“In and Out Air Strategies. From Climate Change to Microclimate. Library, Archives and Museum Preservation Issues”

5-6 March 2009

Bibliothèque nationale de France

http://www.ifla.org/VI/4/pac.htm

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International Conference
Bibliothèque nationale de France
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WIND RESISTANCE STRATEGIES FOR CULTURAL HERITAGE BUILDINGS IN THE AFTERMATH OF HURRICANE KATRINA

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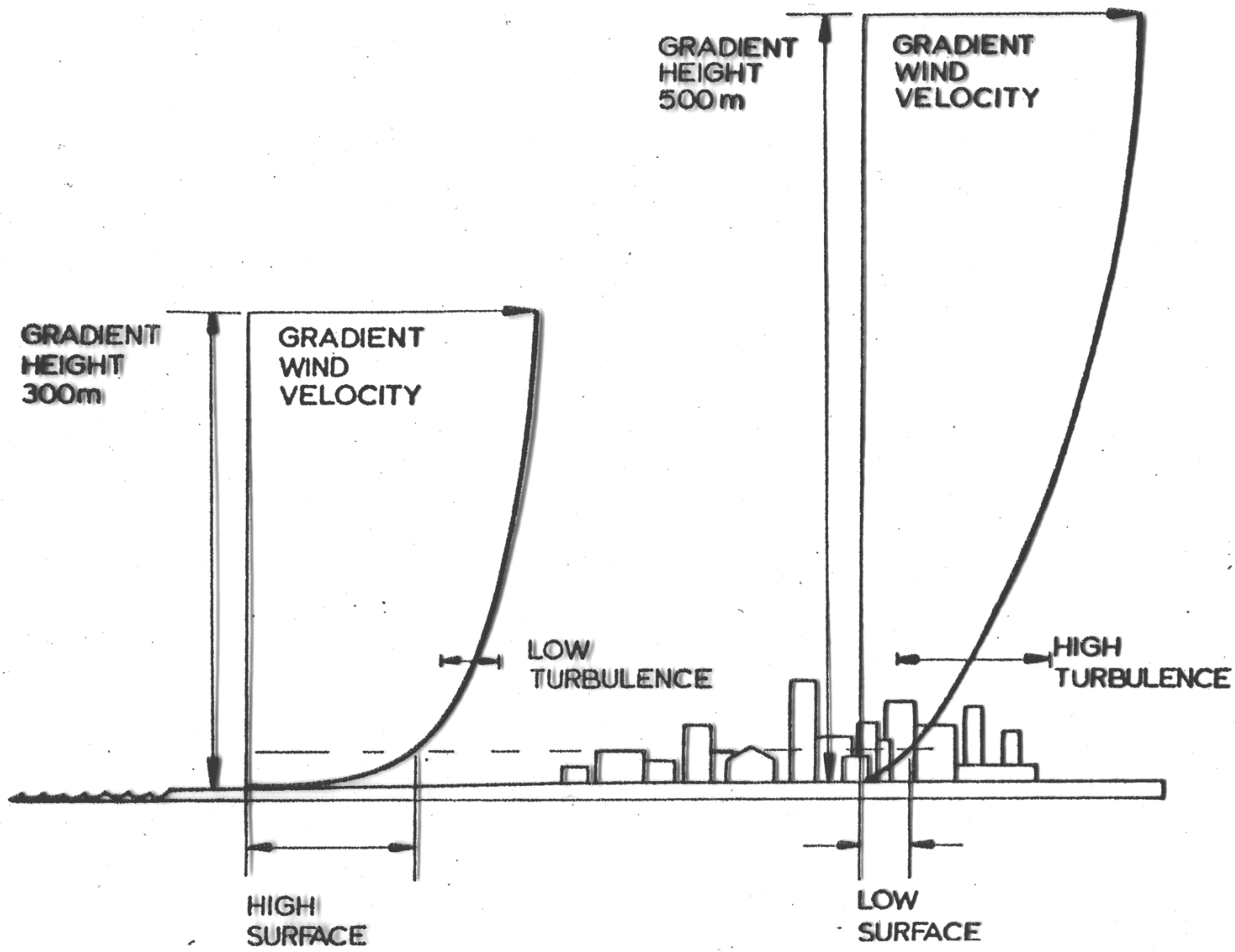
Associate Professor
University of Waterloo School of Architecture


GRADIENT
HEIGHT
300m
GRADIENT
WIND
VELOCITY
LOW
TURBULENCE
HIGH
SURFACE
GRADIENT
HEIGHT
500m
GRADIENT
WIND
VELOCITY
HIGH
TURBULENCE
LOW
SURFACE

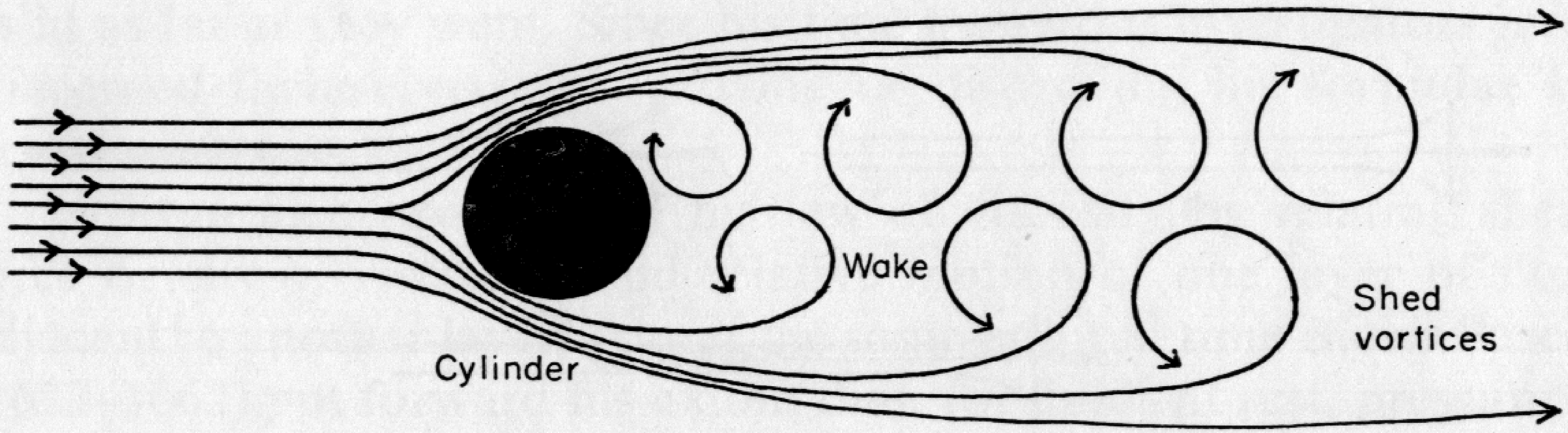


Fig. 1.28. Flow pattern around a circular cylinder indicating vortex shedding downstream in the wake.

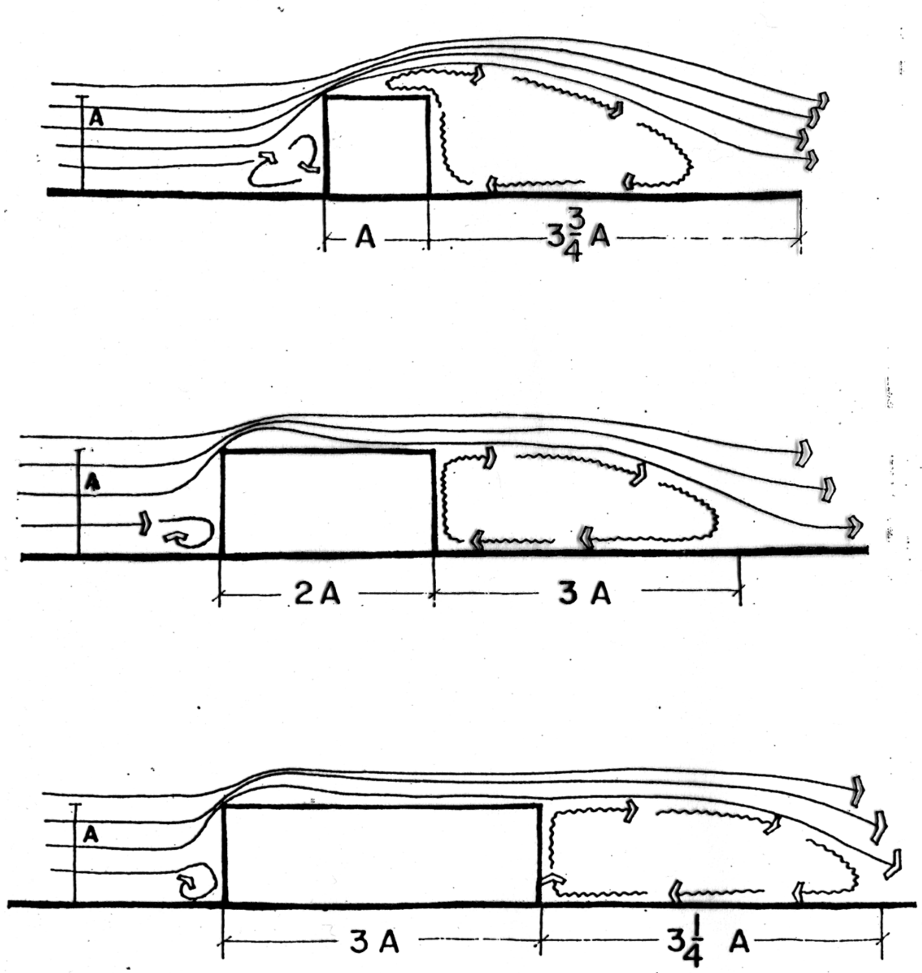


Figure 4-20. Length of leeward eddy area for flat-roof building.

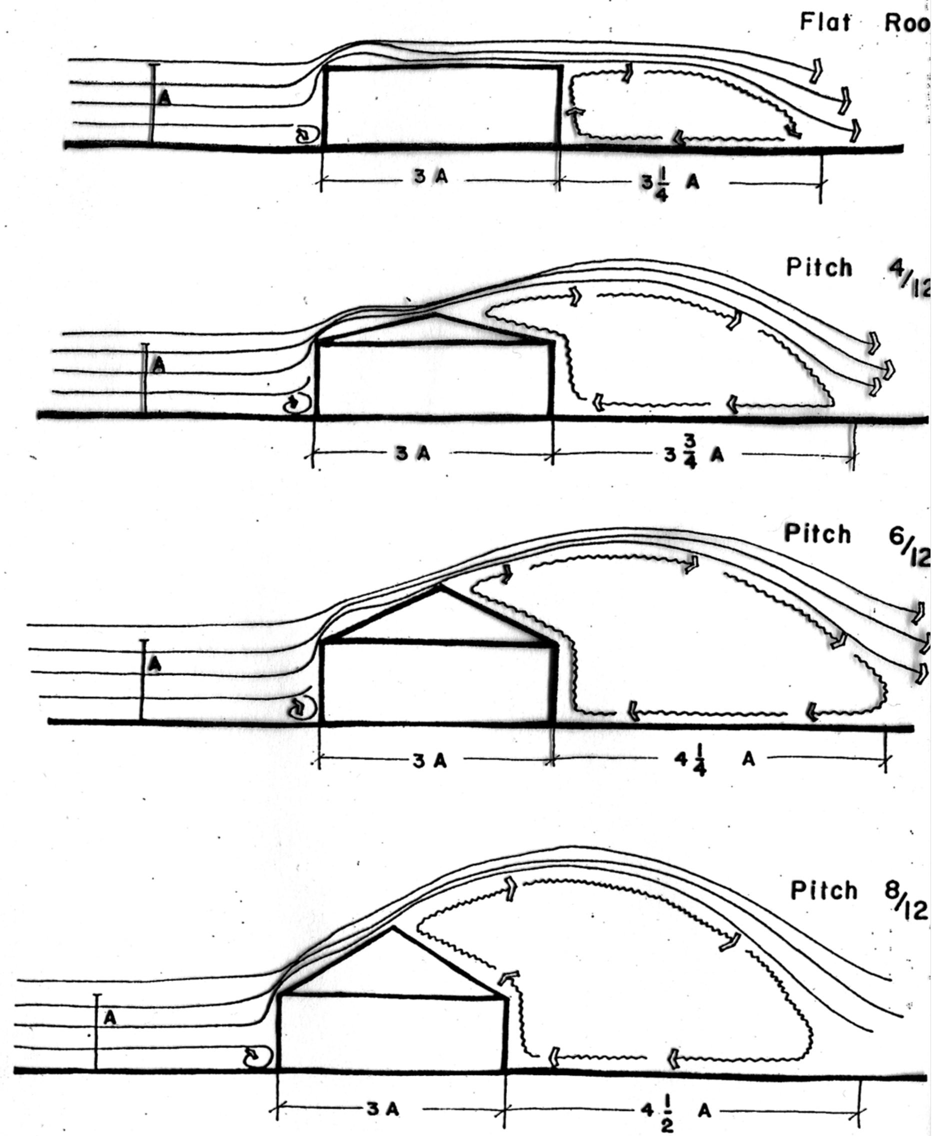


Figure 9a AIR FLOW AT CIRCULAR OBSTRUCTION

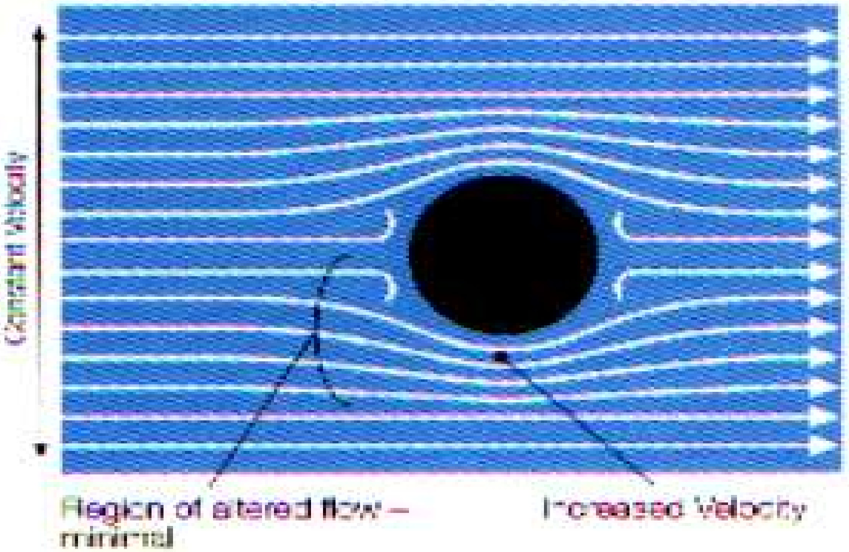


Figure 9b AIR FLOW AT RECTANGULAR OBSTRUCTION

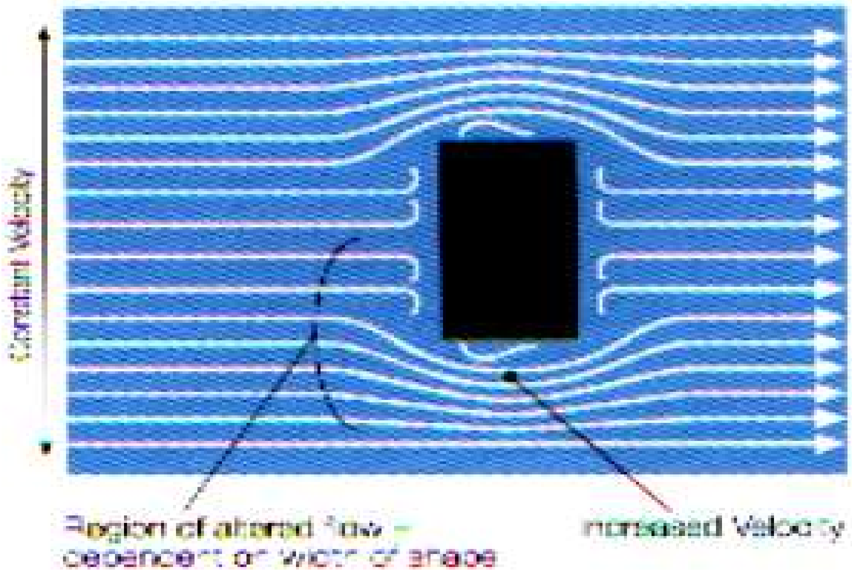


Figure 11a AIR FLOW AT SIMPLE STRUCTURE

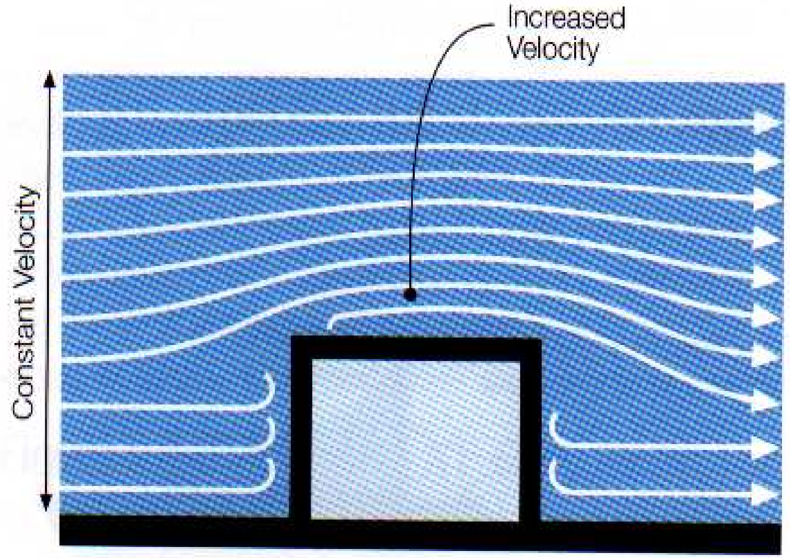


Figure 11b PRESSURE DISTRIBUTION AT SIMPLE STRUCTURE

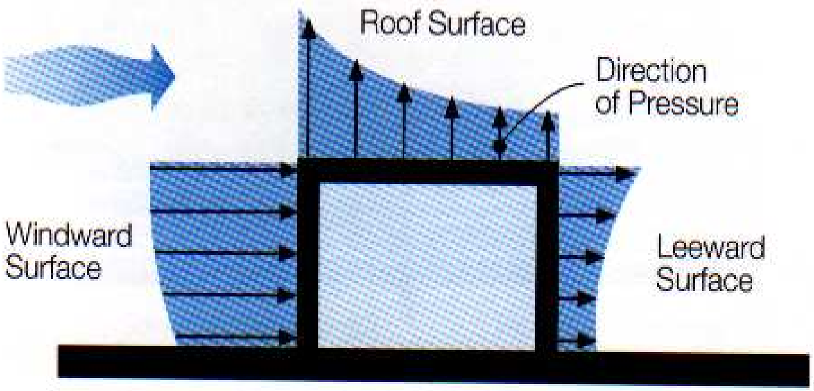


Figure 14 AIR FLOW

Figure 14a LOW ROOF SLOPE

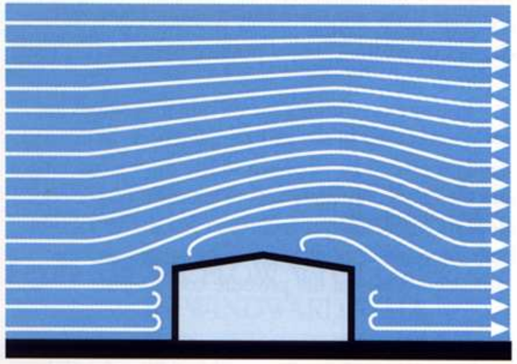


Figure 14b MODERATE ROOF SLOPE

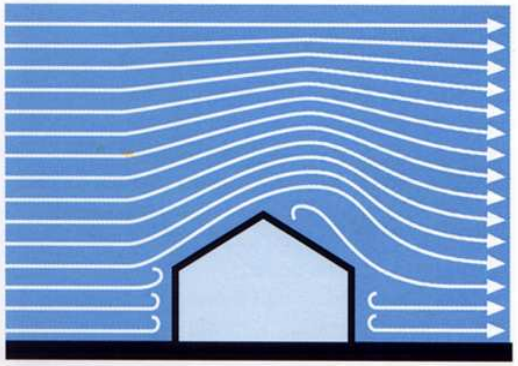


Figure 14c STEEP ROOF SLOPE

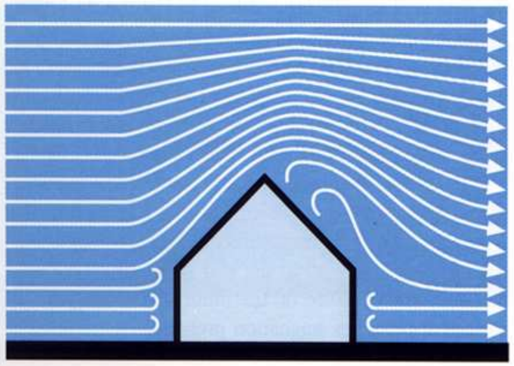


Figure 15 DEVELOPMENT OF PRESSURES

Figure 15a LOW ROOF SLOPE

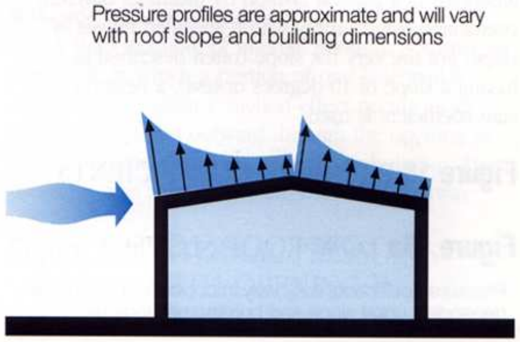


Figure 15b MODERATE ROOF SLOPE

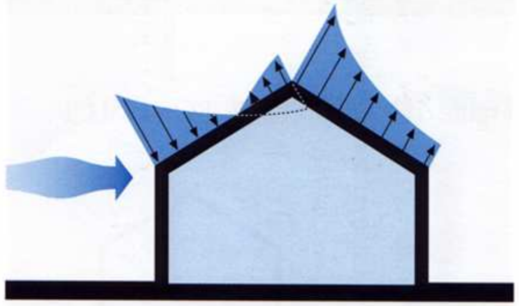


Figure 15c STEEP ROOF SLOPE

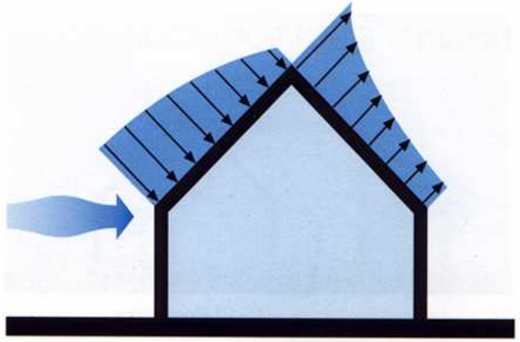


Figure 20 ZONE OF INCREASED PRESSURE COEFFICIENT AT CORNER CONDITION

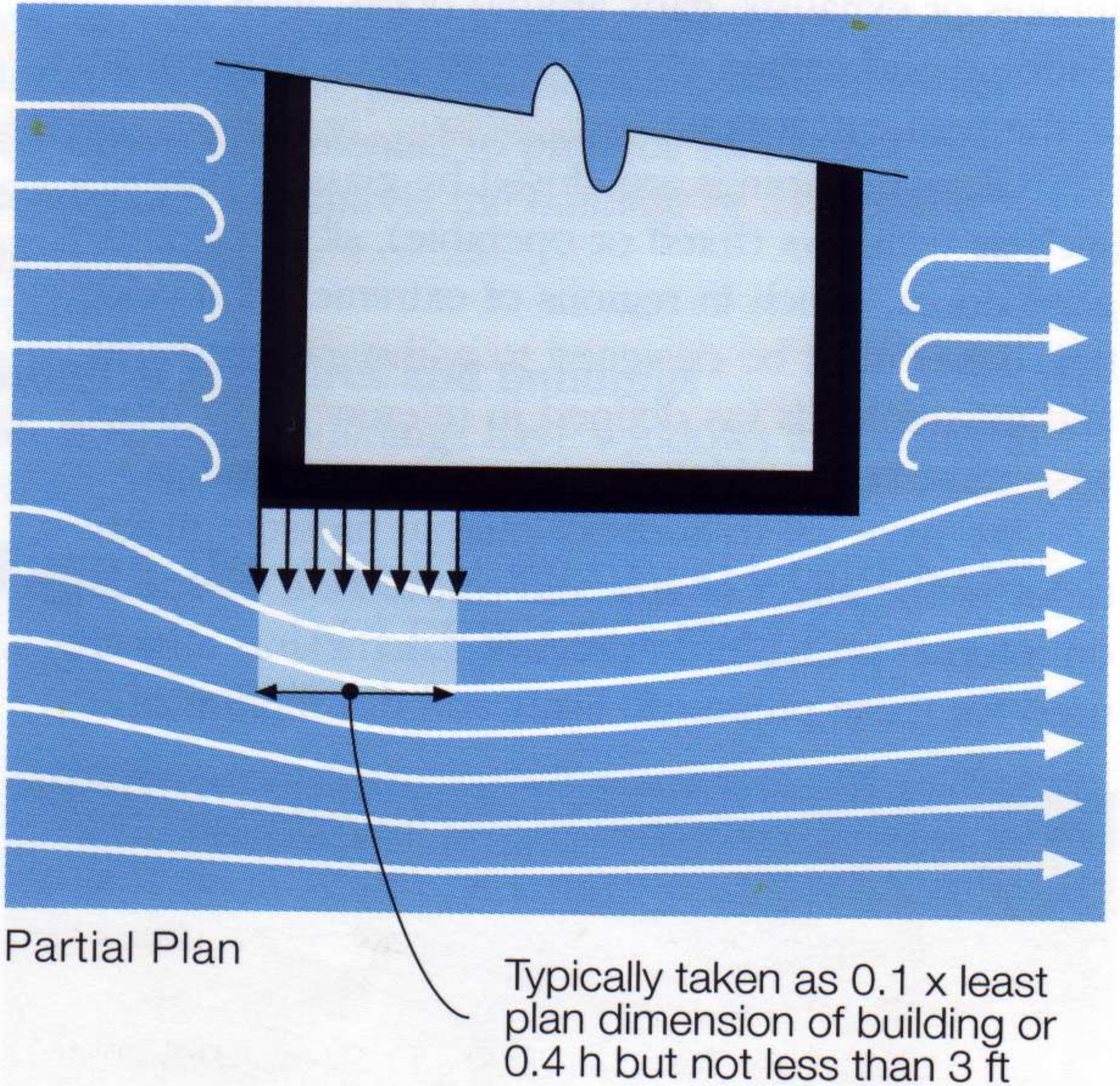


Figure 21 ZONES OF INCREASED PRESSURE COEFFICIENT AT ROOF CONDITION

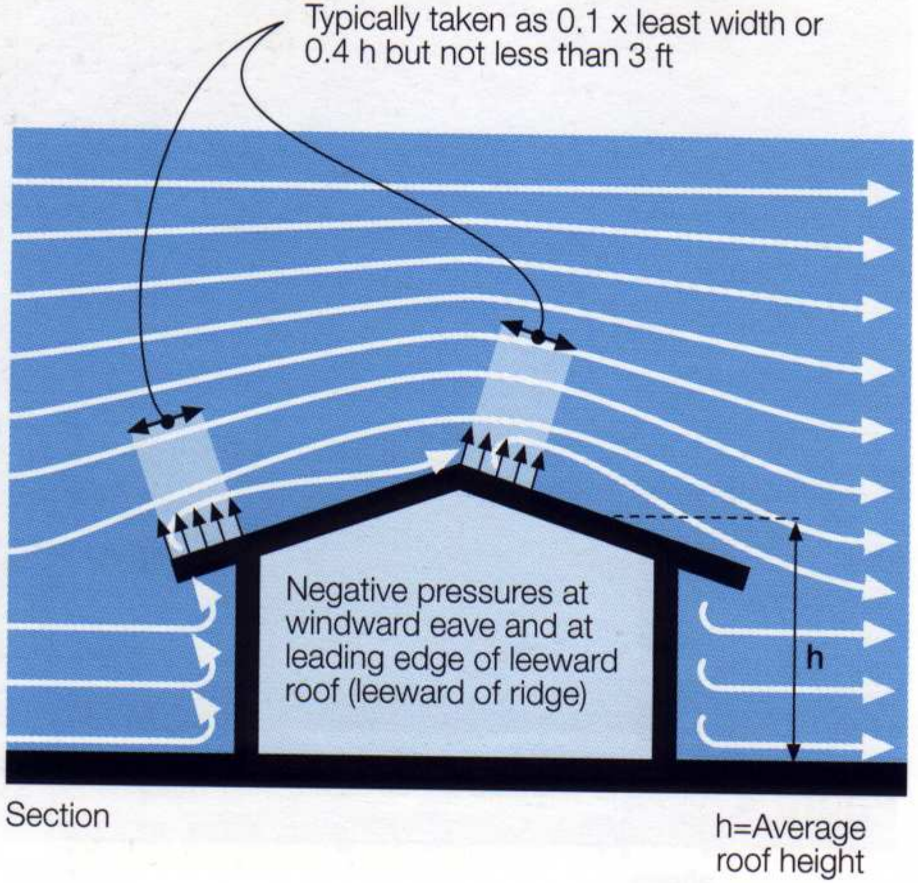
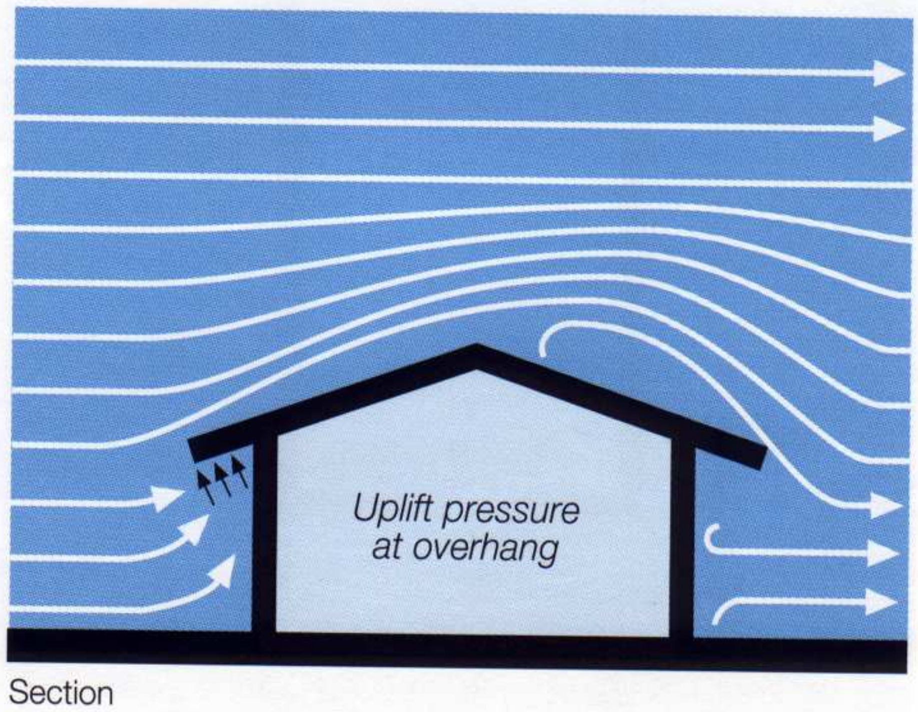


Figure 22 UPLIFT PRESSURE AT ROOF OVERHANG



HURRICANE KATRINA

Wind damage to shop structure near Long Beach MS

HURRICANE KATRINA

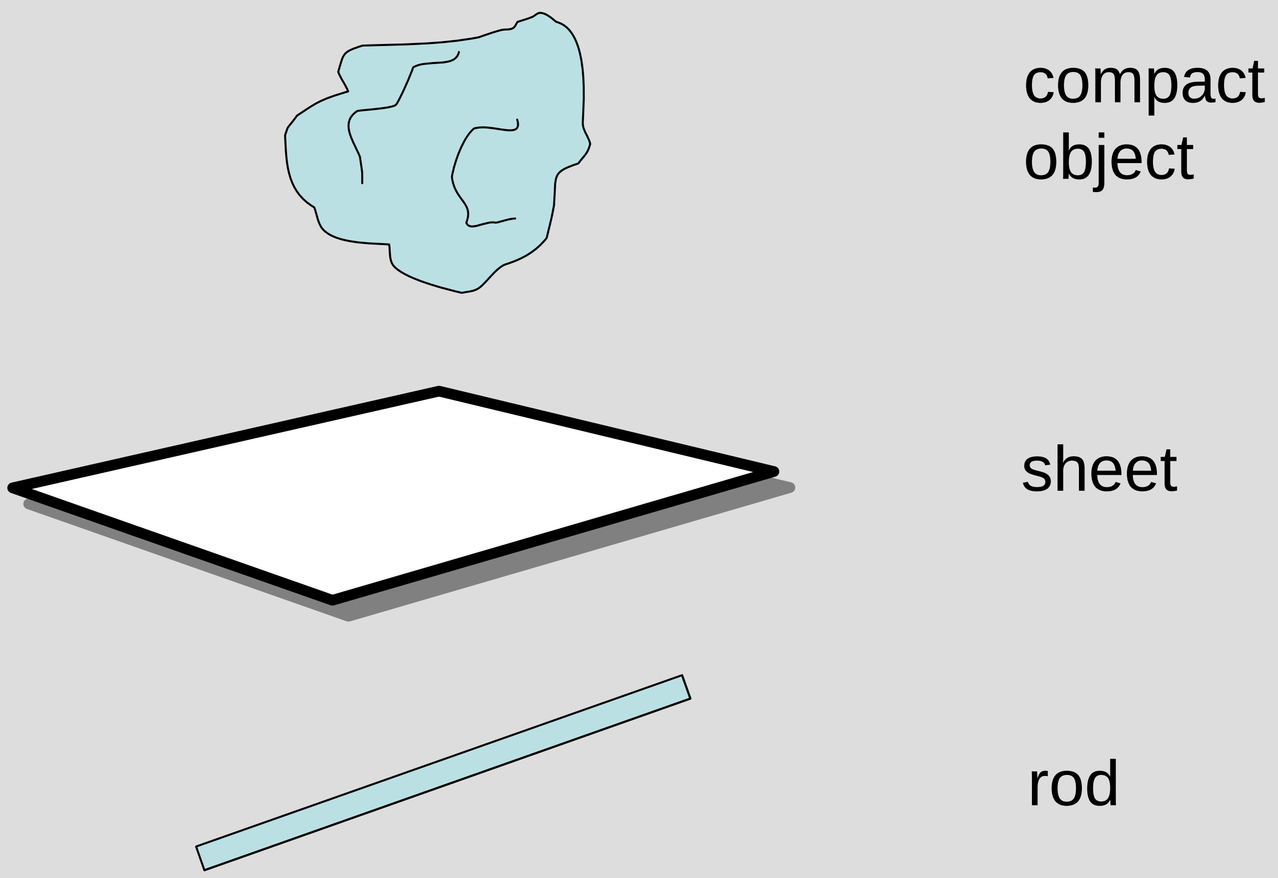
Wind-damaged apartments near West Jefferson Hospital – classic gable end failure

HURRICANE KATRINA

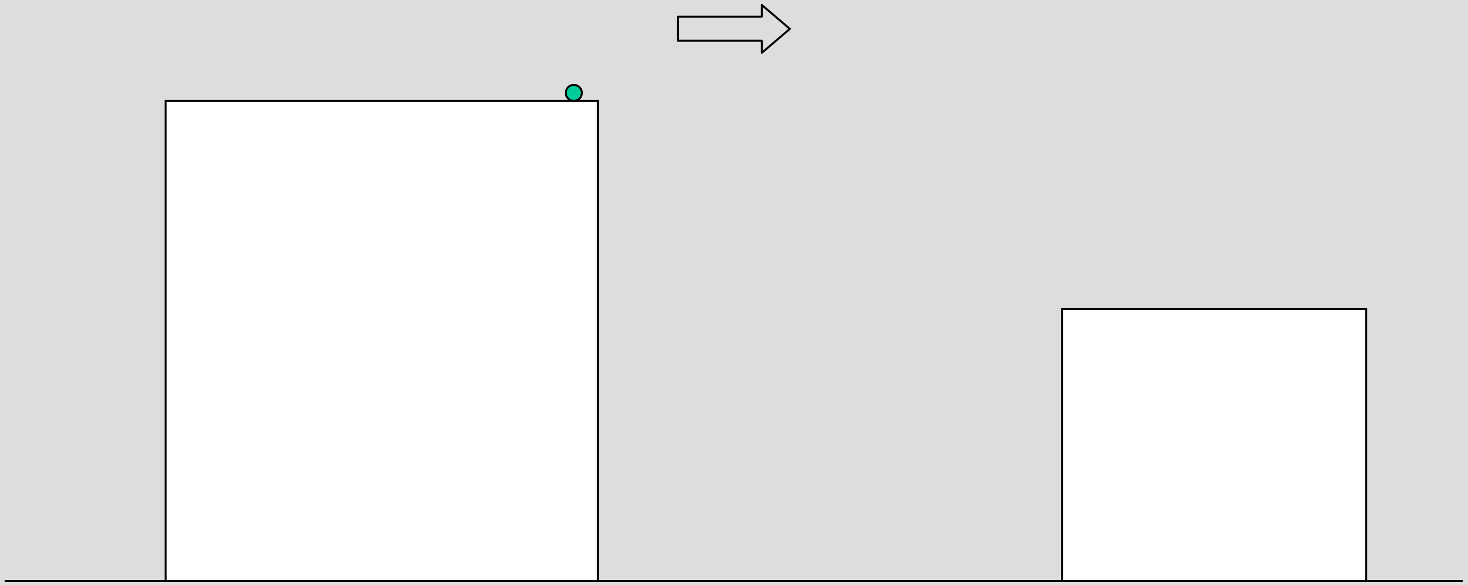
Gable end failure causes loss of roof due to increased internal pressure

HURRICANE KATRINA

DEBRIS TYPES

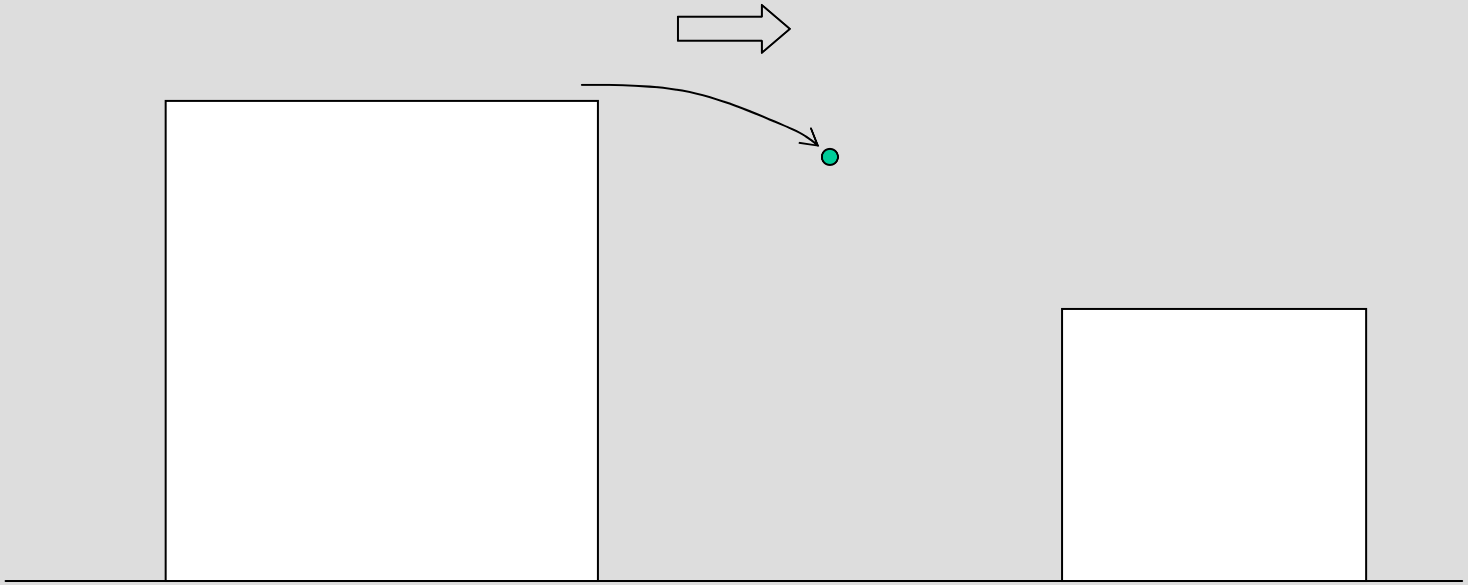


COMPACT OBJECT UNDER THE ACTION OF WIND, GRAVITY AND AIR RESISTANCE



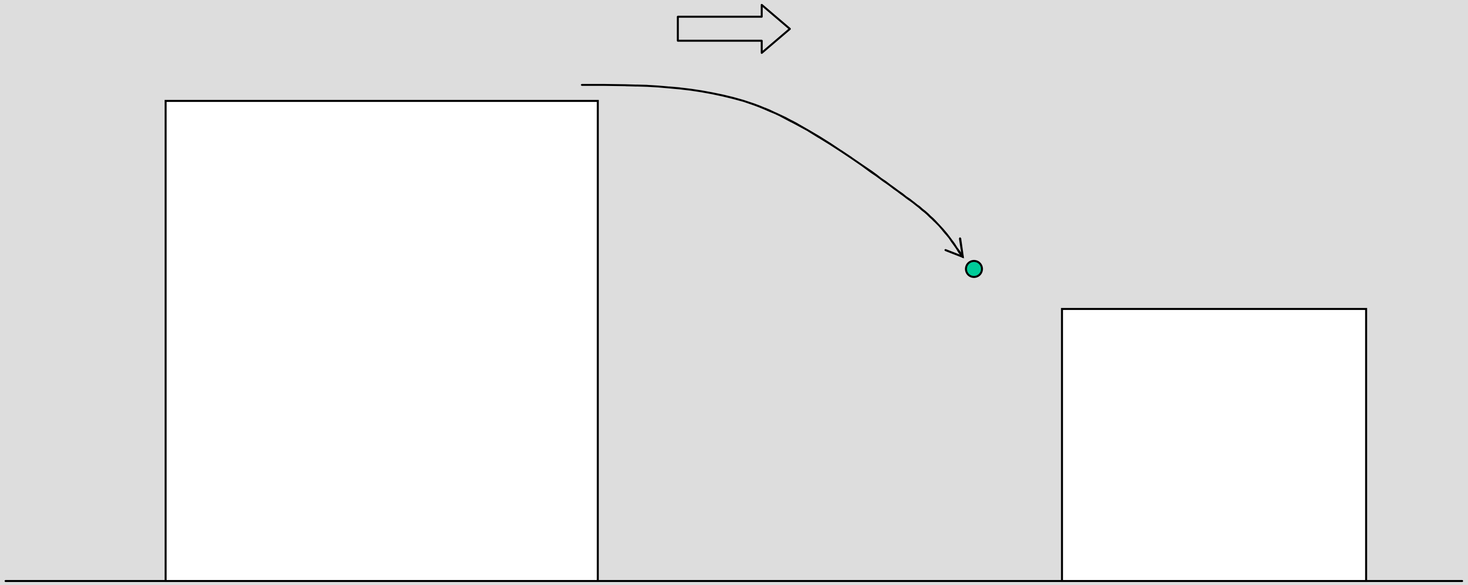
Compact object falls until it impacts the ground or a building

COMPACT OBJECT UNDER THE ACTION OF WIND, GRAVITY AND AIR RESISTANCE



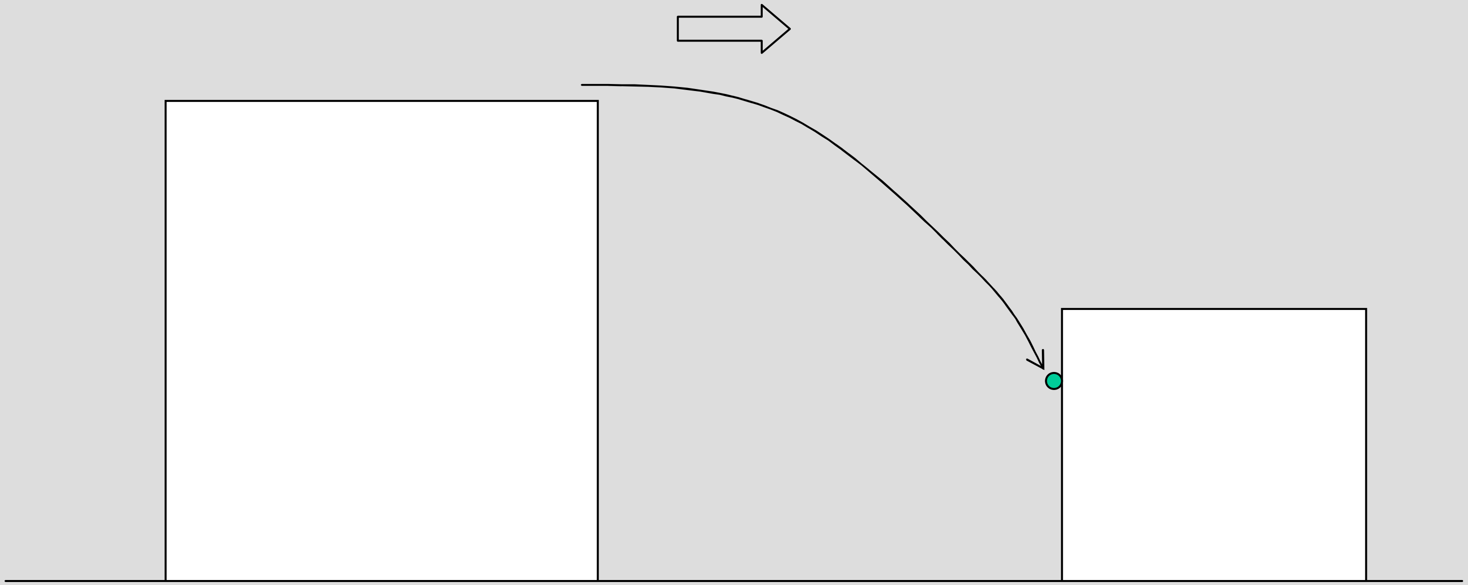
Compact object falls until it impacts the ground or a building

COMPACT OBJECT UNDER THE ACTION OF WIND, GRAVITY AND AIR RESISTANCE



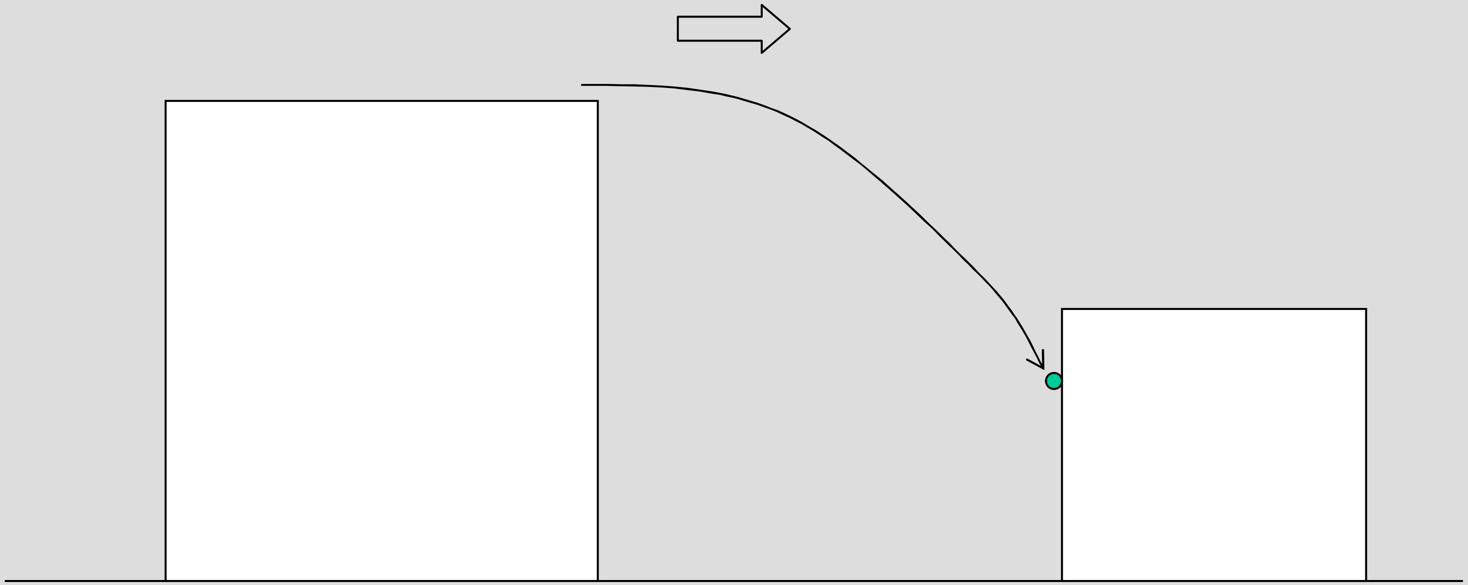
Compact object falls until it impacts the ground or a building

COMPACT OBJECT UNDER THE ACTION OF WIND, GRAVITY AND AIR RESISTANCE



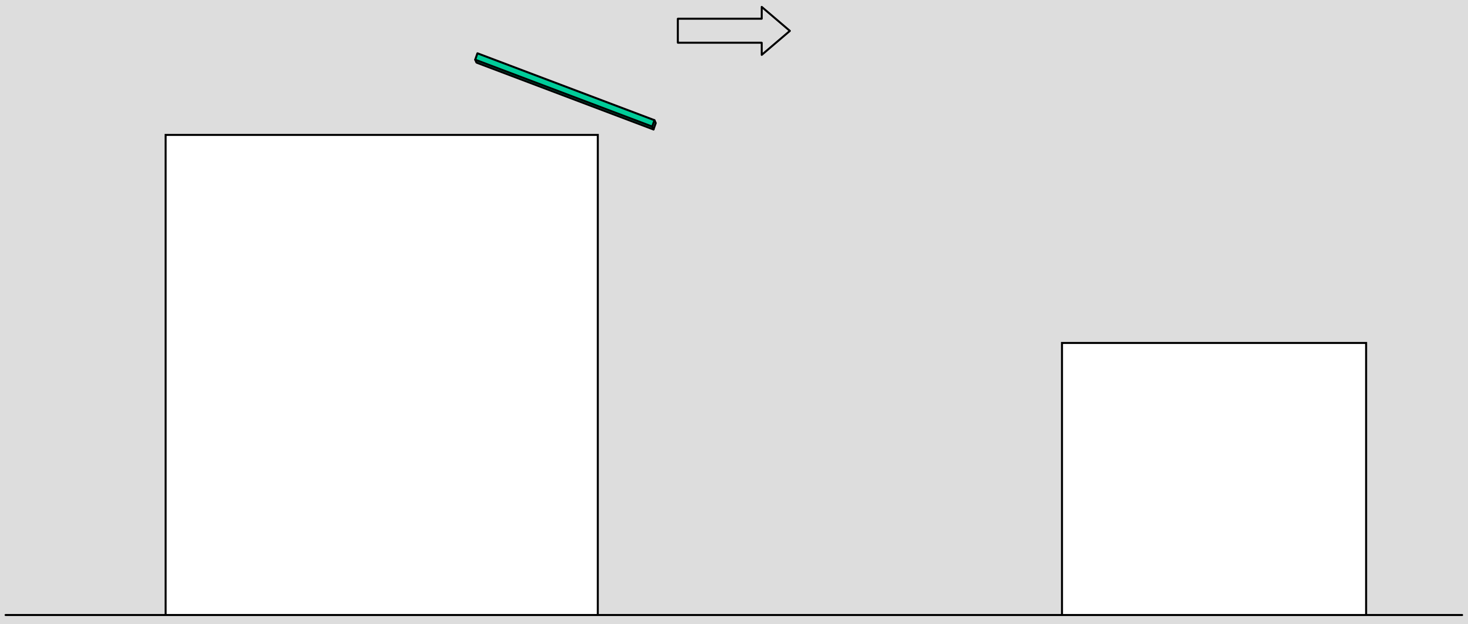
Compact object falls until it impacts the ground or a building

COMPACT OBJECT UNDER THE ACTION OF WIND, GRAVITY AND AIR RESISTANCE



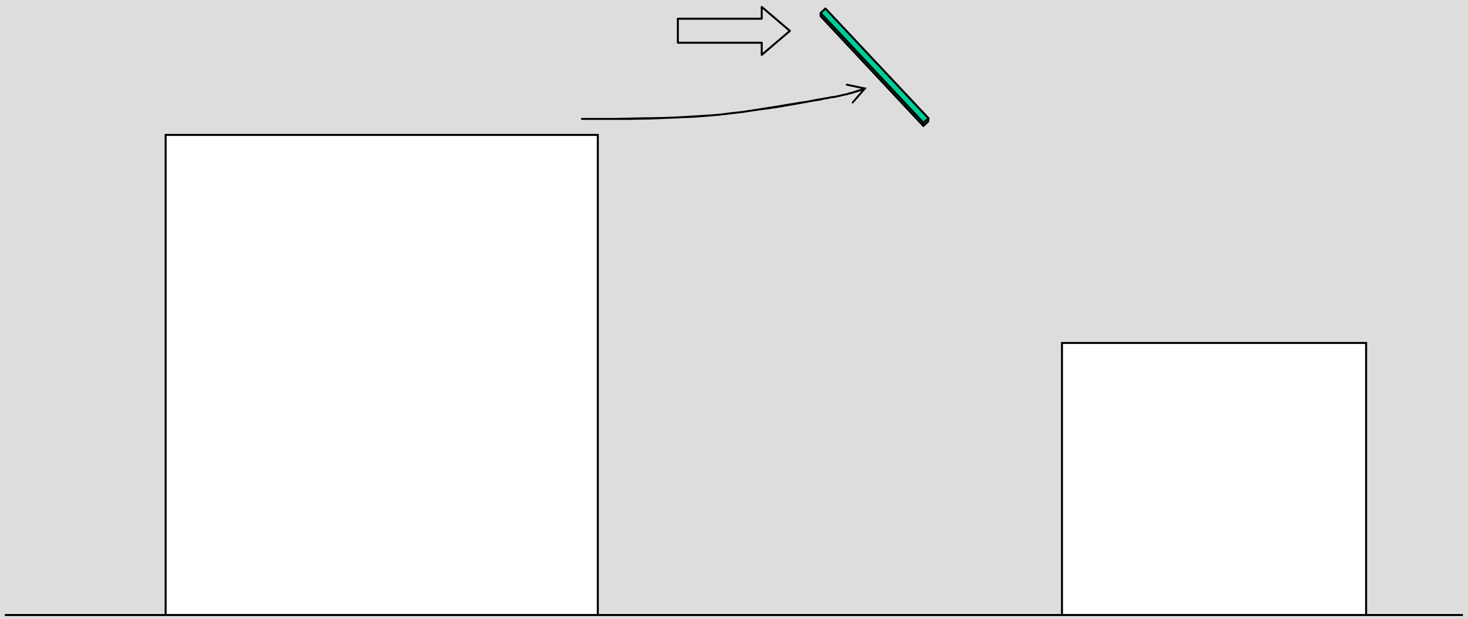
Compact object falls until it impacts the ground or a building

WIND-BORNE DEBRIS: ROD-TYPE OBJECT



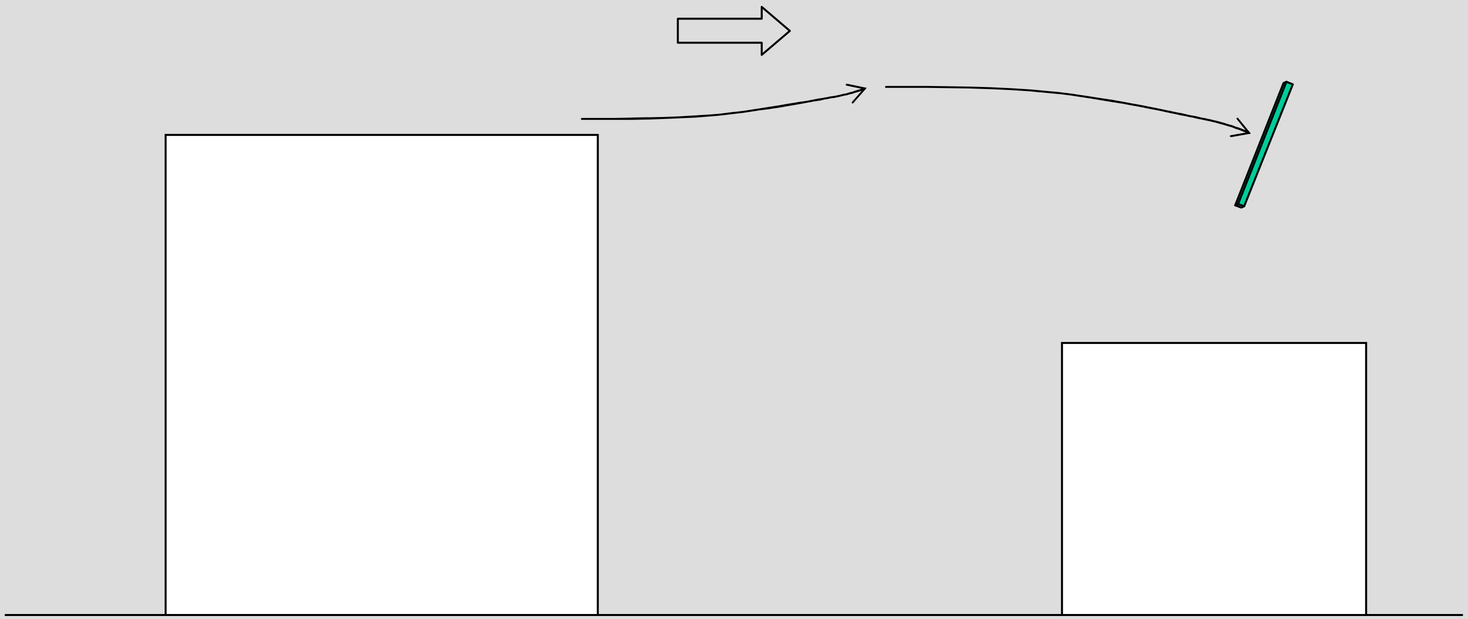
2 by 4s and rod-type objects have complicated rolling and tumbling motions

WIND-BORNE DEBRIS: ROD-TYPE OBJECT



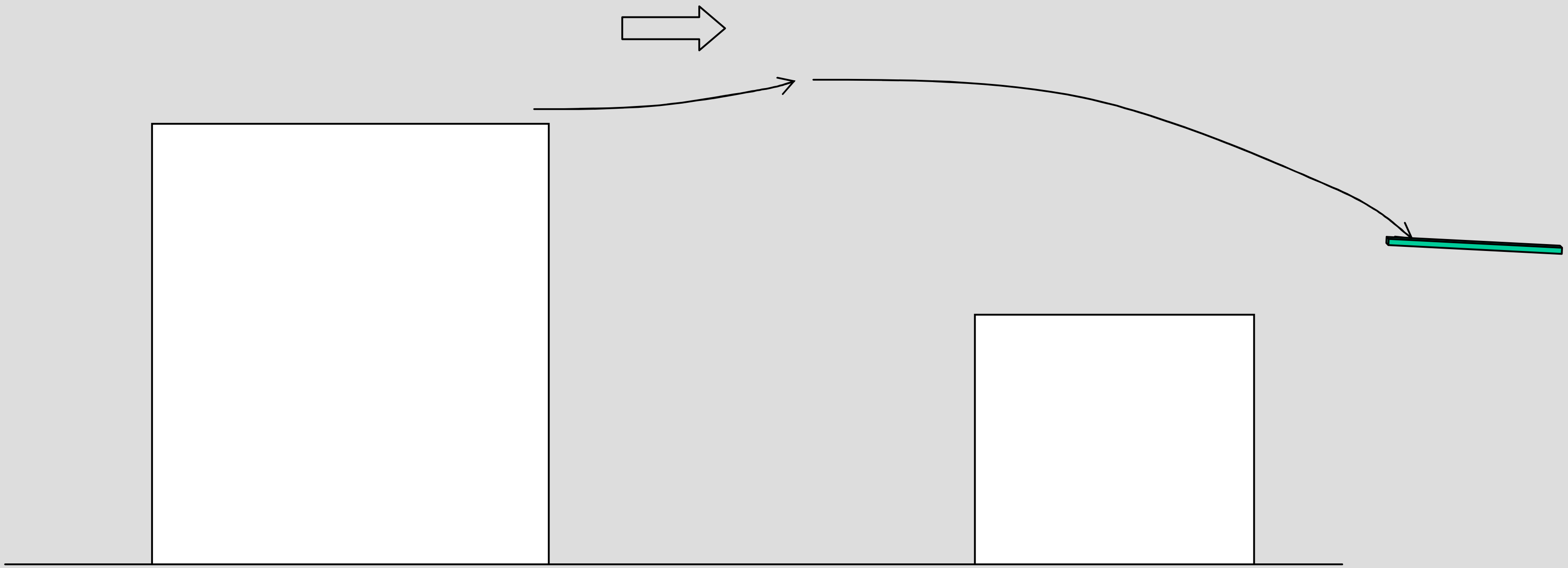
2 by 4s and rod-type objects have complicated rolling and tumbling motions

WIND-BORNE DEBRIS: ROD-TYPE OBJECT



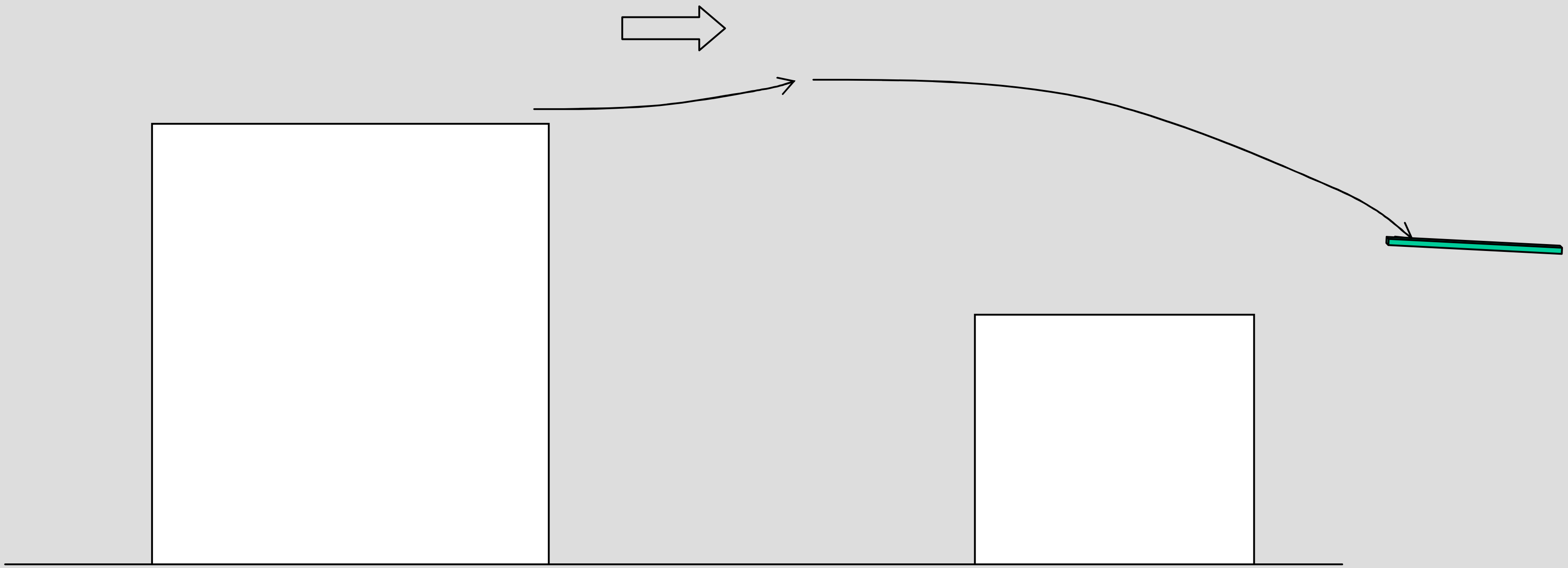
2 by 4s and rod-type objects have complicated rolling and tumbling motions

WIND-BORNE DEBRIS: ROD-TYPE OBJECT



2 by 4s and rod-type objects have complicated rolling and tumbling motions

WIND-BORNE DEBRIS: ROD-TYPE OBJECT



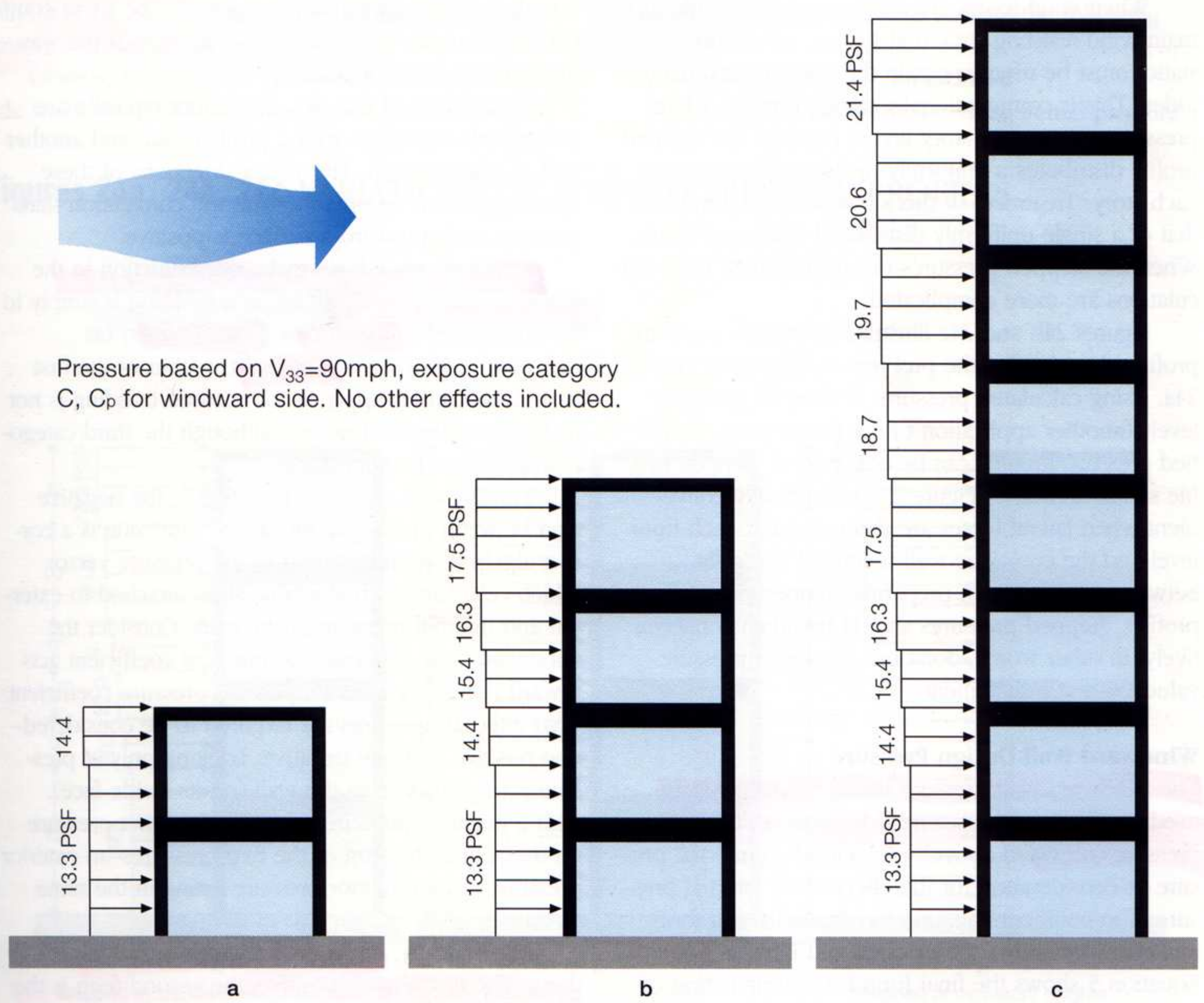
2 by 4s and rod-type objects have complicated rolling and tumbling motions

WIND-BORNE DEBRIS DAMAGE

Wind-borne debris causes damage to windows, followed by failure of roof

Penetration of wall by flying debris

Figures 23a, 23b, 23c STEPPED PRESSURE PROFILES–WINDWARD WALL



HURRICANE KATRINA

Aerial view showing proximities of debris source buildings and damaged buildings

HURRICANE KATRINA

Flyover view of Hyatt with 1250 Poydras in foreground

HURRICANE KATRINA

North façade of Hyatt from 1250 Poydras

HURRICANE KATRINA

Damage to rooms on north face of 27^{th} floor

HURRICANE KATRINA

Scoured gravel on Amoco roof, a source of debris causing damage to Hyatt

HURRICANE KATRINA

Ballasted single-ply roof - Source of debris causing damage to Amoco and Dominion Bank

HURRICANE KATRINA

Debris damage to 1250 Poydras, viewed through broken window. Building had 900 broken panes, 200 of which were complete penetrations (both layers of glass were broken)

HURRICANE KATRINA

Typical window damage to 1250 Poydras due to wind-borne gravel

HURRICANE KATRINA

Documenting gravel debris

HURRICANE KATRINA

Gravel in the gap between broken outer pane and intact inner pane

HURRICANE KATRINA

Gravel on sidewalk at base of Amoco

HURRICANE KATRINA

Texaco Building, single-ply ballasted roof, debris source

HURRICANE KATRINA

2x4 penetrating cooling tower screen

Protection from wind-borne debris

Metal screens

Protection from wind-borne debris

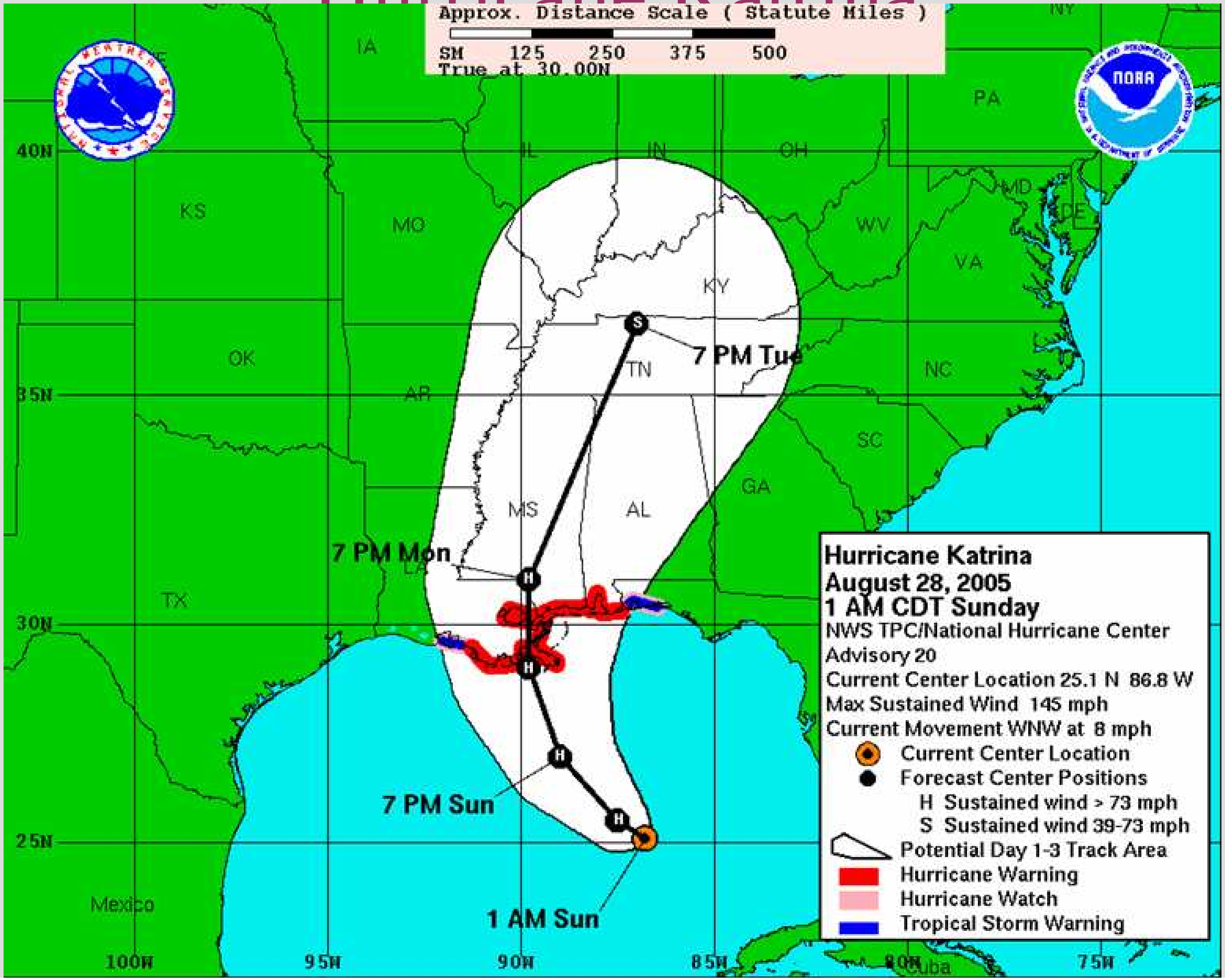
Rolldown perforated metal screen

Tree Damage

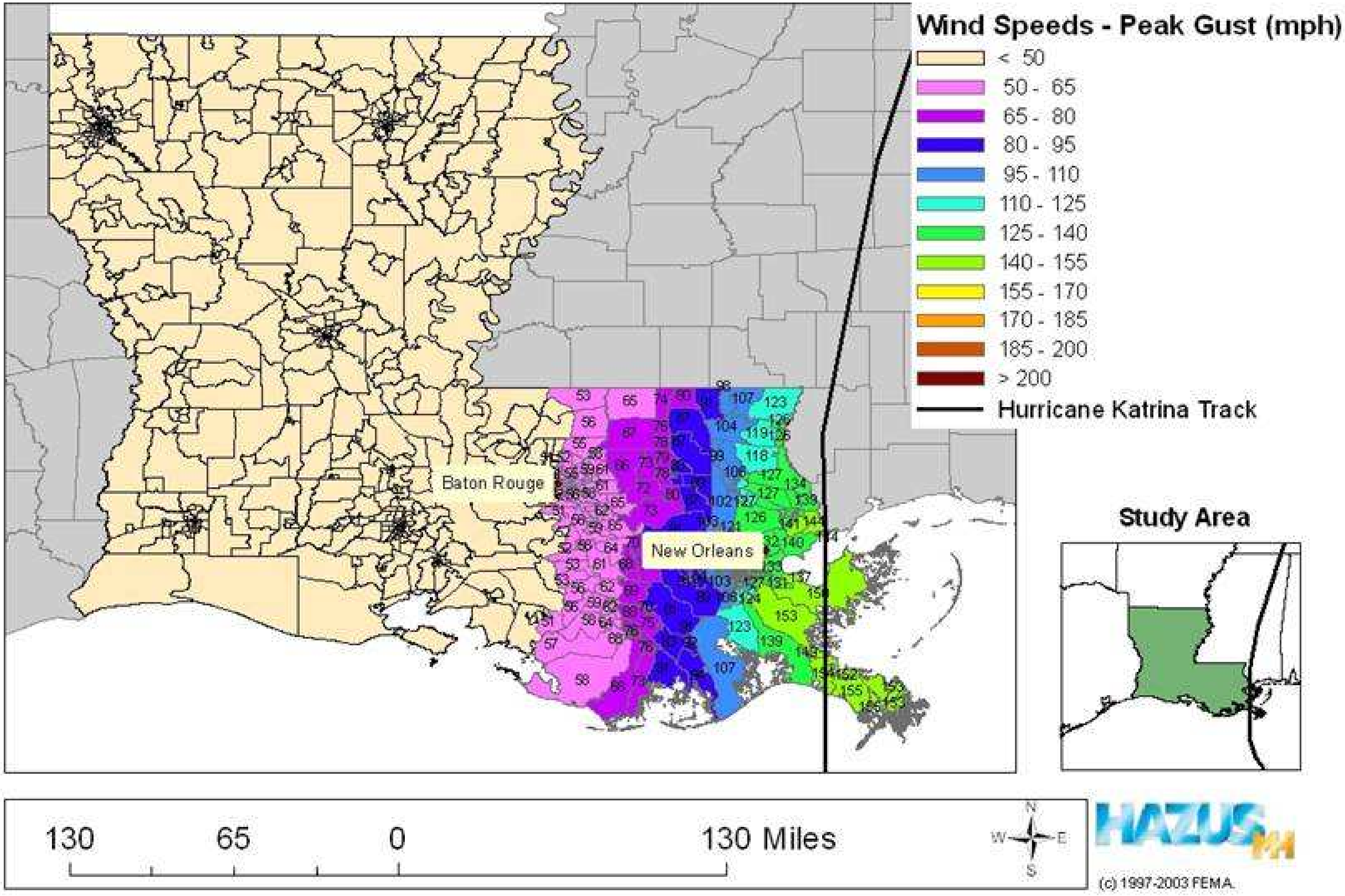
Hurricane Katrina

Aug 29, 2005

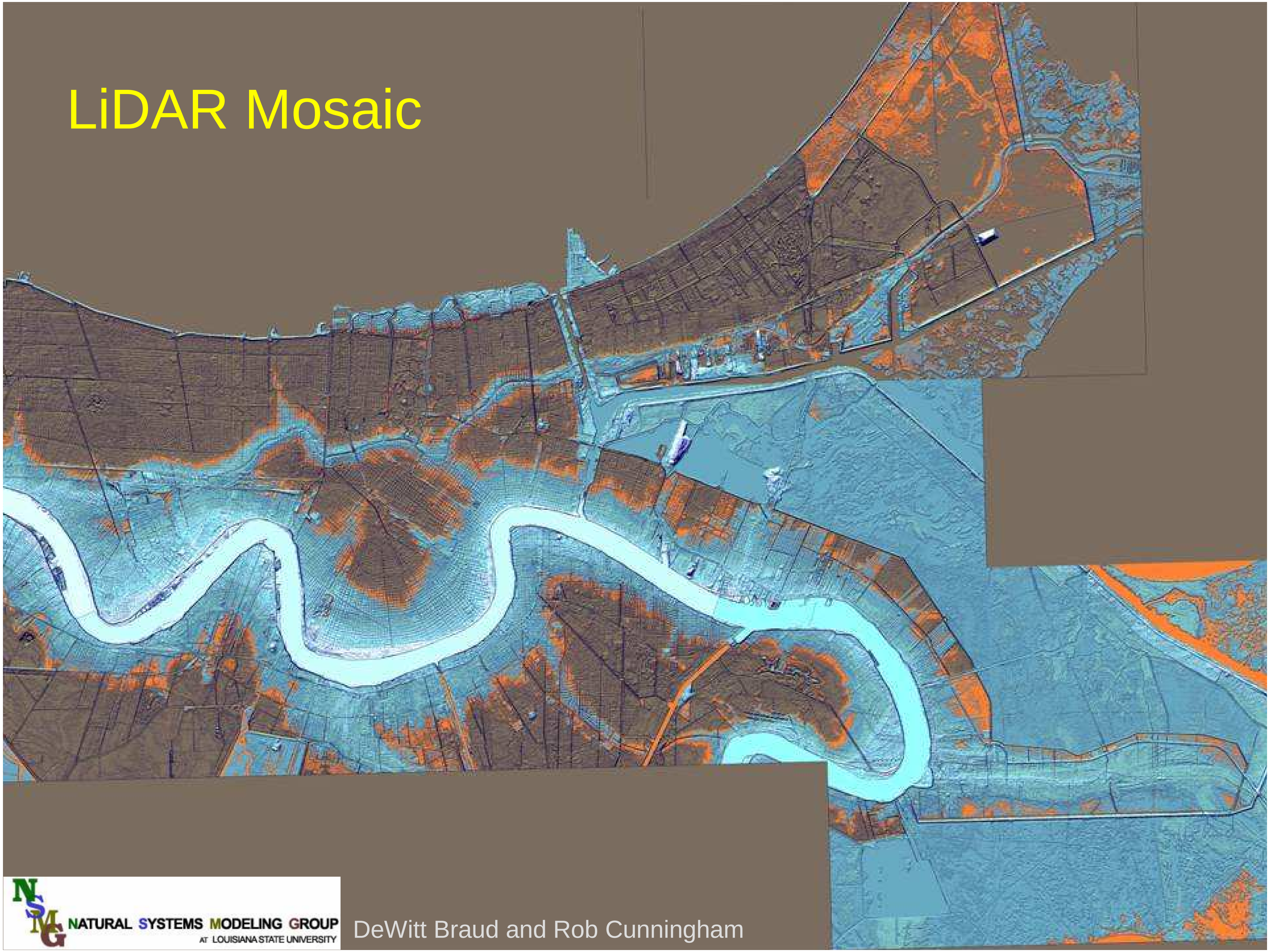
Hurricane Katrina



Peak Gust Wind Speeds



LiDAR Mosaic

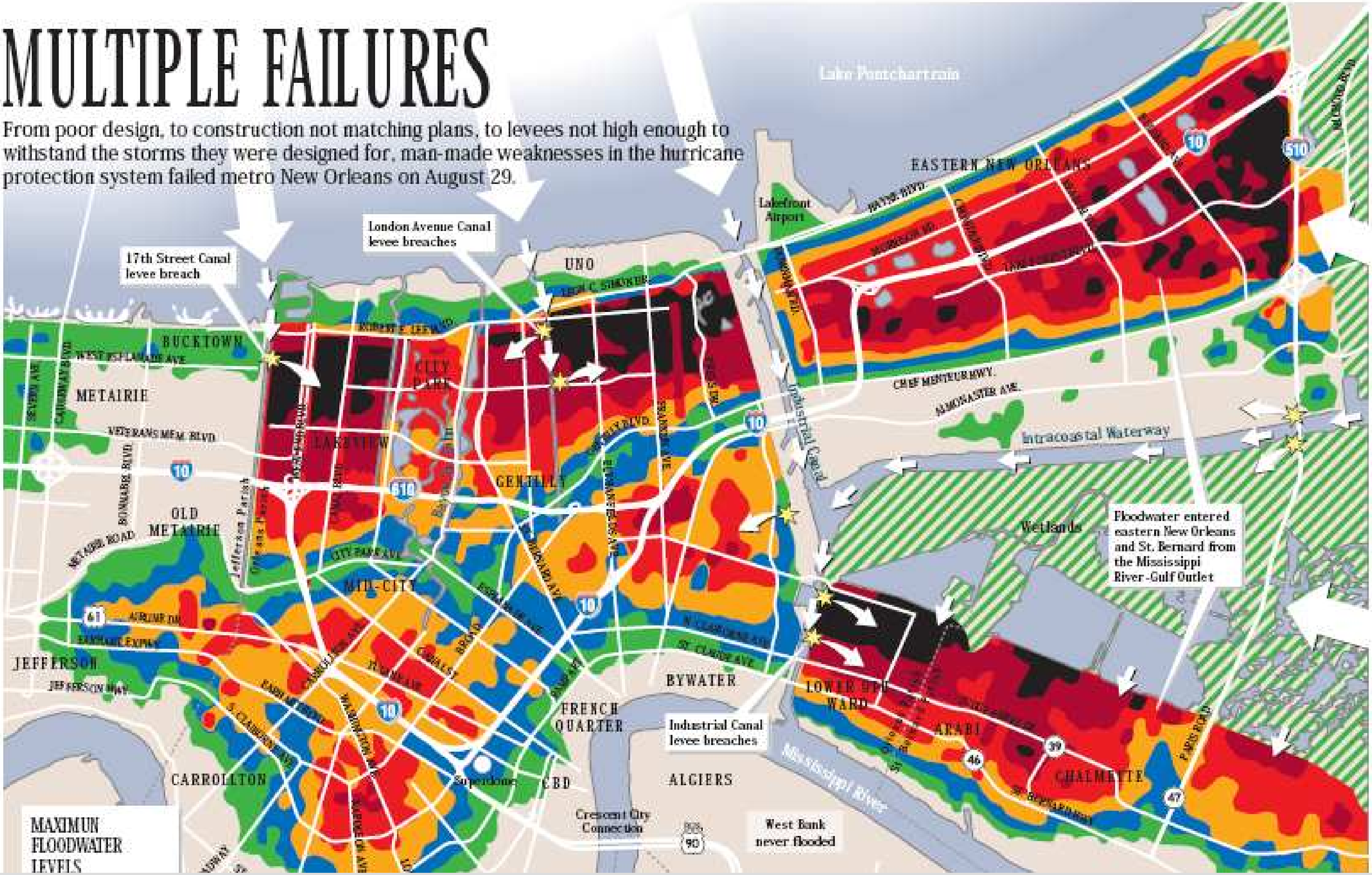


NATURAL SYSTEMS MODELING GROUP AT LOUISIANA STATE UNIVERSITY

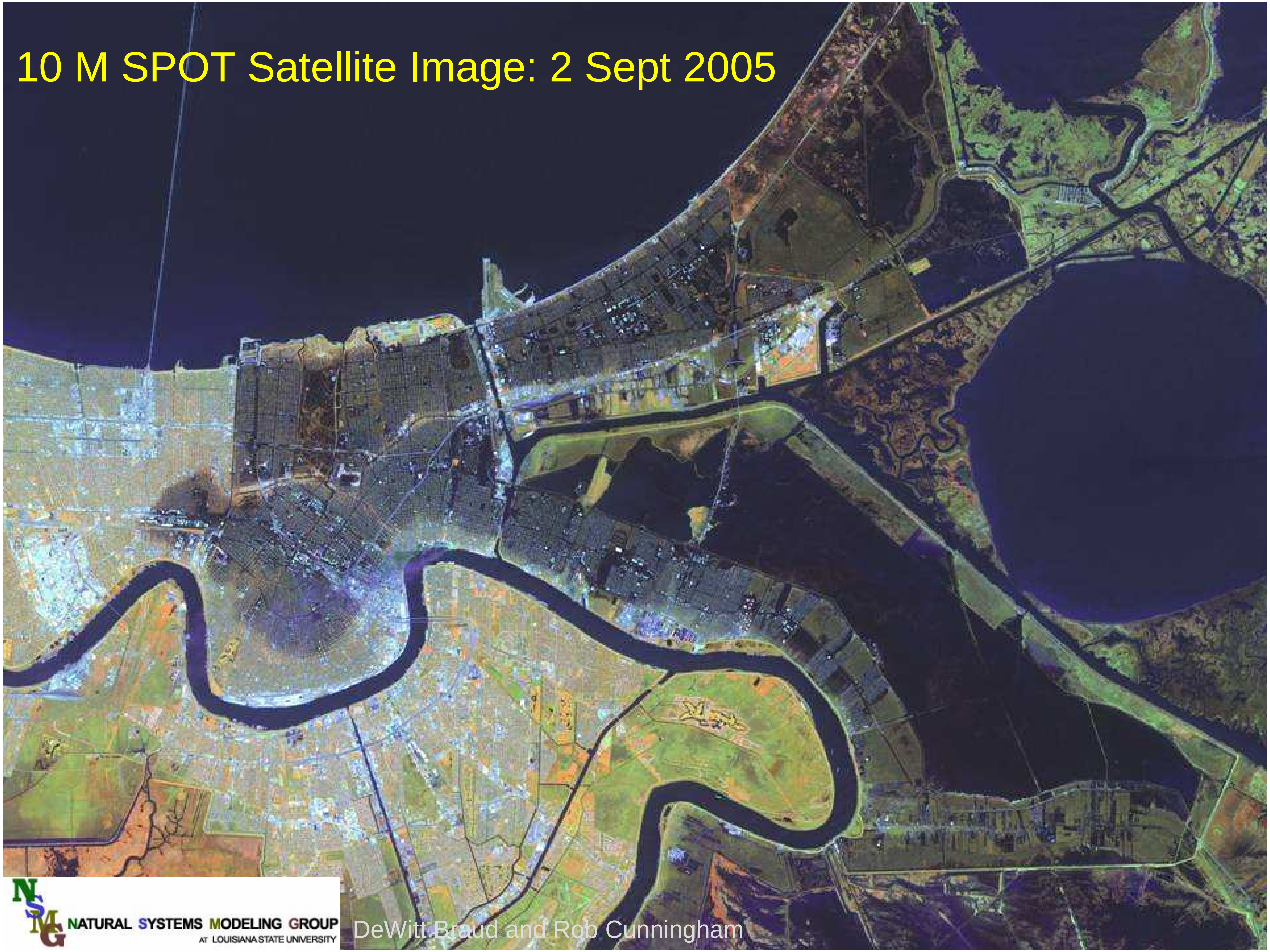
DeWitt Braud and Rob Cunningham

MULTIPLE FAILURES

From poor design, to construction not matching plans, to levees not high enough to withstand the storms they were designed for, man-made weaknesses in the hurricane protection system failed metro New Orleans on August 29.



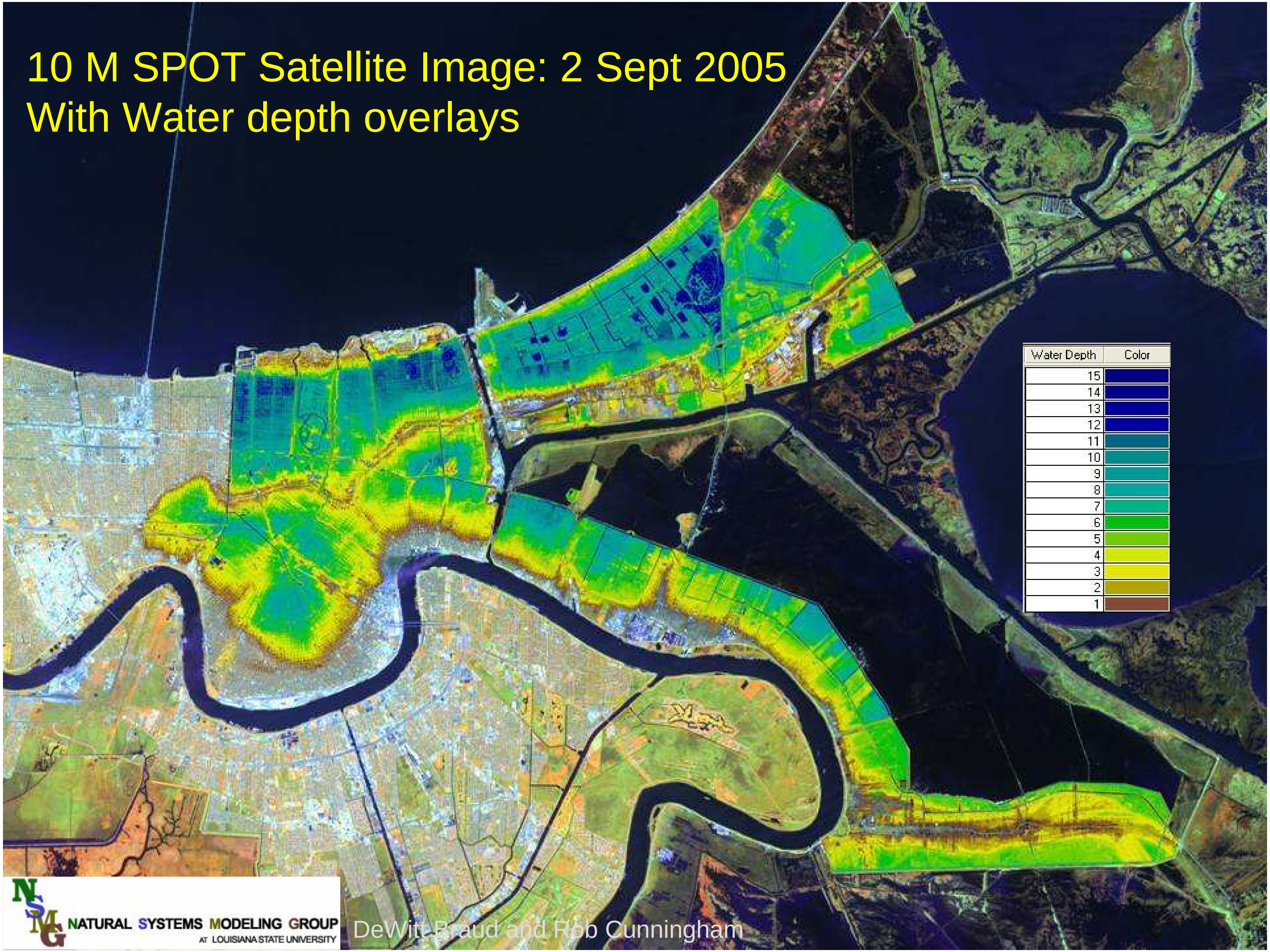
10 M SPOT Satellite Image: 2 Sept 2005



NATURAL SYSTEMS MODELING GROUP AT LOUISIANA STATE UNIVERSITY

DeWitt Braud and Rob Cunningham

10 M SPOT Satellite Image: 2 Sept 2005
With Water depth overlays



Aerial photograph of New Orleans after Hurricane Katrina

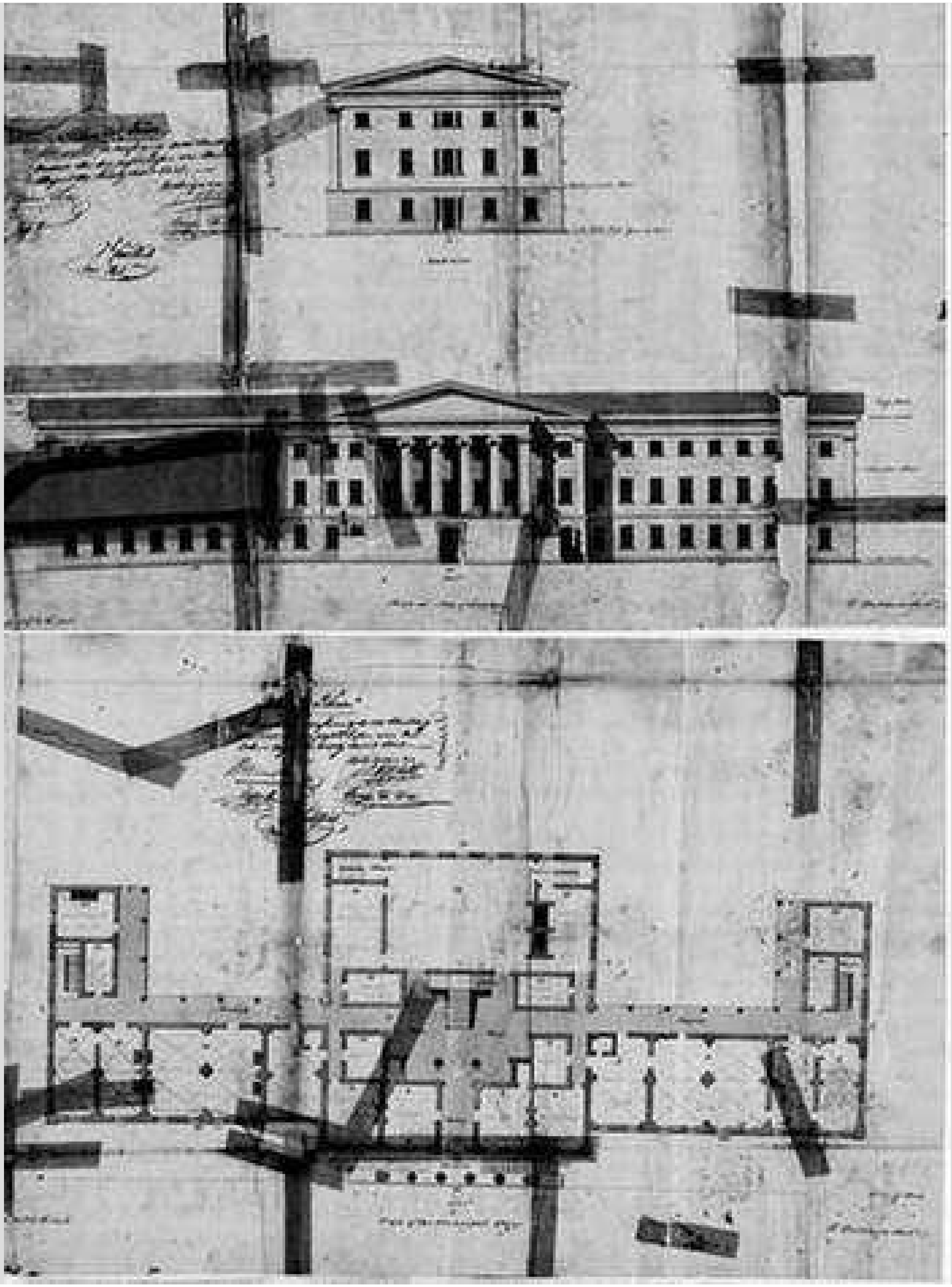

Banks

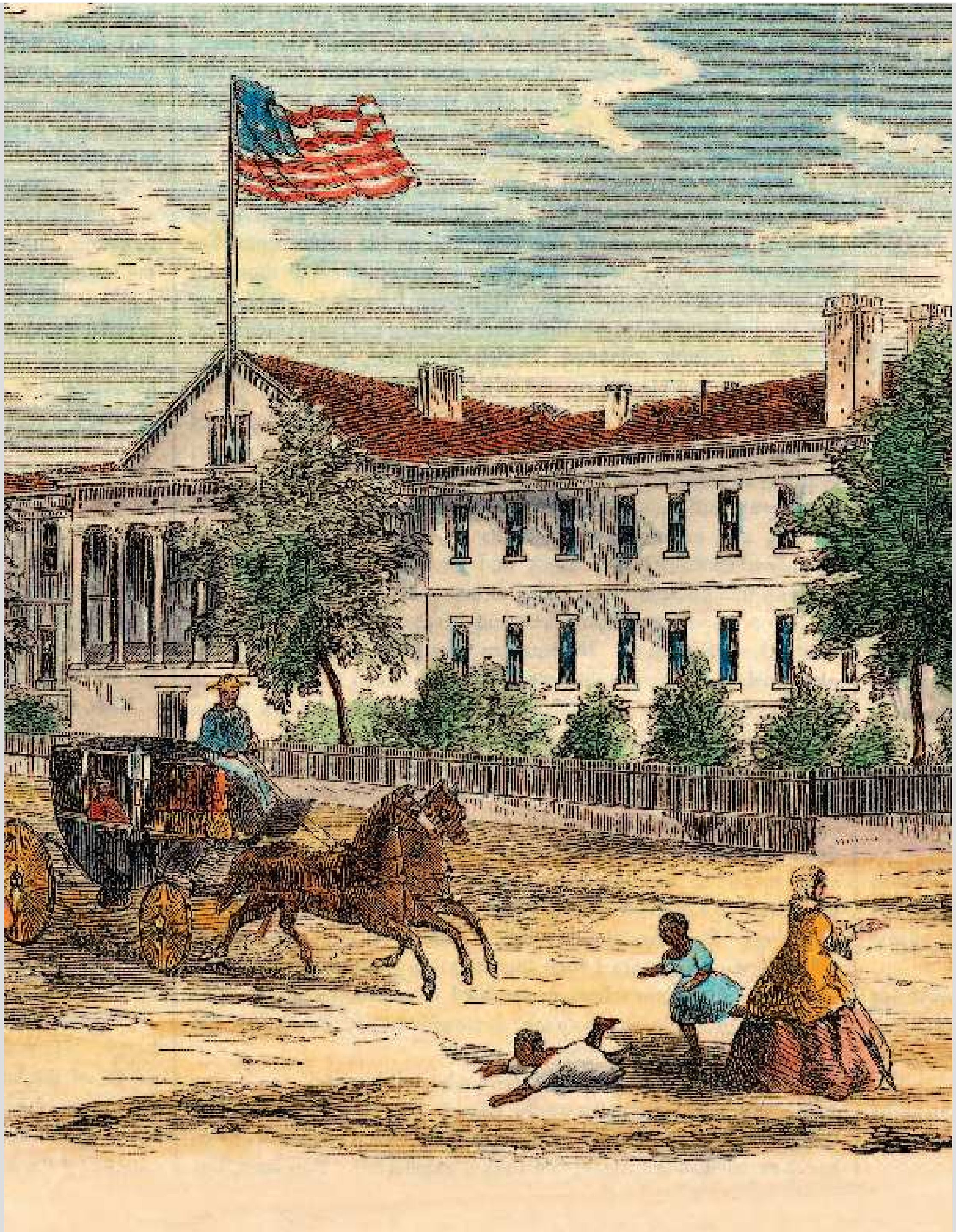

McDonald's

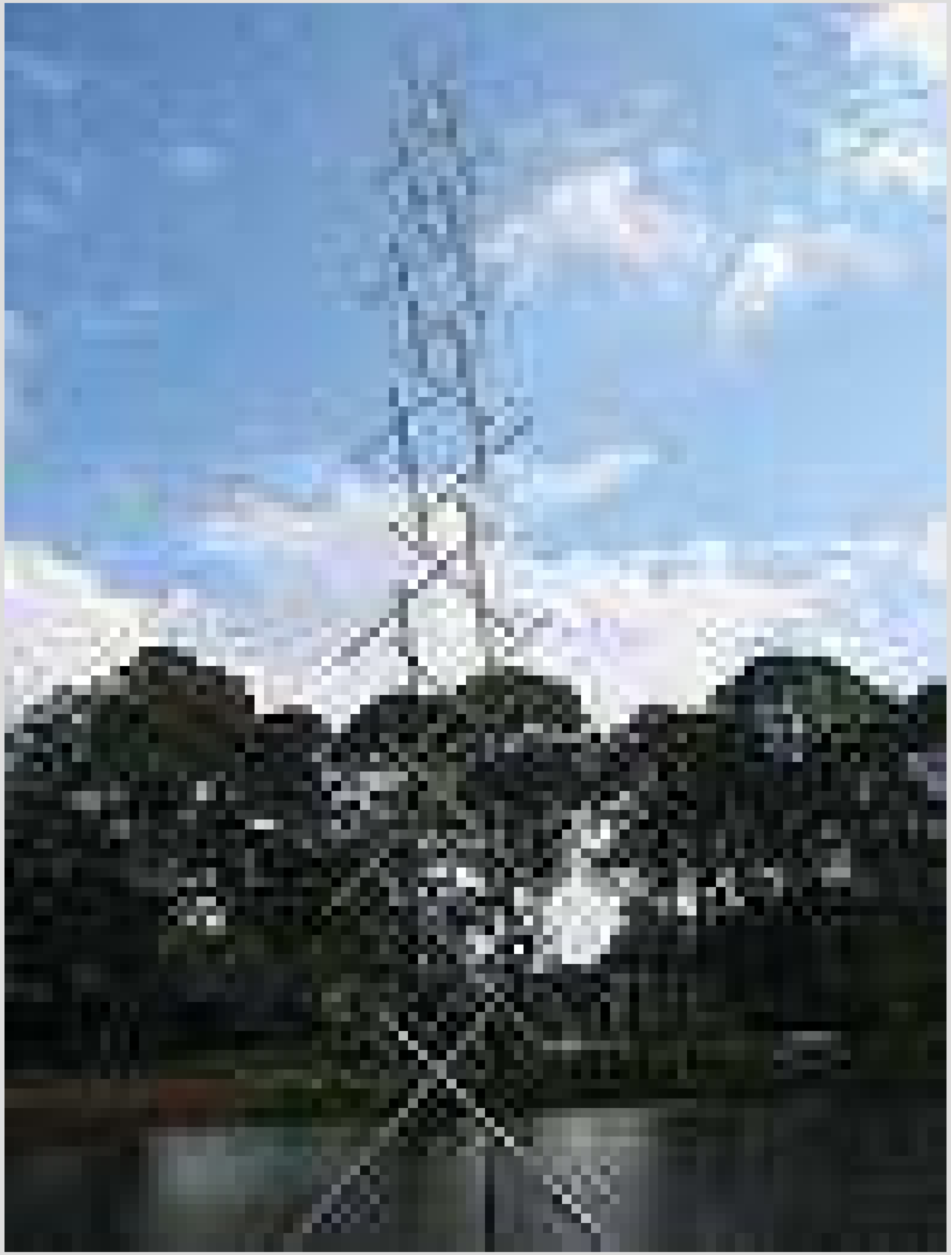

Drive Thru
Extra Value Meal


CONTEMPORARY ARTS CENTER


CONTEMPORARY ARTS








THANK YOU
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www.buoyantfoundation.org