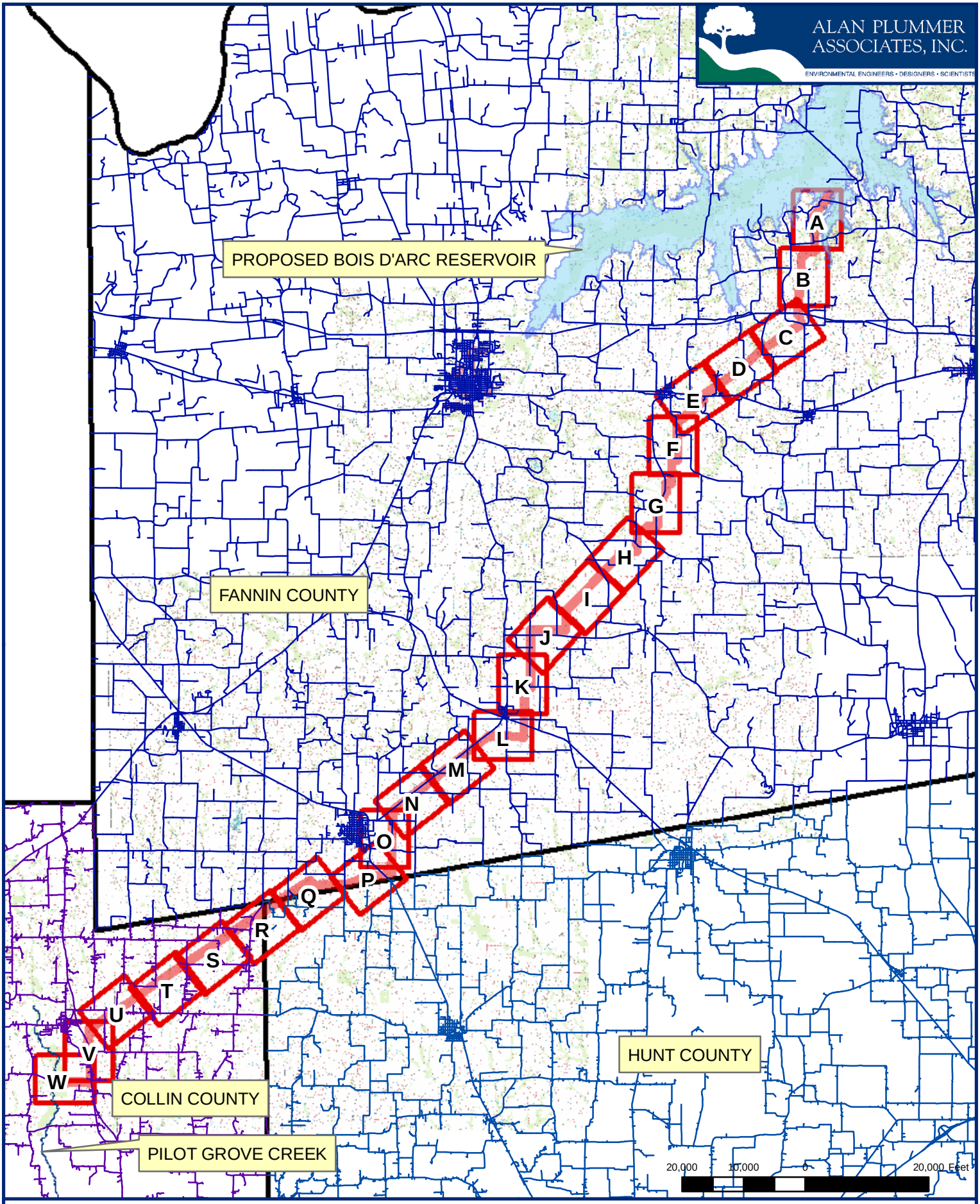
APPENDIX B
RECENT PHOTOGRAPHS

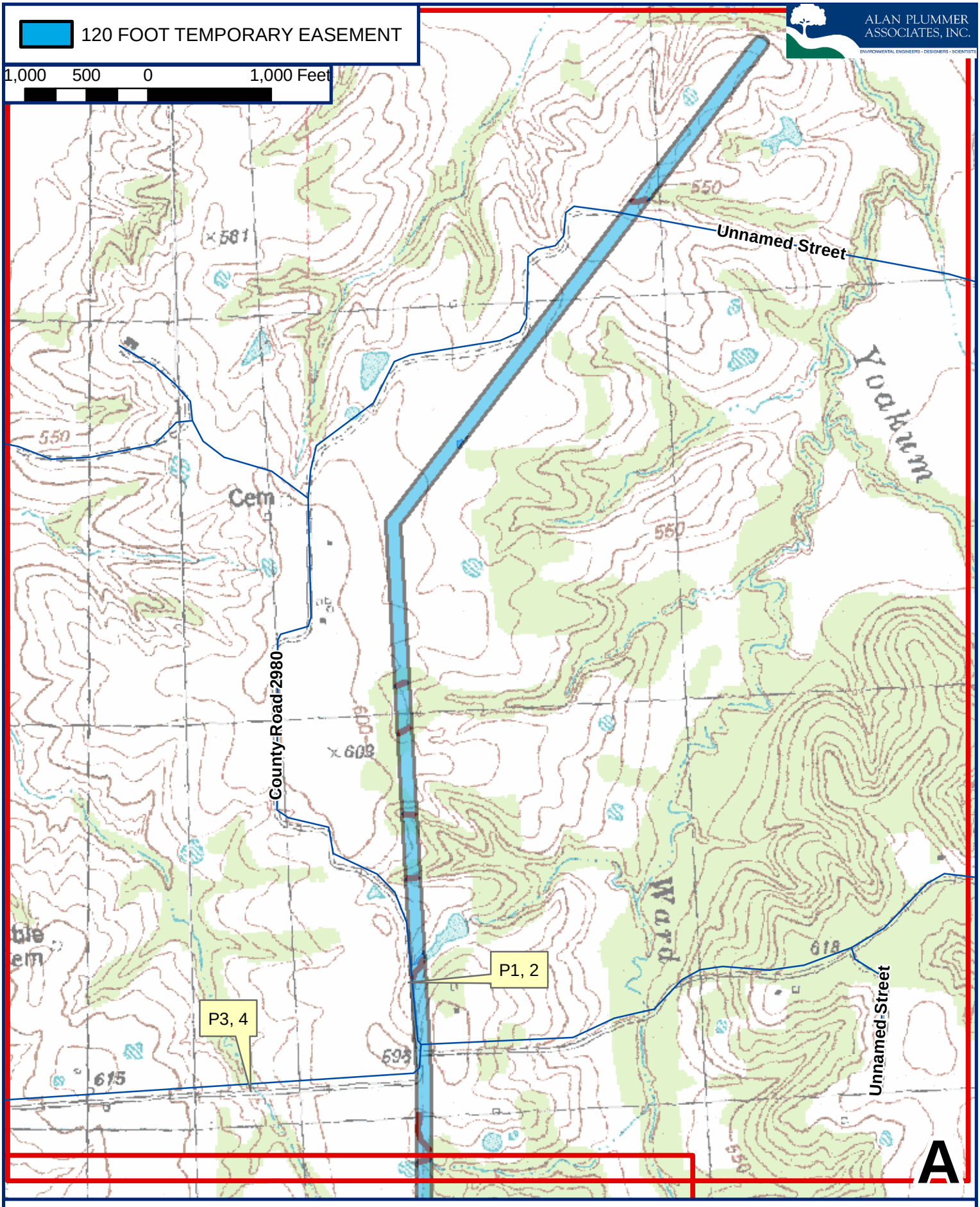


B-1

FIELD INVESTIGATION PHOTOGRAPH LOCATION PLATES

PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 1 OF 24
MARCH 25, 2008

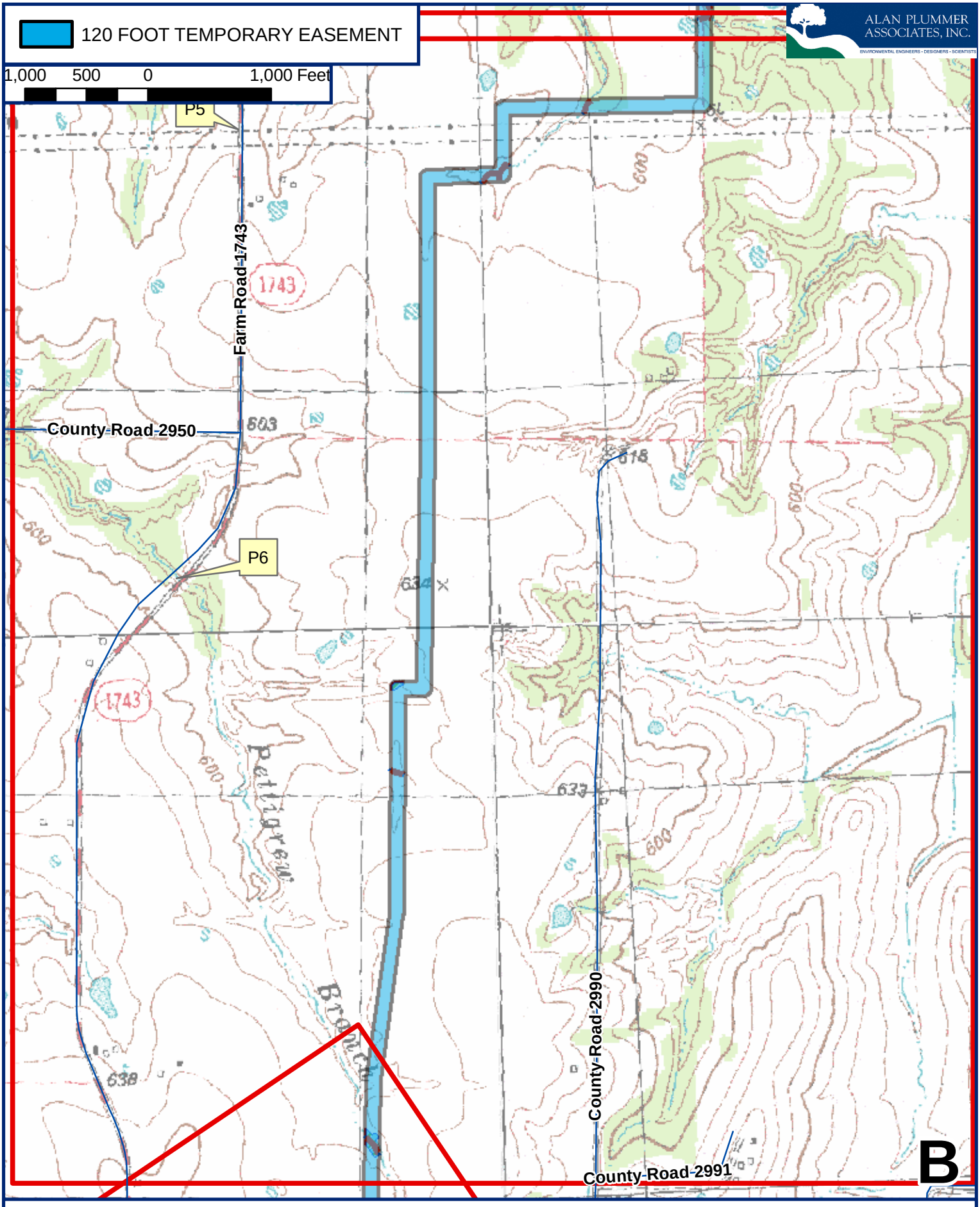


B-2

FIELD INVESTIGATION PHOTOGRAPHS

PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 2 0F 24
MARCH 24, 2008

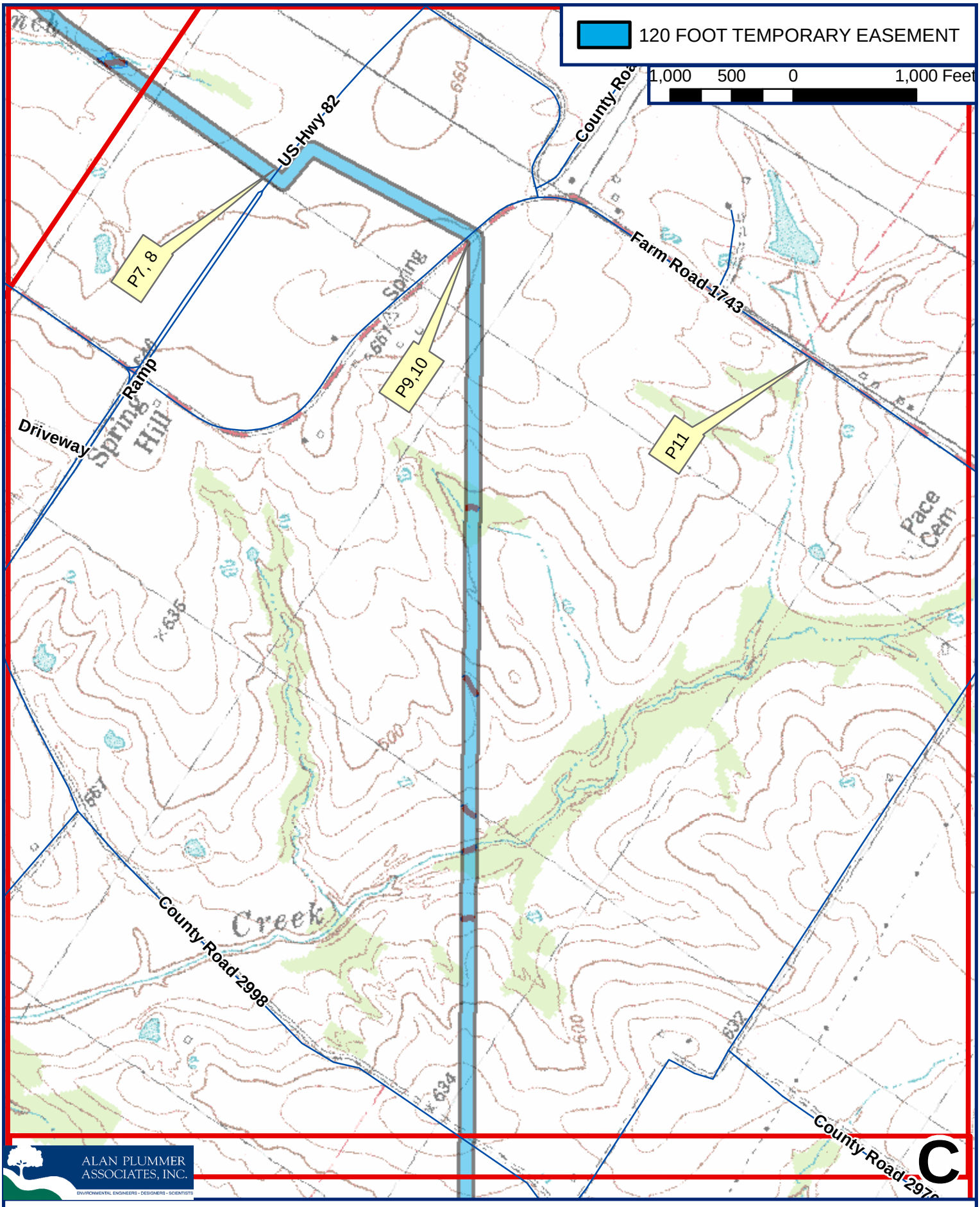


B-3

FIELD INVESTIGATION PHOTOGRAPHS

PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 3 0F 24
MARCH 24, 2008



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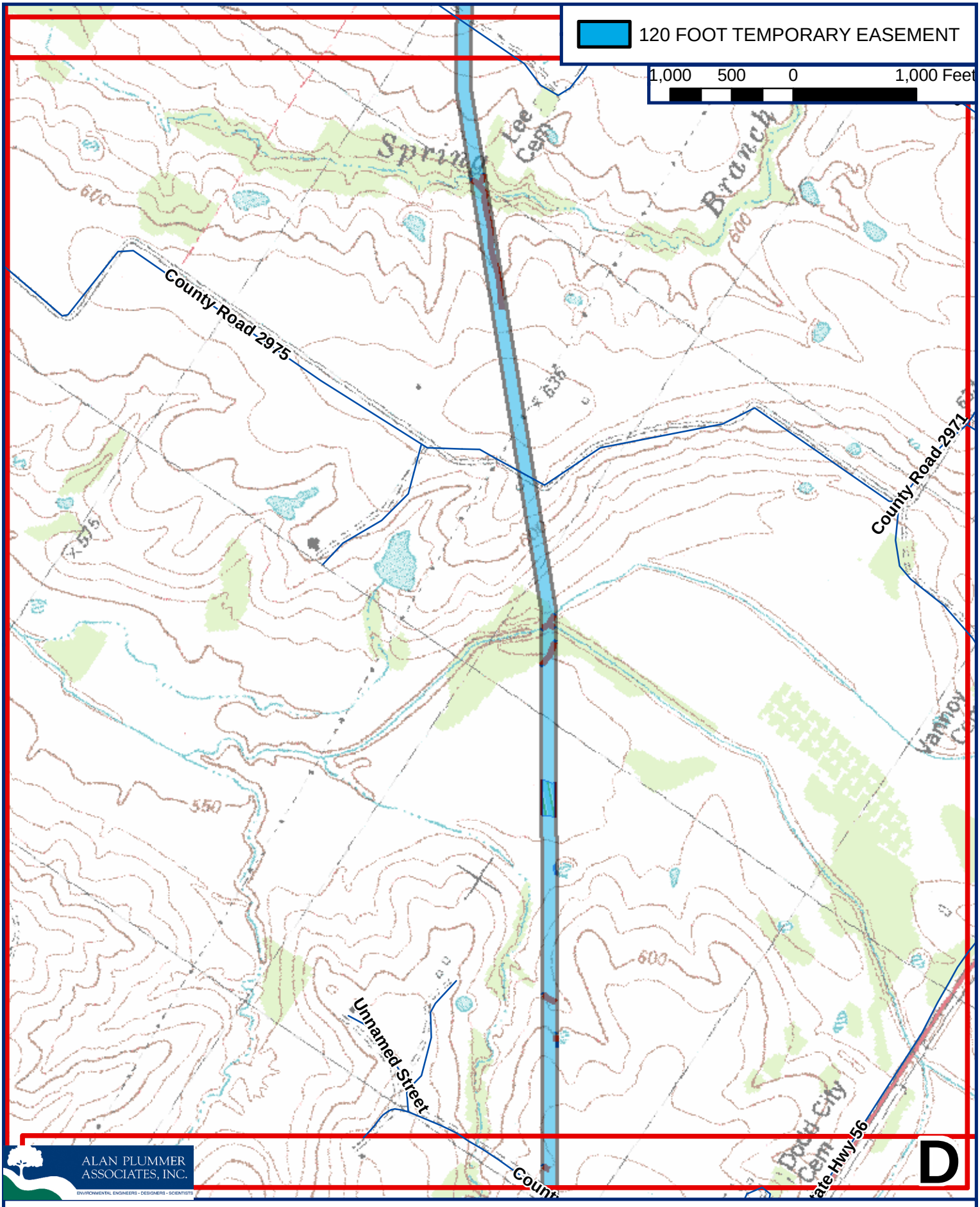
B-4

FIELD INVESTIGATION PHOTOGRAPHS

PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 4 0F 24
MARCH 24, 2008



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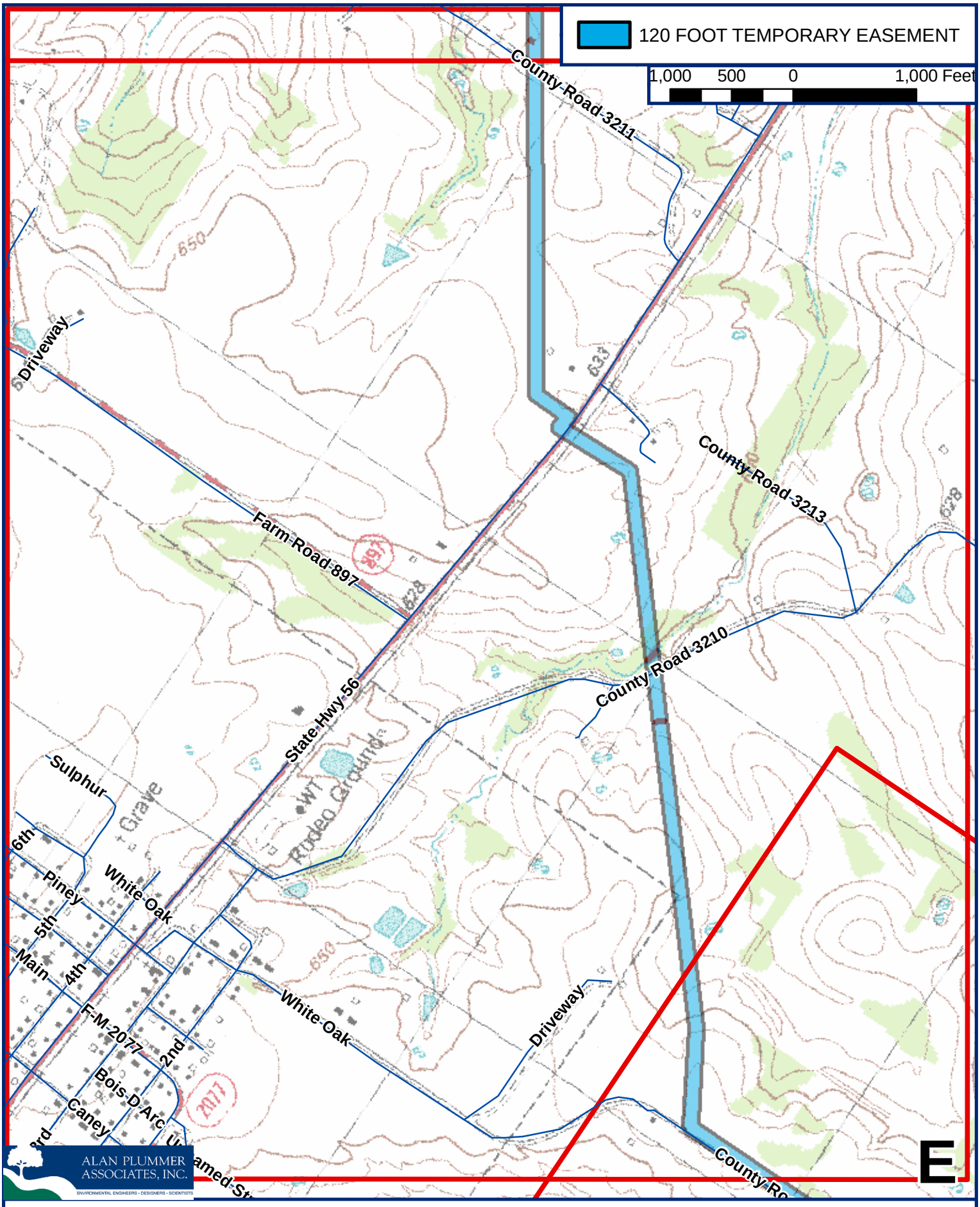
B-5

FIELD INVESTIGATION PHOTOGRAPHS

PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 5 0F 24
MARCH 24, 2008



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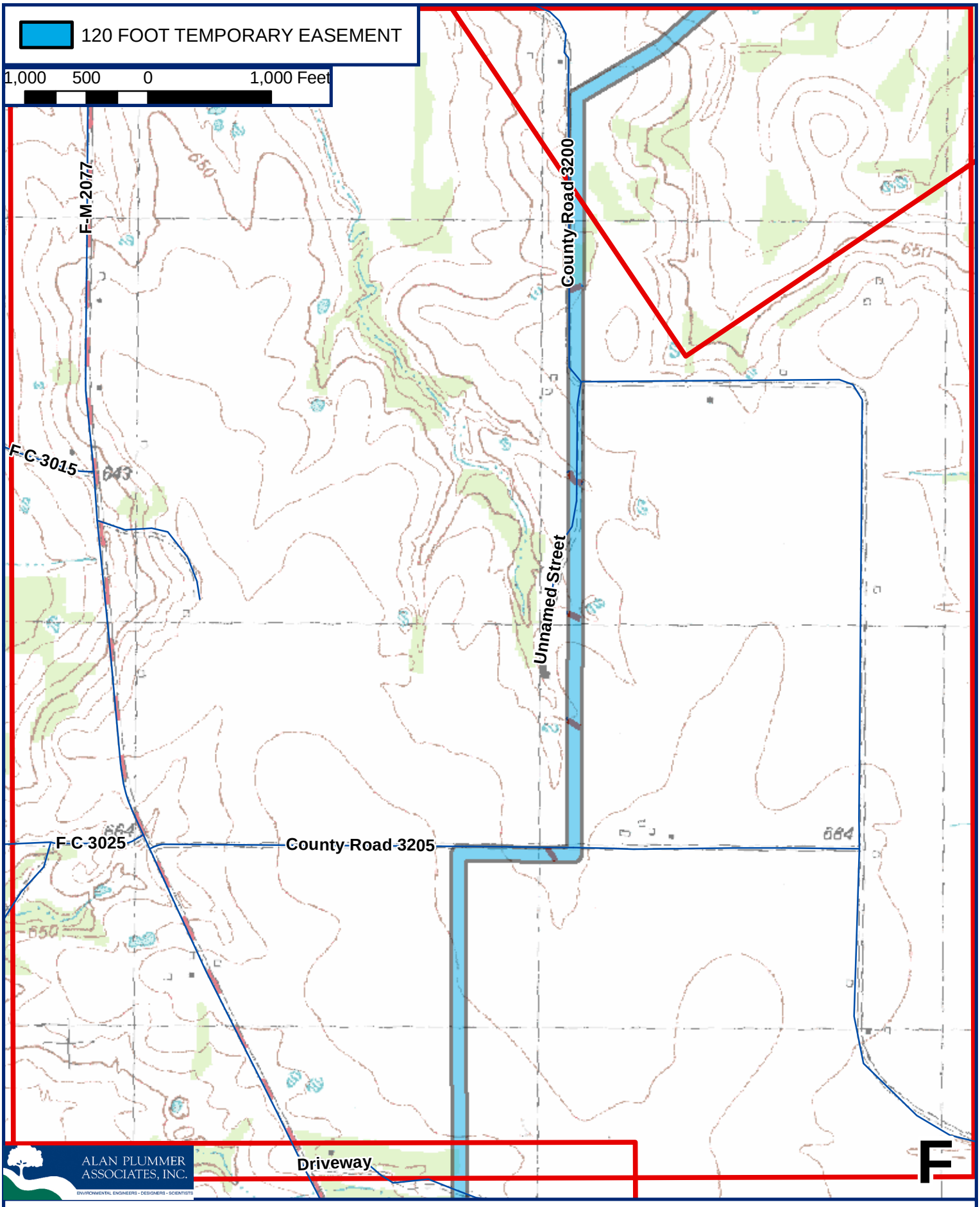
B-6

FIELD INVESTIGATION PHOTOGRAPHS

PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 6 0F 24
MARCH 24, 2008



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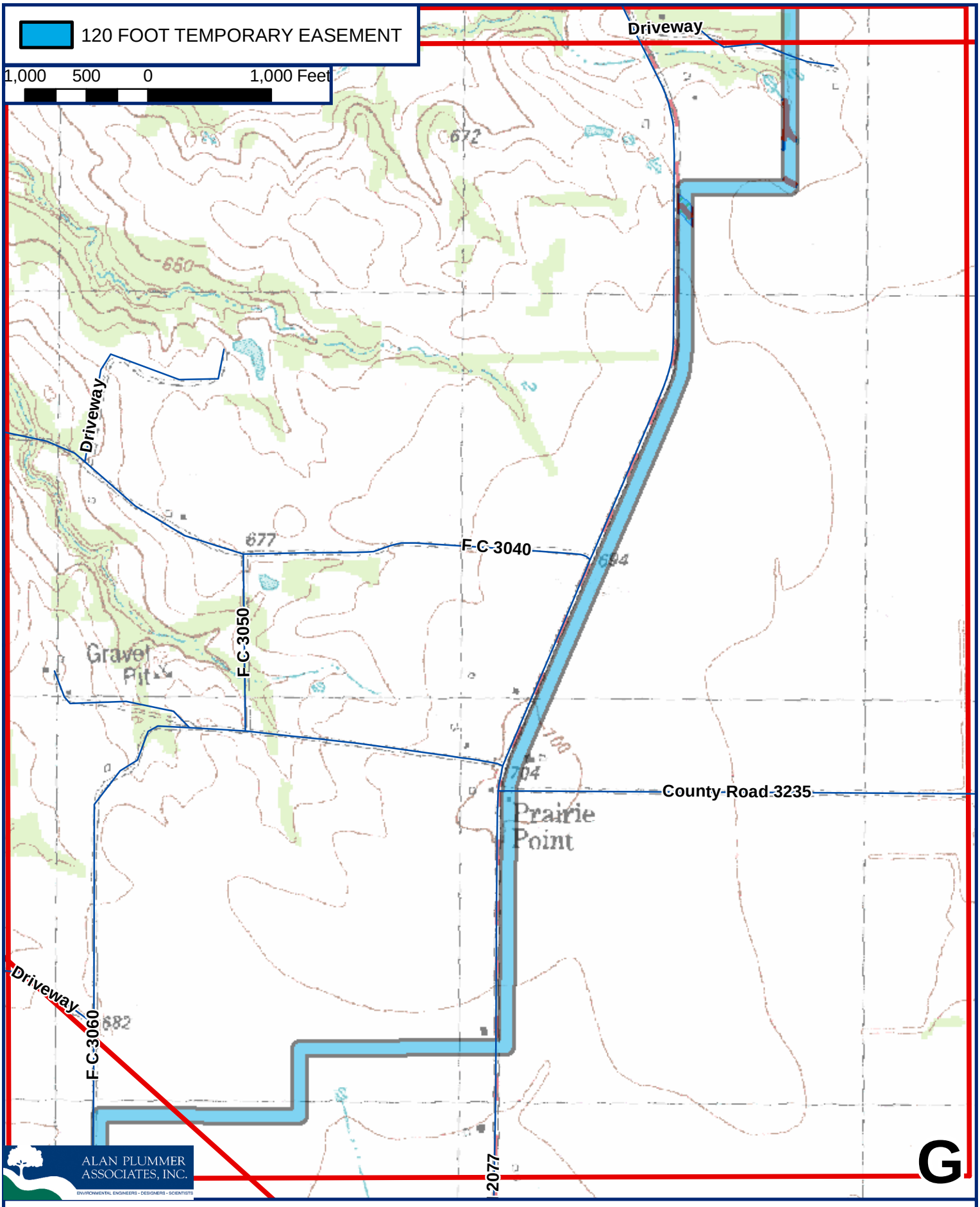
B-7

FIELD INVESTIGATION PHOTOGRAPHS

PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 7 0F 24
MARCH 24, 2008



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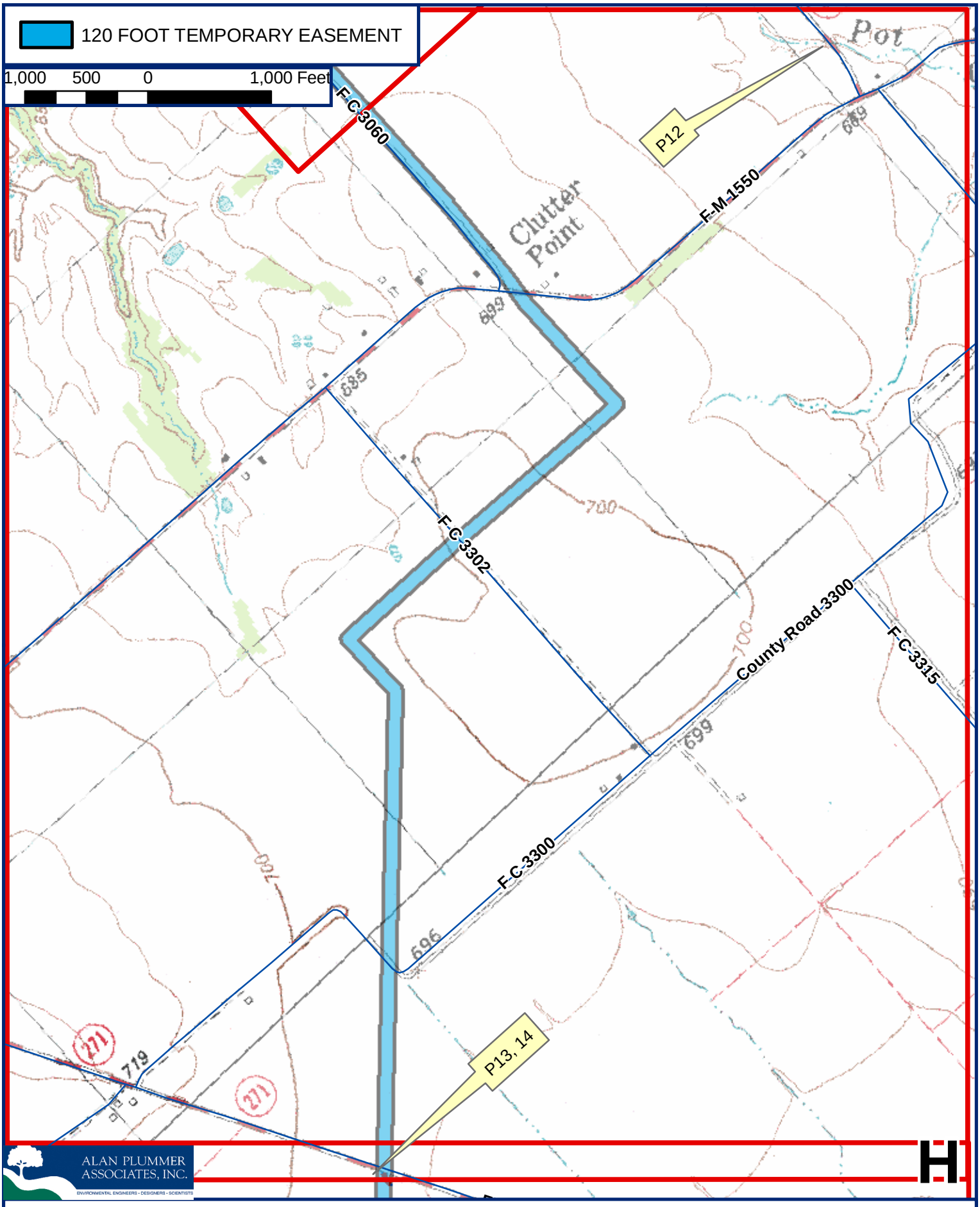
B-8
FIELD INVESTIGATION PHOTOGRAPHS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 8 0F 24
MARCH 24, 2008

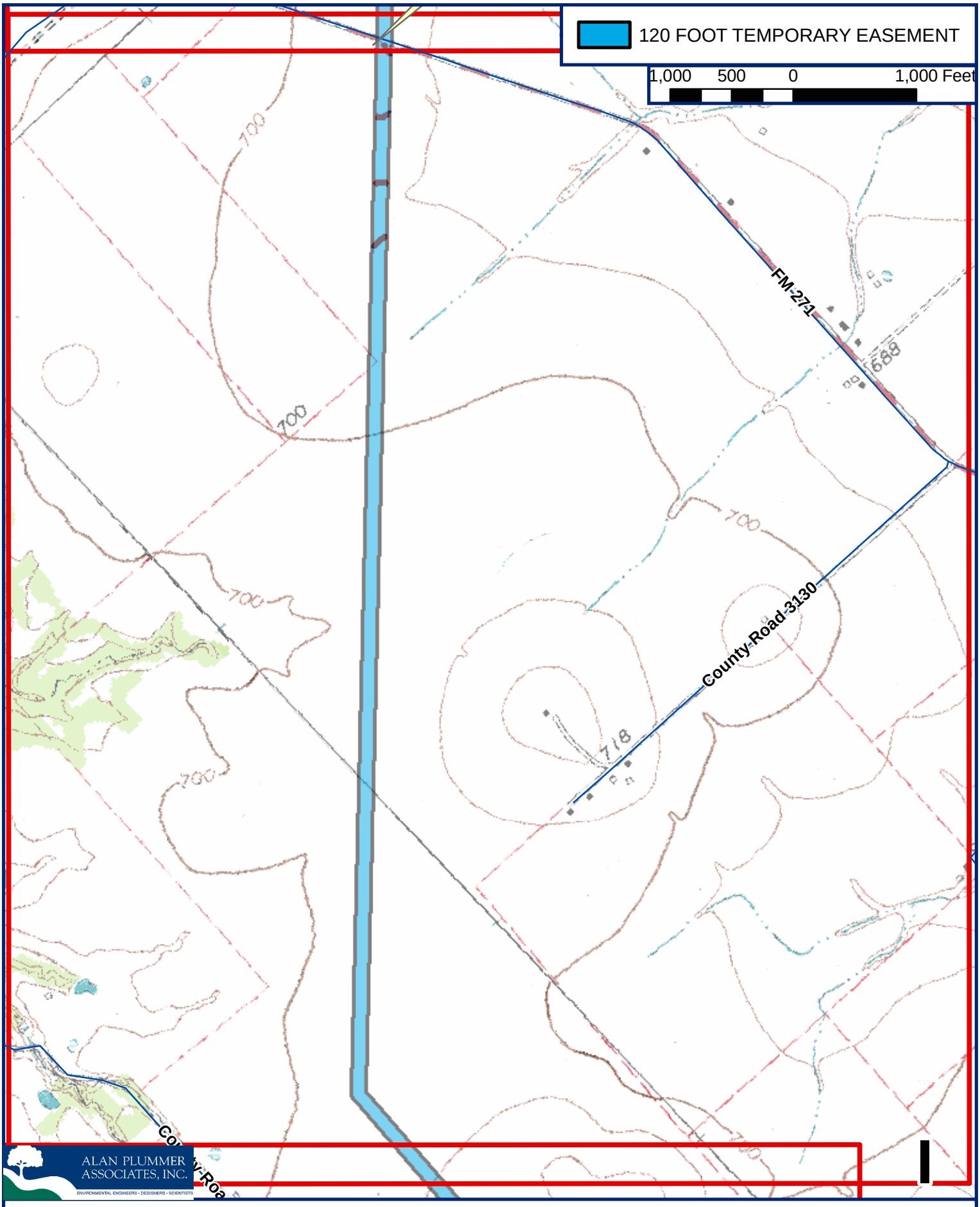


B-9

FIELD INVESTIGATION PHOTOGRAPHS

PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 9 0F 24
MARCH 24, 2008



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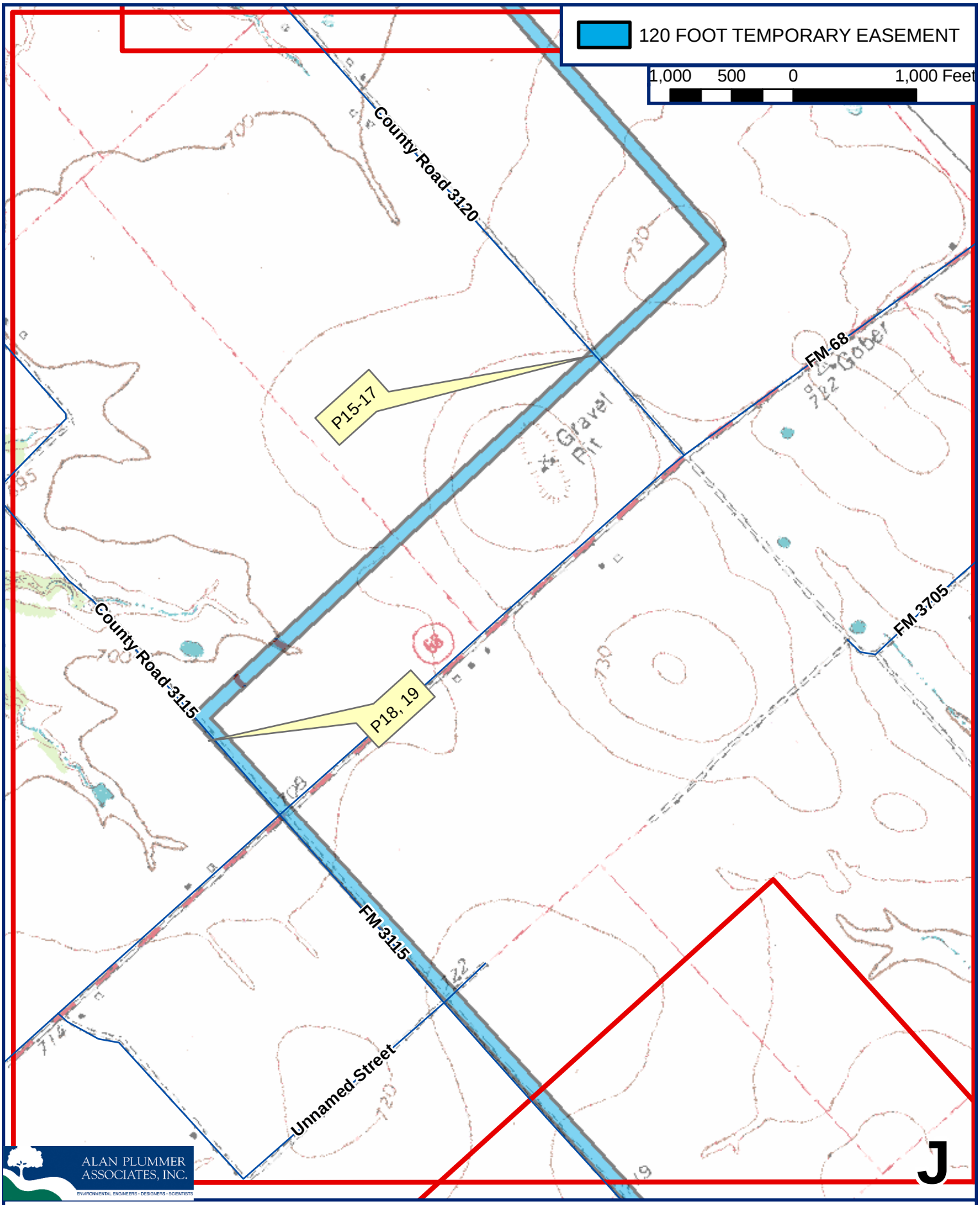
B-10
FIELD INVESTIGATION PHOTOGRAPHS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 10 0F 24
MARCH 24, 2008



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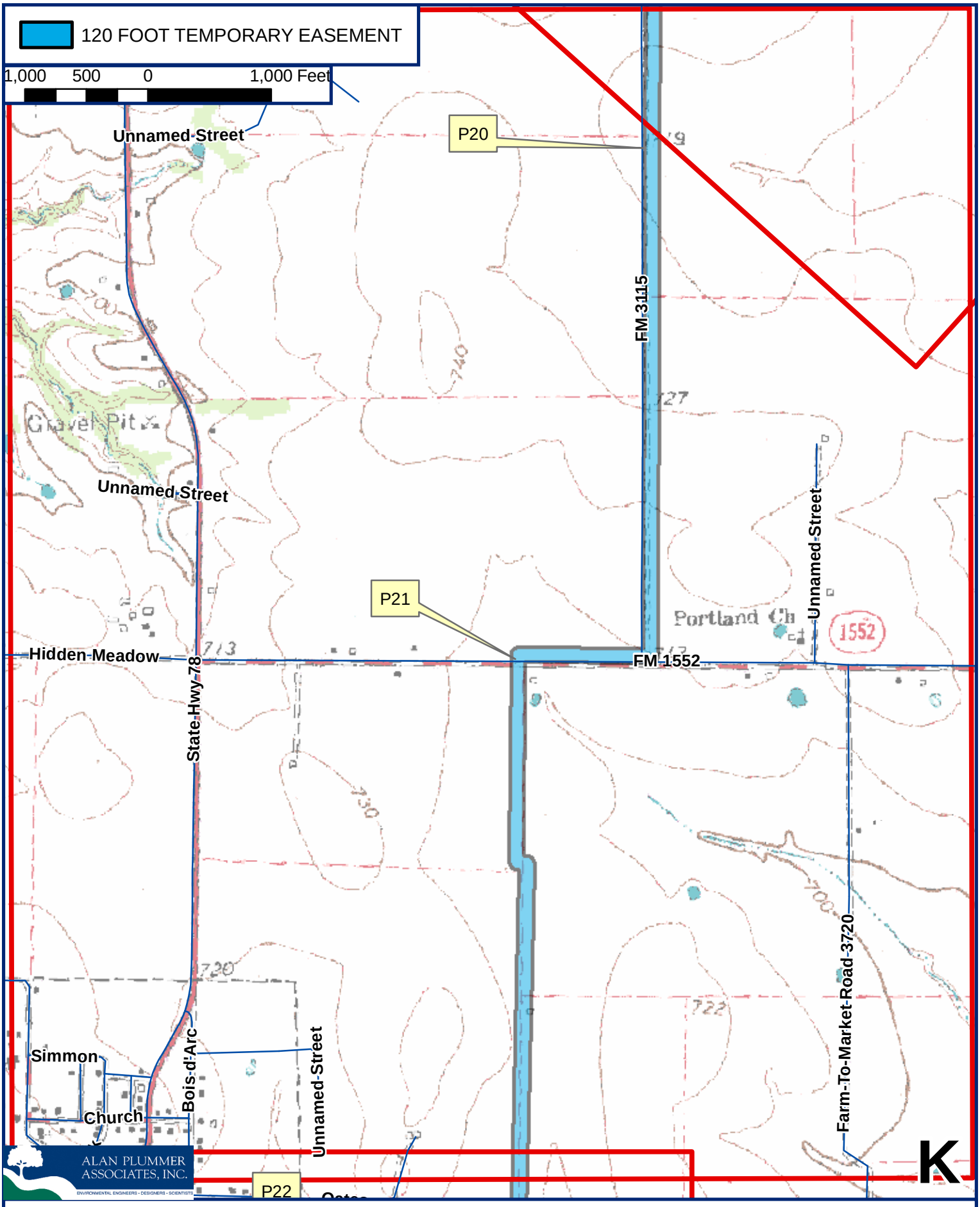
B-11
FIELD INVESTIGATION PHOTOGRAPHS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 10 0F 24
MARCH 24, 2008



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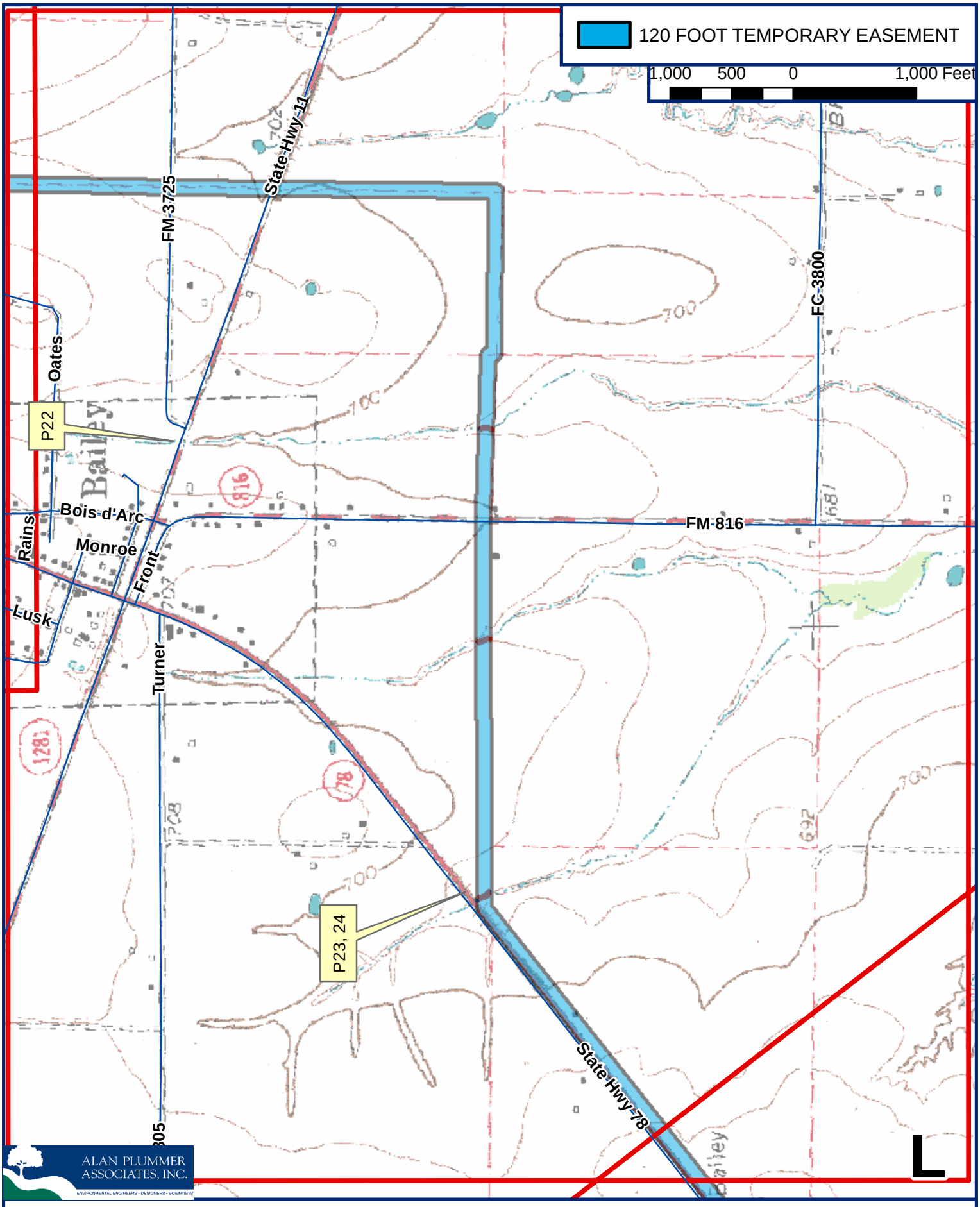
B-12
FIELD INVESTIGATION PHOTOGRAPHS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 12 0F 24
MARCH 24, 2008



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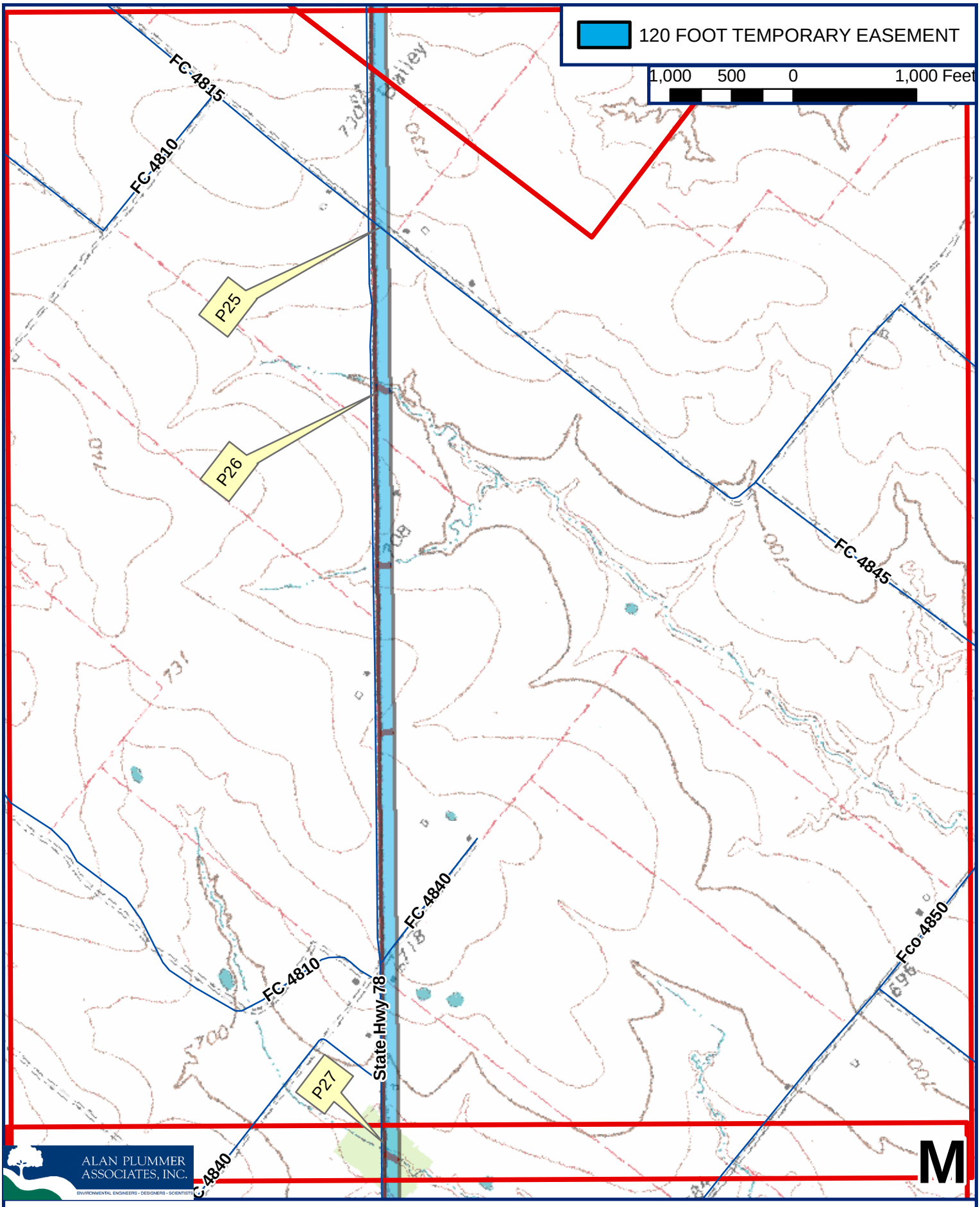
B-13
FIELD INVESTIGATION PHOTOGRAPHS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 13 0F 24
MARCH 24, 2008



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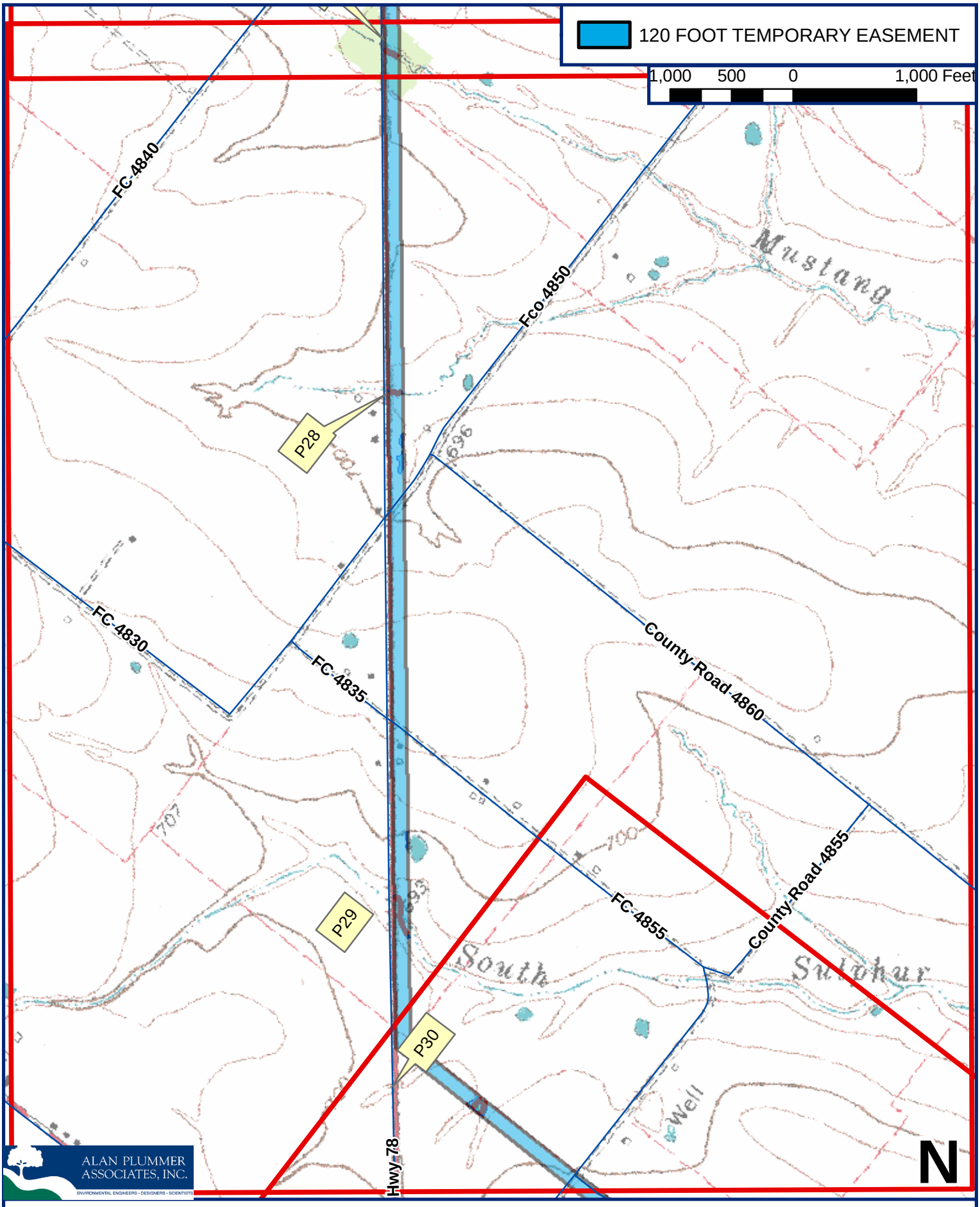
B-14
FIELD INVESTIGATION PHOTOGRAPHS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 14 0F 24
MARCH 24, 2008

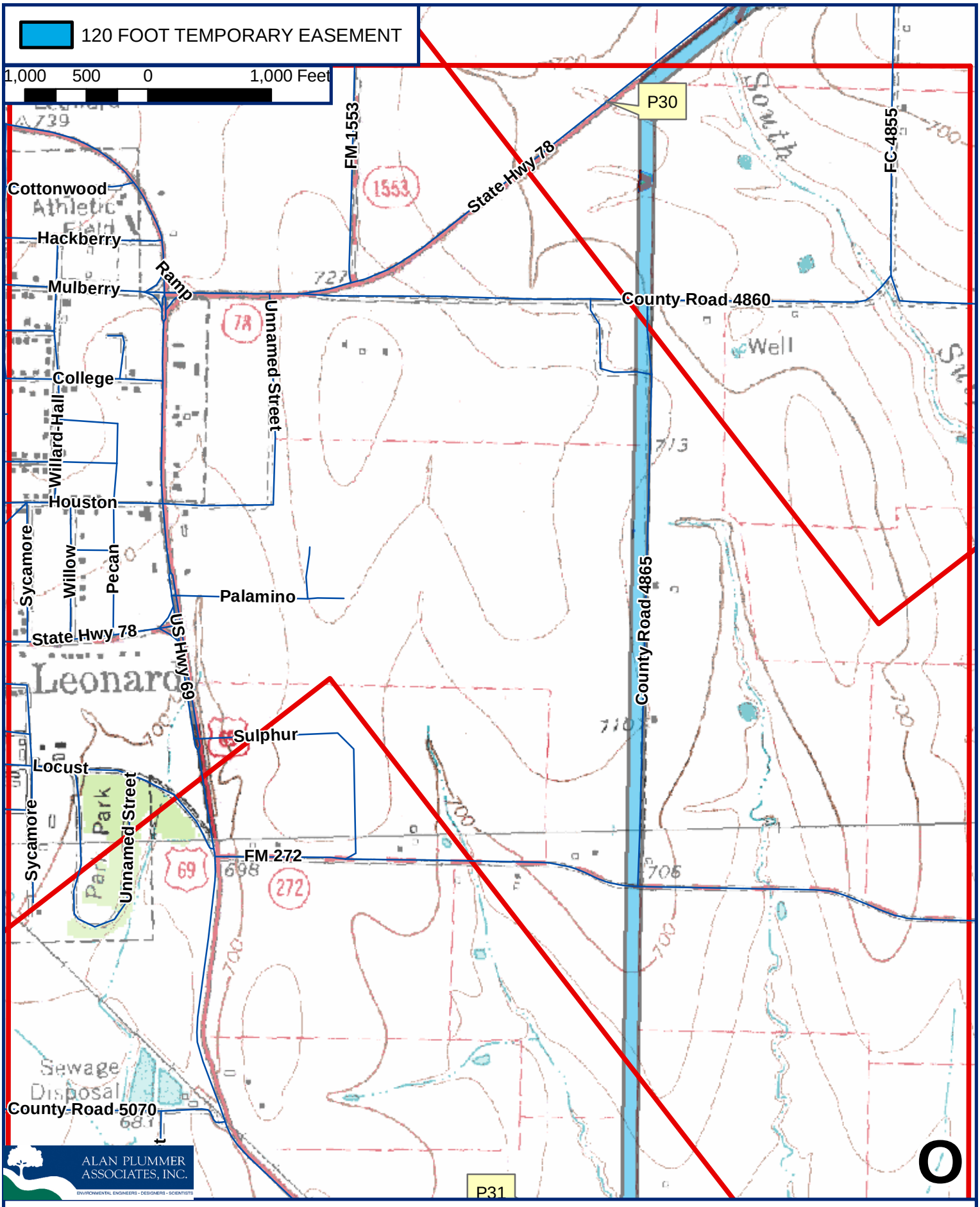


B-15

FIELD INVESTIGATION PHOTOGRAPHS

PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 15 0F 24
MARCH 24, 2008

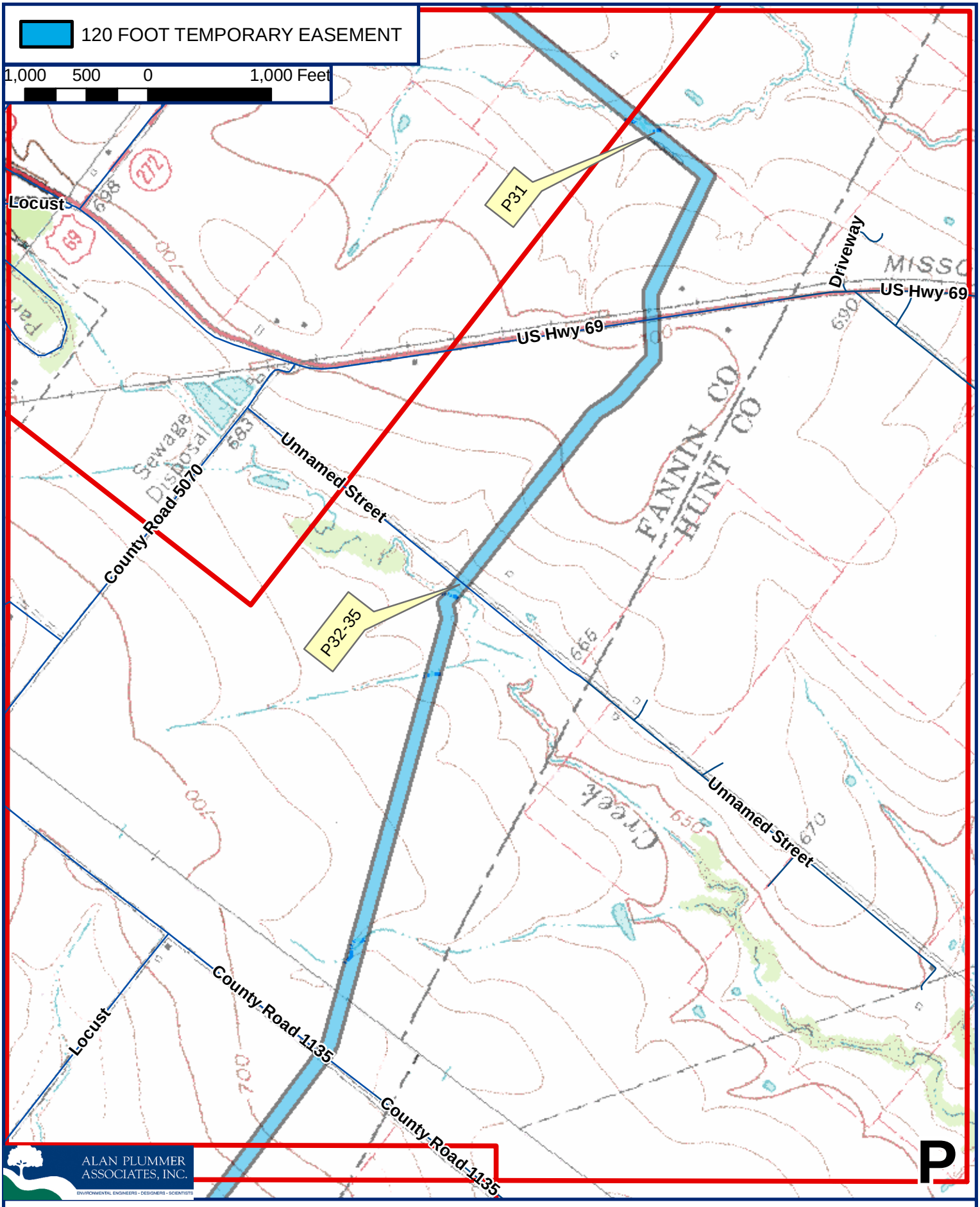


B-16

FIELD INVESTIGATION PHOTOGRAPHS

PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 16 0F 24
MARCH 24, 2008



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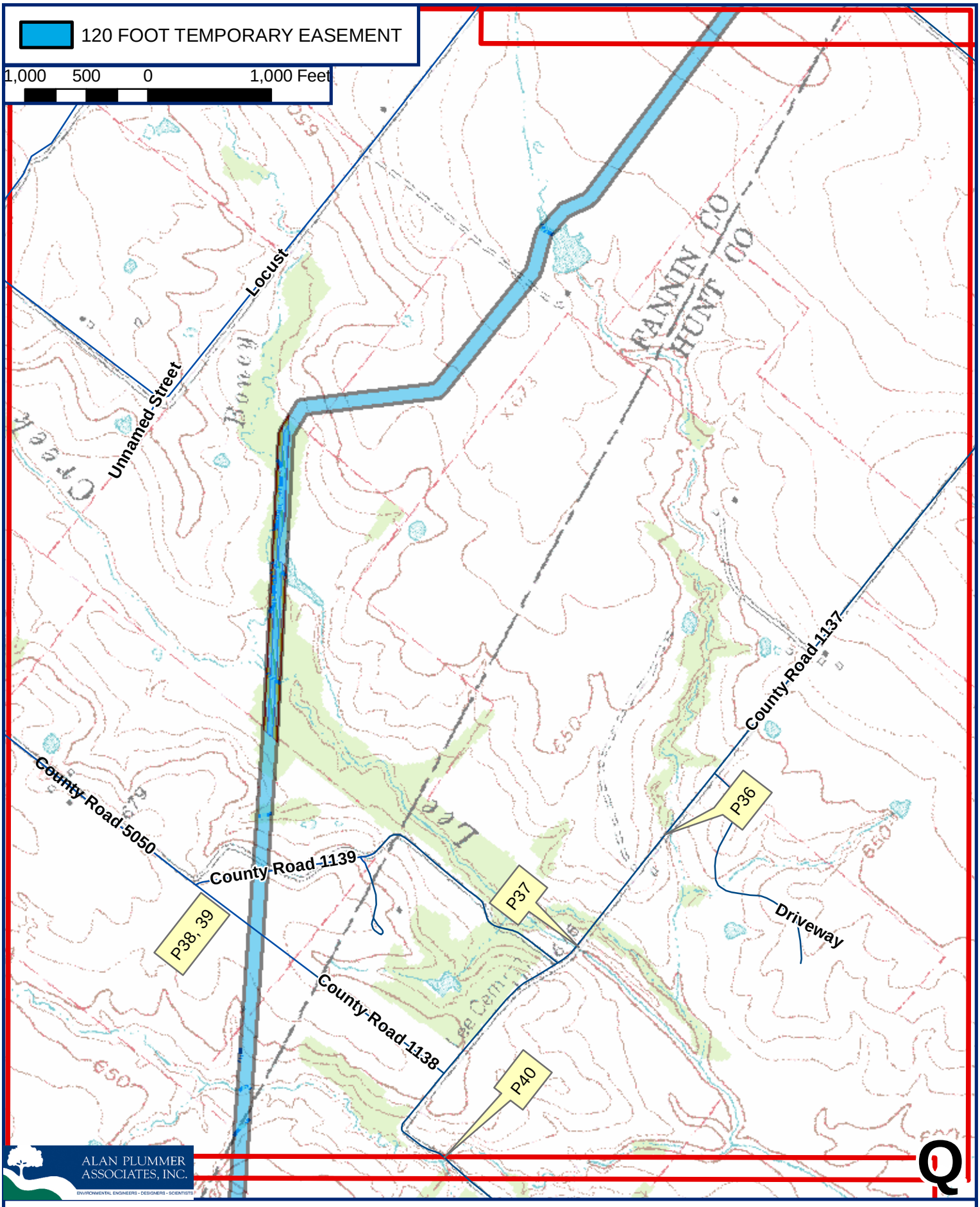
B-17

FIELD INVESTIGATION PHOTOGRAPHS

PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 17 0F 24
MARCH 24, 2008

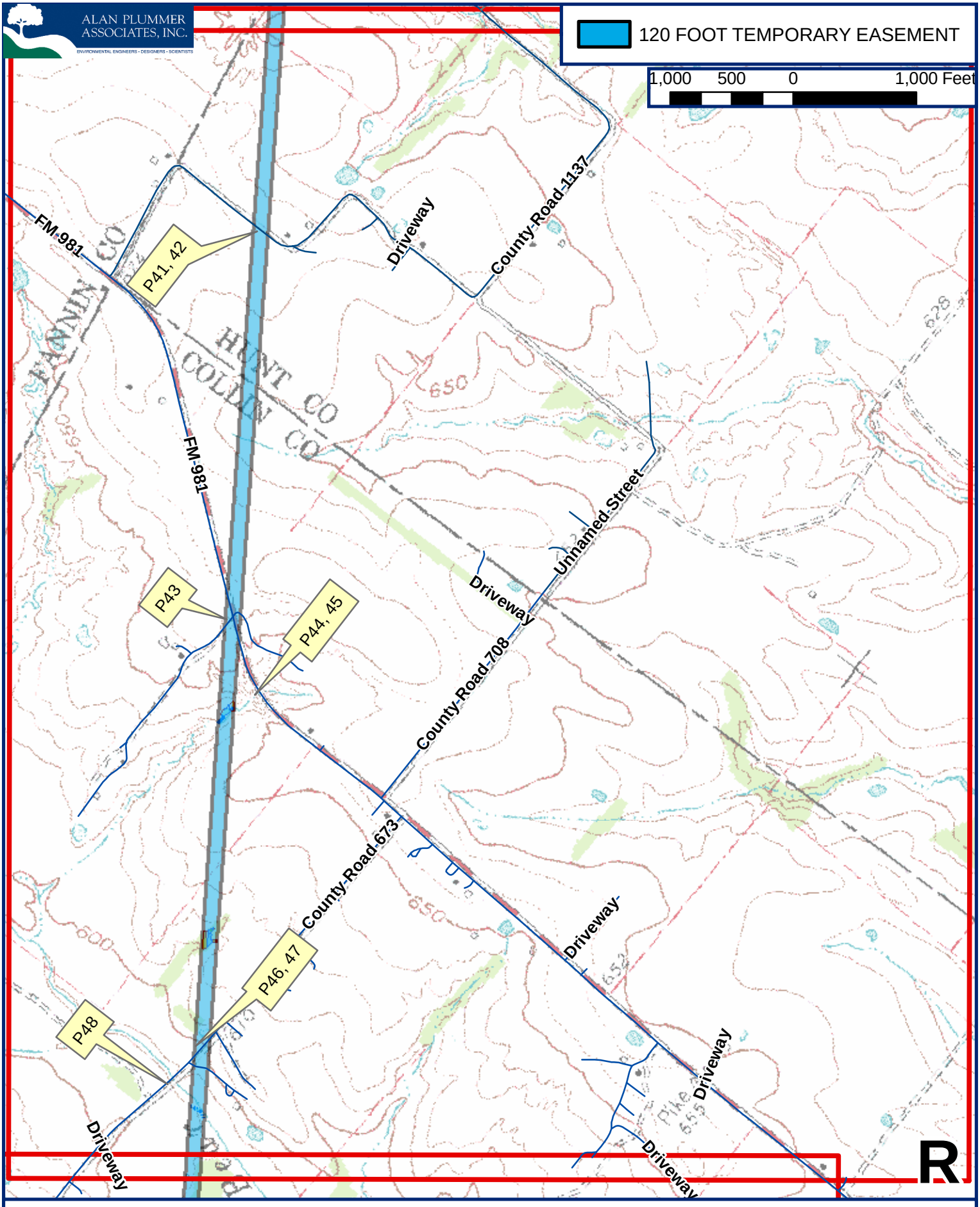


B-18

FIELD INVESTIGATION PHOTOGRAPHS

PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 18 0F 24
MARCH 24, 2008

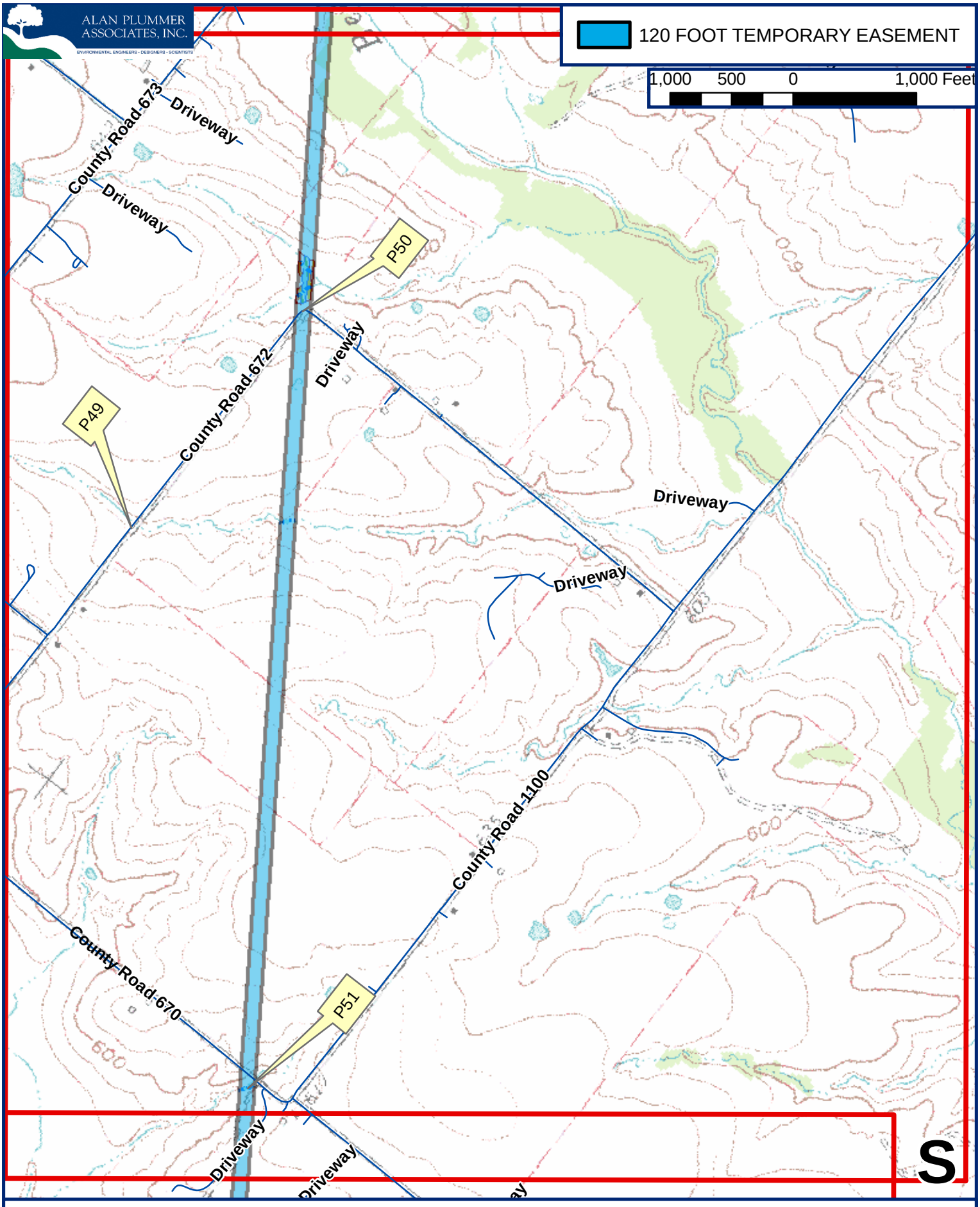


B-19

FIELD INVESTIGATION PHOTOGRAPHS

PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 19 0F 24
MARCH 24, 2008

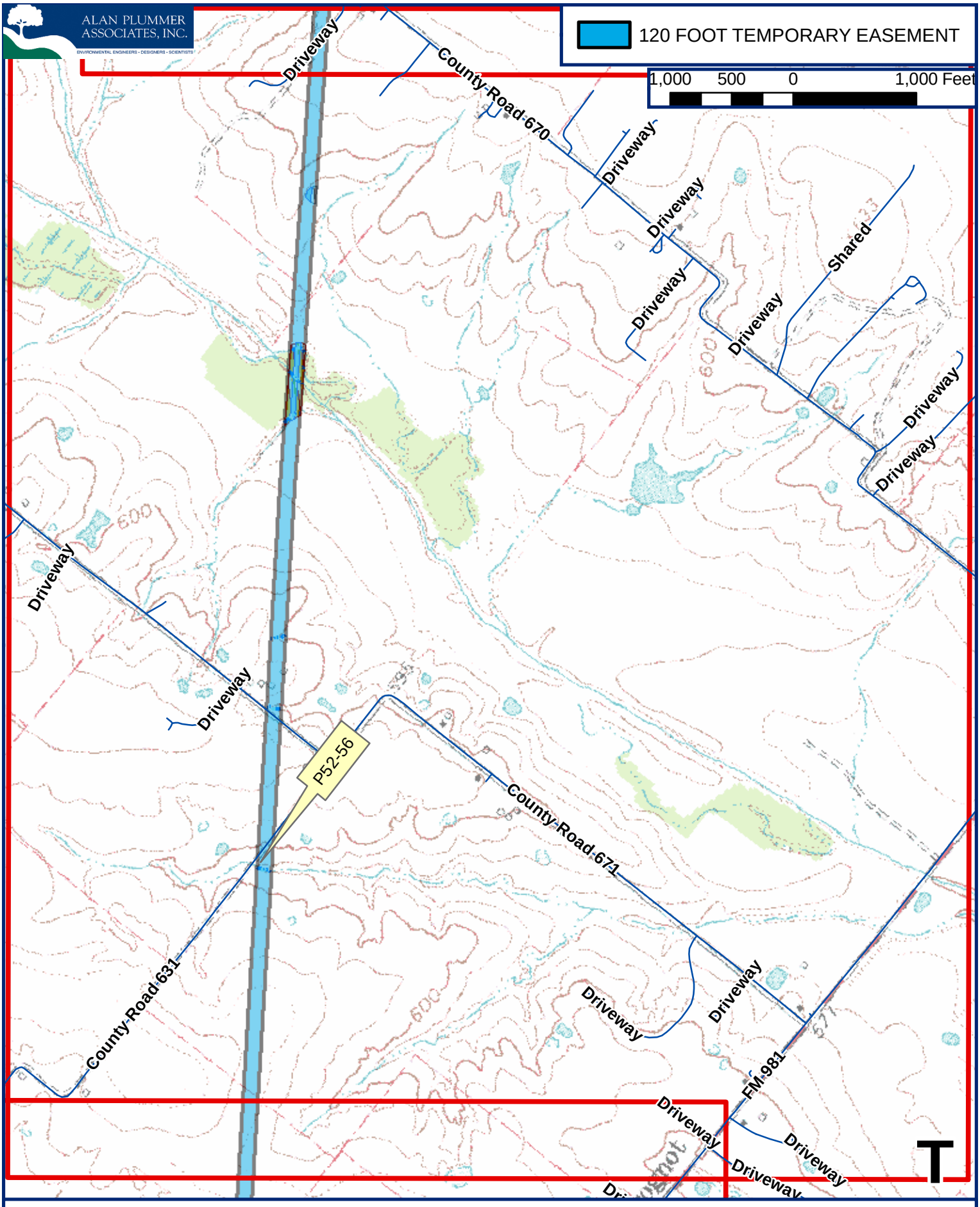


B-20

FIELD INVESTIGATION PHOTOGRAPHS

PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 20 0F 24
MARCH 24, 2008

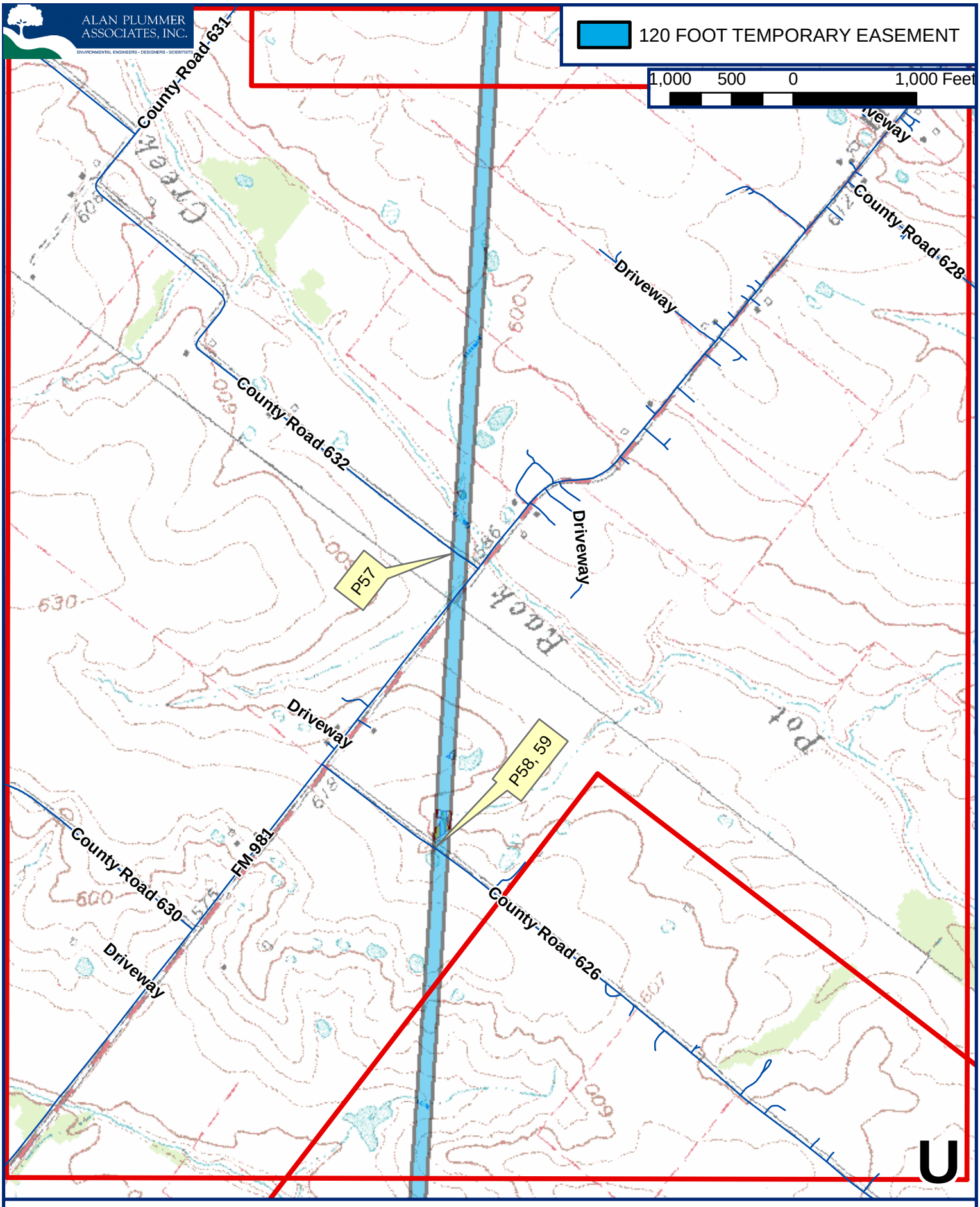


B-21

FIELD INVESTIGATION PHOTOGRAPHS

PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 21 0F 24
MARCH 24, 2008

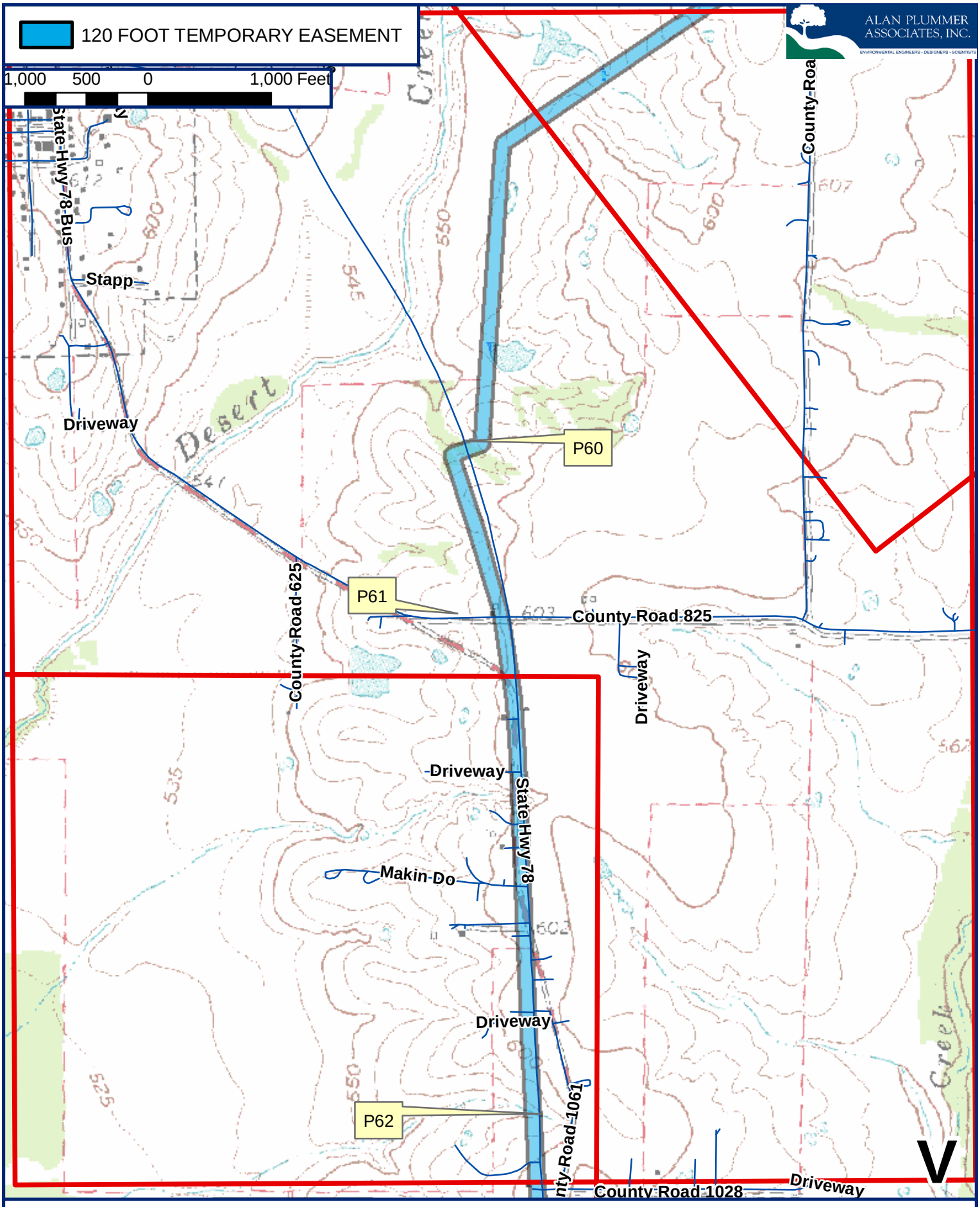


B-22

FIELD INVESTIGATION PHOTOGRAPHS

PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 22 0F 24
MARCH 24, 2008

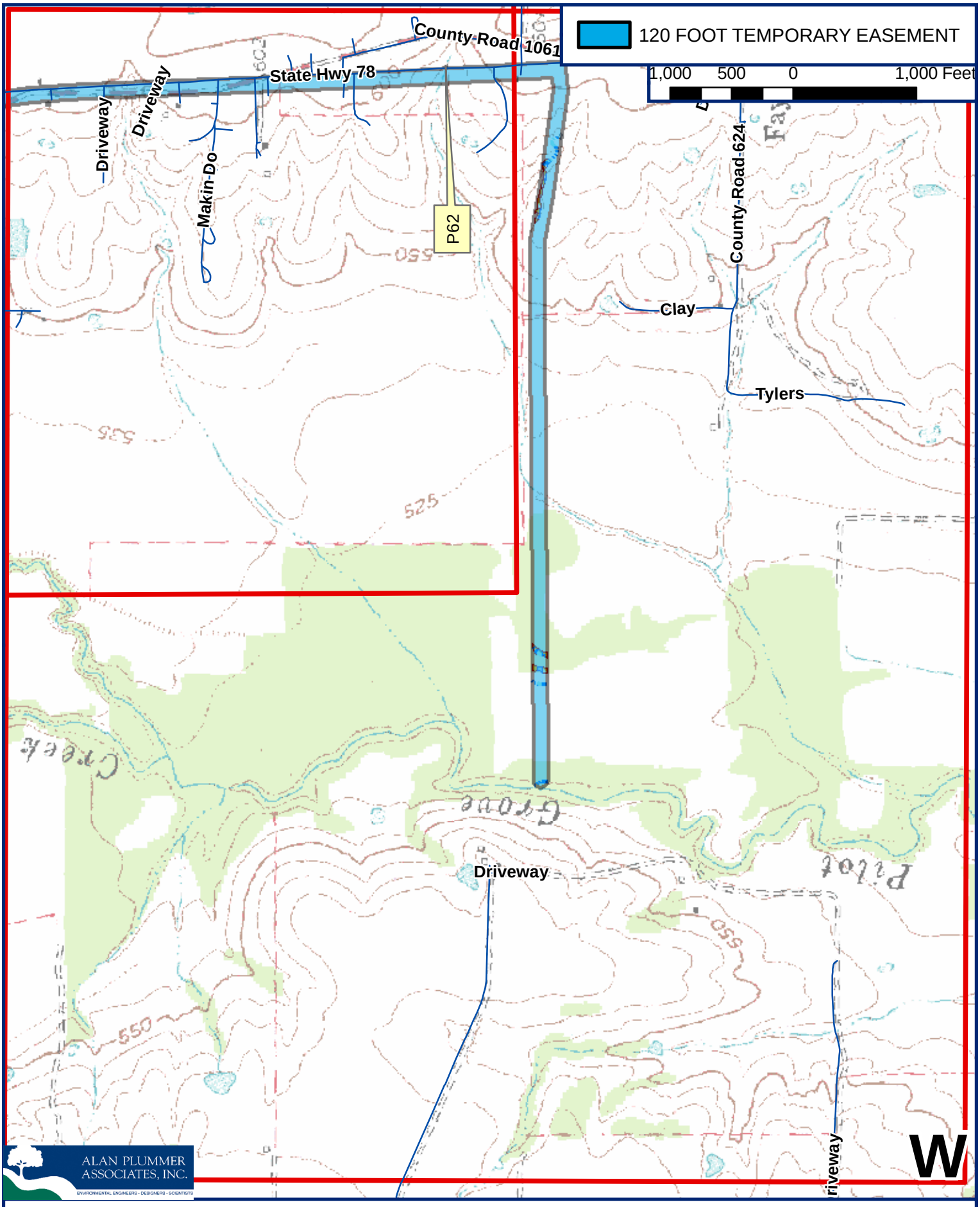


B-23

FIELD INVESTIGATION PHOTOGRAPHS

PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 23 0F 24
MARCH 24, 2008



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B-24
FIELD INVESTIGATION PHOTOGRAPHS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 24 0F 24
MARCH 24, 2008

P1. Unnamed tributary to Ward Creek, looking upstream east.

P2. Unnamed tributary to Ward Creek, looking downstream west at pipeline crossing.

P3. Unnamed tributary to Bois d'Arc Creek, looking downstream east towards the pipeline crossing.

P4. Unnamed tributary to Bois d'Arc Creek, looking upstream west.

P5. Powerline right of way where pipeline would follow, looking east.

P6. Pettigrew Branch, looking downstream southeast. Pipeline crosses the stream approximately 1 mile downstream.

P7. Pipeline ROW at crossing of U.S. Highway 82, looking north.

P8. Pipeline ROW at crossing of U.S. Highway 82, looking east.

P9. Pipeline ROW at FM 1743 crossing, looking southwest.

P10. Pipeline ROW at FM 1743 crossing, looking east.

P11. Unnamed tributary to Cottonwood Creek at pipeline crossing, looking upstream northeast.

P12. Pot Creek headwater.

P13. Pipeline crossing of FM 271, looking northeast.

P14. Pipeline crossing of FM 271, looking southwest.

P15. Pipeline crossing of County Road 3120, looking east at gas pipeline marker.


P16. Pipeline crossing of County Road 3120, looking east.

P17. Pipeline crossing of County Road 3120, looking west.

P18. Pipeline at County Road 3115, looking east.

P19. Pipeline at County Road 3115, looking south.

P20. Road drainage off of FM 3115 looking east. The drainage had no identifiable OHWM.

P21. Road drainage off of FM 1552 looking north. The drainage had no identifiable OHWM.

P22. Unnamed tributary to Loring Creek, looking south.

P23. Loring Creek, looking south.

P24. Loring Creek, looking south.

P25. State Highway 78 and County Road 4815 intersection, looking southwest.


P26. Unnamed tributary to Mustang Creek, looking southwest.

P27. Mustang Creek, looking south.

P28. Unnamed tributary to Mustang Creek, looking downstream southeast.

P29. South Sulfur River, looking downstream south.

P30. Drainage to South Sulfur River, looking downstream east.

P31. Unnamed tributary to South Sulfur River, looking downstream east.

P32. Culverted crossing of an Unnamed tributary to South Sulfur River, looking west.

P33. Unnamed tributary to South Sulfur River, looking upstream north.

P34. Unnamed tributary to South Sulfur River, looking downstream south.

P35. Pipeline ROW, looking southwest.

P36. Unnamed tributary to Bear Creek, looking upstream north.

P37. Lee Creek, looking upstream north.

P38. Pipeline ROW following a power line ROW, looking northeast.

P39. Pipeline ROW following a power line ROW, looking southwest.

P40. Impounded unnamed tributary to Lee Creek, looking upstream north.

P41. Pipeline ROW following a power line ROW, looking northeast.

P42. Pipeline ROW following a power line ROW, looking southwest.

P43. Pipe crossing at FM 881 and County Road 5020 intersection, looking northeast.

P44. Head water of unnamed tributary to Bear Creek at pipeline crossing, looking upstream northwest.

P45. Head water of unnamed tributary to Bear Creek at pipeline crossing, looking downstream southeast.

P46. Pipeline ROW following a power line ROW, looking northeast.

P47. Pipeline ROW following a power line ROW, looking southwest.

P48. Bear Creek, looking downstream south towards the pipeline crossing.

P49. Unnamed tributary to Bear Creek, looking downstream southeast.

P50. Impounded tributaries and potential wetlands at pipeline crossing, looking northeast.

P51. Pipeline ROW following a power line ROW, looking northeast.

P52. Indian Creek, looking upstream north towards pipeline crossing.

P53. Unnamed tributary at pipeline crossing, looking downstream southeast.

P54. Unnamed tributary at pipeline crossing, looking downstream southeast.

P55. Unnamed tributary to Indian Creek, looking downstream southeast.

P56. Pipeline ROW following a power line ROW, looking southwest.

P57. Pipeline ROW following a power line ROW, looking northeast.

P58. Pipeline ROW following a power line ROW, looking southwest.

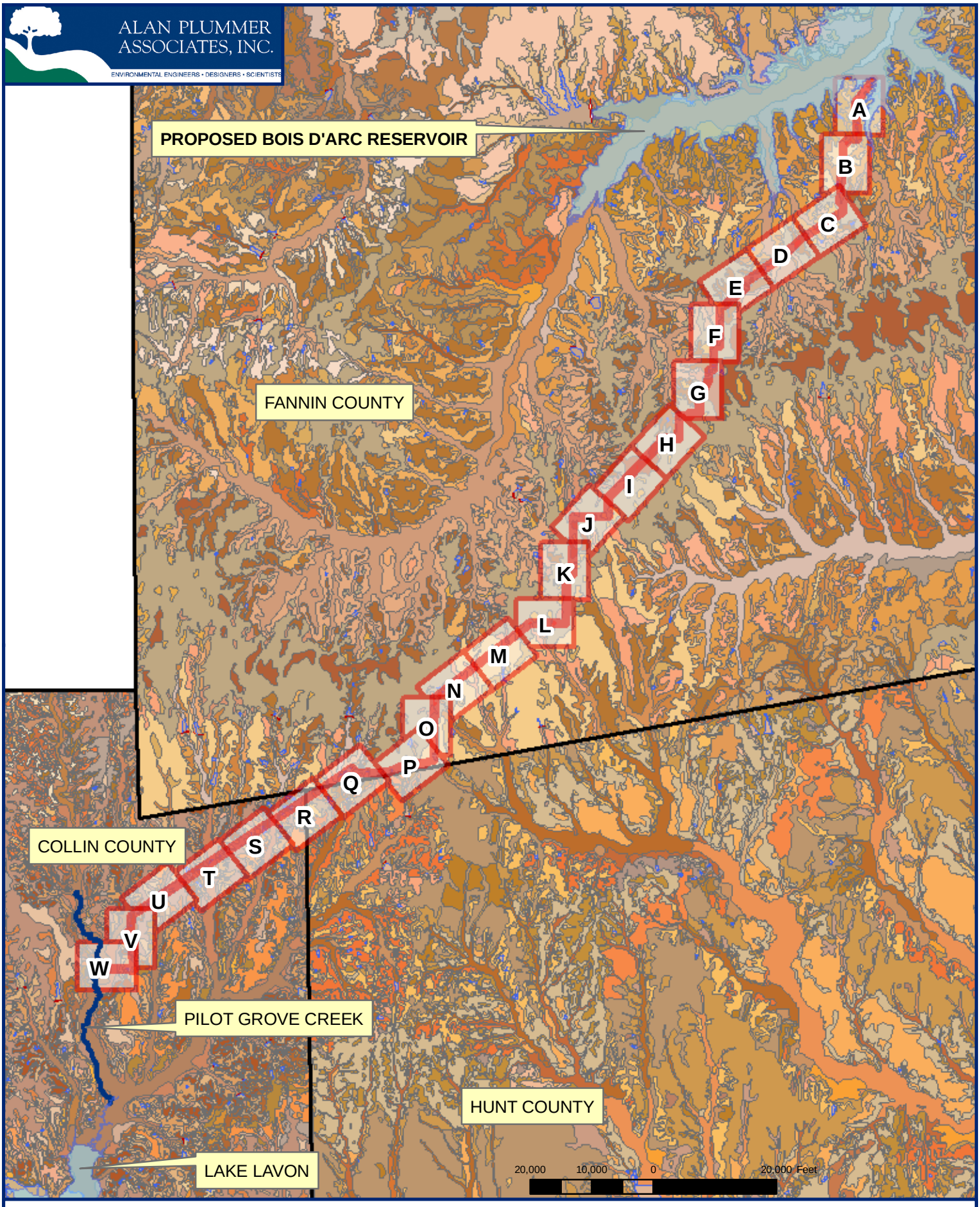
P59. Pipeline ROW following a power line ROW, looking northeast.

P60. Pipeline ROW following a gas pipeline ROW, looking northeast.

P61. Impoundment west of pipeline ROW where pipeline would parallel State Highway 78, looking west.

P62. Impoundment west of pipeline ROW where pipeline would parallel State Highway 78, looking west.

APPENDIX C
SOIL SERIES DESCRIPTIONS



C-1
SOIL MAP UNIT PLATE LOCATIONS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

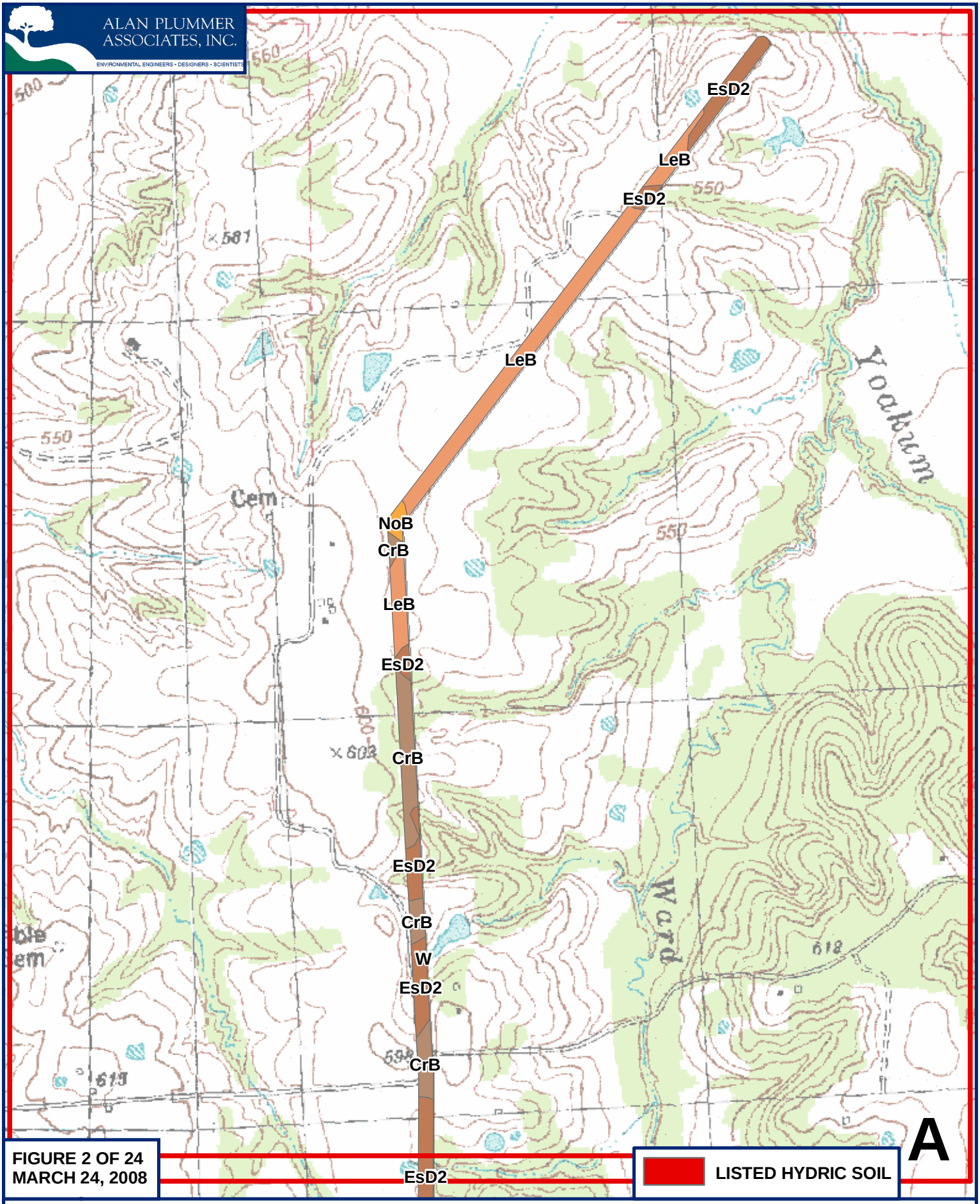


FIGURE C-2
SOIL MAP UNITS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

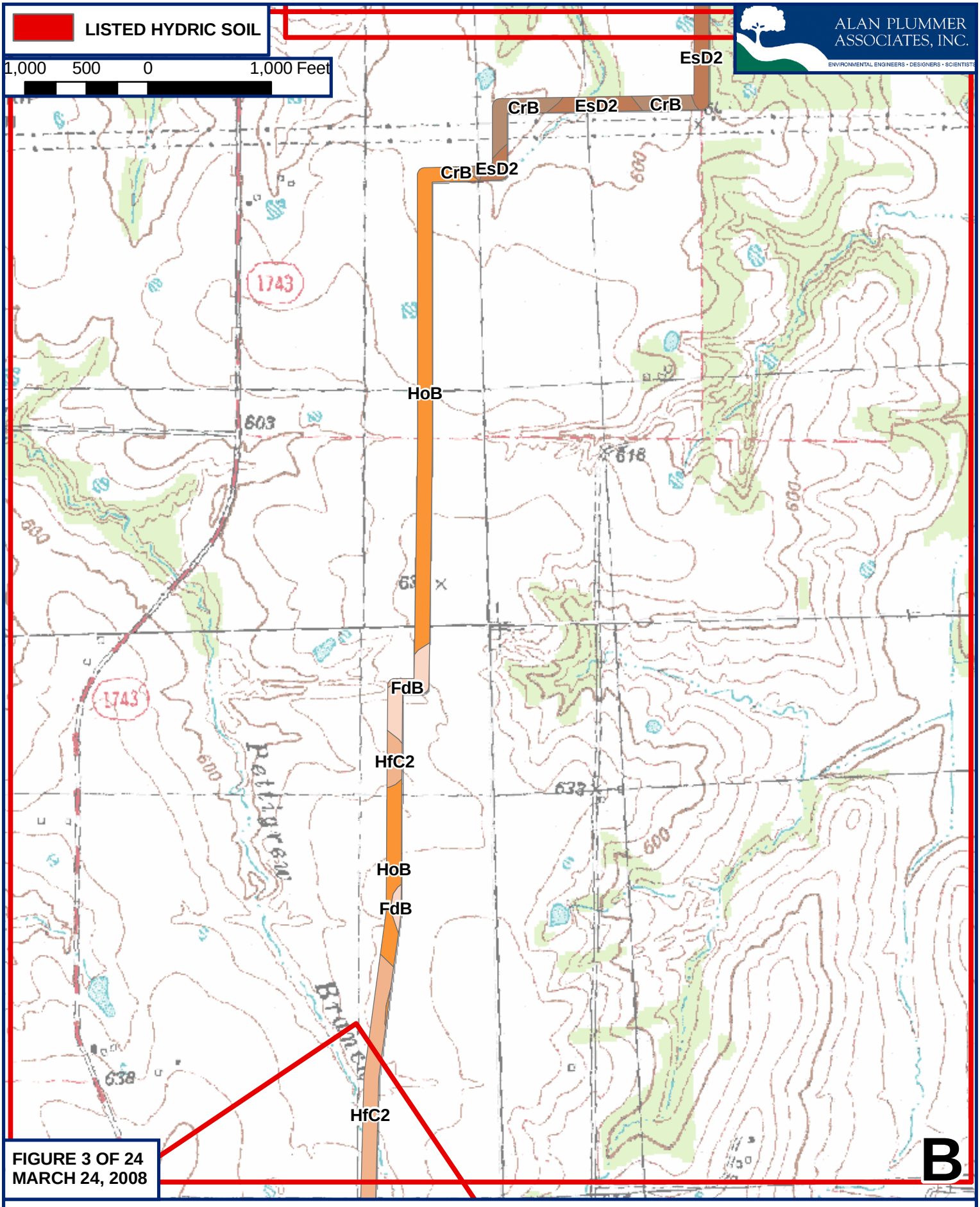


FIGURE 3 OF 24
MARCH 24, 2008

FIGURE C-3
SOIL MAP UNITS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE ■

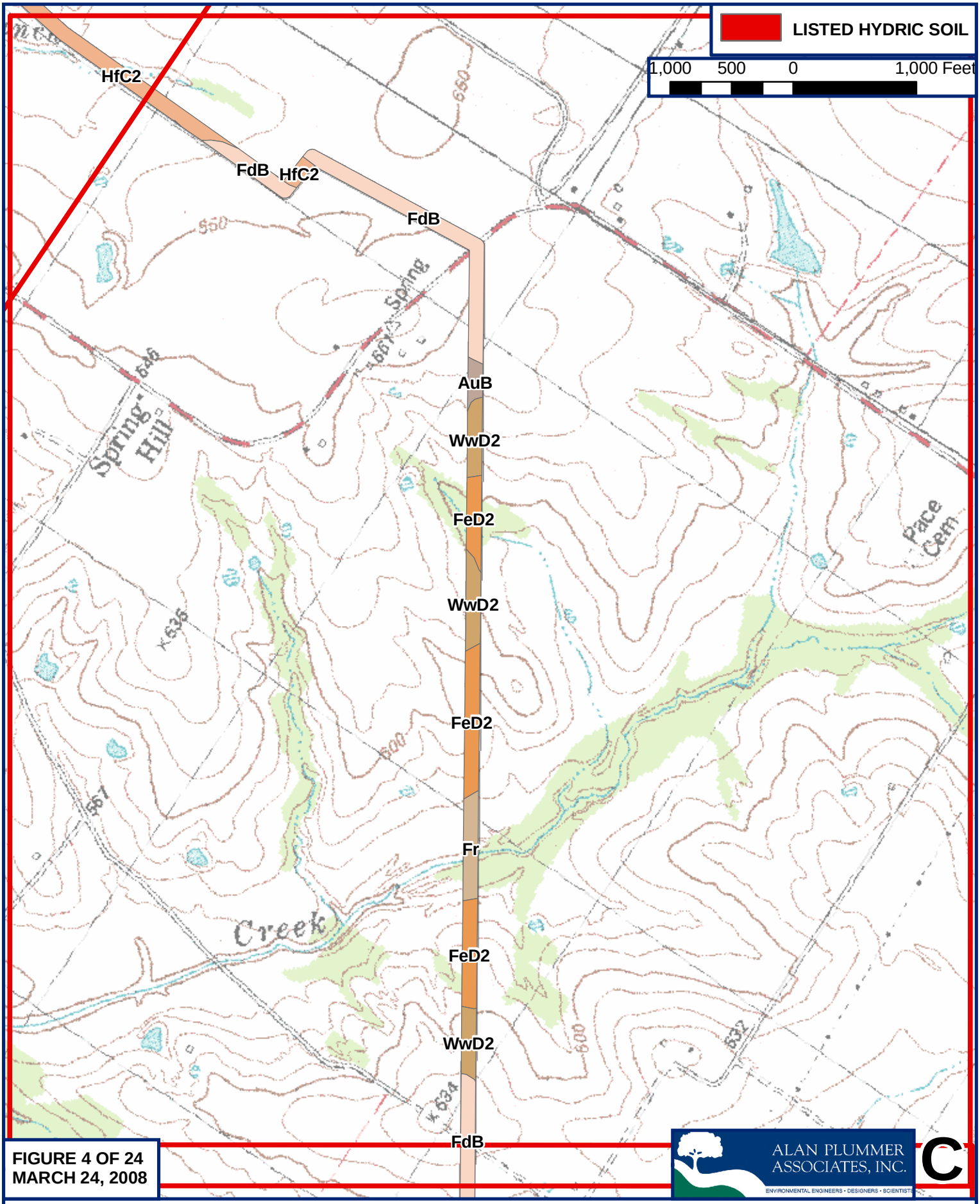


FIGURE 4 OF 24
MARCH 24, 2008

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FIGURE C-4
SOIL MAP UNITS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

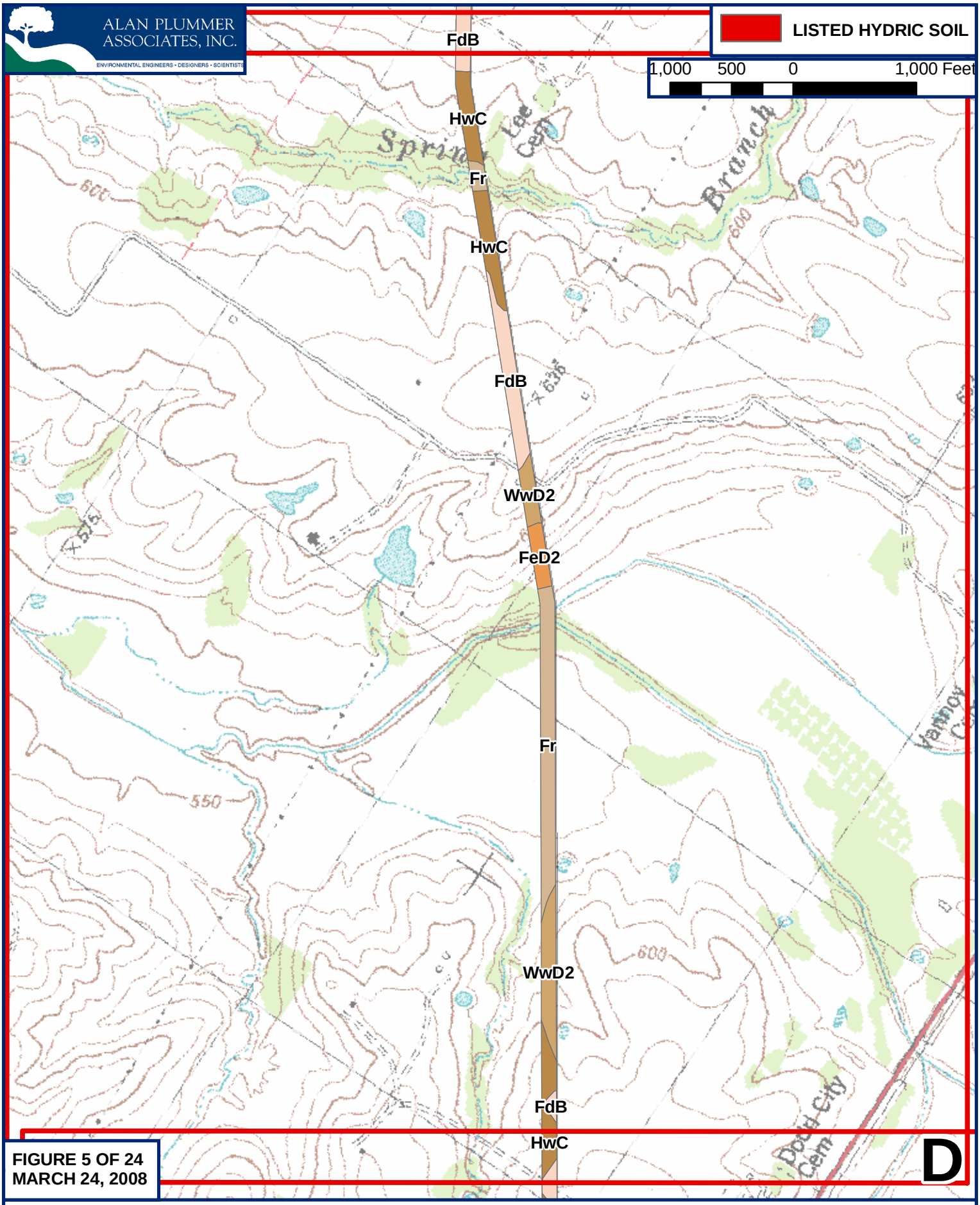

FIGURE C-5
SOIL MAP UNITS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

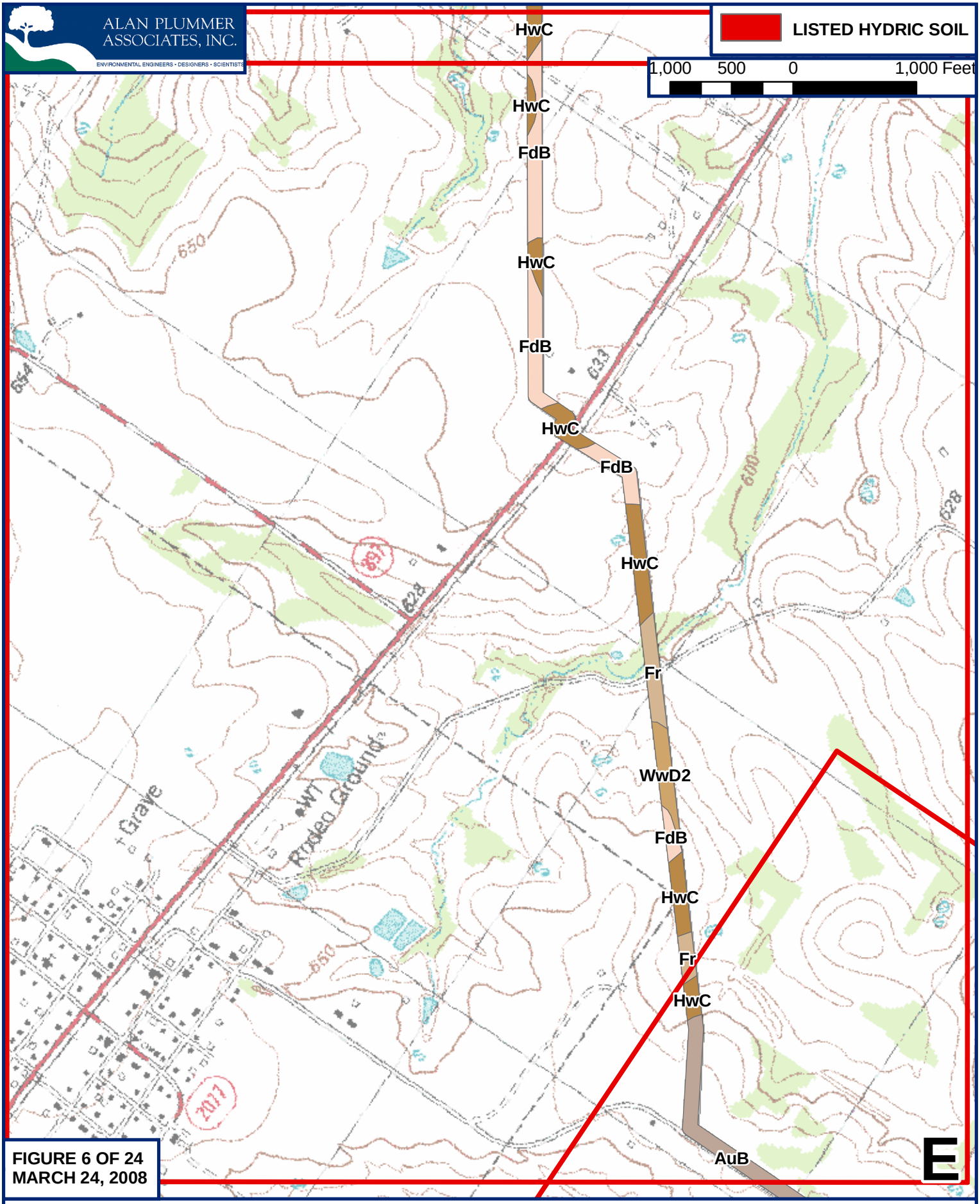

FIGURE 6 OF 24
MARCH 24, 2008

FIGURE C-6
SOIL MAP UNITS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

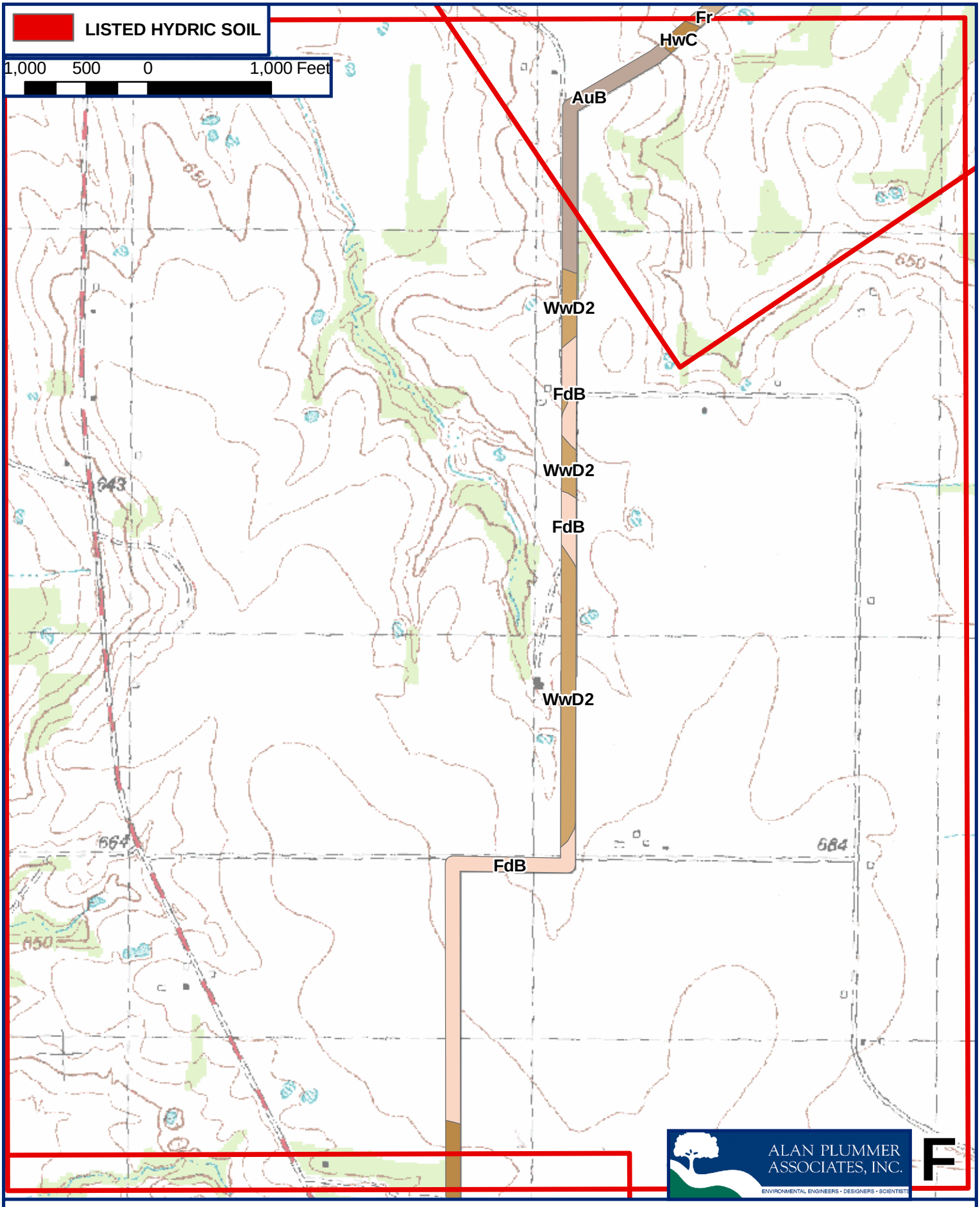

FIGURE C-7
SOIL MAP UNITS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

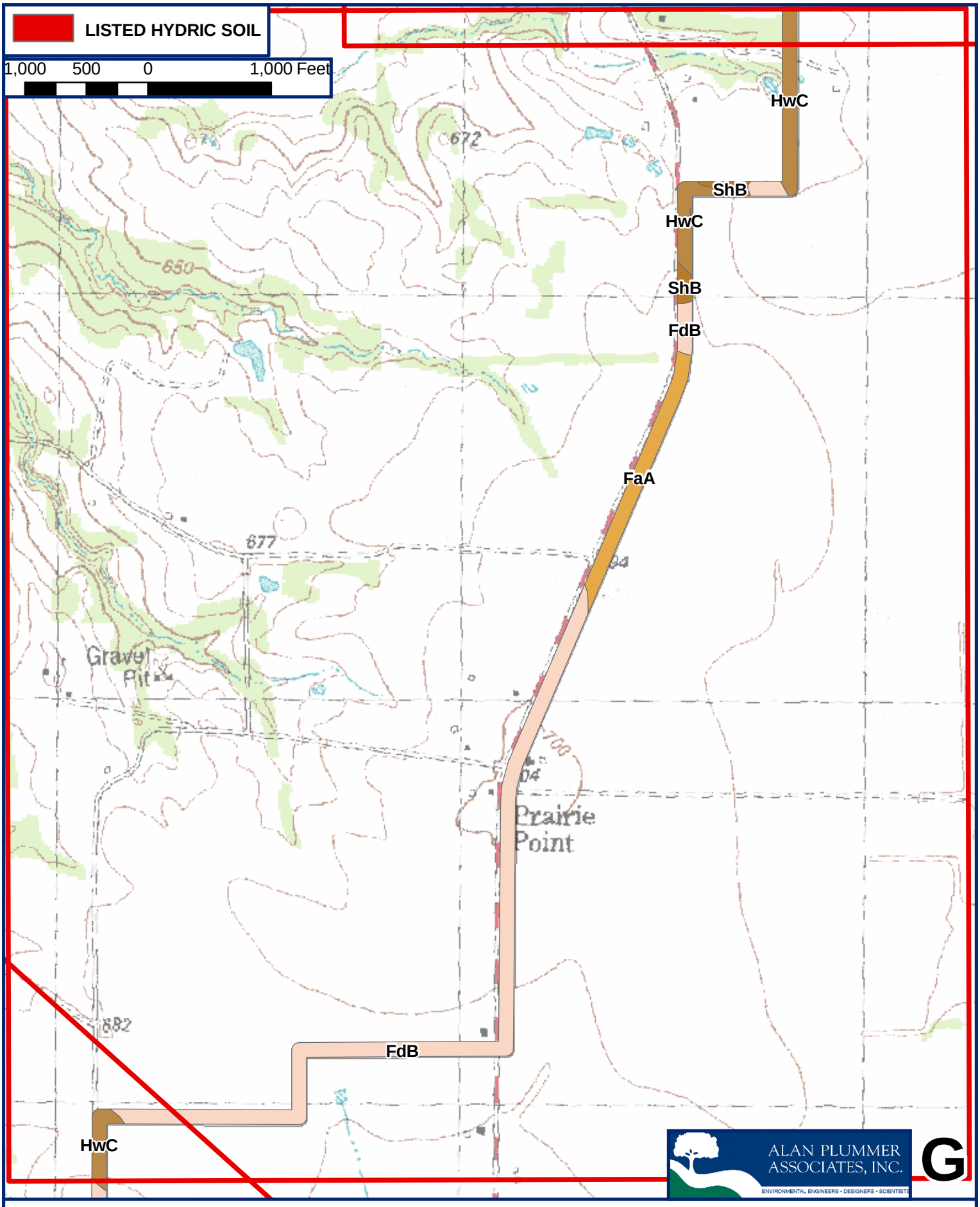

FIGURE C-8
SOIL MAP UNITS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

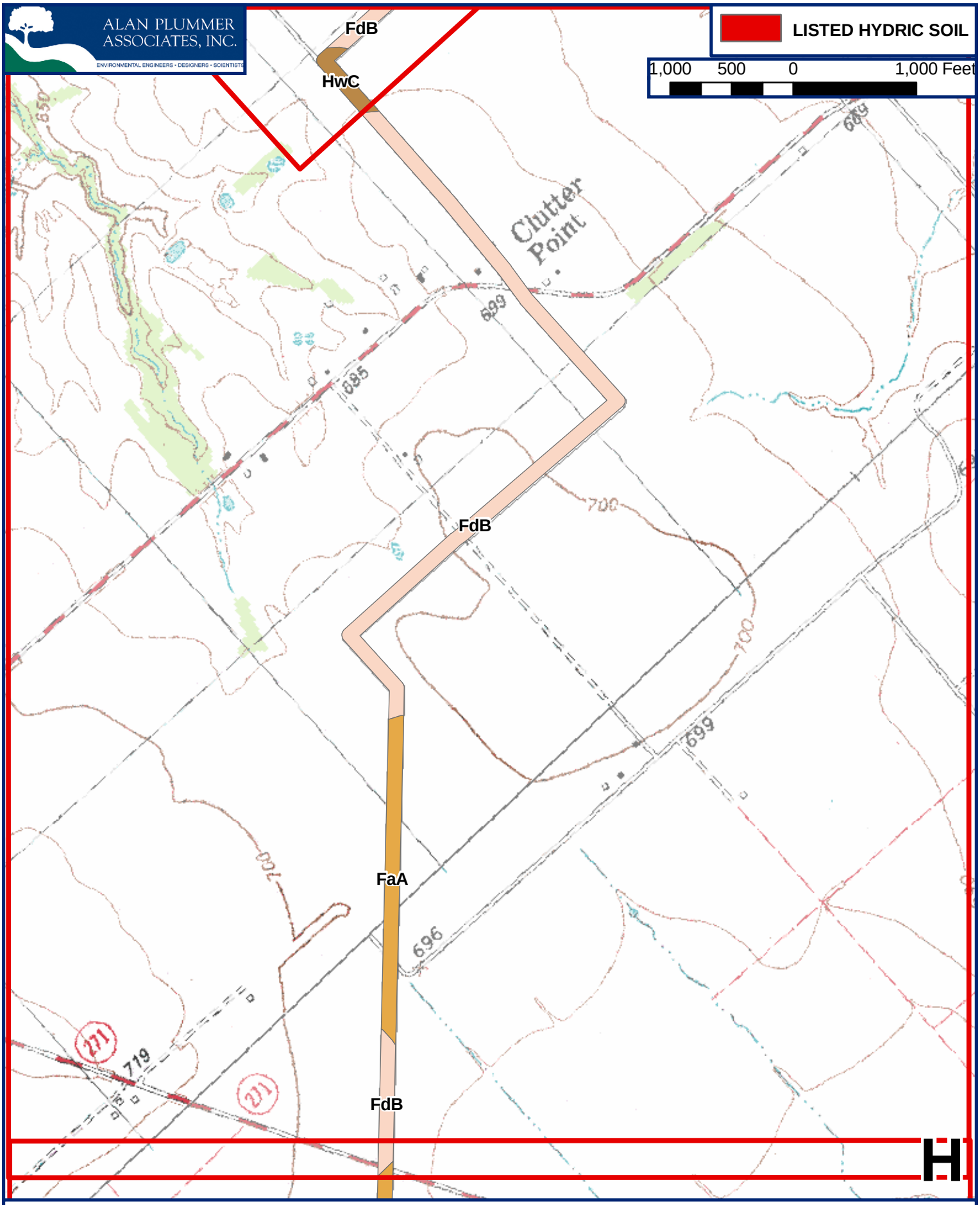

FIGURE C-9
SOIL MAP UNITS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

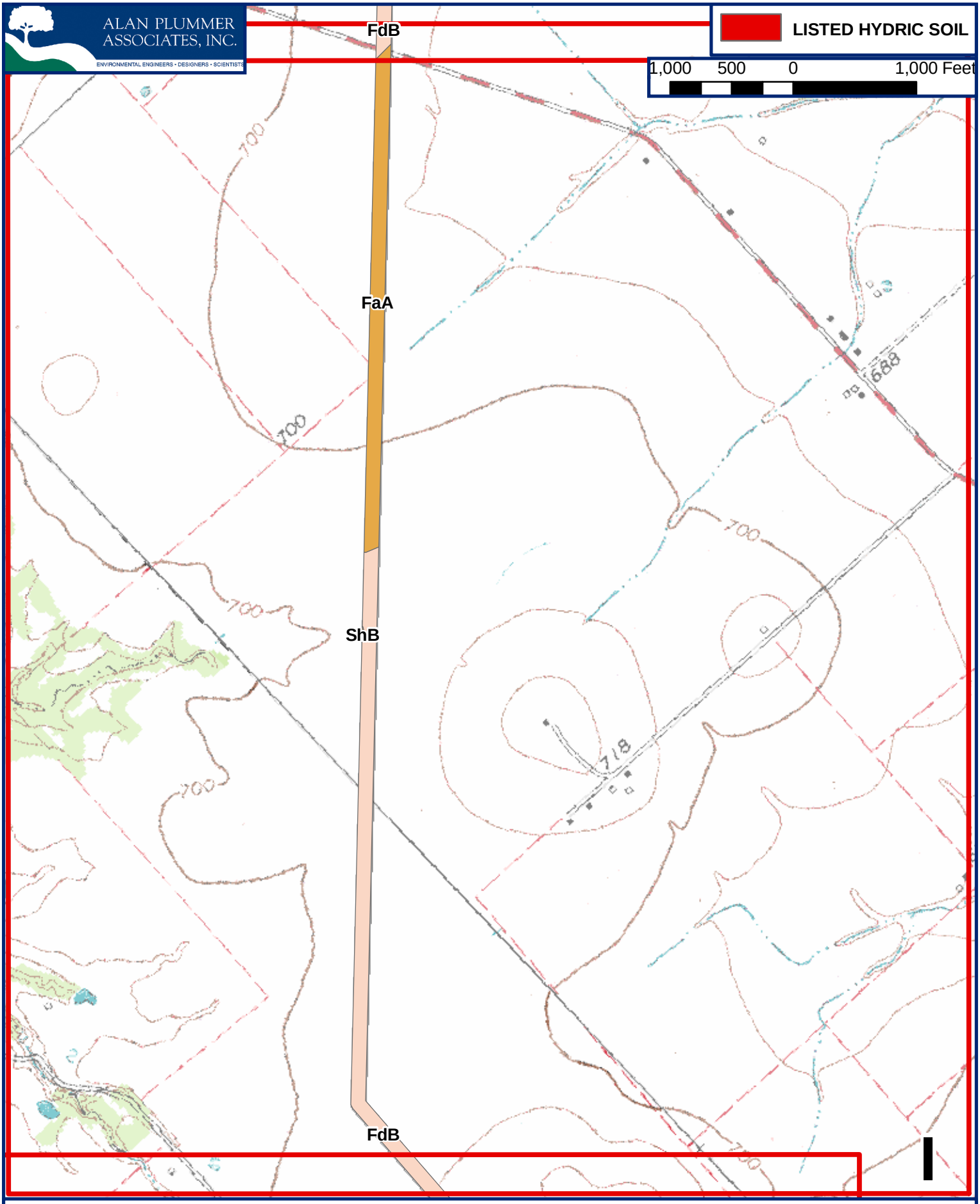

FIGURE C-10
SOIL MAP UNITS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

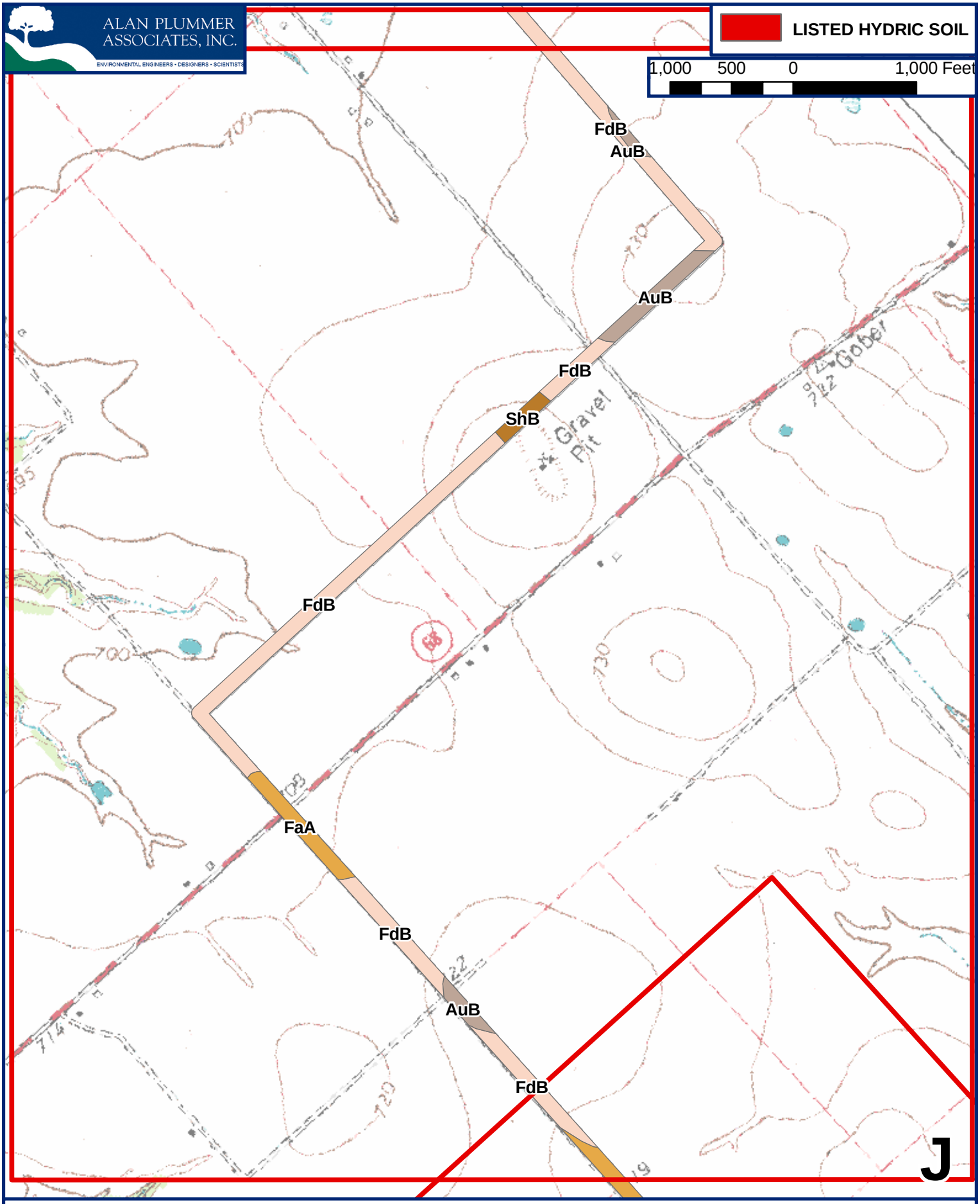

FIGURE C-11
SOIL MAP UNITS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

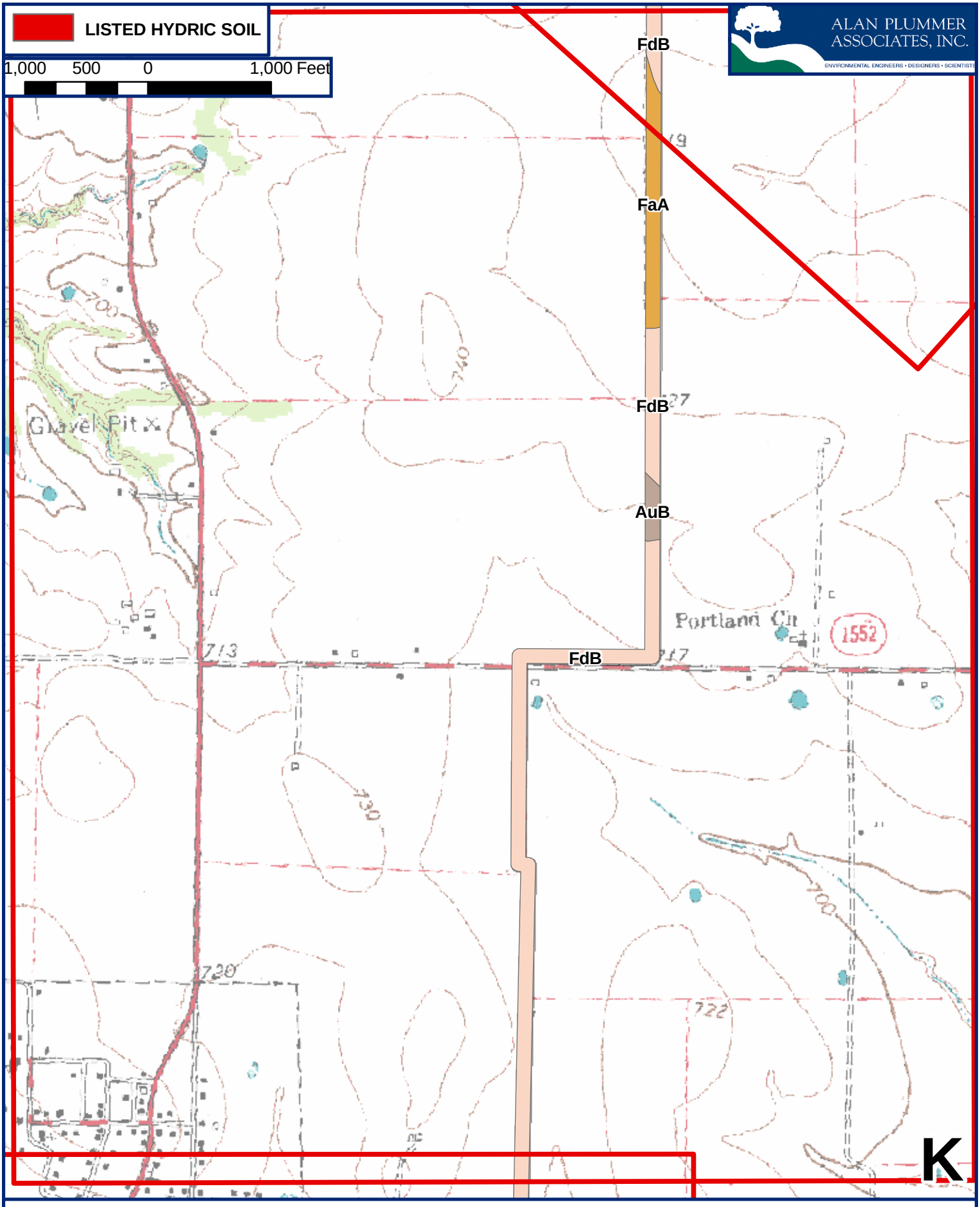

FIGURE C-12
SOIL MAP UNITS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

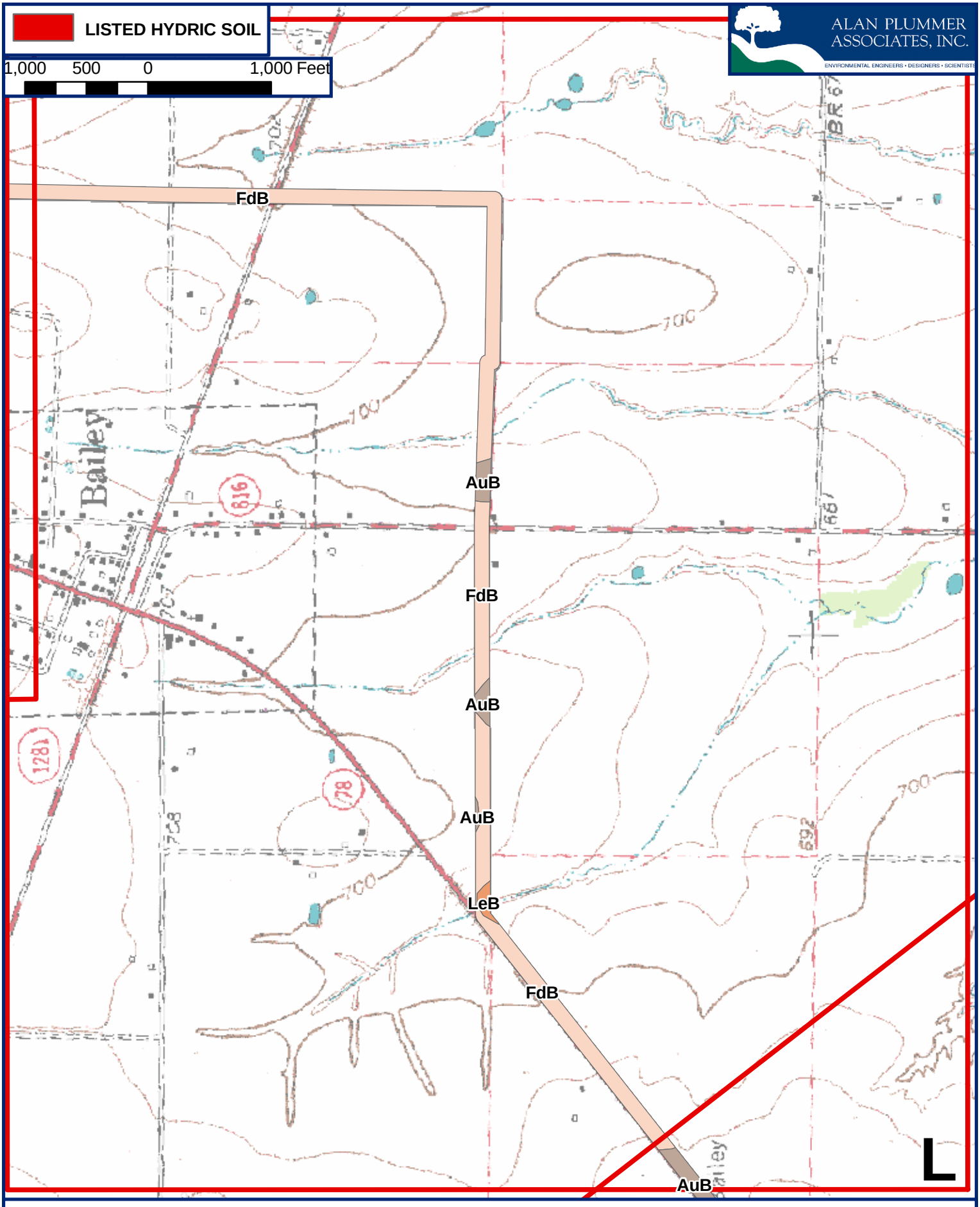

FIGURE C-13
SOIL MAP UNITS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

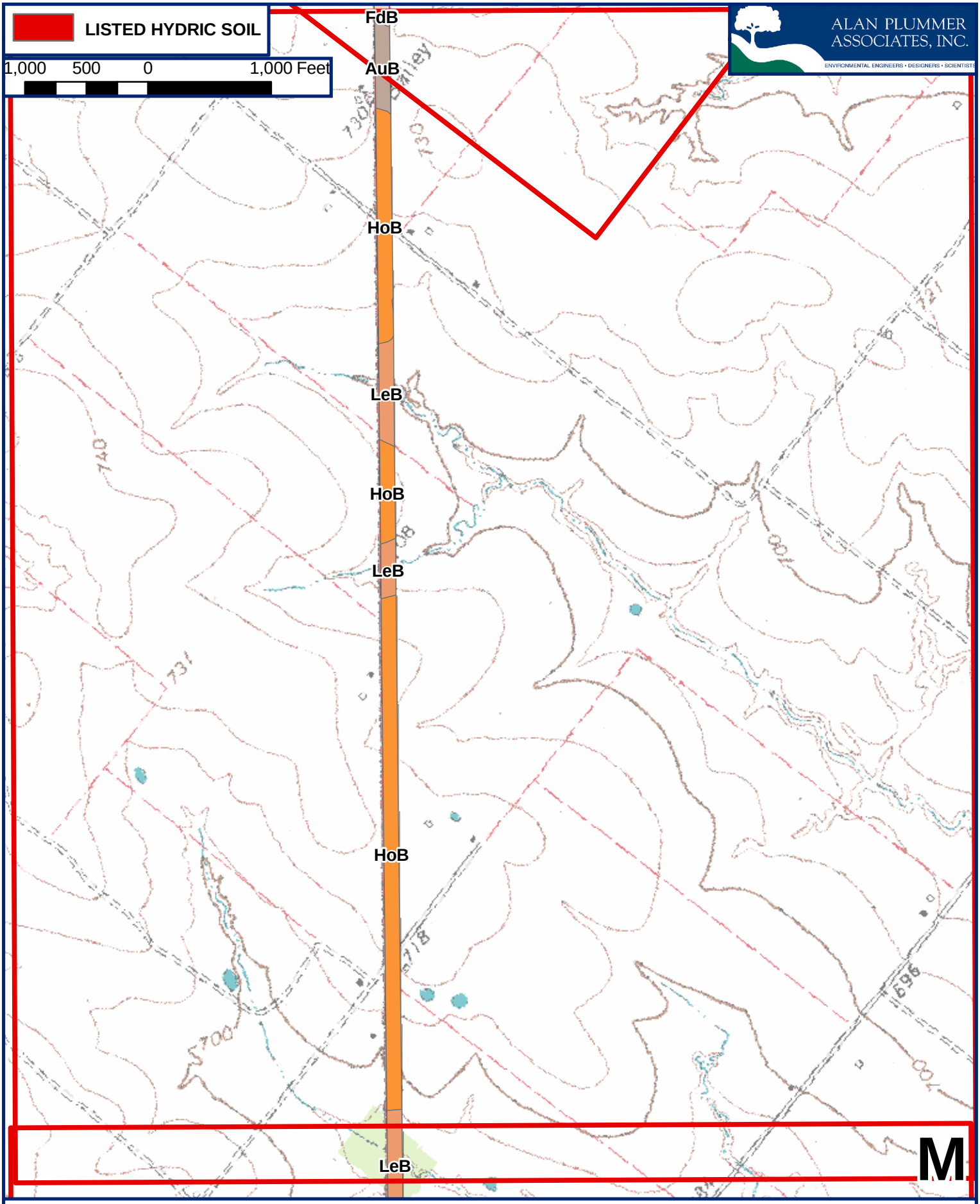

FIGURE C-14
SOIL MAP UNITS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

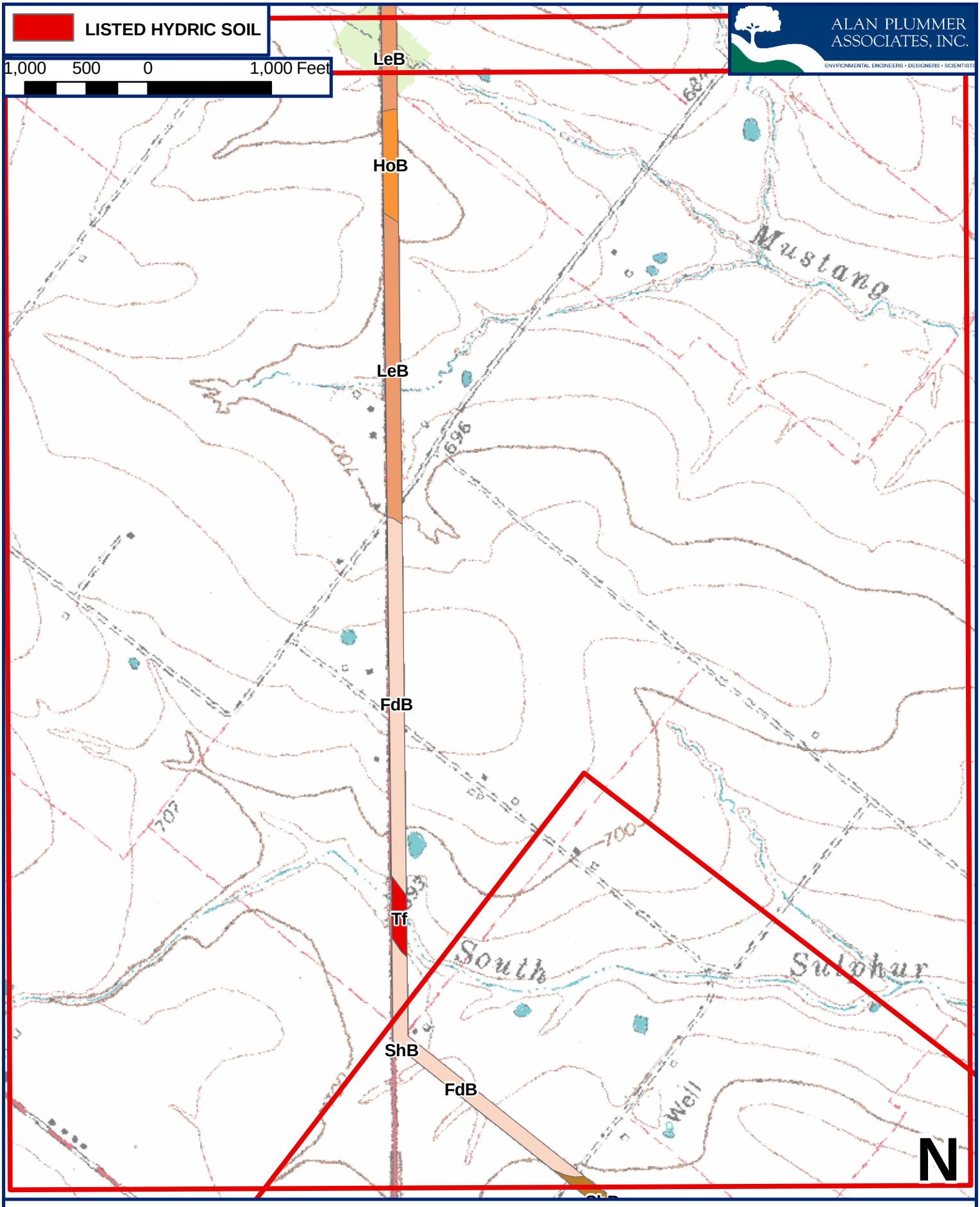

FIGURE C-15
SOIL MAP UNITS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

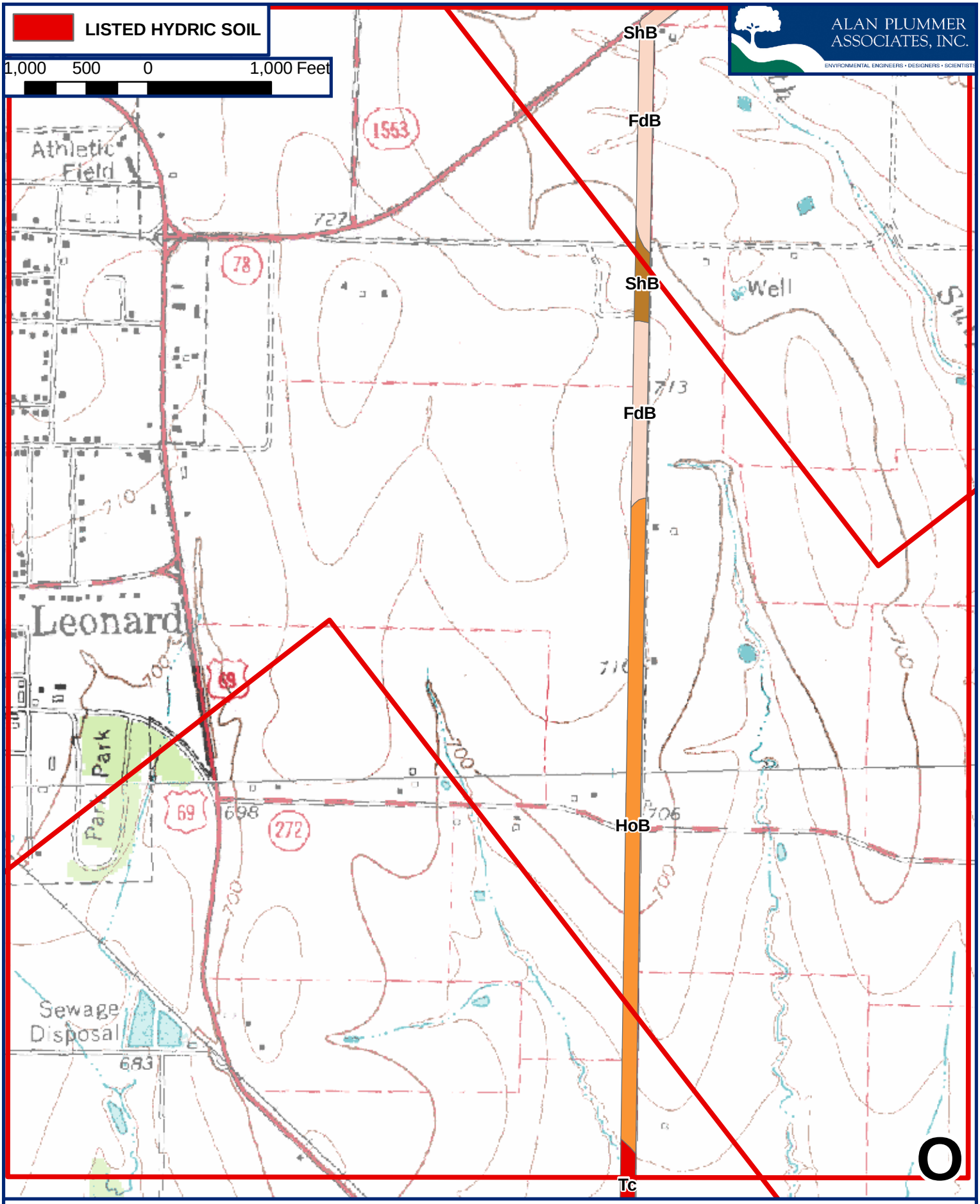

FIGURE C-16
SOIL MAP UNITS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 16 OF 24
MARCH 24, 2008

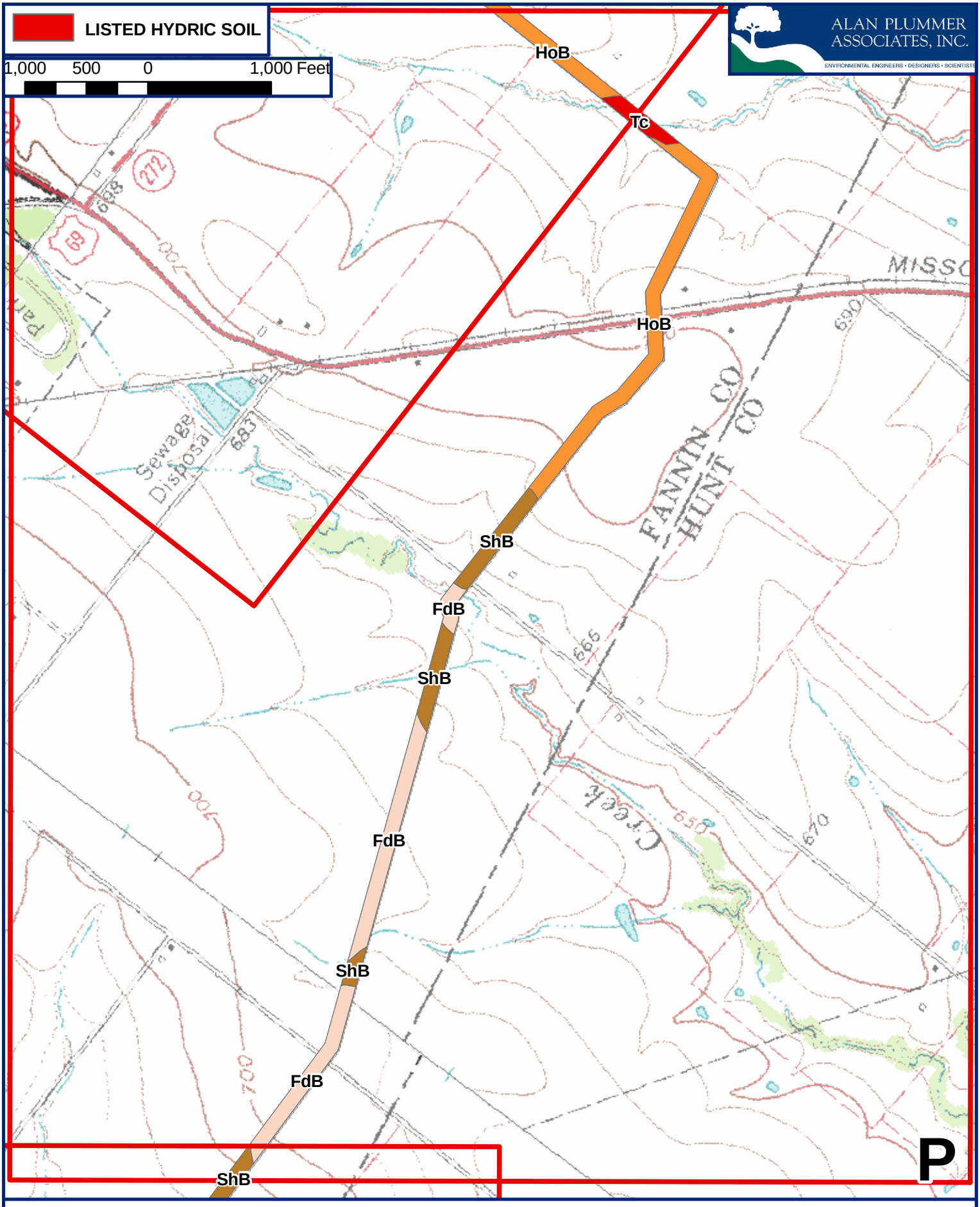

FIGURE C-17
SOIL MAP UNITS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

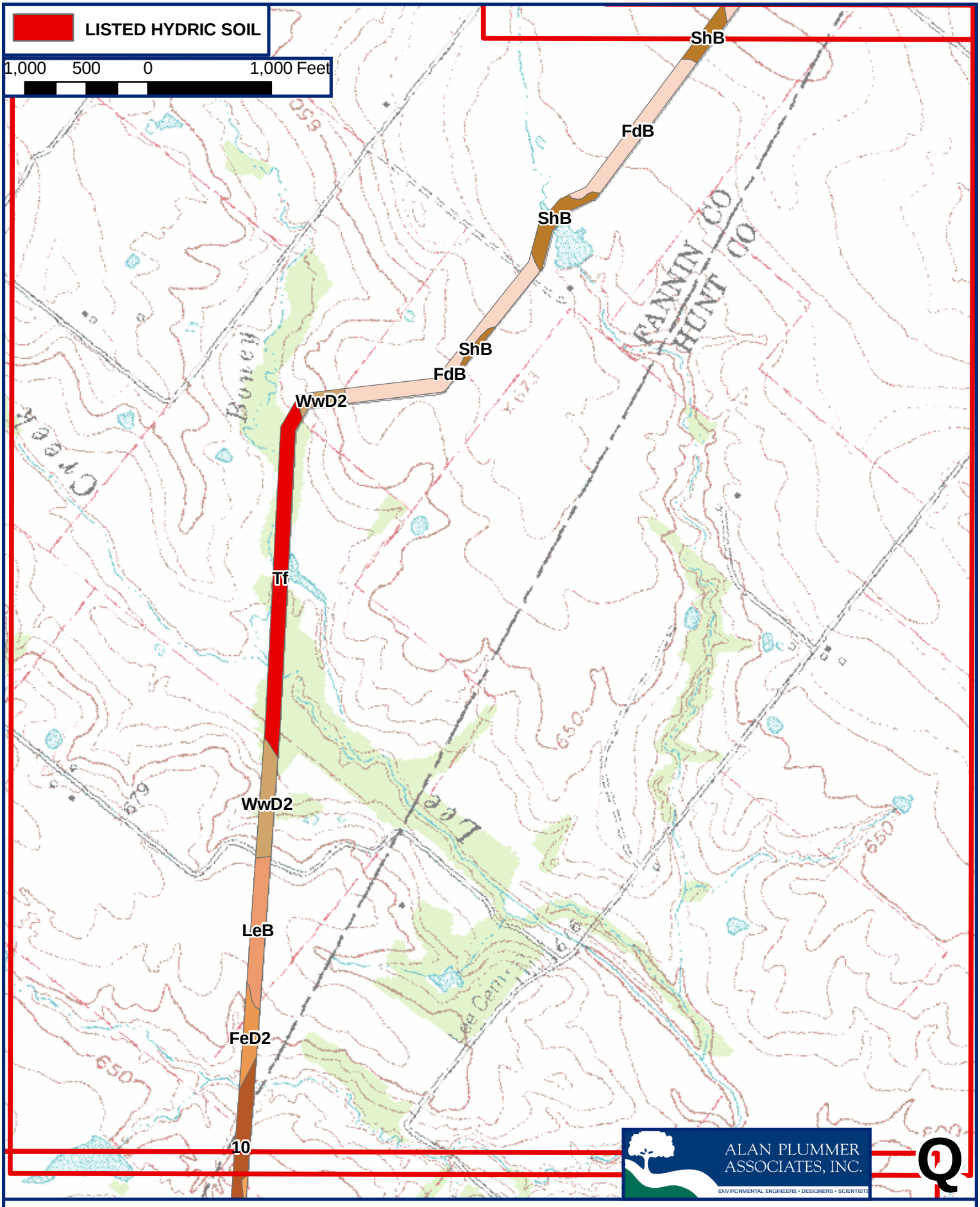

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FIGURE C-18
SOIL MAP UNITS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

FIGURE 18 OF 24
MARCH 24, 2008

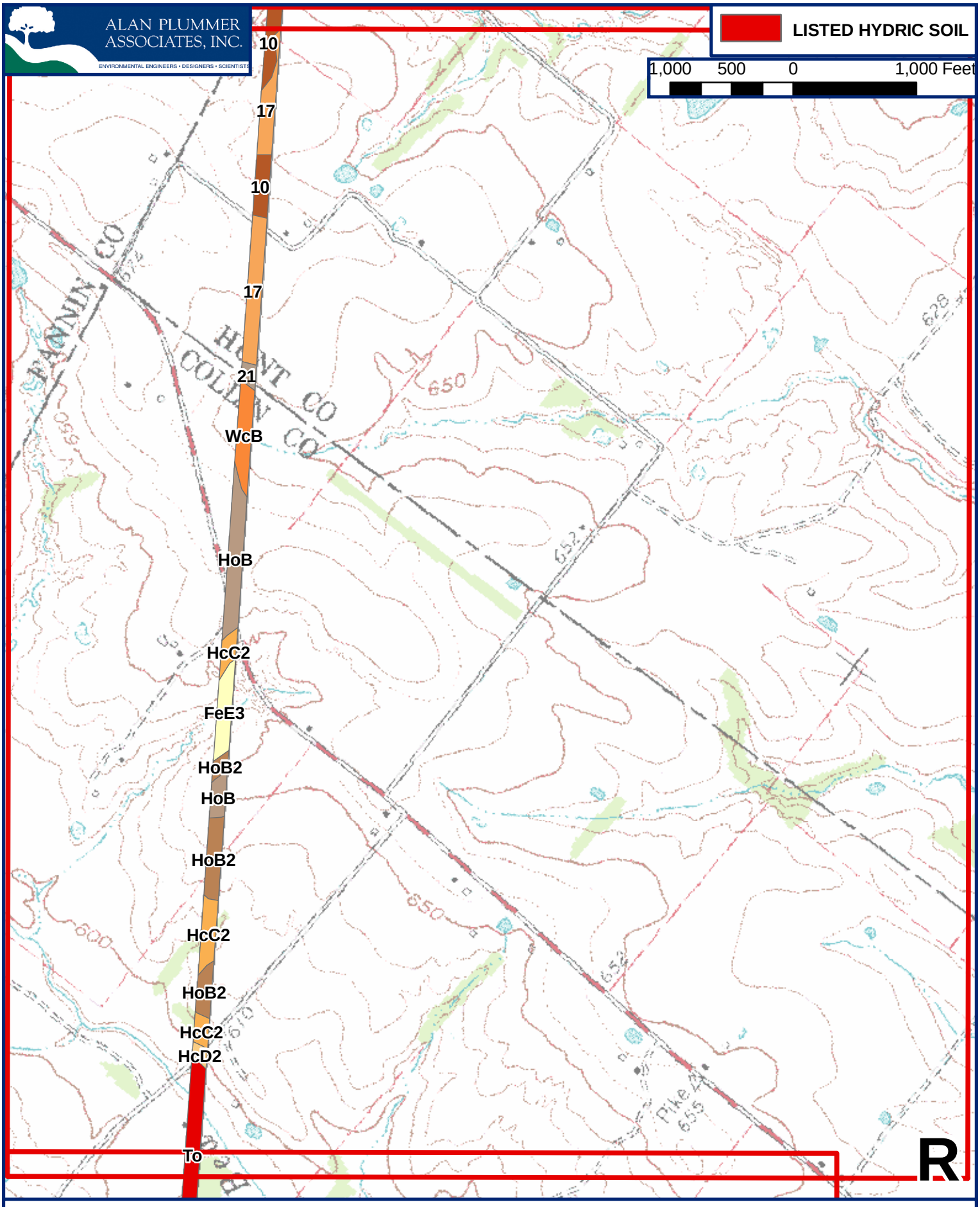

FIGURE C-19
SOIL MAP UNITS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

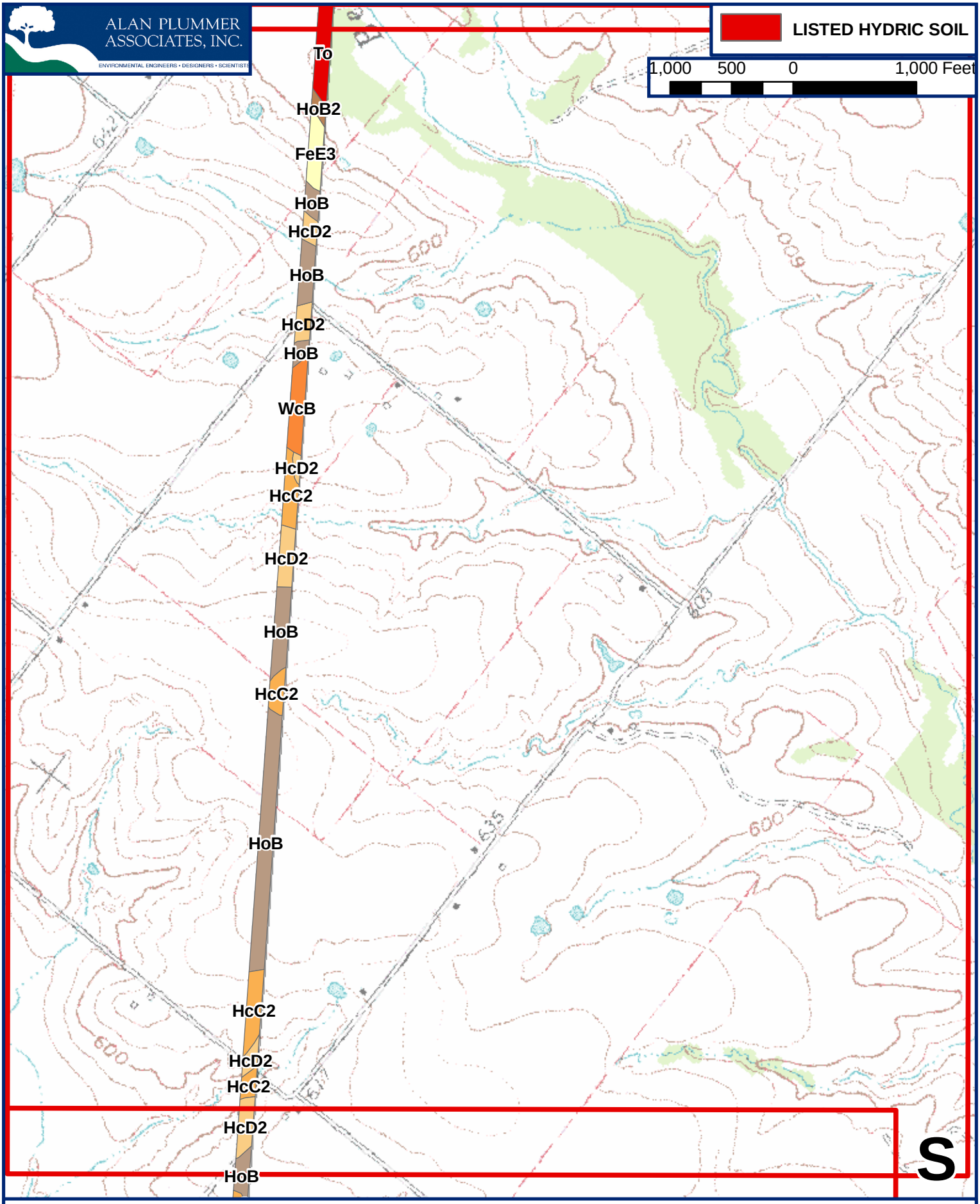

FIGURE C-20
SOIL MAP UNITS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

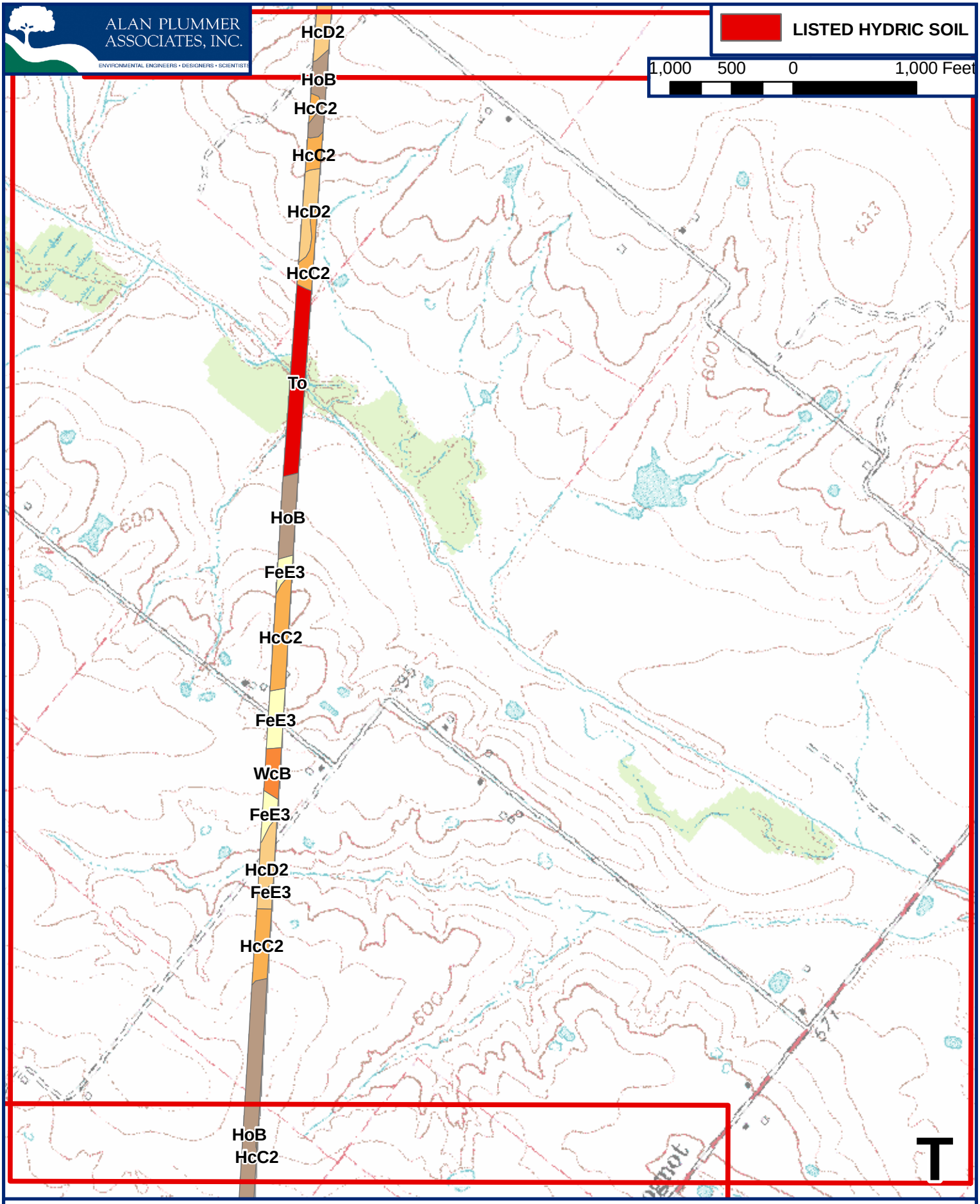

FIGURE C-21
SOIL MAP UNITS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

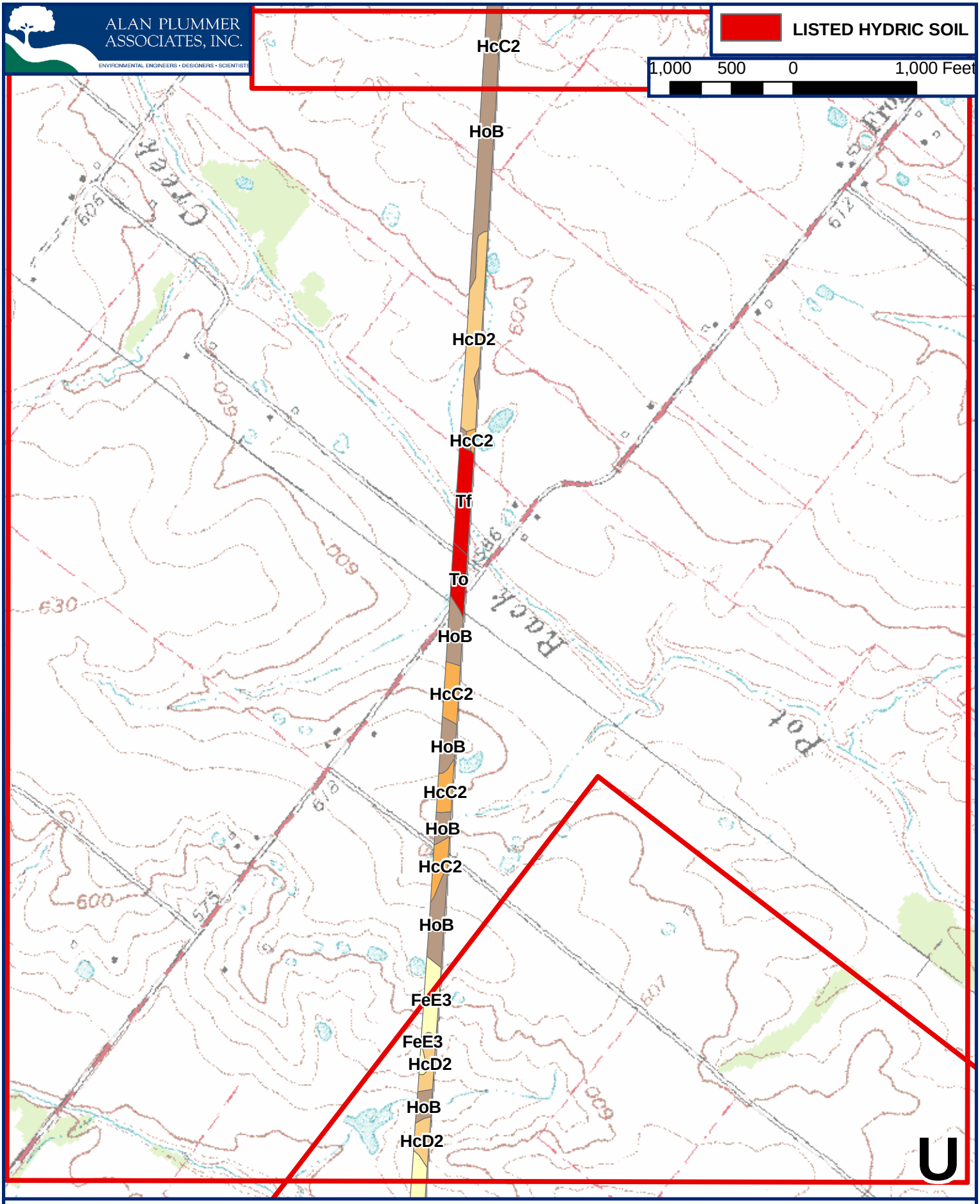

FIGURE C-22
SOIL MAP UNITS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

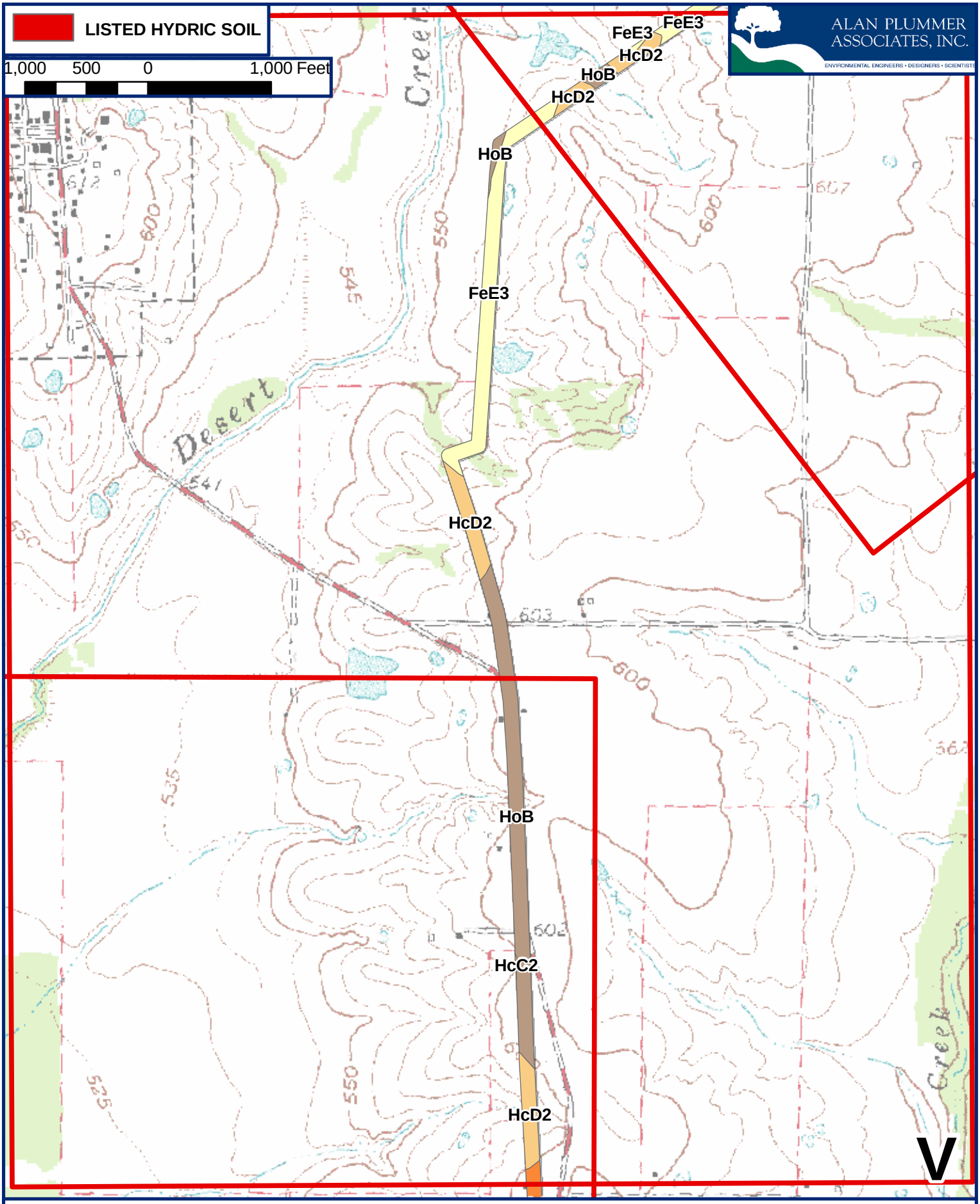

FIGURE C-23
SOIL MAP UNITS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

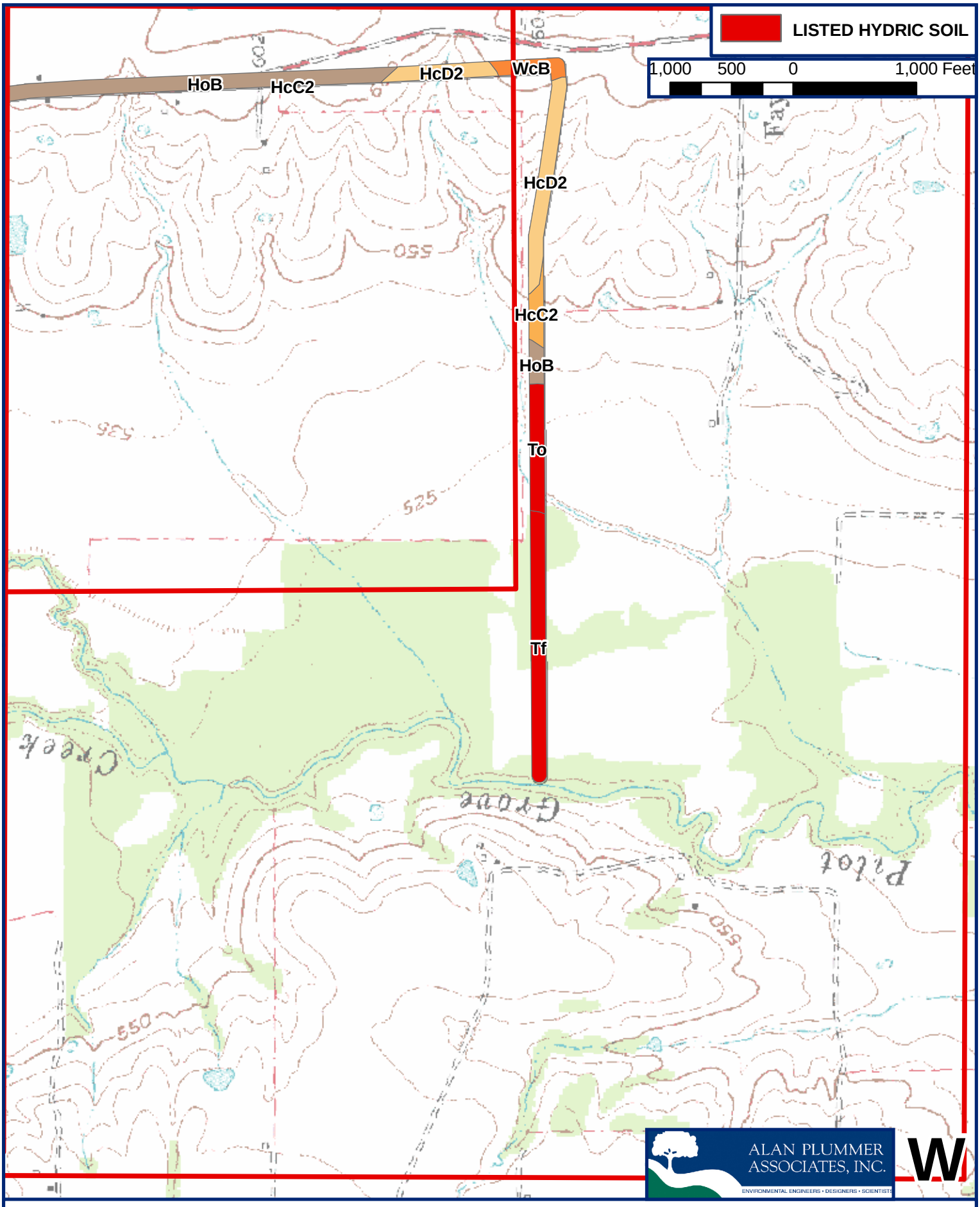

FIGURE C-24
SOIL MAP UNITS
PROPOSED BOIS D'ARC RESERVOIR - RAW WATER TRANSMISSION PIPELINE

DESCRIPTIONS OF THE MAPPED SOIL UNITS

From Soil Surveys of Collin, Hunt, and Fannin Counties, Texas. United States Department of Agriculture, Soil Conservation Service in Cooperation with the Texas Agriculture Experiment Station.

AUSTIN SERIES

The Austin series consists of moderately deep, well drained, moderately slowly permeable soils that formed in chalk and interbedded marl. These soils are on nearly level to sloping erosional uplands. Slopes range from 0 to 8 percent.

TAXONOMIC CLASS: Fine-silty, carbonatic, thermic Udorthentic Haplustolls

TYPICAL PEDON: Austin silty clay--cropland. (Colors are for dry soil unless otherwise stated.)

Ap--0 to 6 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak fine granular and subangular blocky structure; hard, firm but crumbly, sticky, plastic; many fine roots; many fine and very fine pores; many wormcasts; few fine calcium carbonate concretions; calcareous, moderately alkaline; clear smooth boundary. (4 to 8 inches thick)

A--6 to 15 inches; dark brown (10YR 4/3) silty clay, dark brown (10YR 3/3) moist; moderate very fine subangular blocky and granular structure; hard, firm but crumbly, sticky, plastic; many fine roots; many fine and very fine pores; many wormcasts; common fine calcium carbonate concretions; calcareous, moderately alkaline; gradual smooth boundary. (4 to 12 inches thick)

Bw1--15 to 27 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; moderate fine subangular blocky structure; hard, firm, crumbly, sticky, plastic; few fine roots; many fine pores; many light yellowish brown (2.5Y 6/4) wormcasts; common fine calcium carbonate concretions; few fine fragments of chalk; calcareous, moderately alkaline; clear smooth boundary. (10 to 20 inches thick)

Bw2--27 to 30 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; moderate fine subangular blocky structure; hard, firm, sticky, plastic; few fine roots; common wormcasts; about 30 percent platy fragments of chalk less than 3 inches in the axis; calcareous, moderately alkaline; clear irregular boundary. (0 to 10 inches thick)

Cr--30 to 36 inches; white (10YR 8/2) and very pale brown (10YR 8/4) platy chalk that is less hard than 3, Mohs scale; few thin tongues of brown silty clay in crevices between chalk plates.

TYPE LOCATION: McLennan County, Texas; 0.4 mile northeast of the intersection of Robinson Road and Interstate 35, which is 2 miles northeast of Lorena, 150 feet southeast of Robinson Road and 200 feet south of a metal barn.

RANGE IN CHARACTERISTICS: The solum ranges from 20 to 40 inches thick. It is silty clay loam, silty clay, or clay, with clay contents of 35 to 55 percent. Silicate clay content ranges from 20 to 35 percent. Below the A horizon, the soil ranges from 40 to 70 percent calcium carbonate equivalent. Some pedons have few to common fragments of chalk on the surface and within the sola.

The A horizon is brown, dark grayish brown, grayish brown or very dark grayish brown with hue of 7.5YR, 10YR, or 2.5Y, moist value of 3.5 or less and chroma of 2 or 3. It is 8 to 20 inches thick.

The B horizon has colors in shades of brown or gray with hue of 7.5YR, 10YR or 2.5Y, value of 5 to 7, chroma of 2 to 4.

The substrata are platy chalk, interbedded chalk and marl, or soft limestone bedrock.

COMPETING SERIES: These are the Lott series in the same family and the Altoga, Bolar, Brackett, Denton, Krum, Lewisville, Nuvalde, Patrick, Somervell, Stephen, and Valera series. Altoga and Brackett soils lack mollic epipedons, and Brackett soils have sola less than 20 inches thick. Bolar soils have more than 15 percent coarser than very fine sand in the control section. Denton and Krum soils have cracks 0.4-inch wide at depths of 20 inches when dry. Lewisville soils have less than 40 percent calcium carbonate within depths of 40 inches and are not underlain by chalk. Lott soils have sola more than 40 inches deep and are underlain by marl. Nuvalde soils have more than 35 percent noncarbonate clay in the control section. Patrick soils are sandy in the lower part of the control section. Somervell soils contain more than 35 percent coarse fragments. Stephen soils lack B horizons and are less than 20 inches thick. Valera soils have petrocalcic horizons.

GEOGRAPHIC SETTING: Austin soils are on uplands. Slope gradients are mainly less than 5 percent but range from 0 to 8 percent. The soil formed in mainly chalk or interbedded marl and chalk and is mostly of the Austin Formation. In places, the soil formed in soft limestone. The climate is warm subhumid. Mean annual precipitation ranges from 30 to 45 inches, mean annual temperature from 63 degrees to 70 degrees F, and Thornthwaite P-E indices from 44 to 66.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Stephen series and the Eddy, Dalco, Fairlie, Houston Black, Howe, and Whitewright series. Eddy and Whitewright soils have sola less than 20 inches deep and in addition they have ochric epipedons. Dalco, Fairlie and Houston Black soils have intersecting slickensides. Howe soils have ochric epipedons. Eddy and Stephen soils occupy similar positions to Austin soils. Dalco, Fairlie and Houston Black soils occupy lower positions in the landscape. Howe and Whitewright soils occupy adjacent sideslopes.

DRAINAGE AND PERMEABILITY: Well drained; medium to rapid runoff; moderately slow permeability.

USE AND VEGETATION: Mainly cultivated. Principal crops are small grains, cotton, and grain sorghums. Some areas are used for native range. Original vegetation was mid and tall grasses such as little bluestem, indiangrass, and sideoats grama. Grasses now are mainly gramas and buffalograss.

DISTRIBUTION AND EXTENT: The Blackland Prairies of Texas. The series is extensive.

MLRA OFFICE RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Travis County, Texas; 1904.

REMARKS: Classification was changed 11/89 from fine-silty, carbonatic, thermic Entic Haplustolls to fine-silty, carbonatic, thermic Udorthentic Haplustolls.

Diagnostic horizons and features recognized in this pedon are:

Mollic epipedon - 0 to 15 inches, the Ap and A horizons.

Cambic horizon - 15 to 30 inches, the Bw1 and Bw2 horizons.

Paralithic contact of platy chalk at a depth of 30 inches.

Calcium carbonate equivalent in the control section of more than 40 percent.

National Cooperative Soil Survey, U.S.A.

CROCKETT SERIES

The Crockett series consists of soils that are deep to weathered shale. They are moderately well drained, and very slowly permeable. These soils are on uplands. These nearly level to moderately sloping soils formed in alkaline residuum derived from shales and clays. Slopes are dominantly 1 to 5 percent, but range from 0 to 10 percent.

TAXONOMIC CLASS: Fine, smectitic, thermic Udertic Paleustalfs

TYPICAL PEDON: Crockett fine sandy loam--cropland. (Colors are for dry soil unless otherwise stated).

Ap--0 to 8 inches; dark brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) moist; massive; very hard, friable; few wormcasts; moderately acid; abrupt wavy boundary. (4 to 15 inches thick)

Bt1--8 to 16 inches; distinctly and coarsely mottled reddish brown (5YR 4/4) and dark brown (10YR 4/3) clay, moderate fine and medium angular blocky structure; extremely hard, very firm; few fine pores; distinct clay films and dark grayish brown stains on surfaces of peds, few fine pressure faces; vertical cracks partially filled with darker soil; few fine black iron-manganese concretions; few fine and medium prominent dark red (10R 3/6) masses of iron accumulation; moderately acid; diffuse wavy boundary.

Bt2--16 to 30 inches; olive (5Y 5/4) clay, moderate medium and coarse angular blocky structure; extremely hard, very firm; few fine pores; thin clay films on surfaces of peds, few fine pressure faces; few small slickensides; few vertical streaks of dark brown soil that is less clayey; few fine black iron-manganese concretions; common medium and coarse distinct reddish brown (5YR 4/4), and yellow (10YR 7/6) masses of iron accumulation, common medium and coarse distinct grayish brown (10YR 5/2) iron depletions; slightly acid; gradual wavy boundary.

Bt3--30 to 42 inches; pale olive (5Y 6/4) clay, olive (5Y 5/4) moist; weak coarse angular blocky structure; extremely hard, very firm; thin patchy clay films; few fine pressure faces; few small slickensides; few fine black concretions; few black streaks or stains on faces of peds; common medium distinct pale yellow (5Y 7/4) masses of iron accumulation, and common medium distinct light brownish gray (2.5Y 6/2) iron depletions; neutral; gradual wavy boundary. (combined thickness of Bt horizons is 14 t 45 inches)

BCtk--42 to 57 inches; distinctly and coarsely mottled light brownish gray (2.5Y 6/2) and pale olive (5Y 6/4) clay; weak coarse angular blocky structure; extremely hard, very firm; few thin clay films on surfaces of peds; few pressure faces and cleavage planes; few calcium carbonate concretions; few masses of calcium carbonate to 1/2-inch in diameter; few fine black iron-manganese concretions; few black streaks along pressure faces and cleavage planes; slightly alkaline; abrupt smooth boundary. (10 to 30 inches thick)

Ck1--57 to 73 inches; pale yellow (2.5Y 7/4) stratified clay loam, light yellowish brown (2.5Y 6/4) moist; massive; extremely hard and very firm in place, friable when broken; 25 percent of weakly cemented, brittle weathered shale fragments; 20 percent white calcium carbonate masses and concretions; common medium distinct dark yellowish brown (10YR 4/4) masses of iron accumulations, mainly along fractures of weathered shale; violently effervescent; moderately alkaline; diffuse smooth boundary. (0 to 30 inches thick)

Ck2--73 to 80 inches; pale yellow (2.5Y 7/4) clay loam containing about 40 percent interbedded weakly consolidated shale in layers of 1/2 to about 2 inches, shale is light olive brown (2.5Y 5/4) in lower part; massive; extremely hard, very firm in place, friable when broken; 10 percent masses of calcium carbonate in the upper part grading to none in the lower part; soil matrix is violently effervescent in spots and shale is noncalcareous; moderately alkaline.

TYPE LOCATION: Kaufman County, Texas; 250 feet east of Farm Road 986; 1.5 miles north of post office in Terrell.

RANGE IN CHARACTERISTICS: Solum thickness ranges from 40 to 60 inches. Depth to secondary carbonates ranges from 30 to 60 inches. Some pedons do not have visible carbonates. When dry, cracks 1/2 to about 2 inches wide extend from the top of the Bt horizon to depths of 2 to 5 feet. If the A horizon is eroded or thin, the soil cracks to the surface. Pressure faces and slickensides range from few to common throughout the Bt horizon and in the BC and C horizon of some pedons. The average clay content of the control section ranges from 40 to 50 percent, and COLE ranges from 0.07 to 0.10.

The thickness of the A horizon averages less than 10 inches in 50 percent or more of the pedon but ranges up to 15 inches in subsoil troughs. It has colors with hue of 7.5YR or 10YR, value of 3 to 6, and chroma of 2 to 4. Texture is fine sandy loam, very fine sandy loam, loam, silt loam or their gravelly counterparts. Siliceous pebbles range from 0 to 35 percent by volume. Reaction ranges from moderately acid to slightly alkaline. The boundary between the A and Bt horizon is commonly wavy. It is abrupt over subsoil crests and clear in subsoil troughs with an abrupt textural between the A and Bt horizons.

The Bt horizon has a base saturation of 75 to 100 percent by sum of the cations. The dominant color, degree, and distinctness of redoximorphic features in the Bt1 horizon may be extremely variable within a distance of a few feet. It ranges from prominently mottled in shades of brown, yellow, red and olive, to a matrix of reddish brown, dark yellowish brown, or brown, with few to common redoximorphic features as described in the mottled matrix. Texture of the Bt horizon is clay loam, clay, or sandy clay. Siliceous pebbles range from 0 to 15 percent by volume. Reaction of the Bt1 horizon ranges from moderately acid to neutral.

The Bt2 and lower Bt horizons have colors in shades of brown, olive, and yellow with or without reddish redoximorphic features. The reddish features decrease with depth and range from none to a few below the Bt2 horizon. Gray iron depletions range from none to common below the Bt2 horizon. Reaction ranges from slightly acid to moderately alkaline and is typically noncalcareous.

The BCtk horizon has matrix colors in shades of brown, olive, gray, yellow or the matrix is mottled with these colors or there are redoximorphic features, strata or fragments with these colors. Texture of the BCk is clay loam, or clay with or without weathered shale fragments, pockets of loamy materials, or strata of these materials interbedded.

The Ck is in shades of brown, olive or gray. It is mainly shale or clayey siltstone stratified with soil material ranging from loam to clay. Silt and clay dominate the shale materials. Siliceous pebbles range from none to about 5 percent by volume. Reaction ranges from slightly acid to moderately alkaline but typically is slightly or moderately alkaline. Masses and concretions of calcium carbonate range from none to many.

COMPETING SERIES: These are the Axtell, Bremond, Crosstell, Kurten, Navo, Tabor, and Zulch series. Similar soils are the Normangee and Ponder series. Axtell, Kurten and Tabor soils

are strongly acid in the Bt1 horizon and have base saturation of less 75 percent. Bremond soils have sola more than 60 inches thick. Crosstell and Kurten soils have hue of 7.5YR or redder in the upper part of the Bt horizon. Navo soils do not have an abrupt textural change between the A and B horizons. In addition, Axtell, Navo, and Tabor soils also have sola from 60 to greater than 80 inches. Zulch soils have sola 20 to 40 inches thick. Normangee soils do not have an abrupt textural change between the A and Bt horizons. Ponder soils do not have redoximorphic features in the upper part of the Bt horizon.

GEOGRAPHIC SETTING: Crockett soils are on broad nearly level to moderately sloping uplands. Slopes range from 0 to 10 percent, but are mostly between 1 and 5 percent. The soil formed in residuum derived from weathered alkaline marine clays, sandy clays, or shale, interbedded with sandier materials, mainly of Cretaceous age. Mean annual temperatures ranges from 64 to 70 degrees F., and mean annual precipitation ranges from 32 to 45 inches. Frost free days range from 230 to 275 days, and elevation ranges from 200 to 800 feet. Thornthwaite P- E indices ranges from 50 to 75.

GEOGRAPHICALLY ASSOCIATED SOILS: These include the Axtell, Bonham, Burleson, Mabank, Normangee, Payne and Wilson series. Bonham soils have mollic epipedons and have sola greater than 60 inches. Burleson soils are clays throughout with slickensides. Mabank and Wilson soils are dominated by chromas or 2 or less. Axtell, Bonham, Normangee, and Payne soils are on similar landscapes with Crockett soils. Burleson, Mabank, and Wilson soils are on lower positions.

DRAINAGE AND PERMEABILITY: Moderately well drained. Permeability is very slow. Runoff is low on slopes less than 1 percent, medium on 1 to 3 percent slopes, high on 3 to 5 percent slopes, and very high on 5 to 10 percent slopes.

USE AND VEGETATION: Mainly used for growing cotton, grain sorghums, and small grain, but more than half the acreage is now in pastures. Native vegetation is prairie grasses such as bluestems, indiangrass, switchgrass, and gramas, with scattered elm, hackberry, and mesquite trees.

DISTRIBUTION AND EXTENT: Mainly in the Blackland Prairies of Texas (MLRA 86A, 86B, 87A) but minor areas are in Oklahoma. The series is extensive.

MLRA OFFICE RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Houston County, Texas; 1905.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - 0 to 8 inches, layer is hard and massivewhen dry. (Ap horizon).

Pale feature - Abrupt textural change at 8 inches.

Argillic horizon - 8 to 57 inches. (Bt1, Bt2, Bt3 and BCtkhorizons)

Vertic properties - COLE is 0.07 to 0.10

Crockett and Axtell soils are close competitors. Native vegetation of Crockett was dominantly prairie grasses whereas that of Axtell was trees with an understory of grasses. Morphologically, Crockett soils are less acid and leached in the upper part of the Bt horizon than Axtell soils. At present, this difference is attributed primarily to vegetation.

ADDITIONAL DATA: LSL17760-17767, Kaufman County, Texas.

Soil Interpretation Record: TX0318

National Cooperative Soil Survey, U.S.A.

DALCO SERIES

The Dalco series consists of moderately deep, moderately well drained, very slowly permeable soils. These soils are on nearly level to gently sloping uplands. Slopes range from 0 to 5 percent.

TAXONOMIC CLASS: Fine, smectitic, thermic Leptic Udic Haplusterts

TYPICAL PEDON: Dalco clay--cropland - described at center of microdepression. (Colors are for dry soil unless otherwise stated.)

Ap--0 to 9 inches; very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; weak very fine angular and subangular blocky structure; very hard, very firm, very sticky and plastic; few fine roots; few fine chalk fragments and siliceous pebbles; slight effervescence; slightly alkaline; gradual smooth boundary. (4 to 10 inches thick)

Bss1--9 to 26 inches; black (10YR 2/1) clay, black (10YR 2/1) moist; moderate; very fine angular blocky structure; extremely hard, very firm, very sticky and plastic; few fine roots; common pressure faces; few grooved slickensides; slight effervescence; slightly alkaline; gradual wavy boundary.

Bss2--26 to 35 inches; dark gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; fine and very fine angular blocky structure; extremely hard, very firm, very sticky and plastic; few fine roots; common pressure faces; common grooved slickensides; few fine fragments of chalk in lower part; strong effervescence; moderately alkaline, abrupt wavy boundary. (combined Bss subhorizons are 18 to 34 inches thick)

Cr--35 to 60 inches; white (10YR 8/2) chalk that is platy in the upper 6 inches and massive below; few crevices between plates of chalk filled with marly soil material; hardness of chalk is less than 3 on Mohs scale.

TYPE LOCATION: Dallas County, Texas; 3.2 miles north of Garland. About 100 feet west of Galaxy Road and 1000 feet south of the intersection of Galaxy and Arapaho Roads.

RANGE IN CHARACTERISTICS: The solum and depth to a paralithic contact with chalk is 24 to 40 inches. It is silty clay or clay throughout. The weighted average clay content of the particle-size control section ranges from 40 to 50 percent. In undisturbed areas, gilgai microrelief consists of knolls 4 to 8 inches higher than depressions; distance between center of knoll and center of depression is 5 to 12 feet. When dry, cracks 1/2 to 2 inches wide extend from the surface to depths of 12 inches or more. Cracks remain open for 90 to 150 cumulative days during most years. Slickensides and/or wedge shaped peds begin at a depth of 8 to 18 inches. The effervescence ranges from very slight to strong. The reaction is slightly alkaline or moderately alkaline throughout.

The A horizon is black or very dark gray in hue of 10YR to 5Y, value of 2 or 3, and chroma of 1.

The Bss horizon has colors in hue of 10YR to 5Y, value of 2 to 5, and chroma of 1 or 2. Most pedons contain a few iron-manganese concretions. Calcium carbonate films, masses, and concretions and/or fragments of chalk range fron few to common in most pedons.

The Cr layer is massive chalk bedrock or stratified chalk and marl. The bedrock is platy in the upper part of some pedons and commonly becomes massive within a depth of 6 to 18 inches. It is white, light gray, or very pale brown with or without streaks or coatings in shades of yellow or brown. The hardness is less than 3 on Mohs scale.

COMPETING SERIES: These include the Crawford, Greenvine, San Saba, and the similar Anhalt, Austin, Fairlie, and Vertel series. Crawford and Anhalt soils have subsoils with hue redder than 10YR. Greenvine soils have a paralithic contact with tuffaceous siltstone or shale. San Saba soils have a lithic contact of limestone. Anhalt and Vertel soils have a very-fine particle-size control section and are noneffervescent in the upper part. Austin soils have carbonatic mineralogy and do not have large slickensides. Fairlie soils are 40 to 60 inches deep to a paralithic contact of chalk.

GEOGRAPHIC SETTING: Dalco soils are on nearly level to gently sloping uplands underlain by chalk. These soils formed mainly in the Austin Chalk of Upper Cretaceous Age. Slope gradients are generally less than 3 percent but range from 0 to 5 percent. The climate is warm subhumid. Average annual precipitation ranges from 30 to 42 inches, mean annual temperature from 64 to 68 degrees F. Frost free days range from 230 to 260. Elevation ranges from 550 to 850 above sea level. Thornthwaite P-E indices from from 54 to 70.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Austin and Fairlie series and the Eddy, Heiden, Houston Black, and Stephen series. The Austin soils are on slightly higher positions. Fairlie soils are on similar positions. Eddy and Stephen soils are shallow to chalk and are on similar to slightly lower positions. Heiden and Houston Black soils are very deep and are on similar positions of adjacent areas with different parent material.

DRAINAGE AND PERMEABILITY: Moderately well drained with very slow permeability. Water enters the soil rapidly when it is dry and very slow when it is moist. Runoff is low on 0 to 1 percent slopes; medium on 1 to 3 percent slopes; and high on 3 to 5 percent slopes.

USE AND VEGETATION: Mostly cultivated, some areas are used for pastures with bermudagrass or kleingrass. The main crops are cotton, grain sorghum, corn, and small grain. Native vegetation consists of tall and mid grass prairies of little bluestem, big bluestem, indiangrass, switchgrass, sideoats grama and annual grasses.

DISTRIBUTION AND EXTENT: The Blackland Prairies of Texas (MLRA 86A). The series is moderately extensive.

MLRA OFFICE RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Dallas County, Texas; 1974.

REMARKS: The Dalco series were previously included with the Austin, Houston Black, or San Saba series. Classification changed from Udic Pellusterts to Leptic Udic Haplusterts (2/94) based on issue 16, a revision to Soil Taxonomy.

Diagnostic horizons and features recognized in this pedon are:

Mollic epipedon--0 to 35 inches, the A, and Bss horizons.

Vertisol features--Cracks when dry, slickensides in Bss subhorizons.

Paralithic contact of chalk at a depth of 35 inches.

SOIL INTERPRETAAION RECORD NUMBER: TX0158

National Cooperative Soil Survey, U.S.A.

ELLIS SERIES

The Ellis series consists of soils that are moderately deep, to weathered shale. They are well drained, very slowly permeable soils that formed in weakly consolidated shale. These gently sloping to moderately steep soils are on erosional uplands. Slopes range from 1 to 20 percent.

TAXONOMIC CLASS: Fine, smectitic, thermic Udic Haplusterts

TYPICAL PEDON: Ellis clay--native pasture. (Colors are for dry soil unless otherwise noted.)

A--0 to 4 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; hard surface crust about 1/8-inch thick; moderate medium subangular and angular blocky structure; extremely hard, very firm, sticky, plastic; common fine roots; neutral; gradual smooth boundary. (2 to 10 inches thick)

Bw--4 to 13 inches; olive (5Y5/3) clay, olive (5Y 4/3) moist; moderate medium subangular and angular blocky structure; extremely hard, very firm, sticky, plastic; common fine roots; few fine and medium calcium carbonate concretions; neutral; gradual smooth boundary. (0 to 10 inches thick)

Bss1--13 to 23 inches; distinctly and coarsely mottled olive yellow (2.5Y 6/6) and gray (10YR 6/1) clay; weak coarse subangular blocky structure parting to moderate fine angular blocky structure; few small slickensides; extremely hard, very firm, sticky, plastic; few fine roots; few calcium carbonate concretions; slightly alkaline; gradual smooth boundary. (6 to 20 inches thick)

Bss2--23 to 30 inches; gray (N 6/) clay, few medium distinct mottles of brownish yellow (10YR 6/6) weak medium and fine subangular and angular blocky structure; few small slickensides; extremely hard, very firm, sticky, plastic; few fine roots; few fine calcium carbonate concretions; slightly alkaline; gradual smooth boundary. (0 to 12 inches thick)

C1--30 to 36 inches; distinctly and coarsely mottled light olive gray (5Y 6/2) and yellow (10YR 7/8) weakly consolidated shale that has clay texture; massive but natural cleavage of soft shale fragments form coarse angular rock-like structure; extremely hard, very firm, sticky, plastic; slightly alkaline; clear irregular boundary. (2 to 20 inches thick)

C2--36 to 66 inches; gray (N 6/) weakly consolidated shale that has clay texture; distinct yellow (10YR 7/8) mottles; few roots; material has rock-like angular structure; slightly alkaline.

TYPE LOCATION: Navarro County, Texas; from Kerens, 4.0 miles northwest on FM-636 to Bazette; then from the south side of Bazette, 2.2 miles east-northeast on a straight county road; then 50 feet south into pasture. Latitude 32 degrees 11' 44 N, Longitude 96 degrees 14' 22" W.

RANGE IN CHARACTERISTICS: Depth of solum is 20 to 40 inches. It is clay throughout with clay content ranging from 40 to 60 percent. Siliceous and ironstone pebbles range from none to a few throughout. Indurated iron spheroidal concretions 4 to 24 inches in diameter range from none to 1 to 3 concretions each 400 to 600 feet horizontal distance. Pressure faces and small slickensides range from few to common below the A horizon. When dry, the surface forms a crust up to 1/2-inch thick. Cracks extend from the surface to a depth of more than 12 inches. Cracks remain open 120 to 150 cumulative days in most years.

The A horizon has hue of 10YR or 2.5Y, value of 3 to 6, and chroma of 2 to 4. Horizons with moist value of 3 are less than 7 inches thick. The reaction ranges from slightly acid to moderately alkaline and most pedons are noncalcareous.

The Bw and Bss1 horizons has hue of 10YR or 2.5Y, value of 4 to 7, and chroma of 1 to 4. Gray colors are inherited from the shale. Redox concentrations in shades of brown, yellow and olive

range from none to common or the matrix is mottled with these colors. The reaction ranges from slightly acid to moderately alkaline. It is calcareous in the lower part of some pedons. Calcium carbonate concretions and masses range from none to a few.

The BSS2 horizon is in shades of gray, olive yellow, or brown typically with few to common mottles of these colors. Some pedons have a mottled matrix. The reaction ranges from neutral to moderately alkaline and calcareous in some pedons. Calcium carbonate concretions and masses range from none to common.

The C horizon is mottled or interbedded with colors in shades of gray, brown, yellow, or olive. It is clay intermixed and interbedded with soft shale. Reaction ranges from neutral to moderately alkaline with or without calcium carbonate concretions and soft masses. Some pedons have a few gypsum crystals between the interbedded layers.

COMPETING SERIES: These are Bleiblerville, Branyon, Burleson, Clarita, Dimebox, Fairlie, Heiden, Houston Black, Leson, Luling, Ovan, Sanger, Slidell, Tamford and Watonga . Bleiblerville, Branyon, Burleson, Dimebox, Fairlies, Houston Black, Leson and Slidell soils have moist chroma of 1 throughout. Clarita and Tamford soils have hue of 7.5YR or redder in the subsoil. Fairlie soils are underlain by chalk below 40 inches. Heiden, Luling, Sanger, and Slidell soils have sola over 40 inches thick. Watonga soils have mean temperature cooler than 64 degrees. Ovan soils have sola over 80 inches thick.

GEOGRAPHIC SETTING: Ellis soils are on erosional uplands on dominantly convex slopes or plane surfaces. They are on sideslopes and low escarpments above drainageways. Slopes are mostly between 5 and 12 percent but range from 1 to 20 percent. These soils formed in weakly consolidated shales of Cretaceous Age. The climate is moist subhumid. Mean annual precipitation ranges from 30 to 43 inches and the mean annual temperature ranges from 64 to 67 degrees F. Frost free days range from 230 to 250 days and elevation ranges from 250 to 400 feet. Annual Thornthwaite P-E indices ranges from 44 to 66.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the similar Altoga, Ferris, and Lamar series and the Bazette, Burleson, Crockett, and Heiden soils. Altoga soils have fine-silty, carbonatic control sections and are on similar positions. Ferris soils have sola over 40 inches, and Lamar soils have fine-silty control section and are on similar positions. Bazette and Crockett soils have clayey Bt horizons.Burleson and Heiden soils have mollic colored clayey A horizons with sola thicker than 40 inches. Bazette and Heiden soils are on similar positions. Burleson and Crockett soils are above on broad smooth areas. Burleson soils are also below in slightly depressed positions.

DRAINAGE AND PERMEABILITY: Well drained. Runoff is rapid. Permeability is very slow.

USE AND VEGETATION: Used mainly for growing pasture and hay. Some areas have been cultivated, eroded, and retired to grass. Native vegetation is a moderate stand of little bluestem, indiangrass, sideoats grama and Texas wintergrass and a few small mesquite, elm, and hackberry trees. Prickly pear cacti are common in places.

DISTRIBUTION AND EXTENT: In the Blackland Prairies of Texas(MLRA 86A) and Oklahoma. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Ellis County, Texas; 1910.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - the A horizon from 0 to 4 inches.

Cambic horizon - the zone from 4 to 30 inches (Bw, Bss1 and Bss2 horizons)

Vertic properties- slickensides at a depth of 13 to 30 inches. High shrink-swell potential and cracks that are 0.5 to 3 inches wide at a depth of 13 inches or more.

ADDITIONAL DATA: NSSL Data: S72TX701; S72TX1291; S72TX1759.

National Cooperative Soil Survey, U.S.A.

FAIRLIE SERIES

The Fairlie series consists of deep, moderately well drained, very slowly permeable soils. These soils are on nearly level to gently sloping uplands. The slope is typically 1 to 3 percent but ranges from 0 to 5 percent.

TAXONOMIC CLASS: Fine, smectitic, thermic Udic Haplusterts

TYPICAL PEDON: Fairlie silty clay loam, on a smooth plain 2 percent slope, in a cultivated field. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 5 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium platy structure parting to weak fine and medium blocky structure; extremely hard, firm, sticky and plastic; few fine roots; few fine black concretions; slight effervescence in spots; mildly alkaline; abrupt smooth boundary.

A--5 to 12 inches; black (5Y 2/1) silty clay, very dark gray (5Y 3/1) dry; moderate fine and medium angular blocky structure; very hard, firm, sticky and plastic; few fine roots; few pressure faces; strong effervescence; moderately alkaline; gradual wavy boundary. (combined A subhorizons are 6 to 18 inches thick)

Bss1--12 to 24 inches; black (5Y 2/1) silty clay, very dark gray (5Y 3/1) dry; moderate medium angular blocky structure; very hard, firm, sticky and plastic; few fine roots; common pressure

faces; few grooved slickensides; few fine and medium concretions of calcium carbonate; few fine iron-manganese concretions; strong effervescence; moderately alkaline; gradual wavy boundary.

Bss2--24 to 35 inches; very dark gray (5Y 3/1) silty clay, dark gray (5Y 4/1) dry; moderate fine and medium angular blocky structure; very hard, firm, sticky and plastic; few fine roots; few medium distinct olive (5Y 5/3) redox concentrations or masses with sharp boundaries; common grooved slickensides; few fine iron-manganese concretions; few medium and coarse concretions and soft masses of calcium carbonate; few fine and medium pebbles of chert; strong effervescence; moderately alkaline; gradual wavy boundary. (combined Bss subhorizons are 12 to 40 inches thick)

Bkss--35 to 54 inches; dark gray (10YR 4/1) clay, gray (10YR 5/1) dry; moderate fine and medium angular blocky structure; very hard, firm, sticky and plastic; few fine roots; common grooved slickensides; few fine and medium distinct yellowish brown (10YR 5/8) and olive (5Y 5/6) redox concentrations or masses with sharp boundaries; few vertical streaks of black (5Y 2/1) associated with cracks; few fine iron-manganese concretions; common medium and coarse concretions and soft masses of calcium carbonate; few medium pebbles of chert; strong effervescence; moderately alkaline; abrupt wavy boundary. (0 to 30 inches thick)

Cr--54 to 60 inches; white (N 8/0; 2.5Y 8/2) chalk bedrock; with streaks of olive yellow; medium platy in upper 2 inches; massive below; hardness is less than 3 on Mohs' scale.

TYPE LOCATION: Hunt County, Texas; from the intersection of Texas Highways 11 and 34 in Wolfe City, Texas; 3 miles southeast on Texas Highway 11; 1.8 miles south on county road; 0.8 mile west on county road; 0.1 mile south along turn row and 40 feet east in a cultivated field.

RANGE IN CHARACTERISTICS: The range in characteristics includes 50 percent or more of the pedon. Solum thickness and depth to a paralithic contact of chalk ranges from 40 to 60 inches. The weighted average clay content of the control section is 40 to 50 percent. When dry, cracks ranging from 0.4 to 3 inches wide extend from the surface to a depth of more than 12 inches. Cracks are open for 90 to 150 cumulative days in most years. Slickensides and/or wedge shaped peds begin at a depth of 8 to 20 inches. These are cyclic soils, and in undisturbed areas, gilgai microrelief consists of microknolls 4 to 16 inches higher than microdepressions; distance between center of knoll and center of the depression is 5 to 12 feet. Reaction is slightly or moderately alkaline, and ranges from very slight to strong effervescence. There are few to common concretions and soft masses of calcium carbonate and/or chalk fragments in most subhorizons. Iron-manganese concretions and siliceous pebbles range from none to few throughout the solum.

The A horizon has colors in hue of 10YR to 5Y, value of 2 or 3, and chroma of 1. The texture is silty clay loam, silty clay, or clay.

The Bss horizon has colors in hue of 10YR to 5Y, value of 2 to 5, and chroma of 2 or less. Texture is silty clay or clay. Redox concentrations or masses with sharp boundaries in shades of brown, yellow, or olive range from none to common.

The Bkss horizons has colors in hue of 10YR to 5Y, value of 3 to 5, and chroma of 1 or 2. Texture is silty clay or clay. Redox concentrations or masses with sharp boundaries in shades of brown, yellow, or olive range from none to common.

In some pedons, there is a discontinuous C horizon of clay, silty clay, or marly clay with thin strata of weathered chalk. Colors are mainly in shades of gray, olive, or brown. The C horizon is not diagnostic to the series and is absent in most pedons.

The Cr horizon is limestone bedrock. It is mainly chalk, or interbedded chalk and marl. It is light gray or white, and typically platy in the upper few inches, and massive below with a hardness of less than 3 on Mohs' scale.

COMPETING SERIES: These are the Bleiblerville, Branyon, Burleson, Dimebox, Heiden, Houston Black, Ovan, Leson, Luling, Sanger, Slidell, and Watonga series. These soils do not have a paralithic contact with chalk within a depth of 40 to 60 inches.

GEOGRAPHIC SETTING: Fairlie soils are on nearly level to gently sloping uplands. They formed mainly in the Pecan Gap, Gober, and Austin Chalk Formations of Upper Cretaceous Age. Slopes are mainly 1 to 3 percent but range from 0 to 5 percent. Mean annual precipitation ranges from 30 to 42 inches, mean annual temperature from 64 degrees to 68 degrees F. Frost free days range from 230 to 260. Elevation ranges from 550 to 850 feet above sea level. Thornthwaite P-E indices range from 54 to 70.

GEOGRAPHICALLY ASSOCIATED SOILS: These include the competing Branyon, Burleson, Heiden, Houston Black, and Leson series. Also the Austin, Dalco, and Lott soils are associated. Austin and Lott soils are mollisols on slightly higher convex areas. Branyon and Burleson soils are on lower lying terrace positions. Dalco soils are 24 to 40 inches thick over a paralithic contact of chalk and are on similar positions. Heiden, Houston Black, and Leson soils are on similar positions of adjacent areas with different parent material.

DRAINAGE AND PERMEABILITY: Fairlie soils are moderately well drained and very slow permeablility. Water enters the soil rapidly when it is dry and cracked, and very slow when the soil is saturated. Runoff is low on 0 to 1 percent slopes; moderate on 1 to 3 percent slopes; and high on 3 to 5 percent slopes.

USE AND VEGETATION: Used mainly for cultivated crops of cotton, grain sorghum, corn, and small grain, however, some areas are used for pasture and a few small areas are in rangeland. Pastures are mainly bermudagrasses; rangeland plants include eastern grama, little bluestem, indiangrass, Florida paspalum, sideoats grama, switchgrass, meadow dropseed, forbs and annual grasses.

DISTRIBUTION AND EXTENT: Blackland Prairie of Texas, MLRA 86A. The series is moderately extensive.

MLRA OFFICE RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Grayson County, Texas; 1977.

REMARKS: Fairlie soils were previously included with the Houston Black or Austin series. Classification changed from Pellusterts to Haplusterts (2/94) based on Issue 16, a revison of Soil Taxonomy.

Diagnostic horizons and features recognized in this pedon are:

Mollic colors--0 to 35 inches, the Ap, A, Bss horizon.

Cambic horizon - 35 to 54 inches.

Vertisols features--Cracks when dry, slickensides in Bss subhorizons.

Paralithic contact of chalk at a depth of 54 inches.

SOIL INTERPRETATION RECORD NUMBER: TX0726

National Cooperative Soil Survey, U.S.A.

FERRIS SERIES

The Ferris series consists of soils that are deep to weathered shale. They are well drained, very slowly permeable soils that formed from weakly consolidated calcareous dense clays and shales. These soils are on sloping or moderately steep uplands. Slopes range from 1 to 20 percent.

TAXONOMIC CLASS: Fine, smectitic, thermic Chromic Udic Haplusterts

TYPICAL PEDON: Ferris clay--pasture. Pedon described above is an equal distance between its deep and shallow extremes. (Colors are for dry soil unless otherwise stated.)

Ap--0 to 8 inches; olive (5Y 5/3) clay, olive (5Y 4/3) moist; weak medium and fine angular blocky structure; extremely hard, very firm, very sticky and very plastic; surface has a mulch about 1/2 inch thick of fine extremely hard discrete aggregates; many fine roots; few fine calcium carbonate concretions; strongly effervescent; moderately alkaline; gradual smooth boundary. (3 to 12 inches thick)

Bw--8 to 24 inches; pale olive (5Y 6/3) clay; olive (5Y 5/3) moist; moderate fine angular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine roots; common shiny pressure faces; few fine calcium carbonate concretions and masses; strongly effervescent; moderately alkaline. (6 to 20 inches thick)

Bss--24 to 40 inches; pale olive (5Y 6/3) clay; olive (5Y 5/3) moist; common fine faint brownish yellow mottles; moderate fine angular blocky structure forming wedge shaped peds having long axes tilted up to 45 degrees from the horizontal; extremely hard, very firm, very sticky and very plastic; few fine roots; few fine pores; common coarse slickensides; pressure faces are shiny; vertical cracks 1 to 5 cm wide and 18 inches apart extend to 40 inches; few fine calcium carbonate concretions and few fine powdery masses of calcium carbonate; violently effervescent; moderately alkaline; diffuse wavy boundary. (18 to 30 inches thick)

Ck--40 to 80 inches; coarsely and prominently mottled pale olive (5Y 6/3) and yellow (2.5Y 7/8) weakly consolidated shale that has clay texture; weak coarse angular blocky structure mixed with coarse blocky rock (shale) structure; extremely hard, very firm; few fine roots between blocks of rock structure; few slickensides; common fine masses and concretions of calcium carbonate; violently effervescent; moderately alkaline.

TYPE LOCATION: Navarro County, Texas; about 15 miles west of Corsicana on Texas Highway 22; from the northeast part of Blooming Grove, 3.3 miles northward on a county road; then 190 feet east in a pasture. This location is 1.2 miles north-northwest of FP site 105B.

RANGE IN CHARACTERISTICS: The solum ranges from 40 to 60 inches thick. Texture is clay or silty clay, with clay content ranging from 40 to 60 percent. Water worn siliceous pebbles are on the surface of some pedons. When dry, cracks 1/2 to 3 inches wide extend from the surface to a depth of more than 12 inches. Cracks remain open 120 to 150 cumulative days in most years. Calcium carbonate equivalent in the control section ranges from 2 to about 30 percent.

The A horizon has hue of 10YR to 5Y, value of 3 to 6, and chroma of 2 to 4. The lower values and chromas occur where A horizons are thickest in the pedon. In pedons where the moist color value of the A horizon is less than 3.5, the horizon is less than 12 inches thick.

The Bw and Bss horizons have hue of 10YR to 5Y, value of 4 to 7, and chroma of 2 to 6. Some pedons do not have mottles in the upper part of the Bw. Gray mottles are inherited from the shale (lithochromic). Calcium carbonate concretions range from few to many in the Bw and Bss horizons, with total carbonates ranging from 2 to 30 percent.

The C horizon has hue of 10YR to 5Y, value of 5 to 7, and chroma of 1 to 8. Most pedons are coarsely and prominently mottled. It is strongly weathered calcareous clay, weakly consolidated shale that has clay texture or shales. Gypsum crystals occur in the Ck horizon of some pedons.

COMPETING SERIES: These are the Depalt, Deport, Frelsburg, Latium, and Medlin series. Similar soils are the Ellis and Heiden series. Depalt and Deport soils are non calcareous in the surface layer and, in addition, Depalt soils have dominant hue of 7.5YR or redder, and Deport soils have chroma of less than 2 in the surface horizon. Frelsburg soils have sola 60 to 80 inches thick, and formed in Tertiary Age materials. Latium soils are in slightly more moist climates and have cracks that remain open for longer periods (120 to 150 days). In addition, Latium soils are on Tertiary Age materials. Medlin soils have more than 30 percent calcium carbonate equivalent, and are dry for longer periods of time. Ellis soils have sola 20 to 40 inches thick. Heiden soils

have moist color value of 3.5 or less and chroma of 2.5 or less in the upper 12 inches in most pedons.

GEOGRAPHIC SETTING: Ferris soils are on uplands. The surfaces are convex to plane with slope gradients mostly between 5 and 12 percent, but ranging from 1 to 20 percent. Uncultivated areas often have narrow microridges and microvalleys that extend up and down the slope. The soil formed in weakly consolidated mostly Upper Cretaceous formations of calcareous marine sediments, high in montmorillonitic clays. Mean annual precipitation ranges from 28 to 42 inches, and mean annual temperature ranges from 64 to 70 degrees F. Frost free days range from 230 to 260 days and elevation ranges from 400 to 1,000 feet. The Thornthwaite P-E index is 44 to 66.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the similar Ellis and Heiden series and the Altoga, Houston Black, Lamar and McLennan series. Altoga, Lamar and McLennan soils have fine-silty control sections and are on similar positions. Houston Black soils have moist value of less than 3.5 and chroma of less than 1.5 throughout the upper 12 inches. Altoga, Ellis, and Lamar soils are on similar positions with Ferris. Heiden and Houston Black soils are on smoother slightly higher positions.

DRAINAGE AND PERMEABILITY: Well drained. Permeability is very slow. Runoff is medium on 1 to 3 percent slopes, high on 3 to 5 percent slopes, and very high on slopes greater than 5 percent. Infiltration is rapid when the soil is dry and cracked, but very slow when the soil is wet.

USE AND VEGETATION: Used mainly for pasture and production of hay. Most areas have been cultivated, eroded and are now in grass. Vegetation is mainly bluestems, buffalograss and threeawn grasses and scattered mesquite trees.

DISTRIBUTION AND EXTENT: Central and eastern Texas Blacklands (MLRA 86A). The series is of large extent, comprising more than 100,000 acres.

MLRA OFFICE RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Travis County, Texas; 1969.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - the A horizon from 0 to 8 inches. (Ap horizon)

Cambic horizon - 8 to 40 inches. (Bw and Bss horizon)

Vertic properties - Slickensides at a depth of 24 to 40 inches. High shrink-swell potential and cracks that are 1/2 to 3 inches wide at a depth of 12 inches or more.

ADDITIONAL DATA: NSSL Data: Hopkins County, TX S68-223-001 (68L895-68L899).

Soil Interpretation Record Number: TX0296 , TX1150 (COOL)

National Cooperative Soil Survey, U.S.A.

FRIOTON SERIES

The Frioton series consists of very deep, well drained, moderately slowly permeable soils. They formed in loamy and clayey sediments of Pleistocene age. These nearly level soils are on smooth flood plains and formed under trees with an understory of native grasses. Slopes are 0 to 1 percent.

TAXONOMIC CLASS: Fine, mixed, active, thermic Cumulic Hapludolls

TYPICAL PEDON: Frioton silty clay loam--pasture. (Colors are for moist soil unless otherwise stated.)

A11--0 to 24 inches; very dark brown (10YR 2/2) silty clay loam, very dark gray (10YR 3/1) dry; strong fine granularstructure; hard, friable; 10 percent by volume of fragments of limestone less than 3 inches in diameter in the lower part; calcareous, moderately alkaline; diffuse smooth boundary. (12 to 28 inches thick)

A12--24 to 37 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; hard, firm; 2 percent by volume of fragments of limestone less than 3 inches in diameter; few fine threads of carbonate; calcareous, moderately alkaline; gradual smooth boundary. (10 to 30 inches thick)

C--37 to 62 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; massive; hard, firm; 10 percent by volume of fragments of limestone less than 3 inches in diameter; calcareous, moderately alkaline.

TYPE LOCATION: Bryan County, Oklahoma; about 3 miles southwest of Caddo; 360 feet east and 820 feet south of the northwest corner of sec. 24, T. 5 S., R. 9 E.

RANGE IN CHARACTERISTICS: Thickness of the mollic epipedon ranges from 24 to more than 50 inches. Texture throughout the soil is silty clay loam, clay loam, silty clay, or their gravelly counterparts.

The A horizon is black (10YR 2/1), very dark brown (10YR 2/2), very dark gray (10YR 3/1), very dark grayish brown (10YR 3/2), or dark brown (10YR 3/3; 7.5YR 3/2). Reaction is slightly or moderately alkaline. Some pedons are noncalcareous in the upper 10 inches of the A11 horizon. The clay content of the control section ranges from 35 to 50 percent. The control section of some pedons contains 5 to 15 percent by volume of fragments of limestone or chert. Below a

depth of 24 inches, some pedons have B horizons that have higher value or chroma than the A horizons.

The C horizon is very dark gray (10YR 3/1), very dark grayish brown (10YR 3/2), dark brown (10YR 3/3; 7.5YR 3/2), dark gray (10YR 4/1), dark grayish brown (10YR 4/2), brown (10YR 4/3, 5/3; 7.5YR 4/2, 5/2), or gray (10YR 5/1). Some pedons have thin strata of more loamy or clayey sediments in the C horizon.

COMPETING SERIES: These are the Egan series and the closely competing Buxin, Catalpa, Moreland, Pledger, and Ringo series. Buxin, Moreland, and Pledger soils have vertic properties. Catalpa and Ringo soils have mollic epipedons less than 24 inches thick. In addition, Ringo soils are underlain by shale at depths ranging from 20 to 40 inches. Egan soils lack carbonates within the profile.

GEOGRAPHIC SETTING: These soils occur on nearly level flood plains. Slopes range from 0 to 1 percent. They formed in loamy and clayey sediments. They are flooded for very brief periods during the months of February through July. Mean annual temperature ranges from 62 degrees to 70 degrees F.; average annual precipitation ranges from 40 to 50 inches; Thornthwaite P-E indices range from 64 to 80. Frost free days range from 210 to 240. Elevation ranges from 400 to 800 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Gowton, Kaufman, and Trinity series. Gowton and Kaufman soils are down stream and usually on larger streams. Trinity soils are a greater distance from the stream channel. Gowton soils are fine-loamy. Kaufman and Trinity soils have vertic properties.

DRAINAGE AND PERMEABILITY: Well drained; low runoff; moderately slow permeability.

USE AND VEGETATION: Used primarily for bermudagrass pasture but some areas are cultivated to wheat, grain sorghum, soybeans, peanuts, and alfalfa. Native vegetation is oak, elm, hackberry, pecan, and ash with an understory of native grass.

DISTRIBUTION AND EXTENT: Adjacent to the drainageways of the Blacklands in southeastern Oklahoma, possibly Texas, southwestern Arkansas, and Louisiana. These soils are moderately extensive.

MLRA OFFICE RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Bryan County, Oklahoma; 1975.

REMARKS: This series formerly would have been classified in the Alluvial great soil group and included in the Frio series.

HEIDEN SERIES

The Heiden series consists of soils that are well drained and very slowly permeable ..They are deep to weathered shale. These soils are on nearly level to moderately steep uplands. Slopes are mainly 3 to 8 percent but range from 0.5 to 20 percent.

TAXONOMIC CLASS: Fine, smectitic, thermic Udic Haplusterts

TYPICAL PEDON: Heiden clay--cropland. Pedon described near its deepest part. (Colors are for dry soil unless otherwise stated.)

Ap--0 to 6 inches; dark grayish brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; weak angular blocky structure; very hard, very firm, very sticky and very plastic; many fine roots; few wormcasts; few fragments of snail shells; strongly effervescent; moderately alkaline; abrupt boundary. (4 to 8 inches thick)

A--6 to 18 inches; dark grayish brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; moderate fine angular blocky structure; few wedge shaped peds in lower part; extremely hard, very firm ,very sticky and very plastic; few fine roots; shiny faces on peds; strongly effervescent; moderately alkaline; diffuse wavy boundary. (8 to 22 inches thick)

Bssk1--18 to 36 inches; dark grayish brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; moderate medium and coarse angular blocky structure, wedge shaped peds are about 1 to 3 inches long and axis tilted 10 to 60 degrees from the horizontal; extremely hard, very firm, very sticky and very plastic; many slickensides; common fine calcium carbonate concretions; strongly effervescent; moderately alkaline; diffuse wavy boundary. (0 to 20 inches thick)

Bssk2--36 to 58 inches; olive gray (5Y 5/2) clay, olive gray (5Y 4/2) moist; few fine faint olive mottles and streaks; weak coarse angular blocky structure, wedge shaped peds are about 1 to 3 inches long and axis tilted 10 to 60 degrees from the horizontal; extremely hard, very firm, very sticky and very plastic; many distinct slickensides; common fine calcium carbonate concretions; violently effervescent; moderately alkaline; diffuse wavy boundary. (12 to 40 inches thick)

C--58 to 70 inches; prominently and coarsely mottled olive (5Y 5/3) moist; and yellow (5Y 7/6) moist, clay and weakly consolidated shale; few fine olive and yellow mottles; massive, with a few slickensides in the upper part; extremely hard, very firm and very plastic; violently effervescent; moderately alkaline.

TYPE LOCATION: Bell County, Texas; From the intersection of Texas Highway 36 and Farm Road 436 in Heidenheimer; 0.57 miles southeast on Texas Highway 36; 1 5 feet southwest of fence in cropland.

RANGE IN CHARACTERISTICS: Solum thickness ranges from about 40 to 65 inches. They are thinnest in microknolls or microridges and thickest in centers of microdepressions or microvalleys. Texture throughout the soil is clay or silty clay Weighted average clay content ranges from 40 to 60 percent. Cracks remain open 90 to 150 cumulative days in most years. Slickensides and wedge-shaped peds begin at a depth of 10 to 24 inches. Undisturbed areas have gilgai microrelief with microknolls about 4 to 10 inches above microdepressions. On slopes above 5 percent gilgai are linear with slope.

The A horizons have hue of 10YR, 2.5Y or 5Y, value of 3 to 5, and chroma of 1 to 3. Moist color values range from 2 to slightly less than 3.5. Where chromas are less than 1.5, the surface layer is less than 12 inches thick in more than one-half of the pedon. The A horizons are dominantly calcareous, but range to noncalcareous and slightly alkaline in the upper 12 inches. Smooth siliceous pebbles or limestone fragments less than 10 inches across are on and in the surface layers of some pedons.

The Bss horizons have hue of 10YR, 2.5Y or 5Y; value of 4 to 7; and chroma of 2 to 4. They are typically mottled with these colors. Calcium carbonate in the form of masses, threads and concretions range from none in the upper part to many in the lower part with total carbonates ranging from 2 to 35 percent. Gypsum crystals are in the lower part of some pedons.

The C horizon varies from clay, strongly weathered shale, to slightly weathered calcareous shales, with an intermingling of soil and rock structure.

COMPETING SERIES: These include the Bleiblerville, Branyon, Burleson, Clarita, Dimebox, Fairlie, Houston Black, Leson, Luling, Ovan, Sanger, Slidell, Tamford and Watonga. Bleiblerville, Branyon, Burleson, Dimebox, Fairlie, Houston Black, Leson and Slidell have moist chroma of 1 throughout. Clarita and Tamford soils have hue of 7.5YR or redder in the subsoil.. Fairlie soils are underlain by chalk below 40 inches. Burleson, Dimebox, Leson and Luling are non- calcareous in the surface. Sanger and Slidell soils contain more calcium carbonate in the control section and are underlain by marl. Watonga soils have mean temperature cooler than 64 degrees. Ovan soils have sola over 80 inches thick and are in flood plains.

GEOGRAPHIC SETTING: Heiden soils are on erosional uplands. Slopes are mostly 3 to 8 percent, but range from 0 percent to 20 percent. Surfaces are dominantly convex but plane surfaces occur in some areas of low gradients. Most untilled areas have a microrelief of microvalleys 4 to 12 feet wide and 3 to about 12 inches deep, and microridges about 4 to 12 feet wide that extend up and down slope. The soils formed, mainly, in weakly consolidated Upper Cretaceous formations of calcareous marine sediments, high in montmorillonite clays. The climate is moist subhumid. The mean annual precipitation ranges from 28 to 42 inches and the mean annual temperature ranges from 64 to 70 degrees F. Frost free days range from 225 to 275 days and elevation ranges form 400 to 1000 feet. Thornthwaite annual P-E indices range from 44 to 66.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Branyon, Burleson, Crockett, Ellis, Fairlie, Ferris, Houston Black, Lott, McLennan, Ovan and Wilson series. Crockett and Wilson soils have argillic horizons. Ferris Ellis and McLennan soils have color

values higher than 3.5 in the upper 12 inches. Lott and McLennan soils have fine silty control sections. Ferris, Ellis, Lott and McLennan soils are on lower more sloping positions. Branyon, Burleson, Crockett, Wilson and Ovan are on lower positions. Houston Black is on similar positions. Fairlie and Lott soils are on slightly higher positions.

DRAINAGE AND PERMEABILITY: Well drained. Permeability is very slow. Runoff is low on 0 to 1 percent slopes, medium on 1 to 3 percent slopes, high on 3 to 5 percent slopes and very high on 5 to 20 percent slopes. Infiltration is rapid when the soil is dry and cracked, but very slow when the soil is wet.

USE AND VEGETATION: Used mainly for pasture and hay. Many areas have been cultivated but are now in grass. Some areas are used for growing grain sorghum and cotton. Grasses are mainly bluestem, buffalograss, and threeawn grass. Scattered mesquite trees occur in places.

DISTRIBUTION AND EXTENT: Central and eastern Texas in the Blackland MLRA (86A). The series is extensive.

MLRA OFFICE RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Travis County, Texas, 1969

REMARKS: These soils formerly were included with the Houston series.

Diagnostic horizons and features recognized in this pedon are:

Mollic epipedon - the A horizons from 0 to 18 inches.

Vertic Properties - slickensides.at a depth of 18 to 58 inches. High shrink-swell potential and cracks that are 1/2 to 3 inches wide at a depth of 12 inches during dry periods

SIR Number.- TX0151, TX0152 (Stony), TX1149 (Cool), TX1151 (Stony, Cool).

National Cooperative Soil Survey, U.S.A.

HOUSTON SERIES

The Houston series consists of moderately well drained, slowly permeable, cyclic soils that formed in alkaline clays and chalk of the Blackland Prairies. These clayey soils have very high shrink-swell potential. Slope ranges from 0 to 8 percent.

TAXONOMIC CLASS: Very-fine, smectitic, thermic Oxyaquic Hapluderts

TYPICAL PEDON: Houston clay in the center of a micro-pasture. (Colors are for moist soil unless otherwise stated.)

A11--0 to 10 inches; very dark gray (5Y 3/1) clay; moderate fine and medium granular structure; hard, firm, very plastic; common fine roots; mildly alkaline; gradual smooth boundary. (4 to 11 inches thick)

A12--10 to 25 inches; dark olive gray (5Y 3/2) clay; moderate fine angular and subangular blocky structure; hard, firm, very plastic; common fine roots; mildly alkaline; clear irregular boundary. (0 to 24 inches thick)

AC--25 to 42 inches; olive gray (5Y 4/2) clay; few fine faint mottles of very dark gray; large wedge-shaped aggregates that are bordered by intersecting slickensides; parts to successively smaller angular blocky structure; very hard, firm, very plastic, sticky; few fine black concretions; common medium and coarse calcium carbonate concretions; moderately alkaline; gradual wavy boundary. (5 to 27 inches thick)

C1--42 to 58 inches; olive (5Y 4/3) clay; few fine faint mottles of very dark gray; large wedge-shaped aggregates that are bordered by intersecting slickensides; parts to angular blocky structure; very hard, extremely firm, very firm, very plastic, sticky; few fine black concretions; common medium and coarse calcium carbonate concretions; calcareous; moderately alkaline; gradual wavy boundary. (5 to 26 inches thick)

C2--58 to 72 inches; light olive brown (2.5Y 5/6) clay; common fine distinct olive gray and few fine faint yellowish brown mottles; large wedge-shaped aggregates that are bordered by intersecting slickensides; parts to angular blocky structure; very hard, extremely firm, plastic; few medium and coarse calcium carbonate concretions; calcareous; moderately alkaline.

TYPE LOCATION: Dallas County, Alabama; 1 mile northwest of Black Belt Substation and 100 yards west of the Vaiden plots in a pasture, 1000 feet north and 1000 feet west of the SE corner of the NW 1/4 sec. 2, T. 17 N., R. 8 E.

RANGE IN CHARACTERISTICS: Depth to bedrock ranges from 4 to 9 feet. The soil is clay throughout, ranging from 60 to 80 percent with 60 to 70 percent being most common. Common or many intersecting slickensides are in the AC and C horizons. These are cyclic soils, with cycles of microknolls and microbasins repeated at linear intervals of 6 to 12 feet. The amplitude of waviness of the boundary between the A and AC horizon ranges from about 9 to 26 inches. The A horizon ranges from slightly acid through mildly alkaline. Few, common,or many calcium carbonate concretions occur in the AC and C horizons.

The A11 horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 or 3, and chroma of 1 or 2, or it is (N 2/0) or (N 3/0).

The A12 horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 or 3, and chroma of 2. In some pedons it has value of 4 or 5, and chroma of 2 at depths more than 30 cm from the surface.

The AC horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5, and chroma of 2 or 3. It is slightly acid through moderately alkaline.

The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5, and chroma 3 through 6. Many pedons have C horizons mottled with shades of brown, yellow or gray. It ranges from neutral to moderately alkaline. Chalk bedrock is commonly light gray or pale yellow in color.

COMPETING SERIES: There are no other series in this family. Closely similar soils include the Brooksville, LaCerda, Louin, Naclina, Okolona, Redco, Terouge, and Vamont series. All of these soils except LaCerda and Redco have less than 60 percent clay in their control section. LaCerda and Redco soils have values of 4 or more within 30 cm of the surface and have mottles associated with wetness.

GEOGRAPHIC SETTING: Houston soils are on nearly level to sloping uplands with slope gradients of 0 to 8 percent. They are formed in alkaline clays and soft chalk. The climate is warm and humid. Near the type location the average annual temperature is 67 degrees F. and the average annual precipitation is about 51 inches.

GEOGRAPHICALLY ASSOCIATED SOILS: These include the Binnsville, Catalpa, Demopolis, Sumter, and Vaiden series. Binnsville and Demopolis soils have chalk within 20 inches of the surface. Catalpa soils have irregular distribution of organic matter and less than 60 percent clay in the control section. Sumter soils have more than 40 percent calcium carbonate equivalent and lack intersecting slickensides. Vaiden soils are more acid and have distinct or prominant mottles within 20 inches of the surface.

DRAINAGE AND PERMEABILITY: Moderately well drained. Runoff is medium to rapid and permeability is slow.

USE AND VEGETATION: Used mainly for pasture and hay crops. Some acreage is sed for soybeans.

DISTRIBUTION AND EXTENT: The Blackland Prairies of Alabama and Mississippi; possibly Arkansas, Louisiana, and Texas. The series is extensive.

MLRA OFFICE RESPONSIBLE: Auburn, Alabama

SERIES ESTABLISHED: Brazoria County, Texas; 1902.

REMARKS: The Houston series was formerly classified in the Grumusols great soil group.

ADDITIONAL DATA: The typical pedon is characterized in the Southern Cooperative Series N. 130, entitled @Properites of Alabama and Mississippi Black Belt Soils,@ published at Auburn University, February 1968. The pedon is Houston N. 28 - Ala., described on page 34 of that publication.

National Cooperative Soil Survey, U. S. A.

HOUSTON BLACK SERIES

The Houston Black series consists of very deep, moderately well drained, very slowly permeable soils that formed from weakly consolidated calcareous clays and marls of Cretaceous Age. These soils are on nearly level to moderately sloping uplands. Slopes are mainly 1 to 3 percent, but range from 0 to 8 percent.

TAXONOMIC CLASS: Fine, smectitic, thermic Udic Haplusterts

TYPICAL PEDON: At center of microdepression--pasture. (Colors are for dry soil unless otherwise stated.)

A1--0 to 8 inches; very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; moderate fine subangular blocky and moderate medium granular structure; extremely hard, very firm, very sticky and plastic; many fine roots; common very fine pores; common medium wormcasts; few fragments of snail shells; many very fine shiny faces of peds; few fine black concretions; few fine calcium carbonate concretions; strong effervescence; moderately alkaline; clear wavy boundary. (6 to 12 inches thick)

A2--8 to 24 inches; very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; moderate fine and very fine angular blocky natural fragments that form wedge like shapes peds; extremely hard, very firm, very sticky and very plastic; common fine roots; common very fine pores; shiny surfaces on many fine and very fine natural soil fragments; few fine black concretions; few fine calcium carbonate concretions; strong effervescence; moderately alkaline; gradual wavy boundary. (0 to 20 inches thick)

Bss--24 to 38 inches; dark gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; strong coarse angular blocky natural fragments that form wedge shaped peds: extremely hard, very firm, very sticky and very plastic; few fine roots; common very fine pores; many intersecting slickensides shiny surfaces on many fine, medium, and coarse ped faces; few fine black concretions; few fine calcium carbonate concretions; strong effervescence; moderately alkaline; clear wavy boundary. (0 to 20 inches thick)

Bssk1--38 to 80 inches; grayish brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) moist; few medium distinct olive brown (2.5YR 4/4) and many coarse faint gray (10YR 5/1) mottles; strong coarse angular blocky natural fragments that form wedge shaped peds; extremely hard, very firm, very sticky and very plastic; few fine roots; few very fine pores; many intersecting slickensides shiny surfaces on many fine, medium, and coarse ped faces; few fine dark gray vertical streaks; few fine black concretions and soft brown masses; few fine and medium calcium carbonate concretions and soft masses; violent effervescence; moderately alkaline; gradual wavy boundary. (10 to 50 inches thick)

Bssk2--80 to 104 inches; coarsely and distinctly mottled light olive brown (2.5Y 5/4) and gray (10YR 6/1) clay; common fine faint olive brown mottles; weak medium and coarse angular blocky natural fragments that form wedge shaped peds; very firm, very sticky and very plastic; few very fine roots and pores; many prominent slickensides; few fine soft brown masses; few medium soft masses of calcium carbonate; violent effervescence; moderately alkaline.

TYPE LOCATION: Travis County, Texas; from intersection of Farm Road 973 and U. S. Highway 290 in Manor, 3.5 miles east on U. S. Highway 290, 2.4 miles northeast on Farm Road 1100, 1.0 mile northwest and 3.0 miles northeast on Manda Road, 0.5 mile southeast on Lund Road, 900 feet southwest on field road, 105 feet east in pasture.

RANGE IN CHARACTERISTICS: Thickness of the combined A and B horizons is more than 80 inches. The weighted average clay content of the particle size control section is 40 to 60 percent The soil is usually moist, but when dry it has cracks ranging from 0.5 to 4 inches wide extend from the surface to a depth of 12 inches or more Cracks remain open for 90 to 150 cumulative days in most years. Slickensides begin at depths ranging from about 16 to 24 inches below the soil surface. The soil is clayey throughout with dominant textures being clay or silty clay. Some pedons have 15 to 30 percent by volume of siliceous and other pebbles in the upper 12 inches. Dominant textures are clay or silty clay in the upper 12 inches. When dry the surface has a granular mulch about 1/2 inch thick of extremely hard discrete granules. Cycles of microdepressions and microknolls are repeated each 10 to 24 feet. In virgin areas, microknolls are 3 to 18 inches higher than microdepressions. Chromas are less than 1.5 to depths of 30 to 60 inches in the center of microdepressions and 10 to 18 inches in the center of microknolls. The extremes of amplitude or waviness of the boundary between the A and B horizons vary from about 20 to 48 inches from the center of the microknoll to the center of the microdepression.

The A horizons have hue of 10YR to 5Y, value of 2 to 4, and chroma of 0 or 1. Soil reaction is moderately alkaline and calcareous, however, in the center of the microdepressions, the reaction ranges from slightly alkaline to moderately alkaline.

The Bss horizon has hue of 10YR, value of 2 to 4 and chroma of 0 to 1. Chroma ranges to 2 in some pedons: The lower B horizons have hue of 10YR, 2.5Y or 5Y, value of 4 to 7, and chroma of 2 to 6. The grayish brown and dark grayish brown colors occur in microdepressions and grayish brown to olive or yellow colors occur in microknolls. In some pedons chroma ranges to 8 in microknolls.

The lower B or Bk horizon has olive, brown and yellow mottles or is olive to yellow with gray mottles. Calcium carbonate content in the form of masses, threads and concretions range from few to many with total carbonate content ranging from 2 to 35 percent.

Water worn gravel of chert and quartzite are on the surface or within the A and B horizons of some pedons. Few weakly cemented iron manganese oxide concretions ranging from 1 to 5 mm in diameter occur throughout the soil.

COMPETING SERIES: These are the Bleiblerville, Branyon, Burleson, Clarita, Dimebox, Fairlie, Heiden, Leson, Luling, Ovan, Sanger, Slidell, Tamford, and Watonga soils. Bleiblerville

soils are formed on Tertiary age sediments. Branyon soils are on terraces and have less amplitude of waviness. Burleson and Leson soils on terraces and are non-calcareous in the surface layer. Clarita soils have hue of 7.5YR or redder in the subsoil.. Dimebox is non-calcareous in the surface. Fairlie soils have a paralithic contact with chalk at 40 to 60 inches. Heiden, Luling, Ovan and Sanger soils have matrix chroma of 2 or more throughout and Ovan soils are on flood plains. Slidell soils contain more calcium carbonate in the control section and are underlain by marl. Tamford soils have hue of 7.5YR or redder in the subsoil. Watonga soils have sola less than 60 inches thick and are in slightly cooler climates

GEOGRAPHIC SETTING: Houston Black soils are on nearly level to sloping uplands. Slopes range from 0 to 8 percent, but are mainly 1 to 3 percent. The soil formed in calcareous clays and marls mainly of the Taylor Marl geological formation. In places, the substrata are chalks or shales. The climate is warm and subhumid. The mean annual precipitation ranges from 28 to 42 inches and the mean annual temperature ranges from 63 to 70 degrees F. Frost free days range from 220 to 250 days and elevation ranges from 400 to 1000 feet. Thornthwaite annual P-E indices range from 44 to 66.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Burleson, Branyon, Fairlie, Heiden and Ovan in the same family.and the similar Austin and Ferris soils. Burleson, Branyon and Ovan soils are on lower positions. Heiden soils are on similar landscapes with Houston Black. Austin soils are on slightly higher positions. Austin soils are underlain by chalk 20 to 40 inches dry, and prairie soils have chalk at 40 to 60 inches in depth. Ferris soils are on slightly sloping hillsides and have moist color values more than 3.5 and chroma more than 1.5 in the upper 12 inches.

DRAINAGE AND PERMEABILITY: Moderately well drained. Slow to rapid surface runoff. Water enters the soil rapidly when it is dry and cracked, and very slowly when it is moist. Permeability is very slow.

USE AND VEGETATION: Nearly all is cultivated and used for growing cotton, sorghums, and corn. Cotton root rot is prevalent on most areas and limits cotton yields and the use of some legumes in rotations. Native vegetation consists of tall and mid grass prairies of little bluestem, big bluestem, indiangrass, switchgrass, and sideoats grama, with scattered elm, mesquite, and hackberry trees.

DISTRIBUTION AND EXTENT: The Blackland Prairies and eastern part of the Grand Prairies of Texas. The series is extensive.

MLRA OFFICE RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Brazoria County, Texas; 1902. The word "Black" was capitalized in the correlation of Kaufman County in 1947.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Mollic epipedon - 0 to 38 inches

Vertic features - slickensides at a depth of 24 to 80 inches depth. High shrink-swell potential and cracks that are 1/2 to 4 inches wide at 12 inch depths during dry periods.

ADDITIONAL DATA: E. H. Templin, I. C. Mowery, and G. W. Kunze, Houston Black clay the Type Grumusol: Soil Science Society of American Proceedings, Vol. 20, No.1, January 1956. SSIR-30, S53TX-70-1, S54TX-14-90. National Soil Survey Laboratory, S77TS-027-001, S77TX-027-002, S78TX-027-003.

SIR Number. TX0093

National Cooperative Soil Survey, U.S.A.

HOWE SERIES

The Howe series consists of moderately deep, well drained, moderately permeable soils that formed in weakly cemented chalk interbedded with marl of Upper Cretaceous Age. These soils are on gently sloping to strongly sloping uplands. Slopes are dominantly 5 to 12 percent but range from 3 to 12 percent.

TAXONOMIC CLASS: Fine-silty, carbonatic, thermic Udic Haplustepts

TYPICAL PEDON: Howe silty clay loam--pasture. (Colors are for dry soil unless otherwise stated.)

A--0 to 7 inches; grayish brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate medium subangular blocky and fine granular structure; hard, firm; common fine and medium roots; common wormcasts; few weakly cemented fragments of chalk that are less than 10 mm in diameter; calcium carbonate equivalent is about 60 percent; calcareous, moderately alkaline; gradual smooth boundary. (5 to 13 inches thick)

Bk1--7 to 15 inches; light gray (10YR 7/2) silty clay loam, light brownish gray (10YR 6/2) moist; moderate fine subangular blocky structure; hard, firm; common fine roots; common wormcasts; few weakly cemented fragments of chalk that are less than 5 mm in diameter; calcium carbonate equivalent about 60 percent; calcareous, moderately alkaline; gradual wavy boundary. (7 to 20 inches thick)

Bk2--15 to 26 inches; very pale brown (10YR 7/3) silty clay loam, pale brown (10YR 6/3) moist; moderate fine subangular blocky structure; hard, firm; few fine roots; about 27 percent weakly cemented platy fragments of chalk that are slightly hard dry, but break down on wetting and gentle rubbing; calcium carbonate equivalent about 60 percent; few threads and films of calcium carbonate; calcareous, moderately alkaline; gradual wavy boundary. (4 to 17 inches thick.)

Cr--26 to 32 inches; white (10YR 8/1) weakly cemented platy chalk with few thin seams of very pale brown silty clay loam in the upper part in vertical fractures and between plates of chalk; rock structure, distinct horizontal bedding; slightly hard to hard when dry, but can be easily cut with spade when moist; hardness less than about 2 on Mohs scale; calcareous, moderately alkaline.

TYPE LOCATION: Grayson County, Texas; from the intersection of U. S. Highway 82 and Texas Highway 11 in Sherman, Texas; 3.9 miles southeast on Texas Highway 11 to Luella; 0.1 mile west on paved county road; south 1.7 miles on paved county road to gate at the Holloway Cemetery; 25 feet west of road right-of-way in pasture.

RANGE IN CHARACTERISTICS: Solum thickness ranges from 20 to 40 inches. Calcium carbonate equivalent of the control section ranges from 40 to about 80 percent. The texture of the soil is silty clay loam, silty clay or clay loam, with total clay content ranging from 30 to 45 percent and silicate clay content ranging from 25 to 35 percent.

The A horizon has colors with hue of 10YR, value of 4 to 6, and chroma of 2 or 3. Where moist values and chromas are less than 3.5, the A horizon is less than 7 inches thick. Fragments of weakly cemented chalk range from none to common.

The B horizons have colors with hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 to 4. Some pedons have few to common yellow or brown mottles in the lower B horizon. The B horizons are silty clay loam, clay loam or silty clay. Pseudo rock fragments of chalk range from none to about 20 percent by volume in the upper B horizon and from about 5 percent 35 percent by volume in the lower B horizon. The fragments are hard to slightly hard when dry, but disintegrate upon overnight soaking in calgon and water. Platy fragments of calcite range from none to few.

The Cr horizon is white, light gray, very pale brown, or light brownish gray weakly cemented platy chalk or brittle marl. The upper few inches has thin seams of yellowish brown, brownish yellow, very pale brown, or pale yellow silty clay loam in fractures and between plates of chalk. The chalk becomes more massive and less fractured with depth. The chalk is easily cut with a spade when moist.

COMPETING SERIES: These include the Altoga and McLennan in the same family and the similar Austin, Brackett, Cuthand, Ellis, Lamar, Seawillow, and Whitewright series. Altoga, Lamar, McLennan and Seawillow soils lack a paralithic contact with chalk. In addition, Lamar soils have mixed mineralogy and Seawillow soils have fine-loamy control sections. Austin soils have mollic epipedons. Brackett and Whitewright soils have sola less than 20 inches thick. Cuthand soils have coarse-silty control sections. Ellis soils have COLE values of .09 or more and are noncalcareous.

GEOGRAPHIC SETTING: Howe soils are on upland ridges and upper sideslopes. Slope gradients are mostly 5 to 12 percent but range from 3 to 12 percent. The soil formed in weakly cemented marine chalk interbedded with marl, mainly of the Austin Group of Upper Cretaceous

Age. Mean annual precipitation ranges from about 35 to 41 inches. The mean annual temperature ranges from 63 degrees to 66 degrees F. and the Thornthwaite P-E index ranges from 56 to 66.

GEOGRAPHICALLY ASSOCIATED SOILS: These include the competing Altoga, Austin, and Whitewright series and the Eddy, Fairlie and Lewisville series. Altoga and Lewisville soils are on lower lying stream terraces. Lewisville soils have mollic epipedons and lack a paralithic contact with chalk. Austin and Fairlie soils are on higher lying uplands. Fairlie soils have intersecting slickensides and wide cracks when dry. Eddy and Whitewright soils are in similar positions.

DRAINAGE AND PERMEABILITY: Well drained; medium runoff; moderate permeability.

USE AND VEGETATION: Used mostly for pasture. The main grasses are common and improved bermudagrass and K. R. bluestem. Native vegetation includes little bluestem, silver bluestem, sideoats grams, Texas wintergrass, threeawn with scattered elm and oak trees. A few areas are cultivated with cotton, small grain, and grain sorghum being the main crops grown.

DISTRIBUTION AND EXTENT: The Blackland Prairie of north-central Texas. The soil is moderately extensive.

MLRA OFFICE RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Grayson County, Texas; 1977.

REMARKS: Howe soils have formerly been included in the Austin series.

Classification was changed 11/89 from Typic Ustochrepts to Udic Ustochrepts.

Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - 0 to 7 inches, the A horizon.

Cambic horizon - 7 to 26 inches the Bk horizon.

Paralithic contact of chalk at a depth of 26 inches.

National Cooperative Soil Survey, U.S.A.

LESON SERIES

The Leson series consists of very deep, moderately well drained, very slowly permeable soils that formed in alkaline shales and clays. These soils are on nearly level or gently sloping uplands. Slopes range from 0 to 5 percent.

TAXONOMIC CLASS: Fine, smectitic, thermic Udic Haplusterts

TYPICAL PEDON: Leson clay--cropland. Midway between microhigh and microlow. (Colors are for dry soil unless otherwise stated.)

Ap--0 to 10 inches; very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; moderate fine angular blocky structure; on the surface there is a one-half inch layer that has moderate medium granular structure; extremely hard, very firm; common shiny pressure faces; few fine black concretions; moderately alkaline; gradual wavy boundary. (3 to 20 inches thick)

Bss--10 to 30 inches; very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; weak coarse angular blocky structure parting to moderate medium angular blocky; extremely hard, very firm; common intersecting slickensides and wedge-shaped peds having long axis tilted 30 to 45 degrees from the horizontal; few fine iron-manganese concretions; moderately alkaline; gradual wavy boundary. (6 to 40 inches thick)

Bkss--30 to 60 inches; pale olive (5Y 6/3) clay, olive (5Y 5/3) moist; common medium and coarse distinct very dark gray (10YR 3/1) and many fine faint light olive brown (2.5Y 5/6) mottles; moderate fine angular blocky structure; very hard, firm; common slickensides; common fine and medium calcium carbonate concretions and few masses of calcium carbonate; lower part of layer contains few shale fragments; slightly effervescent; moderately alkaline; gradual wavy boundary. (15 to 30 inches thick)

Ck--60 to 80 inches; olive gray (5Y 5/2) weakly consolidated shale that has clay texture; with alternating layers of light olive brown (2.5Y 5/6); evident bedding planes; extremely hard, very firm; few slickensides; contains approximately 10 percent calcium carbonate in the form of concretions and masses; few iron-manganese concretions; strongly effervescent; moderately alkaline.

TYPE LOCATION: Hopkins County, Texas; from intersection of Texas Highway 11 and 19 in Sulphur Springs, 10.8 miles west on Highway 11; 225 feet north in field.

RANGE IN CHARACTERISTICS: Solum thickness range from 60 to 80 inches. The weighted average clay content of the particle size control section ranges from 40 to 60 percent. When dry cracks 1/2 to 3 inches extend from the surface to a depth of more than 12 inches. In undisturbed areas there is gilgai microrelief. Distance between the microknoll and microdepression ranges from 4 to about 16 feet. There are few to many slickensides below a depth of about 15 inches. About 55 to 80 percent of the pedon has matrix colors of chroma 2 or more within 40 inches of the soil surface. Carbonates are below the A horizon and ranges from 9 to 60 inches.

The A horizons have hue of 10YR to 5Y and N, value of 2 to 4, and chroma of 0 or 1. Some pedons contain a few mottles in colors and shades of brown and olive in the lower part. The A horizon ranges from 12 to 20 inches thick on microknolls and 30 to 60 inches thick in microdepressions. It is clay or silty clay and is slightly acid to moderately alkaline.

The Bss horizons have hue of 10YR to 5Y, value of 2 and chroma of 0 to 1 in the upper part and value of 3 to 5, and chroma of 2 to 4 in the lower part. There are few to many mottles in colors and shades of gray, brown, and yellow. It is calcareous or noncalcareous clay or silty clay and typically contains few to common calcium carbonate concretions and soft masses. The Bkss horizon is neutral to moderately alkaline.

The Ck horizon has hue of 10YR to 5Y, value of 4 to 6 and chroma of 2 to 6. It is stratified clay and weakly consolidated shale; bedding planes are evident in most pedons. Few to common concretions and soft masses of calcium carbonate are in most pedons. Gypsum crystals range from none to common. The Ck horizon is mildly or moderately alkaline.

COMPETING SERIES: These are the Bleiberville, Branyon, Burleson, Clarita, Dimebox, Fairlie, Heiden, Houston Black, Luling, Ovan, Sanger, Slidell, Tamford and Watonga series. Bleiberville, Branyon, Fairlie, Heiden, Houston Black, Ovan, Sanger, and Slidell are calcareous in the surface layer. Burleson soils have matrix chrmas of 1 or less throughout the upper 40 inches. Clarita and Tamford soils have hue of 7.rYR or redder in the subsoil. Dimebox soils have ironstone pebbbles and contin calcium sulfate in all parts of the pedon. Fairlie soils are underlain by chalk at 40 to 60 inches depth. Luling soils have chroma of 1.5 or more in the surfae layers. Watonga soils have sola less than 60 inches thick, and are in slighly cooler climates.

GEOGRAPHIC SETTING: Leson soils are on nearly level to gently sloping uplands. Slope gradients range from 0 to 5 percent, but mainly are 1 to 3 percent. The soil formed in alkaline shales and clays. The climate is warm and subhumid. The mean annual precipitation ranges from 34 to 44 inches and mean annual average temperature ranges from 63 to 70 degrees F. Frost free days range from 230 to 260 days and elevation ranges from 350 to 750 feet. Thornthwaite annual P-E indices are 44 to 72.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Branyon, Burleson, Houston Black and Heiden in the same family.also the Ferris and Wilson series. Heiden and Ferris soils have A horizons with chroma 1 of 2. Wilson soils have loamy surface layers and firm textured Bt horizons. Ferris, Heiden, and Houston Black are on higher areas. Branyon, Burleson and Wilson are in similar or slightly lower positions.

DRAINAGE AND PERMEABILITY: Moderately well drained. Runoff is medium; Permeability is very slow. Water enters the soil rapidly when it is dry and cracked, and very slowly when it is moist.

USE AND VEGETATION: Mainly cultivated and used for crops such as cotton, grain sorghums, and corn. Native grasses are mainly bluestem, indiangrass, and gramas. Improved pastures are planted to bermudagrass and lovegrass. Scattered trees include bois d'arc, hackberry, elm, post oak, and locust.

DISTRIBUTION AND EXTENT: The Blackland Prairies of Texas. The series is extensive.

MLRA OFFICE RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Hopkins County, Texas; 1973.

REMARKS: The soil was formerly included in the Burleson or Hunt series.

Diagnostic horizons and features recognized in this pedon are:

Mollic epipedon - 0 to 30 inches

cambic horizon - 30 to 60 inches.

Vertic features - Slickensides at a depth of 10 to 60 inches. High shrink-swell potential and cracks that are 1/2 to 3 inches wide at a depth of 12 inches or more during dry periods.

SIR Number. TX0074

National Cooperative Soil Survey, U.S.A.

NORMANGEE SERIES

The Normangee series consists of soils that are deep to weakly consolidated shale. They are moderately well drained, very slowly permeable soils that formed in Cretaceous Age clay materials. These soils are on nearly level to moderately sloping uplands. Slopes range from 0 to 8 percent.

TAXONOMIC CLASS: Fine, smectitic, thermic Udertic Haplustalfs

TYPICAL PEDON: Normangee clay loam - pastureland. (Colors are for dry soil unless otherwise stated.)

Ap--0 to 7 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak medium angular blocky structure; very hard, firm; few dark ferromanganese concretions and few rounded pebbles of quartz; slightly acid; clear wavy boundary. (4 to 9 inches thick)

Bt1--7 to 18 inches, brown (10YR 5/3) clay, dark brown (10YR 4/3) moist; few fine distinct mottles of yellowish brown (10YR 5/6), dark grayish brown (10YR 4/2), and reddish brown (5YR 4/4); moderate medium angular blocky structure; extremely hard, extremely firm; few fine ferromanganese concretions and pebbles of quartz; distinct clay films on peds; medium acid; gradual smooth boundary. (8 to 16 inches thick)

Bt2--18 to 34 inches; brown (10YR 5/3) clay, brown (10YR 4/3) moist; few fine faint mottles of olive brown and yellowish brown; moderate medium and fine angular blocky structure; distinct

clay films on peds; extremely hard, extremely firm; distinct clay films on face of peds; neutral; gradual smooth boundary. (12 to 20 inches thick)

Bt3--34 to 44 inches, light yellowish brown (2.5Y 6/4) clay, light olive brown (2.5Y 5/4) moist; common fine and medium distinct mottles of yellowish brown (10YR 5/8) and olive yellow (2.5Y 6/8); weak fine angular blocky structure; extremely hard, extremely firm; few clay films; few fine soft masses of calcium carbonate; moderately alkaline; gradual smooth boundary. (6 to 15 inches thick)

Ck--44 to 64 inches; very pale brown (10YR 7/3) weakly consolidated shale; that has clay texture; yellowish brown (10YR 5/4) moist; massive; few fine distinct mottles of brownish yellow and brown; extremely hard, very firm; common soft masses of calcium carbonate up to about 1/2 inch. i. size; moderately alkaline.

TYPE LOCATION: Anderson County, Texas; about 4.0 miles northwest of Cayuga; about 1.5 miles west of Cayuga, 1.8 miles north of U.S. Highway 287 and 1.75 miles west on county road.

RANGE IN CHARACTERISTICS: Solum thickness ranges from 40 to 60 inches. Depth to secondary carbonates is greater than 30 inches. Some pedons lack visible carbonates. The clay content of the control section averages 40 to 50 percent. The COLE values range from .07. to .10 The soil has cracks 1/2 inch wide to a depth of more than 20 inches when dry.

The A horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 2 to 4. The texture is sandy clay loam, loam, clay loam or their gravelly counterparts. It is hard or very hard when dry. Reaction ranges from medium acid to neutral.

The upper Bt horizon has matrix with hue of 5YR, 7.5YR to 10YR, value of 4 or 5, and chroma of 3 or 4. Reddish and brownish mottles range from few to common. Lower Bt horizons are in shades of brown or olive in hue of 10YR or 2.5Y with or without mottles in shades of yellow, brown, or red. The texture of the Bt horizon is clay, however, some pedons have clay loam lower B horizons. Reaction of the upper Bt horizon ranges from medium acid to moderate;y alkaline. Reaction of the lower Bt horizon ranges from slightly acid to moderately alkaline. Some pedons are calcareous in the lower part. Calcium carbonate in the form of concretions and masses ranges from none to common.

The C horizon is weakly consolidated shale with clay texture that is stratified with clay loam, clay and shaly clay. Colors are in shades of gray, olive, yellow and brown. The reaction ranges from neutral to moderately alkaline. Some pedons are calcareous. Visible carbonates range from none to common.

COMPETING SERIES: There are no other series in the same family. Similar soils are the Axtell, Bazette, Chaney, Crockett, Payne, Ponder and Steedman series. Axtell, Chaney, and Crockett soils have an abrupt texture change between the A and Bt horizon. Bazette and Payne soils lack vertic properties. Ponder soils have sola more than 60 inches thick and Steedman soils have sola 20 to 40 inches thick.

GEOGRAPHIC SETTING: Normangee soils occur on nearly level to moderately sloping uplands. Slope gradients are predominantly 1 to 6 percent, but range from 0 to 8 percent. The soil formed in alkaline marine sediments of shale, clay, and sandy clay underlain in places by sandstone or limestone. Mean annual temperature ranges from 67 F. and mean annual precipitation ranges from 32 to 42 inches. Frost free days range from 220 to 270 days and elevation ranges from 350 to 800 feet. Thornthwaite annual P-E indices are 50 to 70.

GEOGRAPHICALLY ASSOCIATED SOILS: These include the competing Axtell and Crockett series and the Ellis and Wilson soils. Axtell and Crockett soils are on similar positions. The Ellis soils are clayey throughout and are on similar or more sloping positions. Wilson soils are gray throughout and are on flat, wetter positions.

DRAINAGE AND PERMEABILITY: Moderately well drained. Runoff is slow to rapid; Permeability is very slow.

USE AND VEGETATION: Principal use is pasture. A few areas are farmed to cotton, grain sorghum, small grain, or corn. Native vegetation is thin strands of postoak with bluestems, Indiangrass, switchgrass, and grama grasses in open areas.

DISTRIBUTION AND EXTENT: Blackland Prairie and Texas Claypan areas; possibly in the Cross Timbers areas of Texas and Oklahoma. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Anderson County, Texas; 1970.

REMARKS: Formerly included in the Crockett and Payne series.

Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - 0 to 7 inches, the Ap horizon. (Ap horizon)

Argillic horizon - 7 to 44 inches the Bt horizon. (the Bt horizons)

Soil has high shrink-swell, and cracks when dry.

National Cooperative Soil Survey, U.S.A.

STEPHEN SERIES

The Stephen series consists of shallow, well drained, moderately slowly permeable soils formed in interbedded marl and chalky limestone. These soils are on gently sloping to sloping uplands. Slopes are mainly 1 to 5 percent but range from 1 to 8 percent.

TAXONOMIC CLASS: Clayey, mixed, active, thermic, shallow Udorthentic Haplustolls

TYPICAL PEDON: Stephen silty clay--cropland. (Colors are for dry soil unless otherwise stated.)

Ap--0 to 8 inches; dark brown (7.5YR 4/2) silty clay, dark brown (7.5YR 3/2) moist; moderate fine subangular blocky and granular structure parting to very fine subangular blocky structure; hard, firm, sticky, plastic; many fine roots; few fine chalk fragments; calcareous, moderately alkaline; abrupt wavy boundary. (7 to 20 inches thick)

C/A--8 to 12 inches; about 65 percent platy chalk fragments and platy chalk in place and about 35 percent dark brown (7.5YR 3/3) moist silty clay in the horizontal and vertical crevices and between the loose chalk fragments; few to strongly cemented cobblestones and limestone; few fine roots; few fine pores; calcareous, moderately alkaline; abrupt irregular boundary. (0 to 6 inches thick)

Cr--12 to 28 inches; pink (5YR 8/3) and white (10YR 8/2) platy chalk this is less hard than 3, Mohs scale; few thin tongues of dark brown calcareous silty clay in crevices between some chalk plates.

TYPE LOCATION: McLennan County, Texas; from the intersection of Farm Road 1695 and Farm Road 2837 in Lorena, 0.6 mile northwest on Farm Road 2837 to intersection with county road, 300 feet west and 100 feet north of intersection in cropland.

RANGE IN CHARACTERISTICS: Solum thickness to chalky limestone ranges from 7 to 20 inches. The chalky limestone, when moist, can be cut with a spade. The layer below the A horizon ranges from 40 to 80 percent or more calcium carbonate equivalent.

The A horizon has hue of 7.5YR or 10YR; value of 3 to 5, and chroma of 1 to 3. It is clay, silty clay, silty clay loam, or clay loam with 35 to 55 percent clay. Chalk fragments in the A horizon range from 2 to 15 percent by volume. Olive mottles or streaks range from none to common in the lower part to the A horizon. The lower boundary of the A horizon ranges from wavy to irregular.

The C/A or A/C horizons, where present, have color and texture similar to those of the A and Cr horizons.

The Cr horizon is interbedded chalk and limy earths or soft limestone and limy earths. It has hue of 5YR to 10YR in shades of pink, white, and gray.

COMPETING SERIES: There are no series in the same family. Similar soils are Brackett, Castephen, Doss, Eckrant, Purves, Real, and Whitewright series. Brackett and Whitewright soils lack a mollic epipedon. Brackett, Castephen, Doss, Real, and Whitewright soils have carbonatic mineralogy and contain less than 35 percent silicate clay. Eckrant and Purves soils have a Lithic contact with indurated limestone. In addition, Eckrant and Real soils contain more than 35 percent coarse fragments.

GEOGRAPHIC SETTING: Stephen soils are on uplands. Surfaces are plane to convex, with gradients mainly less than 5 percent, but range from 1 to 8 percent. The soils formed in interbedded chalk, marl, or soft limestone rubble, mainly of the Austin Formation. The climate is warm and subhumid; mean annual precipitation ranges from 30 to 42 inches, mean annual temperature from 63 to 69 degrees F., and the Thornthwaite annual P-E indices from 44 to 66.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Altoga, Austin, Brackett, Eddy, and Lott series. All of these soils have carbonatic

mineralogy and less than 35 percent clay in the control section. In addition; Altoga, Brackett, and Eddy do not have mollic epipedons.

DRAINAGE AND PERMEABILITY: Well drained; medium to rapid runoff; medium internal drainage; moderately slow permeability.

USE AND VEGETATION: Mainly in cultivation and used for growing small grains. A few areas are in native range. Native grasses are little bluestem, sideoats grama, hairy grama, and buffalograss.

DISTRIBUTION AND EXTENT: The Blackland Prairie of Texas. The series is extensive.

MLRA OFFICE RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Ellis County, Texas; 1962.

REMARKS: Classification was changed 11/89 from clayey, mixed, thermic, shallow Entic Haplustolls to clayey, mixed, thermic, shallow Udorthentic Haplustolls.

Diagnostic horizons and features recognized in this pedon are:

Mollic epipedon - 0 to 8 inches, the Ap horizon.

Paralithic contact of chalk at a depth of 12 inches.

National Cooperative Soil Survey, U.S.A.

TRINITY SERIES

The Trinity series consists of very deep, moderately well drained, very slowly permeable soils on flood plains. They formed in alkaline clayey alluvium. Slopes are typically less than 1 percent, but range from 0 to 3 percent.

TAXONOMIC CLASS: Very-fine, smectitic, thermic Typic Hapluderts

TYPICAL PEDON: Trinity clay--pasture. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 6 inches; very dark gray (5Y 3/1) clay, dark gray (5Y 4/1) dry; moderate fine and medium granular and moderate fine subangular blocky structure; very hard, firm, sticky, very plastic; many fine roots; common fine pores; strongly effervescent; moderately alkaline; clear smooth boundary. (0 to 8 inches thick)

A--6 to 16 inches; very dark gray (5Y 3/1) clay, dark gray (5Y 4/1) dry; moderate medium subangular blocky structure parting to very fine subangular blocky; very hard, firm, sticky, very plastic; common fine roots; common fine pores; many prominent pressure faces; few very fine concretions of calcium carbonate; strongly effervescent, moderately alkaline; gradual wavy boundary. (8 to 24 inches thick)

Bss1--16 to 36 inches; very dark gray (5Y 3/1) clay, dark gray (5Y 4/1) dry; weak fine and very fine subangular blocky structure; very hard, firm, sticky, very plastic; few fine roots; few fine pores; many prominent pressure faces; common prominent grooved slickensides that increase with depth; few very fine and fine concretions of calcium carbonate; strongly effervescent; moderately alkaline; diffuse wavy boundary.

Bss2--36 to 64 inches; very dark gray (5Y 3/1) clay, dark gray (5Y 4/1) dry; weak coarse blocky structure; very hard, very firm; few fine roots and pores; many prominent grooved slickensides; common fine and medium distinct olive yellow (5Y 6/6) and yellowish brown (10YR 5/8) redox concentrations; common fine and medium concretions of calcium carbonate; few hard black concretions; strongly effervescent; moderately alkaline; diffuse wavy boundary.

Bss3--64 to 75 inches; dark olive gray (5Y 3/2) clay, olive gray (5Y 4/2) dry; weak coarse angular blocky structure; very hard, very firm; common fine and medium distinct olive yellow (2.5Y 6/6; 5Y 6/8) and few coarse distinct light olive brown (2.5Y 5/4) redox concentrations; few prominent slickensides; common very fine and medium concretions of calcium carbonate; common fine black concretions; strongly effervescent, moderately alkaline. (combined thickness of Bss horizons is 40 to 70 inches)

TYPE LOCATION: Kaufman County, Texas; from intersection of old U.S. Hwy. 80 and Farm Road 740 in Forney; 6.1 miles south on Farm Road 740; 0.45 mile south on oil top road which is an extension of Farm Road 740; 54 feet east of fence.

RANGE IN CHARACTERISTICS: Solum thickness is more than 80 inches. Gilgai microrelief is present in undisturbed areas but is subdued with the micro highs 2 to 6 inches higher than the micro lows. When dry, cracks 1/4 to more than 1 inch wide extend to a depth of 20 inches or more for less than 90 cumulative days. Grooved slickensides typically begin at a depth of 12 to 24 inches and increase in number and size with depth. Clay content of the control section ranges from 60 to 80 percent. The soil is slightly alkaline or moderately alkaline and slightly or strongly effervescent throughout.

The A horizon has hue of 10YR, 2.5Y, or 5Y, with values of 2 to 3 and chroma of 1.

The Bss or Bkss horizons have hue of 10YR, 2.5Y, or 5Y, value of 2 to 5, and chroma of 2 or less. Few to common masses of redox concentrations in shades of yellow, brown, or olive are in the lower part. Calcium carbonate in the form of masses, concretions, and threads range from none to common.

COMPETING SERIES: These are the Billyhaw, Kaufman, and Wiergate series in the same family and the Hallsbluff, Kaman, Pledger, Texark, Tinn, and Zilaboy series in similar families. The Billyhaw soils have a solum less than 60 inches thick and colors with hue redder than 10YR. Kaman, Kaufman, Texark, and Wiergate soils are noncalcareous in the A horizon. Hallsbluff, Kaman, Tinn, and Zilaboy soils average less than 60 percent clay in the particle-size control section. Kaman and Zilaboy soils are wet for longer periods. Pledger soils have a hyperthermic temperature regime and, in addition, Pledger soils have sola less than 60 inches thick and colors with hue redder than 10YR.

GEOGRAPHIC SETTING: Trinity soils are on nearly level, wide flood plains of major rivers and streams. Slopes are mainly less than 1 percent but range up to 3 percent. The soil formed in calcareous clayey alluvium. The climate is warm and humid to subhumid. The mean annual precipitation ranges from 34 to 52 inches and mean annual temperatures range from 62 to 70 degrees F. Frost free days range from 230 to 280 days and elevation ranges from 100 to 550 feet. Thornthwaite P-E indices range from 52 to about 70.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Kaufman, Tinn, and Zilaboy series and the Gladewater and Ovan series. Ovan soils have less than 60 percent clay in the particle-size control section, have colors with chroma of 2 or 3 in the A horizon, and have cracks that stay open longer than 90 cumulative days. Gladewater soils have aquic soil conditions within a depth of 20 inches. Gladewater and Zilaboy soils are on slightly lower and wetter positions. Kaufman, Tinn, and Ovan soils are on similar flood plain positions.

DRAINAGE AND PERMEABILITY: Moderately well drained. Runoff is low on 0 to 1 percent slopes and medium on 1 to 3 percent slopes. Permeability is very slow. Flooding is common except where the soil is protected.

USE AND VEGETATION: Most areas are in pasture or planted to crops such as cotton, corn, sorghums, or small grains. Native vegetation is hardwood forest of elm, hackberry, oak, and ash.

DISTRIBUTION AND EXTENT: North Central, Central, and South Central Texas. The series is extensive.

MLRA OFFICE RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Monroe County, Mississippi; 1908.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Mollic epipedon - the A horizon from 0 to 16 inches. Cambic horizon - the Bss horizon from 16 to 75 inches. Vertic properties - gilgai microrelief in undisturbed areas, slickensides at a depth of 16 to 75 inches, and cracks that remain open less than 90 cumulative days.

ADDITIONAL DATA: National Soil Survey Laboratory: S77TX-175-(78P068).

Soil Interpretation Record - Trinity (TX0101), commonly flooded (TX1189), frequently flooded (TX1124), depressional (TX0919).

National Cooperative Soil Survey, U.S.A.

TINN SERIES

The Tinn series consists of very deep, moderately well drained, very slowly permeable soils that formed in calcareous clayey alluvium. These soils are on flood plains of streams that drain the Blackland Prairies. Slopes are dominantly less than 1 percent but range from 0 to 2 percent.

TAXONOMIC CLASS: Fine, smectitic, thermic Typic Hapluderts

TYPICAL PEDON: Tinn clay--cultivated. (Colors are for moist soil unless otherwise noted.)

Ap--0 to 6 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; moderate coarse angular blocky structure parting to moderate very fine and fine angular blocky structure; very hard, very firm; plastic; few fine roots; few fine and medium pores; slightly effervescent; moderately alkaline; abrupt smooth boundary. (4 to 8 inches thick)

A--6 to 18 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; moderate coarse angular blocky structure parting to moderate very fine and fine angular blocky; very hard, very firm; few fine roots; few fine and medium pores; common pressure faces; few fine slickensides; about 2 percent fine siliceous pebbles, and about 2 percent fine ironstone pebbles; few worm casts; few medium grayish brown (2.5Y 5/2) streaks along root channels; slightly effervescent; moderately alkaline; gradual wavy boundary. (6 to 15 inches thick)

Bss1--18 to 28 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; moderate coarse angular blocky structure parting to moderate fine and medium angular blocky; very hard, very firm; few fine roots; few fine and medium pores; common fine pressure faces; common fine slickensides; about 2 percent fine siliceous pebbles, and about 2 percent fine ironstone pebbles; few worm casts; few medium grayish brown (2.5Y 5/2) streaks along root channels; slightly effervescent; moderately alkaline; gradual wavy boundary. (8 to 20 inches thick)

Bss2--28 to 54 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; moderate coarse angular blocky structure parting to moderate fine and medium angular blocky structure; very hard, very firm; few fine roots; few fine and medium pores; many prominent grooved

slickensides that range from 5 to 10 cm across; most slickensides are oriented at 45 degrees; few fine black concretions; few medium calcium carbonate concretions that are pitted; about 2 percent siliceous pebbles; about 2 percent shell fragments; few worm casts; few coarse very dark gray (10YR 3/1) masses; slightly effervescent; moderately alkaline; gradual wavy boundary. (0 to 30 inches thick)

Bss3--54 to 72 inches; very dark gray (10YR 3/1) clay, dark gray (10YR 4/1) dry; moderate coarse angular blocky structure parting to moderate fine and medium angular blocky; very hard, very firm; few fine roots; few fine and medium pores; common prominent grooved slickensides up to 1 meter across, slickensides are oriented at 45 to 60 degrees; few fine and medium calcium carbonate concretions that are pitted; few worm casts; slightly effervescent; moderately alkaline; gradual wavy boundary. (10 to 24 inches thick)

Bkss--72 to 80 inches; very dark grayish brown (2.5Y 3/2) clay, dark grayish brown (2.5Y 4/2) dry, moderate coarse angular blocky structure parting to moderate fine and medium angular blocky; very hard, very firm; few fine roots; few fine and medium pores; few fine grooved slickensides up to 50 cm across, slickensides are oriented at 45 to 60 degrees; common fine and medium calcium carbonate concretions; few fine and medium masses of gypsum; few black (10YR 2/1) streaks; slightly effervescent; moderately alkaline.

TYPE LOCATION: Limestone County, Texas; from the intersection of Farm Road 171 and Farm Road 73 in Coolidge, 2.8 miles northeast on Farm Road 73, 0.6 miles north on county road, and 400 feet east on Pin Oak Creek floodplain in cropland.

RANGE IN CHARACTERISTICS: Solum thickness is greater than 80 inches. Reaction is slightly alkaline or moderately alkaline. Effervescence ranges from very slight to strong. Weighted average clay content of the particle size control section ranges from 40 to 60 inches. Texture is silty clay or clay throughout. Undisturbed areas have subdued gilgai, with microhighs 2 to 6 inches higher than microlows. Slickensides and/or wedge-shaped aggregates begin at depths from 6 to 20 inches, becoming more distantly expressed between 20 and 60 inches. The soil cracks when dry and the cracks are 0.5 inch to about 2 inches wide and extend to a depth of more than 12 inches. The cracks remain open from 60 to 90 cumulative days in most years.

The A horizon has dark colors in hue of 10YR to 5Y, value of 2 or 3, and chroma of 1. Texture is silty clay or clay.

A Bw horizon is present in some pedons. Where present, the colors and textures are similar to those of the A horizon.

The Bss and Bkss horizons have hue of 10YR to 5Y, value of 3 to 6, and chroma of 1 to 4. Redox concentrations in shades of brown, olive or yellow range from none to common. Calcium carbonate masses and concretions range from none to common.

COMPETING SERIES: These are the Eastham and Hallsbluff series. Similar soils are the Branyon, Burleson, Kaufman, and Trinity soils. Eastham soils are not calcareous in the upper 20 inches. Hallsbluff soils have a mollic epipedon with chroma of 2. Branyon and Burleson soils are

Usterts. In addition, Burleson soils are noncalcareous in the upper 20 inches. Kaufman and Trinity soils have very-fine control sections.

GEOGRAPHIC SETTING: Tinn soils are on nearly level flood plains. Slopes are mainly less than 1 percent, but some are as much as 2 percent. The soil formed in calcareous clayey alluvium. Mean annual precipitation ranges from 32 to 42 inches, and mean annual temperature ranges from 64 to 68 degrees F. Frost free days range 230 to 270 days and elevation ranges from 250 to 550 feet. Thornthwaite P-E indices exceed 44.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Branyon, Burleson, Ferris, Heiden, Houston Black, and Trinity series. Branyon and Burleson soils are on higher terrace positions. Ferris and Heiden soils have chroma of 2 or more in the upper 12 inches. Houston Black soils have greater amplitude of waviness and are on uplands in a higher position. Trinity soils have very-fine particle-size control sections and are in similar positions.

DRAINAGE AND PERMEABILITY: Moderately well drained. Permeability is very slow. Runoff is low. Flooding is common except where the soil is protected. Duration of flooding is very brief or brief.

USE AND VEGETATION: Most areas are in pasture or cultivated to crops such as cotton, corn, sorghums, or small grains. Native vegetation is elm, hackberry, oak, and ash, with an understory of grasses such as species of paspalums and panicums.

DISTRIBUTION AND EXTENT: Mainly in central Texas on streams draining the Blackland Prairies (MLRA 86A). The series is extensive.

MLRA OFFICE RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Hill County, Texas; 1975.

REMARKS: Classification of the Tinn series was changed from Vertic Haplaquolls to Typic Pelluderts (3/88). This change was based on several years study and analysis of the soils mapped in the Tinn series. The series type location was moved from Hill County to Limestone County to a pedon that is near the center of the series range in characteristics and near the center of the geographic distribution. Classification change from Typic Pelluderts to Typic Hapluderts based on Amendment 16, SOIL TAXONOMY (2/94).

Diagnostic horizons and features recognized in this pedon are:

Mollic colors - throughout this pedon.

Vertic Properties - slickensides from 6 to 80 inches.

SOIL INTERPRETATION RECORD NO: TX0456

National Cooperative Soil Survey, U.S.A.

WILSON SERIES

The Wilson series consists of very deep, moderately well drained, very slowly permeable soils that formed in alkaline clayey sediments. These soils are on nearly level to gently sloping stream terraces or terrace remnants on uplands. Slopes are mainly less than 1 percent but range from 0 to 5 percent.

TAXONOMIC CLASS: Fine, smectitic, thermic Oxyaquic Vertic Haplustalfs

TYPICAL PEDON: Wilson silt loam--cropland. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 5 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak fine granular structure; massive when dry; very hard, firm, sticky and plastic; common fine roots; moderately acid; abrupt wavy boundary. (3 to 10 inches thick)

Bt--5 to 20 inches; very dark gray (10YR 3/1) silty clay, gray (10YR 5/1) dry; moderate medium angular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine roots; few fine pores; thin continuous clay films 1/2 unit of value darker than interior of peds; vertical cracks 1/2 inch wide are filled with material from the Ap horizon; slightly acid; gradual wavy boundary. (10 to 20 inches thick)

Btssg1--20 to 32 inches; grayish brown (2.5Y 5/2) silty clay, light brownish gray (2.5Y 6/2) dry; moderate medium angular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine roots; few fine pores; few slickensides; few medium pressure faces; thin continuous clay films on surface of peds; vertical cracks 1/4 inch wide partly filled with material from above; few fine crystals of gypsum; few fine calcium carbonate concretions; slightly alkaline; diffuse wavy boundary.

Btssg2--32 to 65 inches; grayish brown (2.5Y 5/2) silty clay, light brownish gray (2.5Y 6/2) dry; weak coarse angular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine roots; few fine pores; few slickensides; patchy clay films on surface of peds; common fine crystals of gypsum; few fine masses of calcium carbonate; slightly alkaline; gradual smooth boundary. (combined Btss subhorizons are 25 to 60 inches thick)

BCkss--65 to 80 inches; olive gray (5Y 5/2) silty clay, light gray (5Y 7/2) dry; weak coarse angular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine roots; few fine pores; few slickensides; few coarse masses of calcium carbonate; few small fragments of clay; very slightly effervescent; moderately alkaline.

TYPE LOCATION: Kaufman County, Texas; 4 miles southeast of the intersection of Texas Highway 34 and U. S. Highway 175 in Kaufman, 0.15 mile northeast and 0.2 mile southeast of intersection of county road and U. S. Highway 175, 150 feet southwest in field.

RANGE IN CHARACTERISTICS: Solum thickness ranges from 60 to more than 80 inches. The weighted average clay content of the upper 20 inches of the argillic horizon ranges from 35 to 50 percent. When dry, cracks at least 1/4 inch wide extend from the top of the argillic horizon through a thickness of 12 inches or more within the upper 50 inches of the soil. Slickensides and/or wedged-shaped aggregates and pressure faces range from few to common and begin at a depth of 14 to 26 inches. Linear extensibility is greater than 2.5 inches (6 cm) within 40 inches (100 cm) of the soil surface. COLE ranges from 0.07 to 0.10 in the upper 50 inches of the argillic horizon. The surface layer is variable in thickness with a series of micro crests and troughs in the Bt horizon that range from 4 to about 20 feet apart. Redoximorphic features are contemporary in the upper Bt1 horizon and are mainly relic in the lower part of the Bt horizon. The soil does not have aquic soil conditions in the upper 20 inches in most years.

The A horizon is less than 10 inches thick in more than 50 percent of the pedon, but it is as much as 15 inches thick in some subsoil troughs. It has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 1 or 2. Texture is loam, silt loam, silty clay loam, clay loam or their gravelly counterparts. Siliceous pebbles and small cobbles range from 0 to 35 percent. It is massive and hard or very hard when dry but is soft or friable with structure when moist. Some pedons have a thin E horizon in subsoil troughs. Reaction ranges from moderately acid to neutral.

The Bt horizon has hue of 10YR or 2.5Y, value of 2 to 4, and chroma of 1 or less. Texture is clay loam, silty clay loam, silty clay, or clay. Some pedons have iron concentrations in shades of brown or yellow that range from few to common. Siliceous pebbles range from 0 to about 15 percent by volume. Reaction ranges from slightly acid to slightly alkaline.

The Btss horizon has hue of 10YR to 5Y, value of 3 to 7, and chroma of 2 or less. Iron concentrations in shades of yellow, brown or olive range from none to common. Texture is commonly silty clay or clay and less commonly silty clay loam or clay loam. Reaction ranges from moderately acid to slightly alkaline and is typically noncalcareous.

The BCk or BC horizon has colors in shades of gray or brown. Redoximorphic features of these colors and in other shades of yellow, red or olive range from few to many. Texture is clay loam, silty clay loam, silty clay, or clay. Some pedons have fragments or thin strata of shale or marl. These materials make up less than 35 percent of the matrix. Reaction ranges from neutral to moderately alkaline. Concretions and masses of calcium carbonate range from none to common.

The C horizon, where encountered, is shale or marl or stratified layers of shale, marl and clay.

COMPETING SERIES: There are no competing series. Similar soils are the Dacosta, Herty, Lufkin, Mabank, and Steedham series. Dacosta soils have a mollic epipedon and are members of the hyperthermic family. Herty, Lufkin and Mabank soils have an abrupt texture change between the A and Bt horizon. In addition, Herty soils are in the udic moisture regime. Steedham soils have sola from 20 to 40 inches thick, and are well drained.

GEOGRAPHIC SETTING: Wilson soils are on nearly level to gently sloping terraces or remnants of terraces. Slope gradients are 0 to 5 percent but dominantly less than 1 percent. The soil formed in alkaline clayey alluvium. Mean annual temperature ranges from 64 to 70 degrees F., and mean annual precipitation ranges from 32 to 45 inches. Frost free days range from 220 to 270 days and elevation ranges from 250 to 700 feet. Thornthwaite P-E indices from 50 to 70.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Bonham, Burleson, Crockett, Houston Black, Lufkin, Mabank, and Normangee series. Bonham soils have mollic epipedons. Burleson soils are on similar positions. Burleson and Houston Black soils are clayey to the surface and have slickensides (Vertisols). Crockett and Normangee soils have Bt horizons with chroma of more than 2. Bonham, Houston Black, Crockett and Normangee soils are on slightly higher positions above Wilson. Lufkin soils are on similar or slightly lower concave positions. Mabank soils are on similar positions.

DRAINAGE AND PERMEABILITY: Moderately well drained. Permeability is very slow. Runoff is low on 0 to 1 percent slopes, medium on 1 to 3 percent slopes, and high on 3 to 5 percent slopes. Very slow internal drainage. The soil is seasonally wet and is saturated in the surface layer and upper part of the Bt horizon during the winter and spring seasons for periods of 10 to 30 days.

USE AND VEGETATION: Wilson soils are cropped to cotton, sorghums, small grain, and corn. Many areas are now idle or are used for unimproved pasture. Original vegetation was tall prairie grasses, mainly andropogon species, and widely spaced motts of elm and oak trees. Most areas that are not cropped have few to many mesquite trees.

DISTRIBUTION AND EXTENT: Mainly in the Blackland Prairies of Texas, with small areas in Oklahoma. The soil is extensive, probably exceeding 1,000,000 acres.

MLRA OFFICE RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Wilson County, Texas; 1907.

REMARKS: Classification change from Udertic Haplustalfs to Oxyaquic Vertic Haplustalfs based on knowledge that these soils are saturated for 2 to 4 weeks in most years. This period of time is within the definition of saturation for one month or more if rules of rounding are applied, i.e., 2 to 6 weeks saturation is considered inclusive.

Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - 0 to 5 inches. (A horizon; very hard and massive when dry).

Argillic horizon - 5 to 65 inches. (Bt horizons)

Vertic feature - Cracks in the upper part of the argillic horizon (5 to 32 inches), few slickensides between 20 and 77 inches, and linear extensibility greater than 6.0 cm.

ADDITIONAL DATA: Type location pedon NSSL S62TX-(129)257-2 Kaufman County, Texas. Texas Ag. Exp. Station Lab. S63TX-145-1; S82TX-289-32

National Cooperative Soil Survey, U.S.A.

WHITEWRIGHT SERIES

The Whitewright series consists of shallow, well drained, moderately permeable soils that formed in weakly cemented chalk and marl of Upper Cretaceous Age. These gently sloping to moderately steep soils are on convex upland ridges. Slopes are dominantly 4 to 10 percent but range from 1 to 15 percent.

TAXONOMIC CLASS: Loamy, carbonatic, thermic, shallow Typic Haplustepts

TYPICAL PEDON: Whitewright silty clay loam--pasture. (Colors are for dry soil unless otherwise stated.)

A--0 to 5 inches; light brownish gray (10YR 6/2) silty clay loam, grayish brown (10YR 5/2) moist; moderate medium subangular blocky and granular structure; hard, friable; common medium and fine roots; few fine and medium pores; common wormcasts; few fragments of weakly cemented chalk that are 2 mm to 10 mm in size; few strongly cemented fragments of calcite that are 5 to 15 mm across the long axis; calcium carbonate equivalent is about 60 percent; calcareous, moderately alkaline; clear smooth boundary. (6 to 14 inches thick)

Bk--5 to 16 inches; very pale brown (10YR 7/3) silty clay loam, pale brown (10YR 6/3) moist; few medium distinct brownish yellow (10YR 6/6) mottles; moderate fine and medium subangular blocky structure; hard, friable; common fine and medium roots; few fine pores; common wormcasts; about 20 percent by volume of weakly cemented platy fragments of chalk 5 to 20 mm across the long axis; most of the chalk fragments disintegrate upon moistening and gentle rubbing; few fine shell fragments; calcium carbonate equivalent is about 65 percent; few films and threads of calcium carbonate; calcareous, moderately alkaline; abrupt wavy boundary. (6 to 14 inches thick)

Cr--16 to 34 inches; white (10YR 8/1) weakly cemented fractured chalk, interbedded with thin horizontal strata of olive yellow (2.5Y 6/6) silty clay loam; cleavage planes of rock structure are evident in the chalk; the chalk becomes less fractured and more massive below 30 inches depth; few fine roots in the upper part in vertical crevices and between horizontal plates; calcareous, moderately alkaline.

TYPE LOCATION: Grayson County, Texas; from the intersection of Texas Highway 5 and Farm Road 121 in Van Alstyne, Texas, 0.75 mile east on Farm Road 121; 1.25 miles north on an unpaved county road; 100 feet west of road in pasture.

RANGE IN CHARACTERISTICS: Solum thickness ranges from 10 to 20 inches. Siliate clay ranges from 20 to 35 percent in the control section. The soil is calcareous and ranges from 40 to more than 80 percent calcium carbonate equivalent.

The A horizon has colors in hues of 10YR, value 4 to 6, and chroma of 2 to 4. Where the horizon has moist values and chromas of 3 or less, it is less than 7 inches thick. It is silty clay loam or clay loam. Fragments of weakly cemented chalk range from none to about 15 percent by volume. They are platy and range from 2 mm to 3 cm across the long axis. The fragments are weakly to strongly cemented when dry but most of the fragments slake or soften on soaking in water.

The Bw horizon has colors with hue of 10YR, value of 5 to 7, and chroma of 2 to 4. Some pedons have mottles of brown or yellow that are believed to be inherited from the parent material. It is silty clay loam, or clay loam, or their gravelly counterparts. Fragments of weakly to strongly cemented chalk range from a few to 35 percent by volume. However, upon soaking in water, the chalk fragments slake to where the percentage of strongly cemented fragments range from a few to about 20 percent by volume.

The Cr horizon has colors in shades of gray, brown or white. It is weakly cemented platy chalk interbedded with thin strata of light yellowish brown, pale yellow, brownish yellow, or olive yellow clay loam or silty clay loam. The platy fragments of chalk are weakly to strongly cemented but can be readily cut with a spade when moist. In most pedons the chalk becomes less fractured and more massive at 25 to 40 inches depth.

COMPETING SERIES: There are no other series in this family, similar families include the Altoga, Brackett, Cuthand, Dugout, Eddy, Howe, Seawillow, Shiner, Stephen, and Quinlan series. Altoga, Cuthand, Howe, and Seawillow soils have sola more than 20 inches thick. Brackett, Dugout, and Quinlan soils are dry in the moisture control section for longer periods of time. In addition, Brackett soils contain fragments of hard limestone, Dugout soils have a lithic contact to limestone and Quinlan soils have mixed mineralogy and B horizons with redder hues. Eddy soils lack B horizons and have more than 35 percent chalk fragments in the control section. Shiner soils have a mean annual soil temperature of more than 72 degrees F. Stephen soils have mollic epipedons and mixed mineralogy.

GEOGRAPHIC SETTING: Whitewright soils occupy gently sloping to moderately steep uplands. Slopes are mainly 4 to 10 percent but range from 1 to 15 percent. The soil formed in chalk and interbedded marl of the Austin Group of Upper Cretaceous Age. The mean annual temperature is 63 degrees to 66 degrees F. Average annual precipitation ranges from about 35 to 41 inches, and the Thornthwaite P-E index ranges from 56 to 66.

GEOGRAPHICALLY ASSOCIATED SOILS: These include the competing Eddy, Howe, and Stephen series as well as the Austin series. Eddy and Howe soils occupy similar positions. Stephen and Austin soils occupy slightly higher less sloping positions. Stephen and Austin soils have mollic epipedons, and in addition, Austin soils have sola thicker than 20 inches.

DRAINAGE AND PERMEABILITY: Well drained; rapid runoff; moderate permeability.

USE AND VEGETATION: Used mainly for pasture. A few areas are planted to small grain and sorghum. Dominant pasture grasses are King Ranch bluestem, common and improved bermudagrass. Areas that were formerly in cropland are growing silver bluestem, sideoats grama, hairy grama, little bluestem, threeawn, and annual weeds. Woody vegetation is mainly scattered elm, hackberry, and small oak trees.

DISTRIBUTION AND EXTENT: North-central Texas; in the Blackland Prairie Land Resource area. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Grayson County, Texas; 1977.

REMARKS: These soils were formerly as a shallow phase of the Austin series and in more recent years they were included in the Brackett series.

Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - 0 to 5 inches, the A horizon.

Calcic horizon - 5 to 16 inches, the Bk horizon.

Paralithic contact of chalk at a depth of 16 inches.
