HURRICANES KATRINA & RITA
LOUISIANA'S
RESPONSE AND RECOVERY

2006 AASHTO SUBCOMMITTEE BRIDGES AND STRUCTURES

SALT LAKE CITY, UTAH

MAY 2006

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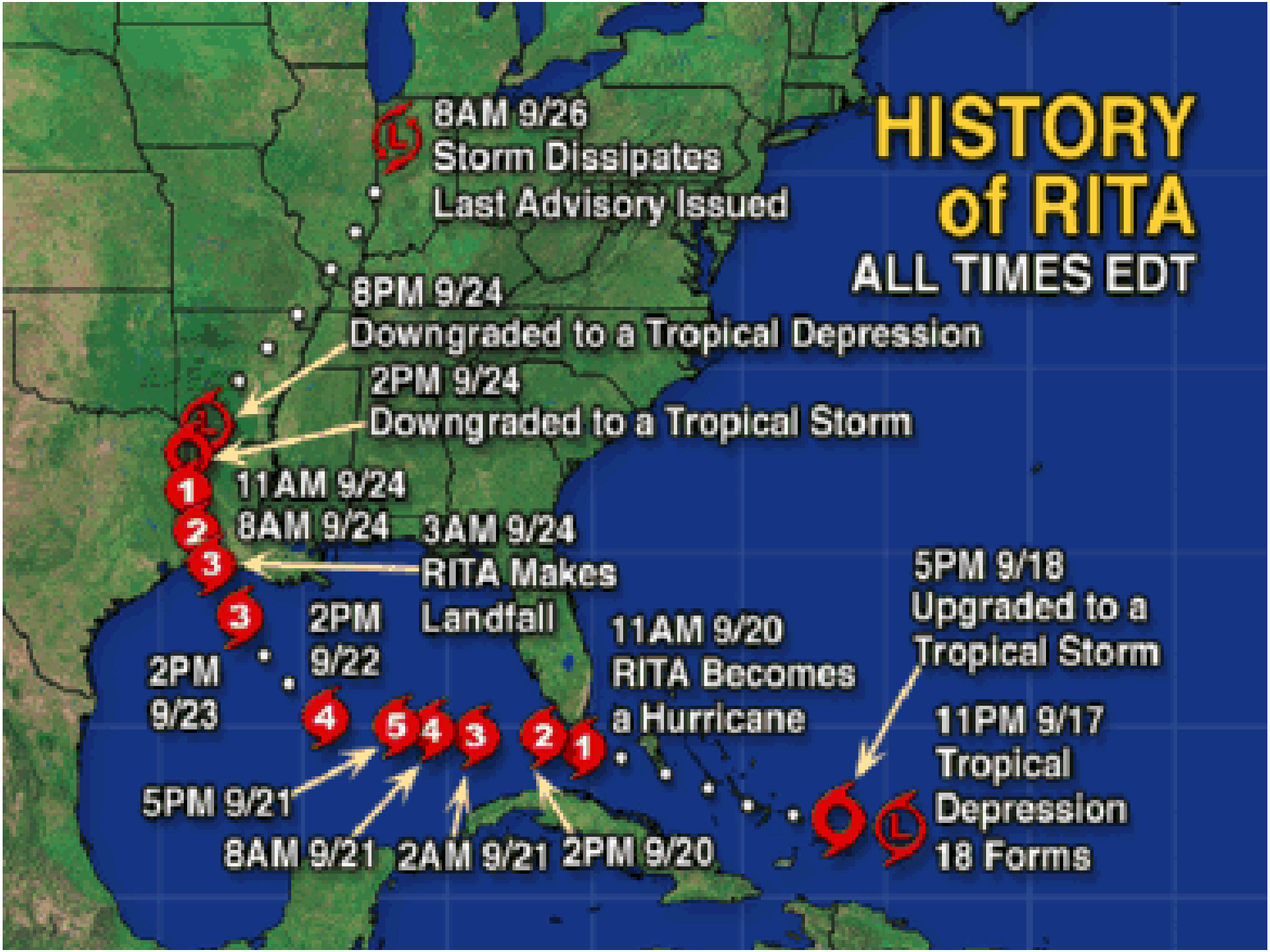
TWO MAJOR HURRICANES HIT THE LOUISIANA COAST IN 2005

- **KATRINA**-Category 4 at landfall
  Morning of August 29, 2005

- **RITA** – Category 3 at landfall
  Morning of September 24, 2005


HISTORY of
KATRINA
ALL TIMES EDT
11AM 8/30
Last Advisory
Issued
Downgraded to a
Tropical Depression
8PM 8/29
Downgraded to a
Tropical Storm
6AM 8/29
KATRINA
Makes
Landfall
1AM 8/26
Downgraded to a
Tropical Storm
5PM 8/25
KATRINA Becomes
a Hurricane
11AM 8/24
Upgraded to a
Tropical Storm
8AM 8/28
2AM 8/28
5AM 8/27
11AM 8/26
7PM 8/25
KATRINA
Makes Landfall
5PM 8/23
Tropical
Depression
12 Forms


HISTORY
of RITA
ALL TIMES EDT
8AM 9/26
Storm Dissipates
Last Advisory Issued
8PM 9/24
Downgraded to a Tropical Depression
2PM 9/24
Downgraded to a Tropical Storm
11AM 9/24
8AM 9/24
3AM 9/24
RITA Makes
Landfall
2PM
9/22
2PM
9/23
11AM 9/20
RITA Becomes
a Hurricane
5PM 9/18
Upgraded to a
Tropical Storm
11PM 9/17
Tropical
Depression
18 Forms
5PM 9/21
8AM 9/21
2AM 9/21
2PM 9/20

FORCES OF NATURE

- STORM SURGE & WAVE ACTION
  - MAJOR INFRASTRUCTURE DAMAGE
- FLOODING
  - LOSS OF LIFE, PROPERTY AND INUNDATION OF BRIDGES
- SCOUR
  - BRIDGE AND ROADWAY INFRASTRUCTURE DAMAGE
- WIND
  - COMMUNICATION, TRANSPORTATION INFRASTRUCTURE & PROPERTY DAMAGE

MOVABLE BRIDGE DAMAGE

- 152 Movable bridges on & off system
- 142 affected
- 52 damaged
- 3 closed to either marine or vehicular traffic

VERTICAL LIFT BRIDGES


YSCLOSKEY

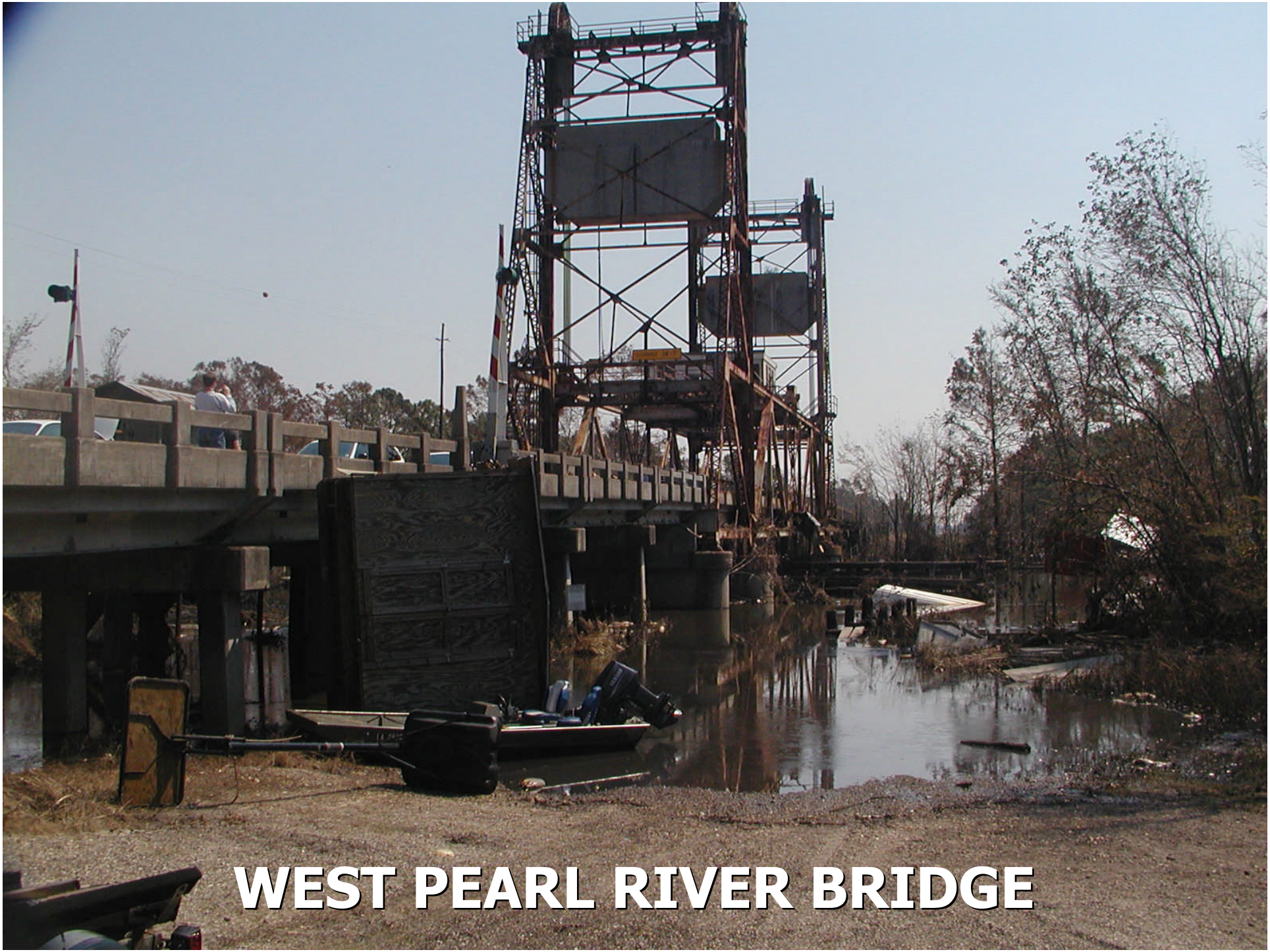

YSCLOSKEY


YSCLOSKEY


DANZIGER BRIDGE


DANZIGER BRIDGE


BYPASS BARRIERS RAISED LIMIT SWITCHES
BYPASS FAR SPAN LOCKS DRIVEN LIMIT SWITCHES
BYPASS FAR END SEATED LIMIT SWITCHES
BYPASS GATES LOWERED LIMIT SWITCHES
BYPASS FAR SPAN LOCKS DRIVEN LIMIT SWITCHES
BYPASS NEAR SPAN LOCKS DRIVEN LIMIT SWITCHES
BYPASS NEAR SPAN SEATED LIMIT SWITCHES
BYPASS RED TR SIGNAL INTERLOCK
BY PASS FED. GATES NEAR/FAR LIMIT SWITCH
ROOM LIGHT
CC 2
DANZIGER BRIDGE

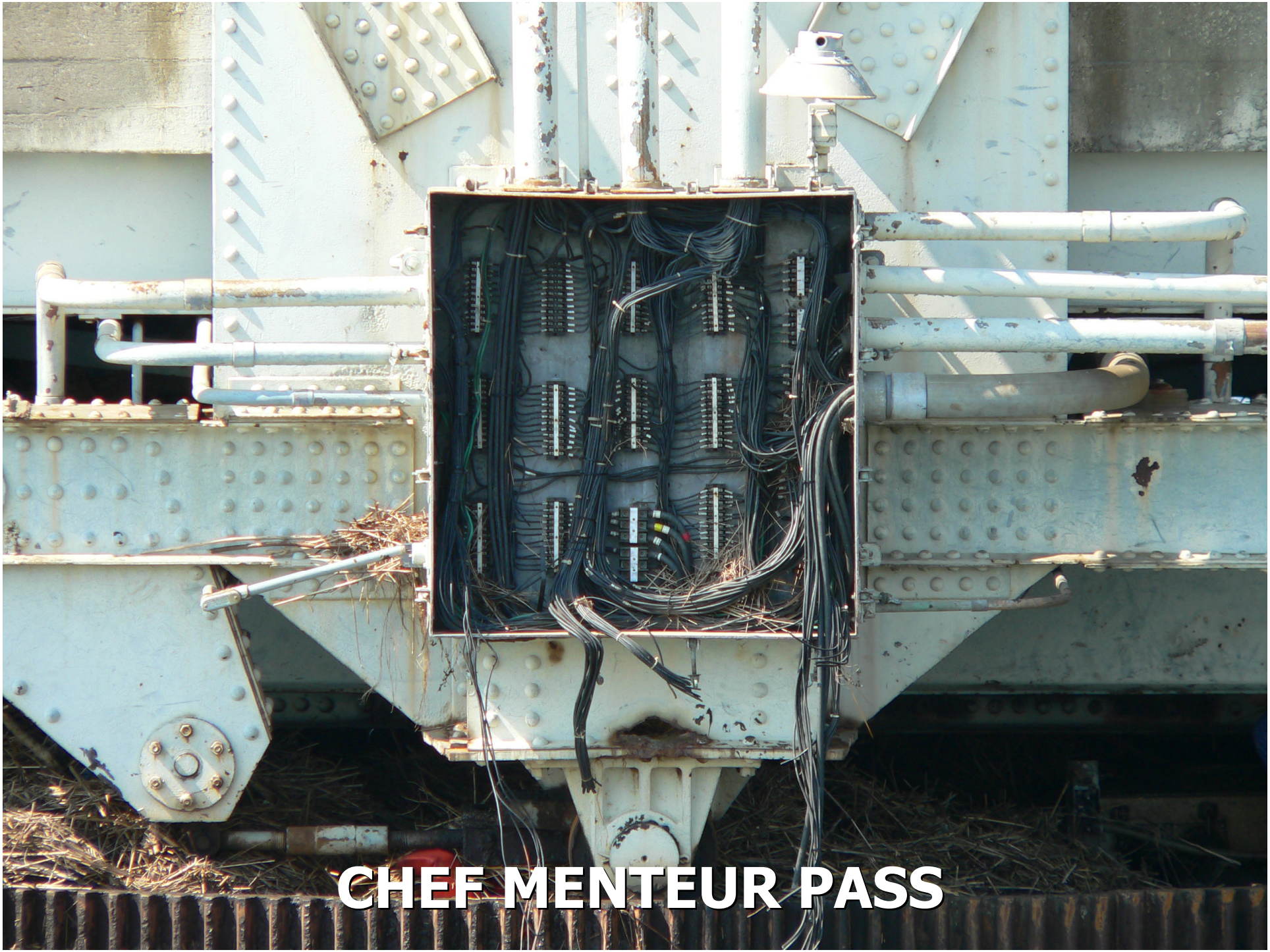

WEST PEARL RIVER BRIDGE


WEST PEARL RIVER BRIDGE

SWING SPAN BRIDGES


CHEF MENTEUR PASS


CHEF MENTEUR PASS – PIER SCOUR


CHEF MENTEUR PASS


CHEF MENTEUR PASS


CHEF MENTEUR PASS


CHEF MENTEUR PASS
2005 9 20


CHEF MENTEUR PASS
2005 9 20

BASCULE BRIDGES


ALMONASTER – INNER HARBOR

ALMONASTER – INNER HARBOR

ALMONASTER – INNER HARBOR


ALMONASTER – INNER HARBOR

PONTOON BRIDGES

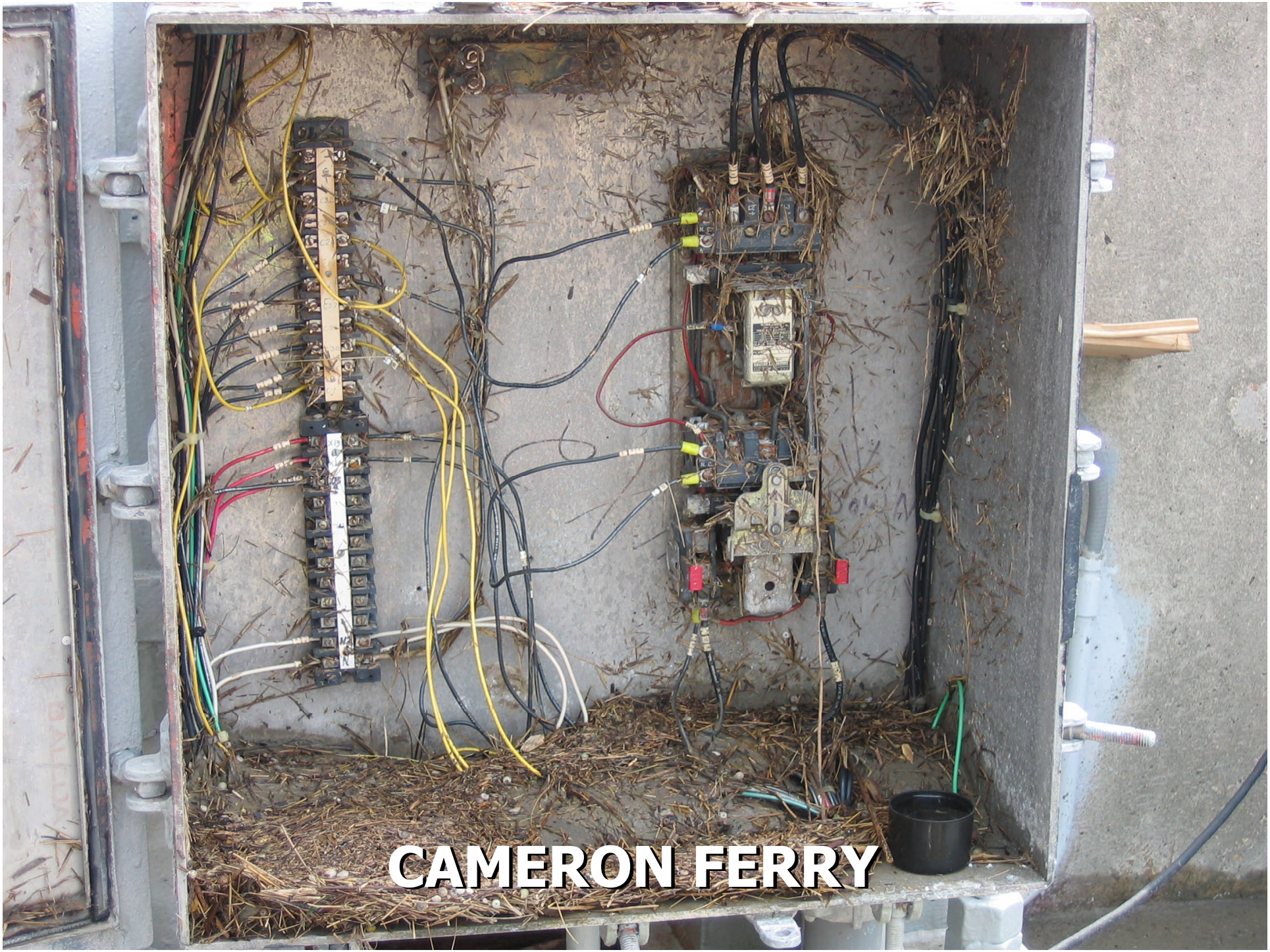
ICWW – BLACK BAYOU

ICWW – BLACK BAYOU


ICWW – BLACK BAYOU

FERRY SYSTEM

CAMERON FERRY


CAMERON FERRY

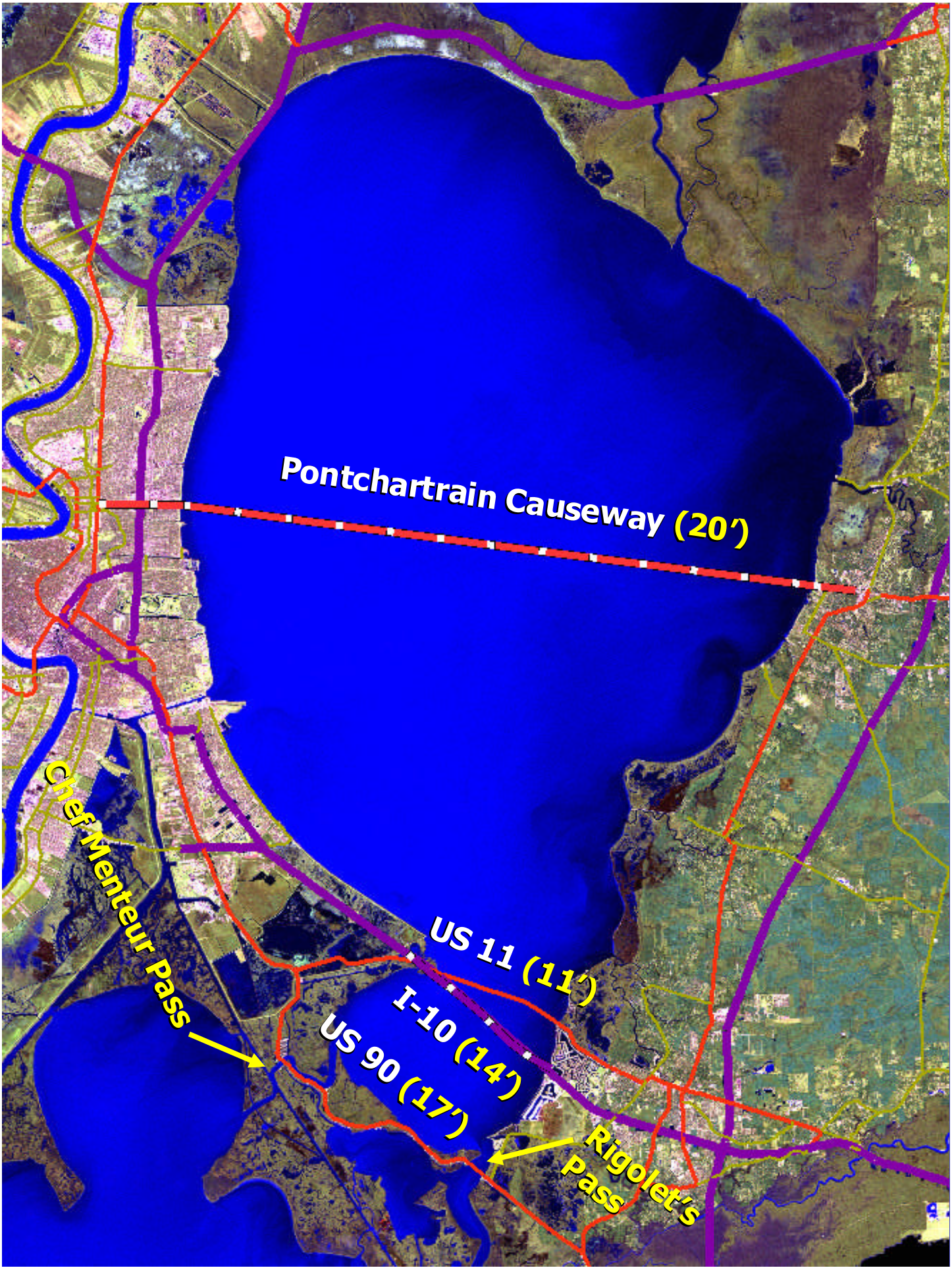
FIXED BRIDGES


EMPIRE


EMPIRE


EMPIRE


CAMINADA BAY BRDIGE AT GRAND ISLE


Pontchartrain Causeway (20')
Chef Menteur Pass
US 11 (11')
I-10 (14')
US 90 (17')
Rigolet's Pass


LAKE PONTCHARTRAIN CAUSEWAY


LAKE PONTCHARTRAIN CAUSEWAY


LAKE PONTCHARTRAIN US 11


LAKE PONTCHARTRAIN US 11


NORFOLK SOUTHERN RAILROAD

DAMAGE OF I-10 TWIN SPANS

I-10 TWIN SPANS

5.4 MILES

Low level 65’ monolithic simple prestress girder spans on 54” ppc cylinder piles.

High rise on short section of bridge

DESCRIPTION OF DAMAGE

- **Eastbound Bridge -**lost 38 spans and 170 spans shifted alignment.
- **Westbound Bridge -** lost 26 spans and 303 spans shifted alignment. Approximately 14,000' of bridge railing damaged.
- **Bridge Bearings -**Major bearing replacement on both bridges, roadway crossovers for traffic, debris removal

I-10 Twin Spans


View looking North


Span movement arrested by risers

I-10 REPAIR PROJECT

- Hurricane Katrina hit Monday, August 29, 2005
- Boh Brothers Construction Co. went to work on Monday, September 12, 2005, Fourteen days after the hurricane made land fall
- Phase I – Eastbound Roadway Opened two way traffic 34 days later , October 16, 2005
- Phase II – Westbound Roadway Opened to traffic 82 days after Phase I, January 6, 2006

I-10 REPAIR PHASES

PHASE 1: REPAIR EASTBOUND ROADWAY

- Move spans from WB to fill gaps on EB
- Realign and repair missing spans on EB

PHASE 2: REPAIR WESTBOUND ROADWAY

- Replace WB spans with approximately 1 mile of ACROW 700 Series bridging, & realign spans

CONSTRUCTION COST

- Total construction cost for repair project and maintenance of the ACROW Bridge = $39 million


Moving Spans - Mammoet


Mammoet - Jack and Slide Method


MASSMAN


Span Supports


01/11/2006

TRAFFIC IS BACK ON I-10

No Permit Loads Allowed

I-10 NEW BRIDGE

CRITICAL FEATURES:

- Six lane facility
- Storm protection
- Enhanced ship collision resistance
- 100 year service life
- Design alternates where possible

GENERAL FACTS

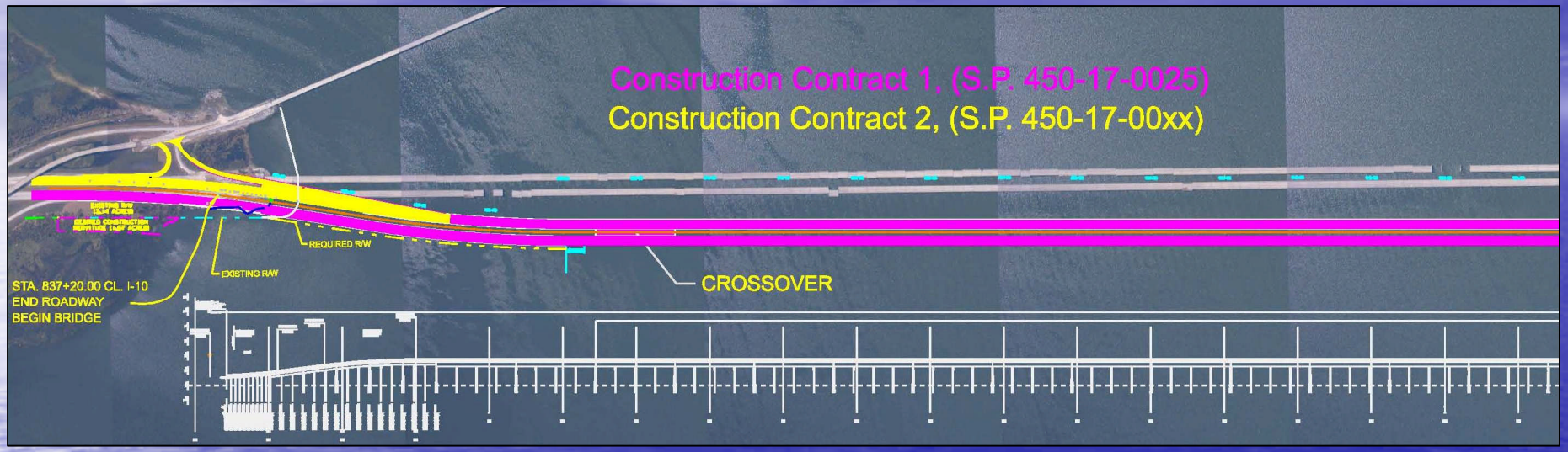
- **Total Bridge Length = 58,388’**
  - 260,000 LF 36” Piles
  - 257,000 LF BT 78
- **Surface area = 3.75 million ft²**

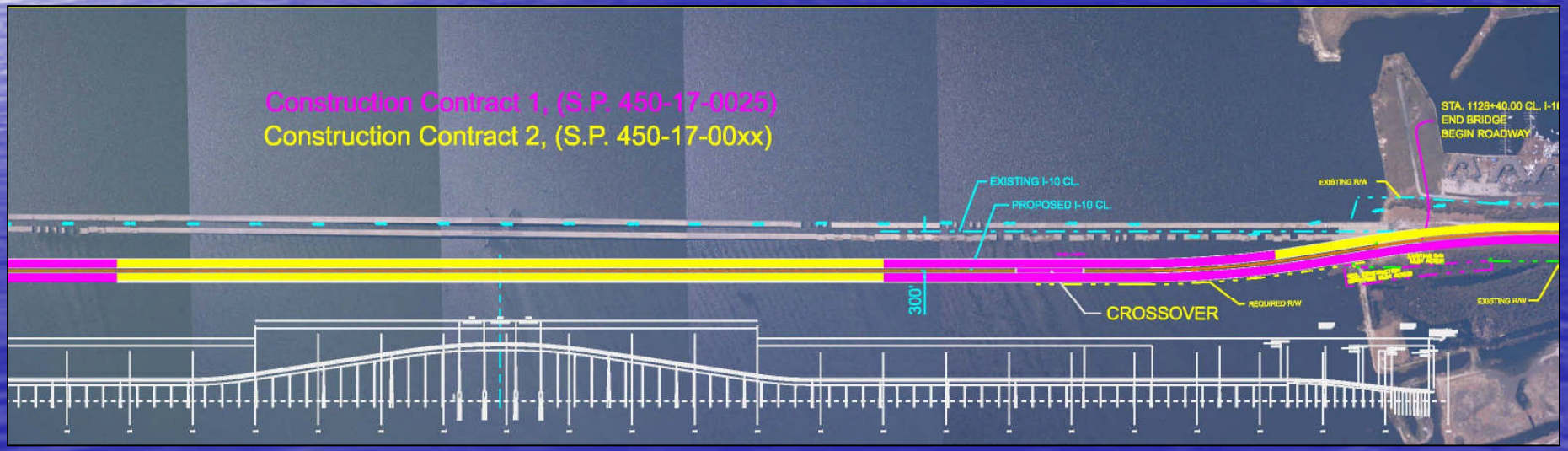
- **Total Roadway Length =1.2 miles**

- **Construction Cost**
  - Phase I (Under Construction) $379 million
  - Phase II (Under Design) $240 million

- **Coastal Engineering Services from Moffatt and Nichol LSU and SITE.**

CONSTRUCTION PHASING





I-10 PONTCHARTRAIN BRIDGES

DESIGN STORMS CONSIDERED

Katrina 2005

Surge +14 NAVD 88, Wave Crest +22.8 NAVD 88

Katrina-like storm (Path 28 miles west)

Surge +19 NAVD 88, Wave Crest +30.6 NAVD 88

Derived from Moffatt & Nichol

STORM PROTECTION

- Set Low Concrete Elevation (30 feet NAVD 88) above the Maximum Wave Crest Height of Katrina West (500 year design event) for main elevated structure
- Transition spans will be designed for the 100 year Katrina event and anchored accordingly
- Transition spans will have open steel bridge rail

I-10 PONTCHARTRAIN BRIDGES (LRFD Load Combinations)

- The AASHTO LRFD specifications do not directly address the surge load condition
- The first load case, the long duration load caused by the surge could be applied as a Strength III case and the short during impact load could be treated as an extreme event load

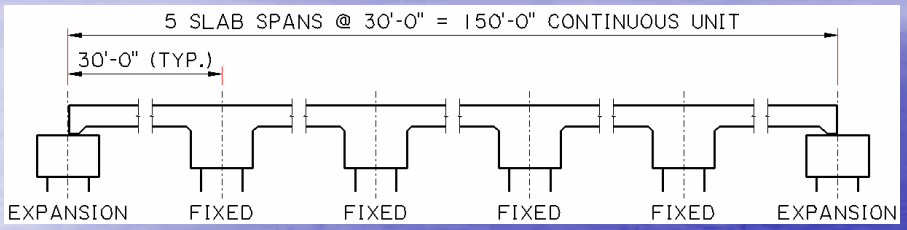
DESIGN SPECIFICATIONS
I-10 Bridge Over Lake Pontchartrain
S.P. 450-17-0025
Rev. 8 ??

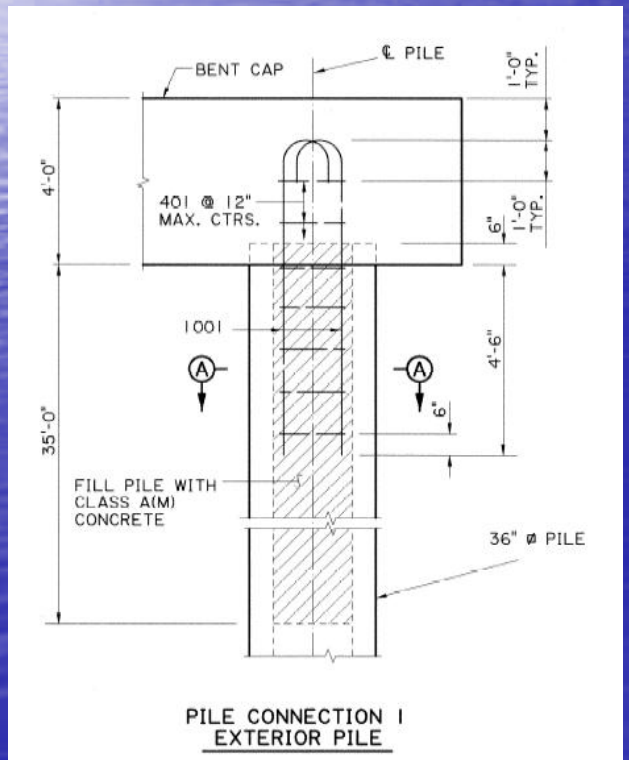
Load Combinations and Load Factors
(Per AASHTO LRFD Bridge Design Specifications Table 3.4.1-1 unless noted otherwise)

Limit States	Load Factors																
	DC		DW		LL	IM	WA	S[1]	S[2]	WS	WL	FR	TU CR SH	TG	SE	CV	SC[3]
	Max	Min	Max	Min													
Strength I	1.25	0.9	1.5	0.65	1.75	1.75	1.0	-	-	-	-	1.0	0.5/1.2	-	1.0	-	-
Strength II	1.25	0.9	1.5	0.65	1.35	1.35	1.0	-	-			1.0	0.5/1.2	-	1.0	-	-
Strength III	1.25	0.9	1.5	0.65	-	-	1.0	-	-	1.4	-	1.0	0.5/1.2	-	1.0	-	-
Strength V	1.25	0.9	1.5	0.65	1.35	1.35	1.0	-	-	0.4	1.0	1.0	0.5/1.2	-	1.0	-	-
Extreme II[5]	1.25	0.9	1.5	0.65	0.25	0.25	1.0	-	-	0.3	-	1.0	-	-	-	1.0	-
Extreme III[5]	1.25	0.9	1.5	0.65	1.75	1.0	1.0	-	-	-	-	1.0	-	-	-	-	1.8[4]
Extreme IV[5]	1.25	0.9	1.5	0.65	-	-	1.0	-	-	1.4	-	1.0	-	-	-	-	0.7
Extreme V[5]	1.25	0.9	1.5	0.65	-	-	1.0	-	-	-	-	1.0	-	-	-	1.0	0.6[6]
Service I	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-	-	0.3	1.0	1.0	1.0/1.2	0.5	1.0	-	-
VService II	1.0	1.0	1.0	1.0	1.3	1.3	1.0	-	-	-	-	1.0	1.0/1.2	-	-	-	-
Service III	1.0	1.0	1.0	1.0	0.8	0.8	1.0	-	-	-	-	1.0	1.0/1.2	0.5	1.0	-	-
Service IV	1.0	1.0	1.0	1.0	-	-	1.0	-	-	0.7	-	1.0	1.0/1.2	1.0	1.0	-	-
Fatigue	-	-	-	-	0.75	0.75	1.0	-	-	-	-	-	-	-	-	-	-
Storm Surge 1	1.25	0.9	-	-	-	-		1.4	-	1.4[7]	-	1.0	0.5/1.2	-	-	-	-
Storm Surge 2	1.25	0.9	-	-	-	-		-	1.0	0.3[7]	-	1.0	-	-	-	-	-

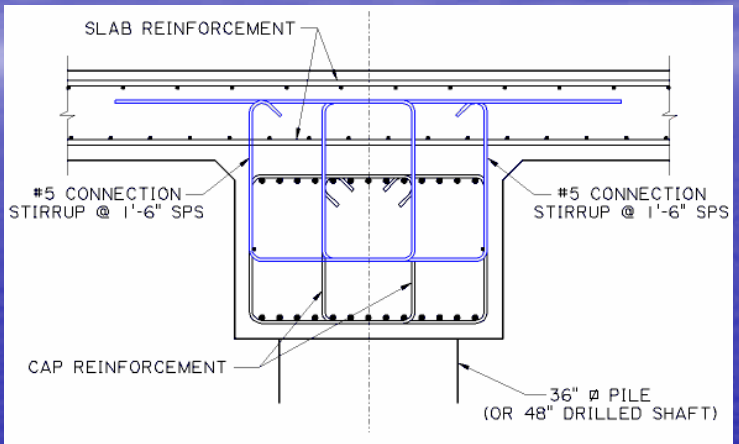
[1] Quasi-Static Storm Surge Forces
[2] Dynamic or Impact Storm Surge Forces
[3] Scour Depth
[4] 180% of the Scour Depth
[5] Per NCHRP Report 489 "Design of Highway Bridges for Extreme Events".
[6] 60% of the Scour Depth
[7] Apply wind load on structure (WS) to surfaces where storm surge forces (S) are absent.

FLAT SLAB SPAN (Anchorage Details)

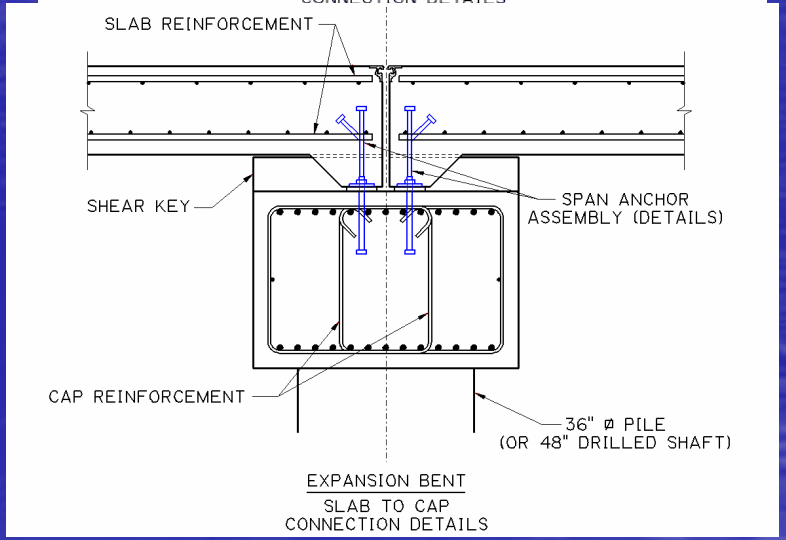




PILE CONNECTION 1
EXTERIOR PILE

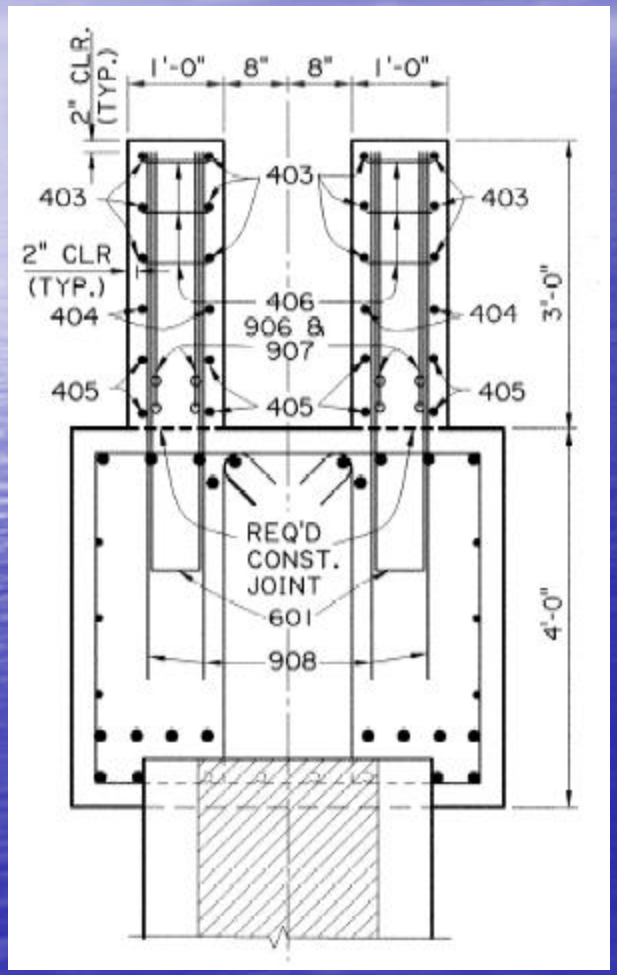


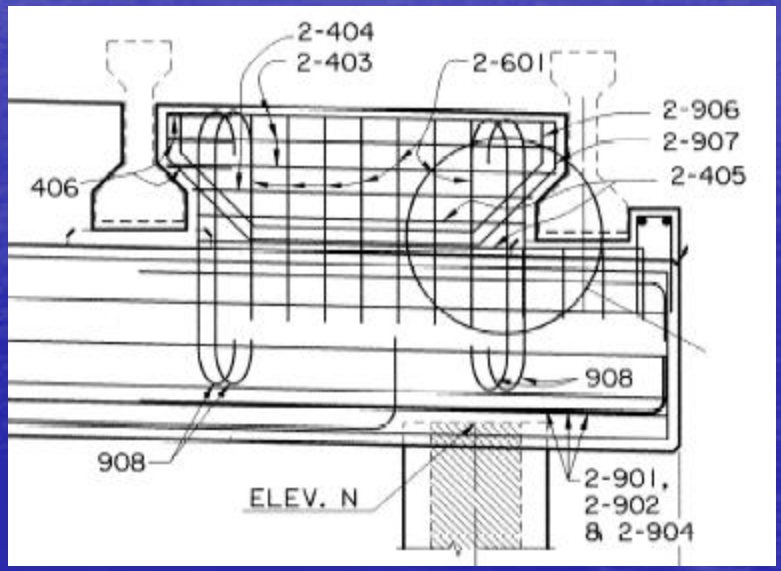
FIXED BENT
SLAB TO CAP
CONNECTION DETAILS



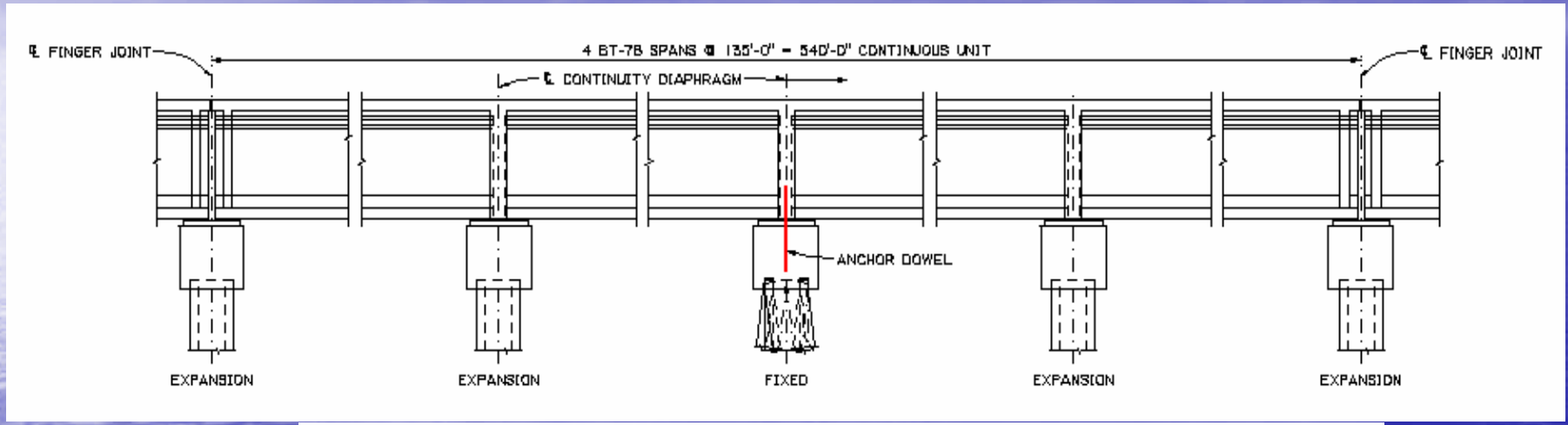
EXPANSION BENT
SLAB TO CAP
CONNECTION DETAILS

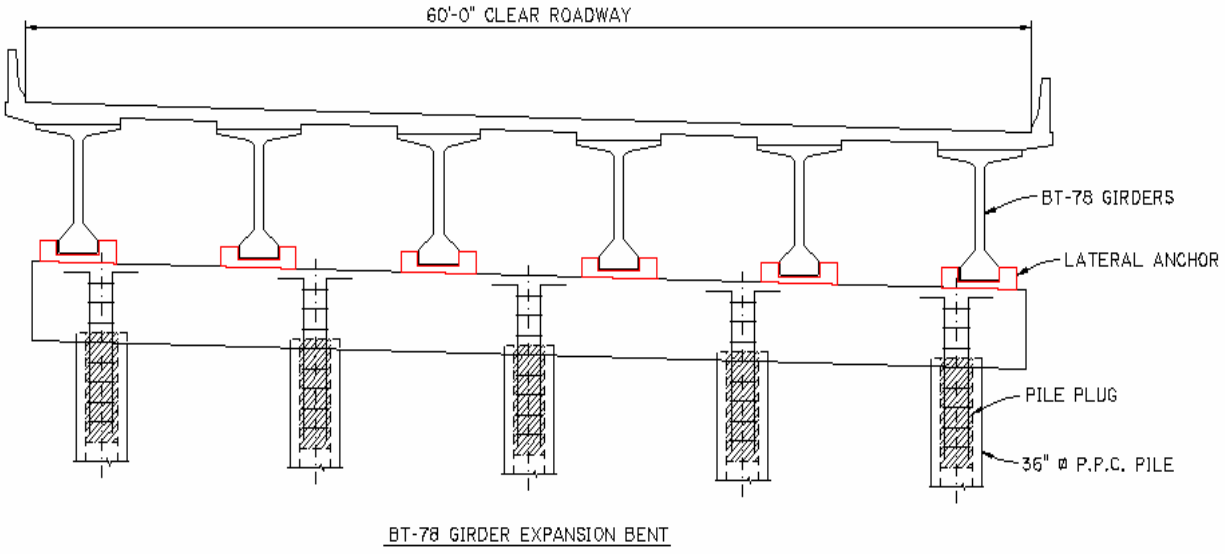
TYPE III GIRDER SPAN (Anchorage Details)





BT 78 GIRDER SPAN (Anchorage Details)

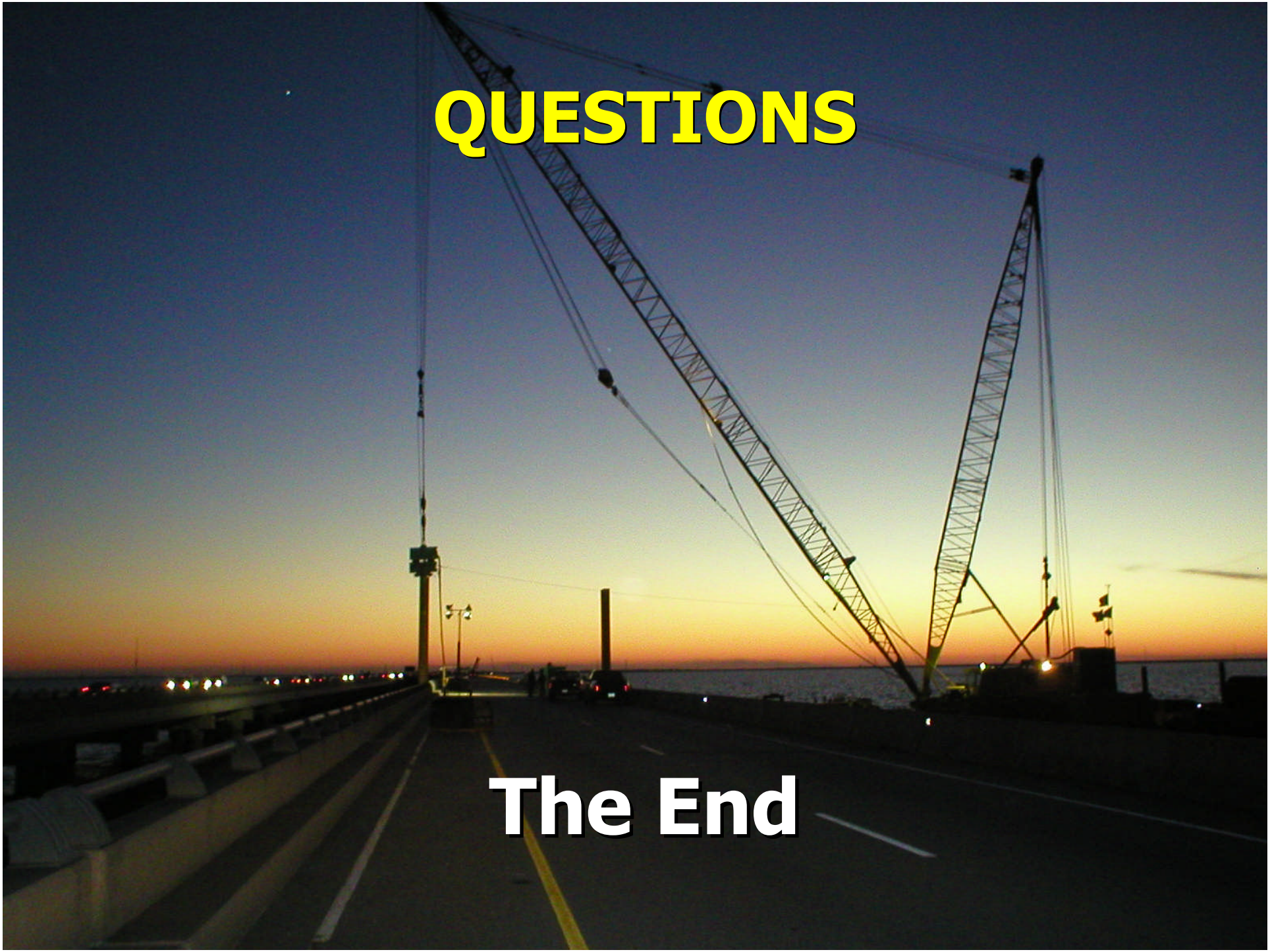




BT-78 GIRDER EXPANSION BENT

CORROSION PROTECTION

- **Provide Minimum 100 Years of Service**
  - Studied HPC mix designs, including the Cooper River and Confederation bridges
  - HPC mix and additional concrete cover
  - Require 1000 Coulombs @ 56 days
  - Pre-qualify mix supplied by source
  - QA/QC element level test program


QUESTIONS
The End