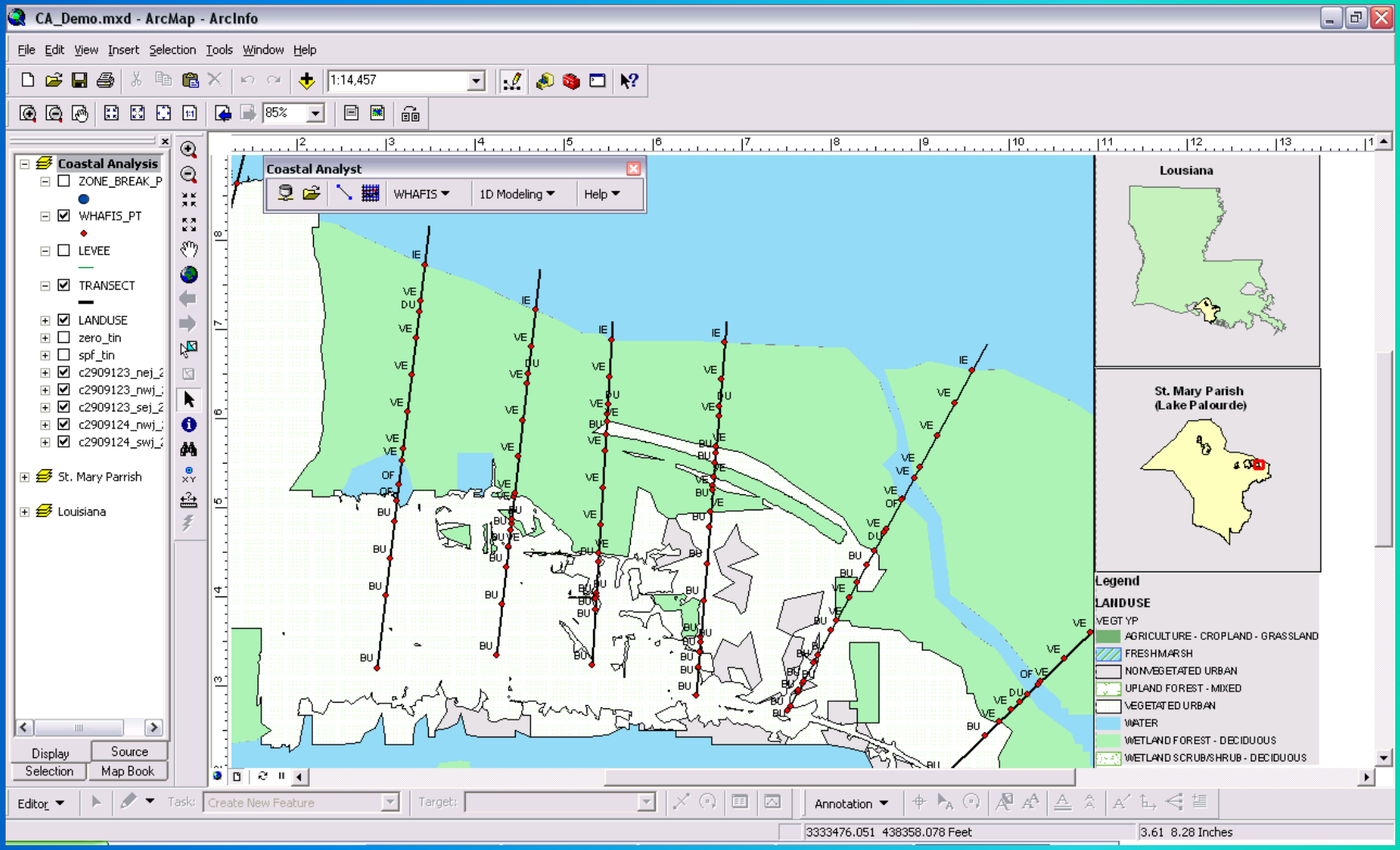
Import into the AECOM proprietary WISE model

Generate a field report to be part of the Technical Study Documentation Notebook (TSDN)

	A	B	C	D	E	F	G	H
1		Description	WHAFIS Card	Classification ID	Avgerage	Avgerage Height	Avgerage Spacing	Drag coefficien
2								
3	version	value		value2	value3	value4	value5	value6
4	2	Rigid Vegetation	VE	VE.A-1	0.75	30	5	1
5	2	Rigid Vegetation	VE	VE.A-2	1.5	30	5	1
6	2	Rigid Vegetation	VE	VE.A-3	2.5	30	5	1
7	2	Rigid Vegetation	VE	VE.B-1	0.75	30	10	1
8	2	Rigid Vegetation	VE	VE.B-2	1.5	30	10	1
9	2	Rigid Vegetation	VE	VE.B-3	2.5	30	10	1
10	2	Rigid Vegetation	VE	VE.C-1	0.75	30	20	1
11	2	Rigid Vegetation	VE	VE.C-2	1.5	30	20	1
12	2	Rigid Vegetation	VE	VE.C-3	2.5	30	20	1
13	2	Rigid Vegetation	VE	VE.D-1	2	30	50	1
14	2	Rigid Vegetation	VE	VE.M-1	0.3	1	1.5	1
15	2	Saw Grass	VH	VH.A-1				
16	2	Salt Grass	VH	VH.A-2				
17	2	Black Grass	VH	VH.A-3				

AECOM

Coastal Flood Hazard Work Maps



Source: AECOM

AECOM

GIS Integration?

- All study phases & elements (i.e., wind, wave, water level, erosion).
- Data →Analysis→Mapping→Planning
- Integrated with other geospatial tools & technologies through common share points and data formats (i.e, one tool's output feed's another's input).

AECOM

Thank You

Chris.Mack@aecom.com