Turkey Point Units 6 & 7 COL Application

Status of Geotechnical and Hydrological Evaluations

Florida Power & Light Company

December 5, 2008

The information provided in the following presentation is of a preliminary nature and is considered DRAFT.

Agenda

- Introduction – Bill Maher
- Site Arrangement – Paul Jacobs
- Storm Surge and Tsunami Effects – Mustafa Samad
- General Geologic Conditions – Dave Fenster
- Subsurface Investigation Overview – John Sturman

Break

- Geotechnical Considerations – John Sturman
- Groundwater – Jerry McLane
- Construction Methods – John Sturman, Greg Davis

Site Arrangement

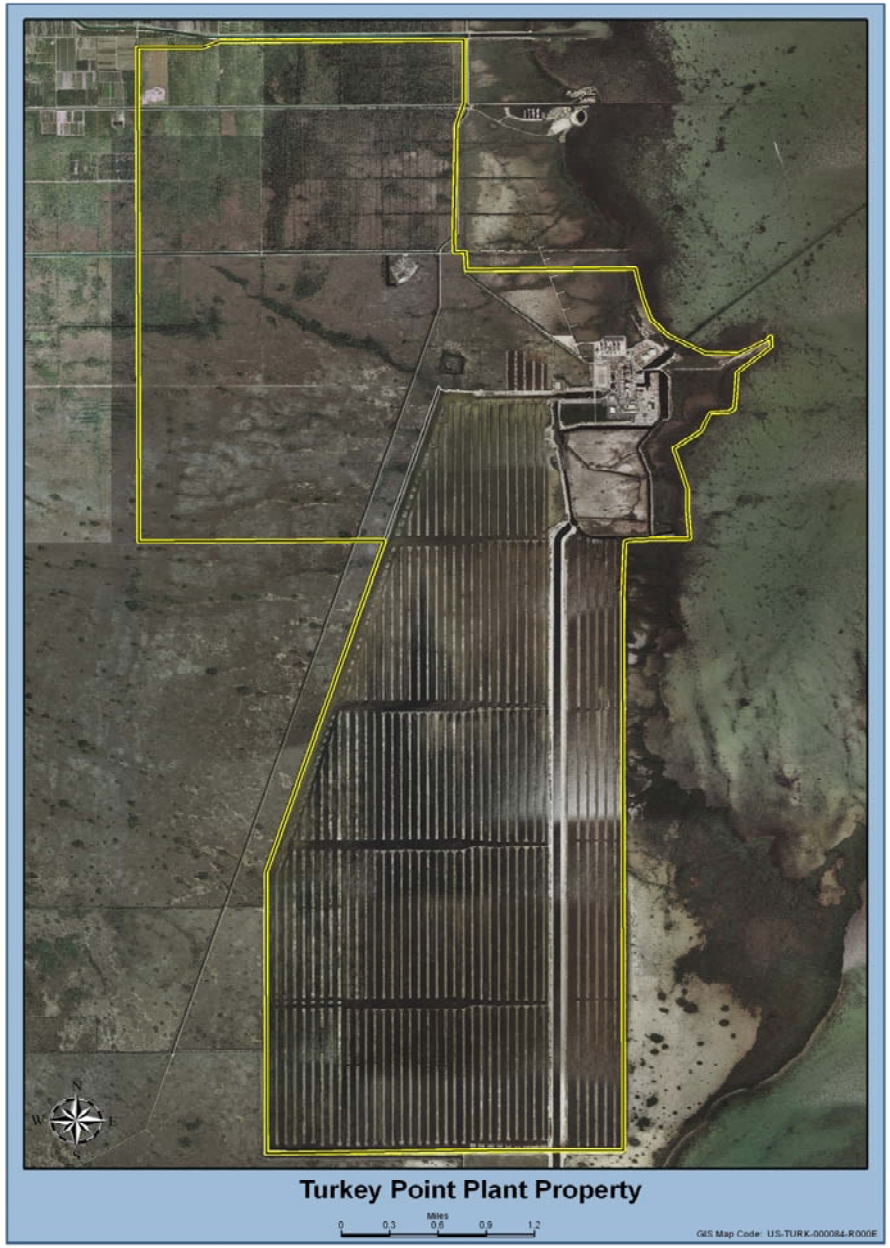
Paul Jacobs

Engineering Supervisor, FPL

December 5, 2008

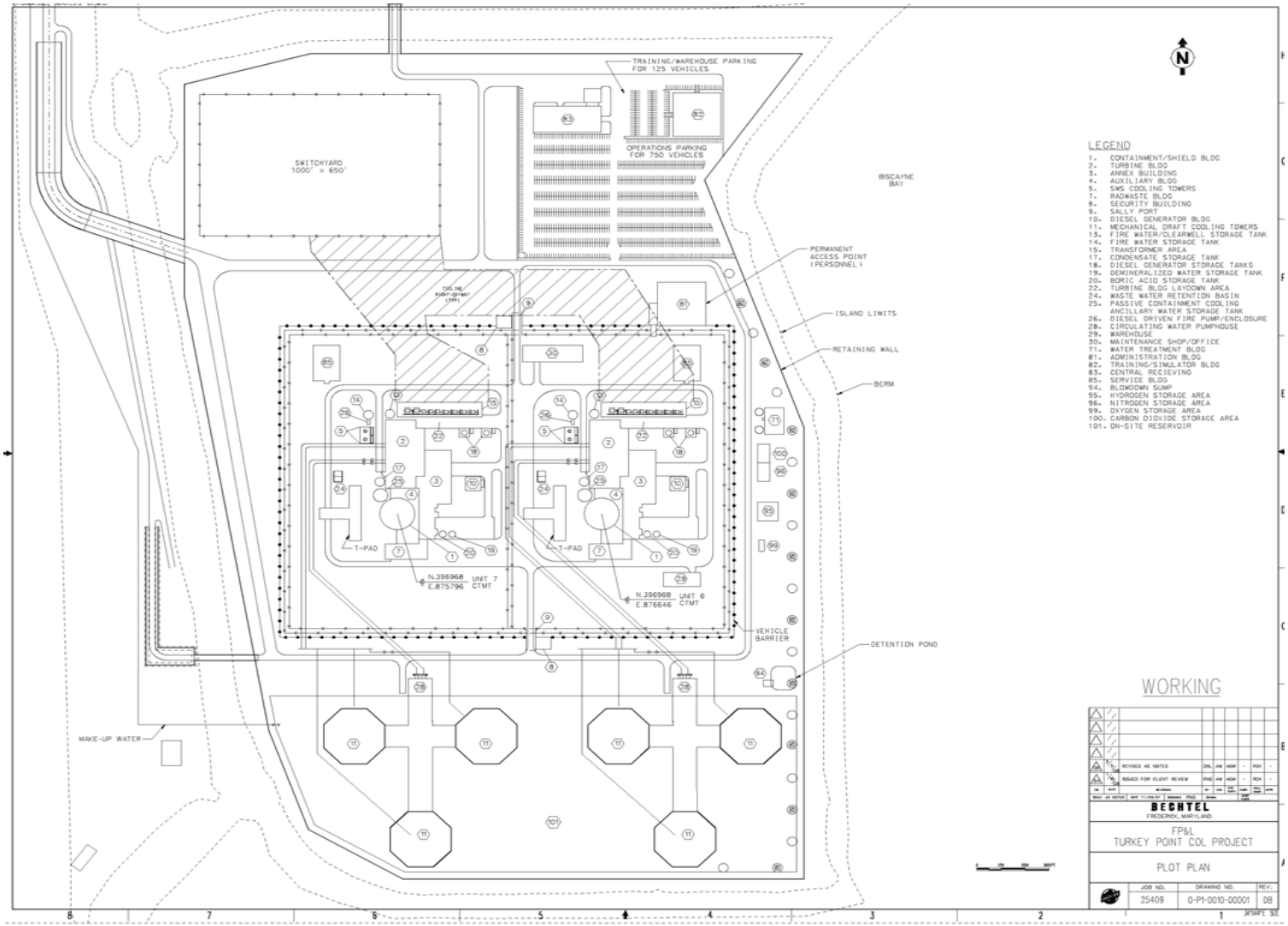
General Project Information

- Approximately 210 acre island area within the Turkey Point Plant Property
- Turkey Point Plant Property bordered on the east by Biscayne National Park and undeveloped wetlands on the west
- Located south of existing Turkey Point Units 1 thru 5 (Units 1 and 2 are Gas/Oil-Fired, Units 3 and 4 are Nuclear, Unit 5 is Gas-Fired Combined Cycle)
- Approximately 8 miles due east of Florida City
- Primarily a limestone site, with alternating layers of silty-sand and limestone
- AP1000 technology selected
- Mechanical draft cooling towers with a reservoir for storage of several days cooling water
- Finished grade at nuclear island will be raised approximately 26 ft due to storm surge wave run up


N
W
E
S
Turkey Point Plant Property
Miles
0
0.3
0.6
0.9
1.2
GIS Map Code: US-TURK-000084-R000F


Access Area
Clear Sky
Access Area
Protected Area
Protected Area
Access Area
Detention Pond
Cooling Water Reservoir
Turkey Point Units 6 and 7 Plant Area
Miles
0 0.025 0.05 0.1 0.15 0.2
0 0.08 0.16 0.24
Kilometers
GIS Map Code: US-TURK-000083-R000C

Plot Plan


TRAINING/WAREHOUSE PARKING FOR 125 VEHICLES
OPERATIONS PARKING FOR 750 VEHICLES
SWITCHYARD 1000' × 650'
BISCAYNE BAY
PERMANENT ACCESS POINT (PERSONNEL)
ISLAND LIMITS
RETAINING WALL
BERM
DETENTION POND
VEHICLE BARRIER
MAKE-UP WATER
T-PAD
N.396968 E.875796 UNIT 7 CTMT
N.396968 E.876646 UNIT 6 CTMT
LEGEND
1. CONTAINMENT/SHIELD BLDG
2. TURBINE BLDG
3. ANNEX BUILDING
4. AUXILIARY BLDG
5. SWS COOLING TOWERS
7. RADWASTE BLDG
8. SECURITY BUILDING
9. SALLY PORT
10. DIESEL GENERATOR BLDG
11. MECHANICAL DRAFT COOLING TOWERS
13. FIRE WATER/CLEARWELL STORAGE TANK
14. FIRE WATER STORAGE TANK
15. TRANSFORMER AREA
17. CONDENSATE STORAGE TANK
18. DIESEL GENERATOR STORAGE TANKS
19. DEMINERALIZED WATER STORAGE TANK
20. BORIC ACID STORAGE TANK
22. TURBINE BLDG LAYDOWN AREA
24. WASTE WATER RETENTION BASIN
25. PASSIVE CONTAINMENT COOLING ANCILLARY WATER STORAGE TANK
26. DIESEL DRIVEN FIRE PUMP/ENCLOSURE
28. CIRCULATING WATER PUMPHOUSE
29. WAREHOUSE
30. MAINTENANCE SHOP/OFFICE
71. WATER TREATMENT BLDG
81. ADMINISTRATION BLDG
82. TRAINING/SIMULATOR BLDG
83. CENTRAL RECIEVING
85. SERVICE BLDG
94. BLOWDOWN SUMP
95. HYDROGEN STORAGE AREA
96. NITROGEN STORAGE AREA
99. OXYGEN STORAGE AREA
100. CARBON DIOXIDE STORAGE AREA
101. ON-SITE RESERVOIR
WORKING
REVISED AS NOTED
ISSUED FOR CLIENT REVIEW
BECHTEL
FREDERICK, MARYLAND
FP&L
TURKEY POINT COL PROJECT
PLOT PLAN
JOB NO. 25409
DRAWING NO. 0-P1-0010-00001
REV. 08

Storm Surge and Tsnumai Effects

Mustafa Samad

Engineering Specialist - Hydrology, Bechtel

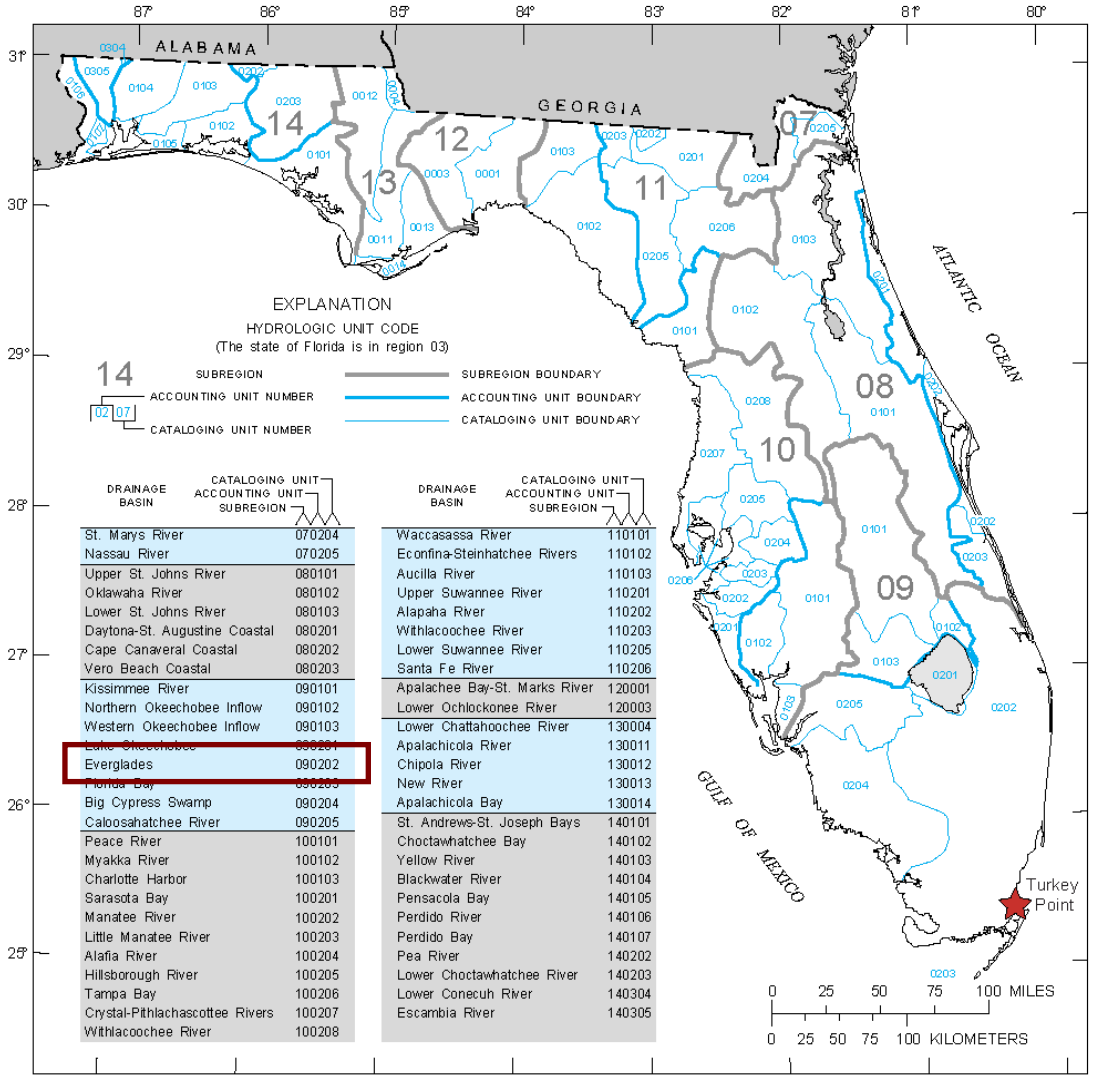
December 5, 2008

Conceptualization of Flood Scenarios

- **Man-made canals have altered general drainage of the south Florida region**
- **No major rivers or dams near the site**
  - Stream or dam breach flooding not expected to affect the site
- **No ice-jam flooding or flooding due to shoreline erosion**
- **Potential flooding from local PMP (Probable Maximum Precipitation)**
  - Site will be built up to higher elevation
  - Local drainage to drain away from safety-related structures
- **Potential flooding from storm surges and tsunamis**

Hydrologic Description (continued)

South Florida Watershed Sub-Region



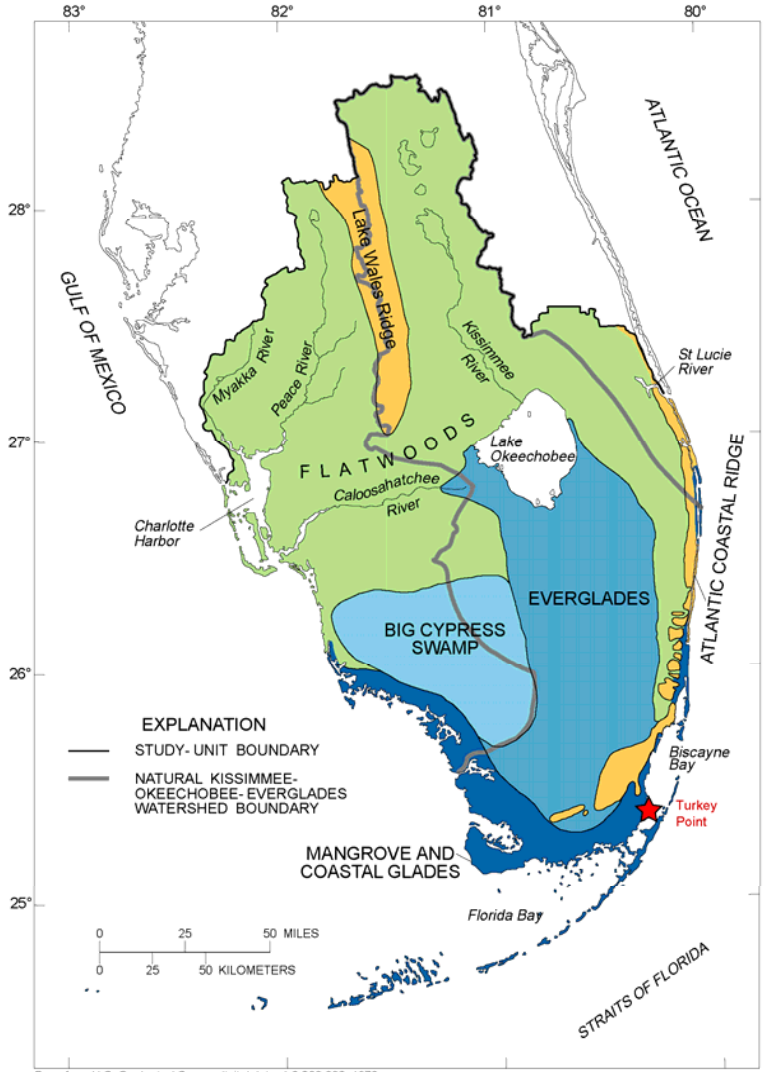
DRAINAGE BASIN	CATALOGING UNIT / ACCOUNTING UNIT / SUBREGION
St. Marys River	070204
Nassau River	070205
Upper St. Johns River	080101
Oklawaha River	080102
Lower St. Johns River	080103
Daytona-St. Augustine Coastal	080201
Cape Canaveral Coastal	080202
Vero Beach Coastal	080203
Kissimmee River	090101
Northern Okeechobee Inflow	090102
Western Okeechobee Inflow	090103
Lake Okeechobee	090201
Everglades	090202
Florida Bay	090203
Big Cypress Swamp	090204
Caloosahatchee River	090205
Peace River	100101
Myakka River	100102
Charlotte Harbor	100103
Sarasota Bay	100201
Manatee River	100202
Little Manatee River	100203
Alafia River	100204
Hillsborough River	100205
Tampa Bay	100206
Crystal-Pithlachascottee Rivers	100207
Withlacoochee River	100208

DRAINAGE BASIN	CATALOGING UNIT / ACCOUNTING UNIT / SUBREGION
Waccasassa River	110101
Econfina-Steinhatchee Rivers	110102
Aucilla River	110103
Upper Suwannee River	110201
Alapaha River	110202
Withlacoochee River	110203
Lower Suwannee River	110205
Santa Fe River	110206
Apalachee Bay-St. Marks River	120001
Lower Ochlockonee River	120003
Lower Chattahoochee River	130004
Apalachicola River	130011
Chipola River	130012
New River	130013
Apalachicola Bay	130014
St. Andrews-St. Joseph Bays	140101
Choctawhatchee Bay	140102
Yellow River	140103
Blackwater River	140104
Pensacola Bay	140105
Perdido River	140106
Perdido Bay	140107
Pea River	140202
Lower Choctawhatchee River	140203
Lower Conecuh River	140304
Escambia River	140305

Reference: USGS 1999a

Hydrologic Description (continued)

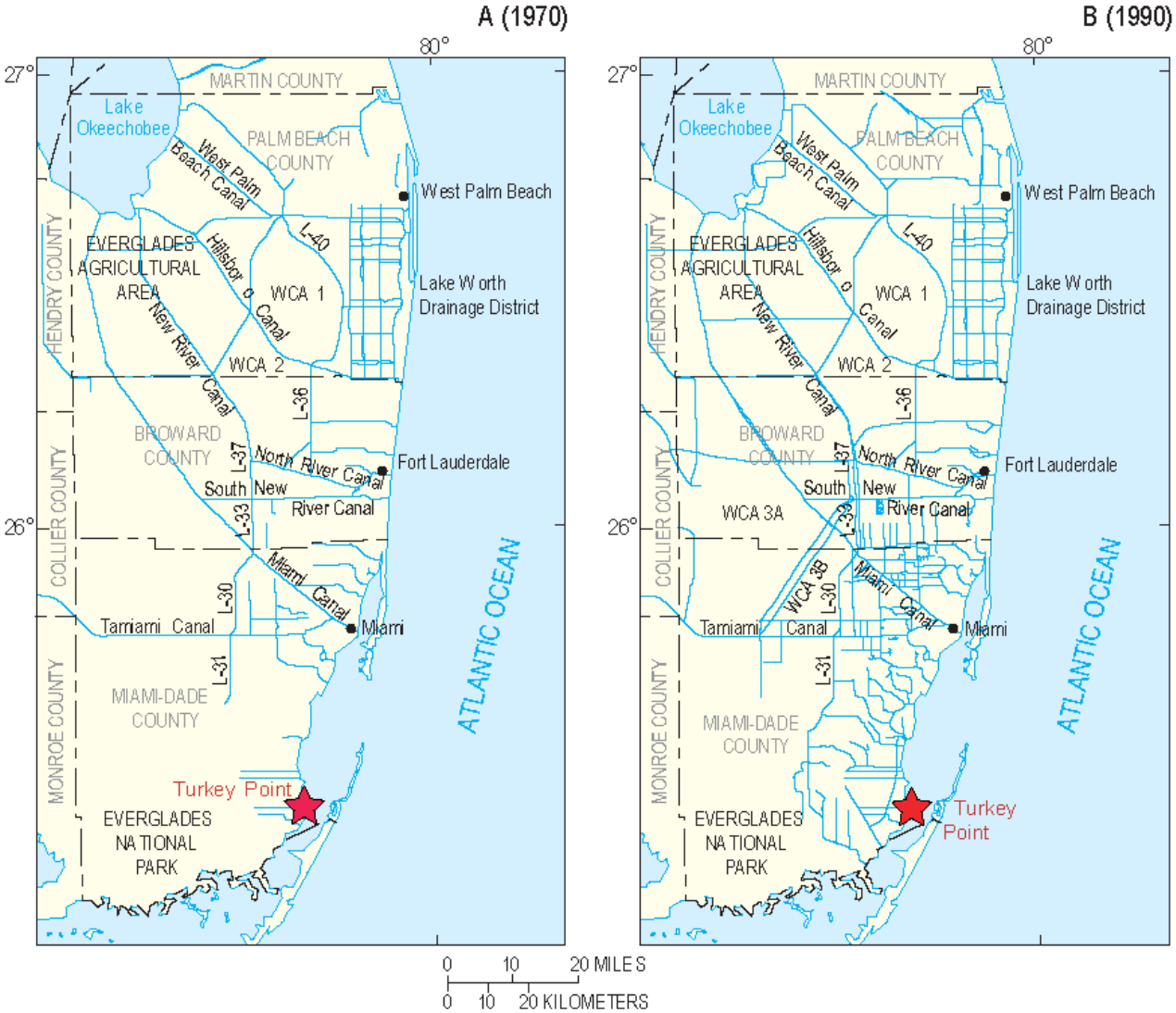
Physiographic Features of South Florida Watershed



Reference: USGS 1997

Hydrologic Description (continued)

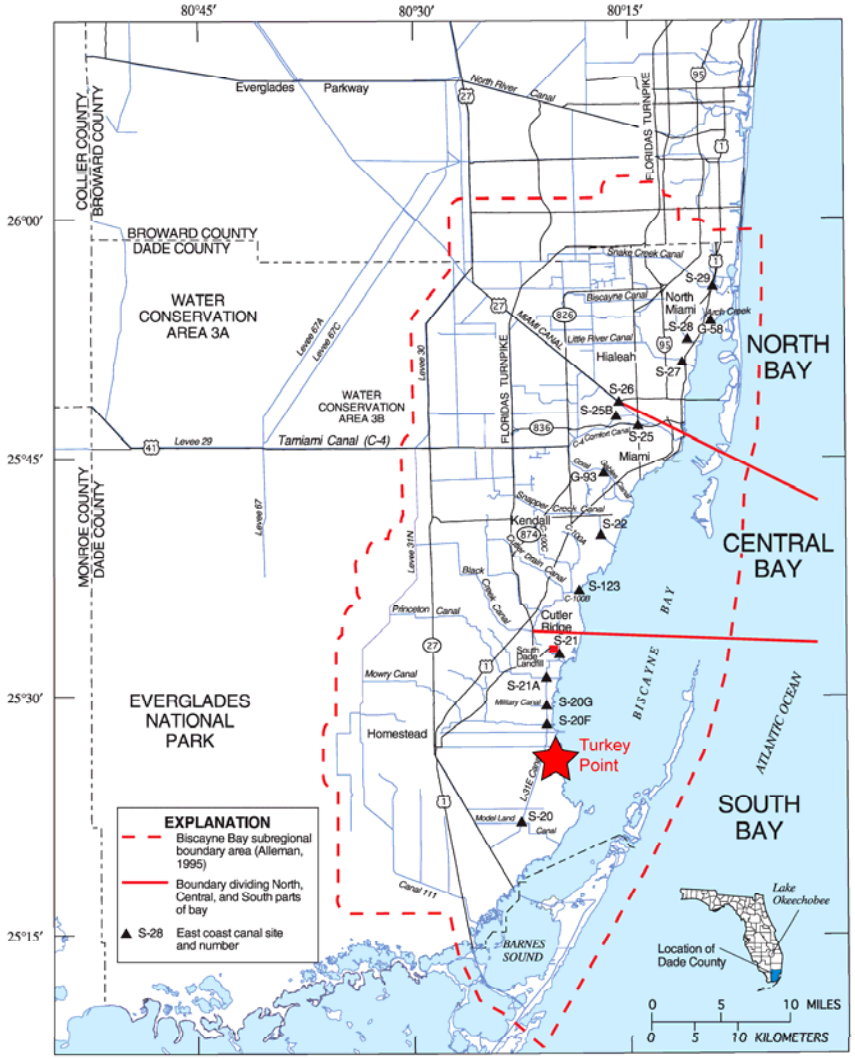
Development of South-Dade Conveyance System



Reference: USGS 2005

Hydrologic Description (continued)

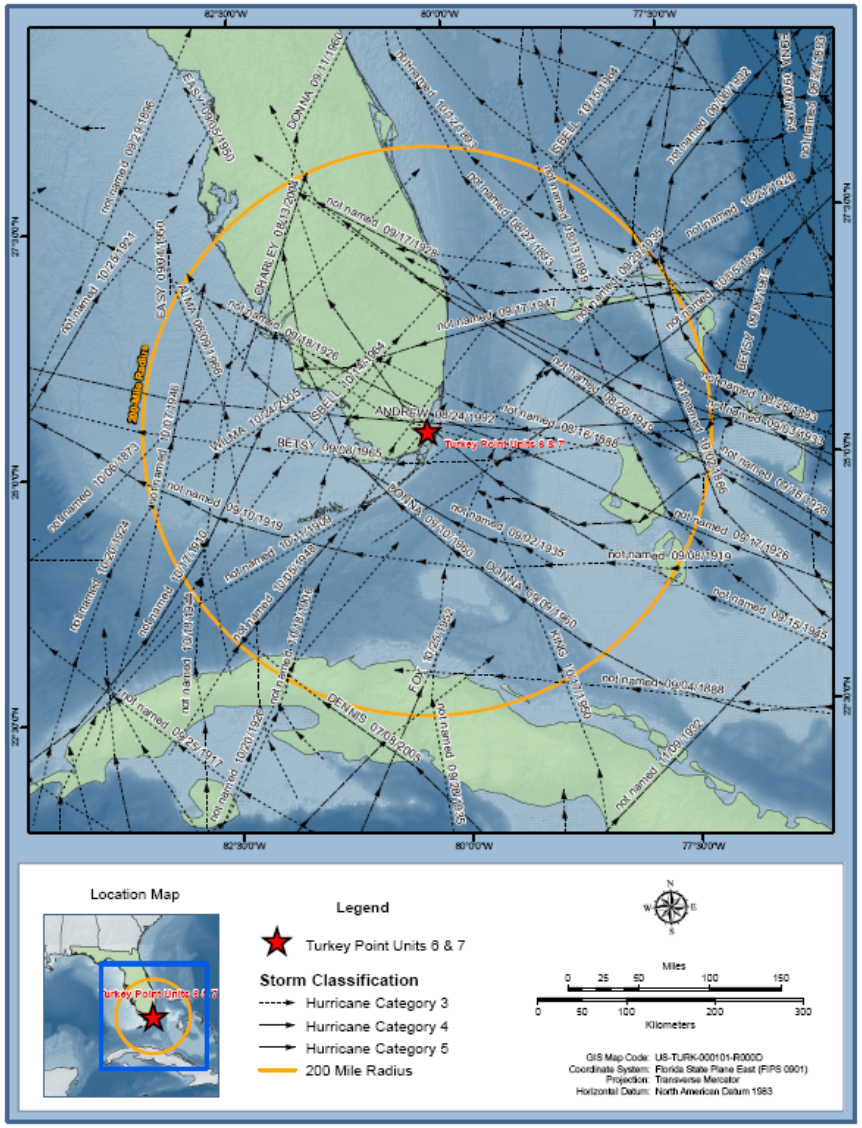
Conveyance Canals and Control Structures



Reference: USGS 1999b

Probable Maximum Surge and Seiche Flooding

Hurricanes, Category 3 and Above, near the Site



Probable Maximum Surge and Seiche Flooding (continued)

Probable Maximum Hurricane (PMH)

- **Parameters are based on NOAA Report NWS-23**
  - Site is approximately at milepost 1450 nautical miles from U.S.-Mexico border

PMH Parameter	Magnitude
Peripheral Pressure	30.12 inch Hg
Central Pressure	26.12 inch Hg
Radius of Max. Wind	4 to 20 NM
Forward Speed	6 to 20 knots
Track Direction (clockwise from north)	72 to 185 deg
Inflow angle	2 to 9 deg

The PMH central and peripheral pressure difference is 4.0 inch Hg, which is approximately 135.5 millibars

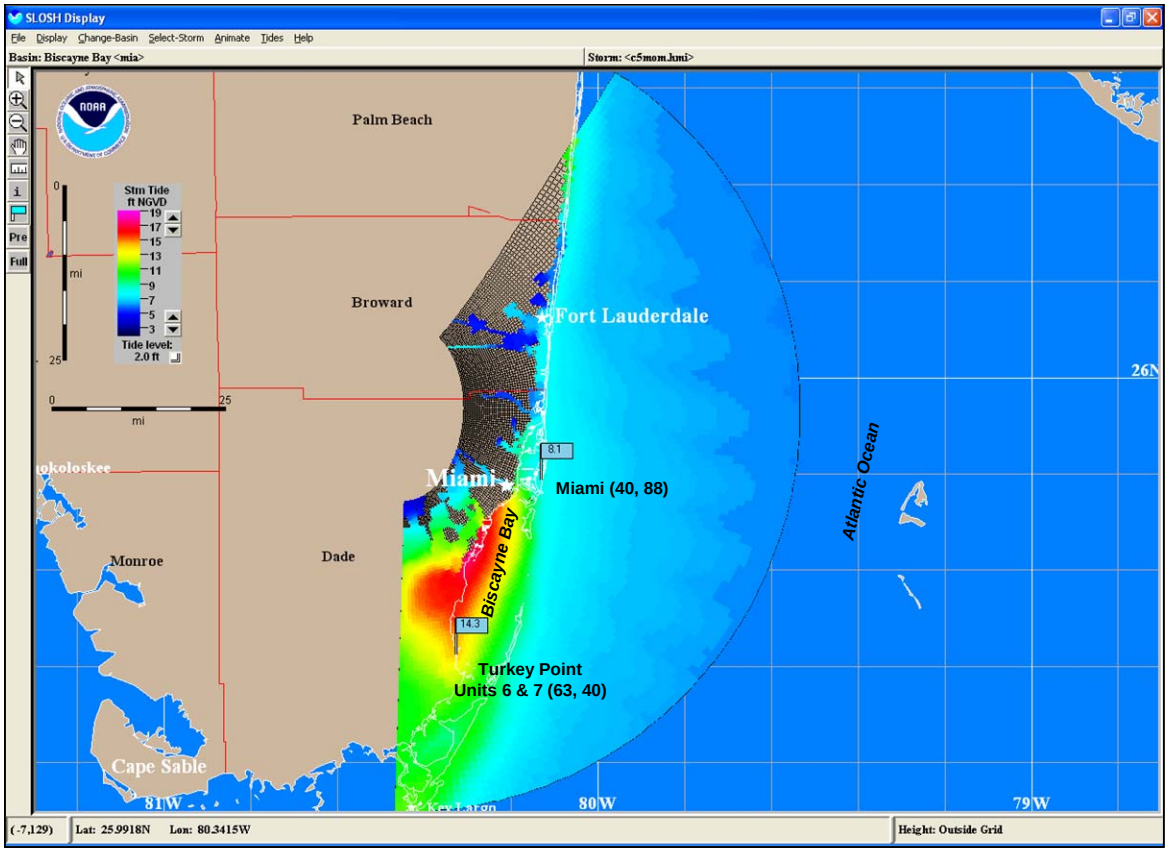
Probable Maximum Surge and Seiche Flooding (continued)

Probable Maximum Storm Surge

- **PMH-induced surge height**
  - Estimated based on two approaches
    - -- Projection of existing SLOSH computer program results to PMH conditions
    - -- Run SLOSH for the PMH and antecedent water level
- **10% exceedance high spring tide**
  - Conservatively from RG 1.59
- **Initial rise**
  - Conservatively from RG 1.59
- **Long-term sea level rise considered**

Probable Maximum Surge and Seiche Flooding (continued)

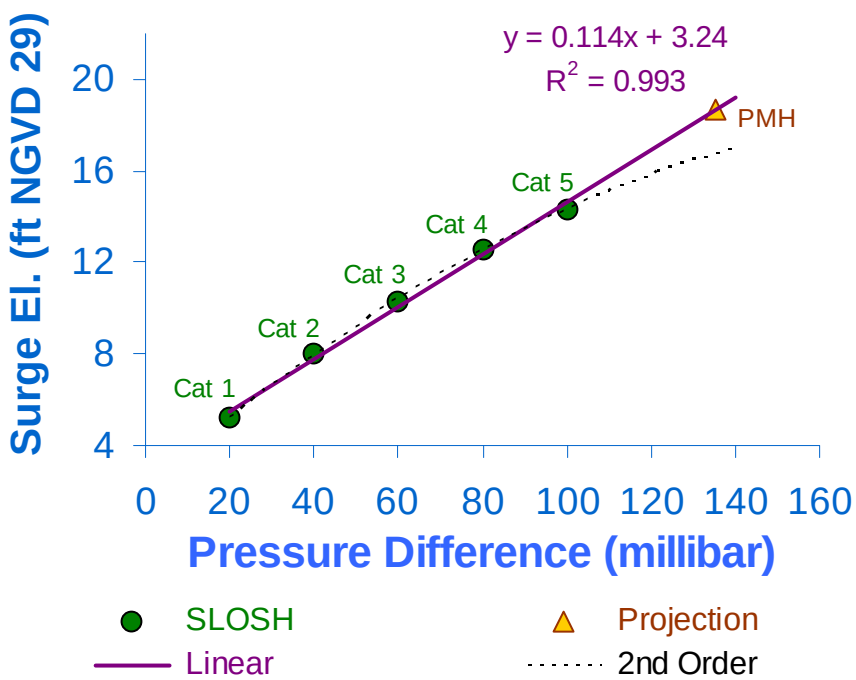
PMH Surge Height from SLOSH Results Projection



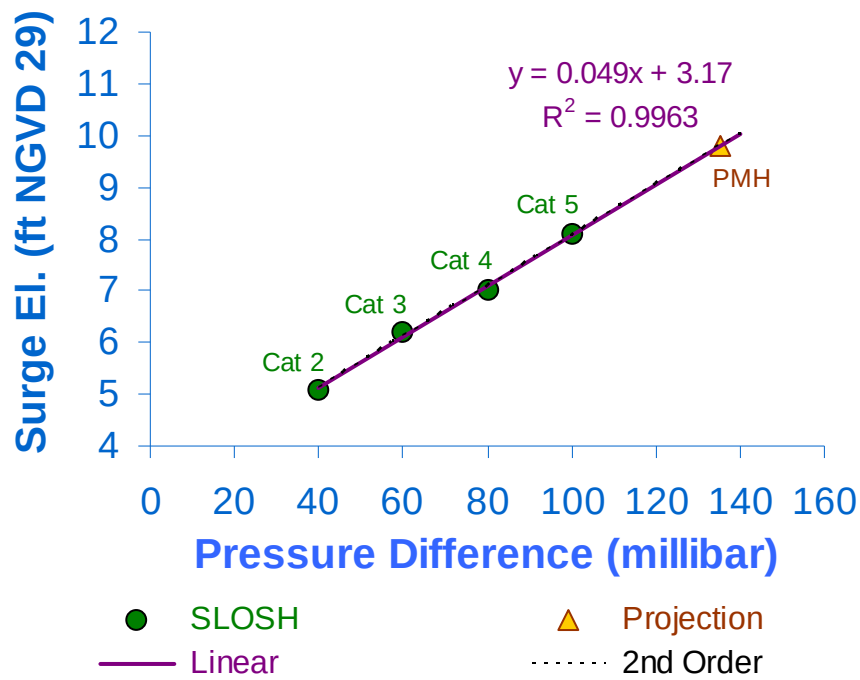
Results from SLOSH Biscayne Bay Basin Model for Hurricane Categories 1 through 5 (Saffir-Simpson scale), Category 5 MOM is shown above

Probable Maximum Surge and Seiche Flooding (continued)

Surge Projection at the Site, SLOSH Grid (63, 40)



Surge Projection near Miami, SLOSH Grid (40, 88)



The projected surge elevation for the PMH at the site is approximately 18.7 ft National Geodetic Vertical Datum NGVD 29, which is approximately 17.2 ft NAVD 88

Probable Maximum Surge and Seiche Flooding (continued)

Antecedent Water Level Conditions

- **Initial water level in SLOSH is 2 ft NGVD 29 (~ 0.5 ft NAVD 88)**
- **10% exceedance high spring tide in RG 1.59**
  - 3.6 ft MLW at Miami Harbor Entrance
- **Initial rise**
  - 0.9 ft MLW at Miami Harbor Entrance
- **10% Exceedance tide + Initial rise = 4.5 ft MLW (mean low water)**
  - Which is ~ 2.6 ft NAVD 88
- **Long-term sea level rise**
  - 0.78 ft/century at the NOAA Miami Beach, Florida station
  - Nominally used 1.0 ft/century (~ 25% increase from current trend)

Probable Maximum Surge and Seiche Flooding (continued)

PMSS Still Water Level and PMH Wind Speed

- **Adjusted surge projection (PMSS)**
  - [(17.2 - 0.5) + 2.6] ft NAVD 88 + 1.0 ft = 20.3 ft NAVD 88
- **PMH-induced maximum wind speed**
  - Wind speeds estimated based on the methodology in NWS-23
    - -- Maximum stationary wind speed estimated
    - -- Maximum hurricane wind speed for moving hurricane for the range of PMH parameters
  - Resulting maximum wind speed (10-min average 33-ft high) at the site is 141 knots or ~ 162 miles per hour

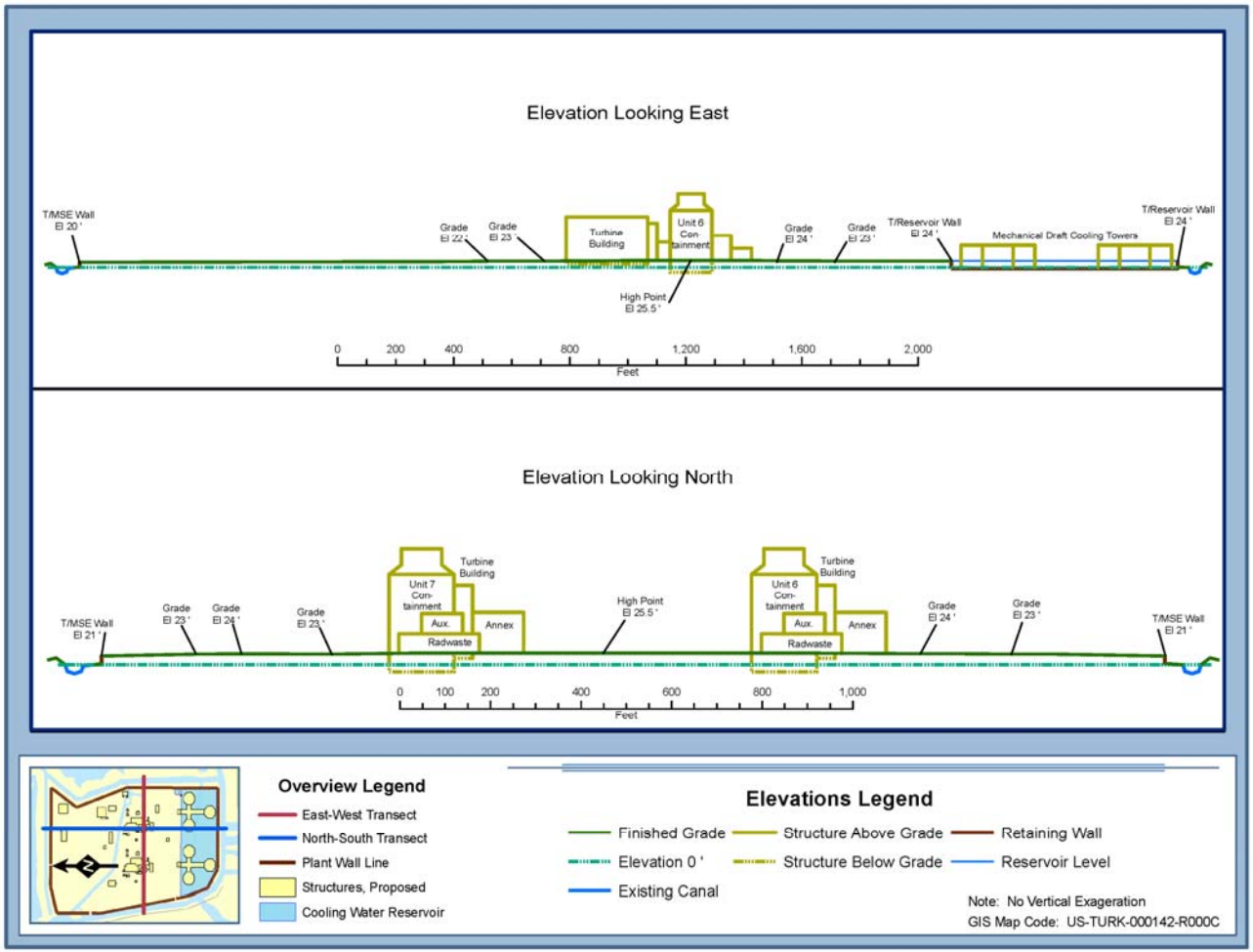
Probable Maximum Surge and Seiche Flooding (continued)

Wind Wave Effects and Maximum Water Level

- **Wave action**
  - Wave height governed by the breaking wave condition, limited by the water depth
  - Wave runup estimated based on methodology in the CEM
  - Resulting wave runup is 3.4 ft
- **Maximum water level due to PMSS**
  - (20.3 ft NAVD 88 + 3.4 ft) = 23.7 ft NAVD 88

Probable Maximum Surge and Seiche Flooding (continued)

Site Grade Elevation

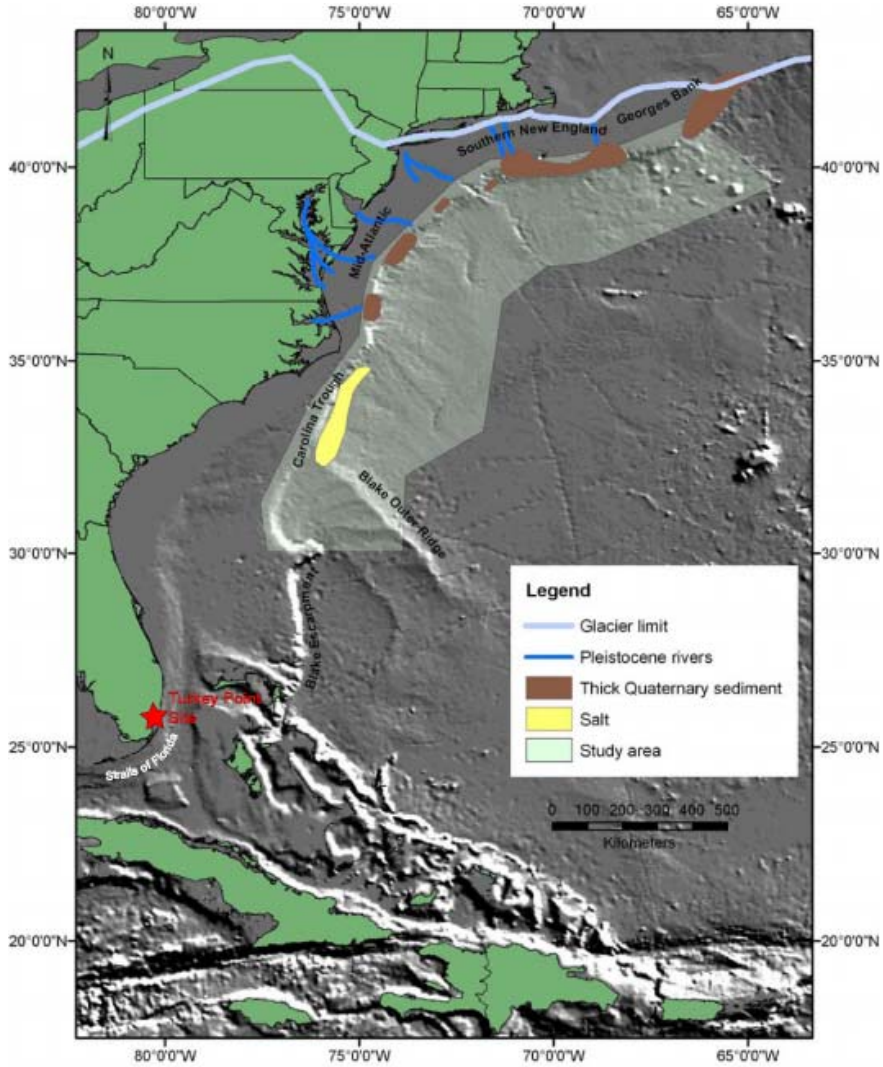


Tsunami Source Mechanisms and Sources

- **Source identification based on National Geophysical Data Center (NGDC) Tsunami Database and published studies**
- **Source mechanisms include**
  - Submarine landslides
    - U.S. and Canada Atlantic margin
    - Gulf of Mexico
  - Earthquakes
    - Caribbean subduction zone
    - East Atlantic region (Azores-Gibraltar fracture zone)
  - Volcanic activities
    - Cumbre Vieja volcano in the Canary Islands of La Palma

Probable Maximum Tsunami Hazards (continued)

Landslide in the U.S. Atlantic Margin

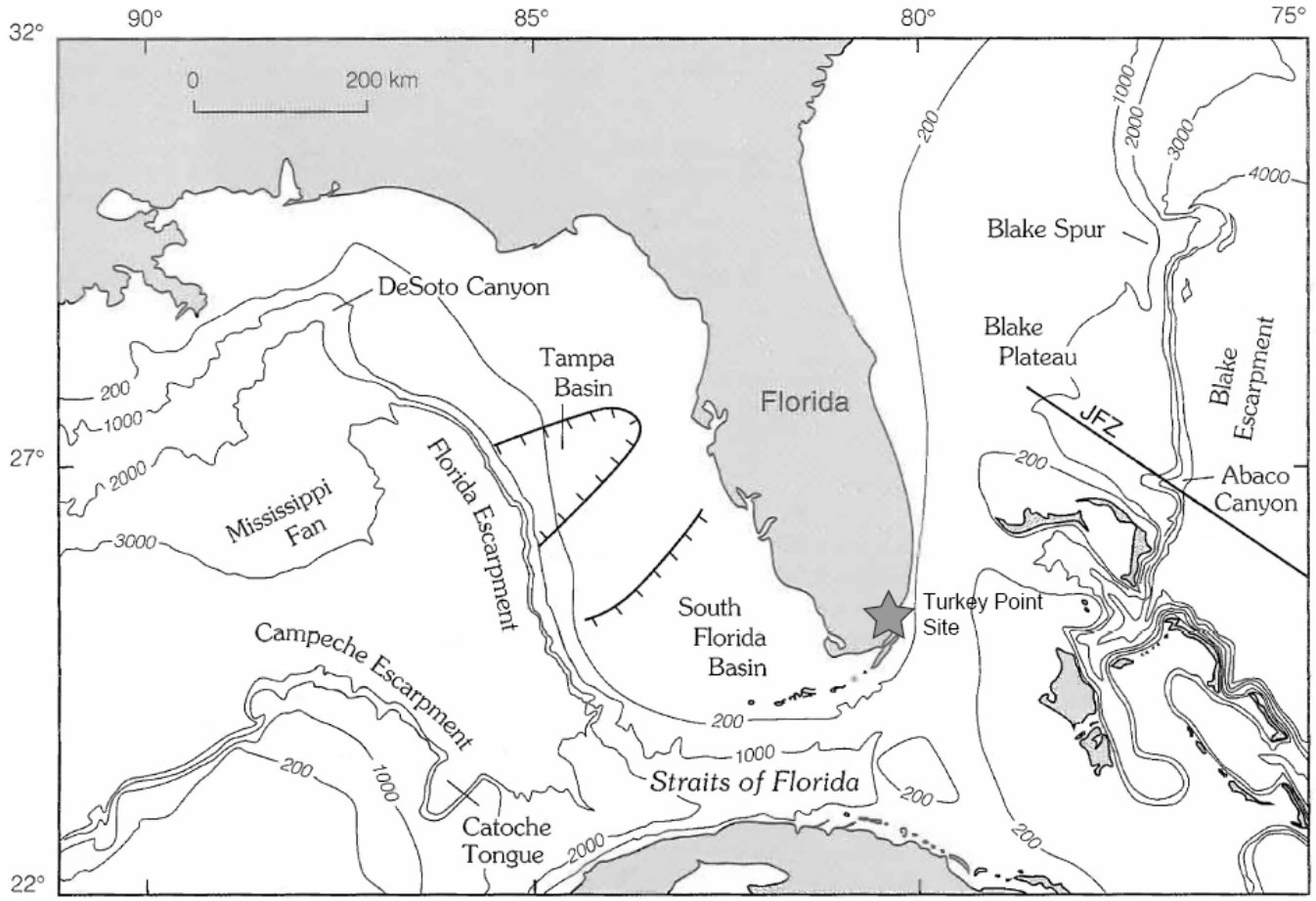


Note: Location of FPL Turkey Point Units 6 & 7 site is approximate.

Reference: AGMTHAG 2007

Probable Maximum Tsunami Hazards (continued)

Landslide in Blake Escarpment

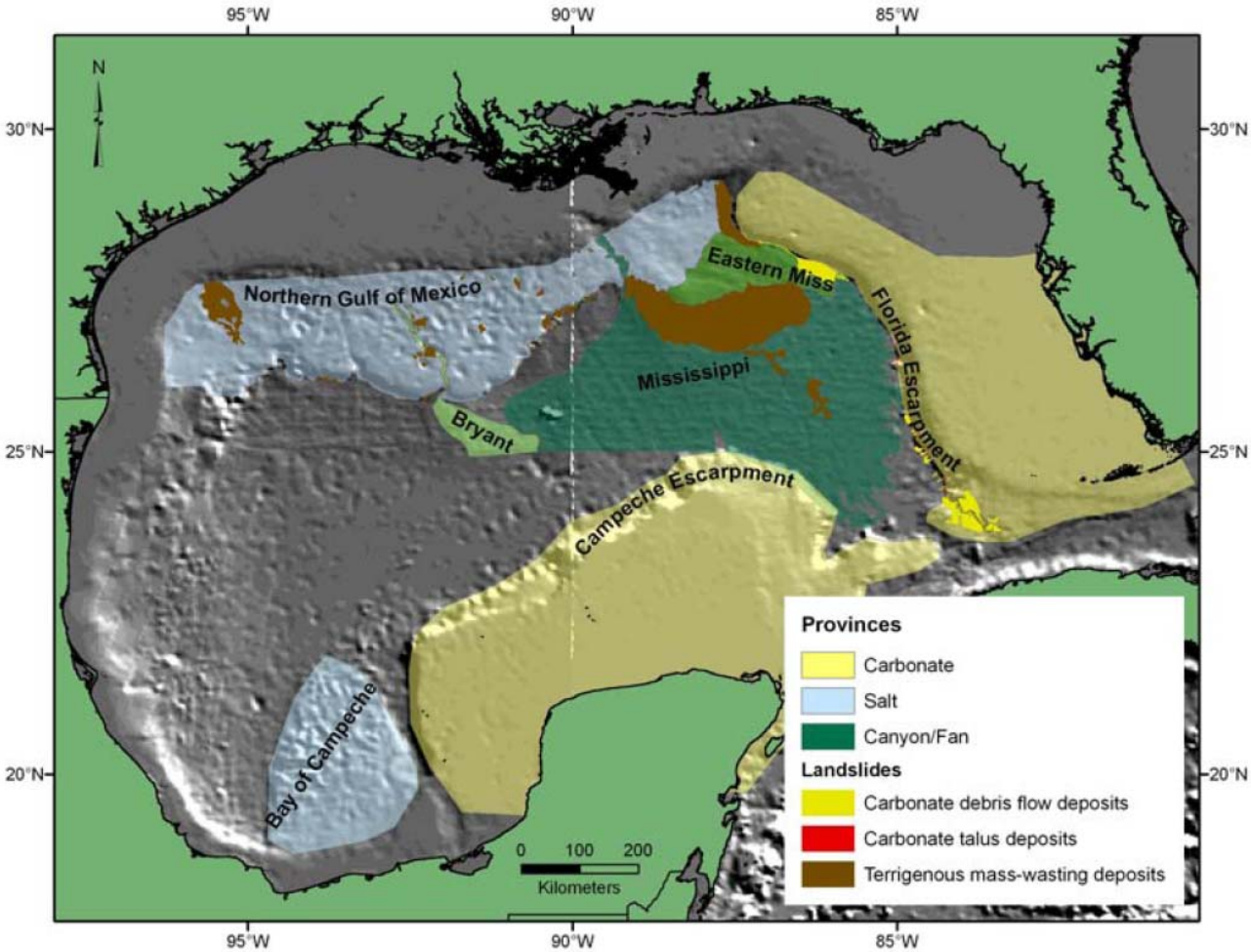


JFZ = Jacksonville fracture zone

Reference: Twitchell et al. 1996

Probable Maximum Tsunami Hazards (continued)

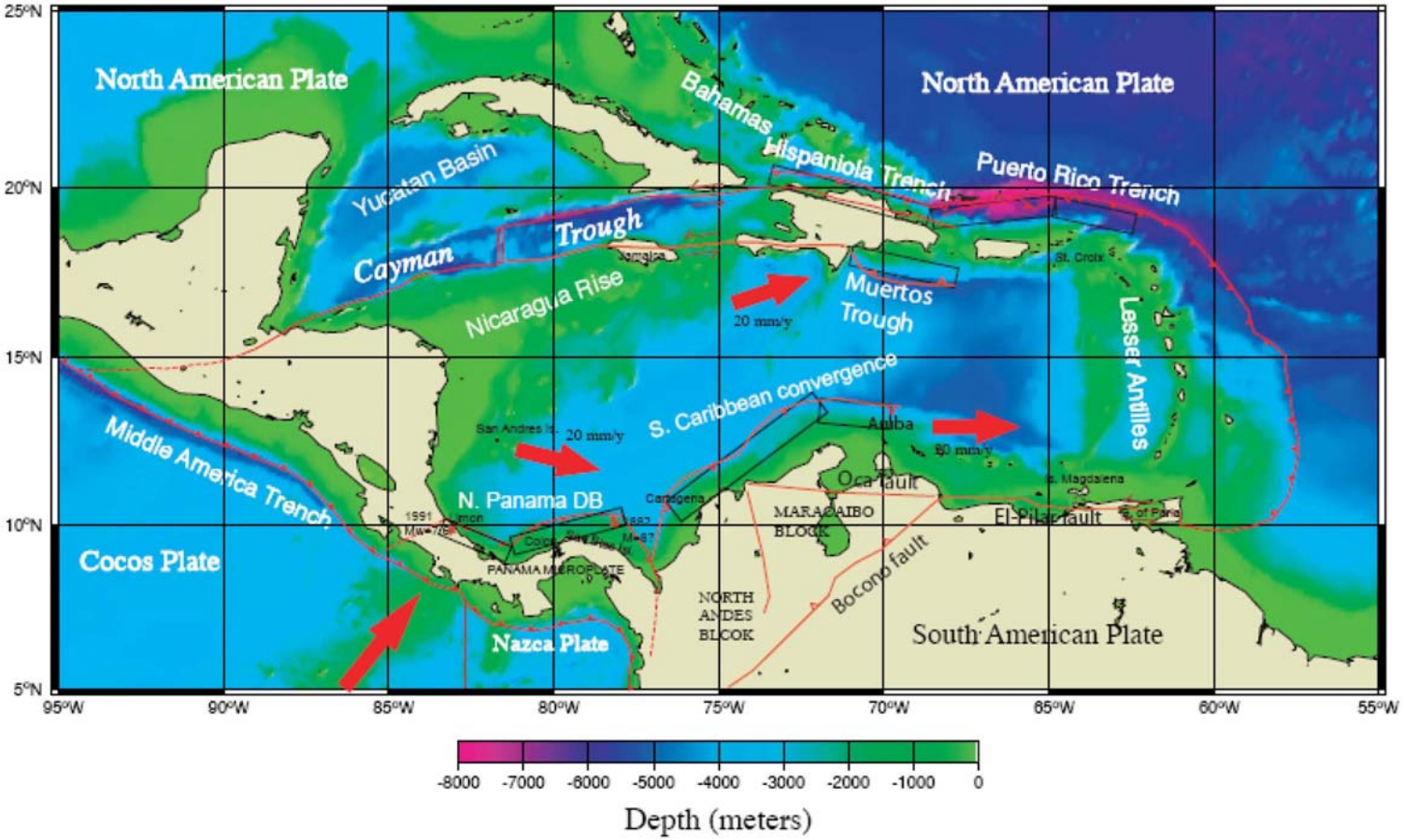
Submarine Landslide in Gulf of Mexico



Reference: AGMTHAG 2007

Probable Maximum Tsunami Hazards (continued)

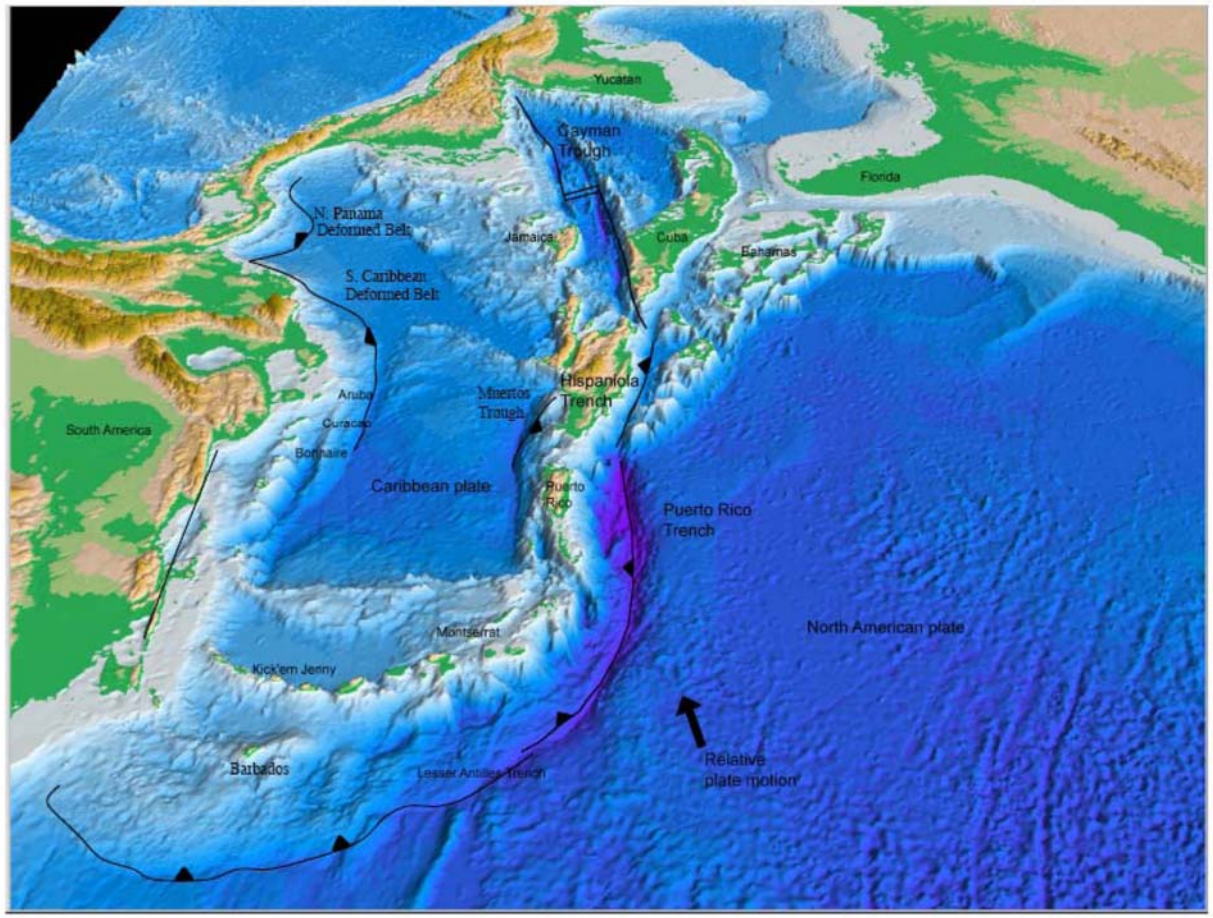
Caribbean Plate Boundary and Tectonic Elements



Note: red lines are plate boundaries and red arrows indicate relative plate movement
Reference: AGMTHAG 2007

Probable Maximum Tsunami Hazards (continued)

Puerto Rico and Hispaniola Trenches



Reference: AGMTHAG 2007

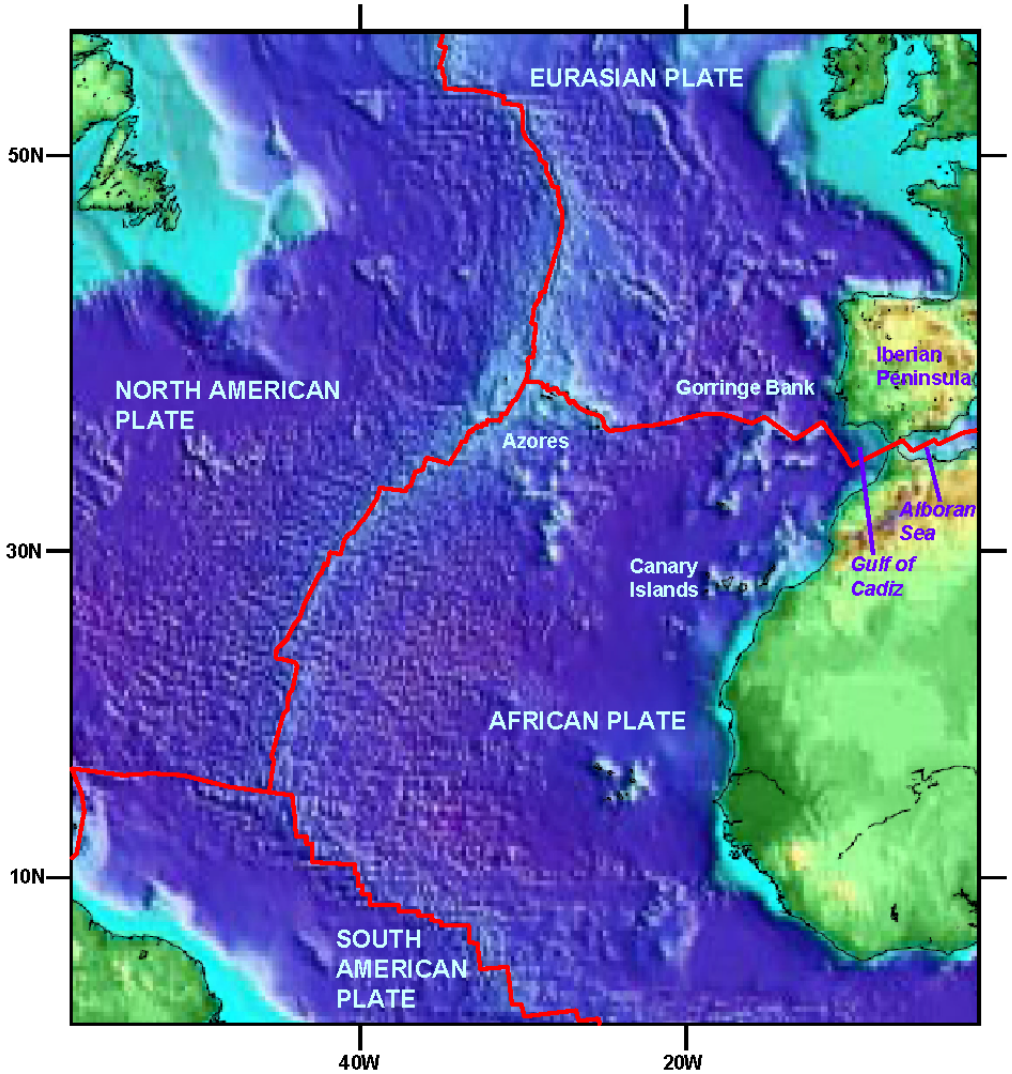
Probable Maximum Tsunami Hazards (continued)

PMT Candidate Source

- **Earthquake sources in the Azores-Gibraltar Fracture Zone (the source for the 1755 Lisbon Earthquake)**
  - Two major views on plate tectonic summarized in AGMTHAG 2007
    - -- Strike-slip motion of plates
    - -- Fragmentation during Miocene with two narrow and active subduction zones
  - Primarily two source regions (AGMTHAG 2007)
    - -- Gorringe Bank
    - -- Gulf of Cadiz
  - AGMTHAG (2007) provides characterization of both sources

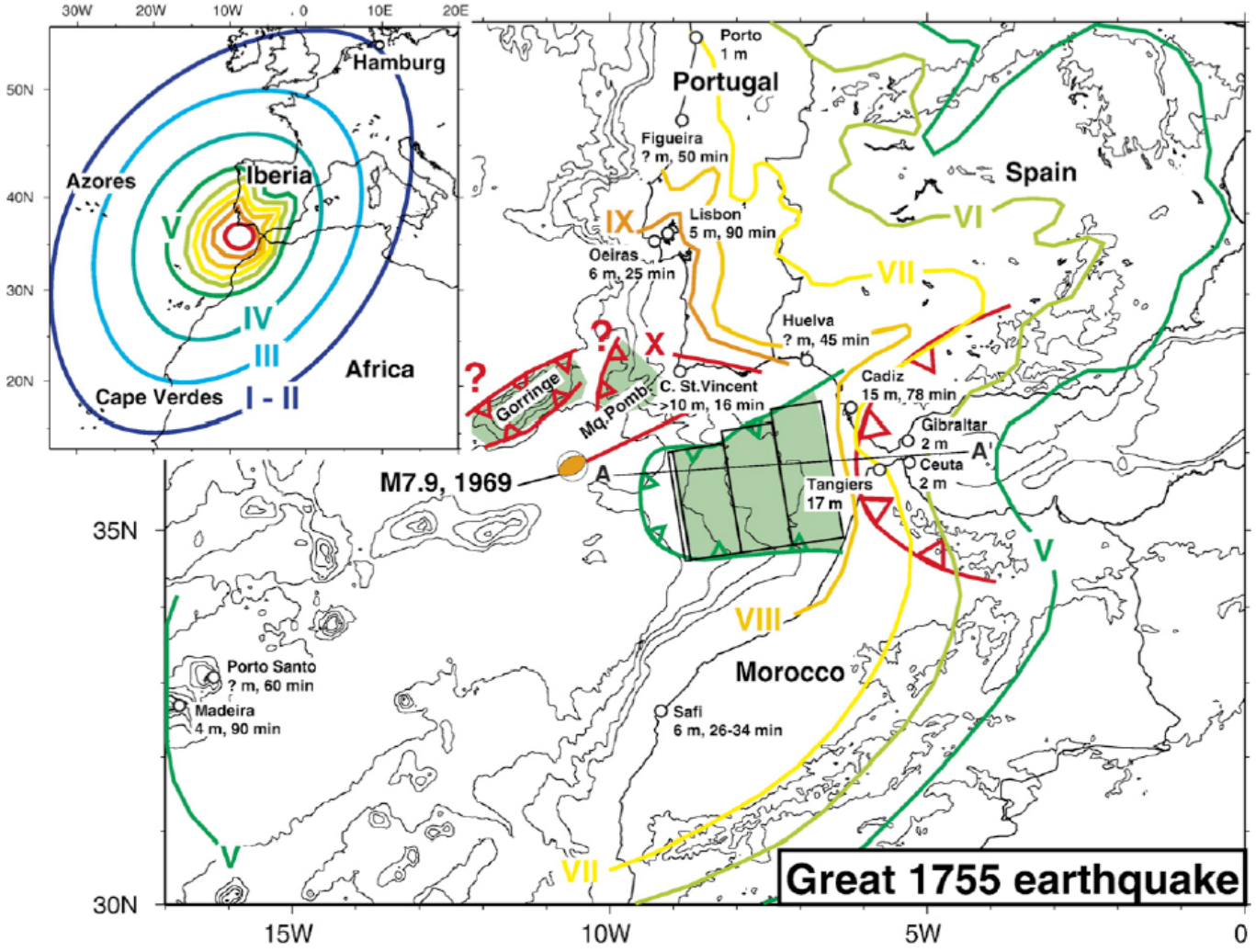
Probable Maximum Tsunami Hazards (continued)

PMT Candidate Source (continued)



Probable Maximum Tsunami Hazards (continued)

PMT Candidate Source (continued)



Reference: AGMTHAG 2007

Probable Maximum Tsunami Hazards (continued)

Tsunami Water Level

- **Mader (2001) simulated the 1755 Lisbon tsunami to match known tsunami amplitudes in the Portugal coast and across the Atlantic Ocean**
- **PMT water level is taken from the simulation results of Mader (2001)**
  - 2 m (6.6 ft) amplitude at 783 m (~ 2570 ft) water depth east of Miami
  - Onshore tsunami amplitude including runup is 2 x deepwater amplitude = 4 m (13.1 ft)
  - Antecedent water level same as defined for storm surge, i.e., 2.6 ft NAVD 88 for 10% exceedance high spring tide and initial rise, and 1.0 ft/century for long-term sea level rise
  - The maximum tsunami water level near the site is (13.1 ft + 2.6 ft NAVD 88 + 1.0 ft) = 16.7 ft NAVD 88

References

- USGS 1999a. Marella, R.B., *Water Withdrawals, Use, Discharge, and Trends in Florida, 1995*, Water-Resources Investigations Report 99-4002, 1999
- USGS 1999b. Lietz, A. C., *Methodology for Estimating Nutrient Loads Discharged from the East Coast Canals to Biscayne Bay*, Miami-Dade County, Florida, Water-Resources Investigations Report 99-4094, 1999
- USGS 1997. McPherson, B. F., and R. Halley, *The South Florida Environment: A Region Under Stress*, Survey Circular 1134, National Water Quality Assessment Program, 1997
- USGS 2005. Renken., R. A., et al., *Impact of Anthropogenic Development on Coastal Ground-Water Hydrology in Southeastern Florida, 1900–2000*, Circular 1275, 2005
- AGMTHAG 2007. *The Current State of Knowledge Regarding Potential Tsunami Sources Affecting U.S. Atlantic and Gulf Coasts – A Report to the Nuclear Regulatory Commission,* U.S. Geological Survey, Administrative Report, September 2007
- Twichell, D.C., Dillon, W.P., Paull, C.K., and N.H. Kenyon, *Morphology of Carbonate Escarpments as an Indicator of Erosional Processes, Geology of the Unites States Seafloor – A View from GLORIA*, Cambridge University Press, 1996
- Mader, C.M.*, Modeling the 1755 Lisbon Tsunami, Science of Tsunami Hazards*, Volume 19, No. 2, pages 93–98, 2001

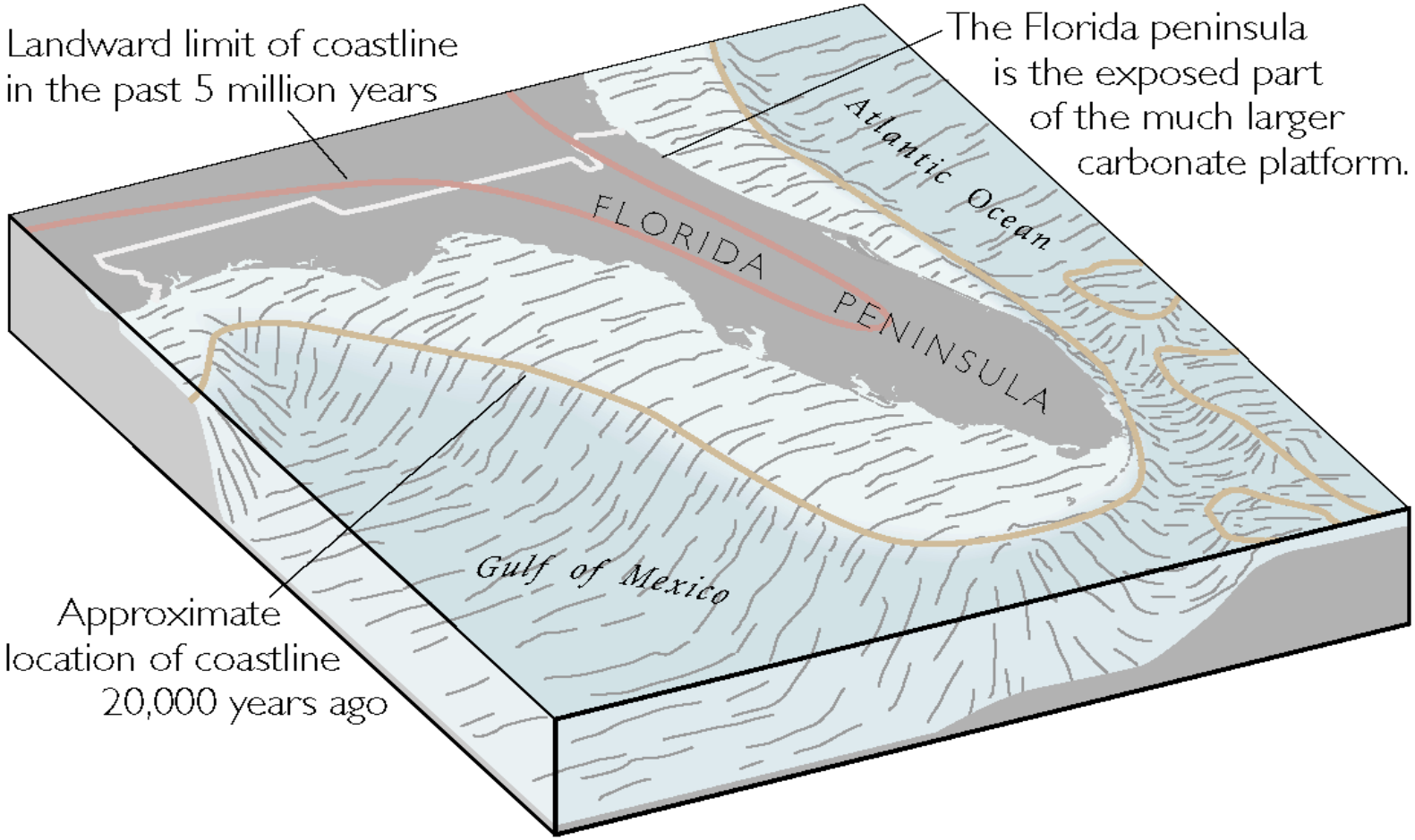
General Geologic Conditions

Dave Fenster

Engineering Geology Supervisor, Bechtel

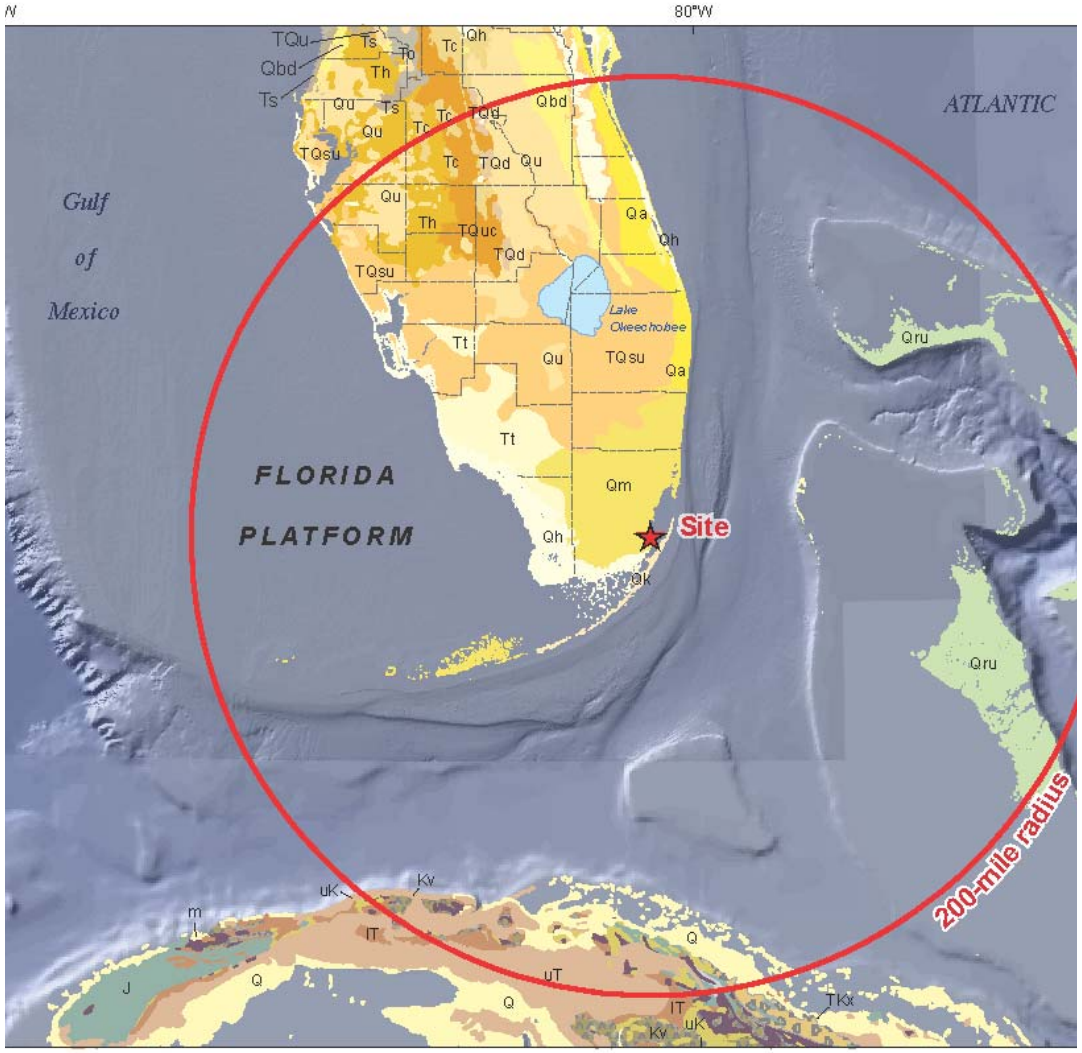
December 5, 2008

Florida Geomorphology



Source: Tihansky, A.B., 1999

Regional Geology



Florida Geologic Units

QUATERNARY

- Qh Holocene sediments
- Qa Anastasia Formation
- Qk Key Largo Limestone
- Qm Miami Limestone
- Qdb Beach Ridge and Dune deposits
- Qu Undifferentiated sediments

LATE TERTIARY/ EARLY QUATERNARY

- TQsu Shelly sediments (includes Fort Thompson, Bermont, and Caloostahatchee Formations)
- TQuc Reworked Cypresshead sediments
- TQd Dune deposits
- TQu Undifferentiated sediments

TERTIARY

- Tc Cypresshead Formation
- Tt Tamiami Formation
- Th Hawthorn Group, undivided
- Ts Suwannee Limestone
- To Ocala Limestone

BODC, 2008; Scott, et al, 2001

Paleozoic & Mesozoic Regional Stratigraphic Column

ERA	SYSTEM	SERIES	STRATIGRAPHIC UNIT		LITHOLOGY	THICKNESS (ft)
MESOZOIC	CRETACEOUS	UPPER	Pine Key Formation		chalk, ls, dol	3000
		LOWER	Naples Bay Group	Corkscrew Swamp Fm	ls with anhyd & dol	450
				Rookery Bay Fm		500
				Panther Camp Fm		350
			Big Cypress Group	Dollar Bay Fm	ls w. dol & anhyd	450-620
				Gordon Pass Fm	anhyd w. ls & dol	475
				Marco Junction Fm	ls w. dol & anhyd	350
			Ocean Reef Group	Rattlesnake Hammock Fm	anhyd w. ls & dol	600
				Lake Trafford Fm	ls with anhyd	150
				Sunniland Fm	ls with dol & anhyd	200-300
			Glades Group	Punta Gorda Anhydrite	salt with anhyd & dol	800
				Lehigh Acres Formation	anhyd with ls, dol, sh	530-700
					anhyd, ls, dol	210
					ls, dol, brown dol zone	300
					sh	200
			Pumpkin Bay Formation		anhyd with ls	1200
			Bone Island Formation		ls with anhyd & dol	1300-2000
	JURASSIC	UPPER	Wood River Formation		dol, anhyd, salt, ss	1700-2100
		MIDDLE	basement volcanic province		felsic rocks: rhyolite porphry	
		LOWER			mafic volcanics: basalt & diabase	
PALEOZOIC			Suwanee terrane	Paleozoic sedimentary Suite	quartzitic sandstone & black shale	
				Osceola volcanic complex	felsic meta-igneous	
				Osceola Granite	granite	
				St. Lucie Meta-morphic Complex	pan-African metamorphics	
TOTAL THICKNESS						12,750-14,300

Developed from selected references including:

Arthur, 1988; Dallmeyer, 1989; Pollastro, et al, 2001; Salvador, 1991; Winston 1987.

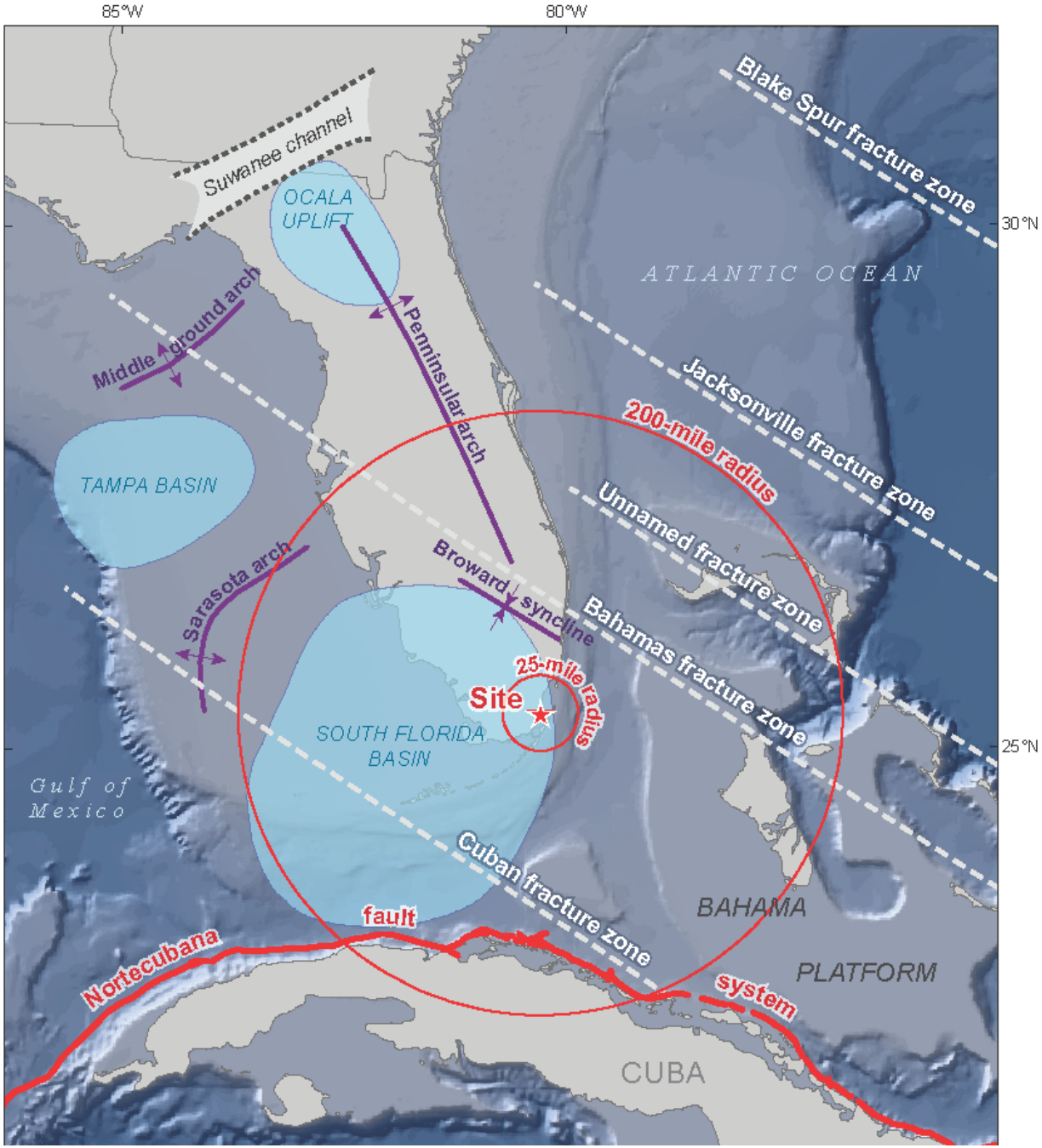
Cenozoic Regional Stratigraphic Column

ERA	SYSTEM		SERIES	STRATIGRAPHIC UNIT		LITHOLOGY	THICKNESS (ft)
CENOZOIC	QUATERNARY		PLEISTOCENE	Miami Limestone / Key Largo Limestone/ Anastasia Formation		sandy, oolitic, corraline, shelly limestone	10-180
				Caloosahatchee Formation/ Fort Thompson Formation		poor/well indurated sandy, fossiliferous limestone	50-100
	TERTIARY	NEOGENE	PLIOCENE	Tamiami Formation/ Cypresshead Formation (Long Key Formation)		fossiliferous sand & silt with limestone	25-220
			MIOCENE	Hawthorn Group	Peace River Formation	sands, clays, & phosphatic carbonates	100-650
					Arcadia Formation	fine XTLn limestone with sand/clay, phosphatic fossiliferous limestone, & dolomite	100-700
		PALEOGENE	OLIGOCENE	Suwannee Limestone		poor/well indurated fossiliferous vuggy to moldic limestone	200-600
			EOCENE	Ocala Limestone		poor/well indurated fossiliferous limestone	200-400
				Avon Park Fomration		poor/well indurated fossiliferours limestone & vuggy dolostone	400-1200
				Oldsmar Formation		vuggy limestone & dolomite	500-1500
			PALEOCENE	Cedar Keys Formation		dolomite, gypsym, & anhydrite	500-2000
TOTAL THICKNESS							5000-6000

Developed from selected references including:

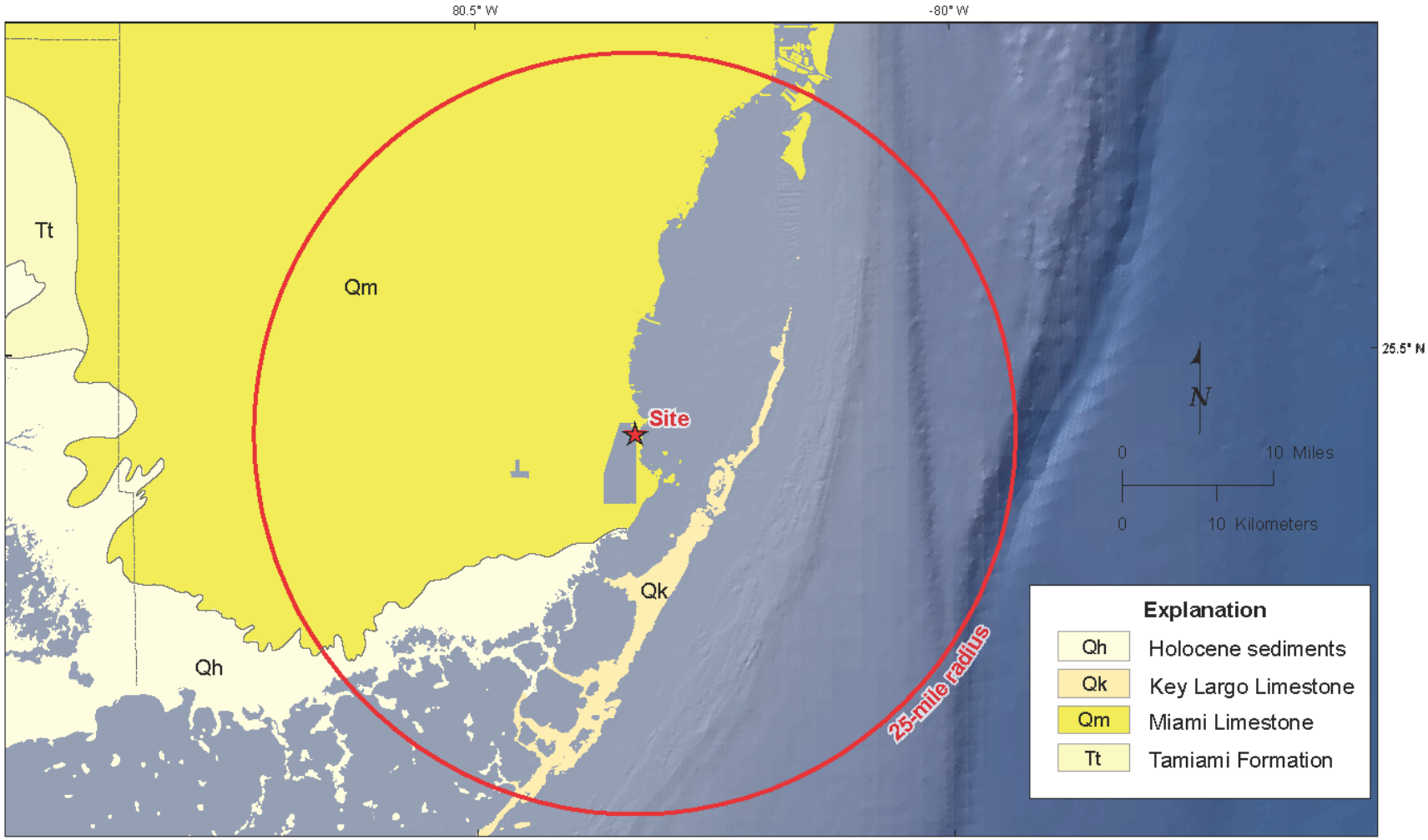
Cunningham, et al, 1998; Halley, et al, 1997; Missimer, 2001; Reese, 1994; Reese & Richardson, 2008.

Regional Geologic Structure

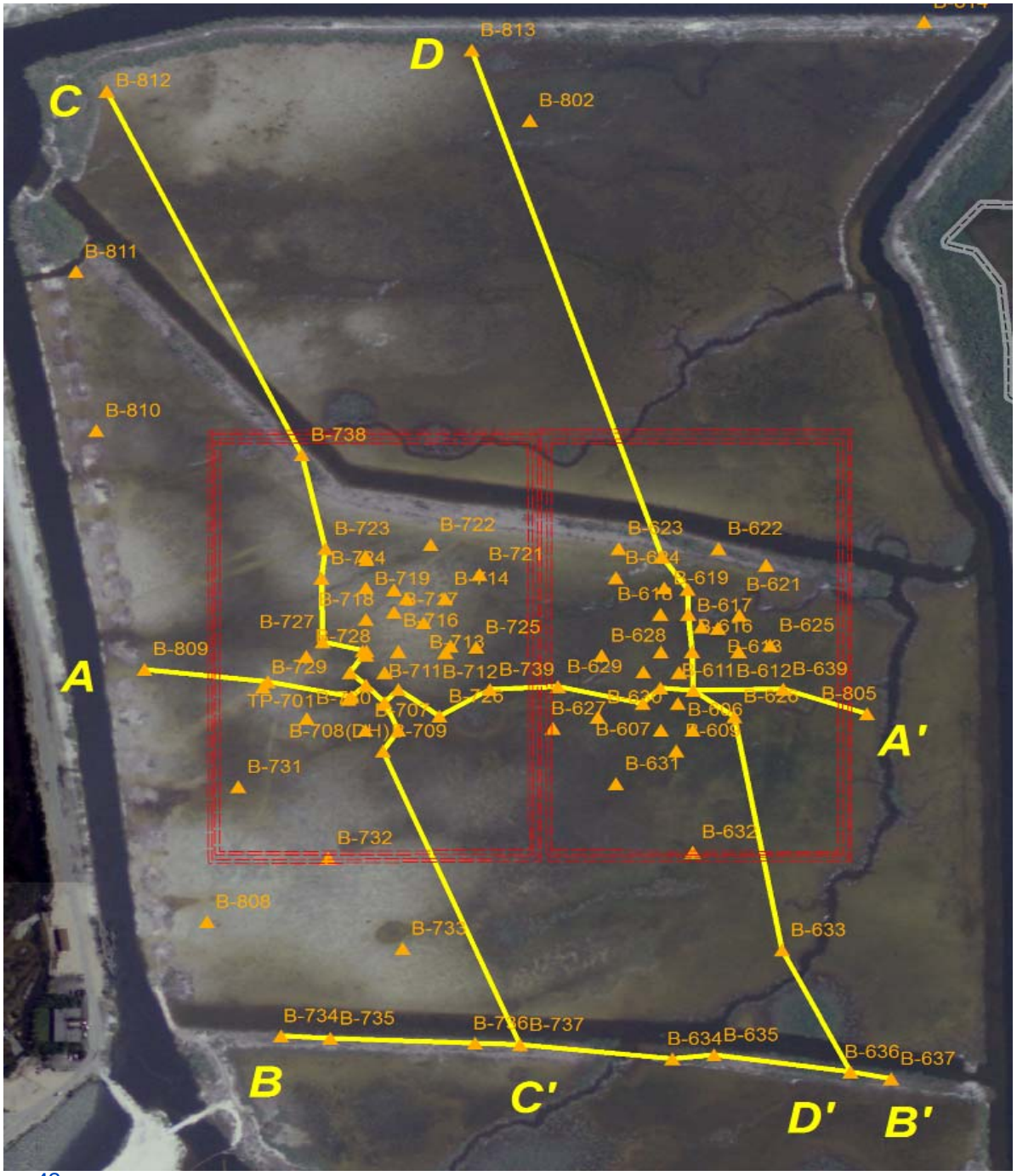


BODC, 2008; Ewing & Lopez, 1991; French, et al, 2004.

Site Geology & Structure

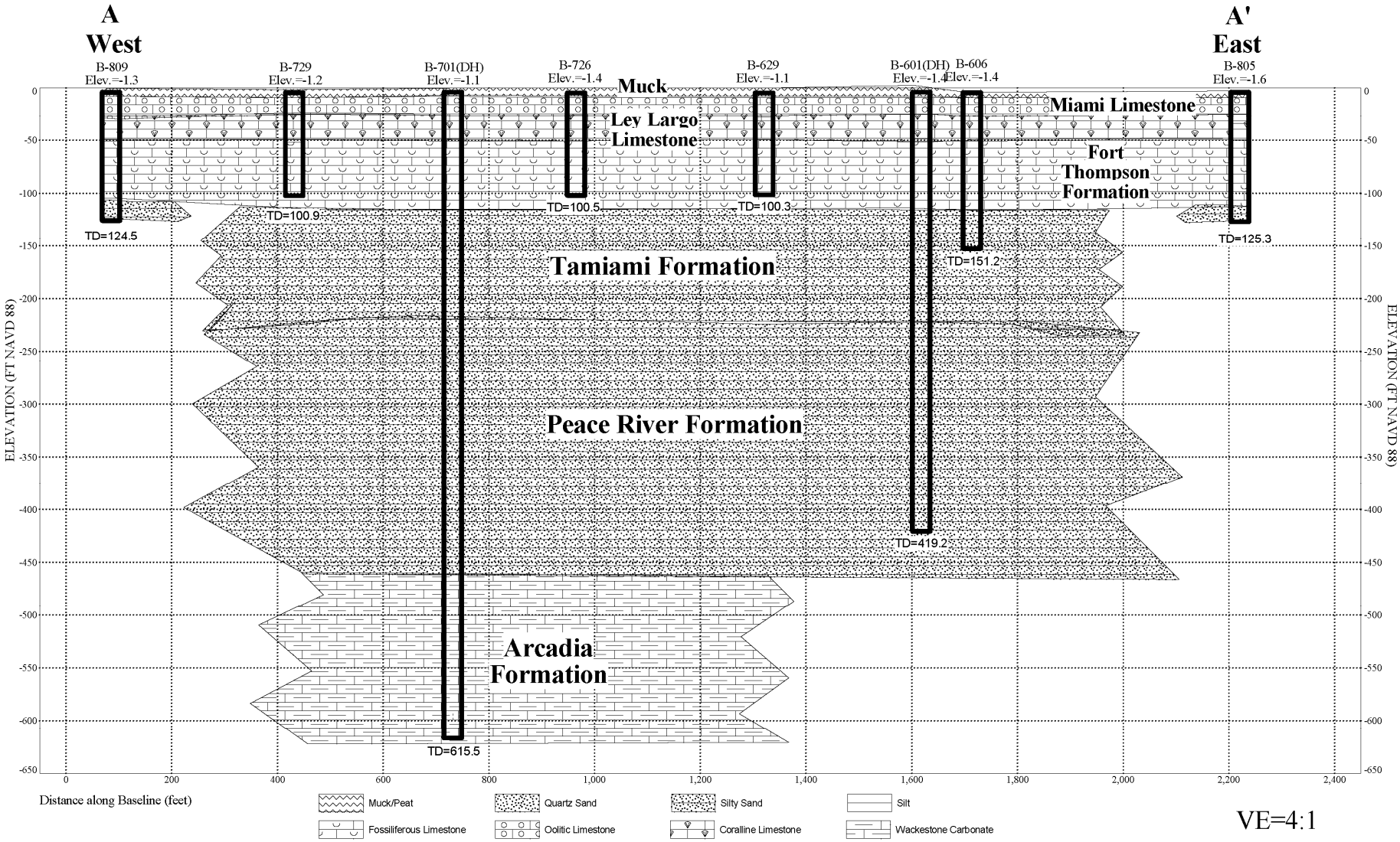


Site Subsurface Exploration



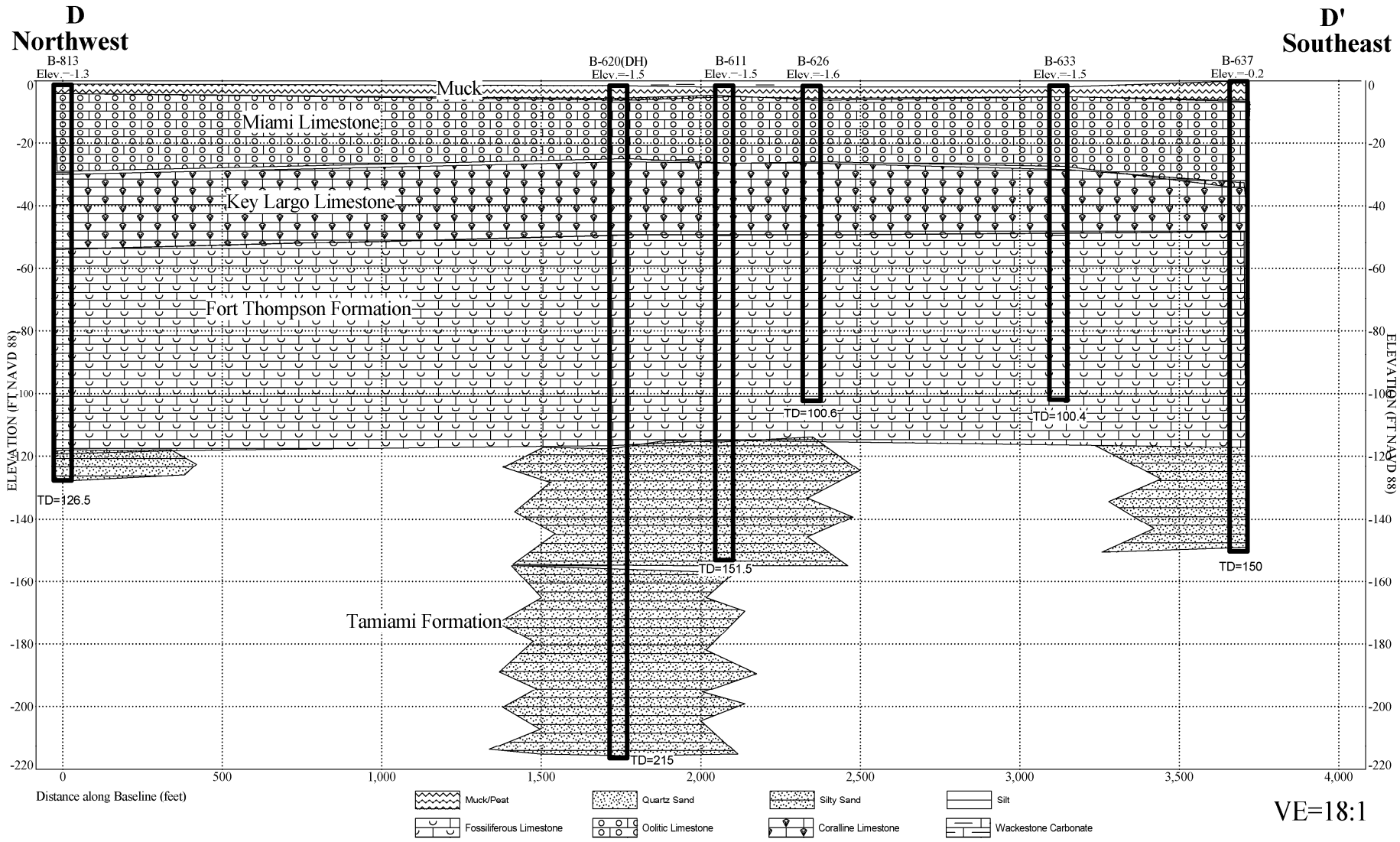
Site Boring & Cross-Section Locations

Geology Cross-Section A – A’



VE=4:1

Geology Cross-Section D – D’



Key Largo Limestone Sample: 26-36 ft.

Fort Thompson Formation Sample: 51-66 ft

Fort Thompson Formation Sample: 91-106 ft

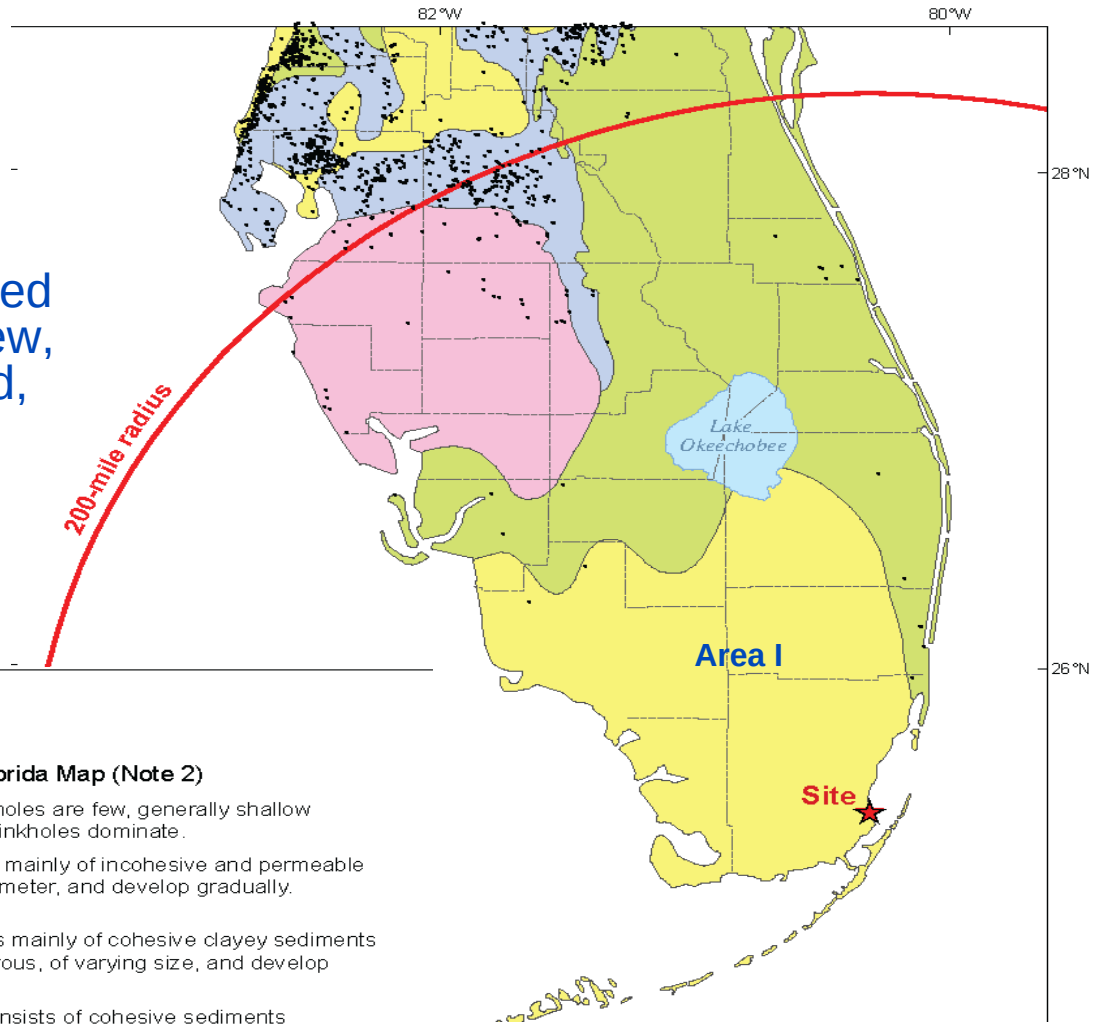
Site Stratigraphic Column

ERATHEM	SYSTEM	SERIES	HYDRO-GEOLOGIC UNIT		STRATIGRAPHIC UNIT		LITHOLOGY	TOP ELEVATION	THICKNESS (ft)
CENEZOIC	QUATERNARY	HOLOCENE	Surficial aquifer system	Biscayne aquifer	organic muck		organic soil and silt	0	3
		PLEISTOCENE			Miami Limestone		sandy, oolitic limestone	-3	25
					Key Largo Limestone		well indurated, vuggy, coralline limestone	-28	22
					Fort Thompon Formation		poor/well indurated fossiliferous limestone	-50	65
	TERTIARY	PLIOCENE		Semi-confining unit	Tamiami Formation		sand and silt with calcarenitic limestone	-115	105
		MIOCENE	Intermediate confining unit		Hawthorn Group	Peace River formation	silty calcareous sand and silt	*formation contact based on natural gamma signature* -220	235
						Arcadia formation	calcareous wackestone with indurated limestones, sandstone, and sand	-456	>160
								drilling ended at -616 ft	

Florida Geological Survey Sinkhole Map

Area I: Bare or thinly covered limestone. Sinkholes are few, generally shallow and broad, and develop gradually.

Source: Florida Geological Survey Sinkhole Map and Database updated 2008.



Explanation

- Documented sinkhole occurence (Note 1)

Sinkhole Type, Development, and Distribution in Florida Map (Note 2)

- Area I. Bare or thinly covered limestone. Sinkholes are few, generally shallow and broad, and develop gradually. Solution sinkholes dominate.
- Area II. Cover is 30 to 200 feet thick. Consists mainly of incohesive and permeable sand. Sinkholes are few, shallow, of small diameter, and develop gradually. Cover-subsidence sinkholes dominate.
- Area III. Cover is 30 to 200 feet thick. Consists mainly of cohesive clayey sediments of low permeability. Sinkholes are most numerous, of varying size, and develop abruptly. Cover-collapse sinkholes dominate.
- Area IV. Cover is more than 200 feet thick. Consists of cohesive sediments interlayed with discontinuous carbonate beds. Sinkholes are very few, but several large diameter, deep sinkholes occur. Cover-collapse sinkholes dominate.

Site Specific Dissolution Issues

- **The Florida Geological Survey (FGS/USGS) map & report (1985)**
  - Limestones underlying southeastern Florida have few sinkholes
  - Limestones exhibit shallow surface depressions
  - Dissolution develops gradually, not catastrophically

- **The FGS "Sinkhole Website" does not list any occurrence of sinkholes in Dade County through February 2008**

- **The FSAR & SER for Turkey Point Units 3 & 4, and an engineering report (1976) on the Units 3 & 4 foundation:**
  - The underlying limestones do not present a danger to foundations
  - Technical basis: good core recovery, examination of core samples and rock exposures in excavations, absence of karst topographic features, diver reconnaissance of deep excavations

Dissolution Investigation

- **Field reconnaissance identified shallow surface depressions**
- **Borings did not find any significant dissolution features**
  - Good core recovery: 60 to 80 percent
  - Negligible rod drops occurred during drilling
  - No unusual loss of drilling fluid
  - Caliper logs did not indicate any large voids
  - Acoustic logs did not indicate any large voids
- **Geophysical investigation is planned to confirm the absence of dissolution cavities. Planned completion by Spring 2009.**

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