OKLAHOMA DEPARTMENT OF TRANSPORTATION

200 Northeast 21st Street

Oklahoma City, OK 73105-3204

May 11, 2006

To : John Fuller, Chief Engineer
From : Materials Division / Geotechnical Branch
Subject : Alice Greenback Mine Investigation, FAS Project No S-509(2)S, Location 0.5 Mile Northeast of Quapaw Adjacent to US 69A, Ottawa County.

We have completed an extensive investigation into the cause of shallow collapse (sinkhole) as outlined in an e-mail dated October 10, 2003 that is connected with the Alice Greenback lead and zinc mine (SW1/4 NE ¼, SE ¼, of section 26, R.23E., T.29N). The scope of the work involves completing a detailed test boring as deep as possible with our NWD4 core barrel, research the boring logs for the vent holes near the location of the collapse, and a mine shaft analysis. The center of the collapse was surveyed to be a station 546+08.5, 55 feet left of the centerline of US 69A according to the project plan and profile. The shape of the collapse was approximately 8-10 foot in diameter, with a maximum depth of 2.5-3.0 foot. The sinkhole has subsequently been filled by Ottawa County maintenance with gravel. The site condition and proximity of the Alice Greenback Mine spoils are seen in Figures 1 through 7. As seen in Figures 6 and 7, a pipe guard was installed by Ottawa County maintenance forces approximately 15-16 years ago around another collapse occurrence at station 540+32.2, 60 feet right of the centerline US69A. Due to overhead power lines, our detailed test boring, B2, was made at station 546+12.5, 54 feet right of the centerline US69A.

Geology. The site of the collapse is located in a nearly level (0-1 percent slope) terrain in a Taloka soil series map unit according to the US Department of Agriculture Natural Resources Conservation Service (NRCS) Ottawa County Soil Survey. Underlying the Taloka soils series is the Chester-Meramec geologic unit. This unit consists of limestone, chert, shale, sandstone and siltstone with lithology varying locally. At this site the detailed test boring, B2, is presented in the gINT format, see enclosured gINT logs in Appendix A. An initial boring, B1, at station 546+32.5, 56 feet right of the centerline of US69A was continuously sampled and cored to a depth of 31 feet at which the boring had to be abandoned due to excessive amount of cuttings that could not be removed, see Appendix A. At this site only limestone and chert were encountered. A hand auger boring near the collapse at station 546+00, 58 feet left of centerline of US69A confirms the Taloka soil series and underlying limestone geology, see B3 gINT log in Appendix A.

Provided in an e-mail on October 10, 2003 is a photograph of the estimated Alice Greenback Mine workings in reference to the US69A alignment. As can be seen in the photographs, there numerous small holes identified by a prefix H. The holes (borings) were air vent holes for the mine shaft according to the Picher mine archives located in Joplin, Missouri. A total of 14 logs were found from the archives for the Alice Greenback Mine, see Table 1 and Appendix B.

Analysis. Based on an analysis of borings B1 and B2 core log data, an analysis of an opening in competent rock was made by the Kirsch solution. What the Kirsch solution involves is the calculation of stresses and displacements in rock that is stressed below the elastic limit of the rock which is about one-half of the unconfined compressive strength and in which the joint system is tightly pre-compressed. This is the plane strain equivalent of a hole in a plate, and we use the solution to the problem of a circular hole in a biaxially loaded plate of homogeneous, isotropic, continuous linearly elastic material in the analysis. What we are analyzing for is the displacement of the springline of a circular opening that stimulates a mine shaft. The inputs on the dimension of the simulated circular mine shaft are the depth of the springline of 116 feet from boring B2, and a diameter equal to 20 feet. Other inputs for the Kirsch displacement equation are the unit weight, Poisson's ratio (ϒ) estimated at 0.3, elastic mass modulus (E_m), and the mass shear modulus (G_m). These inputs are estimated from the rock core and rock mass rating (RMR) as determined from core runs from borings, B1 and B2. Respectively, the unit weight, unconfined compressive strength (UCS), and RMR are presented in Tables 2, 3, and 4. Averaged values of the unit weight, and unconfined compressive strength were used for the design inputs for the Kirsch displacement equation. The RMR was used to estimate the elastic mass modulus per each core run, and the mass shear modulus was, then estimated from the calculated elastic mass modulus along with the Poisson's ratio for each core run.

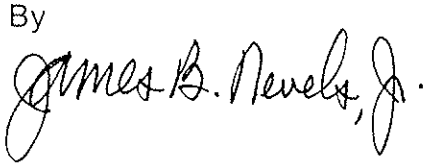
The total displacement for the springline of the simulated circular mine shaft using the Kirsch analytical solution is presented in Table 5 in the lower right of the spread sheet. This displacement is exceptionally low, in millimeters. Research into mine collapses indicates that for pillar and room construction that mine works that are deeper than 15 meters (49.2 feet) little subsidence occurs in competent rock in relatively level strata. Precautions are recommended if the top of the mine are in 10 meters (32.8 feet) or less. We are not sure as to the depth of the top of mine shaft at the Alice Greenback lease. It was reported to us by the US Army Corps of Engineers subsidence team that the depth to the top of the mine shaft was in the range of 176 feet. Our analysis elected to be conservative; therefore, we analyzed for a depth of the top of the circular mine shaft at 116 feet, the depth that we were able to continuously core in boring, B2.

Conclusion. The Kirsch displacement analysis utilizing the minimum depth to the top of the mine shaft estimated at 116 feet does not show any significant displacement of the springline of a simulated mine shaft, only millimeters of movement. An analysis was made by keeping the height constant at 20 feet and varying the 'a' value in the Kirsch equation that represents the width of the mine shaft, to see the effect that an unsupported width has on the mine shaft, see Tables 6, 7, and 8. Only when the span of the simulated mine shaft approaches 40 feet (half the mine shaft width) does displacement become negative value and the potential for a mine collapse exist. Again we do not know all of the facts related to this mine shaft location; however, the analysis

and assumptions appear to be reasonable. The Kirsch solution provides the necessary intuitive insight that supports the historical record of no mine subsidence or collapse on U.S. Highway 69A in the Quapaw area.

Recommendation. We are recommending of the removal of the load and/or weight restrictions for this section of U.S. Highway 69A in the Quapaw area, and Division 8, Ottawa County, maintenance return to their scheduled maintenance operations.

Reynolds Toney, P.E.
Materials Engineer
By



James B. Nevels, Jr., P.E.
Geotechnical Engineer

Enclosure:

Cc:
Gary Ridley, Director
Gary Evans, Director of Operations / Asst. Chief Engineer
Randle White, Division 8 Engineer
Tim Gatz, Asst. Director for Administration
Reynolds Toney
Materials File
Bookkeeping
Geotechnical Branch
Jim Nevels
Chris Clarke
Butch Reidenbach

Figure 1. Taloka Silt Loam Landscape, 0–1 Percent Slope.

Figure 2. Chat Pile from the Alice Greenback Lease.

Figure 3. Looking NE Along US 69A, Mine Site to Extreme Right.

Figure 4. Old Sinkhole in South Ditch, Maybe H-22.

Figure 5. Looking SW Toward Old Sinkhole. Pipe Rail Around Sinkhole to Keep Mowers Out.

Figure 6. Sinkhole July 2003

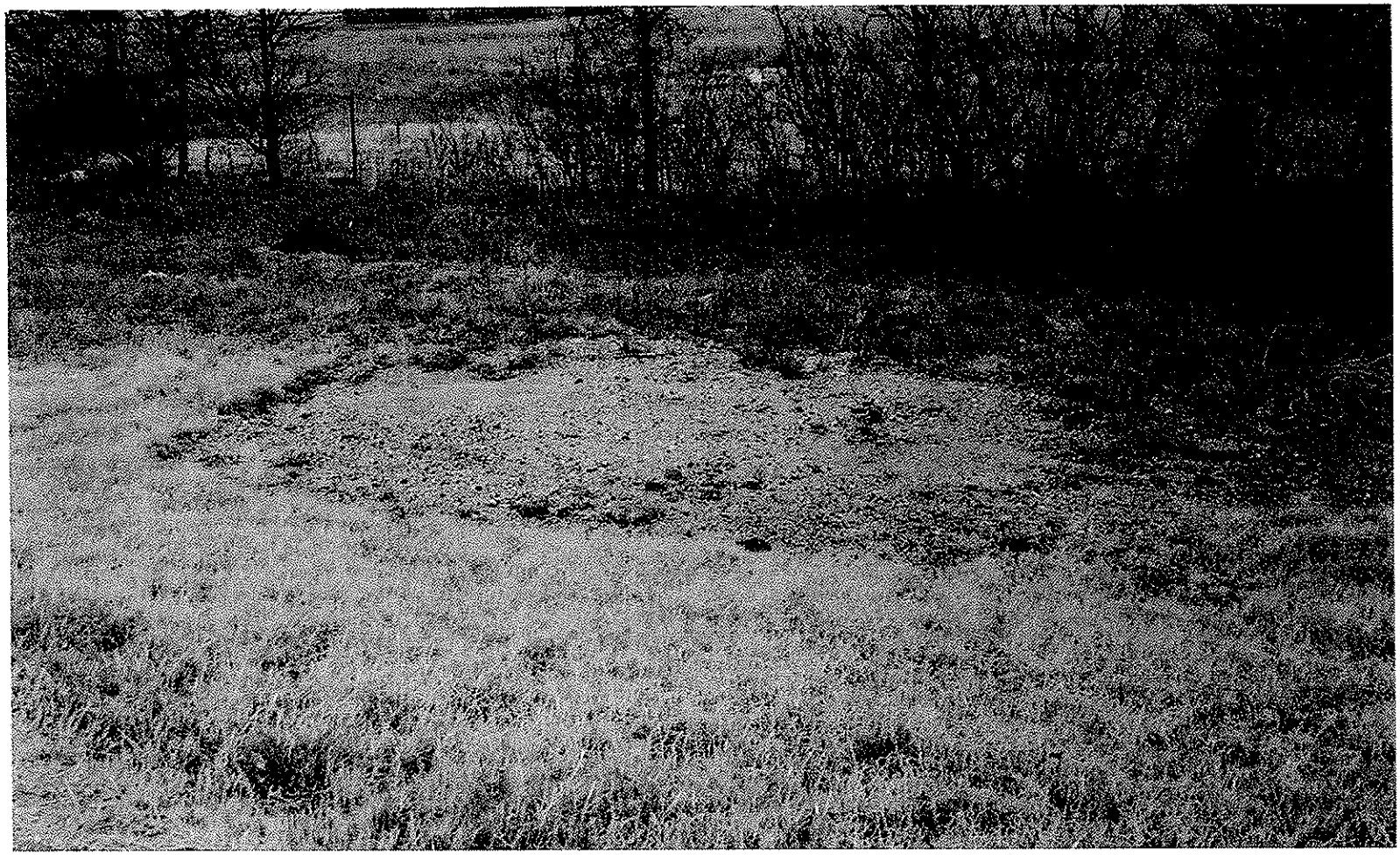


Figure 7. Looking North Across New Sinkhole July 2003.

Table 2. Wet Unit Weight for Borings B1 and B2.

Boring No.	Core No.	USC No.	Wet Unit Weight
1	1A	UC1	163.66
1	1A	UC2	166.08
1	1B	UC3	161.93
1	1B	UC4	160.46
1	1B	UC5	159.67
1	1B	UC6	159.70
1	1B	UC7	159.51
1	1B	UC8	159.74
1	1B	UC9	160.19
1	1B	UC10	161.84
1	1B	UC11	163.02
1	1B	UC12	162.01
1	1C	UC13	160.63
1	1C	UC14	160.08
1	1C	UC15	158.95
1	1C	UC16	157.55
1	1C	UC17	158.46
1	1C	UC18	158.28
1	1C	UC19	161.73
1	1C	UC20	161.34
1	1D	UC21	161.25
1	1D	UC22	159.94
1	1D	UC23	159.99
1	1D	UC24	159.74
1	1D	UC25	160.89
2	2A	UC26	164.14
2	2B	UC27	160.18
2	2B	UC28	154.63
2	2B	UC29	157.64
2	2B	UC30	153.71
2	2B	UC31	152.05
2	2C	UC32	153.90
2	2C	UC33	154.84
2	2C	UC34	154.17
2	2C	UC35	155.49
2	2D	UC36	152.42
2	2D	UC37	153.42
2	2D	UC38	155.21
2	2D	UC39	154.56
2	2D	UC40	155.34
2	2D	UC41	155.56
2	2D	UC42	160.34

Table 2 (cont)

Boring No.	Core No.	USC No.	Wet Unit Weight
2	2E	UC43	160.26
2	2E	UC44	159.32
2	2E	UC45	159.35
2	2E	UC46	159.80
2	2E	UC47	159.72
2	2E	UC48	163.74
2	2E	UC49	164.27
2	2E	UC50	164.70
2	2E	UC51	164.83
2	2F	UC52	164.31
2	2F	UC53	164.14
2	2F	UC54	164.69
2	2F	UC55	163.92
2	2F	UC56	163.12
2	2F	UC57	162.54
2	2F	UC58	165.16
2	2G	UC59	163.43
2	2G	UC60	164.40
2	2G	UC61	163.71
2	2G	UC62	162.44
2	2G	UC63	162.28
2	2G	UC64	161.62
2	2G	UC65	161.35
2	2G	UC66	160.82
2	2G	UC67	161.40
2	2G	UC68	160.30
2	2G	UC69	161.01
2	2H	UC70	163.31
2	2H	UC71	165.03
2	2H	UC72	153.64
2	2H	UC73	152.47
2	2H	UC74	151.28
2	2H	UC75	150.94
2	2H	UC76	150.76
2	2H	UC77	150.62
2	2H	UC78	150.29
2	2I	UC79	150.31
2	2I	UC80	149.72
2	2I	UC81	150.97
2	2I	UC82	151.49
2	2I	UC83	150.38
2	2I	UC84	152.32
2	2I	UC85	152.04

Table 2 (cont)

Boring No.	Core No.	USC No.	Wet Unit Weight
2	2I	UC86	153.77
2	2I	UC87	154.38
2	2I	UC88	156.50
2	2J	UC89	157.94
2	2J	UC90	160.22
2	2J	UC91	160.54
2	2J	UC92	159.67
2	2J	UC93	160.47
2	2J	UC94	160.07
2	2J	UC95	161.33
2	2K	UC96	166.69
2	2K	UC97	165.65
2	2K	UC98	165.13
2	2K	UC99	165.12
2	2M	UC100	156.65
2	2M	UC101	158.92
2	2M	UC102	158.37
2	2M	UC103	159.05
2	2M	UC104	158.59
2	2M	UC105	154.79
2	2M	UC106	155.42
2	2N	UC107	155.61
2	2N	UC108	154.03
2	2N	UC109	152.67
2	2N	UC110	150.13
2	2O	UC111	147.29
2	2O	UC112	148.12
2	2O	UC113	149.42
2	2O	UC114	147.94
2	2O	UC115	149.01
2	2O	UC116	161.33
2	2O	UC117	147.34
2	2P	UC118	142.15
2	2P	UC119	140.67
2	2P	UC120	142.01
2	2Q	UC121	140.50
2	2Q	UC122	148.74
2	2Q	UC123	139.02
2	2Q	UC124	150.65
2	2Q	UC125	150.27
2	2R	UC126	162.09
2	2R	UC127	160.71
2	2R	UC128	160.62

Table 2 (cont)

Boring No.	Core No.	USC No.	Wet Unit Weight
2	2R	UC129	163.05
2	2T	UC130	160.71
2	2U	UC131	162.43

Mean = 157.50 pcf
Standard Deviation = 5.94 pcf
Range = 139.02-166.69 pcf

Table 3. Unconfined Compressive Strength for Borings B1 and B2.

Boring No.	Core No.	UCS No.	UCS (psi)
1	1A	UC1	8180
1	1A	UC2	9822
1	1B	UC3	9641
1	1B	UC4	9430
1	1B	UC5	10546
1	1B	UC6	9723
1	1B	UC7	8606
1	1B	UC8	8490
1	1B	UC9	8107
1	1B	UC10	11370
1	1B	UC11	10484
1	1B	UC12	12552
1	1C	UC13	7602
1	1C	UC14	7517
1	1C	UC15	10619
1	1C	UC16	10352
1	1C	UC17	10285
1	1C	UC18	8171
1	1C	UC19	9097
1	1C	UC20	9950
1	1D	UC21	11735
1	1D	UC22	8641
1	1D	UC23	9084
1	1D	UC24	8503
1	1D	UC25	8640
2	2A	UC26	8436
2	2B	UC27	5894
2	2B	UC28	6771
2	2B	UC29	6300
2	2B	UC30	5787
2	2B	UC31	7277
2	2C	UC32	6772
2	2C	UC33	6277
2	2C	UC34	6152
2	2C	UC35	7323
2	2D	UC36	6853
2	2D	UC37	5336
2	2D	UC38	6302
2	2D	UC39	8208
2	2D	UC40	8389

Table 3 (cont)

Boring No.	Core No.	UCS No.	UCS (psi)
2	2D	UC41	7773
2	2D	UC42	8402
2	2E	UC43	11866
2	2E	UC44	9383
2	2E	UC45	8615
2	2E	UC46	8465
2	2E	UC47	9659
2	2E	UC48	7737
2	2E	UC49	11647
2	2E	UC50	8122
2	2E	UC51	8040
2	2F	UC52	7560
2	2F	UC53	11811
2	2F	UC54	11407
2	2F	UC55	11854
2	2F	UC56	9438
2	2F	UC57	10200
2	2F	UC58	10363
2	2G	UC59	10187
2	2G	UC60	9100
2	2G	UC61	8458
2	2G	UC62	9670
2	2G	UC63	8477
2	2G	UC64	7082
2	2G	UC65	7799
2	2G	UC66	5868
2	2G	UC67	7746
2	2G	UC68	6599
2	2G	UC69	9001
2	2H	UC70	7596
2	2H	UC71	7939
2	2H	UC72	4542
2	2H	UC73	4301
2	2H	UC74	3422
2	2H	UC75	3665
2	2H	UC76	2505
2	2H	UC77	3109
2	2H	UC78	3490
2	2I	UC79	4004
2	2I	UC80	3531
2	2I	UC81	3223
2	2I	UC82	4370
2	2I	UC83	2570

Table 3 (cont)

Boring No.	Core No.	UCS No.	UCS (psi)
2	2I	UC84	4494
2	2I	UC85	4718
2	2I	UC86	4314
2	2I	UC87	5466
2	2I	UC88	7078
2	2J	UC89	8187
2	2J	UC90	9228
2	2J	UC91	7564
2	2J	UC92	8019
2	2J	UC93	7960
2	2J	UC94	9422
2	2J	UC95	6479
2	2K	UC96	18449
2	2K	UC97	13465
2	2K	UC98	12151
2	2K	UC99	15460
2	2M	UC100	22125
2	2M	UC101	27399
2	2M	UC102	11945
2	2M	UC103	7092
2	2M	UC104	5034
2	2M	UC105	19195
2	2M	UC106	14446
2	2N	UC107	17612
2	2N	UC108	14338
2	2N	UC109	15935
2	2N	UC110	20127
2	2O	UC111	18631
2	2O	UC112	15476
2	2O	UC113	26833
2	2O	UC114	14874
2	2O	UC115	25283
2	2O	UC116	17284
2	2O	UC117	26877
2	2P	UC118	14414
2	2P	UC119	15791
2	2P	UC120	9028
2	2Q	UC121	6284
2	2Q	UC122	16429
2	2Q	UC123	4634
2	2Q	UC124	13725
2	2Q	UC125	13579
2	2R	UC126	14332

Table 3 (cont)

Boring No.	Core No.	UCS No.	UCS (psi)
2	2R	UC127	18003
2	2R	UC128	21420
2	2R	UC129	8537
2	2T	UC130	14285
2	2U	UC131	16115

Mean = 9995pcf
Standard Deviation = 5052pcf
Range = 2505-27399pcf

Table 4. RMR for Boring B2.

Classification of Jointed Rock Masses Core	Core Strength (MPa)	Strength of Intact Rock Material	Drill Core Quality Rating (RQD)	Spacing of Joints	Condition of Joints	Groundwater	Orientation of Joints Adjustment for Foundation	RMR Total	Remarks
2A	57.9	7	13	10	20	7	0	57	UCS= 57.9MPa (1Test)
2B	44.1	4	17	10	20	7	0	58	USC= 44.1MPa (Avg. 5 Tests)
2C	46.2	4	13	10	20	7	0	54	UCS= 46.2MPa (Avg. 4 Tests)
2D	50.3	7	20	10	20	7	0	64	UCS= 50.3 MPa (Avg. 7 Tests)
2E	64.1	7	17	10	20	7	0	61	UCS= 64.1 MPa (Avg. 9Tests)
2F	71.7	7	20	10	20	7	0	64	UCS= 71.7 MPa (Avg. 7Tests)
2G	56.5	7	20	10	20	7	0	64	UCS= 56.5 MPa (Avg. 11Tests)
2H	31.0	4	17	10	20	7	0	58	UCS= 31.0 MPa (Avg. 9 Tests)
2I	30.3	4	20	10	20	7	0	61	UCS= 30.3 MPa (Avg. 10 Tests)
2J	55.8	7	20	10	20	7	0	694	UCS= 55.8 MPa (Avg. 7 Tests)
2K	102.7	12	8	10	12	7	0	49	UCS=102.7 MPa (Avg. 4 Tests)
2L	0.0	0	3	5	12	7	0	27	No compression tests were done
2M	113.1	12	17	10	20	7	0	66	UCS= 113.1 MPa (Avg. 7 Tests)
2N	117.2	12	13	10	20	7	0	62	UCS= 117.2 MPa (Avg. 4Tests)
2O	143.4	12	17	10	20	7	0	66	UCS= 143.4 MPa (Avg. 7 Tests)
2P	90.3	7	13	10	12	7	0	49	UCS= 90.3 MPa (Avg. 3 Tests)
2Q	75.2	7	17	10	20	7	0	61	UCS= 75.2 MPa (Avg. 5 Tests)
2R	107.6	12	13	10	12	7	0	54	UCS= 107.6MPa (Avg.4Tests)
2S	0.0	0	8	10	12	7	0	37	No compression tests were done
2T	98.6	7	13	10	12	7	0	49	UCS= 98.6 MPa (1 Test)
2U	111.0	12	13	10	12	7	0	54	UCS= 111.0 MPa (1 Test)
2V	0.0	0	8	10	12	7	0	37	No compression tests were done

Table 5. Kirsch Equation for Estimating Displacement for Boring 2 with a=20

top of mine	=	116	ft
bottom of mine	=	136	ft
a	=	20	ft
θ	=	90	degree
ν	=	0.3	
top of mine r	=	10	

$u_r = ((p_1 + p_2)a^2)/4Gr + ((p_1 - p_2)a^2)/4Gr \times [4(1-\nu) - a^2/r^2] \times \cos 2\theta$

$p_2 = \gamma h$

$p_1 = ½ (p_2)$

$G_m = E_m / (2(1+\nu))$

$E_m = 10^{\wedge} ((RMR - 10)/40)$

data entered into highlighted areas

	Core No.	γ (pcf)	h (ft)	layer thickness	r (ft)	r (m)	RMR	p2 (Pa)	p1 (Pa)	Em	Gm (GPa)	Gm (Pa)	u_r (mm)
	Soil	120.00	8.5	8.5	117.5	35.814	0	48837.60	24418.80	0.56	0.22	216285125.07	1.36E-01
	2A	164.14	11	2.5	115	35.052	57	68485.16	34242.58	14.96	5.75	5754752523.44	7.35E-03
	2B	155.64	16	5.0	110	33.528	58	105745.37	52872.69	15.85	6.10	6095743047.93	1.12E-02
	2C	154.60	21	5.0	105	32.004	54	142756.61	71378.31	12.59	4.84	4842020814.59	1.99E-02
	2D	155.26	26	5.0	100	30.48	64	179925.86	89962.93	22.39	8.61	8610465917.57	1.48E-02
	2E	161.78	31	5.0	95	28.956	61	218655.99	109328.00	18.84	7.24	7244804190.35	2.25E-02
	2F	163.98	36	5.0	90	27.432	64	257912.80	128956.40	22.39	8.61	8610465917.57	2.36E-02
	2G	162.07	41	5.0	85	25.908	64	296712.36	148356.18	22.39	8.61	8610465917.57	2.87E-02
	2H	154.26	46	5.0	80	24.384	58	333642.20	166821.10	15.85	6.10	6095743047.93	4.84E-02
	2I	152.19	51	5.0	75	22.86	61	370076.49	185038.25	18.84	7.24	7244804190.35	4.81E-02
	2J	160.03	56	5.0	70	21.336	64	408387.67	204193.84	22.39	8.61	8610465917.57	4.78E-02
	2K	165.65	61	5.0	65	19.812	49	448044.28	224022.14	9.44	3.63	3631003370.33	1.34E-01
*	2L	161.53	66	5.0	60	18.288	27	486713.37	243356.68	2.66	1.02	1023355792.23	5.57E-01
	2M	157.40	71	5.0	55	16.764	66	524394.93	262197.46	25.12	9.66	9661101659.65	6.91E-02
	2N	153.11	76	5.0	50	15.24	62	561049.46	280524.73	19.95	7.67	7674085826.80	1.02E-01
	2O	150.06	81	5.0	45	13.716	66	596973.83	298486.91	25.12	9.66	9661101659.65	9.54E-02
	2P	141.61	86	5.0	40	12.192	49	630875.26	315437.63	9.44	3.63	3631003370.33	3.00E-01
	2Q	145.84	91	5.0	35	10.668	61	665789.36	332894.68	18.84	7.24	7244804190.35	1.79E-01
	2R	161.62	96	5.0	30	9.144	54	704481.18	352240.59	12.59	4.84	4842020814.59	3.26E-01
	2S	161.17	101	5.0	25	7.62	37	743064.08	371532.04	4.73	1.82	1819812534.47	1.07E+00
*	2T	160.71	106	5.0	20	6.096	49	781538.06	390769.03	9.44	3.63	3631003370.33	6.69E-01
	2U	162.43	111	5.0	15	4.572	54	820423.80	410211.90	12.59	4.84	4842020814.59	6.22E-01
*	2V	162.43	116	5.0	10	3.048	37	859309.54	429654.77	4.73	1.82	1819812534.47	1.64E+00
												Total	6.17E+00

* entered an average value of the one above and below

Table 6. Kirsch Equation for Estimating Displacement for Boring 2 with a=22

top of mine	=	116	ft
bottom of mine	=	136	ft
a	=	22	ft
θ	=	90	degree
ν	=	0.3	
top of mine r	=	10	

$u_r = ((p_1 + p_2)a^2)/4Gr + ((p_1 - p_2)a^2)/4Gr \times [4(1-\nu) - a^2/r^2] \times \cos 2\theta$

$p_2 = \gamma h$

$p_1 = ½ (p_2)$

$G_m = E_m/ (2(1+\nu))$

$E_m = 10^{\wedge} ((RMR - 10)/40)$

data entered into highlighted areas

	Core No.	γ (pcf)	h (ft)	layer thickness	r (ft)	r (m)	RMR	p2 (Pa)	p1 (Pa)	Em	Gm (GPa)	Gm (Pa)	u_r (mm)
	Soil	120.00	8.5	8.5	117.5	35.814	0	48837.60	24418.80	0.56	0.22	216285125.07	1.65E-01
	2A	164.14	11	2.5	115	35.052	57	68485.16	34242.58	14.96	5.75	5754752523.44	8.88E-03
	2B	155.64	16	5.0	110	33.528	58	105745.37	52872.69	15.85	6.10	6095743047.93	1.35E-02
	2C	154.60	21	5.0	105	32.004	54	142756.61	71378.31	12.59	4.84	4842020814.59	2.41E-02
	2D	155.26	26	5.0	100	30.48	64	179925.86	89962.93	22.39	8.61	8610465917.57	1.79E-02
	2E	161.78	31	5.0	95	28.956	61	218655.99	109328.00	18.84	7.24	7244804190.35	2.72E-02
	2F	163.98	36	5.0	90	27.432	64	257912.80	128956.40	22.39	8.61	8610465917.57	2.85E-02
	2G	162.07	41	5.0	85	25.908	64	296712.36	148356.18	22.39	8.61	8610465917.57	3.47E-02
	2H	154.26	46	5.0	80	24.384	58	333642.20	166821.10	15.85	6.10	6095743047.93	5.84E-02
	2I	152.19	51	5.0	75	22.86	61	370076.49	185038.25	18.84	7.24	7244804190.35	5.81E-02
	2J	160.03	56	5.0	70	21.336	64	408387.67	204193.84	22.39	8.61	8610465917.57	5.77E-02
	2K	165.65	61	5.0	65	19.812	49	448044.28	224022.14	9.44	3.63	3631003370.33	1.61E-01
*	2L	161.53	66	5.0	60	18.288	27	486713.37	243356.68	2.66	1.02	1023355792.23	6.72E-01
	2M	157.40	71	5.0	55	16.764	66	524394.93	262197.46	25.12	9.66	9661101659.65	8.33E-02
	2N	153.11	76	5.0	50	15.24	62	561049.46	280524.73	19.95	7.67	7674085826.80	1.23E-01
	2O	150.06	81	5.0	45	13.716	66	596973.83	298486.91	25.12	9.66	9661101659.65	1.15E-01
	2P	141.61	86	5.0	40	12.192	49	630875.26	315437.63	9.44	3.63	3631003370.33	3.60E-01
	2Q	145.84	91	5.0	35	10.668	61	665789.36	332894.68	18.84	7.24	7244804190.35	2.15E-01
	2R	161.62	96	5.0	30	9.144	54	704481.18	352240.59	12.59	4.84	4842020814.59	3.89E-01
	2S	161.17	101	5.0	25	7.62	37	743064.08	371532.04	4.73	1.82	1819812534.47	1.27E+00
*	2T	160.71	106	5.0	20	6.096	49	781538.06	390769.03	9.44	3.63	3631003370.33	7.84E-01
	2U	162.43	111	5.0	15	4.572	54	820423.80	410211.90	12.59	4.84	4842020814.59	7.06E-01
*	2V	162.43	116	5.0	10	3.048	37	859309.54	429654.77	4.73	1.82	1819812534.47	1.55E+00
												Total	6.92E+00

* entered an average value of the one above and below

Table 7. Kirsch Equation for Estimating Displacement for Boring 2 with a=35

top of mine	= 116	ft
bottom of mine	= 136	ft
a	= 35	ft
θ	= 90	degree
ν	= 0.3	
top of mine r	= 10	

$u_r = ((p_1 + p_2)a^2)/4Gr + ((p_1 - p_2)a^2)/4Gr \times [4(1-\nu) - a^2/r^2] \times \cos 2\theta$

$p_2 = \gamma h$

$p_1 = ½ (p_2)$

$G_m = E_m/ (2(1+\nu))$

$E_m = 10^{\wedge} ((RMR - 10)/40)$

data entered into highlighted areas

	Core No.	γ (pcf)	h (ft)	layer thickness	r (ft)	r (m)	RMR	p2 (Pa)	p1 (Pa)	Em	Gm (GPa)	Gm (Pa)	u_r (mm)
	Soil	120.00	8.5	8.5	117.5	35.814	0	48837.60	24418.80	0.56	0.22	216285125.07	4.15E-01
	2A	164.14	11	2.5	115	35.052	57	68485.16	34242.58	14.96	5.75	5754752523.44	2.23E-02
	2B	155.64	16	5.0	110	33.528	58	105745.37	52872.69	15.85	6.10	6095743047.93	3.40E-02
	2C	154.60	21	5.0	105	32.004	54	142756.61	71378.31	12.59	4.84	4842020814.59	6.04E-02
	2D	155.26	26	5.0	100	30.48	64	179925.86	89962.93	22.39	8.61	8610465917.57	4.49E-02
	2E	161.78	31	5.0	95	28.956	61	218655.99	109328.00	18.84	7.24	7244804190.35	6.81E-02
	2F	163.98	36	5.0	90	27.432	64	257912.80	128956.40	22.39	8.61	8610465917.57	7.12E-02
	2G	162.07	41	5.0	85	25.908	64	296712.36	148356.18	22.39	8.61	8610465917.57	8.66E-02
	2H	154.26	46	5.0	80	24.384	58	333642.20	166821.10	15.85	6.10	6095743047.93	1.46E-01
	2I	152.19	51	5.0	75	22.86	61	370076.49	185038.25	18.84	7.24	7244804190.35	1.44E-01
	2J	160.03	56	5.0	70	21.336	64	408387.67	204193.84	22.39	8.61	8610465917.57	1.43E-01
	2K	165.65	61	5.0	65	19.812	49	448044.28	224022.14	9.44	3.63	3631003370.33	3.99E-01
*	2L	161.53	66	5.0	60	18.288	27	486713.37	243356.68	2.66	1.02	1023355792.23	1.65E+00
	2M	157.40	71	5.0	55	16.764	66	524394.93	262197.46	25.12	9.66	9661101659.65	2.04E-01
	2N	153.11	76	5.0	50	15.24	62	561049.46	280524.73	19.95	7.67	7674085826.80	2.99E-01
	2O	150.06	81	5.0	45	13.716	66	596973.83	298486.91	25.12	9.66	9661101659.65	2.76E-01
	2P	141.61	86	5.0	40	12.192	49	630875.26	315437.63	9.44	3.63	3631003370.33	8.55E-01
	2Q	145.84	91	5.0	35	10.668	61	665789.36	332894.68	18.84	7.24	7244804190.35	5.00E-01
	2R	161.62	96	5.0	30	9.144	54	704481.18	352240.59	12.59	4.84	4842020814.59	8.74E-01
	2S	161.17	101	5.0	25	7.62	37	743064.08	371532.04	4.73	1.82	1819812534.47	2.67E+00
*	2T	160.71	106	5.0	20	6.096	49	781538.06	390769.03	9.44	3.63	3631003370.33	1.43E+00
	2U	162.43	111	5.0	15	4.572	54	820423.80	410211.90	12.59	4.84	4842020814.59	7.47E-01
*	2V	162.43	116	5.0	10	3.048	37	859309.54	429654.77	4.73	1.82	1819812534.47	-5.85E+00
												Total	5.29E+00

* entered an average value of the one above and below

Table 8. Kirsch Equation for Estimating Displacement for Boring 2 with a=40

top of mine	=	116	ft
bottom of mine	=	136	ft
a	=	40	ft
θ	=	90	degree
ν	=	0.3	
top of mine r	=	10	

$u_r = ((p_1 + p_2)a^2)/4Gr + ((p_1 - p_2)a^2)/4Gr \times [4(1-\nu) - a^2/r^2] \times \cos 2\theta$

$p_2 = \gamma h$

$p_1 = ½ (p_2)$

$G_m = E_m/ (2(1+\nu))$

$E_m = 10^{\wedge} ((RMR - 10)/40)$

data entered into highlighted areas

	Core No.	γ (pcf)	h (ft)	layer thickness	r (ft)	r (m)	RMR	p2 (Pa)	p1 (Pa)	Em	Gm (GPa)	Gm (Pa)	u_r (mm)
	Soil	120.00	8.5	8.5	117.5	35.814	0	48837.60	24418.80	0.56	0.22	216285125.07	5.40E-01
	2A	164.14	11	2.5	115	35.052	57	68485.16	34242.58	14.96	5.75	5754752523.44	2.90E-02
	2B	155.64	16	5.0	110	33.528	58	105745.37	52872.69	15.85	6.10	6095743047.93	4.42E-02
	2C	154.60	21	5.0	105	32.004	54	142756.61	71378.31	12.59	4.84	4842020814.59	7.85E-02
	2D	155.26	26	5.0	100	30.48	64	179925.86	89962.93	22.39	8.61	8610465917.57	5.83E-02
	2E	161.78	31	5.0	95	28.956	61	218655.99	109328.00	18.84	7.24	7244804190.35	8.85E-02
	2F	163.98	36	5.0	90	27.432	64	257912.80	128956.40	22.39	8.61	8610465917.57	9.25E-02
	2G	162.07	41	5.0	85	25.908	64	296712.36	148356.18	22.39	8.61	8610465917.57	1.12E-01
	2H	154.26	46	5.0	80	24.384	58	333642.20	166821.10	15.85	6.10	6095743047.93	1.89E-01
	2I	152.19	51	5.0	75	22.86	61	370076.49	185038.25	18.84	7.24	7244804190.35	1.87E-01
	2J	160.03	56	5.0	70	21.336	64	408387.67	204193.84	22.39	8.61	8610465917.57	1.85E-01
	2K	165.65	61	5.0	65	19.812	49	448044.28	224022.14	9.44	3.63	3631003370.33	5.15E-01
*	2L	161.53	66	5.0	60	18.288	27	486713.37	243356.68	2.66	1.02	1023355792.23	2.13E+00
	2M	157.40	71	5.0	55	16.764	66	524394.93	262197.46	25.12	9.66	9661101659.65	2.62E-01
	2N	153.11	76	5.0	50	15.24	62	561049.46	280524.73	19.95	7.67	7674085826.80	3.83E-01
	2O	150.06	81	5.0	45	13.716	66	596973.83	298486.91	25.12	9.66	9661101659.65	3.52E-01
	2P	141.61	86	5.0	40	12.192	49	630875.26	315437.63	9.44	3.63	3631003370.33	1.08E+00
	2Q	145.84	91	5.0	35	10.668	61	665789.36	332894.68	18.84	7.24	7244804190.35	6.23E-01
	2R	161.62	96	5.0	30	9.144	54	704481.18	352240.59	12.59	4.84	4842020814.59	1.07E+00
	2S	161.17	101	5.0	25	7.62	37	743064.08	371532.04	4.73	1.82	1819812534.47	3.13E+00
*	2T	160.71	106	5.0	20	6.096	49	781538.06	390769.03	9.44	3.63	3631003370.33	1.50E+00
	2U	162.43	111	5.0	15	4.572	54	820423.80	410211.90	12.59	4.84	4842020814.59	2.89E-01
*	2V	162.43	116	5.0	10	3.048	37	859309.54	429654.77	4.73	1.82	1819812534.47	-1.41E+01

* entered an average value of the one above and below

Total -1.17E+00

APPENDIX A
gINT Logs

BORING LOG

OKLAHOMA
DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION

Project No./Job Piece No.: Quapaw Investigation	Boring No. 1	Date: 5/11/2006	Sheet 1 of 1
Boring Location: STA 546+32.5, 56 ft. RT from centerline of road, CL	Type of Boring: Geotechnical Investigation		
Drill: CME 75	Rotary/Bit Type: Wash NX Core		
Crew: McClendon, Jenkins	Boring Began: 2/11/04	Completed: 2/11/04	
Field Logged By: J. Redenbaugh	Elevation: 833.03ft	County: Ottawa	
Revisions/Final By: S. Bettis	Water Depth: n/a		
	Date:		
	Time:		

Run/Samp No.	Depth *Elevation* (feet)	Graphic Log	Classification (Unified)	Length Recov. feet / % Rec.	RQD	SPT "N" Values / R (Refusal)	Description [LL,PI,#4,#10,#40,#200,MC%]
	833.2						0.0 - 0.5 ft Asphalt
						4	0.5 - 2.5 ft Lean Clay
	833.9					5	2.5 - 7.0 ft Fat Clay
	5					5	
						9	
	835.4					9	7.0 - 10.5 ft Lean (Shaly) Clay
						15	
	836.6 10					5,5,R50(.5in left)	
	836.8						10.5 - 11.0 ft Hindsville Series Limestone
NX CORE 1A				5.0 80%	58		11.0 - 16.0 ft Hindsville Series NX CORE 1A Rec. 48 in of 11 to 16 ft., USC = 9001 psi (Average of 2 Tests) Wet Unit Weight = 164 pcf (Average of 2 Tests)
	838.5 15						
NX CORE 1B				5.0 100%	98		16.0 - 21.0 ft Hindsville Series NX CORE 1B Rec. 60 in of 16 to 21 ft., USC = 9895 psi (Average of 10 Test) Wet Unit Weight = 161 pcf (Average of 10 Tests)
	840.2 20						
NX CORE 1C				5.0 102%	81		21.0 - 26.0 ft Hindsville Series NX CORE 1C Rec. 61.2 in of 21 to 26 ft., UCS = 9199 psi (Average of 8 Tests) Wet Unit Weight = 160 pcf (Average of 8 Tests)
	841.9 25						
NX CORE 1D				5.0 88%	72		26.0 - 31.0 ft Hindsville Series NX CORE 1D Rec. 52.8 in of 26 to 31 ft., UCS = 9321 psi (Average of 5 Tests) Wet Unit Weight = 161 pcf (Average of 5 Tests)
	843.6 30						
							Total Depth: 31.0 ft Note: USC refers to the Unconfined Compressive Strength

BORING LOG PROJ37.GPJ OKDOT MD.GDT 5/11/06

BORING LOG

OKLAHOMA
DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION

Project No./Job Piece No.: Quapaw Investigation	Boring No. 2	Date: 5/12/2006	Sheet 1 of 6
Boring Location: STA 546+12.5, 54 ft LT from centerline of road, CL	Type of Boring: Geotechnical Investigation		
Drill: CME 75	Rotary/Bit Type: Wash NX Core		
Crew: McClendon,Jenkins	Boring Began: 2/11/04	Completed: 2/11/04	
Field Logged By: J. Redenbaugh	Elevation: 832.54 ft	County: Ottawa	
Revisions/Final By: S. Bettis	Water Depth: n/a		
	Date:		
	Time:		

Run/Samp No.	Depth *Elevation* (feet)	Graphic Log	Classification (Unified)	Length Recov. feet / % Rec.	RQD	SPT "N" Values / R (Refusal)	Description [LL,PI,#4,#10,#40,#200,MC%]
						4	0.0 - 5.0 ft Unconsolidated residual soil Unit Weight = 120 pcf
	2					5	
	4					5	
	827.5						5.0 - 8.5 ft Unconsolidated residual soil
	6					9	
	8					9	Hollow-Stem Augers set to 8.5 ft.
	824						8.5 - 51.0 ft Hindsville Series - Limestone, medium light gray, crystalline, fossiliferous (salt and pepper appearance) with occasional veins and shale partings, hard to very hard.
NX CORE 2A	10			2.5 67%	55		NX CORE 2A Rec. 20.2 in of 8.5 to11 ft., UCS = 164 psi (1 Test)
NX CORE 2B	12			5.0 99%	76		NX CORE 2B Rec. 59.3 in of 11 to 16 ft., UCS = 156 psi (Average of 5 Tests)
	14						
	16						NX CORE 2C Rec. 57.7 In of 16 to 21 ft., UCS = 155 psi (Average of 4 Tests)
NX CORE 2C	18			5.0 96%	55		
	20						

BORING LOG PROJ39.GPJ OK.DOT MD.GDT 5/12/06

BORING LOG

OKLAHOMA
DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION

Project No./Job Piece No.: Quapaw Investigation	Boring No. 2	Date: 5/12/2006	Sheet 2 of 6
Boring Location: STA 546+12.5, 54 ft LT from centerline of road, CL	Type of Boring: Geotechnical Investigation		
Drill: CME 75	Rotary/Bit Type: Wash NX Core		
Crew: McClendon,Jenkins	Boring Began: 2/11/04	Completed: 2/11/04	
Field Logged By: J. Redenbaugh	Elevation: 832.5 ft	County: Ottawa	
Revisions/Final By: S. Bettis	Water Depth: n/a		
	Date:		
	Time:		

Run/Samp No.	Depth *Elevation* (feet)	Graphic Log	Classification (Unified)	Length Recov. feet / % Rec.	RQD	SPT "N" Values / R (Refusal)	Description [LL,PI,#4,#10,#40,#200,MC%]
NX CORE 2D	22–24			5.0 100%	79		NX CORE 2D Rec. 60 in of 21 to 26 ft., UCS = 155 psi (Average of 7 Tests)
NX CORE 2E	26–30			5.0 99%	78		NX CORE 2E Rec. 59.4 in of 26 to 31 ft., UCS = 162 psi (Average of 9 Tests)
NX CORE 2F	32–36			5.0 80%	100		NX CORE 2F Rec. 48.1 in of 31 to 36 ft., UCS = 164 psi (Average of 7 Tests)
NX CORE 2G	38–40			5.0 99%	100		NX CORE 2G Rec. 59.3 in of 36 to 41 ft., UCS = 162 psi (Average of 11 Tests)

BORING LOG PROJ39.GPJ OK DOT MD.GDT 5/12/06

BORING LOG

OKLAHOMA
DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION

Project No./Job Piece No.: Quapaw Investigation	Boring No. 2	Date: 5/12/2006	Sheet 3 of 6
Boring Location: STA 546+12.5, 54 ft LT from centerline of road, CL	Type of Boring: Geotechnical Investigation		
Drill: CME 75	Rotary/Bit Type: Wash NX Core		
Crew: McClendon,Jenkins	Boring Began: 2/11/04	Completed: 2/11/04	
Field Logged By: J. Redenbaugh	Elevation: 832.5 ft	County: Ottawa	
Revisions/Final By: S. Bettis	Water Depth: n/a		
	Date:		
	Time:		

Run/Samp No.	Depth *Elevation* (feet)	Graphic Log	Classification (Unified)	Length Recov. feet / % Rec.	RQD	SPT "N" Values / R (Refusal)	Description [LL,PI,#4,#10,#40,#200,MC%]
NX CORE 2H	42 – 46			5.0 98%	84		NX CORE 2H Rec. 58.7 in of 41 to 46 ft., UCS = 154 psi (Average of 9 Tests)
NX CORE 2I	46 – 51			5.0 101%	100		NX CORE 2I Rec. 60.6 in of 46 to 51 ft., UCS = 152 psi (Average of 10 Tests)
NX CORE 2J	*781.5* 51 – 56			5.0 90%	97		51.0 - 96.0 ft Boone Series - Cherty Silicieous Limestone with band layers of silicieous limestone, medium gray lensed medium dark gray with traces of light gray and very light gray, hard to very hard, thin-bedded. NX CORE 2J Rec. 54 in of 51 to 56 ft., UCS = 160 psi (Average of 7 Tests)
NX CORE 2K	56 – 61			5.0 94%	46		NX CORE 2K Rec. 56.6 in of 56 to 61 ft., UCS = 166 psi (Average of 4 Tests)

BORING LOG PROJ39.GPJ OK.DOT MD.GDT 5/12/06

BORING LOG

OKLAHOMA
DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION

Project No./Job Piece No.: Quapaw Investigation	Boring No. 2	Date: 5/12/2006	Sheet 4 of 6
Boring Location: STA 546+12.5, 54 ft LT from centerline of road, CL	Type of Boring: Geotechnical Investigation		
Drill: CME 75	Rotary/Bit Type: Wash NX Core		
Crew: McClendon,Jenkins	Boring Began: 2/11/04	Completed: 2/11/04	
Field Logged By: J. Redenbaugh	Elevation: 832.5 ft	County: Ottawa	
Revisions/Final By: S. Bettis	Water Depth: n/a		
	Date:		
	Time:		

Run/Samp No.	Depth *Elevation* (feet)	Graphic Log	Classification (Unified)	Length Recov. feet / % Rec.	RQD	SPT "N" Values / R (Refusal)	Description [LL,PI,#4,#10,#40,#200,MC%]
	62						NX CORE 2L Rec. 46.6 in of 61 to 66 ft., UCS = No Tests
NX CORE 2L	64			5.0 78%	12		
	66						NX CORE 2M Rec. 57.7 in of 66 to 71 ft., UCS = 157 psi (Average of 7 Tests)
NX CORE 2M	68			5.0 96%	77		
	70						
	72						NX CORE 2N Rec. 57.8 in of 71 to 76 ft., UCS = 153 psi (Average of 4 Tests)
NX CORE 2N	74			5.0 96%	51		
	76						NX CORE 2O Rec. 52.8 in of 76 to 81 ft., UCS = 150 psi (Average of 7 Tests)
NX CORE 2O	78			5.0 88%	89		
	80						

BORING LOG PROJ38.GPJ OK.DOT MD.GDT 5/12/06

BORING LOG

OKLAHOMA
DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION

Project No./Job Piece No.: Quapaw Investigation	Boring No. 2	Date: 5/12/2006	Sheet 5 of 6
Boring Location: STA 546+12.5, 54 ft LT from centerline of road, CL	Type of Boring: Geotechnical Investigation		
Drill: CME 75	Rotary/Bit Type: Wash NX Core		
Crew: McClendon,Jenkins	Boring Began: 2/11/04	Completed: 2/11/04	
Field Logged By: J. Redenbaugh	Elevation: 832.5 ft	County: Ottawa	
Revisions/Final By: S. Bettis	Water Depth: n/a		
	Date:		
	Time:		

Run/Samp No.	Depth *Elevation* (feet)	Graphic Log	Classification (Unified)	Length Recov. feet / % Rec.	RQD	SPT "N" Values / R (Refusal)	Description [LL,PI,#4,#10,#40,#200,MC%]
NX CORE 2P	82 – 86			5.0 / 74%	58		NX CORE 2P Rec. 44.2 in of 81 to 86 ft., UCS = 142 psi (Average of 3 Tests)
NX CORE 2Q	86 – 91			5.0 / 65%	77		NX CORE 2Q Rec. 38.8 in of 86 to 91 ft., UCS = 146 psi (Average of 5 Tests)
NX CORE 2R	91 – 96			5.0 / 61%	53		NX CORE 2R Rec. 36.6 in of 91 to 96 ft., UCS = 162 psi (Average of 4 Tests)
NX CORE 2S	736.5 / 96 – 98 – 732.5 / 100			5.0 / 51%	33		96.0 - 100.0 ft Boone Series - Chert, very light gray lensed light gray, hard to very hard, thin-bedded with irregular masses of limestone as noted above. NX CORE 2S Rec. 30.6 in of 96 to 101 ft., UCS = No Tests

BORING LOG PROJ39.GPJ OK DOT MD.GDT 5/12/06

BORING LOG

OKLAHOMA
DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION

Project No./Job Piece No.: Quapaw Investigation	Boring No. 2	Date: 5/12/2006	Sheet 6 of 6
Boring Location: STA 546+12.5, 54 ft LT from centerline of road, CL	Type of Boring: Geotechnical Investigation		
Drill: CME 75	Rotary/Bit Type: Wash NX Core		
Crew: McClendon,Jenkins	Boring Began: 2/11/04	Completed: 2/11/04	
Field Logged By: J. Redenbaugh	Elevation: 832.5 ft	County: Ottawa	
Revisions/Final By: S. Bettis	Water Depth: n/a		
	Date:		
	Time:		

Run/Samp No.	Depth *Elevation* (feet)	Graphic Log	Classification (Unified)	Length Recov. feet / % Rec.	RQD	SPT "N" Values / R (Refusal)	Description [LL,PI,#4,#10,#40,#200,MC%]
							100.0 - 120.0 ft Boone Series - Cherty Silicieous Limestone with band layers of silicieous limestone, medium gray lensed with traces of light gray and very light gray, hard to very hard, thin-bedded.
NX CORE 2T	102 – 104			5.0 47%	68		NX CORE 2T Rec. 28.2 in of 101 to 106 ft., UCS = 161 psi (1 Test)
NX CORE 2U	106 – 110			5.0 33%	72		NX CORE 2U Rec. 19.6 in of 106 to 111 ft., UCS = 162 psi (1 Test)
NX CORE 2V	112 – 116			5.0 65%	38		NX CORE 2V Rec. 39 in of 111 to 116 ft., UCS = No Tests
	712.5 120						Total Depth: 116.0 ft

BORING LOG PROJ39.GPJ OK DOT MD.GDT 5/12/06

BORING LOG

OKLAHOMA
DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION

Project No./Job Piece No.: Quapaw Investigation	Boring No. 3	Date: 5/4/2006	Sheet 1 of 1
Boring Location: STA 546+00, 58 ft LT of centerline of road, CL	Type of Boring: Geotechnical Investigation		
Drill: CME 75	Rotary/Bit Type: Hollow-Stem Auger		
Crew: McClendon, Jenkins	Boring Began: 2/11/04	Completed: 2/11/04	
Field Logged By: J. Redenbaugh	Elevation: 832.15 ft	County:	
Revisions/Final By: S. Bettis	Water Depth: n/a		
	Date:		
	Time:		

Run/Samp No.	Depth *Elevation* (feet)	Graphic Log	Classification (Unified)	Length Recov. feet / % Rec.	RQD	SPT "N" Values / R (Refusal)	Description [LL,PI,#4,#10,#40,#200,MC%]
	830.4						0.0 - 1.7 ft Lean Clay
	2						1.7 - 2.4 ft Fat Clay
	829.7						2.4 - 2.7 ft Lean Clay
	829.4						2.7 - 3.0 ft Fat Clay
	829.1						3.0 - 6.4 ft Lean Clay
	4						
	6						
	825.7						6.4 - 7.6 ft Fat Clay
	824.5						7.6 - 7.9 ft Lean Clay
	824.2						7.9 - 8.8 ft Fat Clay
	8						
	823.3						8.8 - 9.0 ft Fat Clay with Sand
	823.1						9.0 - 9.9 ft Clayey Sand with Gravel
	822.2						9.9 - 10.3 ft Clayey Sand
	821.8						10.3 ft + Limestone
	10						
	820.1						Total Depth: 12.0 ft
	12						
	14						
	16						
	18						
	20						

BORING LOG_PROJ36.GPJ_OK DOT MD.GDT_5/11/06

BORING LOG

OKLAHOMA
DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION

Project/Job No.: Peck Lease Log Reproduction	Boring No. H-8	Date: 2/2/2004	Sheet 1 of 1
Location: T29N-R23E Sec26	Type of Boring: Mineral Exploration		
County: Ottawa	Rotary Type: unknown		Bit: unknown
Drill: unknown / Crew: Tom Yost	Boring Began: 5/4/1925		Completed: 5/6/1925
Driller: Chas W. Owens	Elevation: unknown		
Revisions/Final By: S. Cosby	Water Depth: 105ft		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ---- % Rec.	RQD %	SPT "N" Values ---------- (Depth)	Description
	8						0.0 - 8.0 ft Clay
	20						8.0 - 43.0 ft Limestone,gray and brown (Original logs notes this material as "lime".)
	40						
	43						43.0 - 46.0 ft Shale,gray and brown
	46						46.0 - 50.0 ft Limestone,gray and brown
	50						50.0 - 65.0 ft Chert,blue and gray (Original logs notes this material as "flint".)
	60						
	65						65.0 - 70.0 ft Chert,blue and white
	70						70.0 - 75.0 ft Chert,white
	75						75.0 - 95.0 ft Cherty limestone,blue and gray
	80						
	95						95.0 - 100.0 ft Cherty limestone,brown and gray
	100						100.0 - 105.0 ft Chert,brown and blue
	100						
	105						105.0 - 115.0 ft Chert with some unknown debris,brown,blue and gray (Original driller referred to the debris as "selvage".)
	115						115.0 - 120.0 ft Chert,blue and black Water present at: 120 ft
	120						120.0 - 125.0 ft Chert with zinc ore and a trace of lead,blue and black
	120						
	125						125.0 - 130.0 ft Chert with zinc ore and a trace of lead,blue and brown
	130						130.0 - 143.0 ft Chert,blue and white (Original Driller's note: Good looking chert(flint) ground, hard and firm to 95 ft)
	140						
	143						Total Depth: 143.0 ft

BORING LOG SP1.GPJ OK DOT MD.GDT 2/2/04

BORING LOG

OKLAHOMA
DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION

Project/Job No.: Peck Lease Log Reproduction	Boring No. H-9	Date: 2/2/2004	Sheet 1 of 1
Location: T29N-R23E Sec26	Type of Boring: Mineral Exploration		
County: Ottawa	Rotary Type: unknown	Bit: unknown	
Drill: unknown / Crew: Tom Yost	Boring Began: 5/8/1925	Completed: 5/18/1925	
Driller: Chas W. Owens	Elevation: unknown		
Revisions/Final By: S. Cosby	Water Depth: 120ft		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet / % Rec.	RQD %	SPT "N" Values / (Depth)

Description

0.0 - 15.0 ft Clay

15.0 - 23.0 ft Limestone boulders

23.0 - 35.0 ft Limestone,gray and brown

35.0 - 45.0 ft Shale with thin limestone stingers

45.0 - 55.0 ft Limestone,gray

55.0 - 70.0 ft Cherty limestone,gray,brown and blue

70.0 - 100.0 ft Cherty limestone,gray,brown,blue and white

100.0 - 110.0 ft Cherty limestone,blue and gray
(Original Driller's note: Good zinc ore or "Jack Shines" present.)

110.0 - 120.0 ft Cherty limestone,blue,gray and black
(Original Driller's note: Good zinc ore or "Jack Shines" present.)

120.0 - 122.5 ft Cherty limestone,blue,gray and black
(Original Driller's note: Fair zinc ore or "Jack Shines" and lead traces present.)
Water present at: 122 ft

122.5 - 130.0 ft Cherty limestone,blue,gray and black
(Original Driller's note: Fair zinc ore or "Jack Shines" and lead traces present.)

130.0 - 150.0 ft Chert,blue and white

150.0 - 162.5 ft Chert,blue and gray

162.5 - 175.0 ft Cherty limestone,gray,brown,and white
(Original Driller's note: Hole very open from 125 to 150 ft.)

Total Depth: 175.0 ft

BORING LOG_SP1.GPJ_OK DOT.MD.GDT 2/2/04

BORING LOG

OKLAHOMA
DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION

Project/Job No.: Peck Lease Log Reproduction	Boring No. H-10	Date: 2/2/2004	Sheet 1 of 1
Location: T29N-R23E Sec26	Type of Boring: Mineral Exploration		
County: Ottawa	Rotary Type: unknown		Bit: unknown
Drill: unknown / Crew: Tom Yost	Boring Began: 5/19/1925		Completed: 5/21/1925
Driller: Chas W. Owens	Elevation: unknown		
Revisions/Final By: S. Cosby	Water Depth:	120ft	
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ---- % Rec.	RQD %	SPT "N" Values -------- (Depth)

Description

0.0 - 10.0 ft Clay

10.0 - 20.0 ft Limestone boulders

20.0 - 40.0 ft Limestone,gray

40.0 - 50.0 ft Limestone with some debris,gray

50.0 - 65.0 ft Cherty limestone,gray,brown and blue

65.0 - 70.0 ft Cherty limestone,blue and white

70.0 - 105.0 ft Cherty limestone,blue,white and gray

105.0 - 117.5 ft Chert,gray and blue
(Original Driller's note: Fair zinc ore or "Jack Shines" present.)

117.5 - 122.5 ft Chert,gray and blue
(Original Driller's note: About 1% zinc ore or "Jack Shines" and lead present.)
Water present at: 122 ft

122.5 - 127.0 ft Chert,gray and blue
(Original Driller's note: Trace of lead present.)
Total Depth: 127.0 ft

BORING LOG SP1.GPJ OK DOT MD.GDT 2/2/04

APPENDIX B
Vent Hole Logs from Picher Mine Field Archive

This information was not included in the web report.