River Bend Unit 3

NRC Onsite Review
Geotechnical / Hydrogeology
Investigation Activities
March 28-29, 2007

Project Introduction & Agenda

- **Project Introduction** – Garry Young (Entergy)
  - Introductions
  - Project Background and Status
- **Project Organization / QA** – George Zinke (Entergy) / Larry Drbal (Black & Veatch)
- **Site Investigations Overview** – Mark Petersen (Black & Veatch)
  - Objective and Scope Review
  - Brief Geology Overview (Kathryn Hanson, Geomatrix)
  - Investigation Overview
  - Field Procedures Overview
  - Investigation Issues/Constraints
- **Site Orientation** – John Caldwell (Black & Veatch)
  - Site safety briefing
  - Site tour

Project Background

Develop COL Application based on ESBWR Reactor Technology

September, 2006	-	Entergy Contract w/ Black & Veatch to Develop COL Application
• September, 2006	-	Initiated Vendor Qualification Process
• October, 2006	-	Review Existing Information and Start Investigation Planning
• November, 2006	-	Start Hydrogeology Investigation
• January, 2007	-	Start Geotechnical Investigation
• May 2008	-	Target COL Submittal date

Overview of Current Status

- **Hydrogeology Investigation**
  - All monitoring wells installed
  - Monthly groundwater measurements and groundwater sampling continuing
- **Geotechnical Investigation**
  - Geotechnical investigation (including borings, CPTs, and pressuremeter testing for ESBWR nearly complete
  - Seismic testing to be completed
- **COLA development in process**

Project Organization and QA

George Zinke

New Plant Project Manager-Licensing/QA

(Entergy)

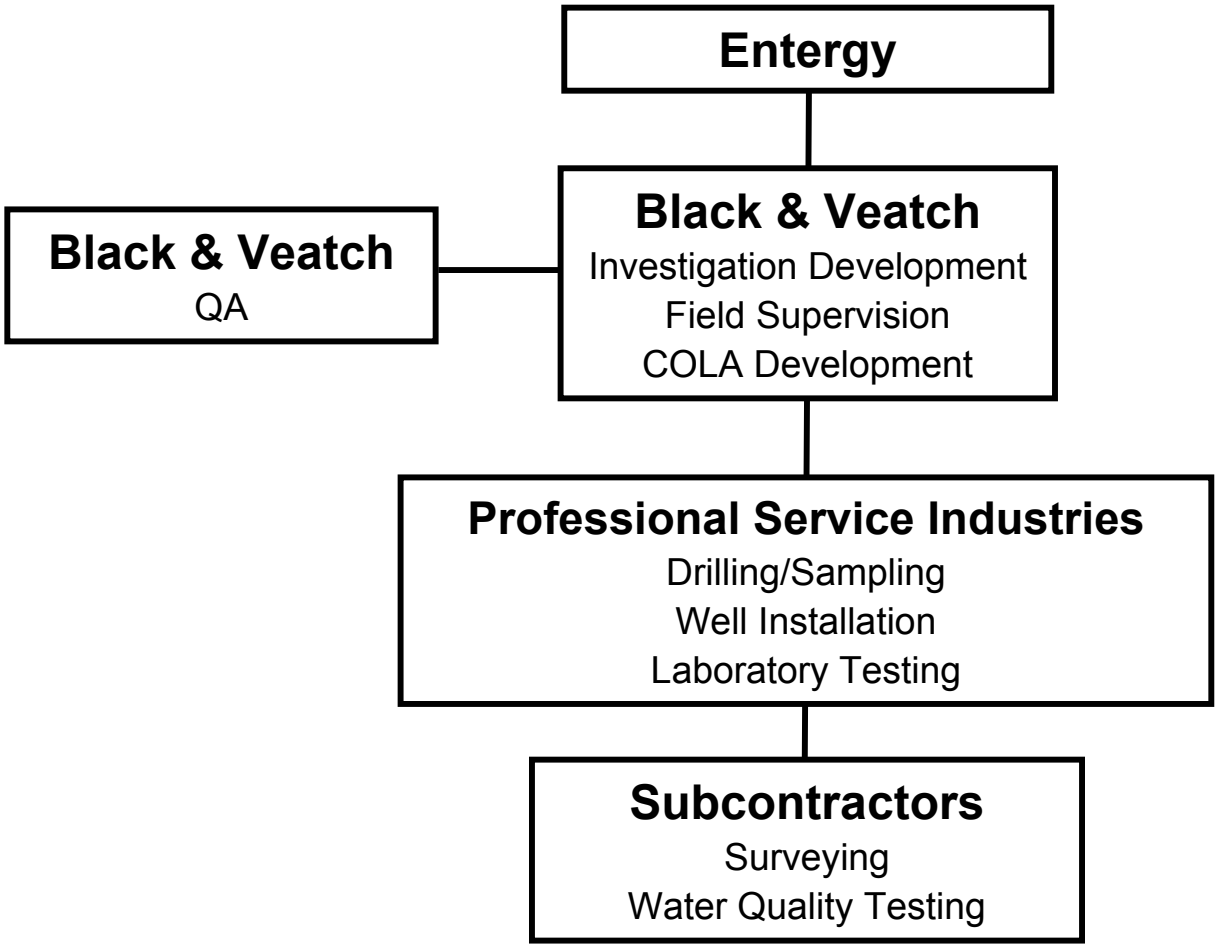
Larry Drbal

Project Manager

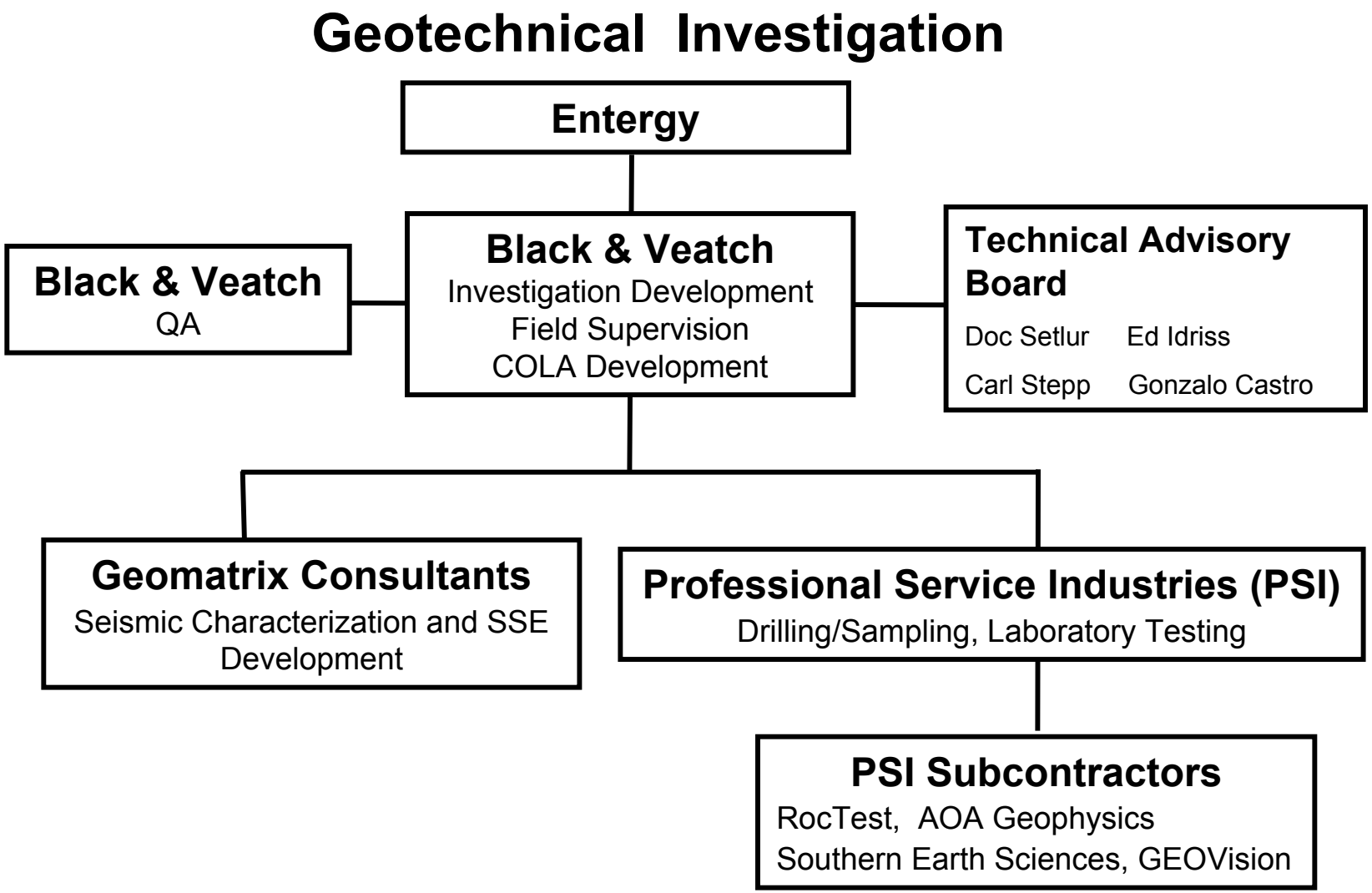
(Black & Veatch)

Project Organization

Hydrogeology Investigation



Project Organization



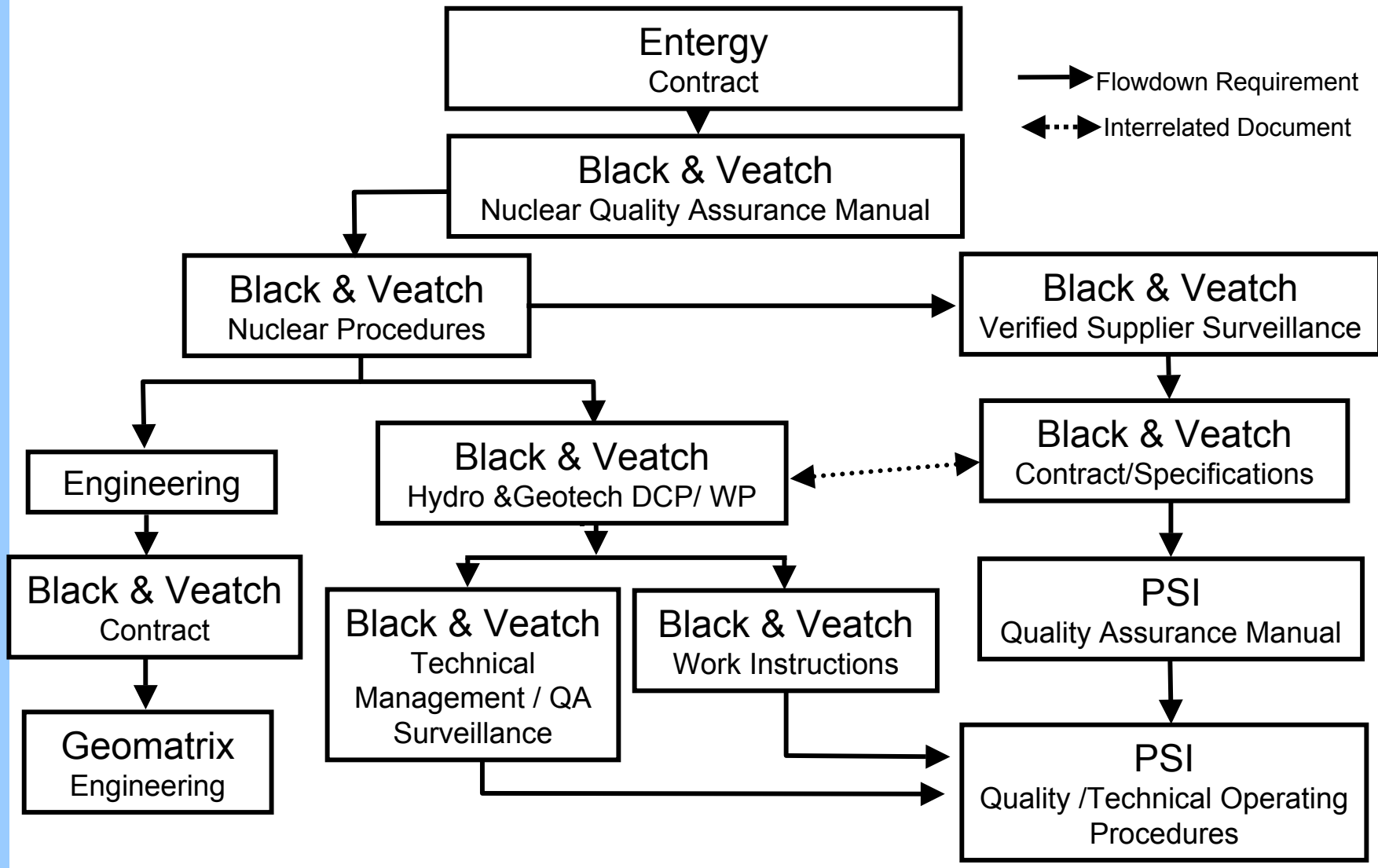
Project Organization - Responsibilities

- Entergy
  - Site owner
- Technical Advisory Board
  - Providing independent review of geotechnical and seismological investigations and analysis.
- Black & Veatch
  - COL Application contractor
  - Providing overall technical direction and engineering for hydrogeology and geotechnical investigations
  - Coordination and management of field investigation activities.
  - Providing QA oversight for field investigation activities as well as managing interface with site owner.
- Black & Veatch Subcontractors
  - Geomatrix Consultants - Providing analysis support for geological and seismological investigations.
  - Professional Service Industries - Drilling, in-situ testing, well installation, laboratory testing, & geophysical testing.

Project Organization -Responsibilities

- Black & Veatch provides field management responsibilities for hydrogeological and geotechnical investigations
- Black & Veatch Site Coordinator provides supervision of the day-to-day field activities
- Black & Veatch Geotechnical Engineer (or Geologist) is assigned full-time to each drill rig for technical direction and oversight

Investigation Quality Assurance



Site Investigations Overview

Mark Petersen
Geotechnical Engineer
(Black & Veatch)

Investigation Objectives

Hydrogeology

- Confirm and demonstrate applicability of previously developed data.
- Refine the site and regional hydrogeologic characterization for COL application.
- Assess potential groundwater flow reversal and Unit 3 liquid effluent release path.

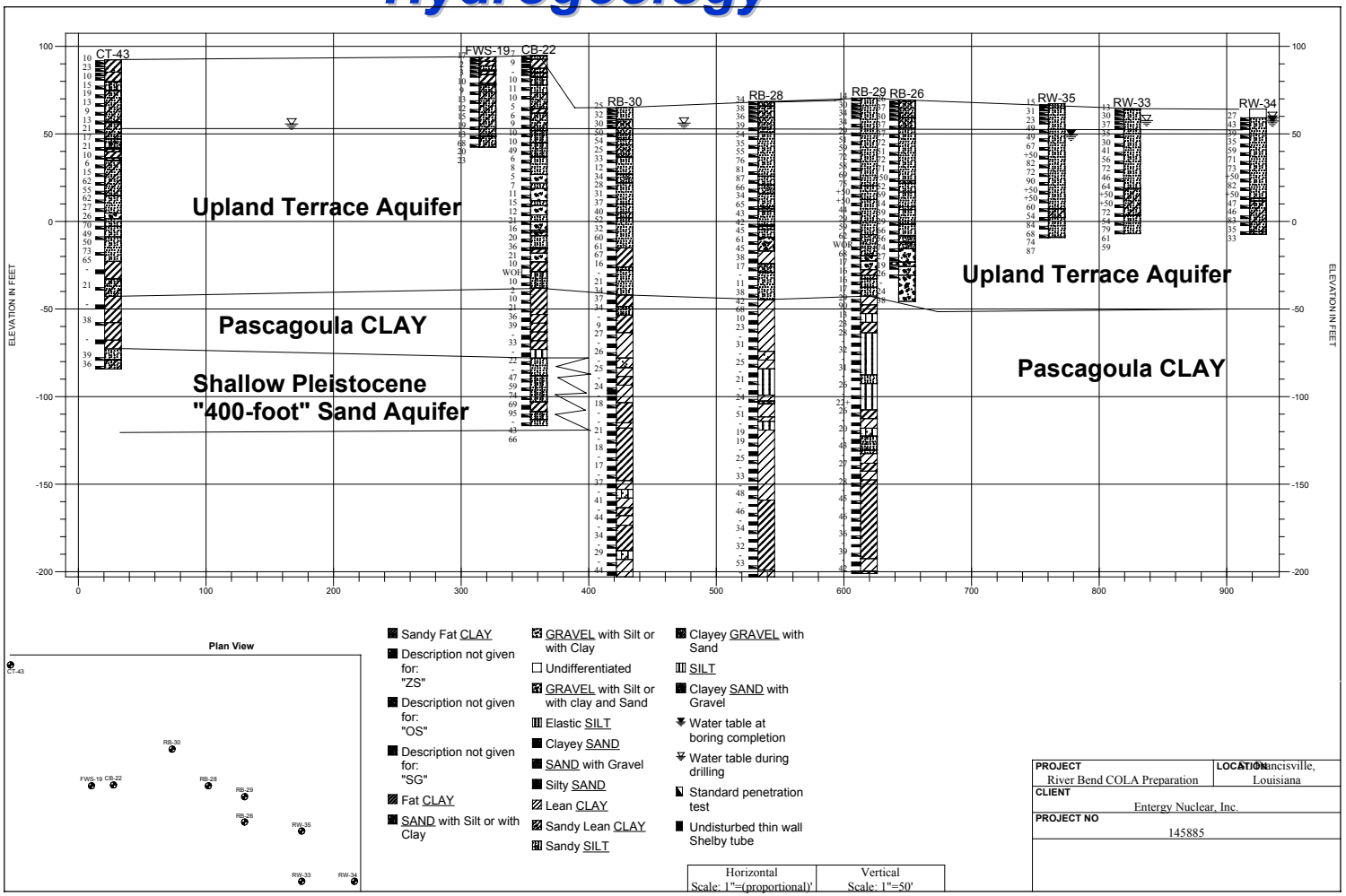
Investigation Scope

Hydrogeology

- Perform hydrogeologic exploration program to confirm and refine:
  - Characterize site aquifers
  - Measure monthly site ground water levels
  - Characterize site ground water flow
  - Test groundwater quality
- Determine hydrogeologic properties
- Evaluate potential for groundwater flow reversal
- Evaluate Unit 3 liquid effluent release path

Investigation Objectives

Hydrogeology



Investigation Objectives

Geotechnical

- Confirm and demonstrate applicability of field data from previous investigations
- Obtain data in areas supporting safety-related foundations to meet:
  - Regulatory Guide 1.132
  - Vendor DCD and Soil Structure Interaction requirements
- Collect new data on certain non-safety related foundation areas
- Obtain additional site groundwater characterization for dewatering evaluation

Investigation Scope

- Perform geological, geotechnical, and geophysical exploration program to confirm and refine:
  - Site stratigraphy and groundwater conditions
  - Static and dynamic soil properties
  - Site geohazards and foundation conditions
- Evaluate variability of site conditions and soil parameters
- Evaluate site suitability with respect to regulatory guidance and reactor vendor DCD
- Establish properties of the soil column for input into a response analysis used to determine the site specific response spectra

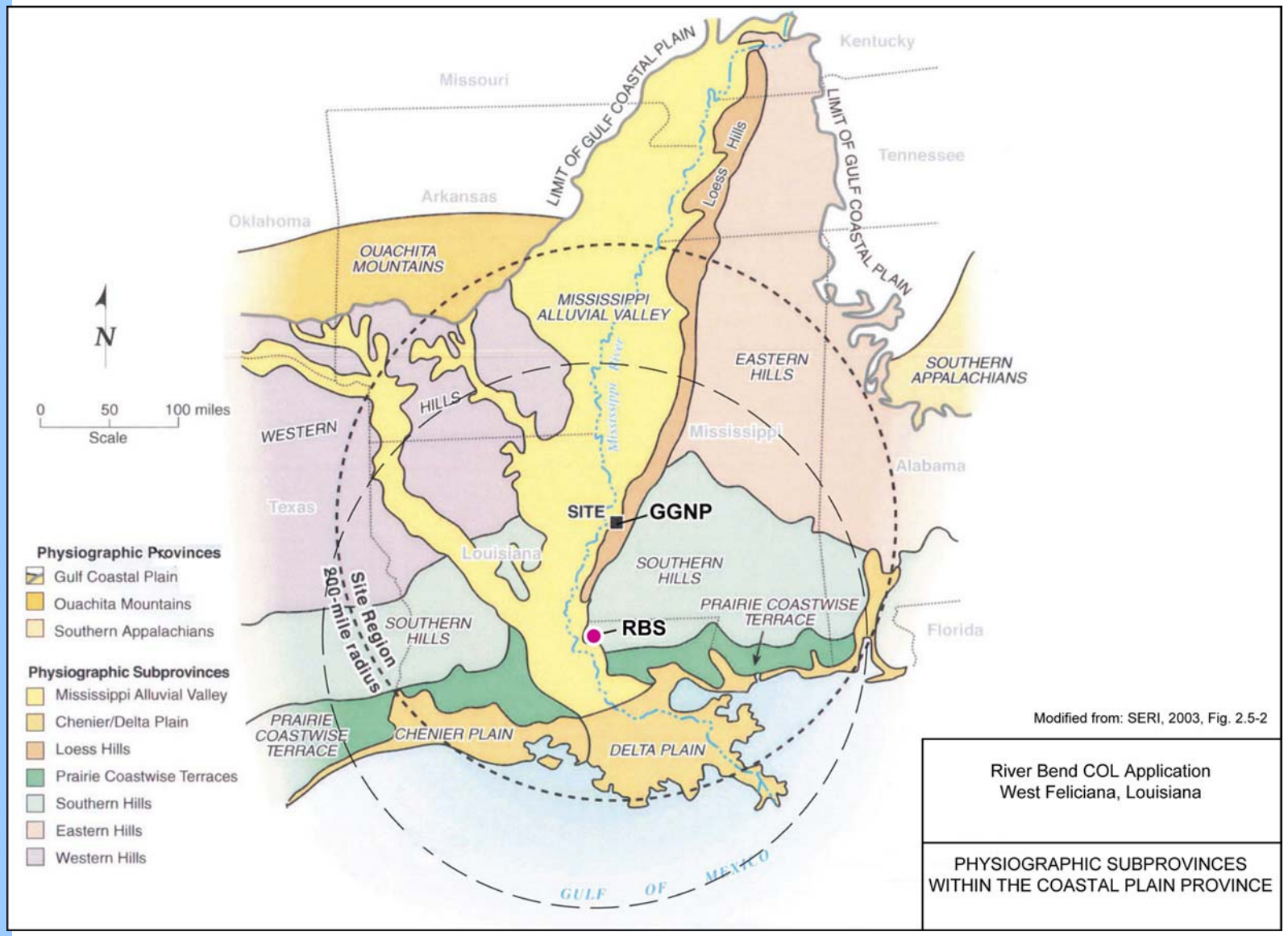
Site Investigations Overview

Kathryn Hanson
Principal Geologist
(Geomatrix Consultants)

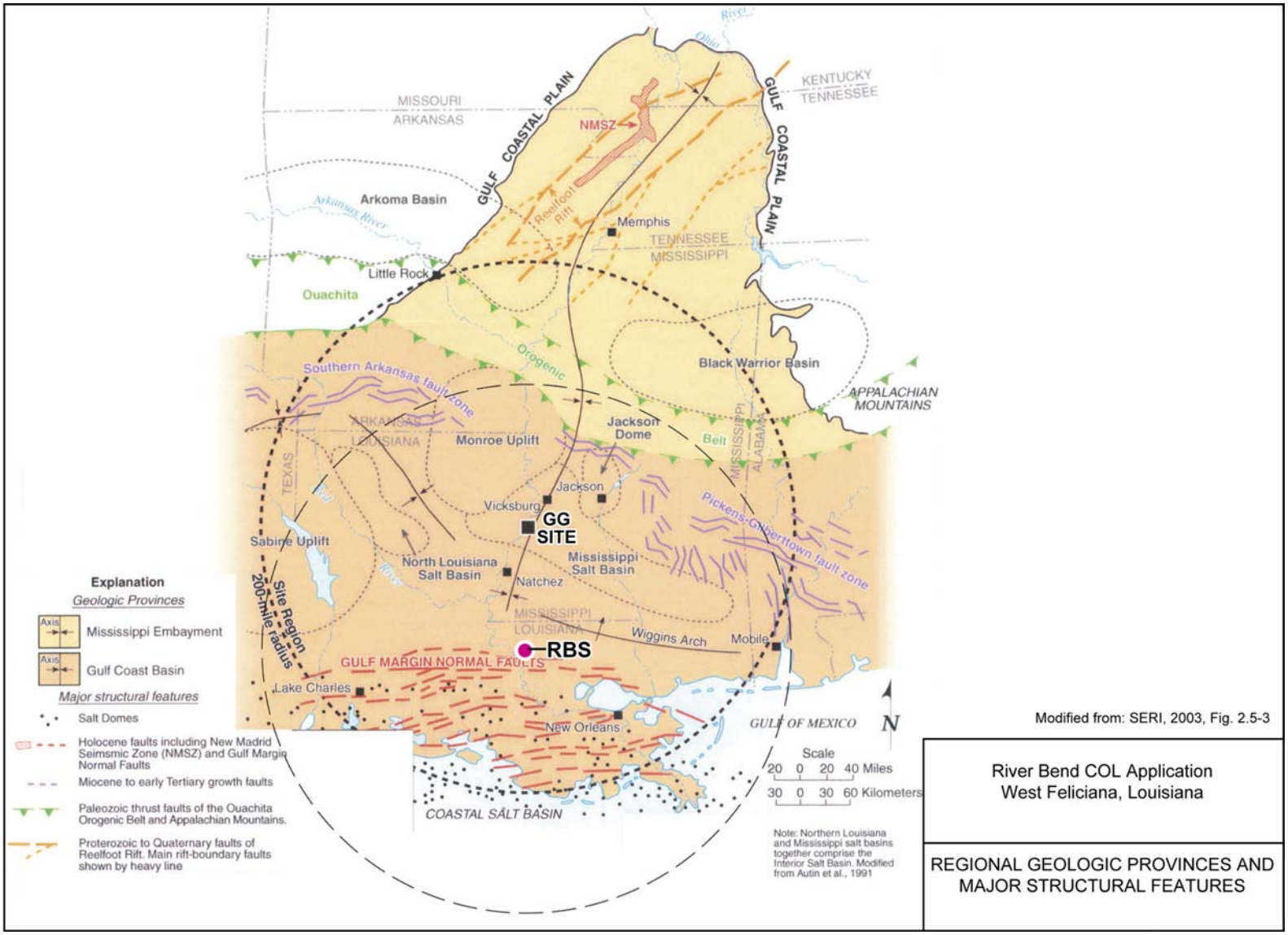
Seismic Investigations

- Compilation of New Data
- Potential for Surface Faulting
- Seismic Source Characterization/PSHA
  - Earthquake Catalog Updates
  - EPRI Source Updates
  - Ground Motion Models
- Site Response

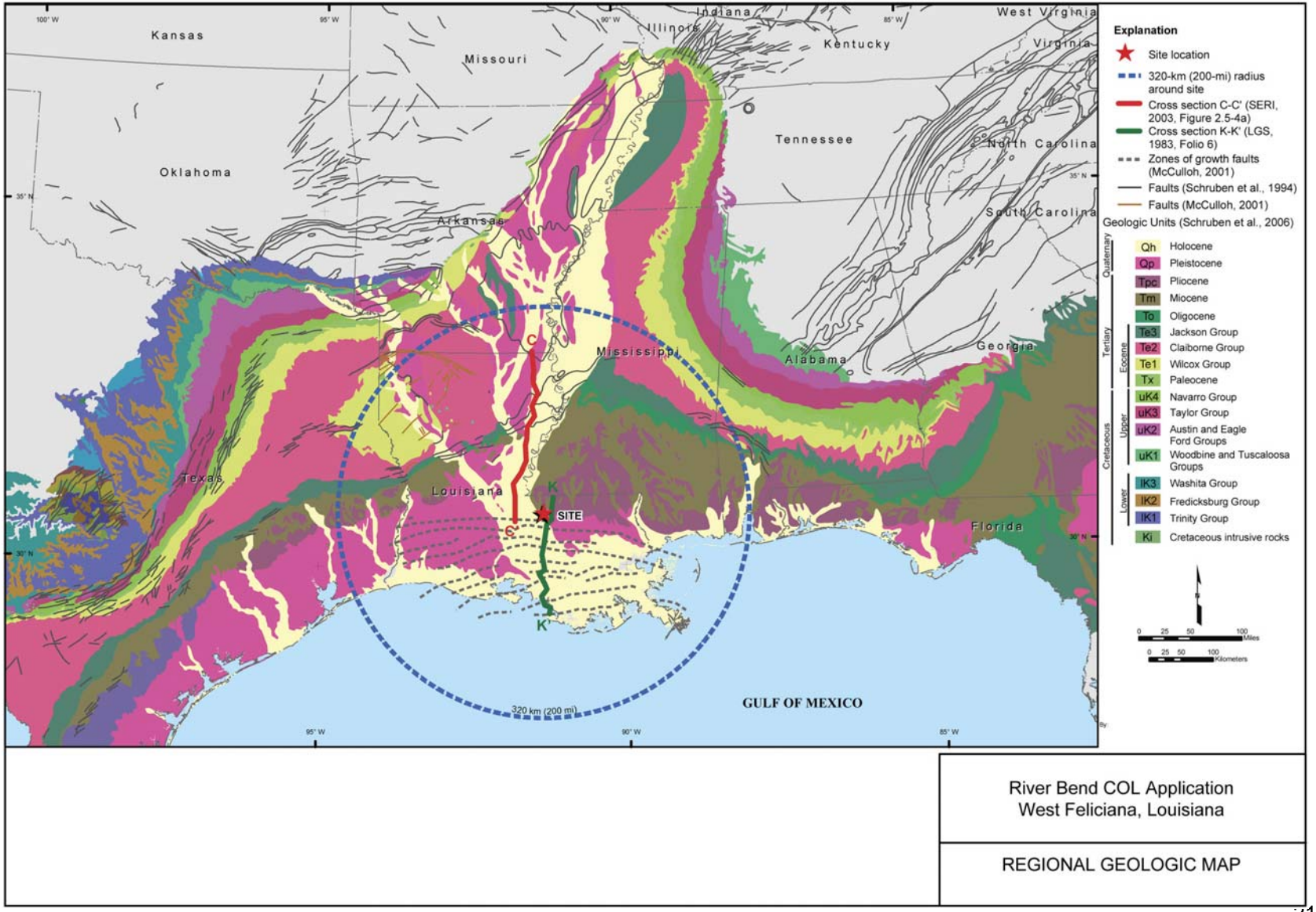
Regional Geology – Physiographic Provinces



Regional Geology – Structural



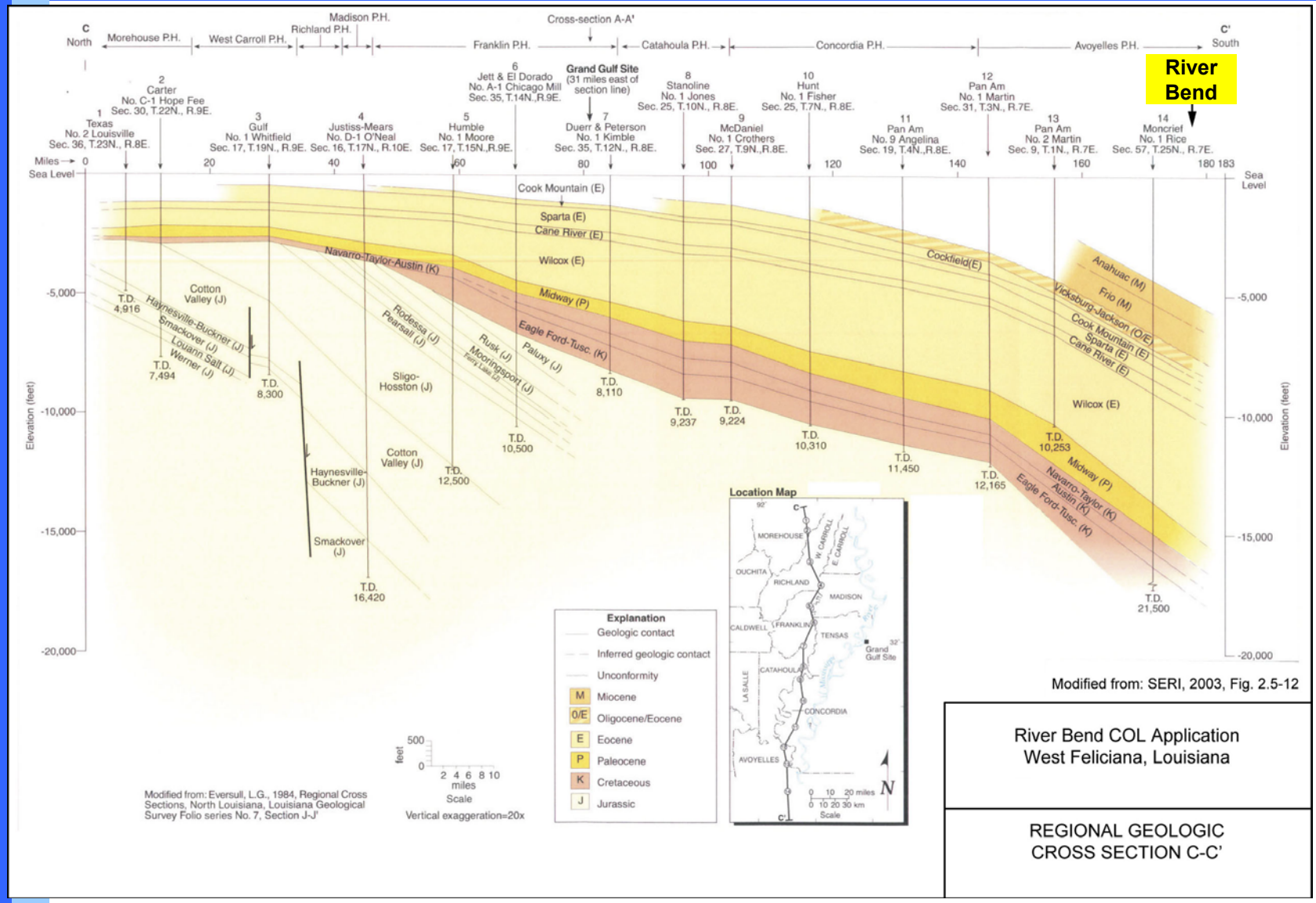
Regional Geology – Stratigraphy



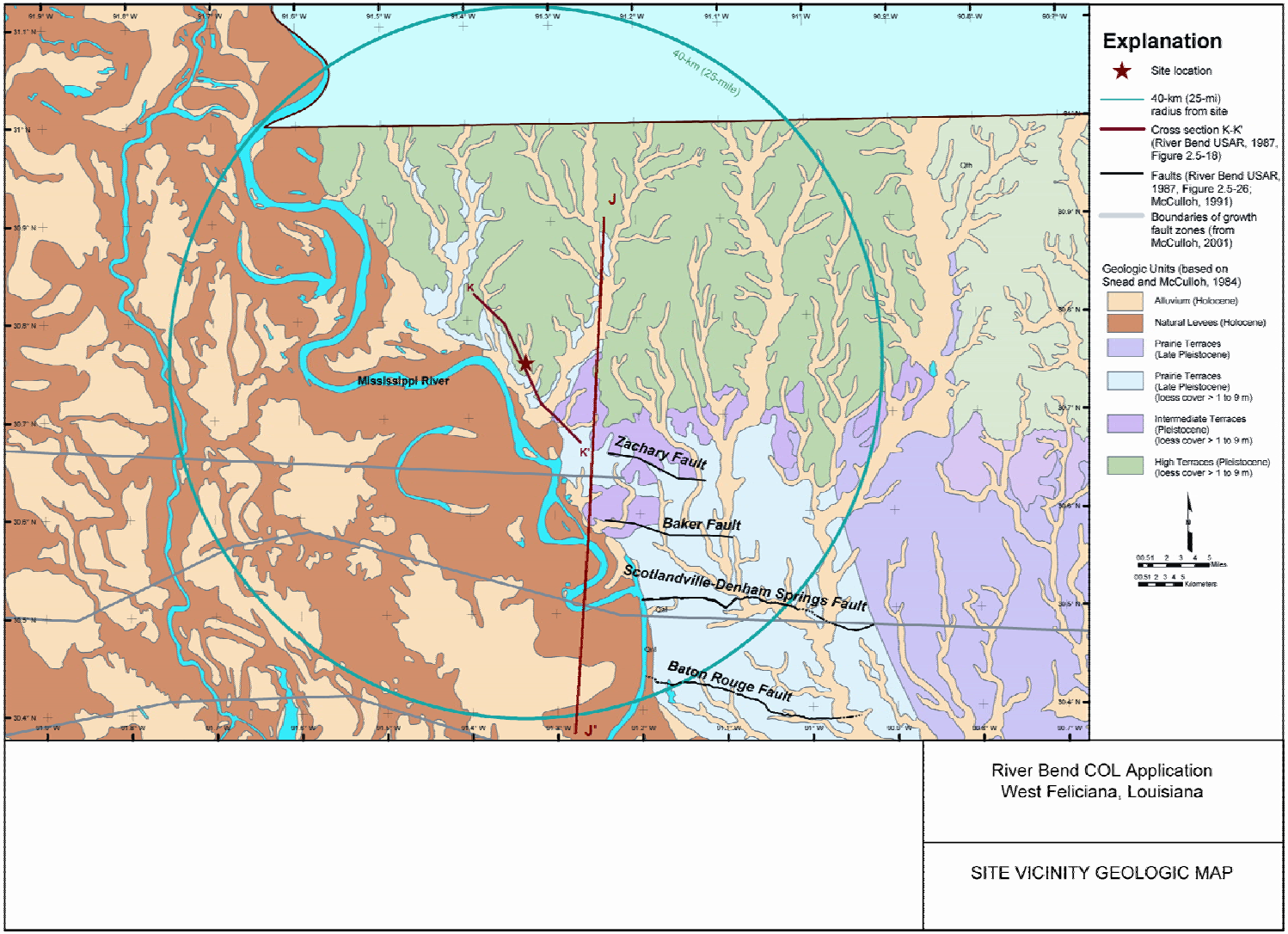
River Bend COL Application
West Feliciana, Louisiana

REGIONAL GEOLOGIC MAP

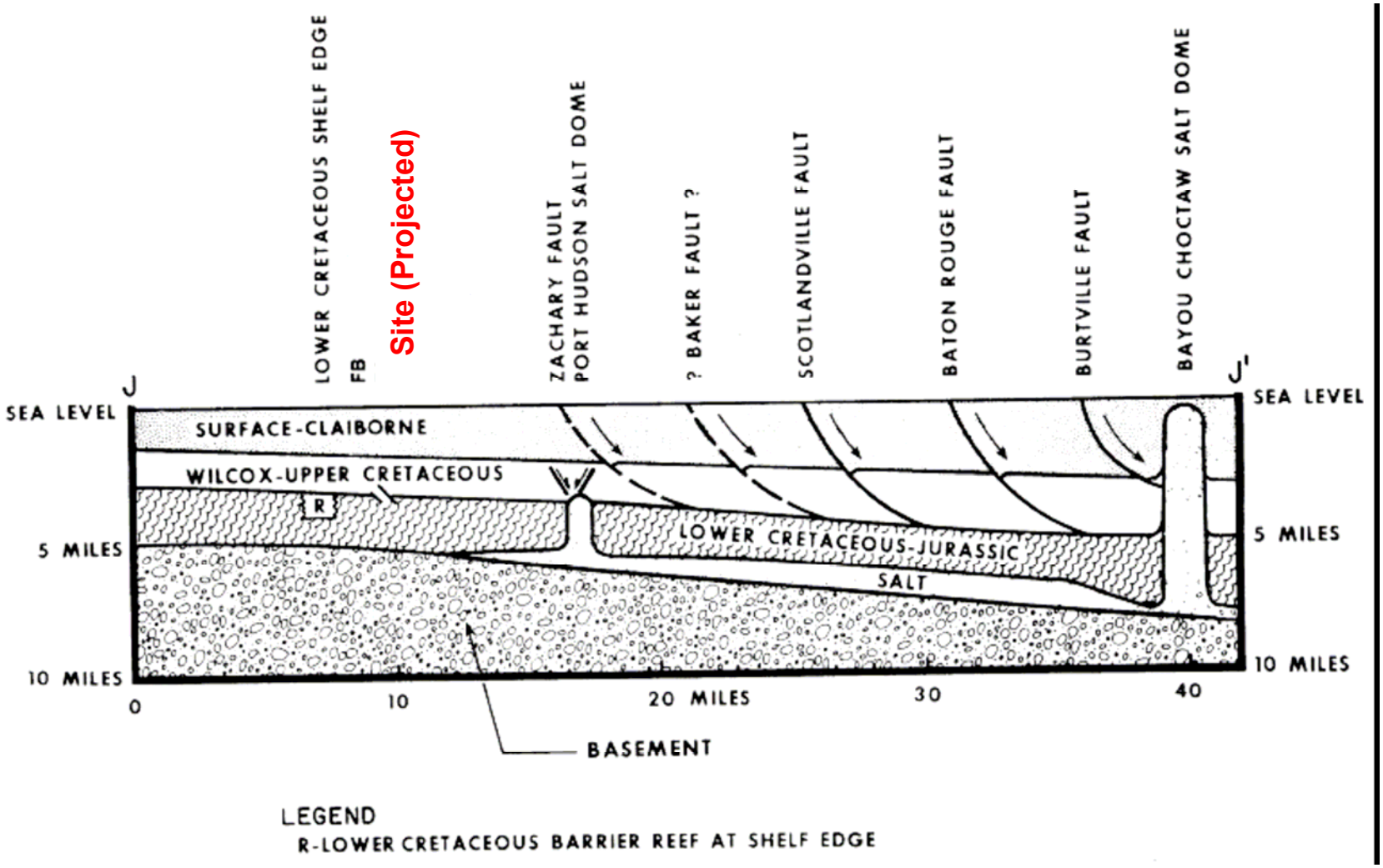
Regional Geology - Cross Section C-C'



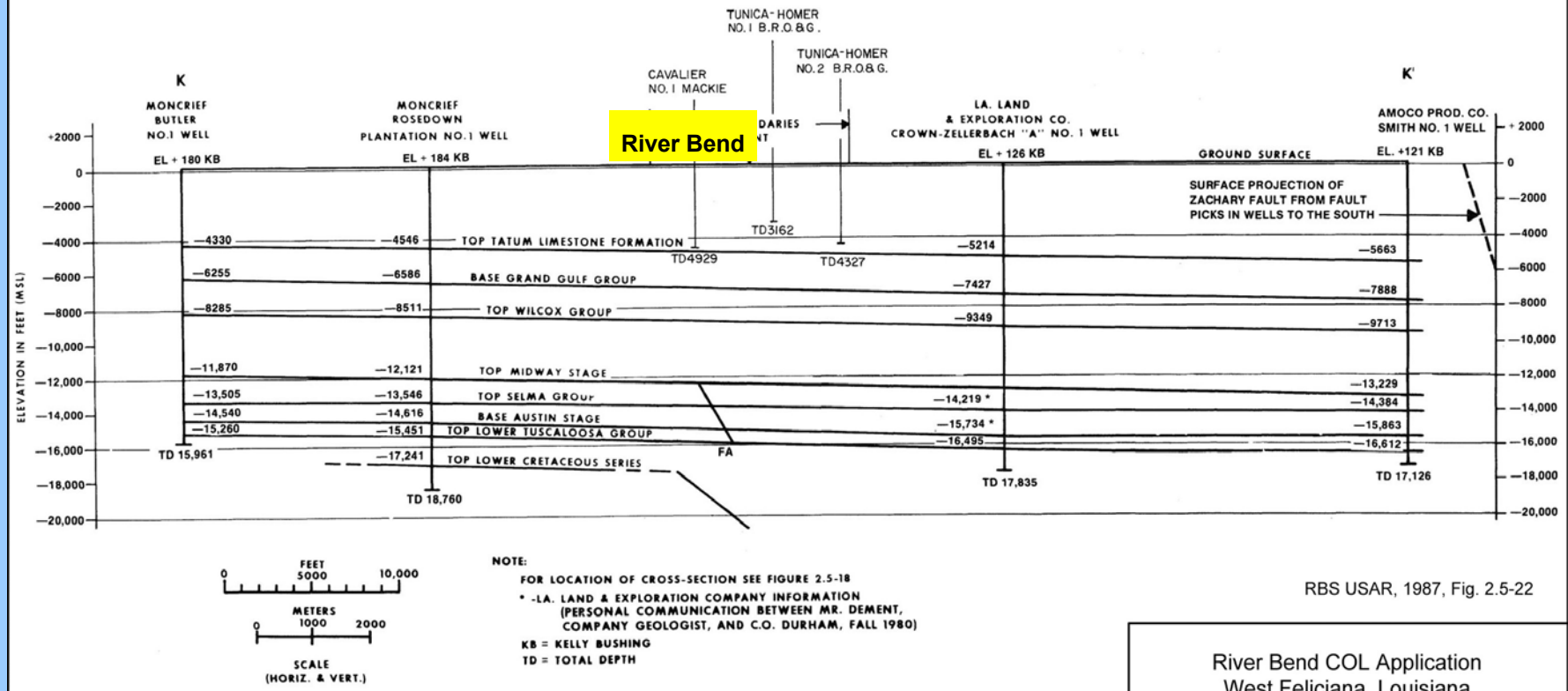
Site Vicinity - Geologic Map



Site Vicinity - Cross Section J-J'



Site Vicinity - Cross Section K-K'

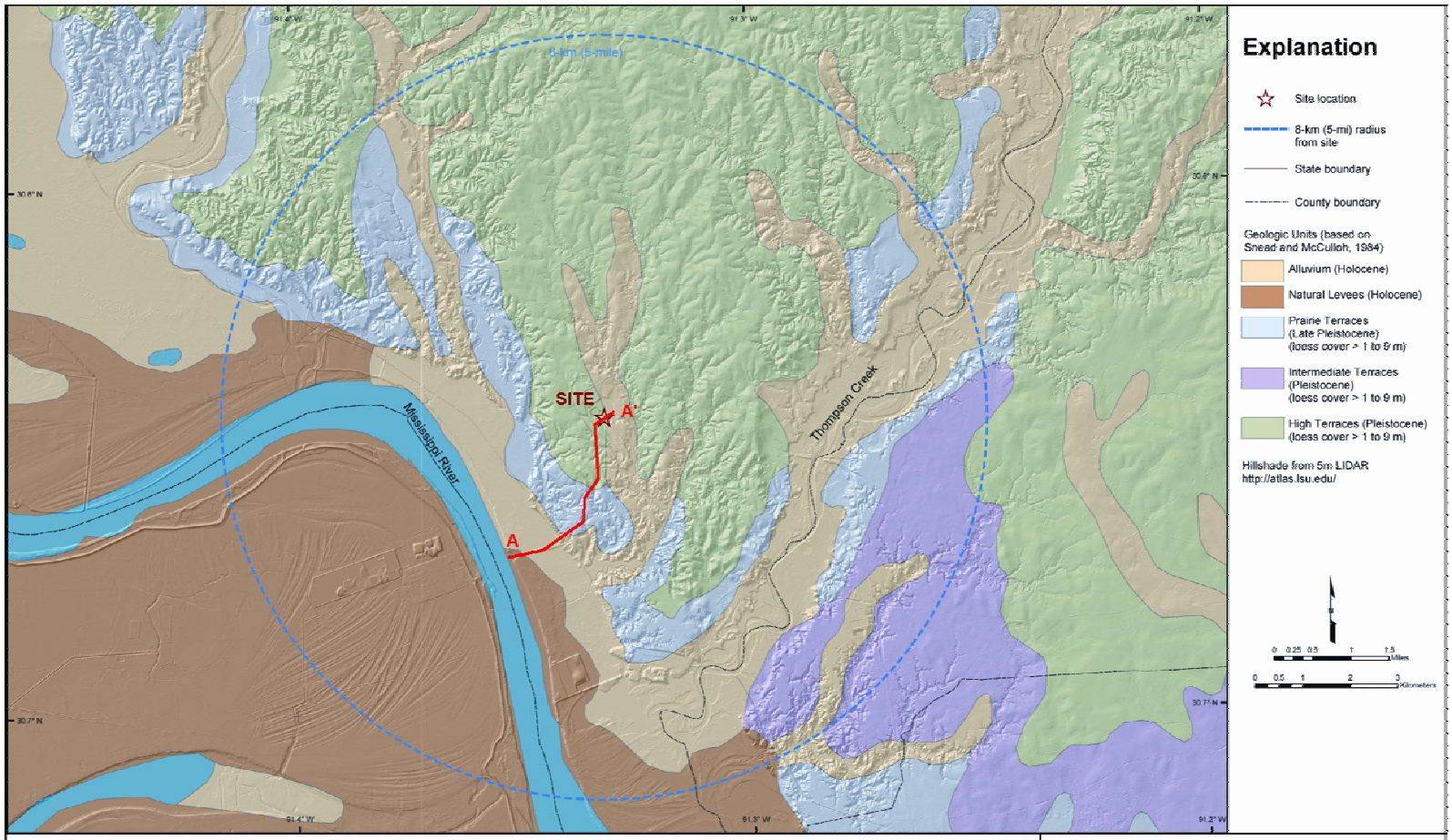


RBS USAR, 1987, Fig. 2.5-22

River Bend COL Application
West Feliciana, Louisiana

GEOLOGIC CROSS SECTION K-K'
(Site Vicinity)

Site Area - Geologic Map

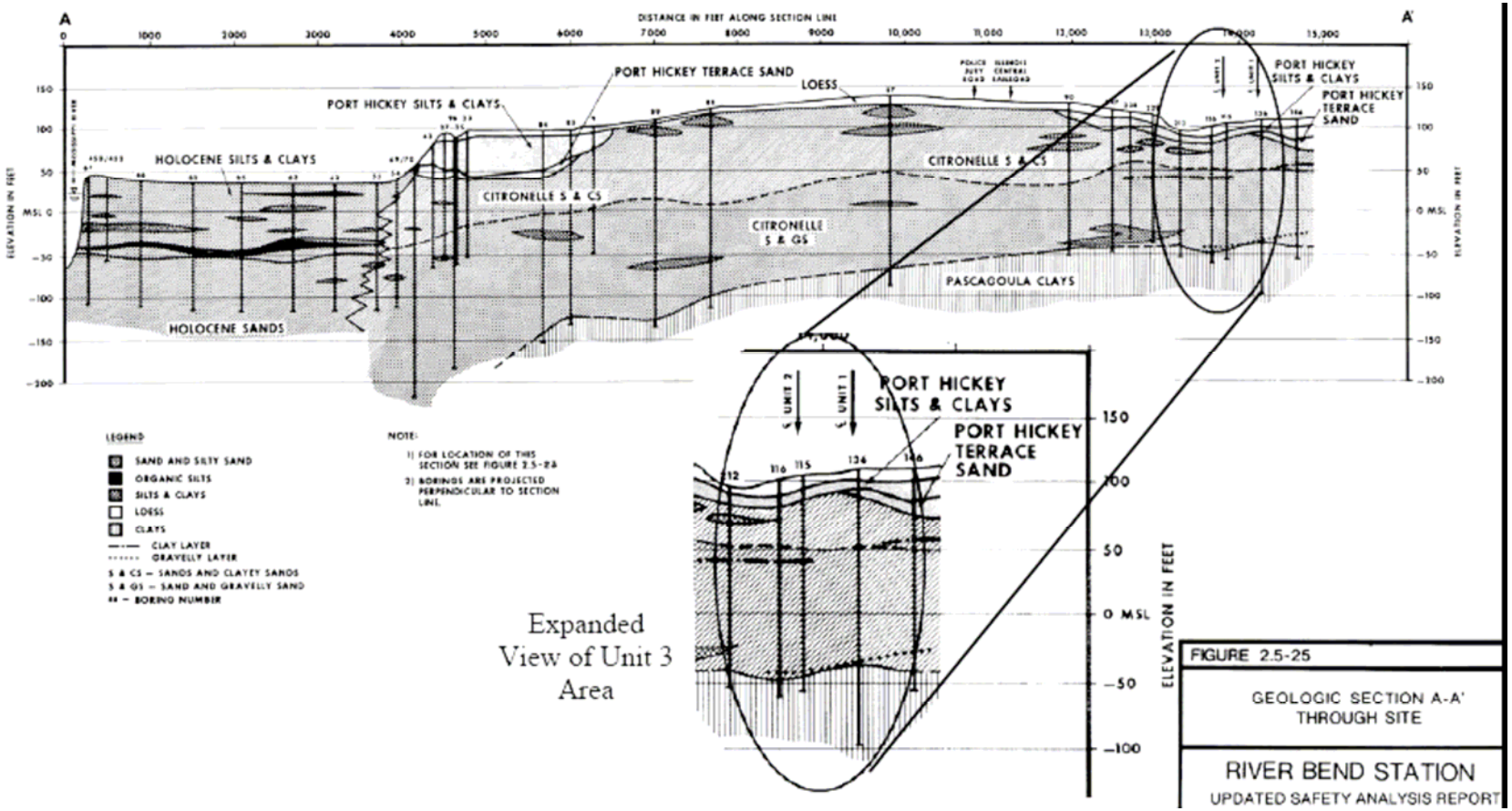


River Bend COL Application
West Feliciana, Louisiana

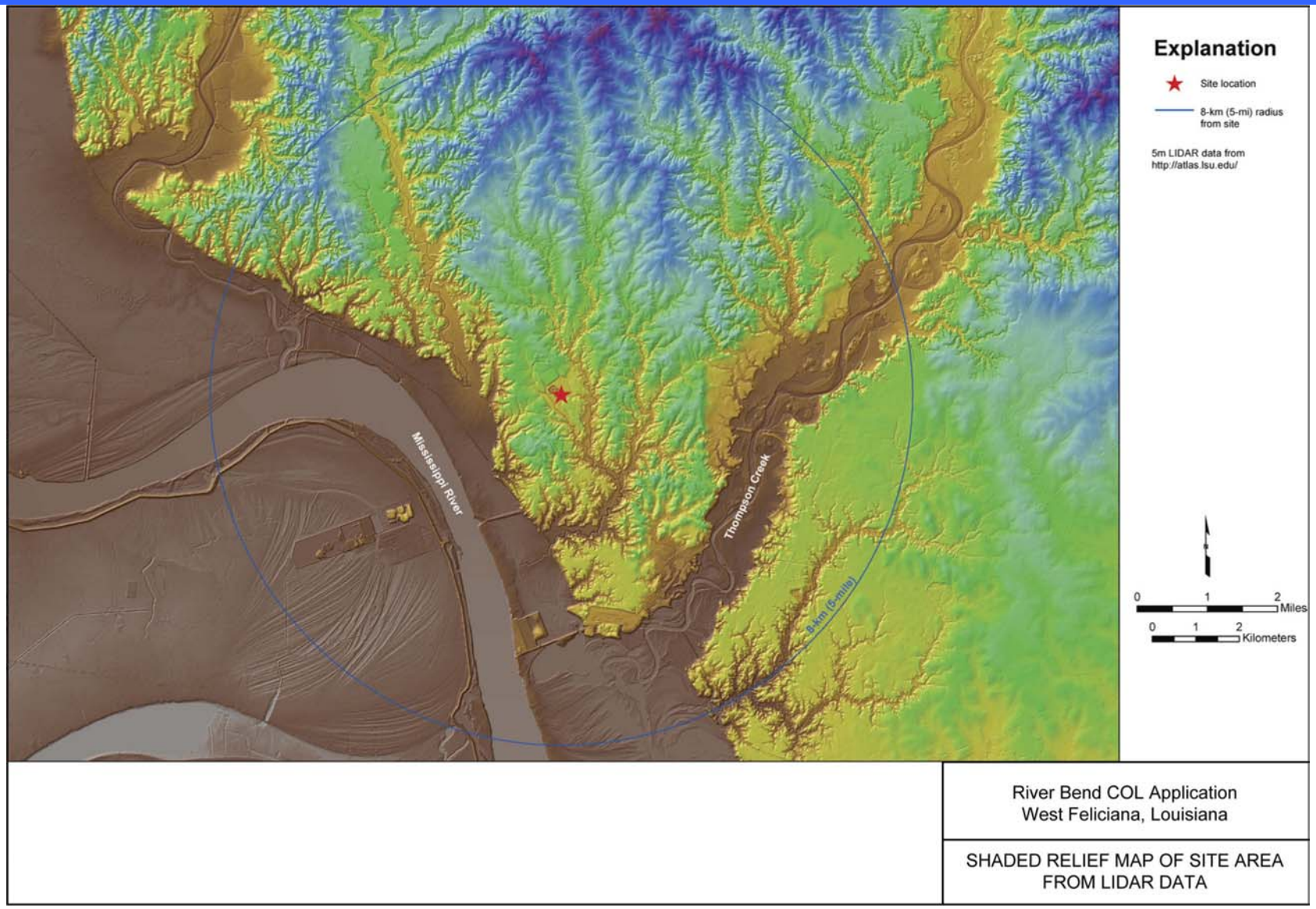
SITE AREA GEOLOGIC MAP

Site Area – Geologic Cross Section A-A'

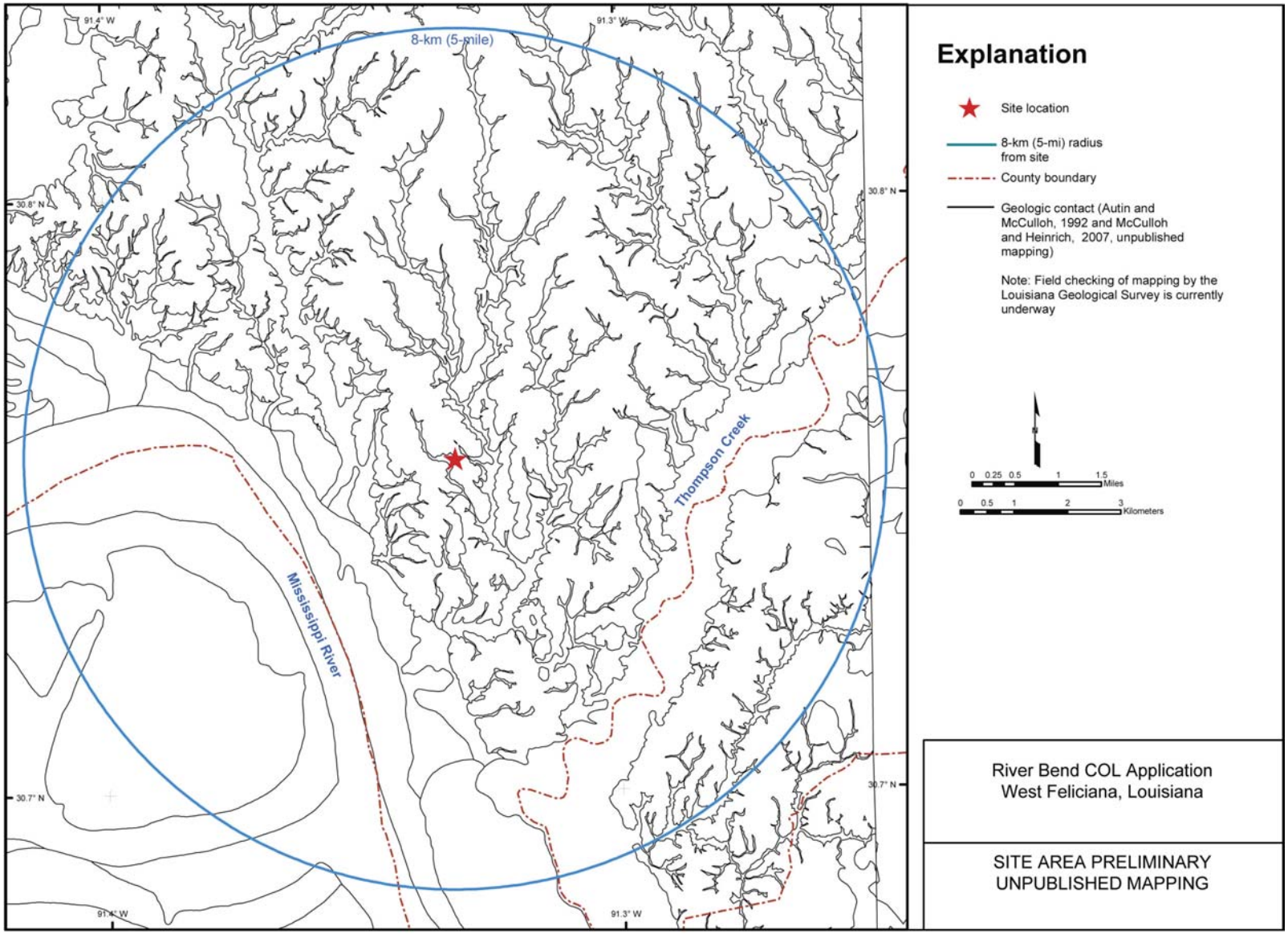
~6,000 feet minimum distance



Site Area - Shaded Relief Map from LiDAR



Site Area - Preliminary (Unpublished) Geologic Map



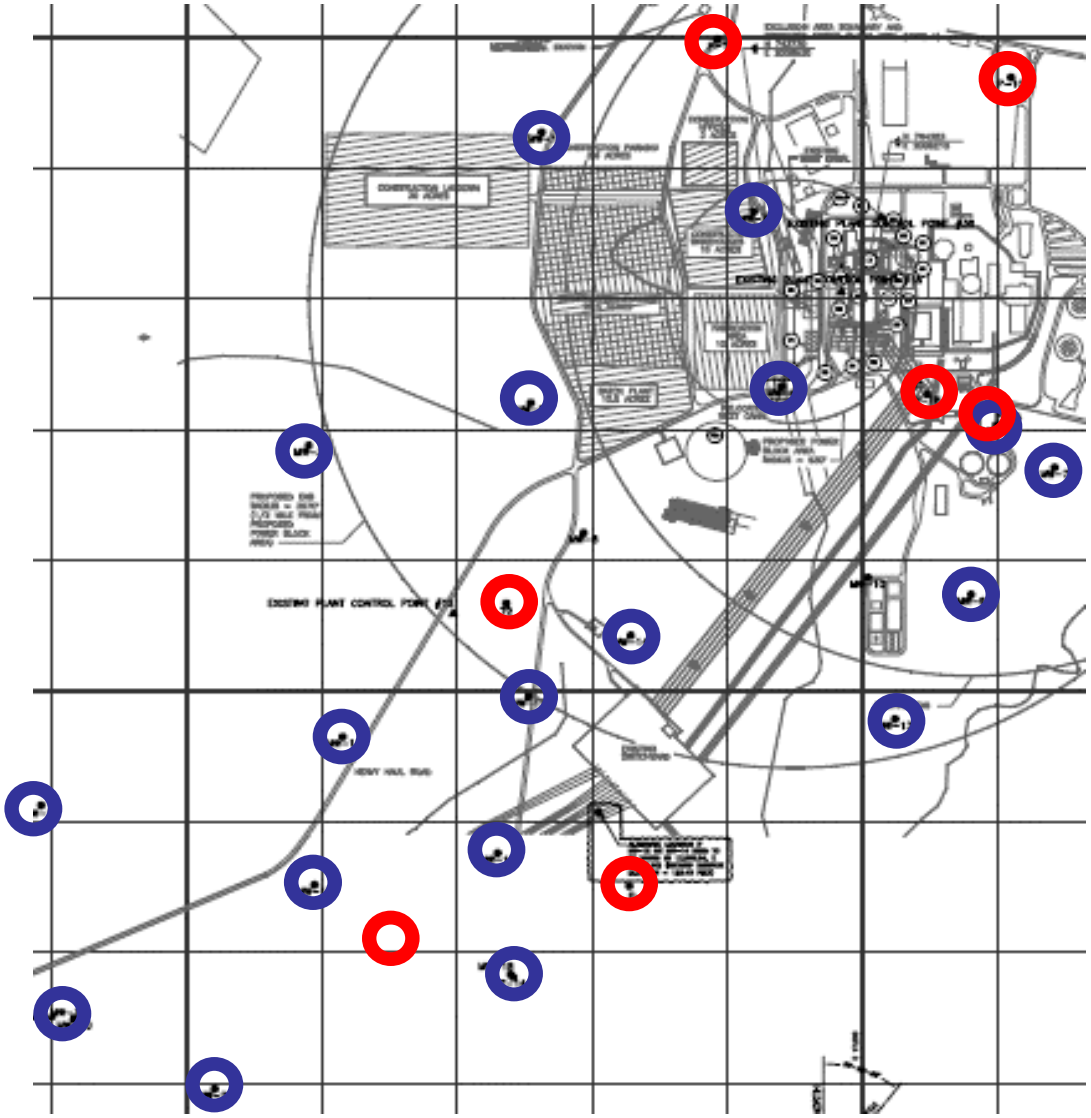
Surface Fault Investigations (RBS COLA study)

- Update literature search (geological and geophysical investigations 1987 to ongoing research)
  (e.g., McCulloh's ongoing LGS program to identify growth faults using LiDAR imagery)
- Interpretation of LiDAR imagery of site area
  (5-mile radius)(including topographic profiles)
- Field Reconnaissance Investigations
  (March and April, 2007)
- Verification of continuity of strata beneath the footprint of the COL site

Site Investigations Overview

Mark Petersen
Geotechnical Engineer
(Black & Veatch)

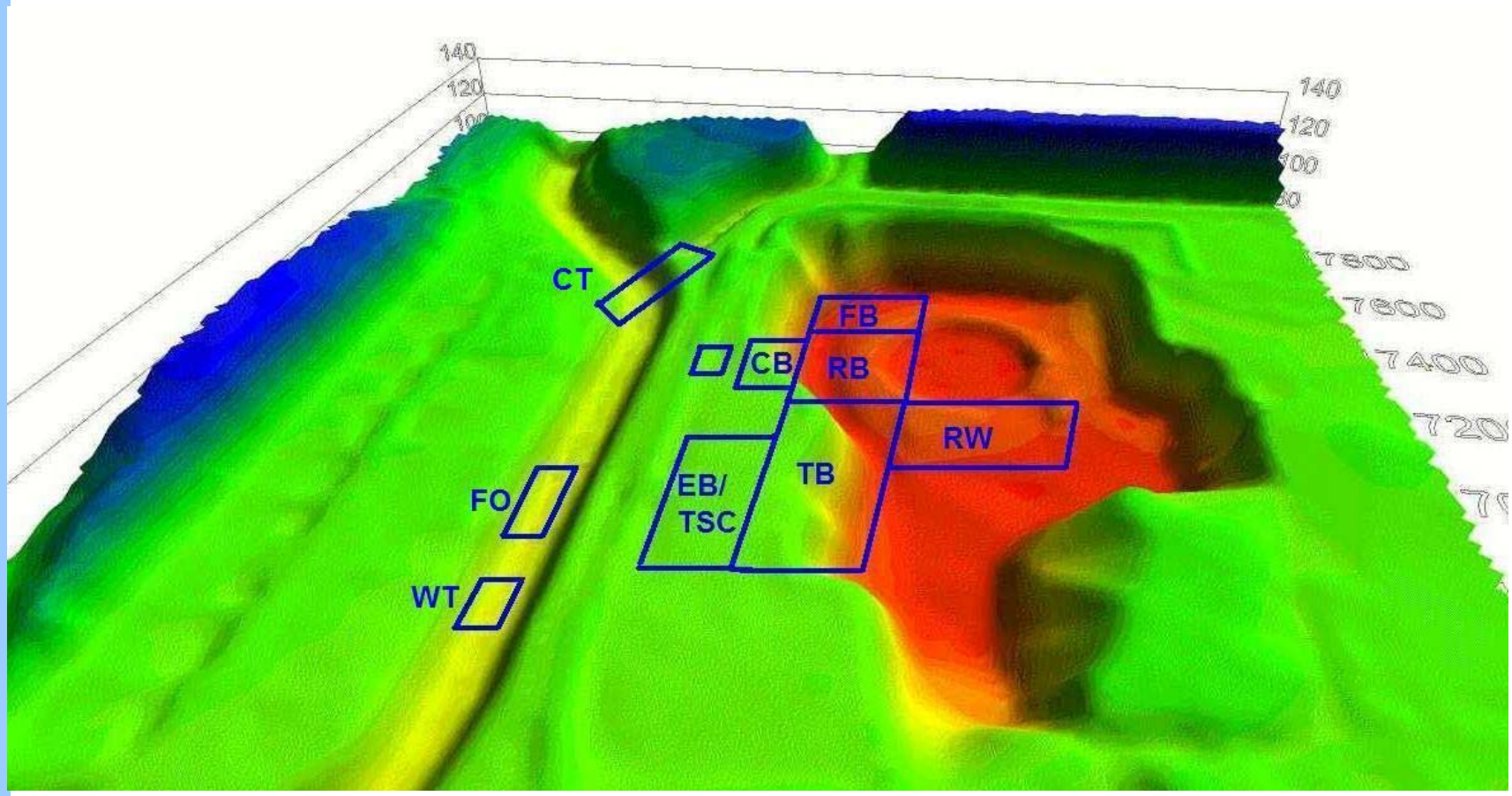
Hydrogeologic Investigation



- 21 New Monitoring Wells
- 7 Existing Monitoring Locations

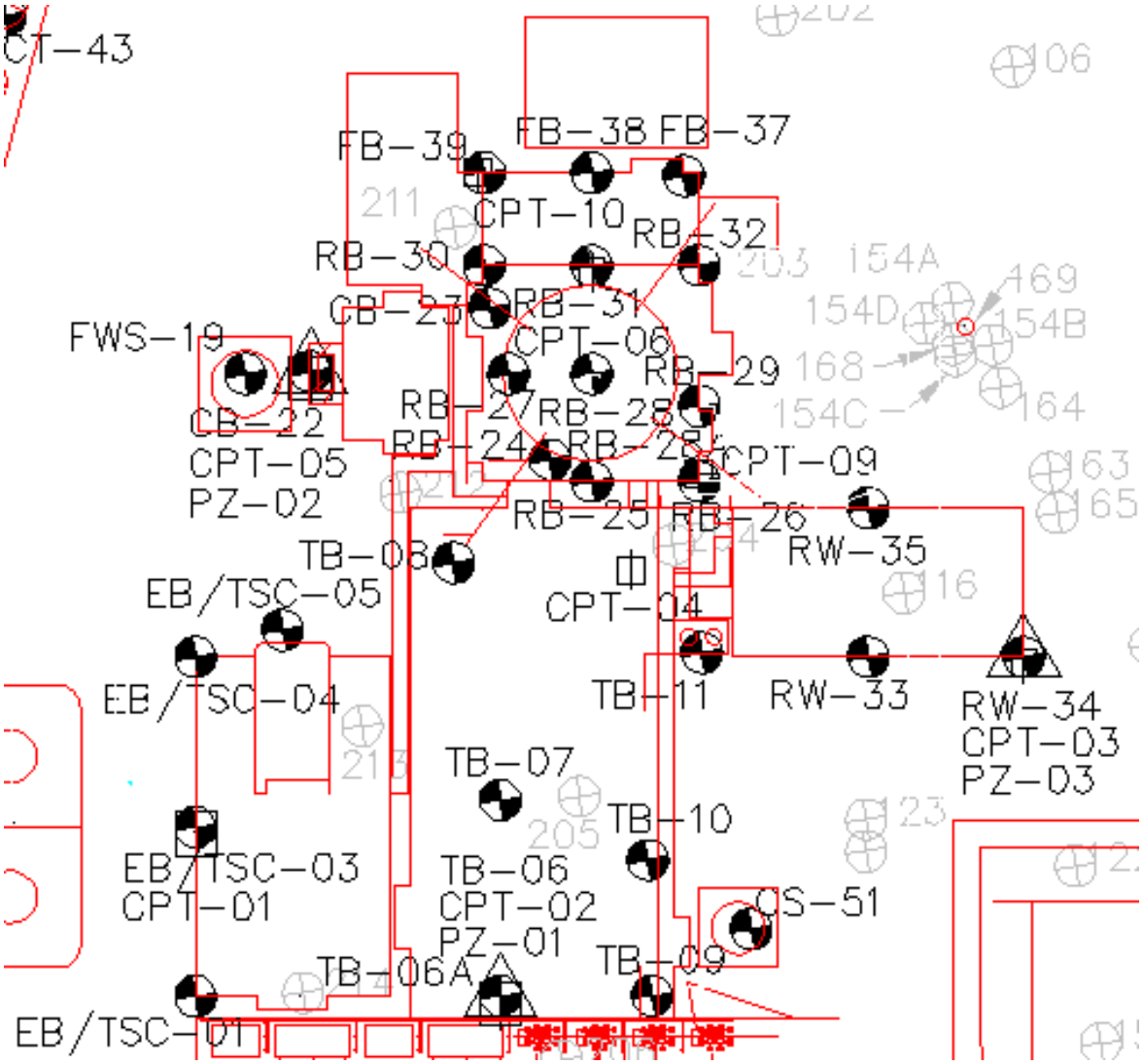
  (three additional piezometers installed as part of geotechnical Investigation)

ESBWR Layout



Note that this is an approximate layout for illustrative purpose only, existing structures not shown

ESBWR Specific Investigation

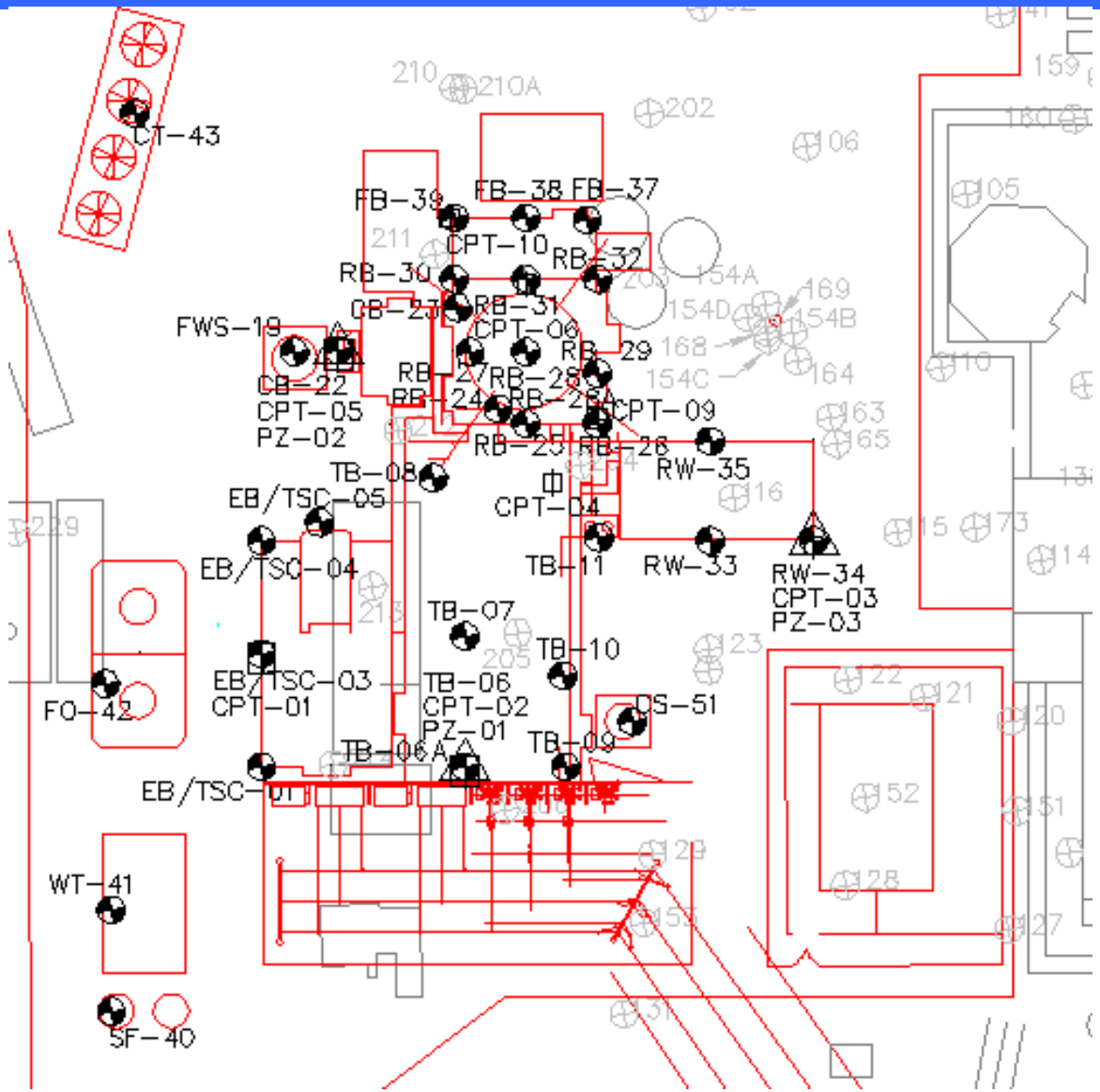


- **29 New borings**

  (35 to 430 feet deep)
- **~20 Existing Borings**
- **3 Piezometers**
- **8 CPTs**
- **2 Seismic Holes**

  (550 feet deep)

ESBWR – Adjacent Facilities



Field Exploration Methods

- Standard Penetration Testing (SPT)
- Cone Penetration Test (CPT) Soundings Including Seismic Velocity Profiling
- Borehole Pressuremeter
- Downhole Seismic Testing
- P-S Suspension Velocity Logging
- Groundwater Monitoring Wells
- Geologic Surface Mapping

Lab Testing Program

- Tests are assigned by Black & Veatch after reviewing boring location (site structure) and boring log
- Subcontractor (PSI) performs laboratory tests
- Testing includes:
  - Index/Classification
  - Strength/Deformation
  - Dynamic Testing

Index / Classification Testing

Laboratory Test	Determines Soil
• Atterberg Limits • Mechanical Sieve Analysis • Hydrometer • Percent Passing # 200 Sieve	Classification/Description
• Standard and Modified Proctor Test	Compaction characteristics
• Unit Weight and Moisture Content Determination	γ_d and γ_t – Dry and total unit weight
• Maximum and Minimum Index Density Test	e_{max} and e_{min} – Maximum & Minimum Void ratio
• Organic Carbon Test	Organic content
• Chemical Analysis	Oxidation-reduction potential, pH, sulfide content, water-soluble chloride ion content, and water-soluble sulfate content.

Strength / Deformation Testing

Laboratory Test	Determines Static Engineering Properties
• Consolidated-Undrained Triaxial Compression Test with Pore Water Pressure Measurements (CU) • Consolidated-Drained Direct Shear Test	Effective Stress Strength Parameters: 1. ϕ' – Internal angle of friction 2. c' – Cohesion intercept
• Unconsolidated-Undrained Triaxial Compression Test (UU) • Unconfined Compression Test (UC)	S_u - Undrained Shear Strength,
• CU • UU • UC	Stiffness: 1. E_s – Young's Modulus
• One-Dimensional Consolidation Test	Consolidation Parameters: 1. C_c Compression Index 2. C_r – recompression Index 3. c_v – Coefficient of vertical consolidation 4. OCR – Overconsolidation Ratio

Dynamic Testing

Laboratory Test	Determines Dynamic Engineering Properties
• Resonant Column Test	Stiffness and Damping at low strain levels: 1. Shear modulus (G) at low strain levels 2. Soil Damping (D) at low strain levels
• Cyclic Triaxial Test	Stiffness and Damping at higher strain levels: 1. Shear modulus (G) at higher strain levels 2. Soil Damping (D) at higher strain levels

Beginning of Day Activities

- B&V Site Coordinator conducts daily briefing with B&V Engineers/Geologist and Contractors at field office before leaving for assignment. Briefing includes:
  - Site Instructions
  - Safety briefing
  - Condition Reports (if any)
- B&V Engineer/Geologist inspects equipment, samplers, and notes on In-Situ Sampling Test Inspection form.
- Working area is checked for any unsafe conditions, issues addressed, drilling started.

Site Instruction Form

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ENERGY WATER INFORMATION GOVERNMENT

SITE INSTRUCTION NO. 307-007

Date: 7/16/07

To: Contractor's Site Representative

From: Awilda Blanco (Black & Veatch Corporation)

Copies to:
John Caldwell (Black & Veatch Corporation) Fax No.
Mike Lavelle (PSI) Fax No.
Mark Petersen B&V

Instructions:

1) Meet with Black & Veatch Construction PFM and Field Engineer/Geologist prior to drilling for work safety related and drilling instructions.
2) Measure and provide all lengths/dimensions of rods, samplers, and bits used to the Field Engineer/Geologist.
3) Periodic cleanout depth checks will be performed when requested by the Field Engineer/Geologist (refer to the Geotechnical Work Plan for procedure).
4) Measure fluid level at the start of each workday for borings in progress, at the completion of drilling, and when the fluid levels have stabilized.
5) Typical sampling intervals for Boring CS-47 is provided below and they are subjected to change as instructed by the Field Engineer/Geologist on site while drilling:

Interval	Depth range (ft)
2.5'	0-10'
5'	10'-175'

6) Sampling methods will be determined by the Field Engineer/Geologist on site while drilling.
7) Mark three 6-inch increments (1.5-ft) on rod for sampling in sands, silts and clays and fifteen 0.1-foot increments (1.5-ft) on rod if gravelly alluvium is expected.
8) Make sure that catcher is properly installed and in good working conditions.
9) Clean the SPT sampler after each use.
10) Borehole deviation survey will be performed after drilling completed if the borehole depth exceeds 100-ft.

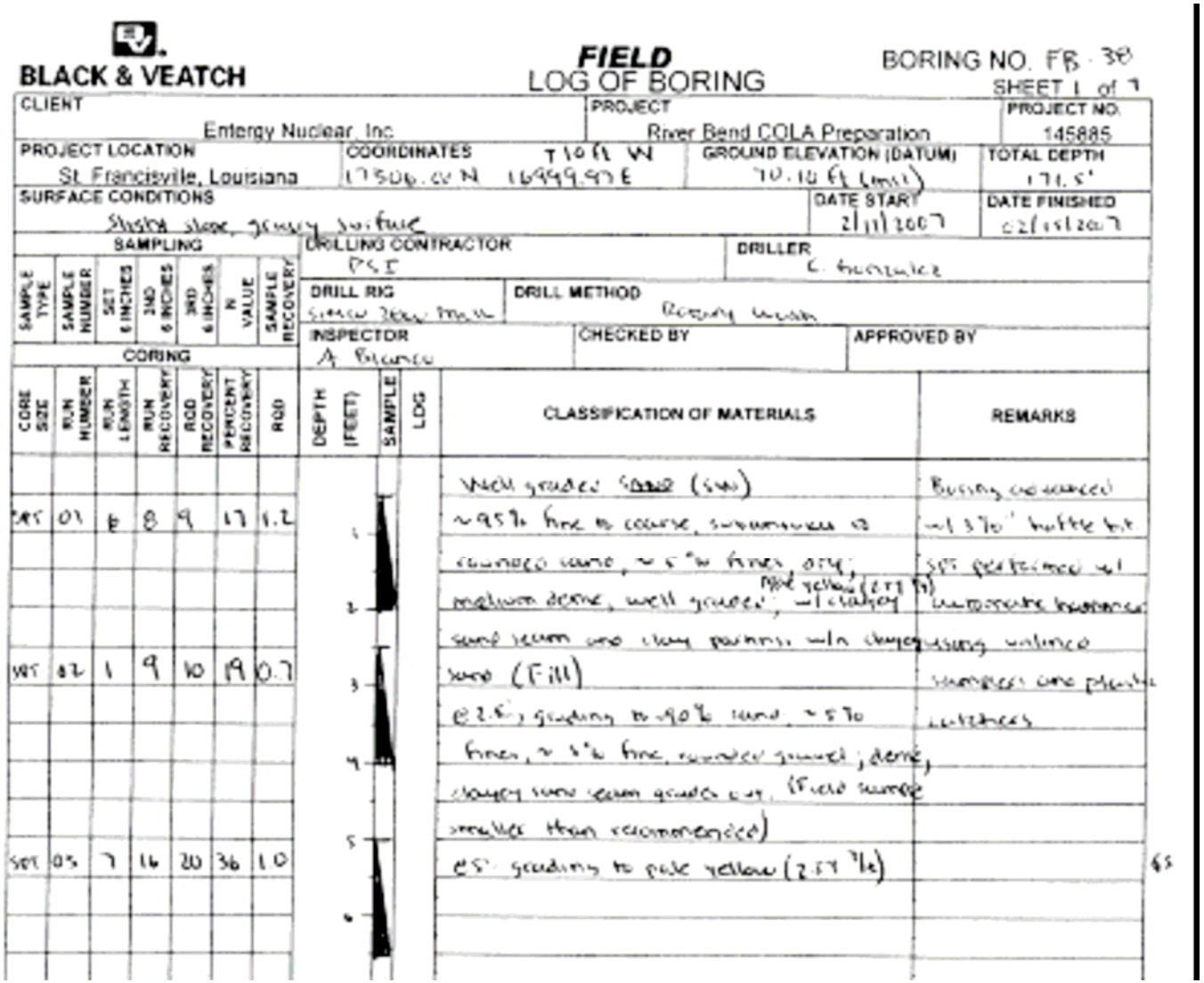
Borehole Procedure Overview

- Daily Site Instructions for each borehole prepared by B&V Field Engineer/Geologist and presented to drilling crew. Per DCP, site instructions specify:
  - Boring depth
  - Sampling intervals & instructions
  - Boring Specific Testing
  - Well installation (if required)

Borehole Procedure Overview

- B&V Engineers/Geologists assigned to each rig perform the following:
  - Ensure drilling or testing operations are conducted in conformance with specification and site instructions.
  - Maintain field logs of borings, including classification of materials recovered and description of geotechnical soil properties (ASTM 2488). Boring logs prepared in triplicate.
  - Photograph each sample obtained.
  - Complete boring inspection and in-situ sampling test inspection forms.
  - Complete any additional testing or well installation per site instruction.
  - Oversee grouting of the borehole when completed.

Field Boring Log



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FIELD LOG OF BORING

BORING NO. FB-38
SHEET 1 of 7

CLIENT	PROJECT	PROJECT NO.
Entergy Nuclear, Inc	River Bend COLA Preparation	145885

PROJECT LOCATION	COORDINATES	GROUND ELEVATION (DATUM)	TOTAL DEPTH
St. Francisville, Louisiana	T10 ft W 17506.00 N 16999.97 E	70.10 ft (msl)	171.5'

SURFACE CONDITIONS	DATE START	DATE FINISHED
Shrubs, steep, grassy surface	2/11/2007	2/15/2007

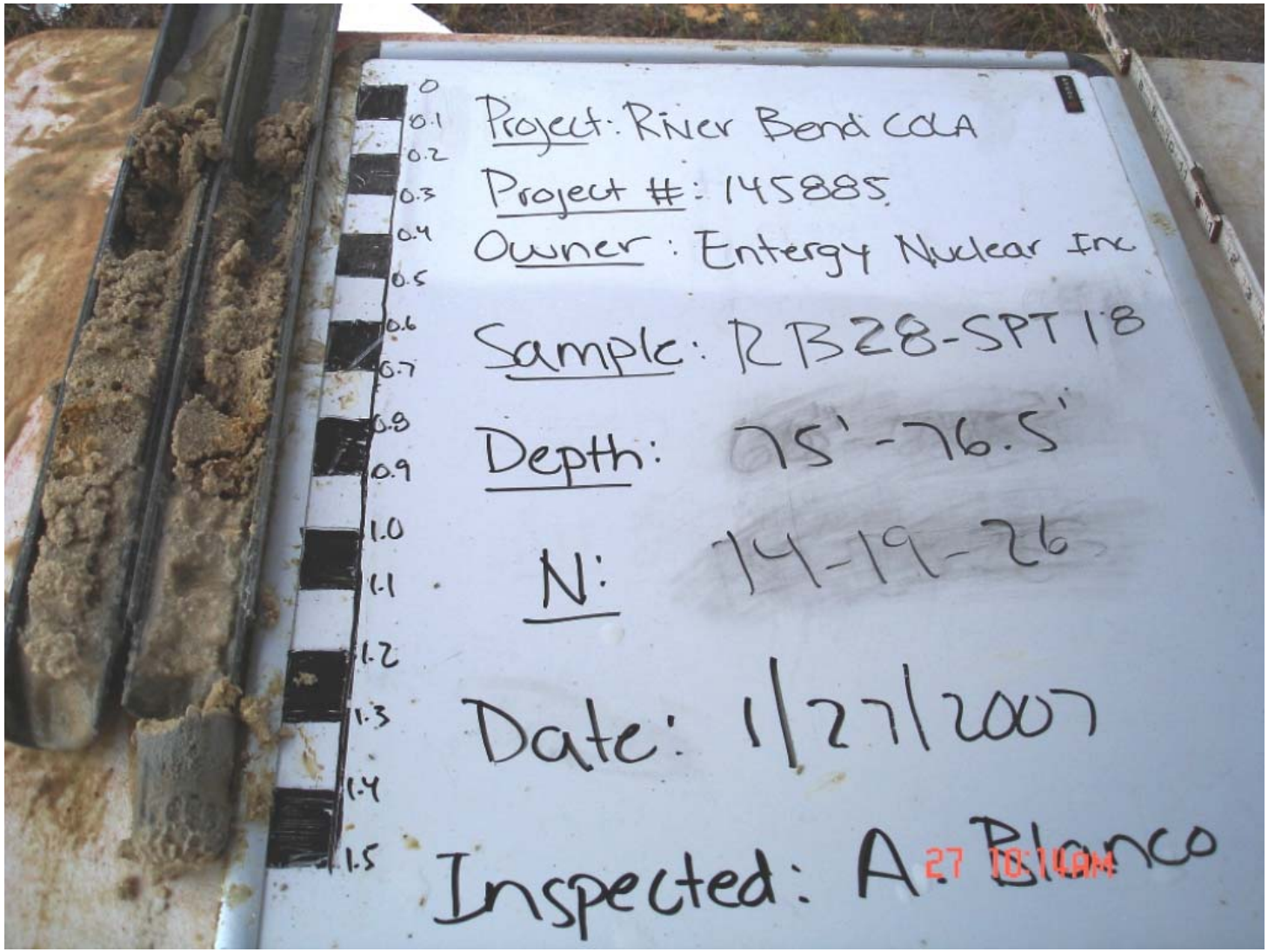
DRILLING CONTRACTOR	DRILLER
PSI	C. Hunsucker

DRILL RIG	DRILL METHOD
Simco 2800 Mobile	Rotary Wash

INSPECTOR	CHECKED BY	APPROVED BY
A. Bivens		

SAMPLING							CORING									
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	ROD RECOVERY	PERCENT RECOVERY	ROD	DEPTH (FEET)	SAMPLE	LOG	CLASSIFICATION OF MATERIALS	REMARKS
																	Much gravel, sand (SW)	Bussing encountered
SPT	01	6	8	9	17	1.2											~95% fine to coarse, subrounded to	~1.5" buffle bit
																	rounded sand, ~5% fines, dry;	SPT performed w/
																	medium dense, well graded, ~1 clayey	Intermittent hardness
																	sand seam and clay pockets w/in clayey	using variance
SPT	02	1	9	10	19	0.7											sand (Fill)	Sandstone and plastic
																	@2.5', grading to ~90% sand, ~5%	interbeds
																	fines, ~5% fine, rounded gravel; dense,	
																	clayey sand seam graded dry. (Field sample	
																	smaller than recommended)	
SPT	03	7	16	20	36	1.0											@5' grading to pale yellow (2.5Y 7/4)	65

Example Soil Sample Photo



End of Day Activities

- Return field records and all samples to the temporary site storage facility.
- B&V Engineer/Geologist completes Sample Identification/Traceability Record and place samples into temporary site storage facility.
- Partially completed field records are electronically sent to B&V Overland Park, Kansas office to assure data backup and begin QA process.
- The original field records are sent to B&V Overland Park, Kansas office; a duplicate copy of the field records remains in the site file.
- B&V Engineer/Geologist prepares daily field report and submits to B&V Site Coordinator.

Example Boring Inspection Form

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BORING INSPECTION FORM

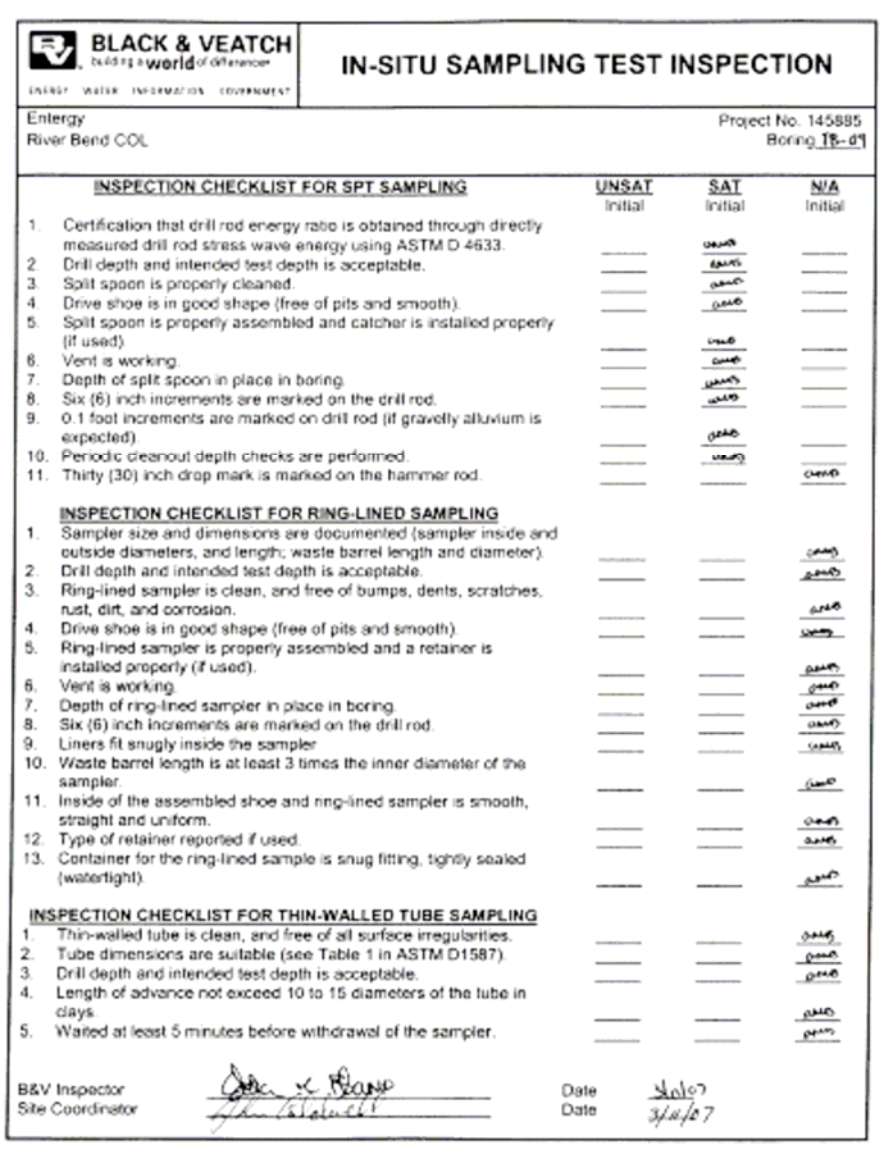
Entergy
River Bend COL

Project No. 145885
Boring RB-27

	UNSAT Initial	SAT Initial	N/A Initial
1. Excavation permit obtained.	____	DNB	____
2. Site instruction issued.	____	DNB	____
3. Coordinates and elevation of stake obtained.	____	DNB	____
4. Offset, if any, from stake noted with bearing and distance.	____	DNB	____
5. Plastic installed beneath rig.	____	DNB	____
6. Samples collected, logged, sealed, and labeled.	____	DNB	____
7. Minimum hole size achieved.	____	DNB	____
8. Sample identification/traceability forms completed for samples.	____	DNB	____
9. Boring log completed.	____	DNB	____
10. Borehole deviation survey performed (if greater than 100-ft deep).	____	DNB	____
11. Pressuremeter testing completed as per Geotechnical DCP.	____	____	DNB
12. Downhole seismic testing completed as per Geotechnical DCP.			DNB
13. Bag samples collected as per Geotechnical DCP.			DNB
14. Fluid level measurement as per Geotechnical DCP requirements.	____	DNB	____
15. Caving depth measurement as per Geotechnical DCP requirements.	____	CPT	____
16. Cuttings spread thinly over ground surface.	____	CPT	____
17. Grout mix meets specification requirements.	____	CPT	____
18. Grout tremied to appropriate level.	____	CPT	____
19. Grout placed in one operation.	____	CPT	____

B&V Inspector _____ Date 03/01/07
Site Coordinator _____ Date 3/4/07

Sampling Inspection Form



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IN-SITU SAMPLING TEST INSPECTION

Entergy
River Bend COL

Project No. 145885
Boring TB-01

INSPECTION CHECKLIST FOR SPT SAMPLING	UNSAT Initial	SAT Initial	N/A Initial
1. Certification that drill rod energy ratio is obtained through directly measured drill rod stress wave energy using ASTM D 4633.			
2. Drill depth and intended test depth is acceptable.			
3. Split spoon is properly cleaned.			
4. Drive shoe is in good shape (free of pits and smooth).			
5. Split spoon is properly assembled and catcher is installed properly (if used).			
6. Vent is working.			
7. Depth of split spoon in place in boring.			
8. Six (6) inch increments are marked on the drill rod.			
9. 0.1 foot increments are marked on drill rod (if gravelly alluvium is expected).			
10. Periodic cleanout depth checks are performed.			
11. Thirty (30) inch drop mark is marked on the hammer rod.			

INSPECTION CHECKLIST FOR RING-LINED SAMPLING			
1. Sampler size and dimensions are documented (sampler inside and outside diameters, and length; waste barrel length and diameter).			
2. Drill depth and intended test depth is acceptable.			
3. Ring-lined sampler is clean, and free of bumps, dents, scratches, rust, dirt, and corrosion.			
4. Drive shoe is in good shape (free of pits and smooth).			
5. Ring-lined sampler is properly assembled and a retainer is installed properly (if used).			
6. Vent is working.			
7. Depth of ring-lined sampler in place in boring.			
8. Six (6) inch increments are marked on the drill rod.			
9. Liners fit snugly inside the sampler.			
10. Waste barrel length is at least 3 times the inner diameter of the sampler.			
11. Inside of the assembled shoe and ring-lined sampler is smooth, straight and uniform.			
12. Type of retainer reported if used.			
13. Container for the ring-lined sample is snug fitting, tightly sealed (watertight).			

INSPECTION CHECKLIST FOR THIN-WALLED TUBE SAMPLING			
1. Thin-walled tube is clean, and free of all surface irregularities.			
2. Tube dimensions are suitable (see Table 1 in ASTM D1587).			
3. Drill depth and intended test depth is acceptable.			
4. Length of advance not exceed 10 to 15 diameters of the tube in clays.			
5. Waited at least 5 minutes before withdrawal of the sampler.			

B&V Inspector _____ Date 3/6/07
Site Coordinator _____ Date 3/6/07

Sample Identification Record

GEOTECH[illegible]AL SOIL
SAMPLE IDENTIFICATION / TRACEABILITY RECORD

Project: River Bend Station COL Application

Sample Location CT-43
Page 1 of 2

Instructions:

1. After entry to the field temporary storage, all transfers shall be noted and signed for in the form below.
2. The original white copy shall remain at the RBS site at all times.
3. When samples are initially transferred off the RBS site, the yellow copy of this record shall accompany the samples. When received by the offsite location, the yellow copy shall be returned to the site with appropriate signatures and a copy shall be retained at offsite location where the samples are stored. Subsequent transfers to other locations shall be completed in a similar manner using the copy of the yellow copy.
4. Any unacceptable condition of sample shall be noted in the sample comments.

Field ID#	Sample Date	Sample Type	Date of Transfer				(optional) Lab ID	Sample Comments
			To Temp. Storage	To Lab Facility	To Final Storage	Other		
CT43 SPT01	01/24/2007	Jar	01/24/2007					
CT43-SPT02	↓	↓	↓					
CT43 SPT03								
CT43 SPT04								
CT43 SPT05								
CT43 SPT06								
CT43 SPT07								
CT43-SPT08								
CT43-SPT09								
CT43 SPT10								
CT43 SPT11								
CT43 SPT12								
CT43 SPT13A								
CT43 SPT13B								
CT43 SPT13C								
CT43 SPT14A								
CT43 SPT14B	↓	↓	↓					

Field Sampler(s) (signature) [signature]

Date of Transfer	Relinquished by: (signature)	Transferred by: (signature)	Date	Received by: (signature)	Date	Comments

Laboratory Testing Procedures

- B&V Engineer reviews borings, assigns appropriate laboratory testing, and submits a laboratory test request to subcontractor.
- All soil samples are transported to laboratory for testing.
  - Samples are transferred using the sample identification / traceability record.
  - Copy of boring log is sent with samples.
  - Laboratory signs for receipt of samples.

Investigation Issues – Site Related

- Started with standard GE investigation plan
- Overlaid GE Plan on to surface encumbrances and underground utilities
- Adjusted boring locations for surface features
- Obtained GE concurrence with the revised boring locastions

Investigation Issues - Soil Related

- Gravel Content in Soil
  - Gravel encountered at shallow depths in excavation area, in small amounts in Upper Citronelle formation, and in the Lower Citronelle formation.
  - Almost all boreholes deeper than 35 ft affected.
  - SPT performed using ASTM D6066 including measuring blowcounts in 0.1 foot increments to check for gravel correction.
- Shallow CPT Probe Refusal
  - Due to gravel content and stiff soil conditions, CPTs could not penetrate the full depth; maximum depth of penetration was 133.2 feet.
  - Nearly all CPTs reached early refusal.
  - Two additional CPTs advanced to attempt to obtain supplemental information.
  - Amount of Seismic CPT information obtained for comparison with other Seismic testing results is limited to shallow depths (Less than 130 feet).
  - Two borings at locations for the reactor building and control building were continuously sampled.

Investigation Issues - Soil Related

- Variable stratigraphy
  - Clay soils encountered at shallow depths south-east (plant grid) of proposed plant location.
  - Monitoring wells drilled deeper than the proposed 90 feet in search of permeable material. If permeable material not encountered within 160 feet, borehole backfilled with bentonite to desired depth and shallower well installed.
- Borehole Instability
  - Sloughing material during drilling occurred at various depths during drilling in nearly all boreholes.
  - Clean-out depth checks per ASTM D6066 performed for SPT tests when gravelly conditions were encountered or anticipated.
  - Several sampling intervals required cleaning per ASTM D6066 to adequately prepare interval for sampling.

Investigation Issues - Soil Related

- Borehole Caving
  - Cave-in encountered at most boreholes inside excavation area and those close to the edge of the top of the existing slope.
  - Casing used in holes that could not be stabilized with thicker drilling mud.
  - Some piezometers overdrilled to place screens/riser pipe due to borehole caving.

Current Site Activities

- Borings
  - Deep Drilling on RB-31 and TB-10
  - Installing casing for seismic testing
- Geophysical Testing
  - Downhole seismic testing
  - P-S suspension logging
  - Full-waveform sonic logging
  - Natural gamma logging
- Monitoring Wells
  - Monthly Groundwater Level Measurements (started December 2006)
  - Groundwater Sampling

QUESTIONS?

Site Orientation

John Caldwell

Site Coordinator

(Black & Veatch)

Safety Requirements

- Vehicle Safety
  - Obey state and site laws
  - Always wear a seat belt in a moving vehicle
  - Remove keys from an unattended vehicle
- Barriers
  - Do not cross yellow barrier without permission of workers inside or supervisor listed on the information tag

Safety Requirements

- Slip and trip hazards
  - Uneven terrain
  - Soft sand
  - Vines and thorn bushes
  - Muddy conditions
- Wildlife
  - Insects (Fire Ants & Wasps)
  - Snakes

Safety Requirements

- Peer checking
  - Take a safety minute to check your co-workers to assure PPE compliance
  - Use questioning attitude when in doubt of a situation
- Emergency preparedness
  - If alarms sound, listen for instructions and proceed to the assembly area (training center by highway 61)
  - In the event of a injury or fire notify the Control Room at 2911