



Hurricane Katrina

Aug 29, 2005



- One of America's largest natural disasters
- Cat 5 less than 12 hrs before landfall
- 127 MPH wind at Louisiana landfall
- Maximum surge of 28 to 30 feet along Mississippi coast
- 80 percent of the city of New Orleans flooded



Hurricane Rita

Sep 24, 2005



- Cat 4 less than 12 hrs before landfall
- 175 MPH max sustained winds in Gulf of Mexico
- 120 MPH max sustained winds at landfall
- Cat 3 strength at landfall

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HSDRRS: Our Mission and Commitment



- *Repair the damages, making what was there before whole again.*
- *Strengthen and improve the system and provide 100-year level of protection capable of withstanding the effects of a storm having a 1% chance of occurring each year.*
- *Current funding level \$14.3 B (fully funded).*
- *Study and recommend solutions to provide higher levels of protection; restore and protect coastal wetlands (LaCPR).*

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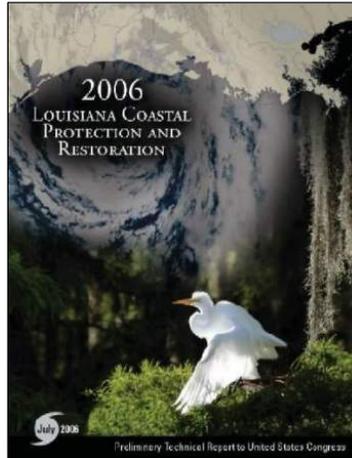


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Louisiana Coastal Protection and Restoration (LaCPR)



- Authorized Technical Report – post Katrina: integration of coastal restoration and higher levels of storm damage risk reduction.
- Collaboration with State of LA and State Master Plan
- Multiple lines of defense strategy
 - Coastal restoration/protection
 - Structural measures
 - Non-structural features
- Describes need for using risk reducing / informing decision making process
- Initial NAS review complete
- Final Technical Report complete for review – Dec. 08



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IPET – Interagency Performance Evaluation Task Force



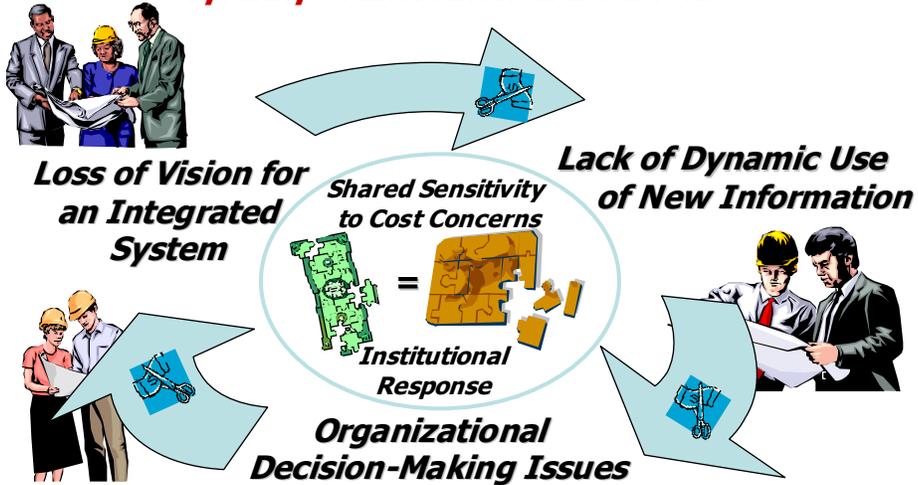
- Over 150 members: academia, industry, state and federal agencies
- Charged to answer 5 Questions:
 - Flood Protection System
 - Storm
 - Performance
 - Consequences
 - Risk
- Peer review by National Academy of Sciences and ASCE
- Draft report June 2006
- Additional NAS reviews complete
- Final report expected late 2008

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HPDC Findings: Key Decision Influences



Tyranny of Incremental Decisions

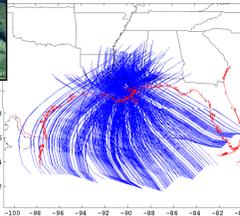
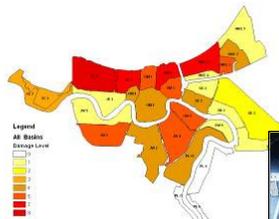


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USACE's Actions for Change



- *Comprehensive systems approach*
- *Risk-informed decision making*
- *Communication of risk to the public*
- *Professional and technical expertise*



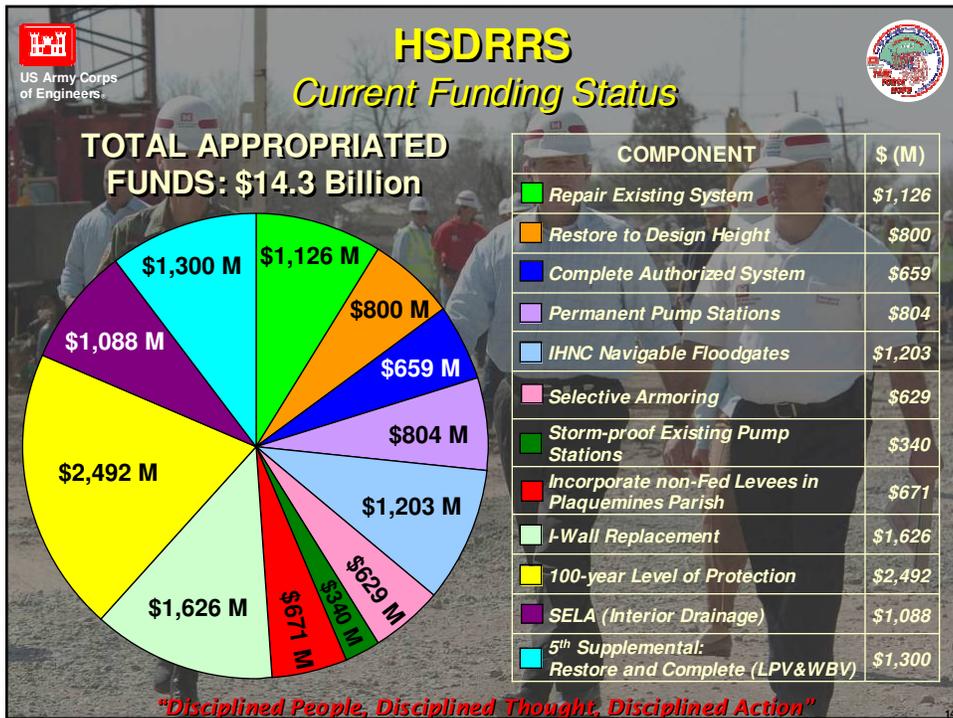
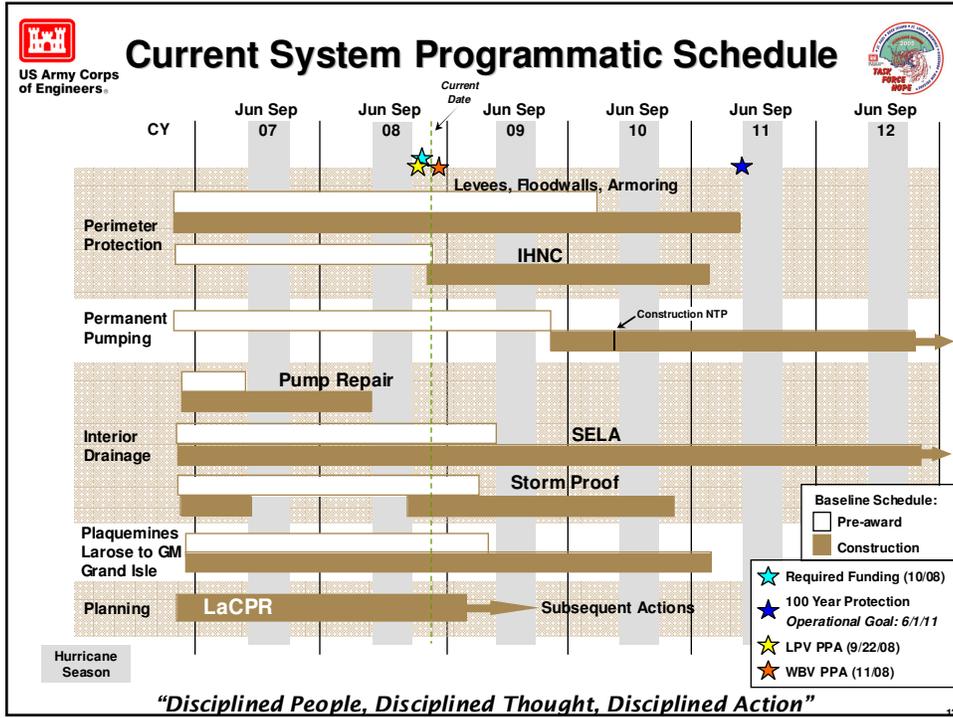
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Program Stakeholders

<u>Local</u>	<u>State</u>	<u>National</u>
<ul style="list-style-type: none"> • People of Metro New Orleans Area • City of New Orleans • 5 Parishes • Sewerage & Water Bd. • Business Community • Neighborhood Associations • And many more..... 	<ul style="list-style-type: none"> • State of Louisiana • Governor's Office • CPRA • LA DOTD • DNR • Levee Authorities • State Insurance Commissioner 	<ul style="list-style-type: none"> • Dept. of Homeland Security • Gulf Coast Rebuilding • OMB • CEQ • Federal Principles • The White House • The Congress

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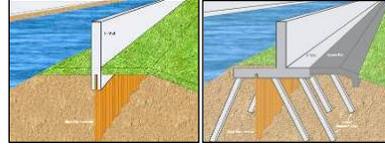


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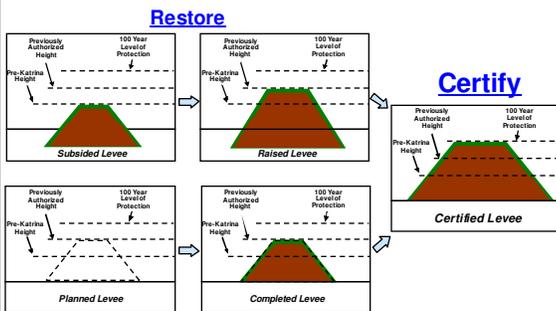
System Improvements: Current and Future



Repair



Correct Floodwall Deficiencies



Improve

Permanent Pump Stations



Navigable Floodgates

Storm Proof Pump Stations

Complete

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System Improvements To Date



- All damages repaired.
 - Lessons learned: deficiencies corrected (failed I-walls to T-walls)
 - Vulnerable floodwalls armored.
 - Transitions strengthened. (floodwalls or flood control structures to levees)
 - New levees and floodwalls restored to pre-Katrina design heights; reduced floodwall "stick-up".
 - Outfall canals protected – Interim Gated Closure Structures installed. Pump capacity increased.
- **Hurricane Protection System Stronger and Better than before Katrina**



Lower 9th Ward Breach Reconstruction



Bayou Bienvenue Control Structure Transition Repair



1949 March 2001 July 2007
17th Street Canal

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System Improvements: Outfall Canal Pumps and Gates



17 th St. Canal	Orleans Ave. Canal	London Ave. Canal
<ul style="list-style-type: none"> • Pumping Capacity: 9,000 cfs • 18 hydraulic pumps • 11 direct drive pumps • 14 portable pumps 	<ul style="list-style-type: none"> • Pumping Capacity: 2,200 cfs • 10 hydraulic pumps 	<ul style="list-style-type: none"> • Pumping Capacity: 5,000 cfs • 12 hydraulic pumps • 8 direct drive pumps
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Construction Status

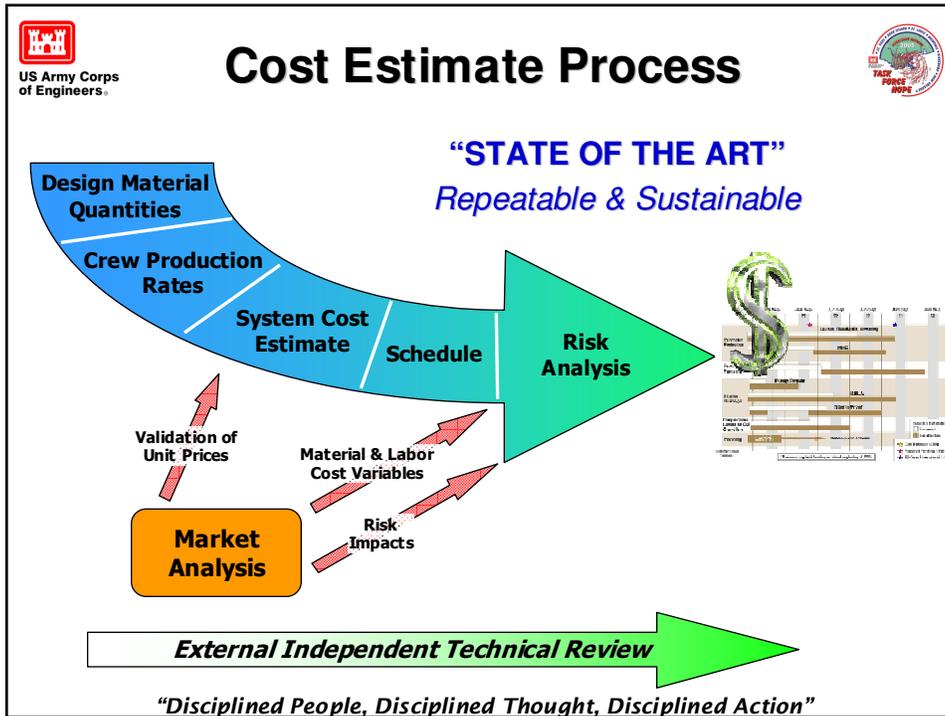


- *Total expected construction contracts: ~350*
- *Awarded 170+ construction contracts for \$2.3B*
- *Overall Program Estimate: ~\$14.6B*
- *45 construction contracts worth \$1.4B ongoing*

2008

- *2008 – Anticipate awarding about 40+ contracts for around \$2B*
- *Awarded IHNC Surge Protection w/Advance Measures*
- *Award 30+ contracts for Levees, Floodwalls and Armoring*
- *Award 3 contracts for pump station repairs*
- *Award 3 contracts for SELA (interior drainage)*

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Market and Risk Analysis

- Performed by World Class industry experts
- Analyzed key materials, equipment and labor
- Researched market prices
- Projected future costs
- Assessed potential for supply constraints
- Cost & quantity uncertainties captured and analyzed
- Developed Risk Register (cost & schedule risk)
- Risk items linked to specific affected activities

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Cost to Complete

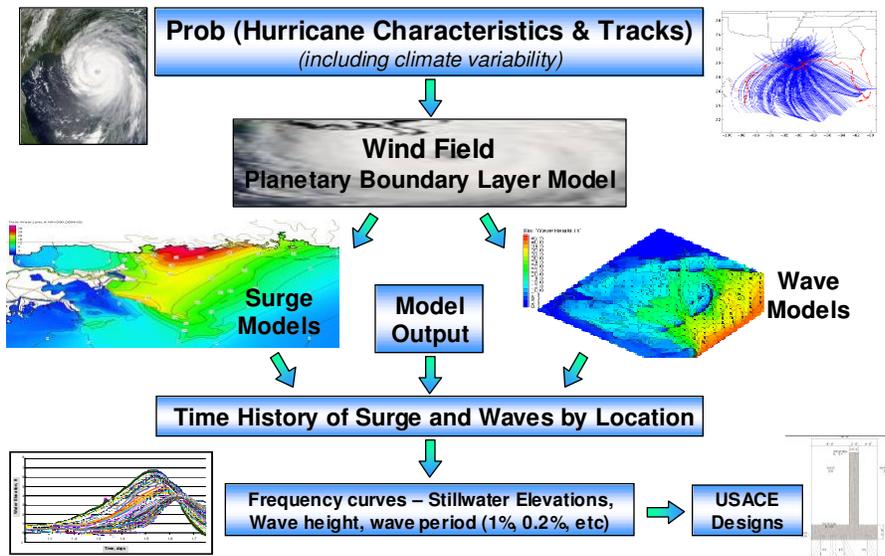


- Key Features:
 - Repair, restore and construct authorized projects and build 100-year level of protection System
 - Unprecedented estimating, engineering and construction processes, aggressive schedule
 - Risk Analysis and Market Analysis by industry experts
 - Independent and external peer review by industry experts
 - Manage as a SYSTEM
- Reflects:
 - lessons learned from IPET
 - state of the art storm projection modeling,
 - risk and reliability analysis,
 - updates for levee and floodwall design criteria
 - new datum and
 - sea level rise

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From Modeling to Designs



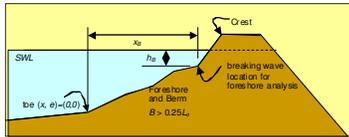
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The Design Process: Levees

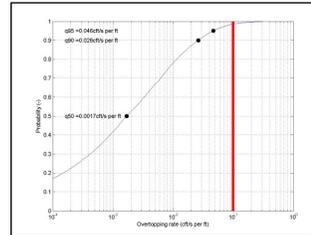


Frequency Curves - Stillwater Elevations, Wave Height, Wave Period (1%, 0.2%, etc)

Uncertainty: Monte Carlo Simulation



Levee Height and Slope



Design Elevation and Slope

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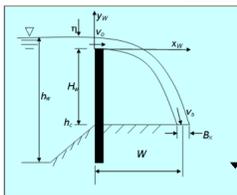
The Design Process: Floodwalls



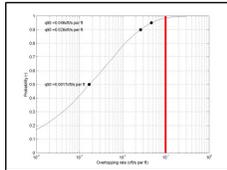
Frequency Curves - Stillwater Elevations, Wave Height, Wave Period (1%, 0.2%, etc)

Wave Forces: GODA

Uncertainty: Monte Carlo Simulation

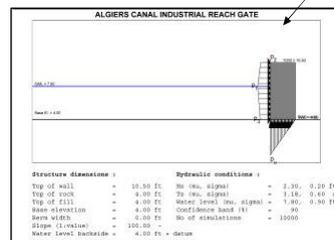


Wall Height



Wave Runup and Overtopping: Franco and Franco

Uncertainty: Monte Carlo Simulation



Structure Design Elevation

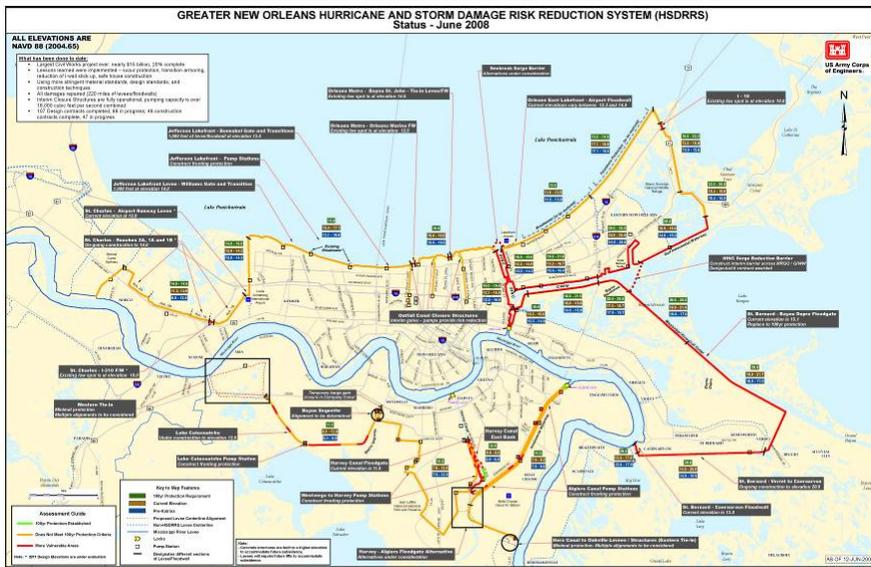
Structure Wave Loads

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HSDRRS Design Heights

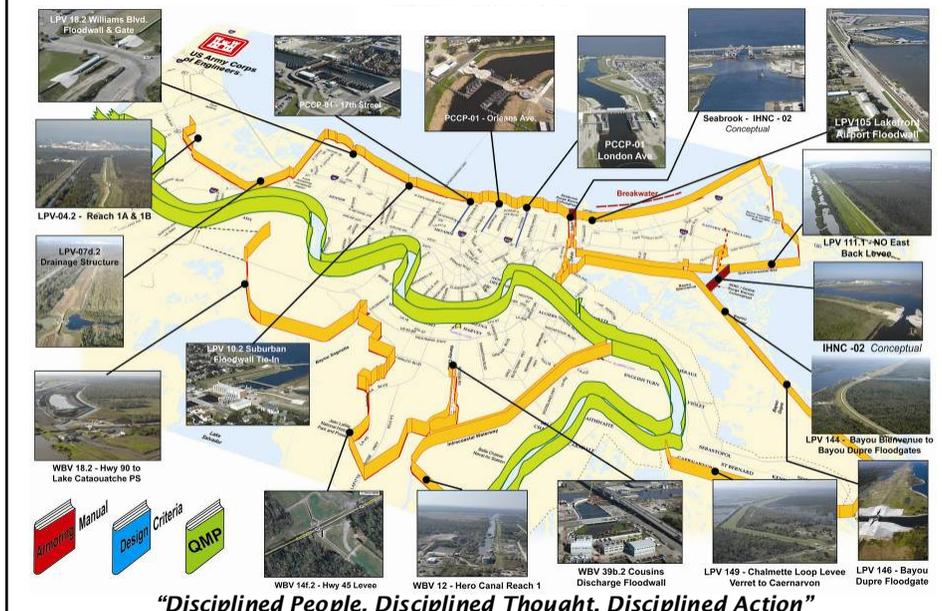


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External Peer Review



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IHNC Surge Protection

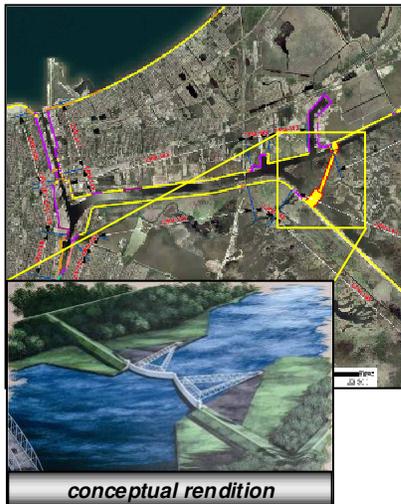


Objectives:

- Provide protection to New Orleans East / New Orleans Metro / IHNC-MRGO / St. Bernard area.
- Complete protection by 2011 with advanced measures (risk reduction) by Aug 2009

Status

- Awarded 3 APR 08 a design-build contract to Shaw E&I for \$695M – largest in Corps history
- Formal partnering sessions 24-25 APR 08
- Wide stakeholder engagement
- Environmental Compliance complete
- Contractor mobilized
- Notice to proceed with construction issued 4 Nov 2008



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Hurricane Gustav



- Formed: 25 Aug 2008
- Landfall: 1 Sep 2008
- Landfall: near Houma, LA
- Highest winds: 150 mph
- Lowest pressure: 941 mbar
- Diameter: 440 miles
- Hurricane Katrina diameter: 460 miles
- Actual surge: 12 ft.

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Hurricane Ike



- Formed: 1 Sep 2008
- Landfall: 13 Sep 2008
- Landfall: Galveston, TX



- Highest winds: 145 mph
- Lowest pressure: 935 mbar
- Diameter: 550 miles
- Hurricane Katrina diameter: 460 miles
- Actual surge: 15 ft.

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Performance of the GNHSDRRS

Waves Over IHNC Floodwall



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Performance of the GNHSDRRS

Lower 9th Ward IHNC Floodwall



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Performance of the GNHSDRRS

interim measures in the IHNC



Pre-Gustav

Post-Gustav



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IPET and Risk Informed Planning



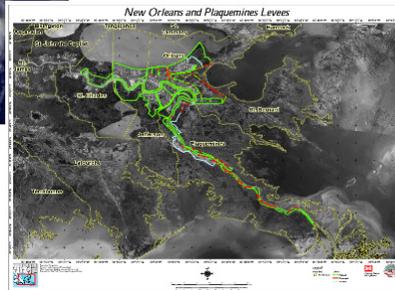
Forensic Analysis and Risk-Based System-Wide Assessment

STORM

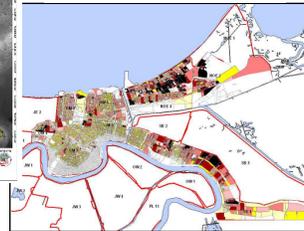


Results are
"in the Ground"

SYSTEM



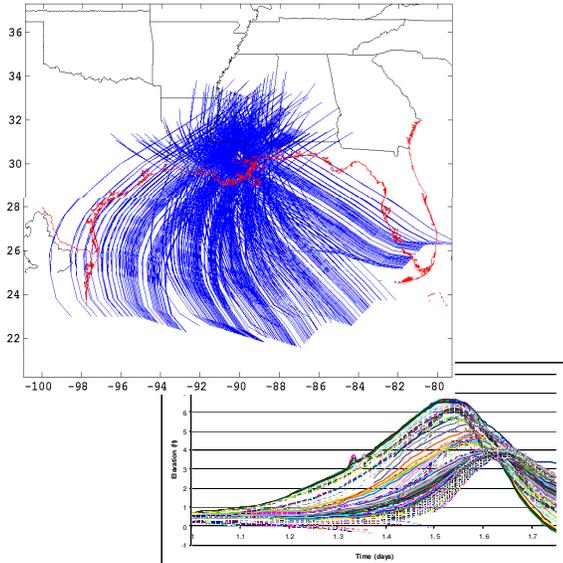
CONSEQUENCES



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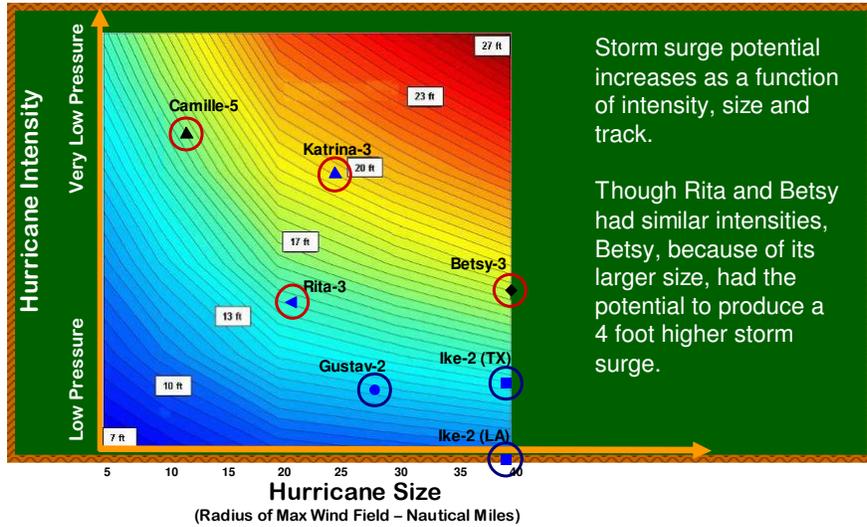
Hurricane Paths Considered in the Risk Analysis



- 3 HPS Geometries
 - Pre-Katrina
 - Current (1 June 07)
 - 100-year LOP (~2011)
- 152 storms
- 350+ features
 - Floodwalls
 - Levees
 - Pumps Stations
- 62,928 Hurricane Hydrographs

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Hurricane Size Matters



Storm surge potential increases as a function of intensity, size and track.

Though Rita and Betsy had similar intensities, Betsy, because of its larger size, had the potential to produce a 4 foot higher storm surge.

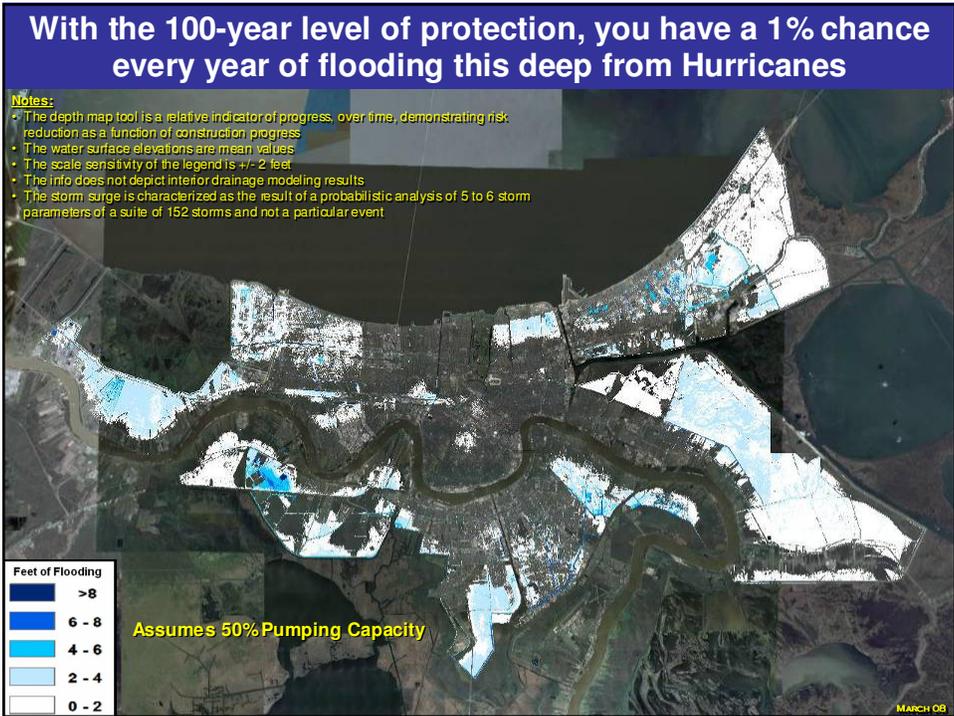
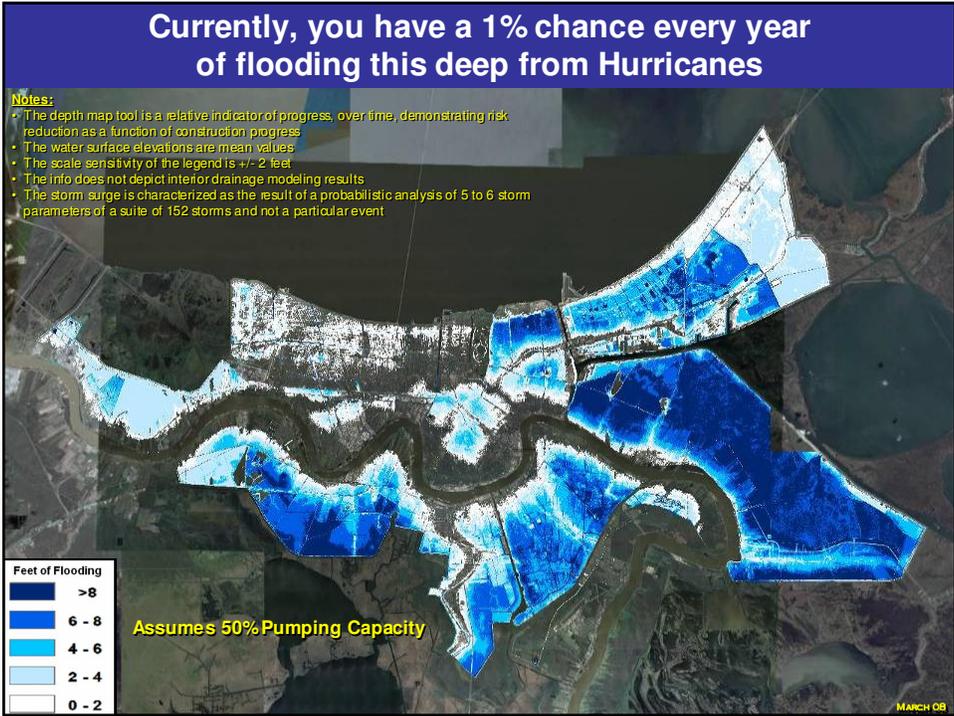
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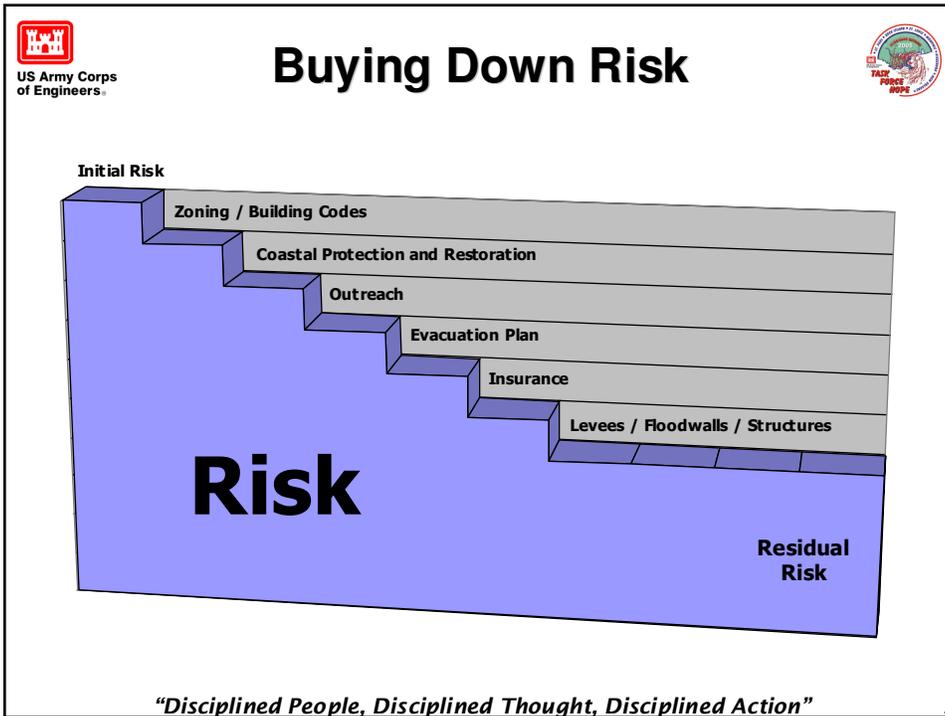
Before Katrina, you had a 1% chance every year of flooding this deep from Hurricanes

Notes:

- The depth map tool is a relative indicator of progress, over time, demonstrating risk reduction as a function of construction progress
- The water surface elevations are mean values
- The scale sensitivity of the legend is +/- 2 feet
- The info does not depict interior drainage modeling results
- The storm surge is characterized as the result of a probabilistic analysis of 5 to 6 storm parameters of a suite of 152 storms and not a particular event







***New Orleans
Hurricane and Storm
Damage Risk Reduction
System***

by

***Karen Durham-Aguilera, P.E.
Director
Task Force Hope
U.S. Army Corps of Engineers***

November 7, 2008