Test Pile Program
for
US 90 Biloxi Bay Bridge
Biloxi to Ocean Springs
Mississippi

2006 STGEC
November 1, 2006

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Dan Brown and Associates, LLC

Project Summary

- US 90 Bridge over Biloxi Bay destroyed by Hurricane Katrina on August 29, 2005.
- Design-Build contract awarded June 7, 2006
- Project cost: $338.6 million
- Schedule date open to traffic: March 28, 2008

Project Team

- Owner – Mississippi DOT
- Contractor Joint Venture – GC Constructors
  - Massman Construction Co.
  - Kiewit Southern Co.
  - Traylor Brothers, Inc.
- Design Engineer – Parsons Transportation Group, Inc.
- Geotechnical Engineer – Eustis Engineering Company, Inc.
- Geotechnical QC Consultant – Dan Brown and Associates, LLC

Project Design

- Main Bridge
  - Two bridges of 3 lanes each
  - South bridge (east bound) – includes 12-foot wide bike/pedestrian lane
  - Increased main span height to 95 feet above Biloxi Bay, eliminating need for draw span
- New bridge over CSX railroad on east approach
- Changes to approach grades
- Pile supported retaining walls
- MSE walls

Pile Foundations

Main Bridge

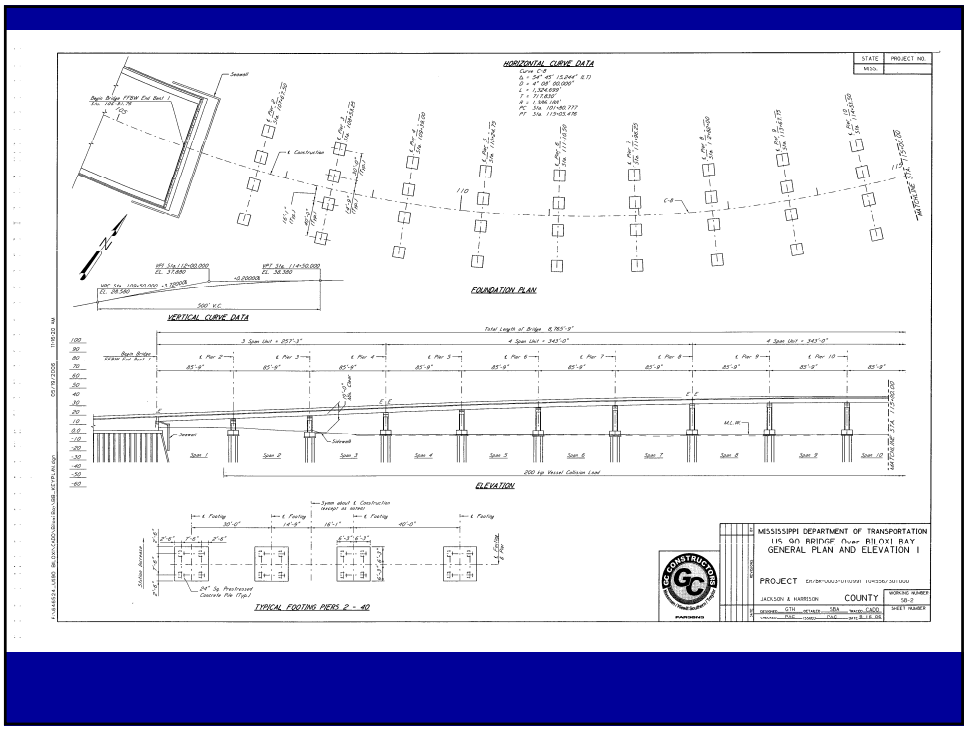
- 24-inch and 30-inch pre-stressed PCC piles
- Axial service loads:
  - 320 to 450 kips for 24-inch piles
  - 420 to 570 kips for 30-inch piles
- Vessel impact loads of 200 kips to 2850 kips at piers
- Pile footings with 4 to 36 piles each
- Total scour of 20 to 30 feet below mudline

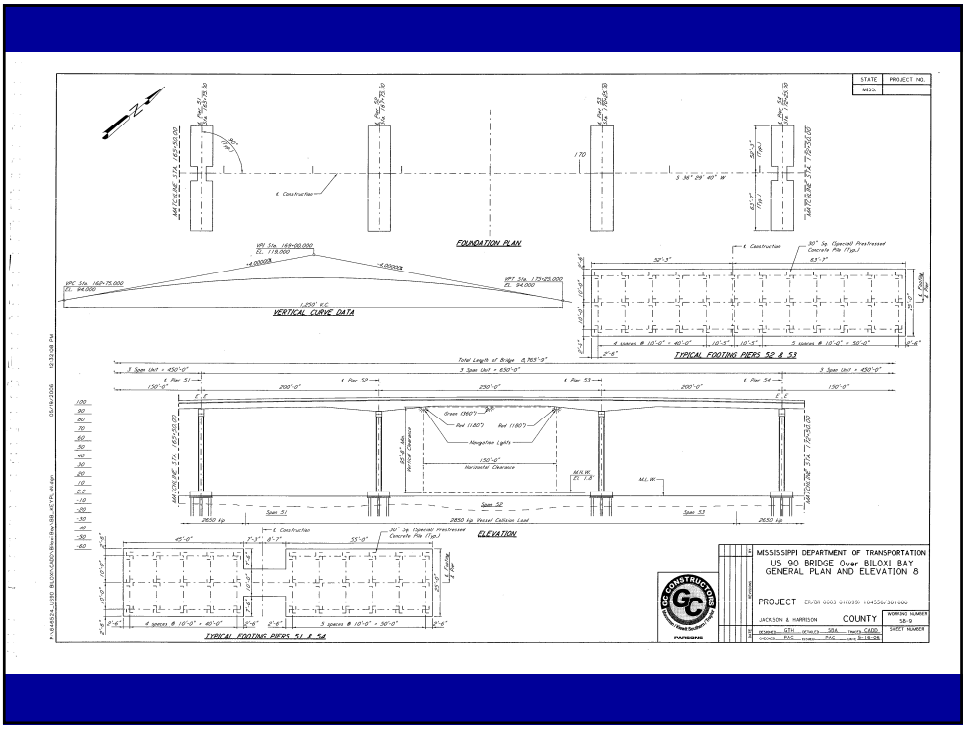
Pile Foundations

CSX Bridge, US 90 Abutments and Approach Embankment Walls

- 18-inch pre-stressed PCC piles
- Axial service loads ranging from 120 to 200 kips
- Lateral loads ranging from 10 to 40 kips

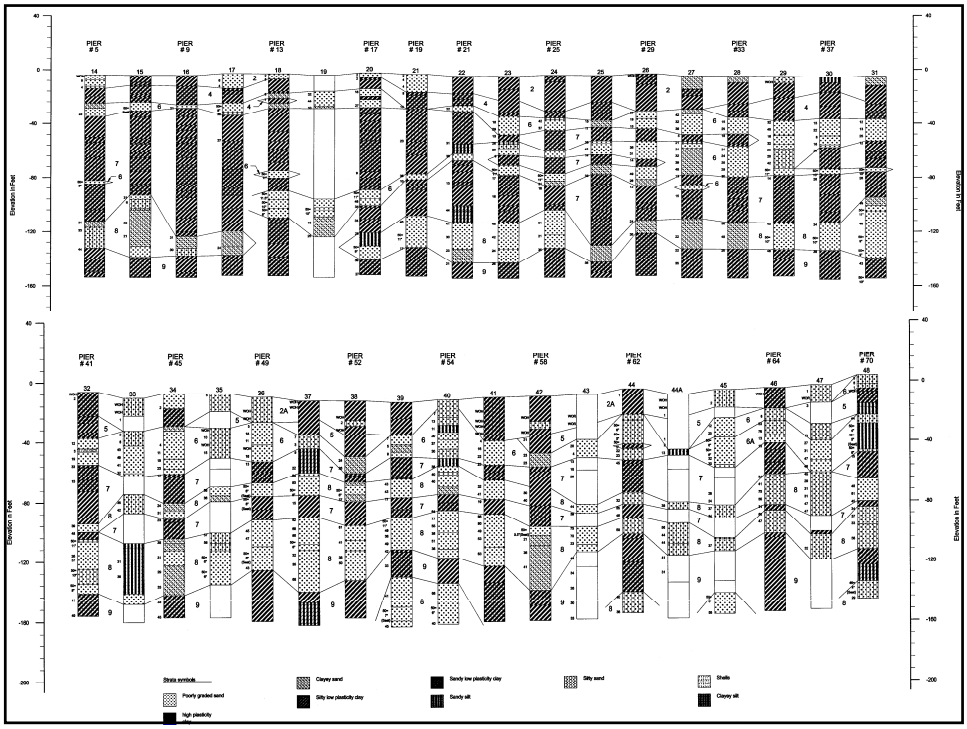

HIGH LEVEL APPROACH CROSS-SECTION


HORIZONTAL CURVE DATA
FOUNDATION PLAN
VERTICAL CURVE DATA
ELEVATION
TYPICAL FOOTING PIERS 2 - 40
MISSISSIPPI DEPARTMENT OF TRANSPORTATION
I-10 BAY BRIDGE Over BILOXI BAY
GENERAL PLAN AND ELEVATION I
PROJECT
JACKSON & HARRISON
COUNTY



Geotechnical Exploration

- 62 Soil Test Borings (39 for main bridge)
- Boring drilled at both abutments, every other approach pier, and at both main channel piers
- Borings drilled 150 feet below mudline
- Laboratory testing included UC and UU triaxial tests



Test Pile Program

- Understanding “The Big Picture”
- Where is the risk?
  - Schedule!!!!!!
- How to reduce risk?
  - Provide information that reduces schedule uncertainties: pile set-up, restrikes, extra driving, etc.

Test Pile Program

Indicator Piles

- 21 total piles
  - 19 on main bridge, 2 on CSX bridge
  - 4 18-inch (Main Bridge Abutments and CSX)
  - 10 24-inch
  - 7 30-inch
- Tip elevations estimated by axial analysis using DRIVEN and other techniques
- Piles driven with continuous PDA monitoring
- Restrikes performed over time

Test Pile Program

Objectives of Indicator Piles

1. Verify that piles can be installed to minimum tip elevation with the hammer selected.
2. Evaluate need for any driving aids to achieve #1.
3. Define the driving resistance level below which reduced stroke is needed to avoid pile damage, and evaluate any changes required to cushions to avoid pile damage.

Test Pile Program

Objectives of Indicator Piles

4. Verify or adjust the estimated tip elevation with appropriate allowance for setup.

5. Verify end of drive acceptance criteria.

Test Pile Program

Evaluation of Pile Setup

- Systematic documentation of setup through restrike measurements at a range of times after initial driving.
- End-of-drive blow count established which includes an allowance for setup.
- Provide assurance to the project owner that piles driven to satisfy the established criteria will ultimately achieve the required ultimate axial resistance.
- Reduce the risk of delays due to questions regarding pile axial resistance and the need for set checks through restrikes or splices.

Test Pile Program

Load Tests

- Static axial load tests
  - IP-3 (24-inch) and IP-17 (30-inch)
- Statnamic axial load tests
  - IP-8 (24-inch) and IP-14 (30-inch)
- Statnamic lateral load tests
  - IP-8 (24-inch) and IP-14 (30-inch)

- Separate piles were driven for each test (axial and lateral)

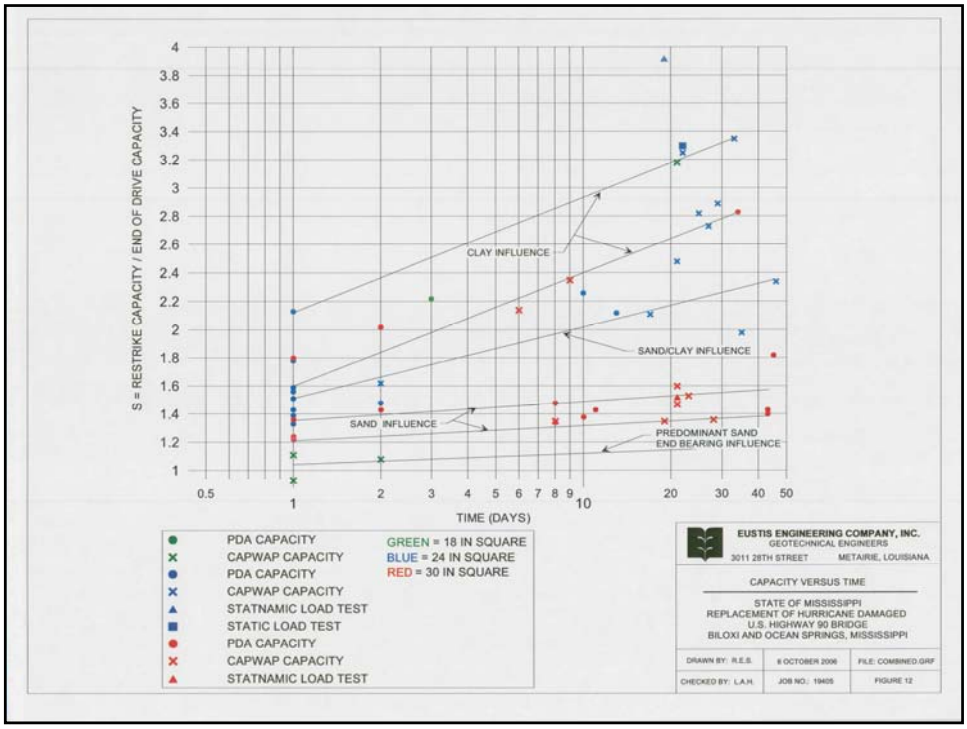
STATE OF MISSISSIPPI
REPLACEMENT OF HURRICANE DAMAGED U.S. HIGHWAY 90 BRIDGE
BILOXI AND OCEAN SPRINGS (HARRISON AND JACKSON COUNTIES), MISSISSIPPI
EUSTIS ENGINEERING PROJECT NO. 19405

DYNAMIC PILE TESTING SUMMARY

PILE NUMBER	PILE TIP ELEVATION	PREDOMINANT SOIL INFLUENCE	BLOW COUNT AT TIP	HAMMER ENERGY AT TIP FT-KIPS	END OF DRIVE CAPACITY KIPS	RESTRIKE CAPACITY IN KIPS			
IP-11	-95	Sand	17@2"	66.5	1,243	1300[1] 1.05[2] 1 Day	1676[3] 1.35 8 Days		
IP-12	-96	Clay	181	40	708	1278 1.8[2] 1 Day	1516[3] 2.14[2] 6 Days		
IP-13	-93	Sand	145	73.8	1076	1460 1.36[2] 1 Day	1486 1.34[2] 10 Days	1584[3] 1.47[2] 21 Days	1957 1.82[2] 45 Days
IP-14 (LST)	-93	Sand	74@3"	59.4	1109	1378 1.24[2] 1 Day	1454 1.34[2] 8 Days	1509[3] 1.36[2] 28 Days	1581 1.43[2] 43 Days
IP-14 (AST)	-91	Sand	90@8"	47.1	1035			1575[4] 1.52[2] 21 Days	
IP-15	-90	Sand	36	69	1055	1503 1.43[2] 2 Days	1557 1.48[2] 8 Days	1423[3] 1.35[2] 19 Days	1450 1.40[2] 43 Days
IP-16	-91	Clay	21@4"	33.3	613	1239 2.02[2] 2 Days	1442[3] 2.35[2] 9 Days	1733 2.83[2] 34 Days	

EUSTIS ENGINEERING COMPANY, INC.

FIGURE 4, PAGE 1 OF 2



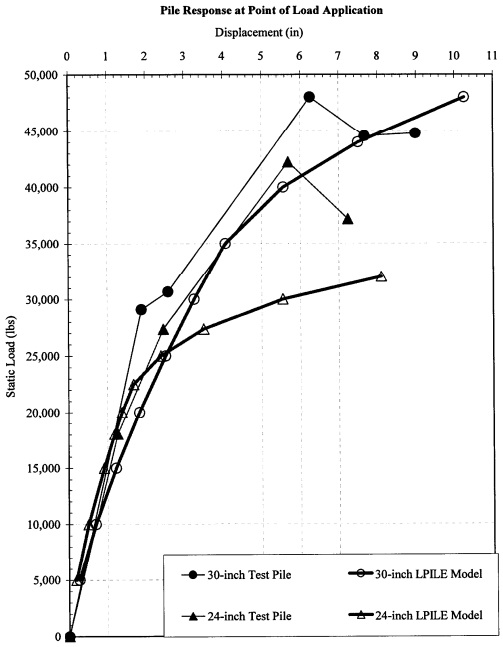
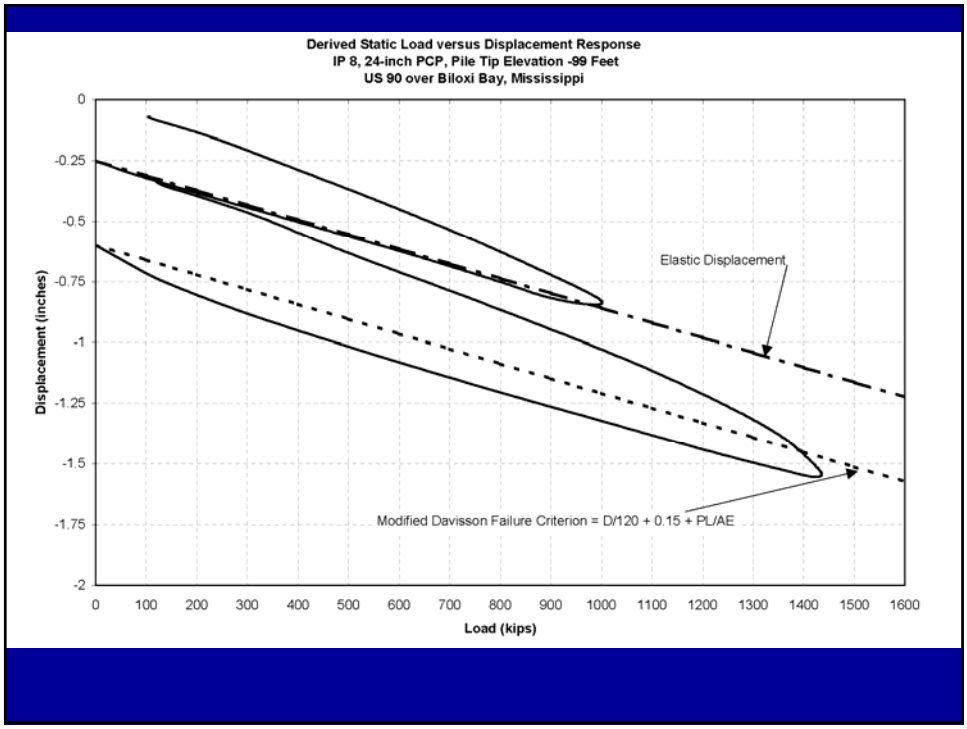
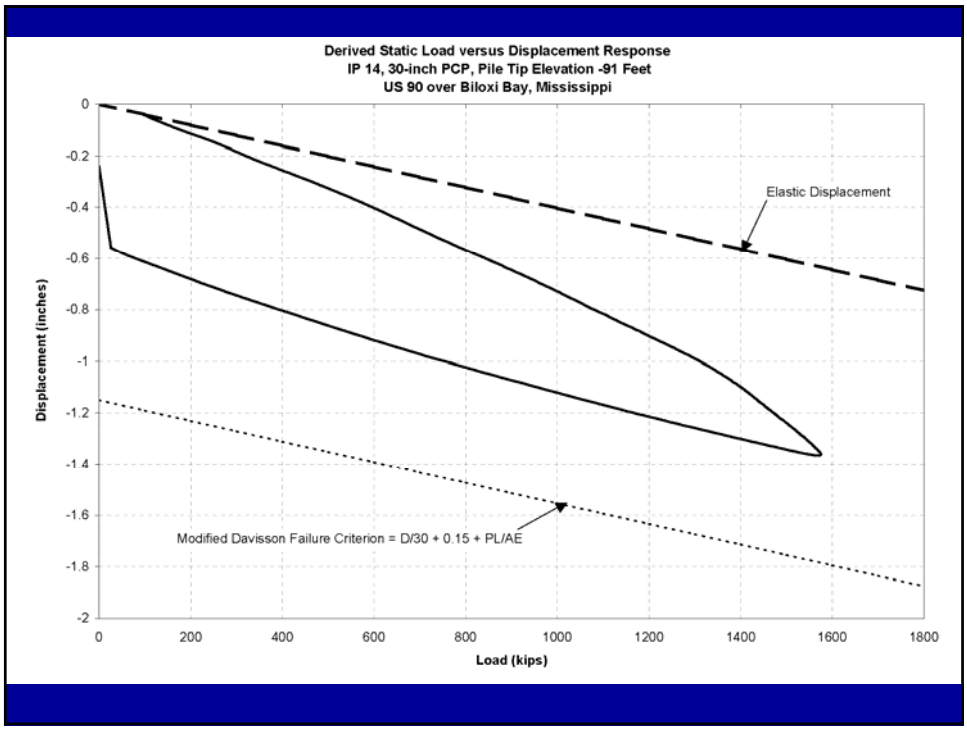
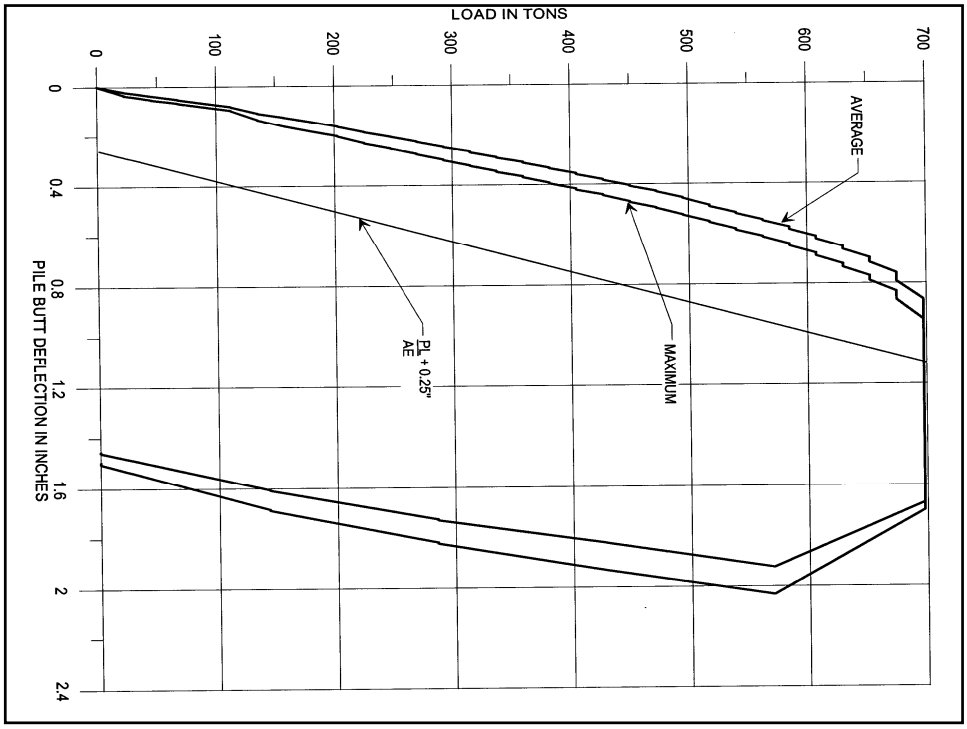


Figure 17 - Static Load vs. Top of Pile Displacement Response Derived from Statnamic Testing compared to LPILE model.


Derived Static Load versus Displacement Response
IP 8, 24-inch PCP, Pile Tip Elevation -99 Feet
US 90 over Biloxi Bay, Mississippi
Displacement (inches)
Load (kips)
Elastic Displacement
Modified Davisson Failure Criterion = D/120 + 0.15 + PL/AE


Derived Static Load versus Displacement Response
IP 14, 30-inch PCP, Pile Tip Elevation -91 Feet
US 90 over Biloxi Bay, Mississippi
Displacement (inches)
Load (kips)
Elastic Displacement
Modified Davisson Failure Criterion = D/30 + 0.15 + PL/AE



Summary of Axial Load Test Data

Pile	Tip Elevation (feet)	Soil at tip	Maximum Load (kips)	Failure Load (kips)	Maximum Displacement (in)	Permanent Displacement (in)	Unit Side Friction (ksf)	Unit End Bearing (ksf)
IP-03	-95	Clay	697.5	697.5	2	1.5	1.2 - 2.4	13.4
IP-08	-99	Clay	1434	1390	1.15	0.35	0.7 - 2.5	44
IP-14	-91	Sand	1575	N/A	1.36	0.24	1.3 - 4.0	79.3

IP-03 – Static Test; IP-08 and IP-14 Statnamic Test


D St.
G St.
H St.
I St.
J St.


Ingersoll Rand


09/01/2006


08/29/2006

Test Pile Program Results

- Test pile program successfully:
  - Documented setup
  - Provided end of drive criteria
  - Validated installation methods
  - Verified axial and lateral resistance
  - Allowed appropriately conservative pile tip elevations higher than planned during bid
- First pile at each bent is monitored with PDA to evaluate driving stresses.
- Production piles started mid-September.

Questions?