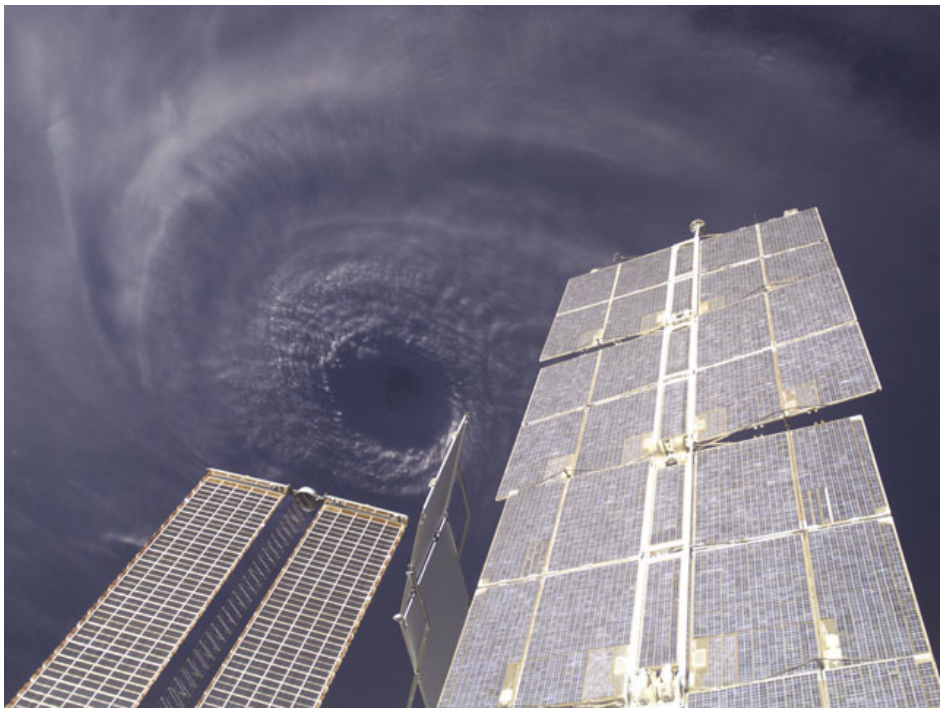
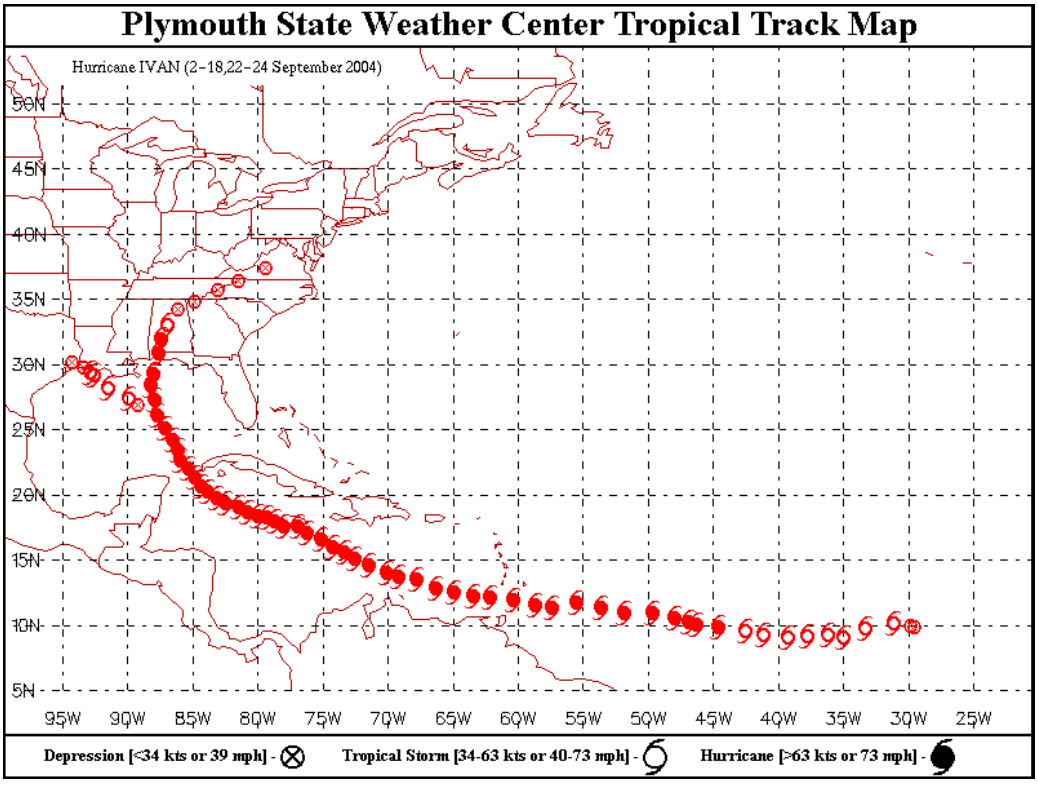
Hurricane Ivan
September 2004



Source: NASA



Tide Gage Data for Hurricane Ivan

The US Army Corps of Engineers Mobile District maintains a network of tide gages along the Gulf Coast from Gulfport, MS eastward to Carrabelle, FL. Each tide gage is installed to support our navigation dredging program. When there is a great possibility that a hurricane is going to strike the Gulf Coast COE personnel are dispatched to remove recorded data from coastal gages and insure that the gages are working properly to record the hurricane surge. All equipment is removed from gage sites in areas of direct storm path. Three gages were removed near the Alabama/Mississippi state line on 14 September 2004, two days before the projected landfall. Tide levels along the Gulf Coast for the time period during the storm are available at 15 gages and partial record from 3 gages. Five gages were destroyed by the hurricane and three gages malfunctioned from storm damage. The United States Geological Survey (USGS) operates a series of gages along the Gulf Coast. Data from 4 of the USGS gages was used to fill-in gaps from the COE gage network. The next section contains the tide hydrographs. The following table contains location and storm peak information for the tide gages. High water marks were obtained at or near the gages that were removed, destroyed or malfunctions. In addition high water marks were obtained on the West Bank of Escambia Bay at the Hwy 90 Bridge and 1.5 north I-10 Causeway Bridge. For comparison peak information from Hurricanes Georges (Sept 28, 1998), Opal (October 1995) and Frederic (September 1979) are listed. Location maps follow the hydrographs

Tide Gage Designation	Peak During Ivan (ft-NGVD)	Peak During Georges (ft-NGVD)	Peak During Opal (ft-NGVD)	Peak During Frederic (ft-NGVD)	Latitude	Longitude
[1]Mississippi Sound at Waveland, MS (USGS)	4.56				30° 16' 50"	89° 21' 53"
Gulfport Harbor at Gulfport, MS (540)	4.63	7.05		2.98	30° 21' 37"	89° 05' 27"
Mississippi Sound at Ship Island	5.15				30° 12' 43"	88° 58' 19"
Biloxi Bay at Point Cadet	4.23	7.17			30° 23' 23"	88° 51' 26"
Back Bay Biloxi at Biloxi, MS		8.05			30° 24' 17"	88° 50' 40"
[1]West Pascagoula River at Hwy 90 at Gautier, MS	4.10				30° 22' 58"	88° 36' 32"
[2]Pascagoula River (NOAA) at Pascagoula, MS	6.72	8.36		5.78	30° 22' 01"	88° 33' 48"
Mississippi Sound at Pascagoula PI- Rear Range	5.83				30° 17' 56"	88° 30' 52"
Mississippi Sound at Petit Bois Island	4.83				30° 12' 52"	88° 30' 20"
[1]Escatawpa River at I-10 nr Orange Grove, MS	3.93				30° 27' 31"	88° 27' 05"
Middle Gage at Bayou LaBatre	4.66	8.27			30° 23' 55"	88° 15' 25"
[2]Mobile Bay at Cedar Point, AL	6.90	5.60			30° 18' 38"	88° 08' 18"
Mobile Bay at Exxon Well					30° 11' 18"	88° 07' 18"
[3]Dauphin Island Bay at Dauphin Island	7.80	5.00	4.50	7.80	30° 15' 30"	88° 06' 28"
[2]Mobile Bay at Dauphin Island (USCG)	8.00	4.59			30° 15' 04"	88° 04' 46"
Mobile River at Mobile, AL	4.87	8.94		8.05	30° 42' 16"	88° 02' 22"
Mobile River at Bucks, AL (Barry Steam Plant)	6.82			5.50	31° 00' 16"	88° 00' 40"
Mobile Bay at McNally Park					30° 35' 38"	88° 02' 02"
Mobile Bay at Ft Morgan Front Range	7.85				30° 14' 00"	88° 02' 00"
Mobile Bay at Middle Bay Light House					30° 26' 42"	88° 06' 51"
Perdido Pass Orange Beach, AL	8.81	5.58	5.40	7.10	30° 16' 43"	87° 33' 18"
GIWW at Pensacola Gulf Beach, FL	9.68			7.19	30° 18' 50"	87° 25' 40"
[3]Pensacola Bay at Ft. McRee, FL (USCG)	9.70		7.50		30° 20' 42"	87° 17' 23"
[3]Pensacola Bay at Pensacola, FL (NOAA)	10.20		6.20		30° 24' 13"	87° 12' 44"
[3]Escambia Bay West Bank at HWY 90	12.92				30° 32' 49"	87° 11' 39"
[3]Escambia Bay West Bank 1.5 miles N of I-10	12.12				30° 31' 14"	87° 10' 31"
[3]GIWW at Gulf Breeze, FL	10.30		6.30		30° 21' 08"	87° 09' 23"
[1]Yellow River near Milton, FL	9.66				30° 34' 16"	86° 55' 28"
Fort Walton Brooks Bridge	6.12		5.80		30° 24' 00"	86° 36' 00"
DESTIN AT CHOCTAWHACHEE BAY (USCG)	5.39	4.60	6.80	3.28	30° 23' 31"	86° 31' 33"
GIWW at Choctawhachee Bay (HWY 331)	5.51				30° 24' 43"	86° 10' 08"
GIWW at West Bay, FL (HWY 79)	6.60				30° 17' 38"	85° 51' 31"
St Andrew Bay at Panama City, FL	4.94	3.51			30° 09' 10"	85° 40' 00"
Watson Bayou at Panama City, FL			6.92		30° 09' 22"	85° 38' 12"
Apalachicola River at Apalachicola, FL	5.10	4.52	6.40		29° 43' 59"	84° 59' 43"
GIWW at St. George Island, FL	3.55				29° 41' 14"	84° 52' 37"
Carrabelle River at Carrabelle, FL	5.04	4.58	5.54		29° 51' 06"	84° 40' 33"

[1] USGS gage
[2] Outside High Water Mark
[3] Inside High Water Mark

High Water Mark Categories

As a hurricane makes landfall and water begins to recede, evidence of high water is left behind. These are referred to as High Water Marks (HWM) and categorized into 4 groups

Inside Mark (I)– Marks defined by lines of mud, seed, and small broken debris or other marking substance left in closets, storage rooms, or other protected areas that would produce stilling well[1] type marks.

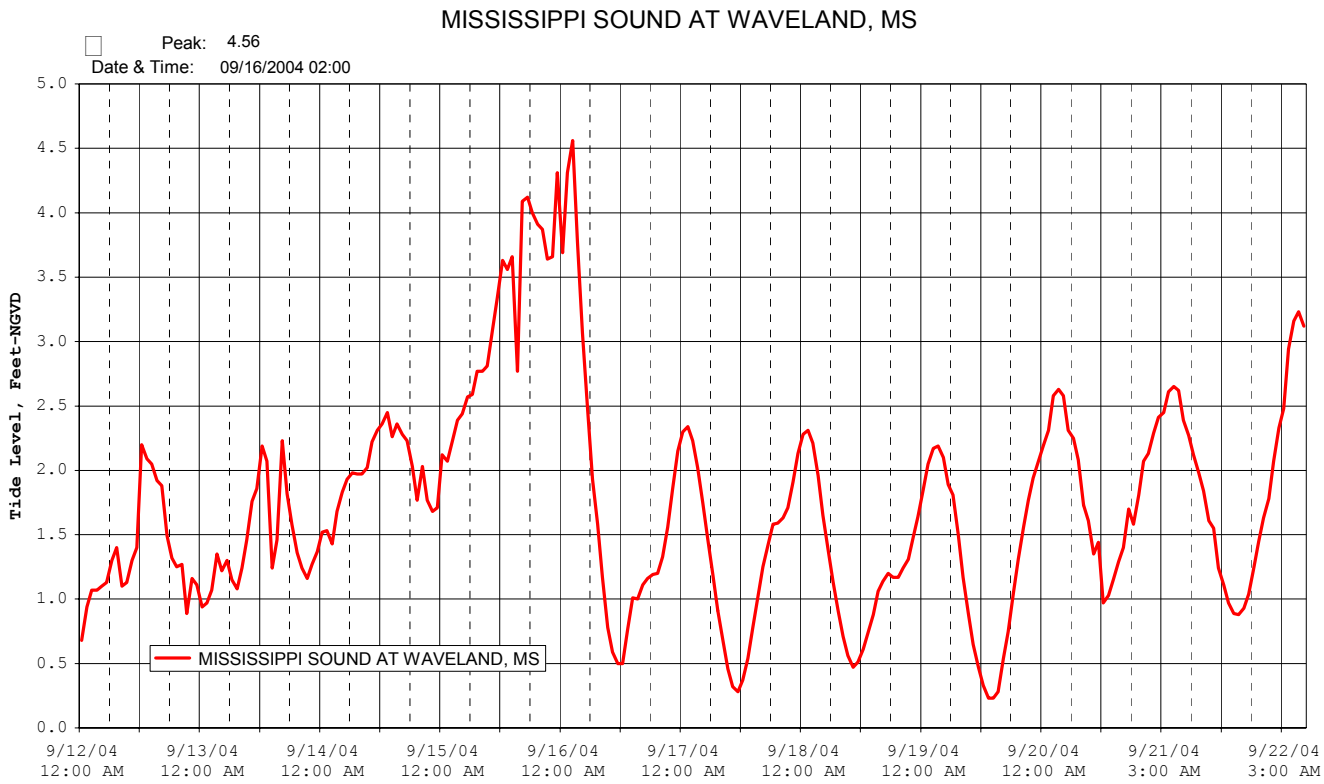
Outside Mark (O)– A mark from debris, mud seeds, or other marking substance left on building, post, trees, or on the ground.

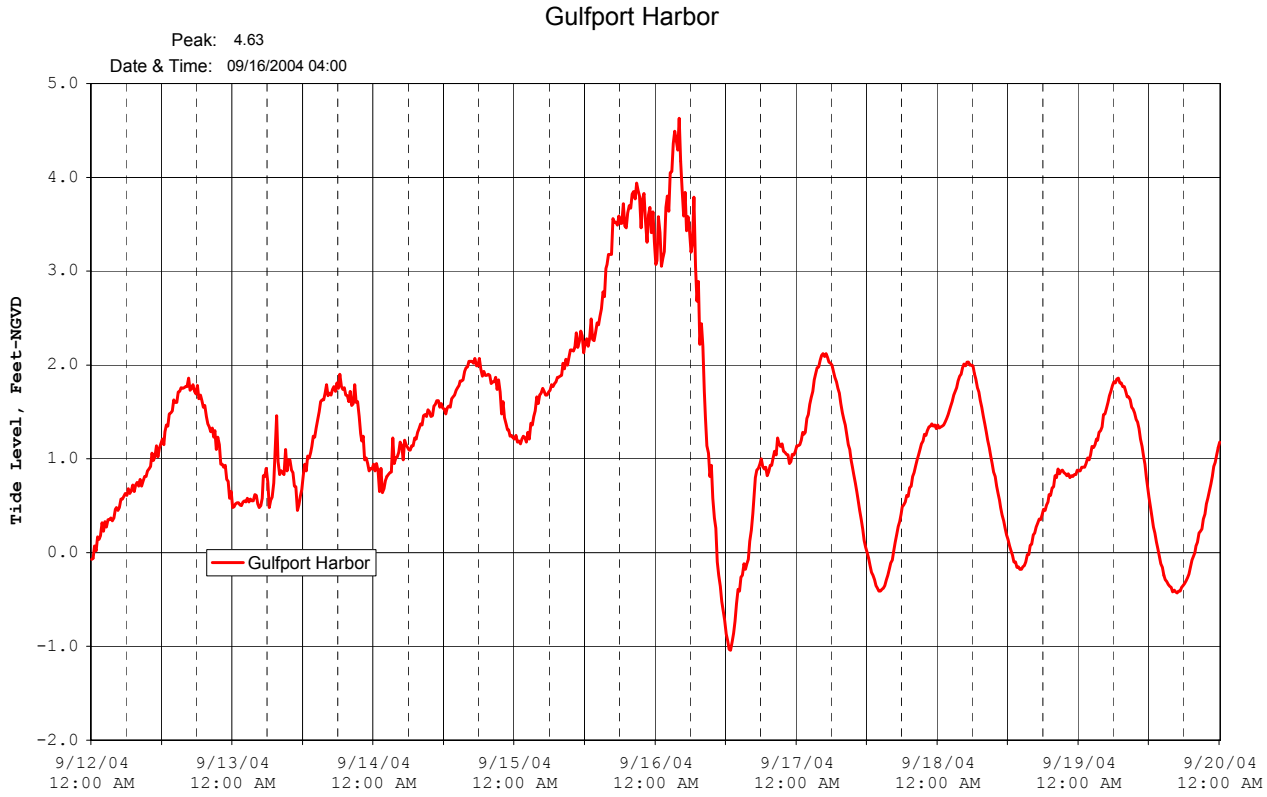
Wave Height (W.H.) – A mark such as foam, debris or seed line on sand dunes, bulkheads, etc., within 200-300 feet of the water' edge at normal water level where a wave passed between the sand dunes, bulkheads, etc.

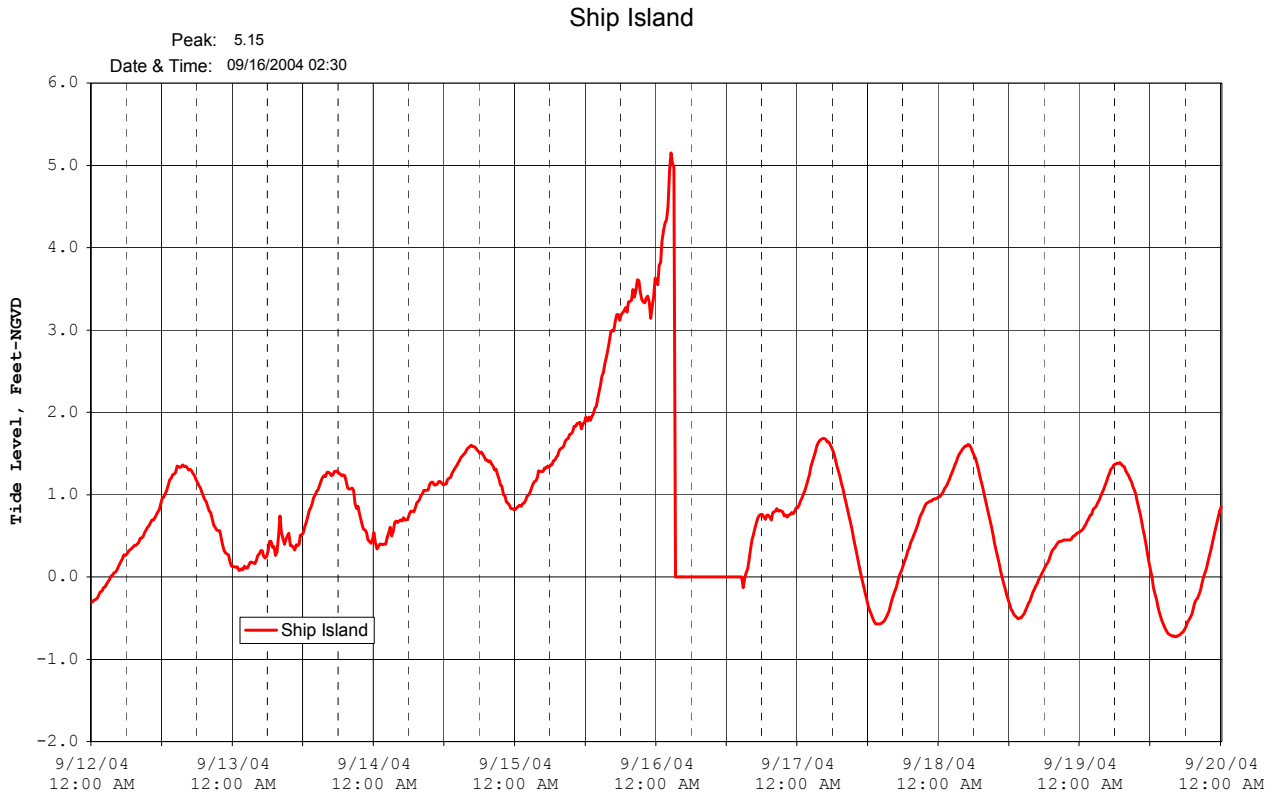
Wave Height Run-up (W.H.R.U.) – A mark such as a foam, debris or seed line where the waves approached the shore and ran up an incline within 220-500 feet from the water's edge at normal water level.

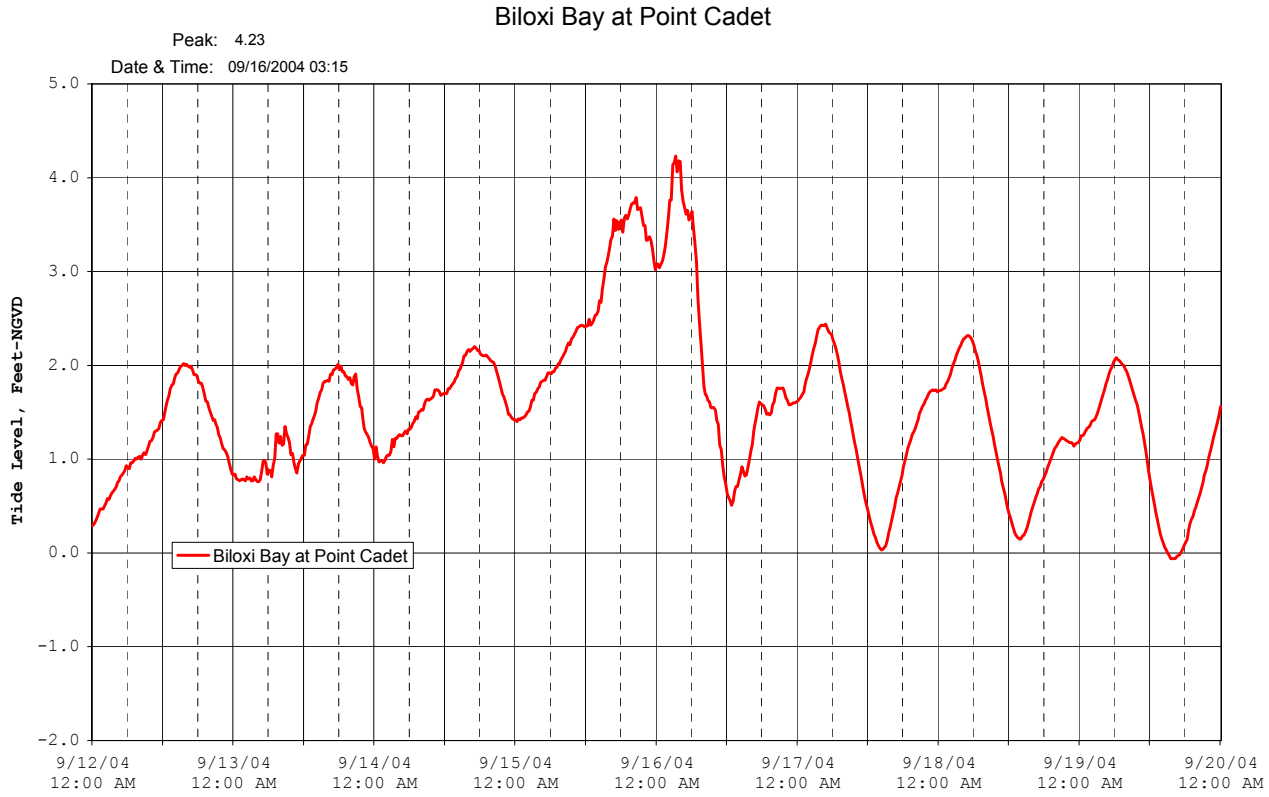
[1]Stilling Well - A device used to allow monitoring of water levels in turbulent flow.

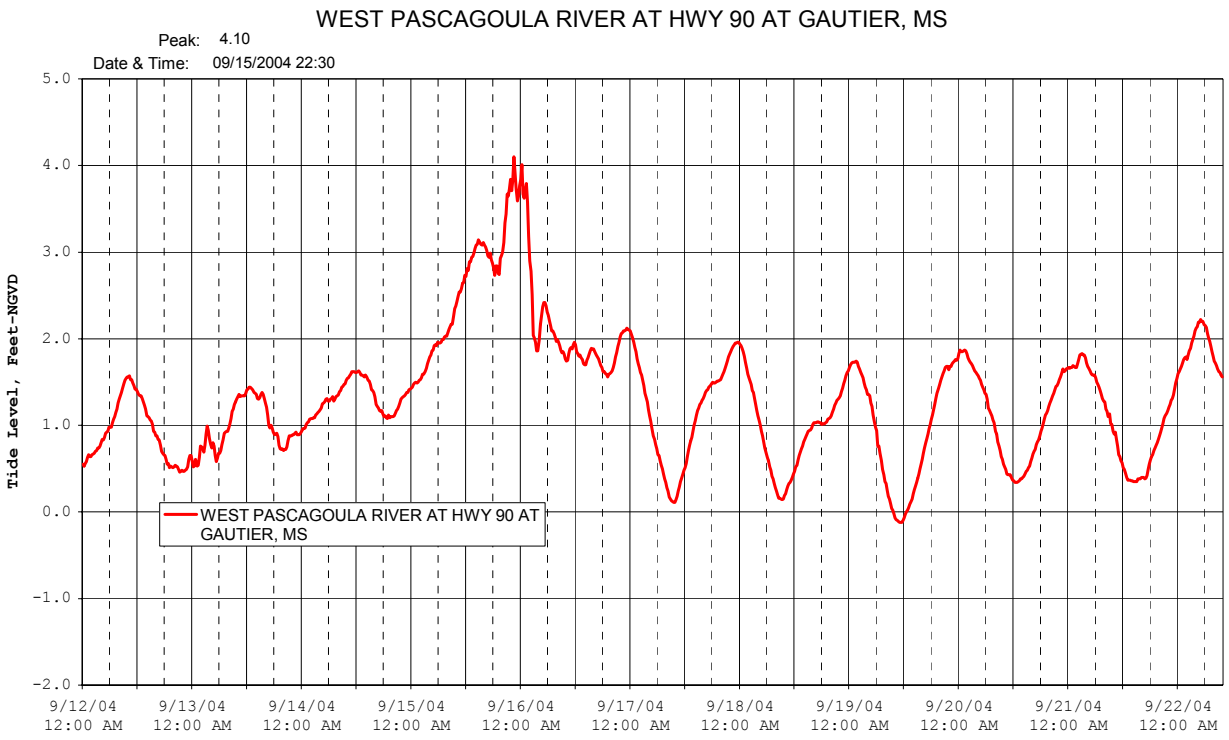
The next section contains the tide hydrographs. Peak elevations are feet above National Geodetic Vertical Datum of 1929 (NGVD) and the time is Greenwich Mean Time (GMT) Location maps follow the hydrographs. Missing values plot as zero.

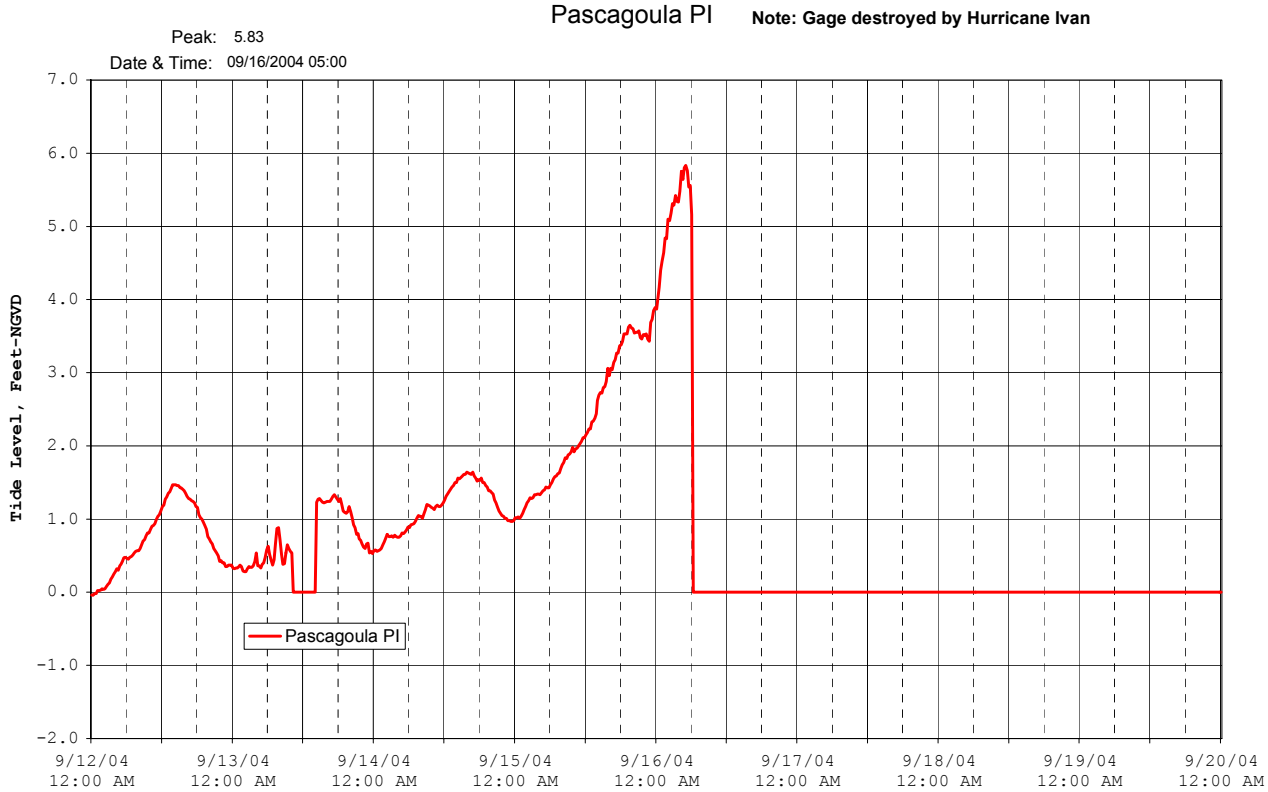

MISSISSIPPI SOUND AT WAVELAND, MS
Peak: 4.56
Date & Time: 09/16/2004 02:00
Tide Level, Feet-NGVD
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
MISSISSIPPI SOUND AT WAVELAND, MS
9/12/04 12:00 AM
9/13/04 12:00 AM
9/14/04 12:00 AM
9/15/04 12:00 AM
9/16/04 12:00 AM
9/17/04 12:00 AM
9/18/04 12:00 AM
9/19/04 12:00 AM
9/20/04 12:00 AM
9/21/04 3:00 AM
9/22/04 3:00 AM


Gulfport Harbor
Peak: 4.63
Date & Time: 09/16/2004 04:00
Tide Level, Feet-NGVD
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
Gulfport Harbor
9/12/04 12:00 AM
9/13/04 12:00 AM
9/14/04 12:00 AM
9/15/04 12:00 AM
9/16/04 12:00 AM
9/17/04 12:00 AM
9/18/04 12:00 AM
9/19/04 12:00 AM
9/20/04 12:00 AM


Ship Island
Peak: 5.15
Date & Time: 09/16/2004 02:30
Tide Level, Feet-NGVD
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
Ship Island
9/12/04 12:00 AM
9/13/04 12:00 AM
9/14/04 12:00 AM
9/15/04 12:00 AM
9/16/04 12:00 AM
9/17/04 12:00 AM
9/18/04 12:00 AM
9/19/04 12:00 AM
9/20/04 12:00 AM


Biloxi Bay at Point Cadet
Peak: 4.23
Date & Time: 09/16/2004 03:15
Tide Level, Feet-NGVD
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
Biloxi Bay at Point Cadet
9/12/04 12:00 AM
9/13/04 12:00 AM
9/14/04 12:00 AM
9/15/04 12:00 AM
9/16/04 12:00 AM
9/17/04 12:00 AM
9/18/04 12:00 AM
9/19/04 12:00 AM
9/20/04 12:00 AM


WEST PASCAGOULA RIVER AT HWY 90 AT GAUTIER, MS
Peak: 4.10
Date & Time: 09/15/2004 22:30
Tide Level, Feet-NGVD
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
WEST PASCAGOULA RIVER AT HWY 90 AT GAUTIER, MS
9/12/04 12:00 AM
9/13/04 12:00 AM
9/14/04 12:00 AM
9/15/04 12:00 AM
9/16/04 12:00 AM
9/17/04 12:00 AM
9/18/04 12:00 AM
9/19/04 12:00 AM
9/20/04 12:00 AM
9/21/04 12:00 AM
9/22/04 12:00 AM


Pascagoula PI
Note: Gage destroyed by Hurricane Ivan
Peak: 5.83
Date & Time: 09/16/2004 05:00
Tide Level, Feet-NGVD
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
Pascagoula PI
9/12/04 12:00 AM
9/13/04 12:00 AM
9/14/04 12:00 AM
9/15/04 12:00 AM
9/16/04 12:00 AM
9/17/04 12:00 AM
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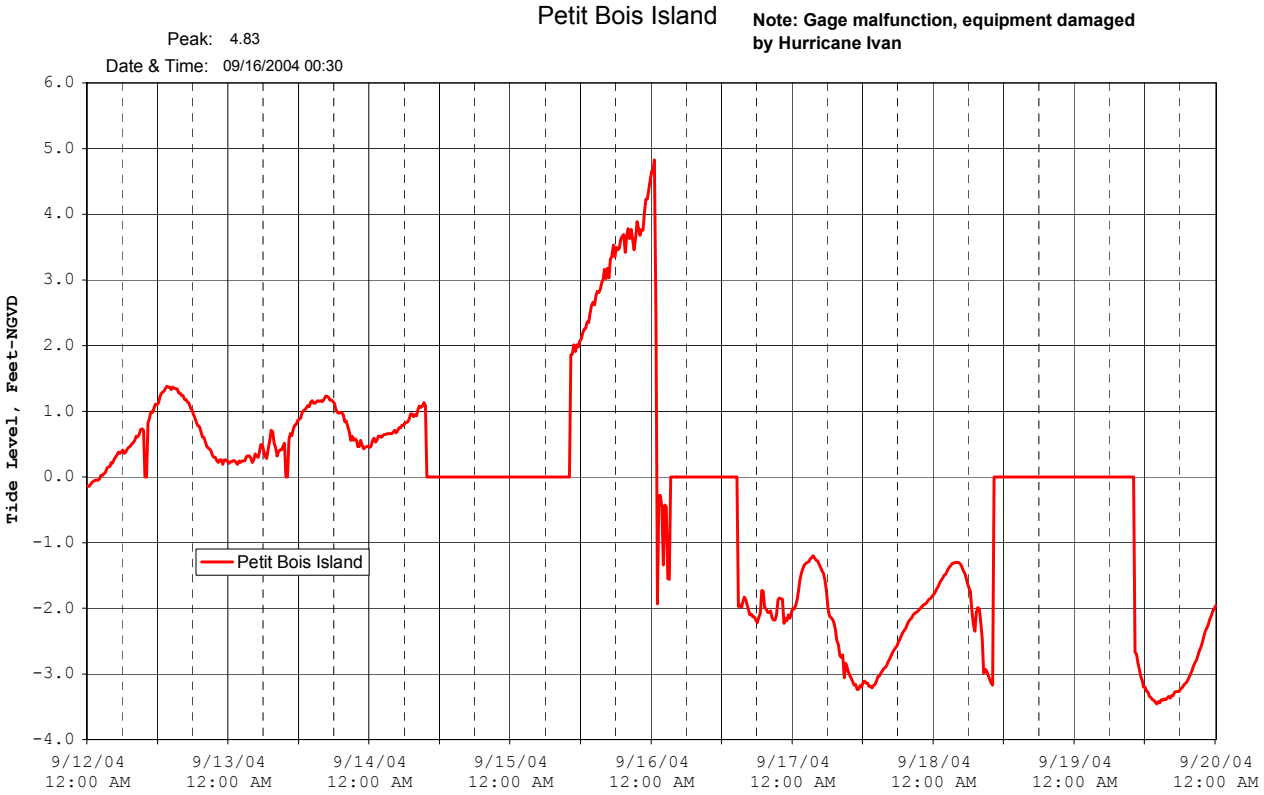
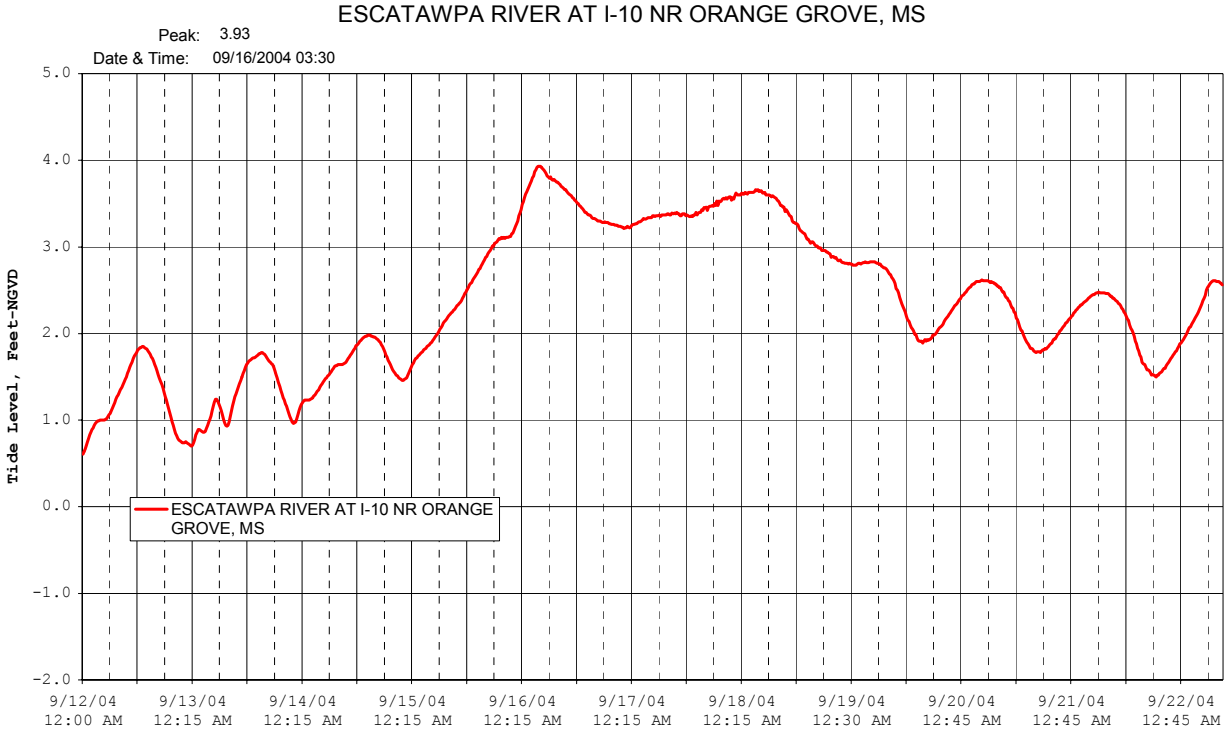
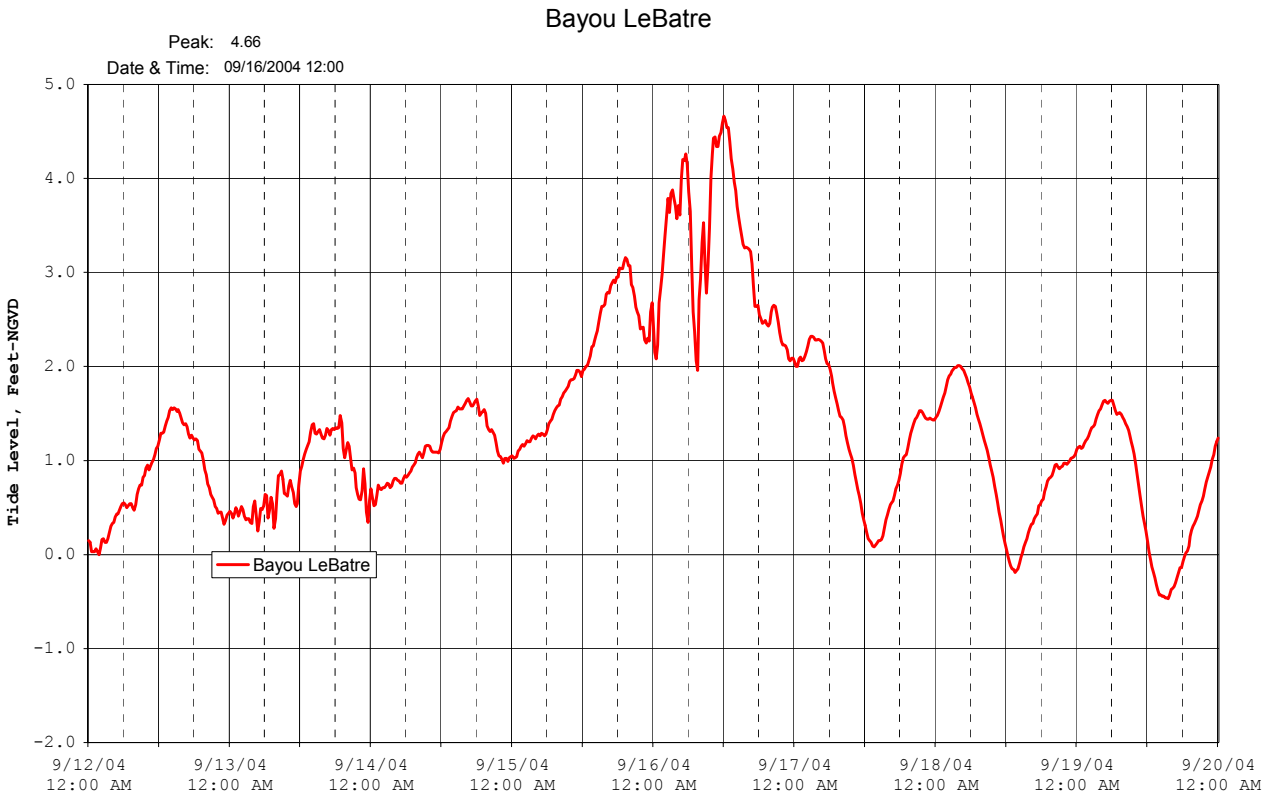
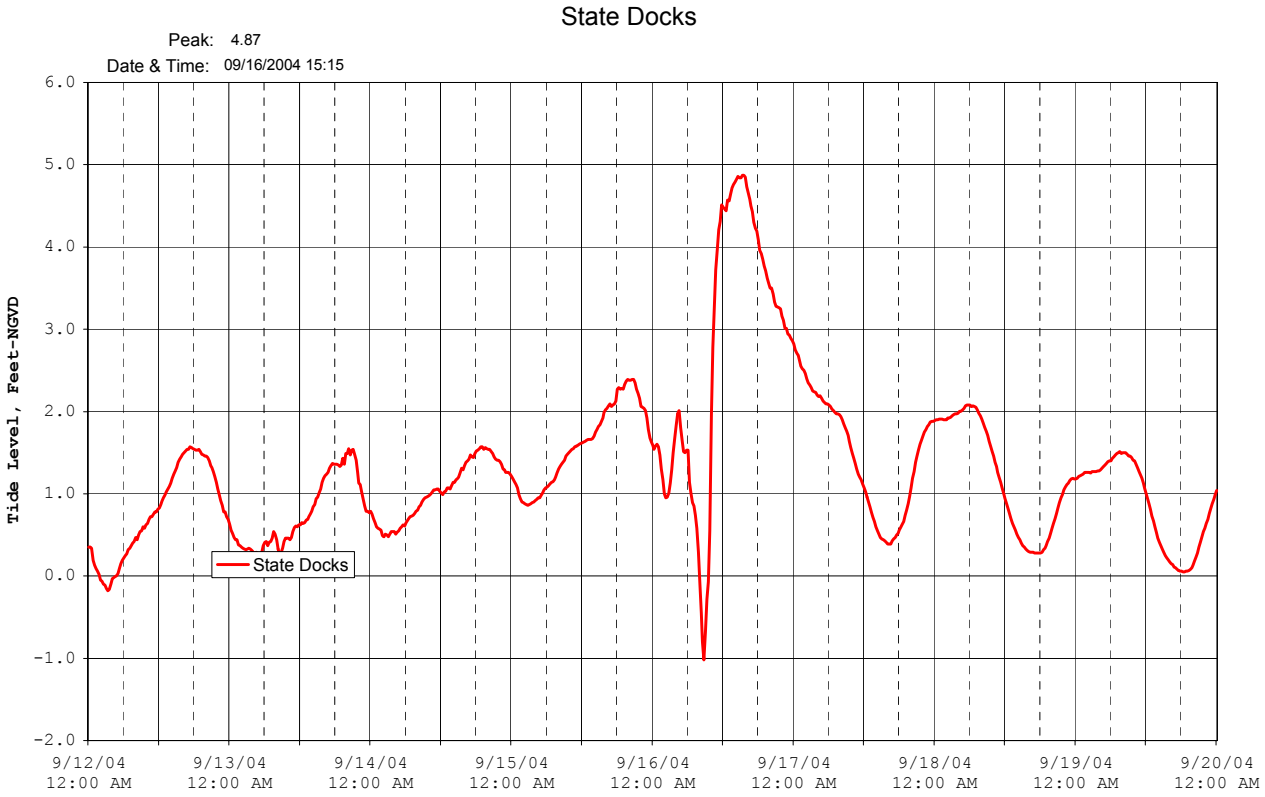
9/19/04 12:00 AM
9/20/04 12:00 AM


Petit Bois Island
Note: Gage malfunction, equipment damaged by Hurricane Ivan
Peak: 4.83
Date & Time: 09/16/2004 00:30
Tide Level, Feet-NGVD
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
-4.0
Petit Bois Island
9/12/04 12:00 AM
9/13/04 12:00 AM
9/14/04 12:00 AM
9/15/04 12:00 AM
9/16/04 12:00 AM
9/17/04 12:00 AM
9/18/04 12:00 AM
9/19/04 12:00 AM
9/20/04 12:00 AM


ESCATAWPA RIVER AT I-10 NR ORANGE GROVE, MS
Peak: 3.93
Date & Time: 09/16/2004 03:30
Tide Level, Feet-NGVD
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
ESCATAWPA RIVER AT I-10 NR ORANGE GROVE, MS
9/12/04 12:00 AM
9/13/04 12:15 AM
9/14/04 12:15 AM
9/15/04 12:15 AM
9/16/04 12:15 AM
9/17/04 12:15 AM
9/18/04 12:15 AM
9/19/04 12:30 AM
9/20/04 12:45 AM
9/21/04 12:45 AM
9/22/04 12:45 AM


Bayou LeBatre
Peak: 4.66
Date & Time: 09/16/2004 12:00
Tide Level, Feet-NGVD
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
Bayou LeBatre
9/12/04 12:00 AM
9/13/04 12:00 AM
9/14/04 12:00 AM
9/15/04 12:00 AM
9/16/04 12:00 AM
9/17/04 12:00 AM
9/18/04 12:00 AM
9/19/04 12:00 AM
9/20/04 12:00 AM


State Docks
Peak: 4.87
Date & Time: 09/16/2004 15:15
Tide Level, Feet-NGVD
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
State Docks
9/12/04 12:00 AM
9/13/04 12:00 AM
9/14/04 12:00 AM
9/15/04 12:00 AM
9/16/04 12:00 AM
9/17/04 12:00 AM
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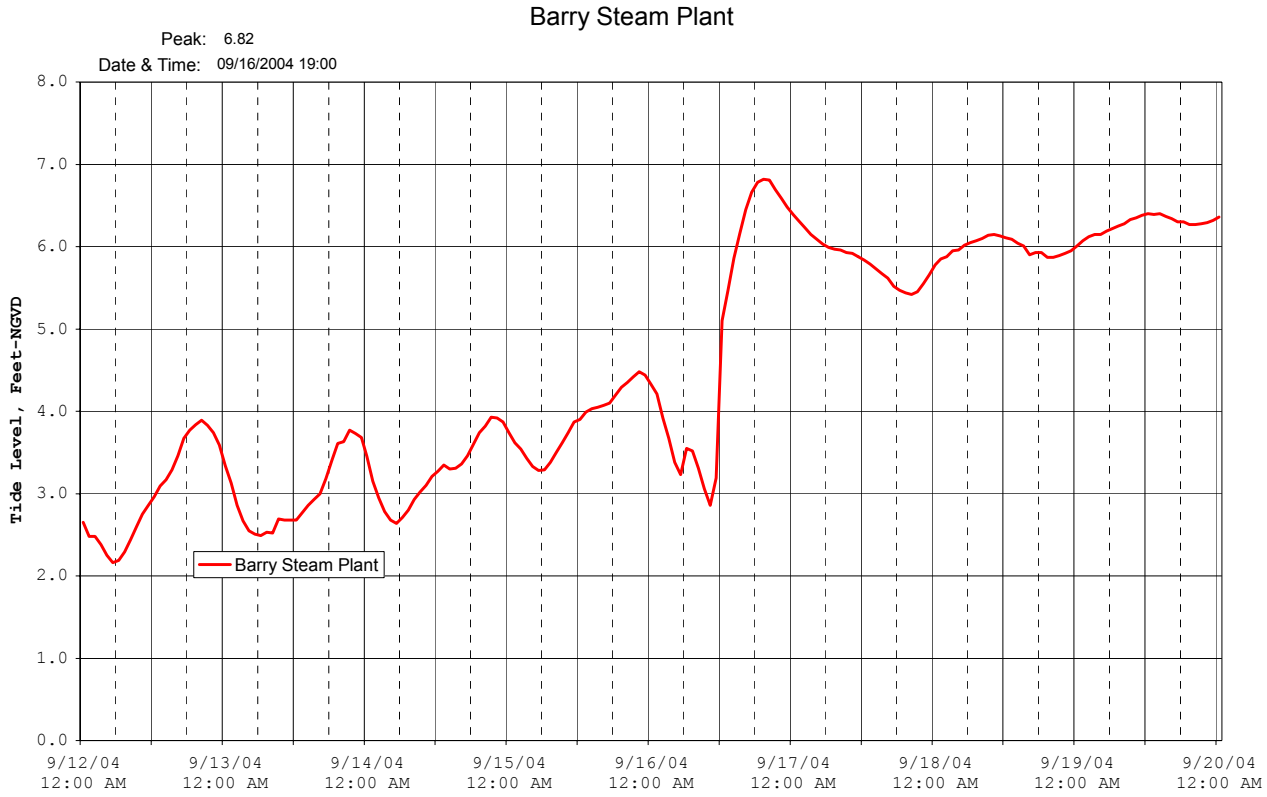
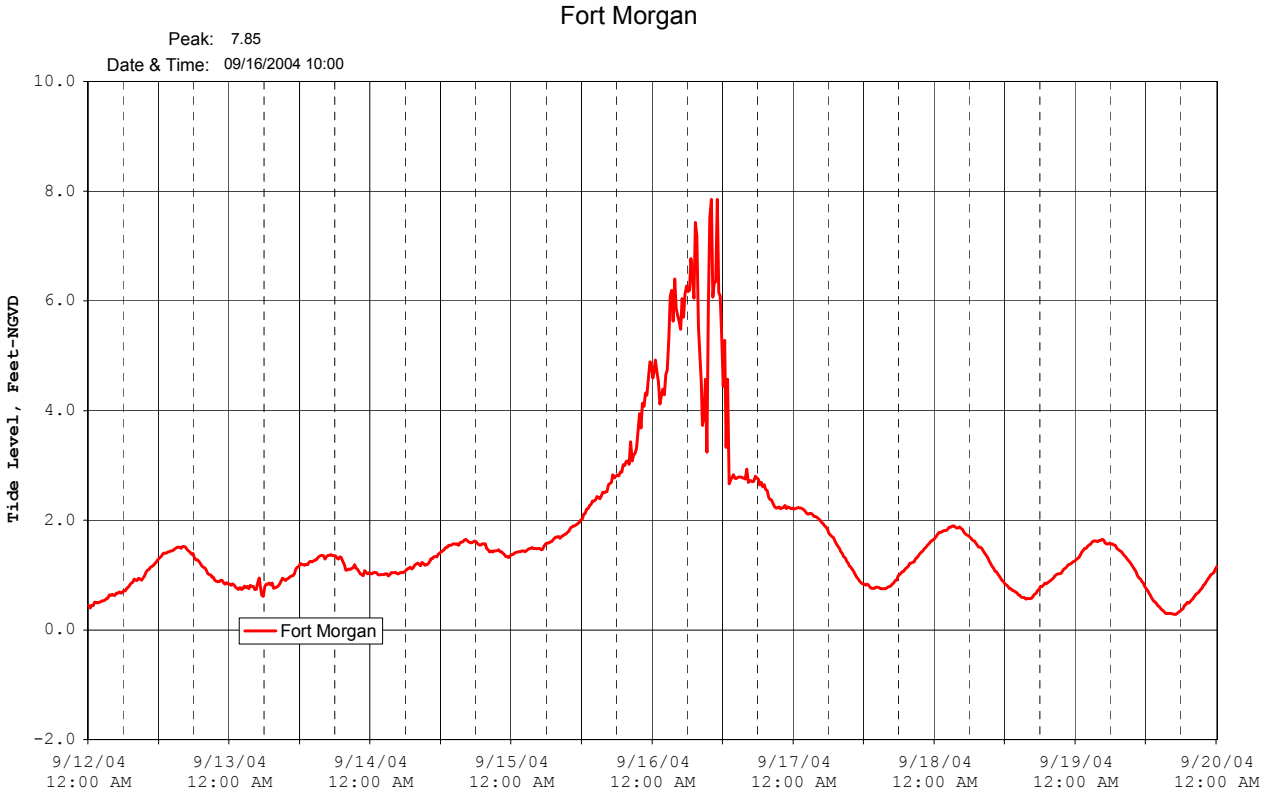
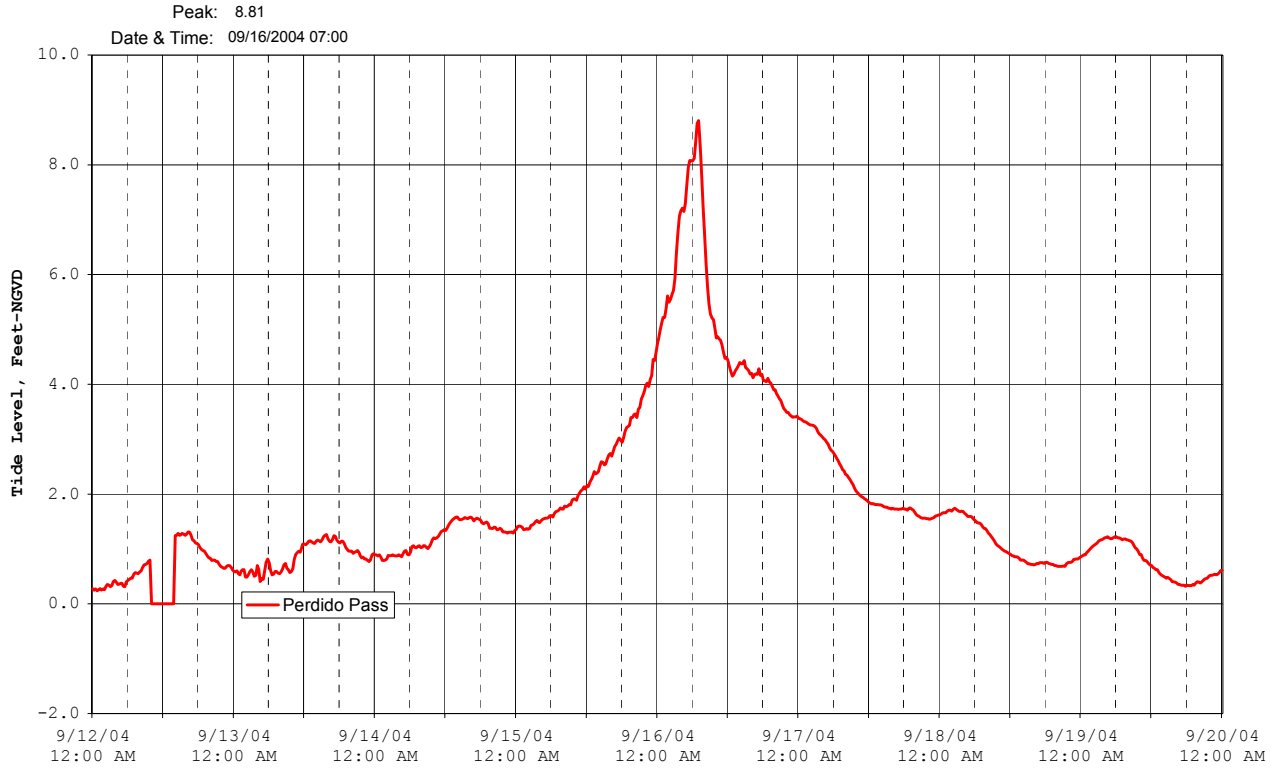
9/19/04 12:00 AM
9/20/04 12:00 AM

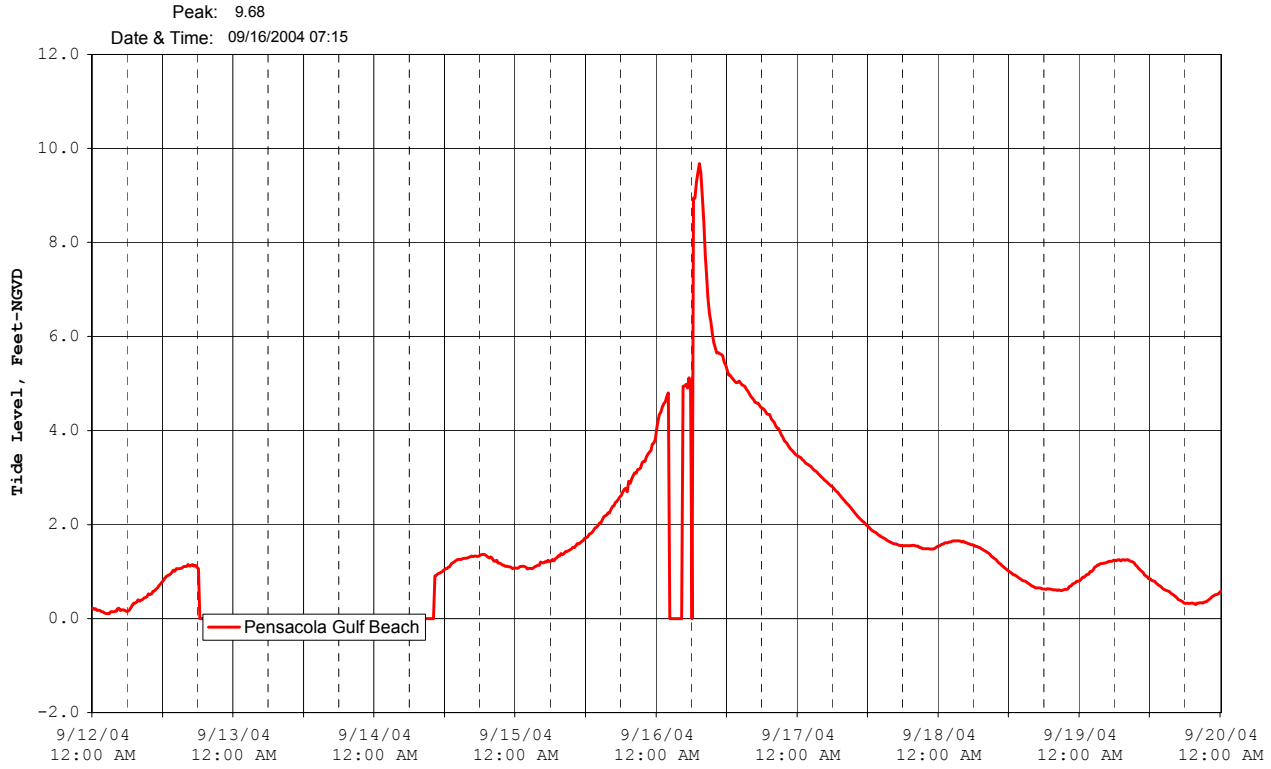

Barry Steam Plant
Peak: 6.82
Date & Time: 09/16/2004 19:00
Tide Level, Feet-NGVD
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Barry Steam Plant
9/12/04 12:00 AM
9/13/04 12:00 AM
9/14/04 12:00 AM
9/15/04 12:00 AM
9/16/04 12:00 AM
9/17/04 12:00 AM
9/18/04 12:00 AM
9/19/04 12:00 AM
9/20/04 12:00 AM

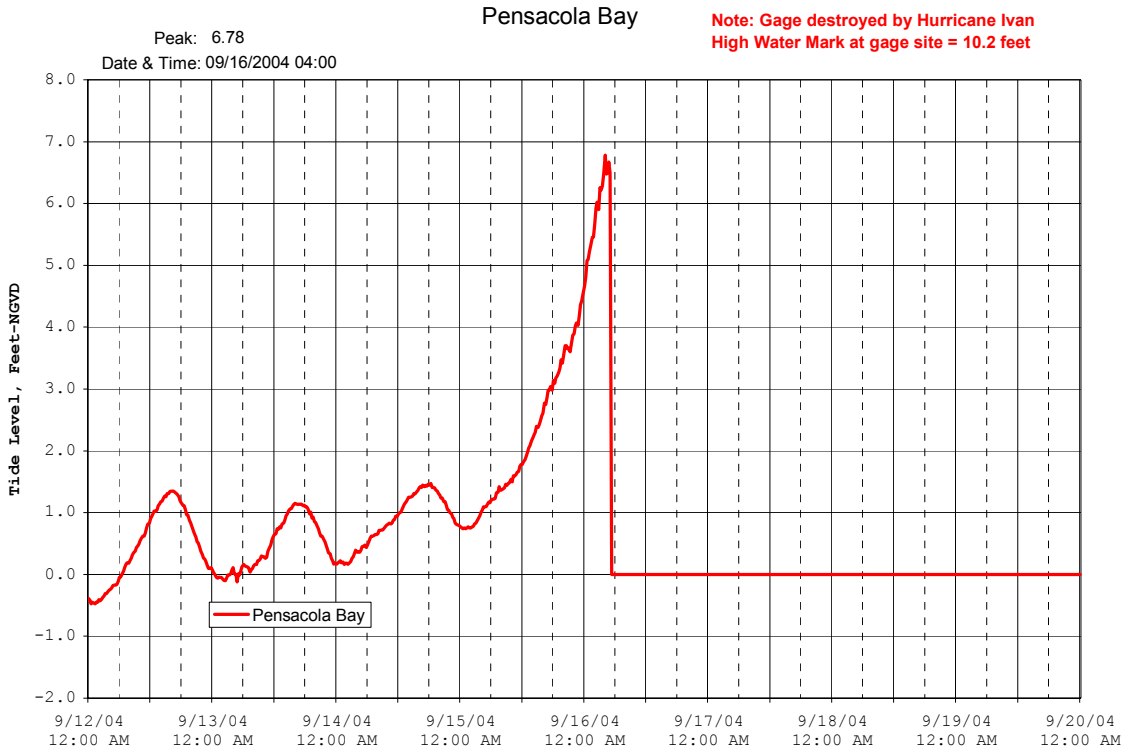

Fort Morgan
Peak: 7.85
Date & Time: 09/16/2004 10:00
Tide Level, Feet-NGVD
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
Fort Morgan
9/12/04 12:00 AM
9/13/04 12:00 AM
9/14/04 12:00 AM
9/15/04 12:00 AM
9/16/04 12:00 AM
9/17/04 12:00 AM
9/18/04 12:00 AM
9/19/04 12:00 AM
9/20/04 12:00 AM

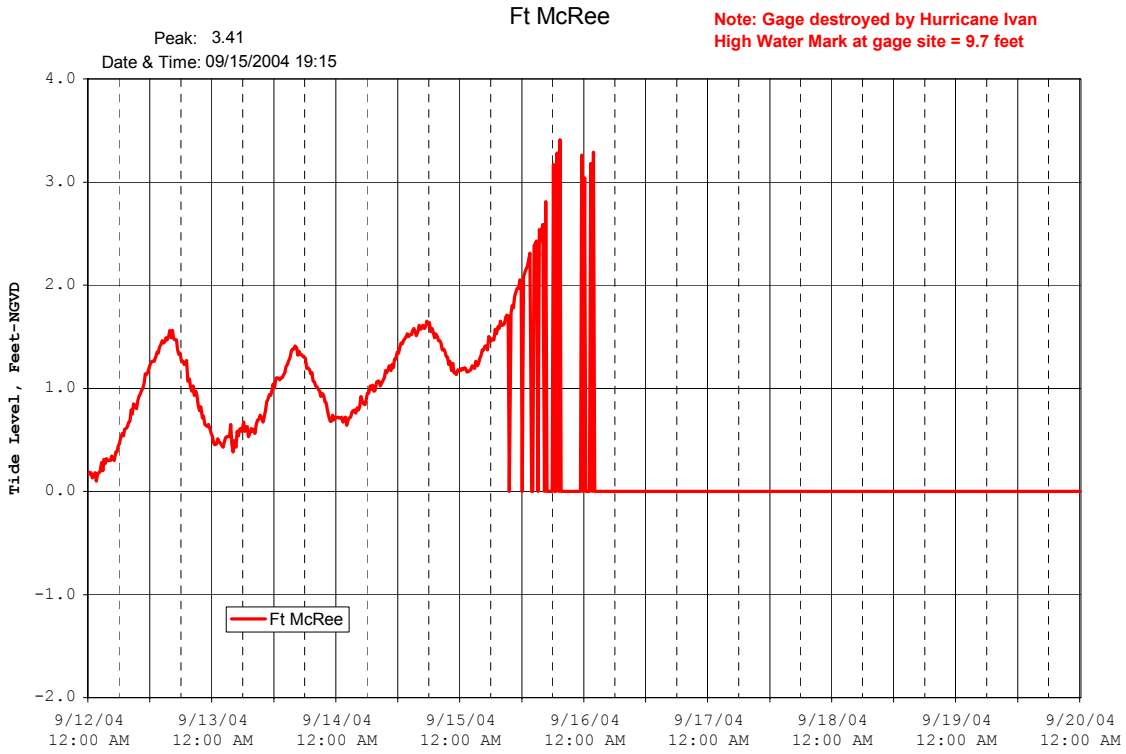
Perdido Pass



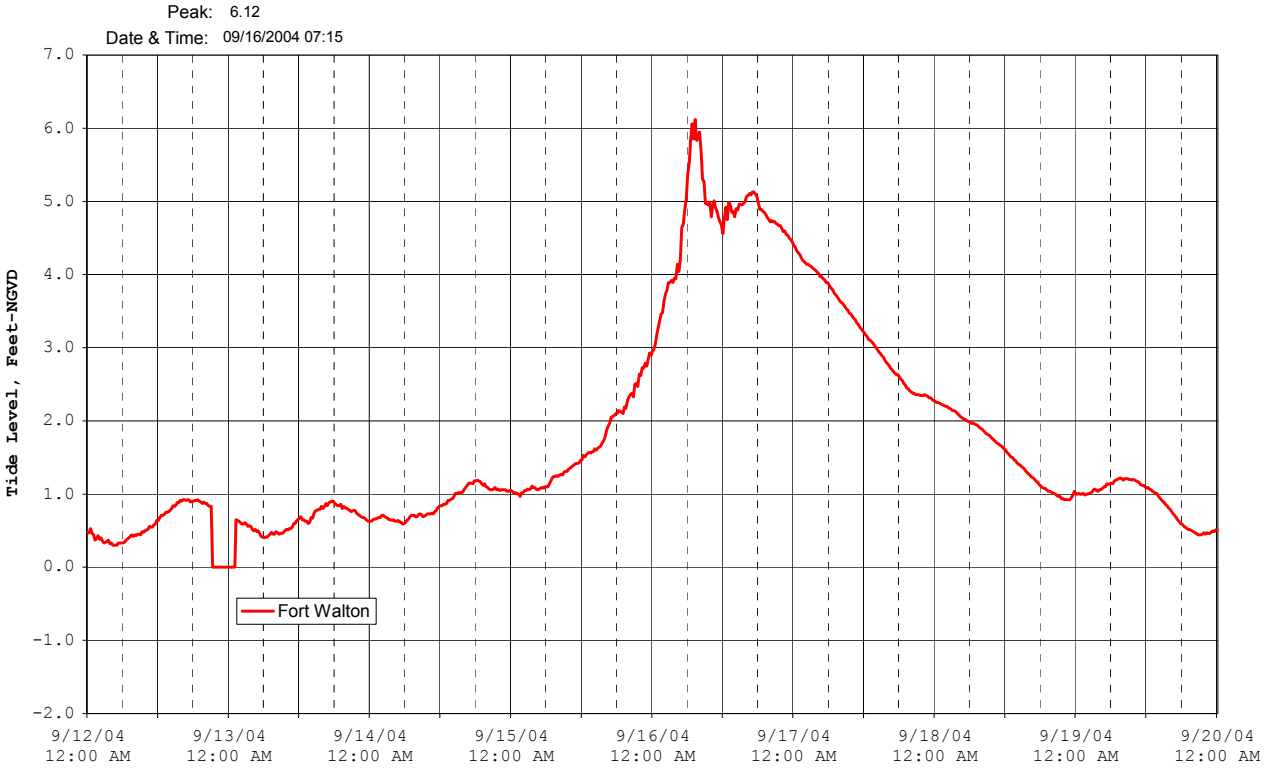
Pensacola Gulf Beach



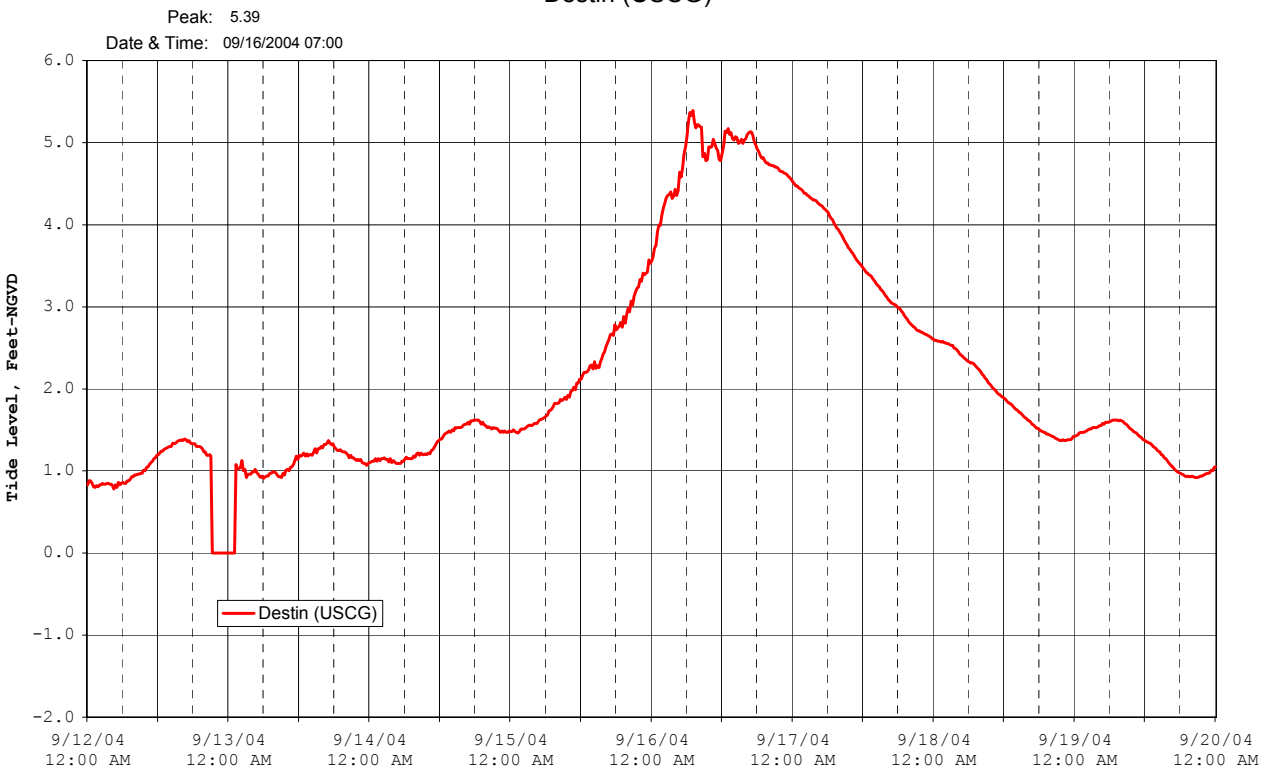

Pensacola Bay
Note: Gage destroyed by Hurricane Ivan
High Water Mark at gage site = 10.2 feet
Peak: 6.78
Date & Time: 09/16/2004 04:00
Tide Level, Feet-NGVD
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
9/12/04 12:00 AM
9/13/04 12:00 AM
9/14/04 12:00 AM
9/15/04 12:00 AM
9/16/04 12:00 AM
9/17/04 12:00 AM
9/18/04 12:00 AM
9/19/04 12:00 AM
9/20/04 12:00 AM
Pensacola Bay

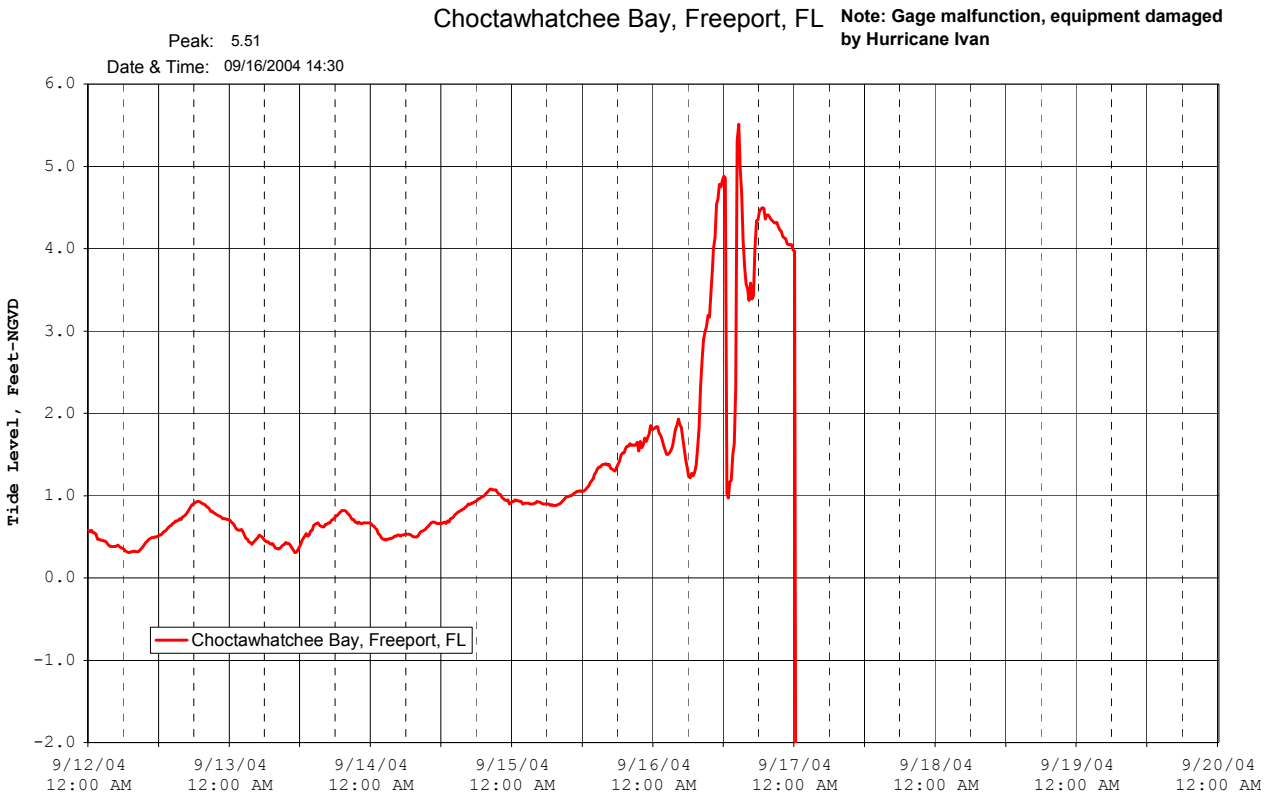

Ft McRee
Note: Gage destroyed by Hurricane Ivan
High Water Mark at gage site = 9.7 feet
Peak: 3.41
Date & Time: 09/15/2004 19:15
Tide Level, Feet-NGVD
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
9/12/04 12:00 AM
9/13/04 12:00 AM
9/14/04 12:00 AM
9/15/04 12:00 AM
9/16/04 12:00 AM
9/17/04 12:00 AM
9/18/04 12:00 AM
9/19/04 12:00 AM
9/20/04 12:00 AM
Ft McRee

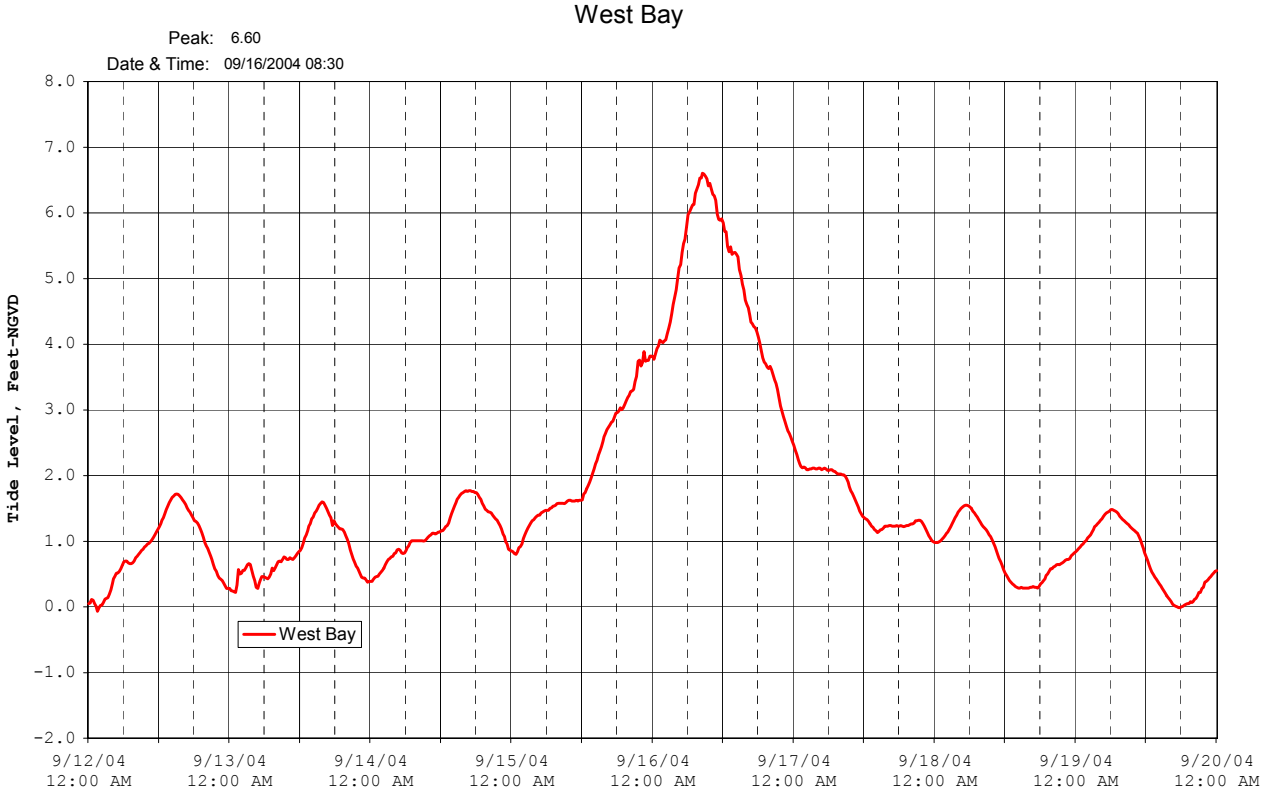
Fort Walton



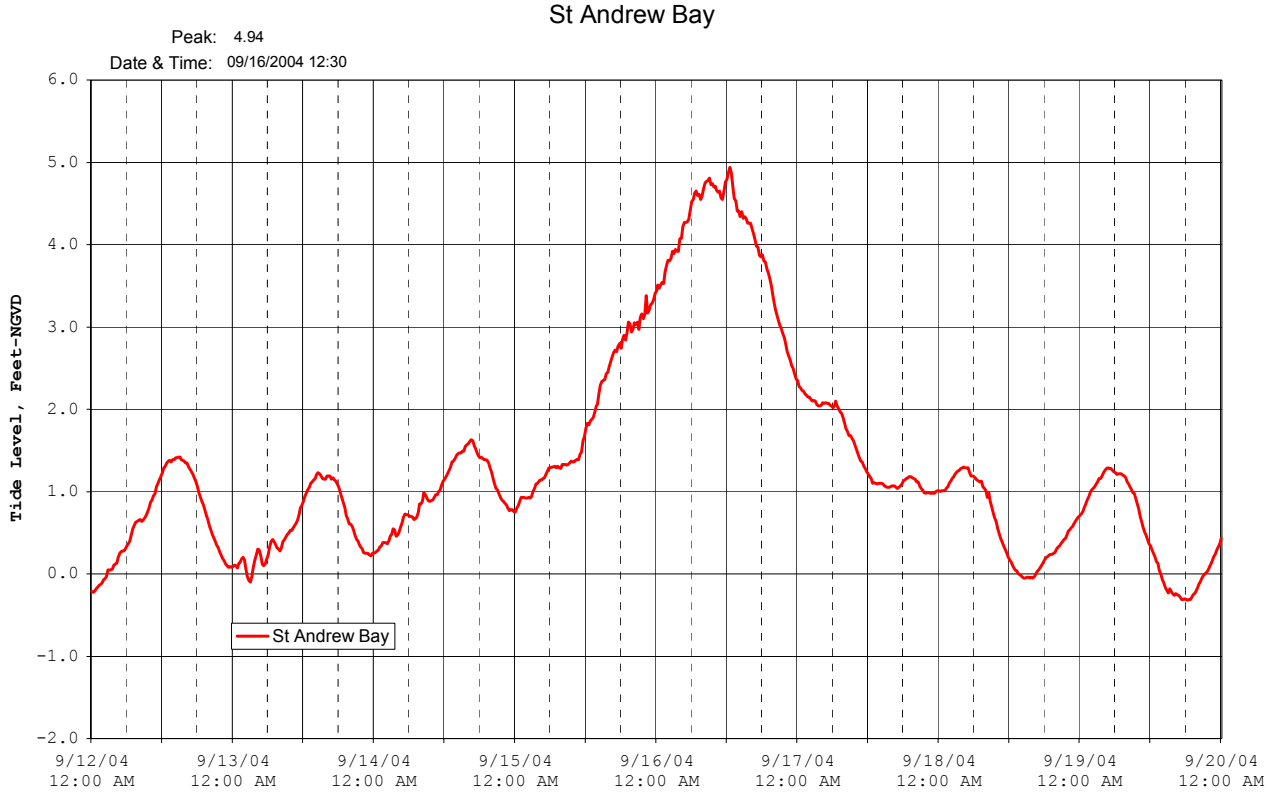
Destin (USCG)



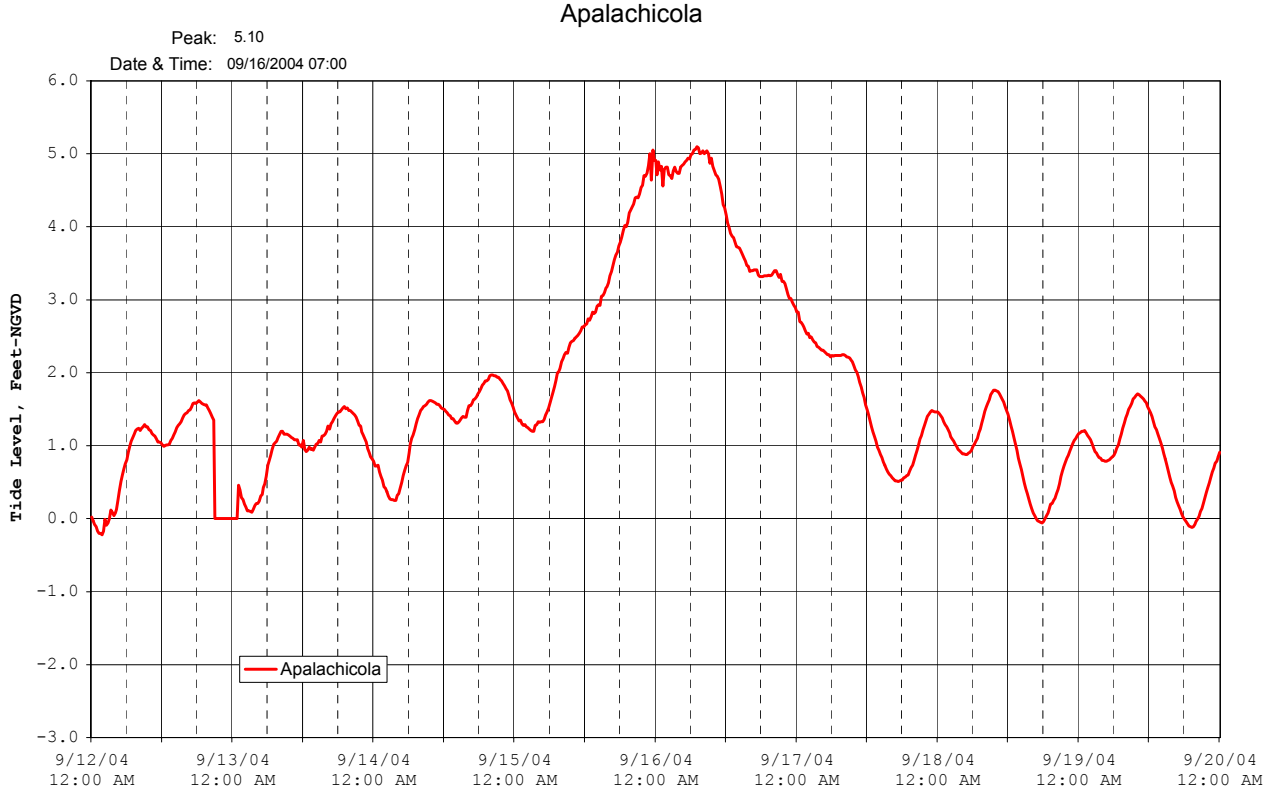

Choctawhatchee Bay, Freeport, FL
Note: Gage malfunction, equipment damaged by Hurricane Ivan
Peak: 5.51
Date & Time: 09/16/2004 14:30
Tide Level, Feet-NGVD
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
Choctawhatchee Bay, Freeport, FL
9/12/04 12:00 AM
9/13/04 12:00 AM
9/14/04 12:00 AM
9/15/04 12:00 AM
9/16/04 12:00 AM
9/17/04 12:00 AM
9/18/04 12:00 AM
9/19/04 12:00 AM
9/20/04 12:00 AM


West Bay
Peak: 6.60
Date & Time: 09/16/2004 08:30
Tide Level, Feet-NGVD
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
West Bay
9/12/04 12:00 AM
9/13/04 12:00 AM
9/14/04 12:00 AM
9/15/04 12:00 AM
9/16/04 12:00 AM
9/17/04 12:00 AM
9/18/04 12:00 AM
9/19/04 12:00 AM
9/20/04 12:00 AM

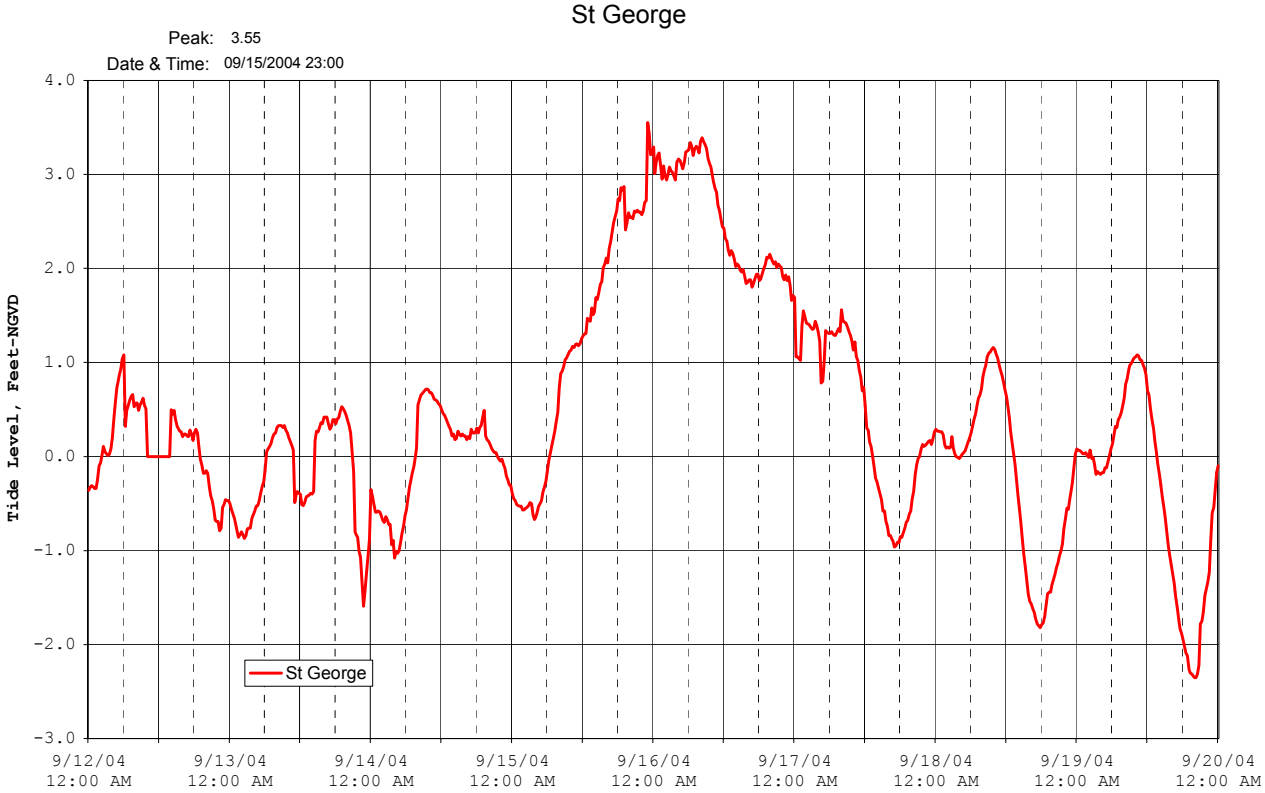
St Andrew Bay



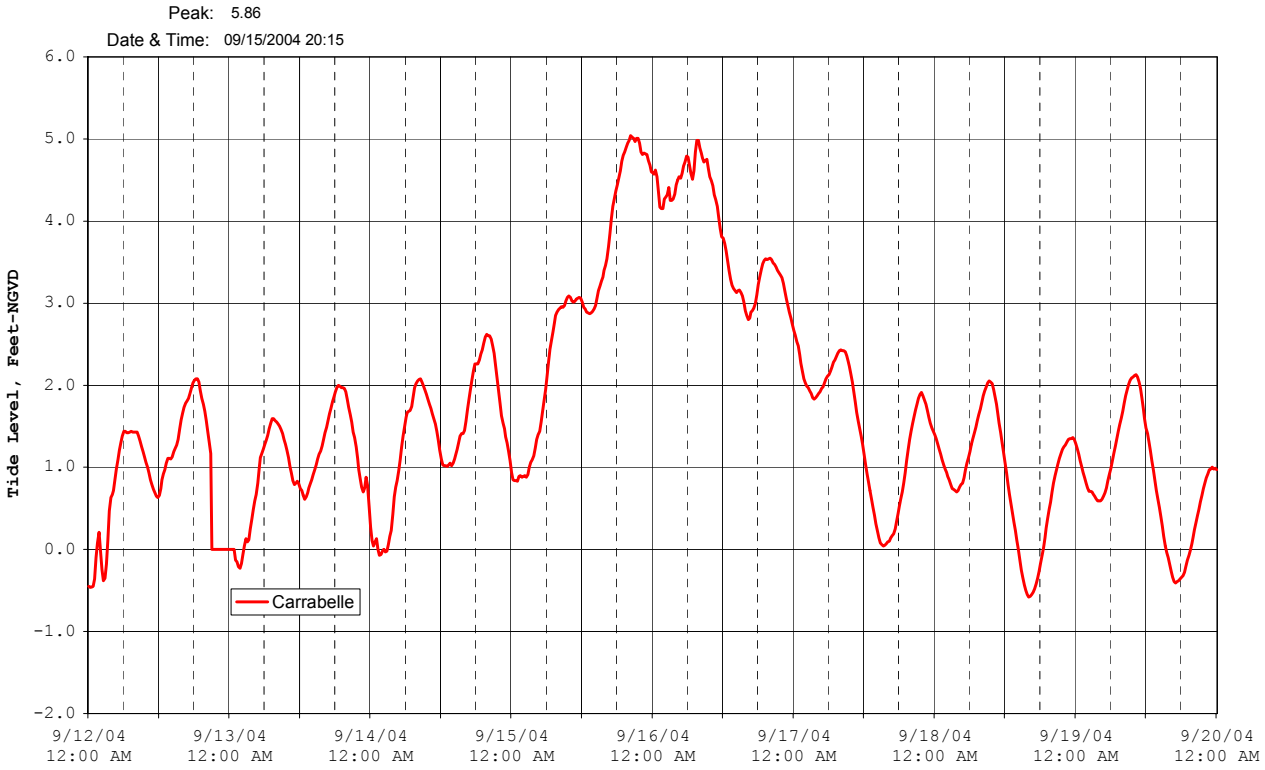
Apalachicola

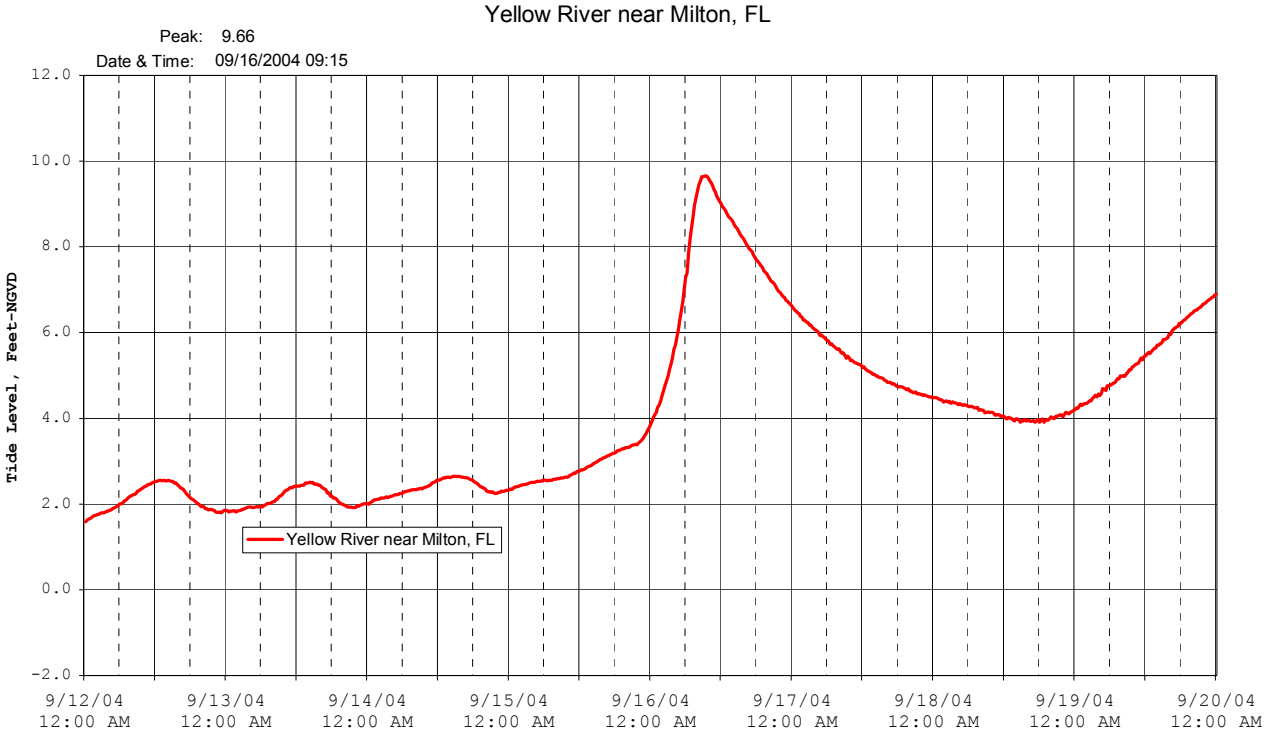


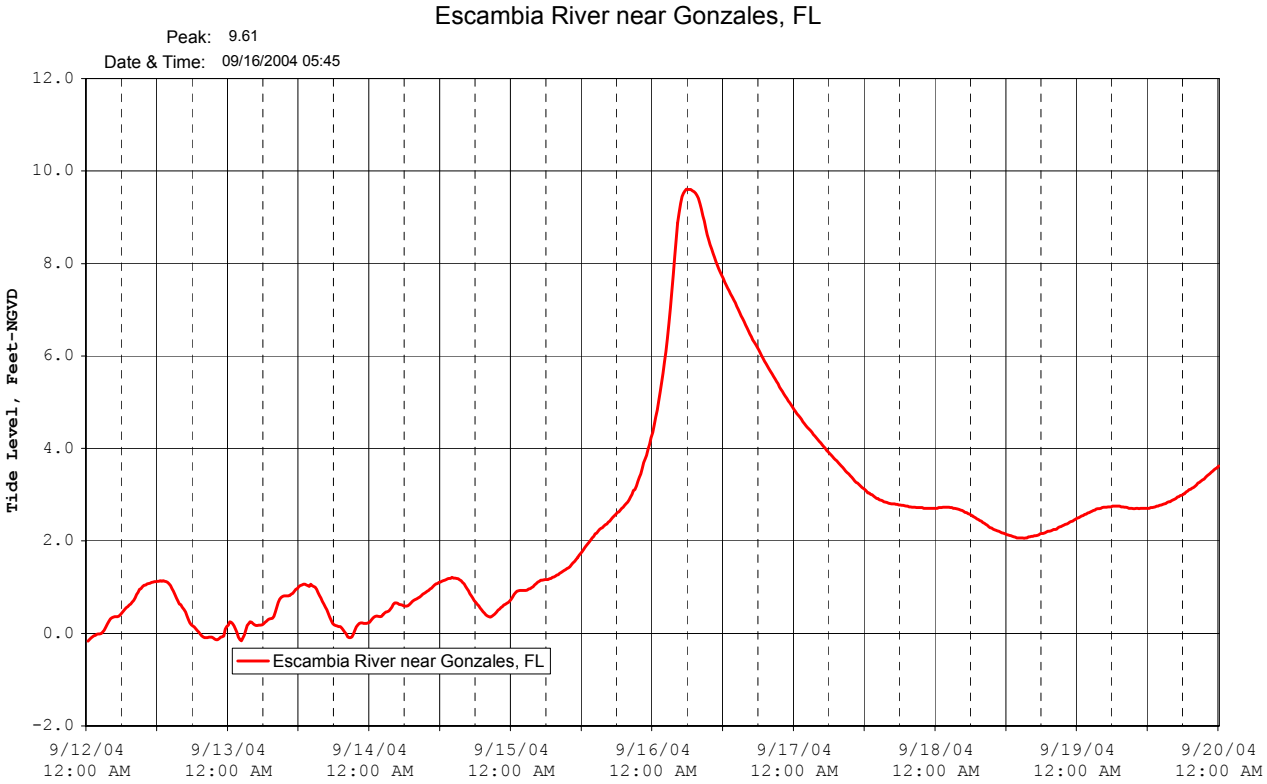
St George



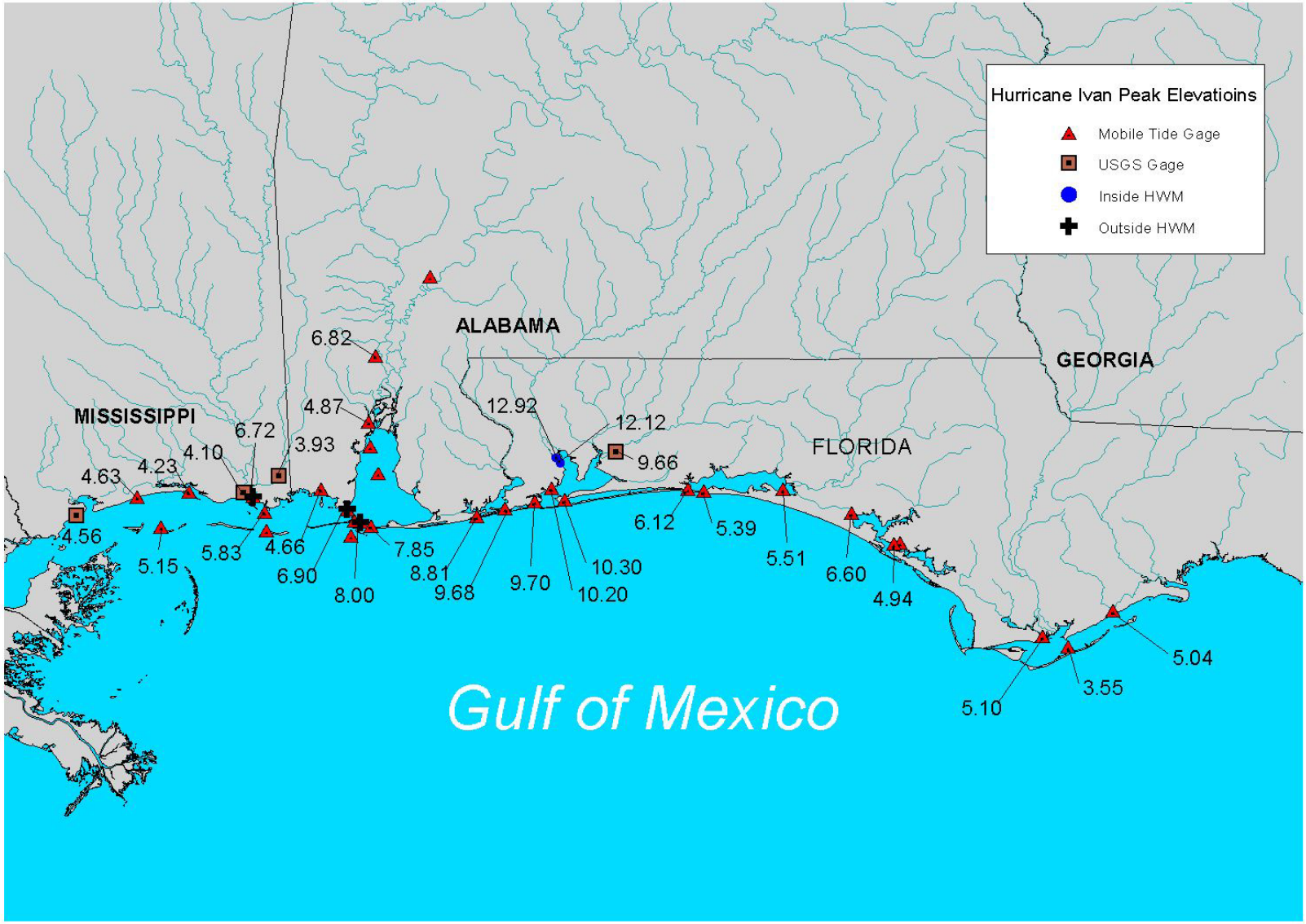
Carrabelle

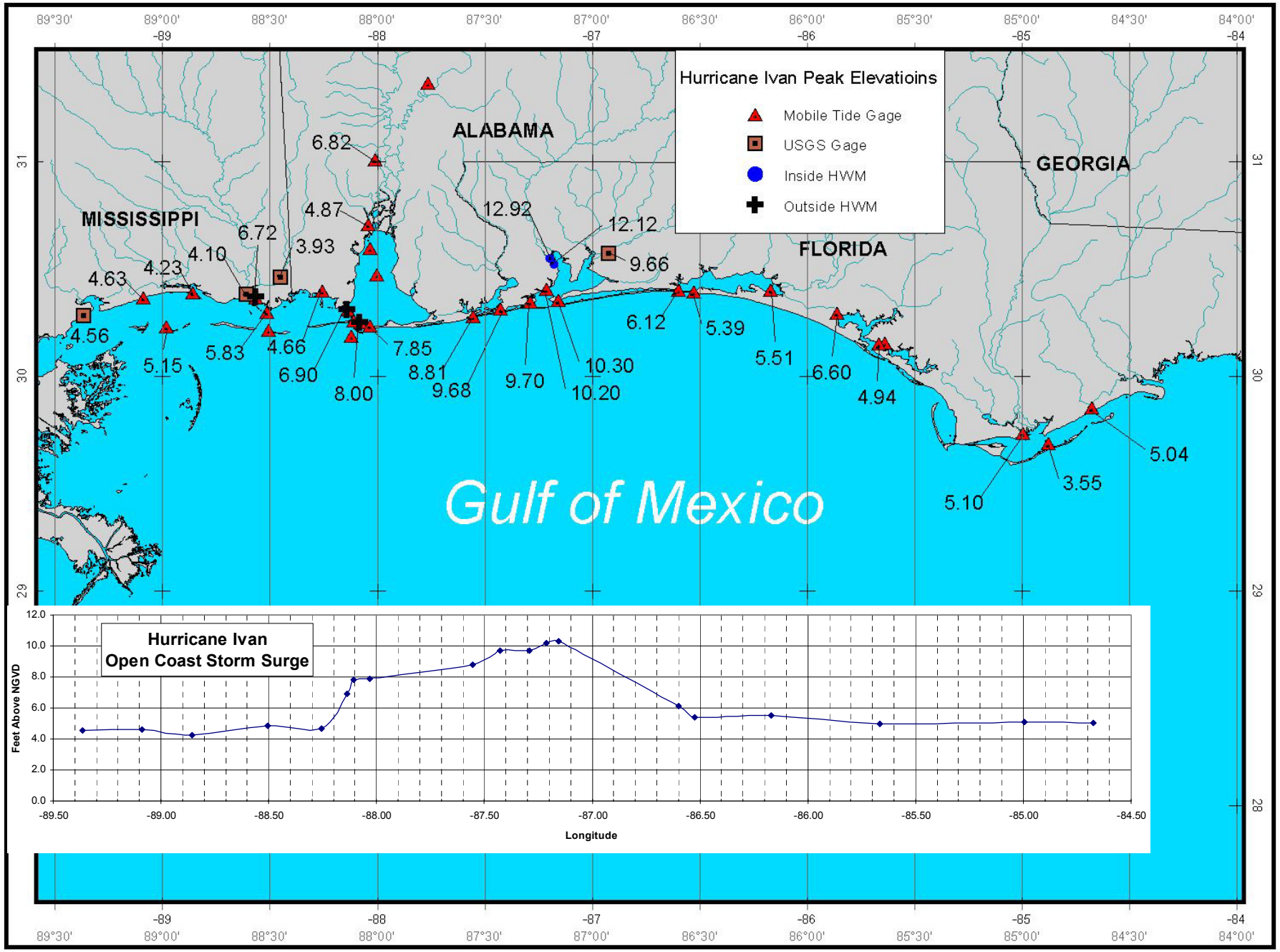



Yellow River near Milton, FL
Peak: 9.66
Date & Time: 09/16/2004 09:15
Tide Level, Feet-NGVD
12.0
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
Yellow River near Milton, FL
9/12/04 12:00 AM
9/13/04 12:00 AM
9/14/04 12:00 AM
9/15/04 12:00 AM
9/16/04 12:00 AM
9/17/04 12:00 AM
9/18/04 12:00 AM
9/19/04 12:00 AM
9/20/04 12:00 AM

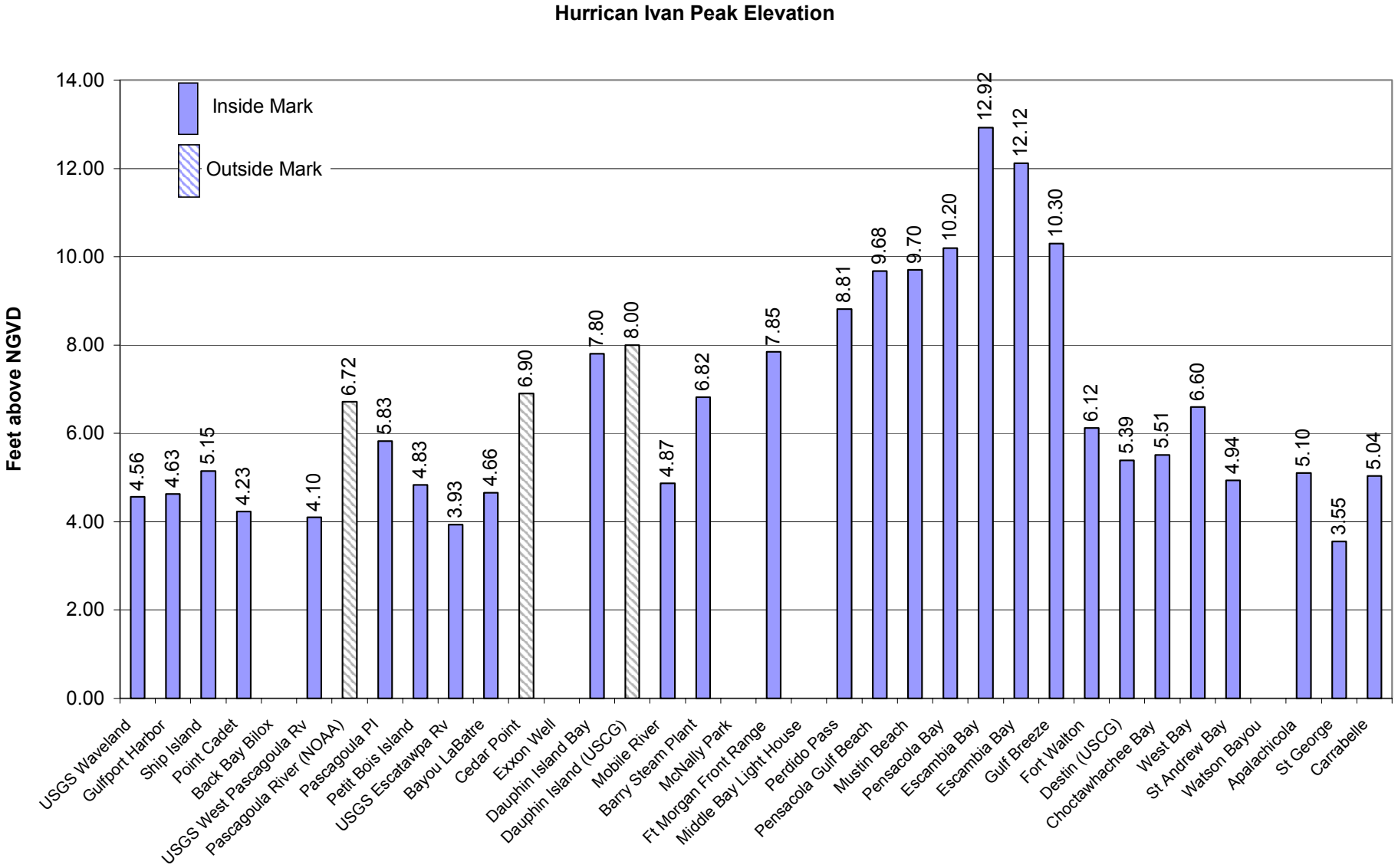

Escambia River near Gonzales, FL
Peak: 9.61
Date & Time: 09/16/2004 05:45
Tide Level, Feet-NGVD
12.0
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
Escambia River near Gonzales, FL
9/12/04 12:00 AM
9/13/04 12:00 AM
9/14/04 12:00 AM
9/15/04 12:00 AM
9/16/04 12:00 AM
9/17/04 12:00 AM
9/18/04 12:00 AM
9/19/04 12:00 AM
9/20/04 12:00 AM

Mobile District Tide gages peak elevation during Hurricane Ivan. (feet above NGVD 1929)

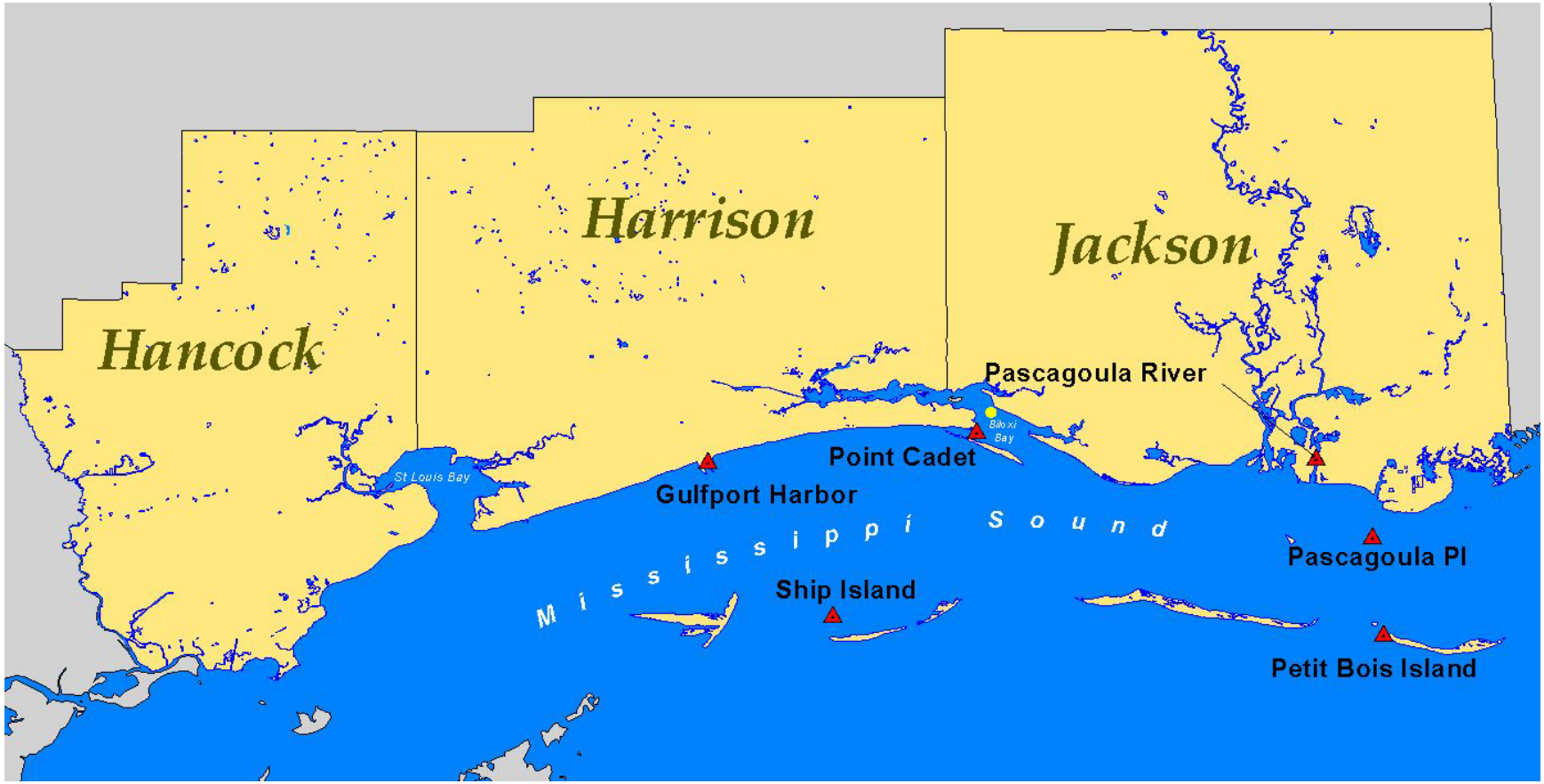




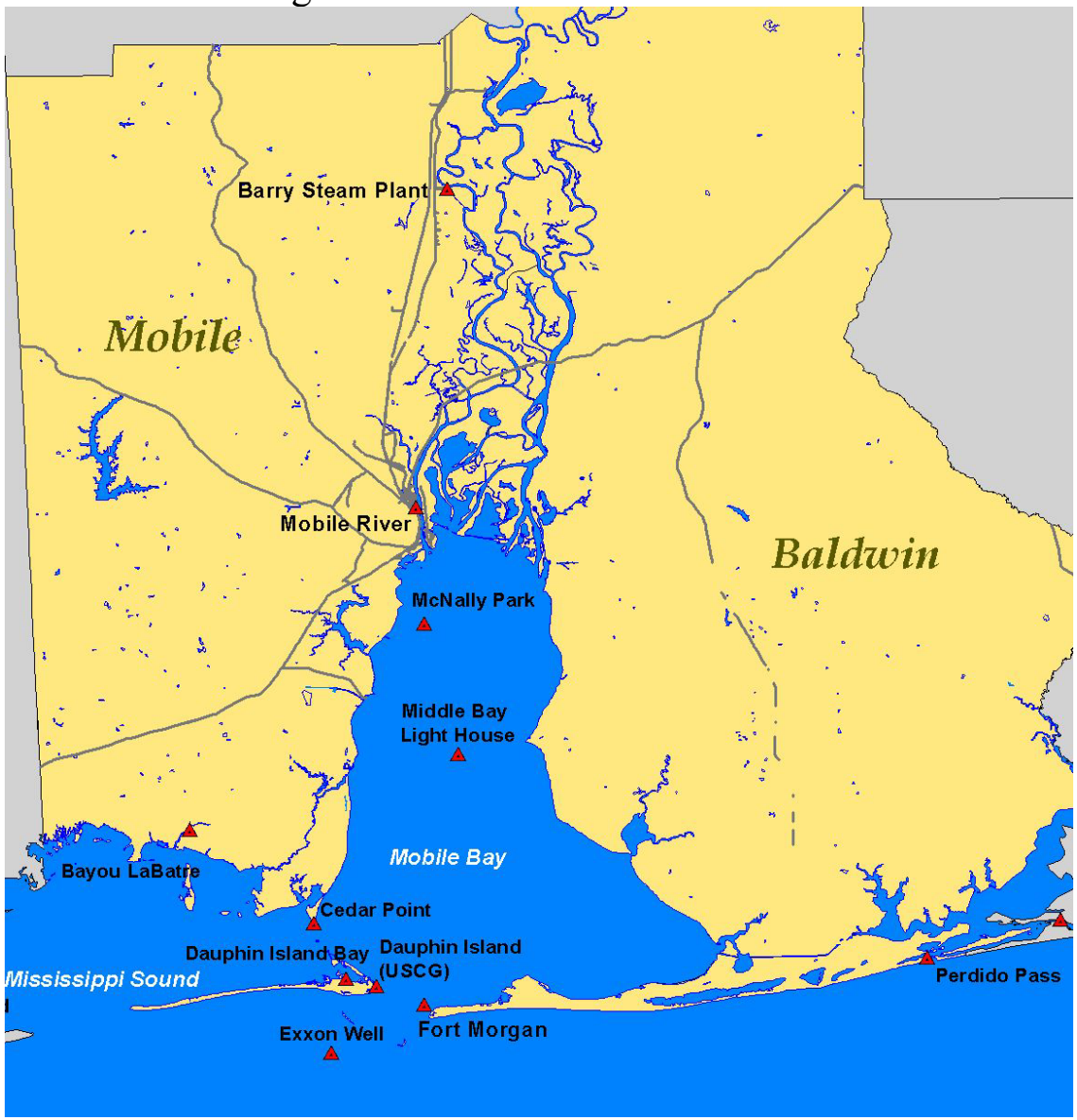
Engineering Division
Hydrology and Hydraulics Branch; September 2004


Hurrican Ivan Peak Elevation
Feet above NGVD
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Inside Mark
Outside Mark
4.56
4.63
5.15
4.23
4.10
6.72
5.83
4.83
3.93
4.66
6.90
7.80
8.00
4.87
6.82
7.85
8.81
9.68
9.70
10.20
12.92
12.12
10.30
6.12
5.39
5.51
6.60
4.94
5.10
3.55
5.04
USGS Waveland
Gulfport Harbor
Ship Island
Point Cadet
Back Bay Biloxi
USGS West Pascagoula Rv
Pascagoula River (NOAA)
Pascagoula Pl
Petit Bois Island
USGS Escatawpa Rv
Bayou LaBatre
Cedar Point
Exxon Well
Dauphin Island Bay
Dauphin Island (USCG)
Mobile River
Barry Steam Plant
McNally Park
Ft Morgan Front Range
Middle Bay Light House
Perdido Pass
Pensacola Gulf Beach
Mustin Beach
Pensacola Bay
Escambia Bay
Escambia Bay
Gulf Breeze
Fort Walton
Destin (USCG)
Choctawhachee Bay
West Bay
St Andrew Bay
Watson Bayou
Apalachicola
St George
Carrabelle

Mississippi Tide Gages



Alabama Tide Gages



Florida Tide Gages