SUMMARY OF DATA COLLECTED BY GOVERNOR'S TAR CREEK TASK FORCE REGARDING GROUNDWATER DISCHARGE FROM ABANDONED LEAD AND ZINC MINES OF OTTAWA COUNTY, OKLAHOMA, DECEMBER 1979 TO MARCH 1981

WATER QUALITY DIVISION
OKLAHOMA WATER RESOURCES BOARD

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INTRODUCTION

In response to a complaint regarding historically poor water quality and recent mine discharges into Tar Creek, Oklahoma Water Resources Board personnel reconnoitered the Tar Creek basin in Ottawa County on February 5, 1980.[1] Conclusions of this reconnaissance led to the following recommendations:

Further investigation is necessary to determine:

(1) Movement of water in the Boone Formation through the mined area, and directions of flow and possible consequences to Roubidoux Formation, and the impact of these formations on rural domestic and stock wells, stream contamination, and springs.

(2) Variations and trends of water quality in groundwater in abandoned mines and groundwater levels.

(3) Future impact of mine discharge of the artesian spring on Tar Creek.

[1] Adams, James C. 1980. Tar Creek Quality Reconnaissance Regarding Groundwater Discharge From Abandoned Lead and Zinc Mines of Picher Field, Ottawa County, Oklahoma. Oklahoma Water Resources Board, Publication No. 100.

On June 2, 1980, Governor George Nigh formed the Tar Creek Task Force which is composed of 23 state and federal agencies, and local interest groups (Appendix A). The interdisciplinary nature of the Tar Creek Task Force provided needed expertise in each of the problem areas identified by OWRB reconnaissance, i.e., streamwater, groundwater, and mine water quantity and quality, and biological reconnaissance and sampling and allowed development of a work plan which established a monitoring system to satisfy the recommendations cited in the OWRB Tar Creek reconnaissance report (Appendix B). This report will summarize the data gathered on all elements of the work plan.

MATERIALS AND METHODS

Stream sample sites, frequency, and analyses parameters are in accordance with Phase I of the Task Force work plan. Sample sites were located as shown in Figure 1. Narrative descriptions of each sample site are given in Table 1.

Water samples were taken from each site sample and consisted of one-half liter for chemical quality, iced to 4°C; one-half liter for filtered metals using a 0.45 micron Millipore filter system; and one-half liter for total metals preserved both with nitric acid and iced to 4°C. Field parameters were recorded at each site using a Model 4041 digital Hydrolab. Sample analyses were performed by the Oklahoma State Department of Health, Water Quality Laboratory (Tables 2 and 3). Bottom material sampling was discontinued because of substrate type. The U.S.

Figure 1. Tar Creek Task Force stream water sample sites on Tar Creek and the Neosho River, Ottawa County, Oklahoma.

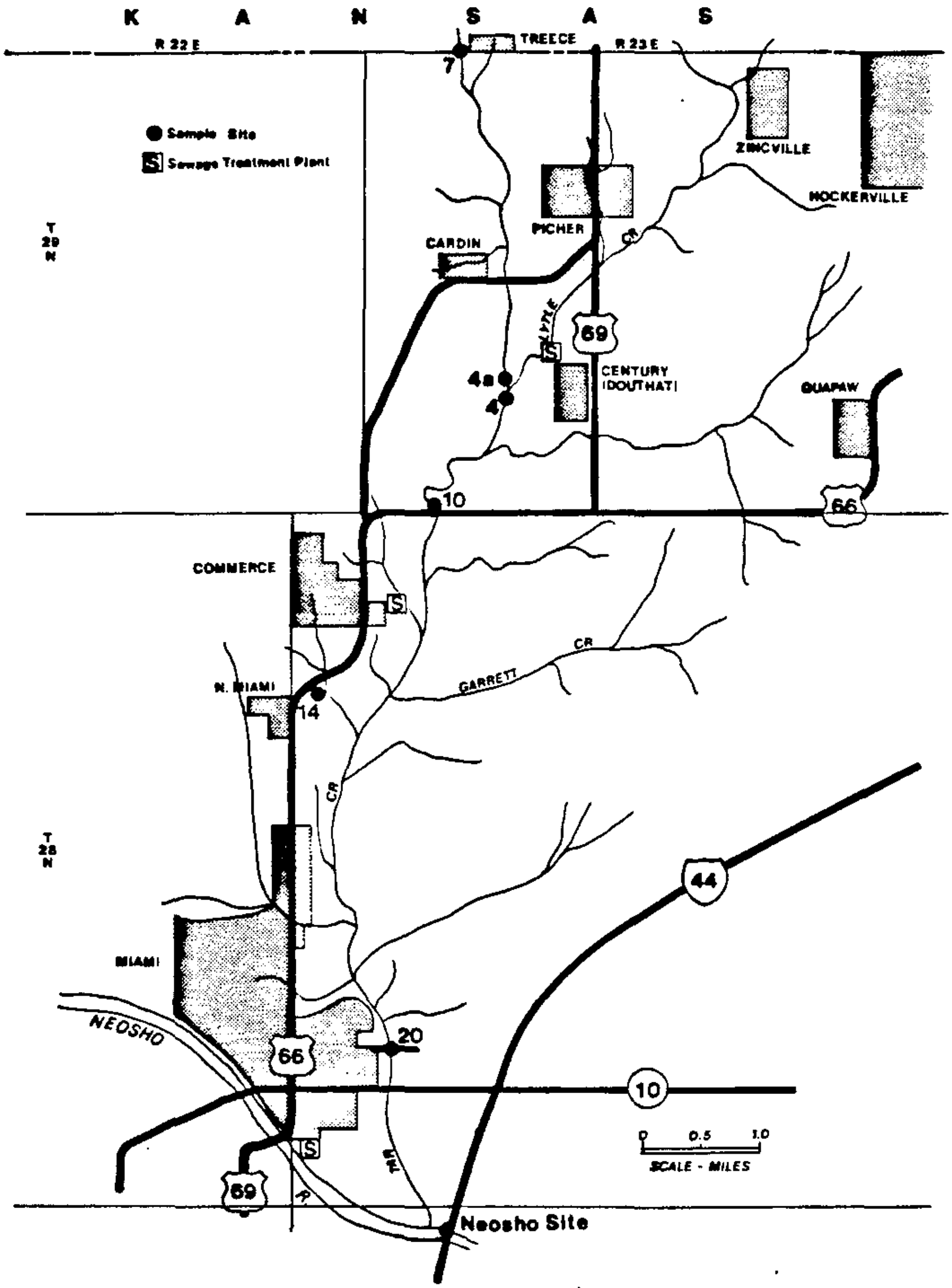


Table 1. Narrative descriptions of water sample sites on Tar Creek and the Neosho River, Ottawa County, Oklahoma.

SITE #	NARATIVE DESCRIPTION
7	Located on the Kansas-Oklahoma border immediately south of a low-water bridge. This site was sampled only when flow was observed crossing over the bridge.
4a	Located 20 yards north of the Lytle Creek-Tar Creek confluence and immediately south of the confluence of Tar Creek with a constant chat-seep discharge.
4t	Located immediately above Site 4a. This sample site consists totally of chat pile leachate.
4	Located in the mixing zone of the Tar Creek-Lytle Creek confluence. This site receives sewage discharge from Picher, Oklahoma via Lytle Creek.
10	Located on Tar Creek where it is crossed by State Highways 66 and 69. This site is one mile south of Site 4 and receives additional flow from an unnamed tributary which runs along the southern edge of the mine field.
14	Located just south of Commerce, Oklahoma, approximately one-half mile from Tar Creek. This site consists of two suspected artesian springs of questionable origin. This site discharged mine water for at least six months prior to the Tar Creek study and has continued discharging to this date.
20	Located one mile from the Neosho River. This site receives discharge from the Commerce Sewage Treatment Plant, Garret Creek and Site 14 in addition to upstream flow.
Neosho River	Located at the base of the Will Rogers Turnpike bridge approximately 200 yards below its confluence with Tar Creek. This site receives discharge from the Miami Sewage Treatment Plant.

Table 2. Streamwater quality data from sites on Tar Creek and the Neosho River from December 27, 1979 to March 6, 1981, Ottawa County, Oklahoma.

SITE	DATE	Cl mg/L	SUSPENDED SOLIDS mg/L	TOTAL ALKALINTY mg/L	TOTAL Al µg/L	TOTAL Pb µg/L	TOTAL Zn µg/L	SO_4 mg/L	TDS mg/L	TOTAL SOLIDS mg/L	TOTAL Fe µg/L	TOTAL Mn µg/L	pH SU	TEMP C°	SPECIFIC COND. µmho/cm
4a	2-5-80	8	7	114	<2,000	<20	16,600	802	1,215	1,222	710	560	8.3	5.0	900
	5-28-80	*	13	105	*	<20	11,600	586	970	*	3,800	1,100	5.9	28.0	1,350
	1-29-81	*	*	104	<2,000	<20	80,000	1,076	1,819	*	2,400	900	6.4	5.3	1,300
	3-6-81	*	*	35	*	<20	31,200	966	1,509	*	760	*	6.9	7.5	1,140
4	3-14-80	*	*	*	*	86	21,300	*	*	*	15,000	*	*	*	*
	5-28-80	*	104	33	*	75	52,000	714	*	*	39,000	1,000	5.5	27.0	1,500
	8-28-80	*	*	124	<2,000	78	25,500	1,666	1,320	2,611	400	2,300	*	*	*
	9-24-80	*	*	125	<2,000	20	21,900	1,576	2,545	*	430	1,410	*	*	*
	10-15-80	*	*	80	<2,000	1,920	24,600	539	474	*	5,800	555	6.6	20.0	1,150
	11-12-80	*	*	75	<2,000	<20	30,400	1,146	1,728	*	1,080	1,830	7.3	16.7	1,578
	12-3-80	*	*	111	<2,000	<20	25,300	1,109	1,672	*	930	1,150	5.7	7.5	1,738
	1-29-81	*	*	121	<2,000	<20	28,200	725	1,297	*	15,000	610	6.3	5.4	1,000
	3-6-81	*	*	*	*	*	25,400	832	1,391	*	900	*	6.2	7.2	1,100
4t	8-28-80	*	*	115	<2,000	84	29,500	1,811	1,370	2,837	600	200	*	*	*
	10-22-80	*	*	83	<2,000	<20	31,000	1,441	2,139	*	230	130	6.2	16.5	2,300
	11-12-80	*	*	66	<2,000	<20	32,000	1,601	2,271	*	250	70	7.2	17.8	2,340
7	2-5-80	6	1	85	<2,000	<20	3,300	392	600	601	220	90	8.0	3.3	590
	10-15-80	*	*	73	<2,000	247	6,500	911	1,476	*	870	370	6.7	20.5	1,670
	11-12-80	*	*	90	<2,000	<20	13,800	1,296	1,844	*	1,010	160	7.4	17.8	1,676
10	2-6-80	8	7	126	<2,000	<20	11,400	526	1,181	1,188	1,030	640	8.5	2.0	800
	5-28-80	*	106	11	*	30	49,000	785	1,226	*	30,500	1,400	5.5	26.5	1,600
	8-28-80	*	*	127	<2,000	73	9,400	1,082	963	1,715	4,300	3,700	*	*	*
	9-24-80	*	*	107	<2,000	<20	3,390	1,237	2,004	*	280	720	*	*	*
	10-8-80	*	*	122	*	<20	9,400	1,337	2,263	*	850	470	7.1	17.5	2,050
	10-15-80	*	*	43	19,200	1,090	14,000	173	153	*	21,200	610	6.4	20.0	*
	11-6-80	*	*	105	<2,000	36	23,000	909	1,326	*	1,260	1,120	6.7	22.0	1,373
	11-12-80	*	*	96	<2,000	<20	18,300	1,024	1,461	*	1,220	1,000	7.7	14.0	1,630
	11-19-80	*	*	111	<2,000	<20	22,700	1,223	1,571	*	1,140	1,440	7.1	5.0	1,290
	12-3-80	*	*	124	<2,000	34	28,500	1,001	1,513	*	1,790	820	5.8	4.4	1,645
	1-29-81	*	*	121	<2,000	<20	31,500	753	1,330	*	12,000	630	6.7	4.4	1,000
	3-6-81	*	*	43	*	23	18,000	76	1,283	*	1,110	*	6.4	6.1	1,025

* not sampled

Table 2. Cont.

SITE	DATE	DO mg/L	NO_2-NO_3 mg/L	TOC mg/L	O-PO_4 or P mg/L	TOTAL P mg/L	TOTAL Cd µg/L	BOD_5 mg/L	TOTAL F mg/L	TOTAL As µg/L	TOTAL Cr µg/L	TOTAL Cu µg/L	TOTAL Hg µg/L	TOTAL Ni µg/L	Al-d µg/L
4a	2-5-80	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	5-28-80	*	0.6	30.5	0.080	0.085	<2	14.3	0.38	*	*	*	*	*	*
	1-29-81	7.3	*	*	*	*	46	*	*	<10	<10	15	<0.5	83	<2,000
	3-6-81	7.4	*	*	*	*	23	*	*	*	*	*	*	*	*
4	3-14-80	*	*	*	*	*	38	*	*	*	*	5	*	*	*
	5-28-80	*	<0.5	16.8	0.405	0.480	28	25.5	1.00	*	*	*	*	*	*
	8-28-80	*	*	*	*	*	46	*	0.70	<10	<10	11	<0.5	145	*
	9-24-80	*	*	*	*	*	63	*	*	<10	15	12	<0.5	108	<2,000
	10-15-80	5.7	*	*	*	*	160	*	*	<10	<10	207	<0.5	72	<2,000
	11-12-80	7.2	*	*	*	*	26	*	*	11	<10	13	<0.5	119	<2,000
	12-3-80	1.1	*	*	*	*	26	*	*	<10	19	12	<0.5	119	<2,000
	1-29-81	8.2	*	*	*	*	23	*	*	<10	<10	12	<0.5	78	<2,000
	3-6-81	7.2	*	*	*	*	20	*	*	*	*	*	*	*	*
	4-9-81	8.5	*	*	*	*	12	*	0.49	*	*	*	*	*	*
4t	8-28-80	*	*	*	*	*	47	*	0.86	<10	18	12	<0.5	170	*
	10-22-80	4.3	*	*	*	*	130	*	*	<10	16	<4	<0.5	90	<2,000
	11-12-80	6.9	*	*	*	*	170	*	*	10	<10	9	<0.5	88	<2,000
7	2-5-80	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	10-15-80	6.3	*	*	*	*	21	*	*	<10	<10	20	<0.5	78	<2,000
	11-12-80	0.8	*	*	*	*	16	*	*	<10	<10	10	<0.5	62	<2,000
10	2-6-80	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	5-28-80	*	<0.5	25.0	0.160	0.240	35	*	1.00	*	*	*	*	*	*
	8-28-80	*	*	*	*	*	10	*	1.15	<10	17	11	<0.5	202	<2,000
	9-24-80	*	*	*	*	*	7	*	*	<10	<10	7	<0.5	58	<2,000
	10-8-80	6.4	*	*	*	*	15	*	*	<10	<10	16	<0.5	142	*
	10-15-80	12.0	*	*	*	*	82	*	*	<10	30	94	<0.5	67	12,200
	11-6-80	6.8	*	*	*	*	22	*	*	<10	<10	11	<0.5	113	<2,000
	11-12-80	0.7	*	*	*	*	14	*	*	<10	<10	14	<0.5	137	<2,000
	11-19-80	1.0	*	*	*	*	22	*	*	<10	<10	10	<0.5	174	<2,000
	12-3-80	1.2	*	*	*	*	24	*	*	<10	27	14	<0.5	168	<2,000
	1-29-81	7.6	*	*	*	*	21	*	*	<10	<10	13	<0.5	109	<2,000
	3-6-81	7.6	*	*	*	*	18	*	*	*	*	*	*	*	*

* not sampled

Table 2. Cont.

SITE	DATE	As-d µg/L	Cd-d µg/L	Cr-d µg/L	Cu-d µg/L	Fe-d µg/L	Pb-d µg/L	Mn-d µg/L	Hg-d µg/L	Ni-d µg/L	Zn-d µg/L	TOTAL HARDNESS mg/L	TOTAL Ag-T µg/L	Ag-d µg/L	Mg µg/L
4a	2-5-80	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	5-28-80	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	1-29-81	<10	46	<10	14	780	<20	900	<0.5	83	45,000	*	*	*	*
	3-6-81	*	*	*	*	*	*	*	*	*	*	*	*	*	*
4	3-14-80	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	5-28-80	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	8-28-80	*	*	*	*	*	*	*	*	*	*	1,742	*	*	*
	9-24-80	<10	51	<10	11	<100	<20	1,410	<0.5	95	18,800	*	*	*	*
	10-15-80	<10	130	<10	45	1,570	580	555	<0.5	56	12,500	*	*	*	*
	11-12-80	<10	26	<10	11	1,080	<20	1,800	<0.5	112	28,600	*	*	*	*
	12-3-80	<10	24	19	11	750	<20	1,150	<0.5	112	23,200	*	*	*	*
	1-29-81	<10	21	<10	10	15,000	<20	600	<0.5	78	28,200	*	*	*	*
	3-6-81	*	*	*	*	1,290	*	*	*	*	*	*	*	*	*
	4-9-81	*	12	*	*	*	35	*	*	*	8,700	*	*	*	*
4t	8-28-80	*	*	*	*	*	*	*	*	*	*	1,926	*	*	*
	10-22-80	<10	130	16	<4	230	<20	120	<0.5	108	30,000	1,570	7.0	7.0	*
	11-12-80	10	170	<10	9	220	<20	70	<0.5	83	32,000	*	*	*	*
7	2-5-80	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	10-15-80	<10	17	<10	17	470	66	100	<0.5	70	5,500	*	*	*	*
	11-12-80	<10	16	<10	10	1,010	<20	160	<0.5	58	11,700	*	*	*	*
10	2-6-80	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	5-28-80	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	8-28-80	10	2	19	9	1,800	58	3,400	<0.5	159	8,600	1,043	*	*	*
	9-24-80	<10	14	<10	9	100	<20	600	<0.5	81	520	*	*	*	*
	10-8-80	<10	15	<10	15	570	<20	380	<0.5	142	9,200	*	*	*	*
	10-15-80	<10	55	16	56	10,300	650	410	<0.5	51	9,800	*	*	*	*
	11-6-80	<10	22	<10	11	1,040	24	1,120	<0.5	113	23,000	*	*	*	*
	11-12-80	<10	14	<10	10	780	<20	1,000	<0.5	131	18,300	*	*	*	*
	11-19-80	<10	22	<10	9	880	<20	1,440	<0.5	174	22,700	*	*	*	*
	12-3-80	<10	23	15	13	1,280	34	810	<0.5	168	27,800	*	*	*	*
	1-29-81	<10	20	<10	12	3,200	<20	630	<0.5	109	31,500	*	*	*	*
	3-6-81	*	*	*	*	*	*	*	*	*	*	*	*	*	*

* not sampled

Table 2. Cont.

SITE	DATE	Cl mg/L	SUSPENDED SOLIDS mg/L	TOTAL ALKALINTY mg/L	TOTAL Al µg/L	TOTAL Pb µg/L	TOTAL Zn µg/L	SO_4 mg/L	TDS mg/L	TOTAL SOLIDS mg/L	TOTAL Fe µg/L	TOTAL Mn µg/L	pH SU	TEMP C°	SPECIFIC COND. µmho/cm
14	12-27-79	*	*	163	*	49	121,000	2,387	*	*	340,000	2,900	6.0	*	*
	2-6-80	94	185	291	<2,000	<20	138,000	2,355	3,920	4,105	340,000	2,600	6.2	14.0	3,200
	3-14-80	*	*	*	*	88	113,000	*	*	*	280,000	*	*	*	*
	8-7-80	*	*	*	3,750	<20	126,000	*	*	*	2,600,000	*	6.0	16.5	3,700
	8-28-80	*	*	244	4,000	104	172,000	3,043	2,145	4,450	740,000	7,600	*	*	*
	10-22-80	*	*	272	4,500	<20	215,000	3,021	4,927	*	530,000	6,300	6.1	24.5	4,290
	11-13-80	*	*	69	<2,000	<20	172,000	3,301	5,115	*	490,000	5,300	5.8	15.9	3,500
	12-3-80	*	*	183	4,400	<20	181,000	2,924	4,677	*	530,000	5,300	4.8	16.0	4,300
	1-29-81	*	*	294	4,600	<20	560,000	2,812	4,954	*	900,000	4,200	5.0	16.0	3,780
20	1-18-80	*	*	*	*	<20	63,000	*	669	*	790	730	*	*	1,217
	2-6-80	25	*	133	<2,000	<20	9,300	493	950	432	600	560	8.1	5.5	755
	5-28-80	*	17	33	*	<20	15,000	411	692	*	2,100	800	5.5	26.0	1,000
	8-28-80	*	*	65	<2,000	40	5,400	407	540	796	2,100	1,600	*	*	*
	9-18-80	*	*	92	<2,000	<20	2,070	312	779	*	2,040	430	*	*	*
	9-24-80	*	*	98	<2,000	<20	281	292	644	*	2,790	210	*	*	*
	10-8-80	*	*	97	*	<20	330	270	594	*	770	110	8.5	24.0	920
	10-15-80	*	*	276	16,000	196	5,500	80	85	*	32,000	430	6.3	19.5	*
	11-6-80	*	*	93	<2,000	<20	14,000	609	1,000	*	1,470	740	7.0	24.0	*
	11-13-80	*	*	90	<2,000	<20	13,600	806	1,085	*	940	670	7.1	12.1	1,062
	11-19-80	*	*	99	<2,000	<20	12,800	656	1,138	*	12,800	1,000	7.3	7.0	1,056
	12-3-80	*	*	108	<2,000	<20	13,200	733	1,181	*	790	740	*	*	*
	1-29-81	*	*	96	<2,000	<20	16,500	485	997	*	14,000	1,200	6.2	5.5	900
	3-6-81	*	*	34	*	<20	8,300	441	759	*	2,800	*	7.2	8.3	710
NEOSHO	9-17-80	*	*	122	<2,000	<20	108	68	286	*	960	230	*	*	*
	9-24-80	*	*	143	<2,000	<20	78	87	294	*	1,330	390	*	*	*
	11-13-80	*	*	102	<2,000	<20	227	77	249	*	890	250	7.5	14.6	317
	1-29-81	*	*	152	<2,000	<20	720	137	407	*	280	110	6.7	6.3	450
	3-6-81	*	*	57	*	<20	670	149	407	*	870	*	7.0	11.0	490

* not sampled

Table 2. Cont.

DATE	SITE	DO mg/L	NO_2-NO_3 mg/L	TOC mg/L	O-PO_4 or P mg/L	TOTAL P mg/L	TOTAL Cd µg/L	BOD_5 mg/L	TOTAL F mg/L	TOTAL As µg/L	TOTAL Cr µg/L	TOTAL Cu µg/L	TOTAL Hg µg/L	TOTAL Ni µg/L	Al-d µg/L
14	12-27-79	*	<0.5	9.8	2.380	0.035	7	*	*	*	*	*	*	*	*
	2-6-80	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	3-14-80	*	*	*	*	*	22	*	*	*	*	<4	*	*	*
	7-1-80	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	8-7-80	0.2	*	*	*	*	15	*	*	<10	14	9	<0.5	1,580	*
	8-28-80	*	*	*	*	*	27	*	3.70	<10	16	14	<0.5	1,910	4,100
	10-22-80	0.3	*	*	*	*	26	*	*	<10	32	8	<0.5	2,250	2,400
	11-13-80	0.6	*	*	*	*	16	*	*	<10	<10	12	<0.5	1,740	<2,000
	12-3-80	0.6	*	*	*	*	24	*	*	14	29	13	<0.5	2,100	4,100
	1-29-81	0.9	*	*	*	*	22	*	*	22	14	19	<0.5	3,160	3,900
20	2-6-80	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	1-18-80	*	*	*	*	*	7	*	*	*	20	6	*	*	*
	5-28-80	*	<0.5	*	0.220	0.315	11	28.0	0.54	*	*	*	*	*	*
	8-28-80	*	*	*	*	*	3	*	0.87	<10	14	5	<0.5	118	<2,000
	9-18-80	*	*	*	*	*	2	*	*	<10	10	8	<0.5	68	<2,000
	9-24-80	*	*	*	*	*	<2	*	*	<10	<10	5	<0.5	31	<2,000
	10-8-80	*	*	*	*	*	<2	*	*	<10	<10	5	<0.5	38	*
	10-15-80	13.0	*	*	*	*	17	*	*	<10	88	33	5.5	89	8,300
	11-6-80	8.2	*	*	*	*	14	*	*	<10	<10	8	<0.5	99	<2,000
	11-13-80	6.1	*	*	*	*	4	*	*	<10	<10	9	<0.5	169	<2,000
	11-19-80	0.9	*	*	*	*	7	*	*	<10	23	11	<0.5	197	<2,000
	12-3-80	*	*	*	*	*	3	*	*	<10	22	10	<0.5	255	<2,000
	1-29-81	8.4	*	*	*	*	5	*	*	<10	<10	11	<0.5	325	<2,000
	3-6-81	7.5	*	*	*	*	13	*	*	*	*	*	*	*	*
Neosho	9-17-80	*	*	*	*	*	3	*	*	<10	<10	9	<0.5	18	<2,000
	9-24-80	*	*	*	*	*	<2	*	*	<10	<10	<4	2.0	<10	<2,000
	11-13-80	4.8	*	*	*	*	<2	*	*	<10	<10	5	<0.5	18	<2,000
	1-29-81	8.7	*	*	*	*	<2	*	*	<10	<10	6	<0.5	14	<2,000
	5-6-81	6.6	*	*	*	*	<2	*	*	*	*	*	*	*	*

* not sampled

Table 2. Cont.

SITE	DATE	As-d µg/L	Cd-d µg/L	Cr-d µg/L	Cu-d µg/L	Fe-d µg/L	Pb-d µg/L	Mn-d µg/L	Hg-d µg/L	Ni-d µg/L	Zn-d µg/L	TOTAL HARDNESS mg/L	TOTAL Ag-T µg/L	Ag-d µg/L	Mg µg/L
14	12-27-79	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	2-6-80	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	3-14-80	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	7-1-80	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	8-7-80	*	*	*	*	*	*	*	*	*	*	*	*	*	110.0
	8-28-80	<10	12	13	14	730,000	103	8,100	<0.5	2,030	181,000	2,278	*	*	*
	10-22-80	<10	26	13	<7	530,000	<20	5,700	<0.5	2,130	186,000	*	18.0	18.0	*
	11-13-80	<10	16	<10	12	490,000	<20	5,000	<0.5	1,710	172,000	*	*	*	*
	12-3-80	11	24	28	13	510,000	<20	5,200	<0.5	2,100	181,000	*	*	*	*
	1-29-81	20	19	14	19	900,000	<20	680	<0.5	3,160	560,000	*	*	*	*
20	1-18-80	*	*	*	*	*	<20	*	*	*	*	*	*	*	27.0
	2-6-80	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	5-28-80	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	8-28-80	<10	30	12	5	1,000	41	1,400	<0.5	126	4,500	499	*	*	*
	9-18-80	<10	2	<10	7	1,230	<20	400	<0.5	59	1,520	*	*	*	*
	9-24-80	<10	2	<10	5	760	<20	50	<0.5	30	316	*	*	*	*
	10-8-80	<10	<2	<10	4	240	<20	40	<0.5	32	55	*	*	*	*
	10-15-80	<10	5	<10	14	6,400	63	210	1.3	63	1,600	*	*	*	*
	11-6-80	<10	14	<10	8	1,290	<20	740	<0.5	99	14,000	*	*	*	*
	11-13-80	<10	4	<10	9	940	<20	670	<0.5	169	12,400	*	*	*	*
	11-19-80	<10	6	22	11	470	<20	1,000	<0.5	197	12,800	*	*	*	*
	12-3-80	<10	3	22	10	410	<20	740	<0.5	255	12,200	*	*	*	*
	1-29-81	<10	4	<10	4	3,000	<20	1,100	<0.5	325	13,800	*	*	*	*
	3-6-81	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Neosho	9-17-80	<10	<2	<10	7	110	<20	230	<0.5	16	89	*	*	*	*
	9-24-80	<10	3	<10	<4	270	<20	260	<0.5	<10	52	*	*	*	*
	11-13-80	<10	<2	<10	5	290	<20	140	<0.5	18	147	*	*	*	*
	1-29-81	<10	<2	<10	5	280	<20	110	<0.5	14	720	*	*	*	*
	3-6-81	*	*	*	*	*	*	*	*	*	*	*	*	*	*

* not sampled

Table 3. Streamwater quality data by date from Tar Creek and the Neosho River from December 27, 1979 to March 6, 1981, Ottawa County, Oklahoma.

DATE	SITE	Cl mg/L	SUSPENDED SOLIDS mg/L	TOTAL ALKALINTY mg/L	TOTAL Al µg/L	TOTAL Pb µg/L	TOTAL Zn µg/L	SO_4 mg/L	TDS mg/L	TOTAL SOLIDS mg/L	TOTAL Fe µg/L	TOTAL Mn µg/L	pH SU	TEMP C°	SPECIFIC COND. µmho/cm
12-27-79	14	*	*	163	*	49	121,000	2,387	*	*	340,000	2,900	6.0	*	*
1-18-80	20	*	*	*	*	<20	63,000	*	669	*	790	730	*	*	1,217
2-5-80	4a	8	7	114	<2,000	<20	16,600	802	1,215	1,222	710	560	8.3	5.0	900
	7	6	1	85	<2,000	<20	3,300	392	600	601	220	90	8.0	3.3	590
2-6-80	10	8	7	126	<2,000	<20	11,400	526	1,181	1,188	1,030	640	8.5	2.0	800
	14	94	185	291	<2,000	<20	138,000	2,355	3,920	4,105	340,000	2,600	6.2	14.0	3,200
	20	25	*	133	<2,000	<20	9,300	493	950	432	600	560	8.1	5.5	755
3-14-80	4	*	*	*	*	86	21,300	*	*	*	15,000	*	*	*	*
	14	*	*	*	*	88	113,000	*	*	*	280,000	*	*	*	*
5-28-80	4a	*	13	105	*	<20	11,600	586	970	*	3,800	1,100	5.9	28.0	1,350
	4	*	104	33	*	75	52,000	714	*	*	39,000	1,000	5.5	27.0	1,500
	10	*	106	11	*	30	49,000	785	1,226	*	30,500	1,400	5.5	26.5	1,600
	20	*	17	33	*	<20	15,000	411	692	*	2,100	800	5.5	26.0	1,000
8-7-80	14	*	*	*	3,750	<20	126,000	*	*	*	2,600,000	*	6.0	16.5	3,700
8-28-80	4	*	*	124	<2,000	78	25,500	1,666	1,320	2,611	400	2,300	*	*	*
	4t	*	*	115	<2,000	84	29,500	1,811	1,370	2,837	600	200	*	*	*
	10	*	*	127	<2,000	73	9,400	1,082	963	1,715	4,300	3,700	*	*	*
	14	*	*	244	4,000	104	172,000	3,043	2,145	4,450	740,000	7,600	*	*	*
	20	*	*	65	<2,000	40	5,400	407	540	796	2,100	1,600	*	*	*
9-17-80	Neosho	*	*	122	<2,000	<20	108	68	286	*	960	230	*	*	*
9-18-80	20	*	*	92	<2,000	<20	2,070	312	779	*	2,040	430	*	*	*
9-24-80	4	*	*	125	<2,000	20	21,900	1,576	2,545	*	430	1,410	*	*	*
	10	*	*	107	<2,000	<20	3,390	1,237	2,004	*	280	720	*	*	*
	20	*	*	98	<2,000	<20	281	292	644	*	2,790	210	*	*	*
	Neosho	*	*	143	<2,000	<20	78	87	294	*	1,330	390	*	*	*
10-8-80	10	*	*	122	*	<20	9,400	1,337	2,263	*	850	470	7.1	17.5	2,050
	20	*	*	97	*	<20	330	270	594	*	770	110	8.5	24.0	920

* not sampled

Table 3. Cont.

DATE	SITE	DO mg/L	NO_2-NO_3 mg/L	TOC mg/L	O-PO_4 or P mg/L	TOTAL P mg/L	TOTAL Cd µg/L	BOD_5 mg/L	TOTAL F mg/L	TOTAL As µg/L	TOTAL Cr µg/L	TOTAL Cu µg/L	TOTAL Hg µg/L	TOTAL Ni µg/L	Al-d µg/L
12-27-79	14	*	<0.5	9.8	2.380	0.035	7	*	*	*	*	*	*	*	*
1-18-80	20	*	*	*	*	*	7	*	*	*	20	6	*	*	*
2-5-80	4a	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	7	*	*	*	*	*	*	*	*	*	*	*	*	*	*
2-6-80	10	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	14	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	20	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3-14-80	4	*	*	*	*	*	38	*	*	*	*	5	*	*	*
	14	*	*	*	*	*	22	*	*	*	*	<4	*	*	*
5-28-80	4a	*	0.6	30.5	0.080	0.085	<2	14.3	0.38	*	*	*	*	*	*
	4	*	<0.5	16.8	0.405	0.480	28	25.5	1.00	*	*	*	*	*	*
	10	*	<0.5	25.0	0.160	0.240	35	*	1.00	*	*	*	*	*	*
	20	*	<0.5	*	0.220	0.315	11	28.0	0.54	*	*	*	*	*	*
7-1-80	14	*	*	*	*	*	*	*	*	*	*	*	*	*	*
8-7-80	14	0.2	*	*	*	*	15	*	*	<10	14	9	<0.5	1,580	*
8-28-80	4	*	*	*	*	*	46	*	0.70	<10	<10	11	<0.5	145	*
	4t	*	*	*	*	*	47	*	0.86	<10	18	12	<0.5	170	*
	10	*	*	*	*	*	10	*	1.15	<10	17	11	<0.5	202	<2,000
	14	*	*	*	*	*	27	*	3.70	<10	16	14	<0.5	1,910	4,100
	20	*	*	*	*	*	3	*	0.87	<10	14	5	<0.5	118	<2,000
9-17-80	Neosho	*	*	*	*	*	3	*	*	<10	<10	9	<0.5	18	<2,000
9-18-80	20	*	*	*	*	*	2	*	*	<10	10	8	<0.5	68	<2,000
9-24-80	4	*	*	*	*	*	63	*	*	<10	15	12	<0.5	108	<2,000
	10	*	*	*	*	*	7	*	*	<10	<10	7	<0.5	58	<2,000
	20	*	*	*	*	*	<2	*	*	<10	<10	5	<0.5	31	<2,000
	Neosho	*	*	*	*	*	<2	*	*	<10	<10	<4	2.0	<10	<2,000
10-8-80	10	6.4	*	*	*	*	15	*	*	<10	<10	16	<0.5	142	*
	20	*	*	*	*	*	<2	*	*	<10	<10	5	<0.5	38	*

* not sampled

Table 3. Cont.

DATE	SITE	As-d µg/L	Cd-d µg/L	Cr-d µg/L	Cu-d µg/L	Fe-d µg/L	Pb-d µg/L	Mn-d µg/L	Hg-d µg/L	Ni-d µg/L	Zn-d µg/L	TOTAL HARDNESS mg/L	TOTAL Ag-T µg/L	Ag-d µg/L	Mg µg/L
12-27-79	14	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1-18-80	20	*	*	*	*	*	<20	*	*	*	*	*	*	*	27.0
2-5-80	4a	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	7	*	*	*	*	*	*	*	*	*	*	*	*	*	*
2-6-80	10	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	14	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	20	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3-14-80	4	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	14	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5-28-80	4a	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	4	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	10	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	20	*	*	*	*	*	*	*	*	*	*	*	*	*	*
7-1-80	14	*	*	*	*	*	*	*	*	*	*	*	*	*	*
8-7-80	14	*	*	*	*	*	*	*	*	*	*	*	*	*	110.0
8-28-80	4	*	*	*	*	*	*	*	*	*	*	1,742	*	*	*
	4t	*	*	*	*	*	*	*	*	*	*	1,926	*	*	*
	10	10	2	19	9	1,800	58	3,400	<0.5	159	8,600	1,043	*	*	*
	14	<10	12	13	14	730,000	103	8,100	<0.5	2,030	181,000	2,278	*	*	*
	20	<10	30	12	5	1,000	41	1,400	<0.5	126	4,500	499	*	*	*
9-17-80	Neosho	<10	<2	<10	7	110	<20	230	<0.5	16	89	*	*	*	*
9-18-80	20	<10	2	<10	7	1,230	<20	400	<0.5	59	1,520	*	*	*	*
9-24-80	4	<10	51	<10	11	<100	<20	1,410	<0.5	95	18,800	*	*	*	*
	10	<10	14	<10	9	100	<20	600	<0.5	81	520	*	*	*	*
	20	<10	2	<10	5	760	<20	50	<0.5	30	316	*	*	*	*
	Neosho	<10	3	<10	<4	270	<20	260	<0.5	<10	52	*	*	*	*
10-8-80	10	<10	15	<10	15	570	<20	380	<0.5	142	9,200	*	*	*	*
	20	<10	<2	<10	4	240	<20	40	<0.5	32	55	*	*	*	*

* not sampled

Table 3. Cont.

DATE	SITE	Cl mg/L	SUSPENDED SOLIDS mg/L	TOTAL ALKALINTY mg/L	TOTAL Al µg/L	TOTAL Pb µg/L	TOTAL Zn µg/L	SO_4 mg/L	TDS mg/L	TOTAL SOLIDS mg/L	TOTAL Fe µg/L	TOTAL Mn µg/L	pH SU	TEMP C°	SPECIFIC COND. µmho/cm
10-15-80	4	*	*	80	<2,000	1,920	24,600	539	474	*	5,800	555	6.6	20.0	1,150
	7	*	*	73	<2,000	247	6,500	911	1,476	*	870	370	6.7	20.5	1,670
	10	*	*	43	19,200	1,090	14,000	173	153	*	21,200	610	6.4	20.0	*
	20	*	*	276	16,000	196	5,500	80	85	*	32,000	430	6.3	19.5	*
10-22-80	4t	*	*	83	<2,000	<20	31,000	1,441	2,139	*	230	130	6.2	16.5	2,300
	14	*	*	272	4,500	<20	215,000	3,021	4,927	*	530,000	6,300	6.1	24.5	4,290
11-6-80	10	*	*	105	<2,000	36	23,000	909	1,326	*	1,260	1,120	6.7	22.0	1,373
	20	*	*	93	<2,000	<20	14,000	609	1,000	*	1,470	740	7.0	24.0	*
11-12-80	4	*	*	75	<2,000	<20	30,400	1,146	1,728	*	1,080	1,830	7.3	16.7	1,578
	4t	*	*	66	<2,000	<20	32,000	1,601	2,271	*	250	70	7.2	17.8	2,340
	7	*	*	90	<2,000	<20	13,800	1,296	1,844	*	1,010	160	7.4	17.8	1,676
	10	*	*	96	<2,000	<20	18,300	1,024	1,461	*	1,220	1,000	7.7	14.0	1,630
11-13-80	14	*	*	69	<2,000	<20	172,000	3,301	5,115	*	490,000	5,300	5.8	15.9	3,500
	20	*	*	90	<2,000	<20	13,600	806	1,085	*	940	670	7.1	12.1	1,062
	Neosho	*	*	102	<2,000	<20	227	77	249	*	890	250	7.5	14.6	317
11-19-80	10	*	*	111	<2,000	<20	22,700	1,223	1,571	*	1,140	1,440	7.1	5.0	1,290
	20	*	*	99	<2,000	<20	12,800	656	1,138	*	12,800	1,000	7.3	7.0	1,056
12-3-80	4	*	*	111	<2,000	<20	25,300	1,109	1,672	*	930	1,150	5.7	7.5	1,738
	10	*	*	124	<2,000	34	28,500	1,001	1,513	*	1,790	820	5.8	4.4	1,645
	14	*	*	183	4,400	<20	181,000	2,924	4,677	*	530,000	5,300	4.8	16.0	4,300
	20	*	*	108	<2,000	<20	13,200	733	1,181	*	790	740	*	*	*
1-29-81	4a	*	*	104	<2,000	<20	80,000	1,076	1,819	*	2,400	900	6.4	5.3	1,300
	4	*	*	121	<2,000	<20	28,200	725	1,297	*	15,000	610	6.3	5.4	1,000
	10	*	*	121	<2,000	<20	31,500	753	1,330	*	12,000	630	6.7	4.4	1,000
	14	*	*	294	4,600	<20	560,000	2,812	4,954	*	900,000	4,200	5.0	16.0	3,780
	20	*	*	96	<2,000	<20	16,500	485	997	*	14,000	1,200	6.2	5.5	900
	Neosho	*	*	152	<2,000	<20	720	137	407	*	280	110	6.7	6.3	450
3-6-81	4a	*	*	35	*	<20	31,200	966	1,509	*	760	*	6.9	7.5	1,140
	4	*	*	*	*	*	25,400	832	1,391	*	900	*	6.2	7.2	1,100
	10	*	*	43	*	23	18,000	76	1,283	*	1,110	*	6.4	6.1	1,025
	20	*	*	34	*	<20	8,300	441	759	*	2,800	*	7.2	8.3	710
	Neosho	*	*	57	*	<20	670	149	407	*	870	*	7.0	11.0	490

* not sampled

Table 3. Cont.

DATE	SITE	DO mg/L	NO_2-NO_3 mg/L	TOC mg/L	O-PO_4 or P mg/L	TOTAL P mg/L	TOTAL Cd µg/L	BOD_5 mg/L	TOTAL F mg/L	TOTAL As µg/L	TOTAL Cr µg/L	TOTAL Cu µg/L	TOTAL Hg µg/L	TOTAL Ni µg/L	Al-d µg/L
10-15-80	4	5.7	*	*	*	*	160	*	*	<10	<10	207	<0.5	72	<2,000
	7	6.3	*	*	*	*	21	*	*	<10	<10	20	<0.5	78	<2,000
	10	12.0	*	*	*	*	82	*	*	<10	30	94	<0.5	67	12,200
	20	13.0	*	*	*	*	17	*	*	<10	88	33	5.5	89	8,300
10-22-80	4t	4.3	*	*	*	*	130	*	*	<10	16	<4	<0.5	90	<2,000
	14	0.3	*	*	*	*	26	*	*	<10	32	8	<0.5	2,250	2,400
11-6-80	10	6.8	*	*	*	*	22	*	*	<10	<10	11	<0.5	113	<2,000
	20	8.2	*	*	*	*	14	*	*	<10	<10	8	<0.5	99	<2,000
11-12-80	4	7.2	*	*	*	*	26	*	*	11	<10	13	<0.5	119	<2,000
	4t	6.9	*	*	*	*	170	*	*	10	<10	9	<0.5	88	<2,000
	7	0.8	*	*	*	*	16	*	*	<10	<10	10	<0.5	62	<2,000
	10	0.7	*	*	*	*	14	*	*	<10	<10	14	<0.5	137	<2,000
11-13-80	14	0.6	*	*	*	*	16	*	*	<10	<10	12	<0.5	1,740	<2,000
	20	6.1	*	*	*	*	4	*	*	<10	<10	9	<0.5	169	<2,000
	Neosho	4.8	*	*	*	*	<2	*	*	<10	<10	5	<0.5	18	<2,000
11-19-80	10	1.0	*	*	*	*	22	*	*	<10	<10	10	<0.5	174	<2,000
	20	0.9	*	*	*	*	7	*	*	<10	23	11	<0.5	197	<2,000
12-3-80	4	1.1	*	*	*	*	26	*	*	<10	19	12	<0.5	119	<2,000
	10	1.2	*	*	*	*	24	*	*	<10	27	14	<0.5	168	<2,000
	14	0.6	*	*	*	*	24	*	*	14	29	13	<0.5	2,100	4,100
	20	*	*	*	*	*	3	*	*	<10	22	10	<0.5	255	<2,000
1-29-81	4a	7.3	*	*	*	*	46	*	*	<10	<10	15	<0.5	83	<2,000
	4	8.2	*	*	*	*	23	*	*	<10	<10	12	<0.5	78	<2,000
	10	7.6	*	*	*	*	21	*	*	<10	<10	13	<0.5	109	<2,000
	14	0.9	*	*	*	*	22	*	*	22	14	19	<0.5	3,160	3,900
	20	8.4	*	*	*	*	5	*	*	<10	<10	11	<0.5	325	<2,000
	Neosho	8.7	*	*	*	*	<2	*	*	<10	<10	6	<0.5	14	<2,000
3-6-81	4a	7.4	*	*	*	*	23	*	*	*	*	*	*	*	*
	4	7.2	*	*	*	*	20	*	*	*	*	*	*	*	*
	10	7.6	*	*	*	*	18	*	*	*	*	*	*	*	*
	20	7.5	*	*	*	*	13	*	*	*	*	*	*	*	*
4-9-81	4	8.5	*	*	*	*	12	*	0.49	*	*	*	*	*	*
5-6-81	Neosho	6.6	*	*	*	*	<2	*	*	*	*	*	*	*	*

* not sampled

Geological Survey collected 24-hour monitoring data at Sites 10 and 20 for pH, D.O., specific conductance, and temperature, using a mounted Hydrolab unit. Site 20 also contained a USGS manometer to record flucuations in stream stage. Flow measurements at Sites 10 and 20 were performed by USGS personnel for development of a flow/stage curve. Flows were measured with a pygmy flow meter using a beaded transect line and stopwatch.

Table 2 is a compilation of all data collected at stream sites from December 27, 1979, to March 6, 1981. It is presented by site and by dates for each parameter analyzed. Table 3 is a historical presentation of the same data organized in a format to compare various sites by date.

Groundwater sampling consisted of two types; mine water and well or drill hole water. Mine water samples were taken from the three previously sampled mine shafts reported in USGS Open File Report 78-294 (Figure 2). Mine shaft samples were collected using a USGS aluminum boom and a two liter PVC Kemmerer sampler. A Model 4041 digital Hydrolab was used for measuring field parameters at 20 foot increments in each shaft from surface to bottom. The water level was recorded and samples were taken at the surface of each shaft. When stratified levels were indicated by the Hydrolab data, samples were collected above and below that point. If no stratification was detected, surface and bottom samples were collected. Water samples consisting of identical one-half liter samples as described above with lab analysis as listed in Table 4. Trace metals from each mine shaft were analyzed on a one time basis using U.S. Environmental Protection Agency (EPA) Cincinatti Lab ICAP analysis (Table 5).

Figure 2. Mine and groundwater sample sites of the Tar Creek Task Force in the Picher Mine Field, Ottawa County, Oklahoma.

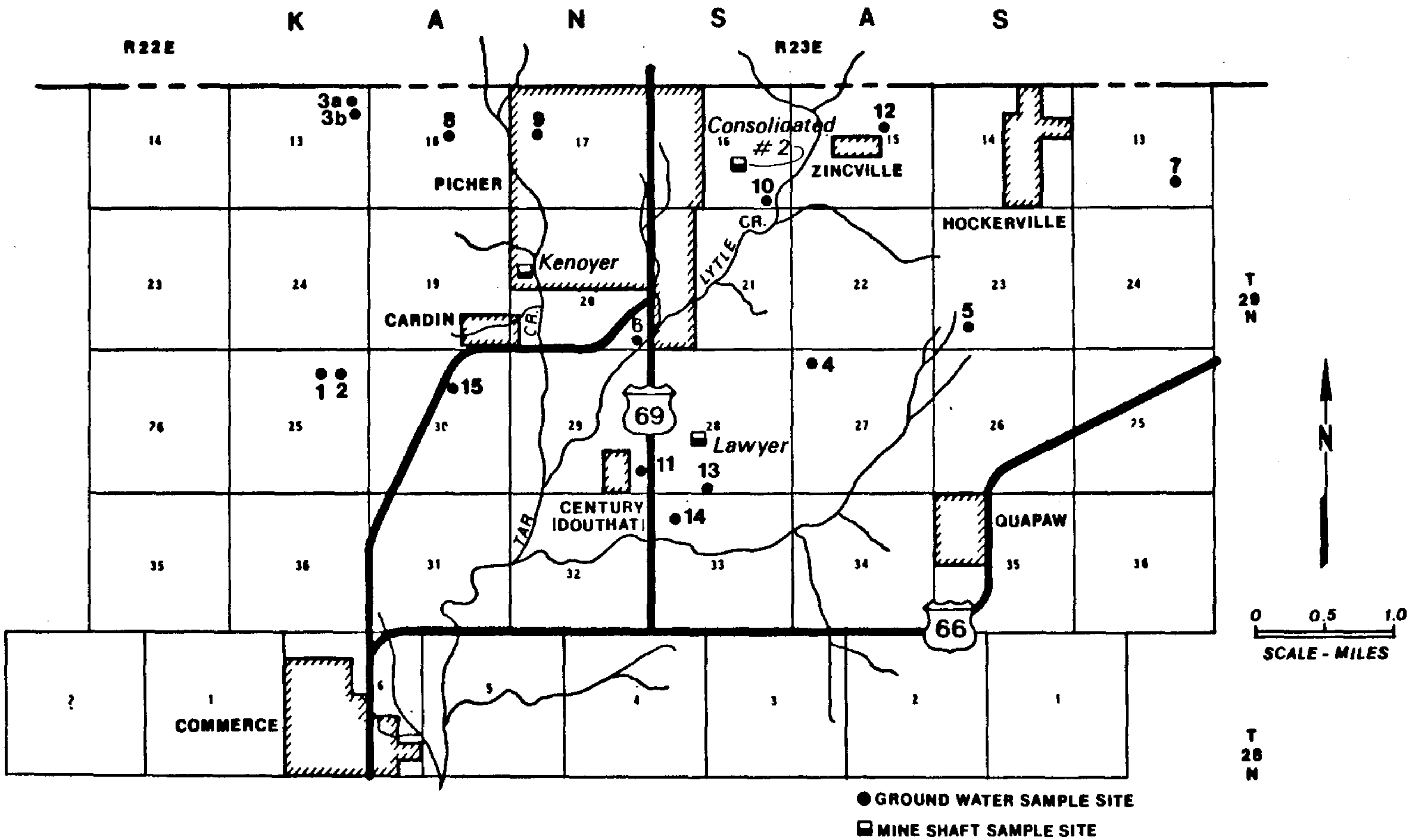


Table 4. Data from samples collected from August 19, 1980, to March 27, 1981 at the Lawyer, Consolidated #2, and Kenoyer mine shafts in the Picher mine Field, Ottawa County, Oklahoma.

DATE	SITE DEPTH	DO mg/L	pH SU	SO_4 mg/L	TOTAL ALK. mg/L	TOTAL SOLIDS mg/L	TOTAL Al µg/L	TOTAL Cd µg/L	TOTAL Cu µg/L	TOTAL Pb µg/L	TOTAL Hg	TOTAL Zn	TOTAL F Mg/L	SPECIFIC CONDUCTANCE µmho/cm	TDS µg/L
	Lawyer														
8-19-80	10'	6.8	7.9	1,838		3,186	<2,000	14	22	<20	<0.5	4,000	0.68	2,200	1,210
	30'	4.5	7.3	1,749		2,759	<2,000	12	34	32	<0.5	6,300	0.70	2,400	1,320
	40'	4.3	7.1	1,569		5,953	<2,000	8	19	<20	<0.5	6,700	0.65	2,400	1,320
	110'	4.3	7.2	1,569		2,664	<2,000	8	17	37	<0.5	6,400	0.67	2,500	1,375
	150'	4.3	7.1	1,614		2,645	<2,000	10	17	<20	<0.5	7,900	0.68	2,400	1,320
	170'	3.0	4.3	3,080		6,247	86,900	430	45	53	<0.5	370,000	0.65	4,200	2,310
	190'	2.9	4.6	3,080		6,163	97,800	410	42	50	<0.5	330,000	0.70	3,900	2,145
	210'	2.4	4.4	3,080		5,800	90,300	450	45	56	<0.5	360,000	0.72	3,950	2,173
9-18-80	10'	*	*	1,762		*	*	12	*	<20	*	5,300	0.67	*	2,906
	200'	*	*	3,944		*	*	440	*	51	*	2,850,000	0.75	*	5,522
10-30-80	sfc.	4.7	6.6	1,482		*	*	33	*	22	*	18,000	0.56	2,340	2,090
	190'	4.7	6.9	1,482		*	*	33	*	33	*	15,000	0.54	2,340	2,096
12-17-80	sfc.	*	6.2	*		*	*	*	30	*	*	16,000	*	2,500	*
	170'	*	6.1	*		*	*	*	10	*	*	17,000	*	4,430	*
1-28-81	sfc.	3.9	5.8	160		*	*	36	*	<20	*	23,000	0.40	2,220	2,597
	140'	3.8	6.1	810		*	*	40	*	<20	*	23,200	0.48	2,220	2,589
	160'	0.3	3.5	3,400		*	*	590	*	72	*	420,000	0.56	3,700	5,644
3-26-81	sfc.	0.6	6.2	1,900		*	*	13	*	102	*	11,700	1.00	2,700	2,775
	140'	0.6	6.3	1,853		*	*	12	*	<20	*	12,400	0.95	2,720	2,774
	180'	0.6	4.1	2,452		*	*	180	*	27	*	127,000	5.50	*	3,549
	Consolidated #2														
8-20-80	10'	7.1	7.5	402		811	<2,000	38	19	<20	<0.5	1,130	0.40	900	495
	50'	5.8	7.6	308		721	<2,000	41	11	<20	<0.5	1,400	0.32	800	440
	90'	5.6	7.2	300		724	<2,000	3	4	<20	<0.5	1,450	0.31	800	440
	130'	5.8	7.3	300		721	<2,000	41	7	<20	<0.5	2,170	0.31	900	495
	170'	6.0	7.5	300		755	<2,000	11	8	<20	<0.5	2,150	0.41	800	440
10-30-80	234'	*	6.9	2,685		*	*	190	*	48	*	241,000	1.38	1,090	4,287
12-17-80	40'	*	5.9	*		*	*	*	*	*	*	4,000	*	1,200	*
1-28-81	160'	6.2	6.0	432		*	*	64	*	<20	*	6,000	0.25	880	826
	200'	0.9	4.9	2,690		*	*	96	*	136	*	274,000	1.10	3,340	4,530
3-28-81	sfc.	6.1	7.2	477		*	*	42	*	61	*	2,680	0.35	997	835
	180'	6.2	6.6	460		*	*	42	*	<20	*	2,490	0.40	1,012	833
	220'	0.8	4.7	2,915		*	*	78	*	104	*	152,000	1.65	*	4,880
	Kenoyer														
10-30-80	sfc.	0.6	6.4	539		*	*	65	*	<20	*	25,000	0.36	1,332	1,765
	175'	0.7	6.6	659		*	*	120	*	<20	*	18,000	0.47	1,305	1,103
	195'	0.7	5.4	2,436		*	*	14	*	<20	*	125,000	3.00	1,305	3,679
12-4-80	sfc.	0.7	6.3	615		*	*	90	*	<20	*	14,900	0.44	1,209	978
	140'	0.7	6.3	602		*	*	110	*	<20	*	15,000	0.44	1,209	967
	180'	0.3	5.2	2,847		*	*	28	*	53	*	257,000	0.28	4,240	4,522
1-28-81	sfc.	0.6	5.6	510		*	*	140	*	218	*	19,400	0.38	1,100	1,024
	160'	0.6	5.3	2,401		*	*	29	*	57	*	340,000	22.00	3,100	4,021
3-27-81	sfc.	1.1	6.0	464		*	*	69	*	78	*	11,100	0.54	1,243	1,063
	180'	0.0	5.7	2,954		*	*	7	*	61	*	215,000	5.30	*	4,891

* not sampled

Table 4. Cont.

DATE	SITE & DEPTH	TOTAL HARDNESS mg/L	TEMP C°	TOTAL As µg/L	TOTAL Cr µg/L	TOTAL Fe µg/L	TOTAL Mn µg/L	TOTAL Ni µg/L	Cd-d µg/L	Fe-d µg/L	Pb-d µg/L	Zn-d µg/L	TOTAL Ag µg/L	Ag-d µg/L	Mn-d µg/L
	Lawyer														
8-19-80	10'	2,298	29.0	<10	<10	120	200	35	*	*	*	*	*	*	*
	30'	2,005	24.0	<10	12	210	610	62	*	*	*	*	*	*	*
	40'	1,834	23.0	<10	<10	260	650	64	*	*	*	*	*	*	*
	110'	1,855	23.5	<10	<10	610	640	62	*	*	*	*	*	*	*
	150'	650	22.0	<10	<10	840	650	67	*	*	*	*	*	*	*
	170'	3,033	21.5	22	32	340,000	4,600	4,310	*	*	*	*	*	*	*
	190'	3,061	21.0	20	32	390,000	5,000	3,970	*	*	*	*	*	*	*
	210'	2,870	20.0	26	41	42,000	5,300	4,500	*	*	*	*	*	*	*
9-18-80	10'	1,807	*	*	*	340	*	*	6	110	<20	5,600	*	*	*
	200'	2,003	*	*	*	470,000	*	*	470	430,000	45	320,000	4.0	4.0	*
10-30-80	sfc.	1,433	14.0	*	*	300	240	*	33	290	22	18,000	*	*	240
	190'	1,433	14.6	*	*	350	240	*	33	190	22	15,000	*	*	240
12-17-80	sfc.	*	*	*	*	7,500	*	*	*	*	*	*	*	*	*
	170'	*	*	*	*	175,000	*	*	*	*	*	*	*	*	*
1-28-81	sfc.	2,059	13.0	*	*	13,000	*	*	35	11,000	<20	21,400	*	*	*
	140'	2,036	13.7	*	*	1,240	*	*	33	630	<20	19,800	*	*	*
	160	3,033	15.0	*	*	700,000	*	*	580	700,000	67	420,000	*	*	*
3-26-81	sfc.	1,799	14.2	*	*	700	*	*	*	*	*	*	*	*	*
	140'	1,875	13.9	*	*	690	*	*	*	*	*	*	*	*	*
	180'	2,128	15.4	*	*	150,000	*	*	100	110,000	<20	94,000	*	*	*
	Consolidated #2														
8-20-80	10'	4,979	23.0	<10	<10	470	230	30	38	470	<20	1,110	*	*	220
	50'	458	22.0	<10	10	260	20	25	32	170	<20	<2,000	*	*	20
	90'	504	21.0	<10	<10	100	40	33	37	230	<20	2,140	*	*	50
	130'	504	21.0	<10	<10	270	40	37	39	140	<20	2,040	*	*	30
	170'	507	20.0	<10	41	220	40	38	39	140	<20	2,040	*	*	30
10-30-80	234'	2,385	*	*	*	1,500	5,350	*	190	1,500	48	241,000	*	*	5,350
12-17-80	40'	*	*	*	*	7,500	*	*	*	*	*	*	*	*	*
1-28-81	160'	495	13.4	*	*	6,500	*	*	64	6,400	<20	5,800	*	*	*
	200'	2,731	15.0	*	*	410,000	*	*	96	400,000	136	249,000	*	*	*
3-28-81	sfc.	564	13.4	*	*	600	*	*	*	*	*	*	*	*	*
	180'	539	13.4	*	*	460	*	*	*	*	*	*	*	*	*
	220'	2,506	15.2	*	*	290,000	*	*	78	270,000	102	152,000	*	*	*
	Kenoyer														
10-30-80	sfc.	563	14.8	*	*	1,190	2,040	*	64	960	<20	25,000	*	*	2,040
	175'	625	14.9	*	*	300	560	*	120	300	<20	18,000	*	*	560
	195'	2,385	14.9	*	*	1,000	3,600	*	11	1,000	<20	125,000	*	*	3,600
12-4-80	sfc.	579	14.6	*	*	<100	*	*	90	<100	<20	14,900	*	*	*
	140'	470	14.6	*	*	<100	*	*	110	<100	<20	15,000	*	*	*
	180'	301	15.1	*	*	350,000	*	*	23	350,000	47	257,000	*	*	*
1-28-81	sfc.	556	14.6	*	*	540	*	*	140	540	218	19,400	*	*	*
	160'	2,390	15.1	*	*	400,000	*	*	28	400,000	57	336,000	*	*	*
3-27-81	sfc.	623	14.6	*	*	550	*	*	*	*	*	*	*	*	*
	180'	2,561	15.3	*	*	270,000	*	*	7	200,000	43	204,000	*	*	*

*=not sampled

Table 4. Cont.

DATE	SITE & DEPTH	Cu-d	Hg-d	TOTAL As	As-d	Ni-d	Al-d
	Consolidated #2						
8-20-80	10'	14	<0.5	<10	<10	30	<2,000
	50'	9	<0.5	<10	<10	24	<2,000
	90'	5	<0.5	<10	<10	34	<2,000
	130'	5	<0.5	<10	<10	37	<2,000
	170'	9	<0.5	<10	<10	38	<2,000
10-30-80	234'	*	*	*	*	*	*
1-28-81	160'	*	*	*	*	*	*
	200'	*	*	*	*	*	*

* not sampled

Table 5. U.S. Environmental Protection Agency, Cincinatti, ICAP sample analyses for samples collected January 28, 1981, at the Site 14 artesian springs and the Consolidated #2, Kenoyer, and Lawyer mine shafts, Picher mine field, Ottawa County, Oklahoma, in mg/L.

PARAMETER*	Site #14 Artesian Springs	Consolidated #2		Kenoyer		Lawyer		
	Surface	160'	200'	Surface	160'	Surface	140'	160'
AL	3.811	ND	1.462	ND	2.117	ND	ND	25.962
B	0.777	ND	0.347	0.140	0.320	ND	ND	0.395
CA	517.249	186.065	456.841	201.945	423.694	410.508	409.346	432.397
CD	ND	ND	ND	0.078	ND	ND	ND	0.385
CO	0.109	ND	0.476	ND	0.459	ND	ND	0.679
FE	501.108	0.617	335.467	0.451	278.584	0.998	1.022	373.919
LI	0.367	0.070	0.292	0.069	0.261	0.120	0.125	0.344
MG	134.664	24.253	261.368	37.328	240.030	176.805	175.768	243.533
MN	5.318	0.072	4.326	0.327	4.140	0.259	0.252	5.333
MO	0.113	ND	0.115	ND	0.221	0.102	0.052	0.198
NA	135.463	11.127	77.334	28.453	82.055	25.730	25.822	72.604
NI	1.567	ND	2.694	0.051	2.671	0.076	0.082	3.543
P	0.478	ND	0.418	ND	0.366	0.165	0.199	0.531
PB	0.116	ND	0.245	ND	0.132	ND	0.153	0.236
Pt	ND	ND	ND	ND	ND	ND	ND	0.150
SI	3.873	5.753	4.096	5.068	5.579	4.311	4.320	8.643
TE	0.442	ND	0.350	ND	0.922	ND	ND	0.813
TL	0.482	ND	0.365	ND	0.297	ND	ND	0.499
Y	0.103	ND	ND	ND	0.062	ND	ND	0.522
ZN	141.567	2.778	176.506	13.544	185.210	15.189	15.477	293.907

ND = Non-detectable levels

* Analyses for the following parameters resulted in non-detectable levels in all samples: Ag, As, Be, Cr, Cu, Se, Sn, Ti, V, W, and Zr.

Groundwater data for the Boone aquifer was collected from drill holes located on U.S. Bureau of Mines maps of the Picher mine field or existing Boone wells (Figure 2). Drill holes were selected for sampling if isolated from subsurface mine works and their total depth within the confines of the Boone formation. Field parameters were collected at each drill hole/well site along with static level and total depth (Table 6). Additional well or drill hole sample data are given in Table 7. Roubidoux aquifer data is currently being investigated by the USGS (Appendix C).

Biological samples were taken by Oklahoma Department of Wildlife Conservation (ODWC) at sites on the Neosho River and Grand Lake (Figure 3). Four or five fish species were collected at each site and wrapped in aluminum foil and tagged. Fillets of all species except gizzard shad were utilized (Table 8). Personnel from the U.S. Fish and Wildlife Service (USFWS) and the ODWC sampled the Neosho River and Tar Creek following the same procedure. The USFWS samples were analyzed at their Columbia lab and have not been received at this time. The ODWC also performed a preliminary biological reconnaissance of Tar Creek to identify and quantify biota from the confluence of Tar Creek and the Neosho River to the Kansas border, approximately five miles south of the headwaters of Tar Creek (Figure 4 and Appendix D). EPA-Las Vegas Laboratory , performed a complete biological evaluation of Tar Creek from Cardin to the headwaters in Kansas (Figure 5, Table 9, and Appendix D). Final results of this study are expected by September 1981.

Figure 3. Site locations of Oklahoma Department of Wildlife Conservation fish samples taken on June 25-27, 1980, in the Neosho River, Ottawa County, Oklahoma.

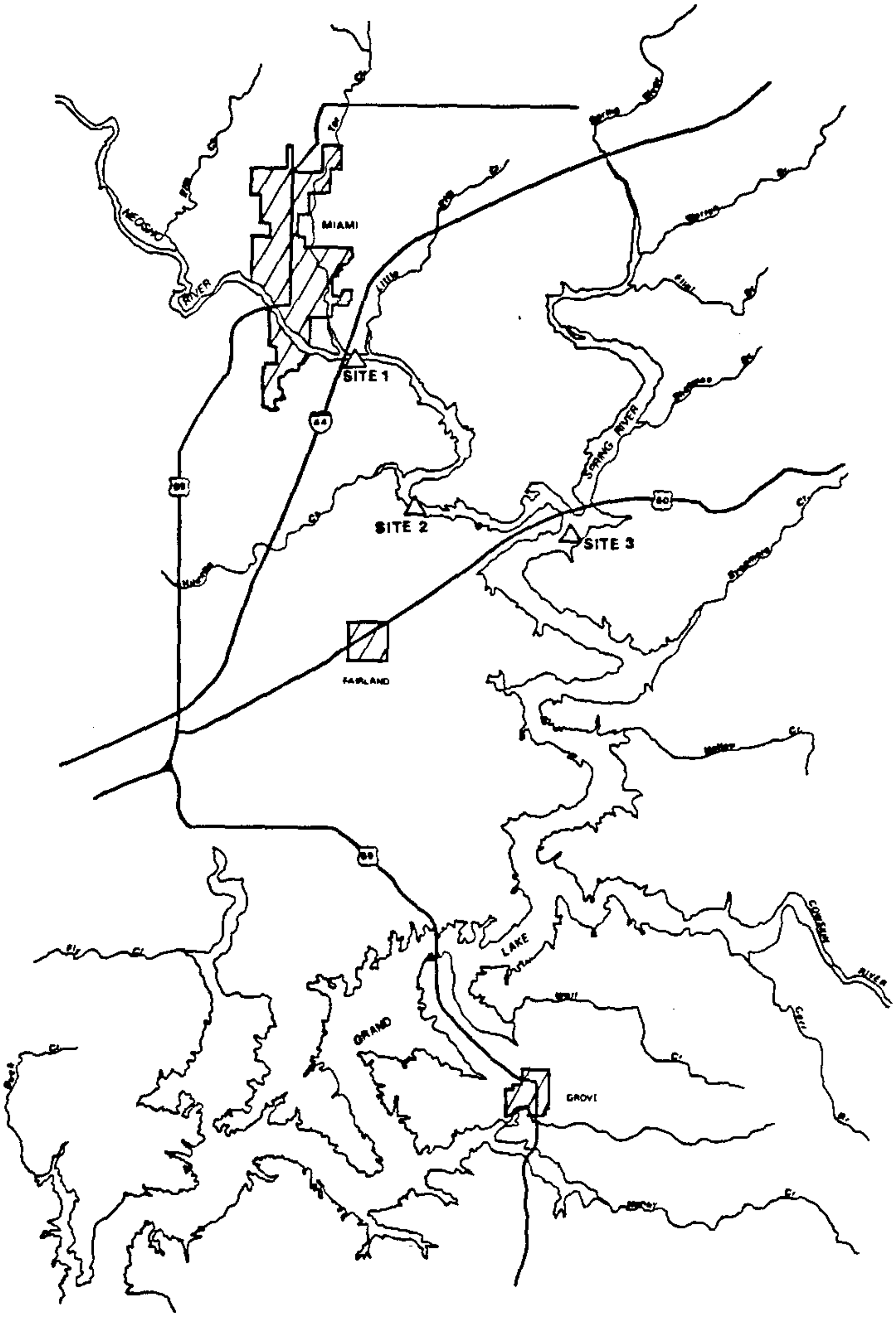


Figure 4. Oklahoma Department of Wildlife Conservation preliminary biological reconnaissance on Tar Creek July 15 and 16, 1980, Ottawa County, Oklahoma.

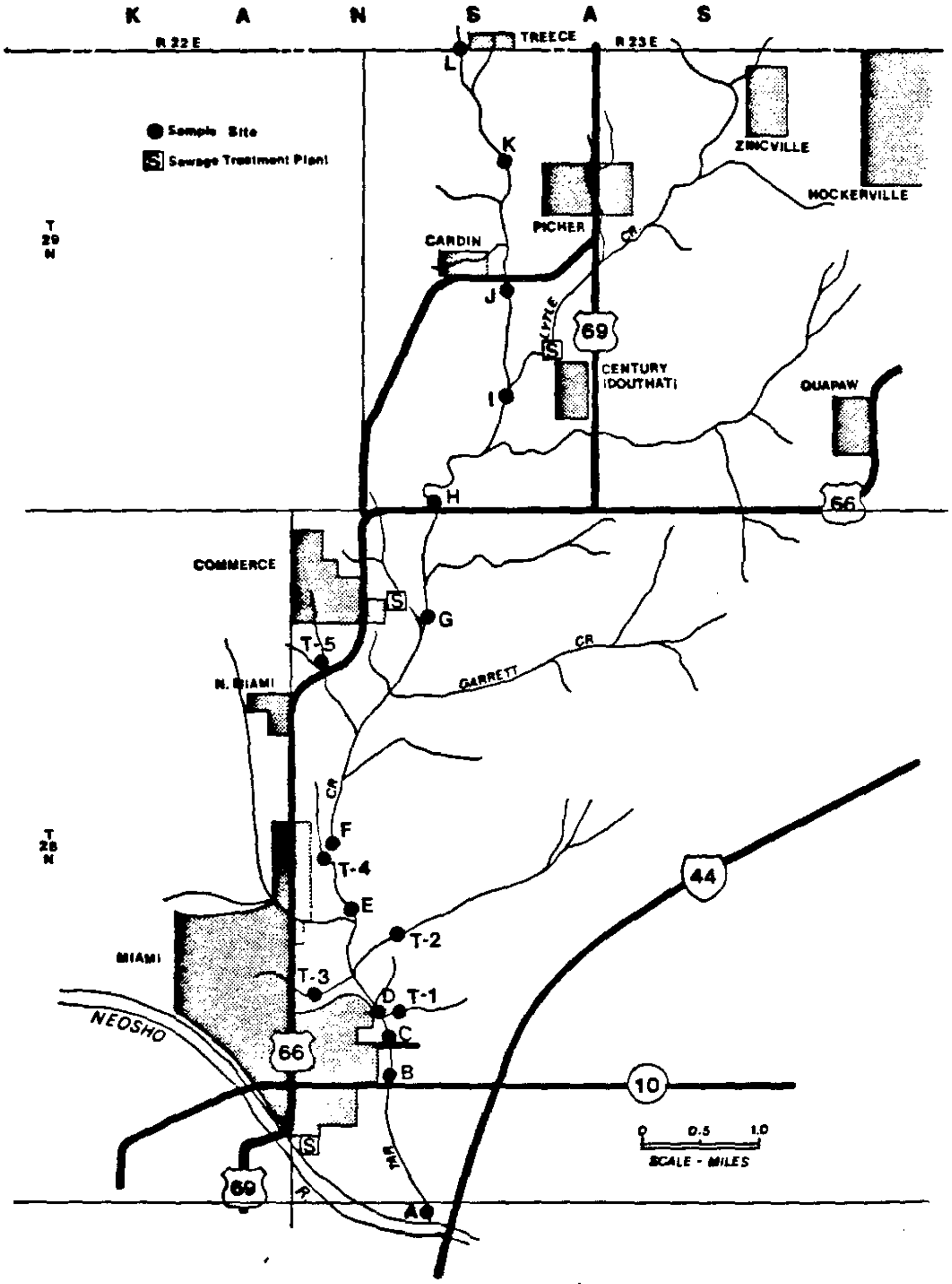


Figure 5. EPA-Las Vegas Laboratory biological study sites on Tar Creek, Cherokee County, Kansas, and Ottawa County, Oklahoma.

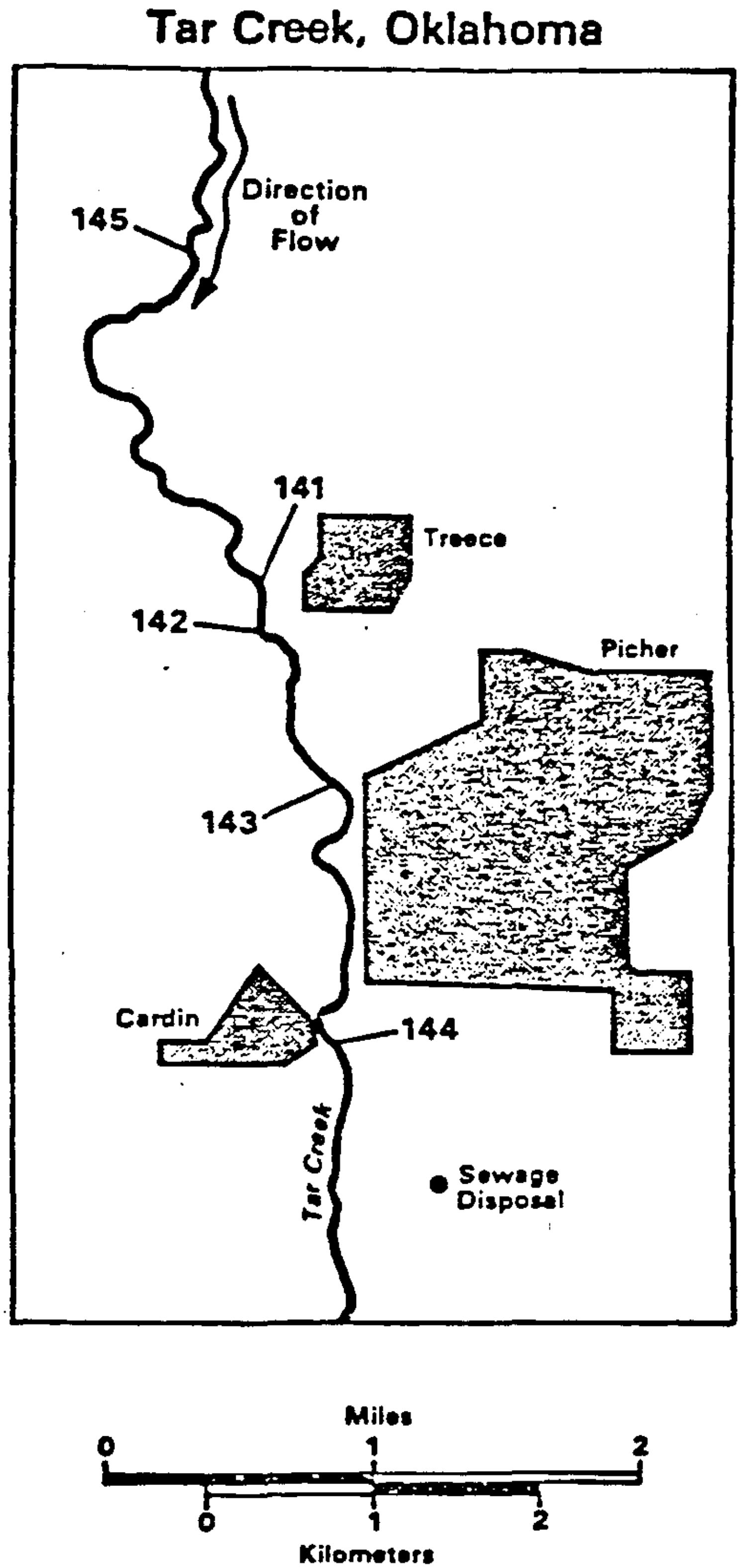


Table 6. Boone aquifer wells sampled on February 27, 1981, in the Picher Mine Field area, Ottawa County, Oklahoma.

SITE	LEGAL DESCRIPTION S T R	BICARBONATE mg/L	CHLORIDE mg/L	NO_3-NO_2 mg/L	pH SU	SULFATE mg/L	TOTAL HARDNESS mg/L	TOTAL Al µg/L	TOTAL Cd µg/L	TOTAL Cr µg/L	TOTAL Fe µg/L	TOTAL Mg mg/L	TOTAL Hg µg/L	TOTAL K mg/L
1	25, 29N, 22E	1,089	45	<0.5	7.4	1,266	1,547	<2,000	7	<10	11,000	630	<0.5	27.00
2	25, 29N, 22E	695	48	<0.5	7.7	1,132	*	<2,000	8	10	6,900	290	<0.5	17.00
3a	13, 29N, 22E	29	<10	<0.5	7.9	629	428	22,600	8	10	150,000	18	<0.5	<0.10
3b	13, 29N, 22E	279	10	<0.5	7.7	2,566	2,626	<2,000	6	<10	58,000	16	<0.5	24.00
4	27, 29N, 23E	273	<10	0.5	8.1	282	419	2,000	9	12	68,000	46	<0.5	10.00
5	23, 29N, 23E	201	10	6.4	8.1	285	419	<2,000	8	<10	3,000	100	<0.5	9.00
6	20, 29N, 23E	332	<10	<0.5	7.9	<20	*	<2,000	13	<10	15,000	13	<0.5	10.00
7	13, 29N, 23E	189	<10	<0.5	8.2	829	*	2,200	7	12	130,000	19	<0.5	7.00
8	18, 29N, 23E	32	16	<0.5	7.8	2,214	*	<2,000	4	12	140,000	390	<0.5	22.00
9	17, 29N, 23E	245	19	<0.5	7.8	1,319	*	<2,000	5	10	8,000	76	<0.5	6.00
10	16, 29N, 23E	117	22	<0.5	7.8	3,395	3,103	5,300	133	16	300,000	780	<0.5	8.00
11	29, 29N, 23E	41	<10	<0.5	8.1	1,792	*	35,500	126	13	20,000	99	<0.5	4.00
12	15, 29N, 23E	351	<10	<0.5	8.0	1,402	*	<2,000	22	10	30,000	240	<0.5	16.00
13	28, 29N, 23E	221	*	8.3	8.2	*	*	<2,000	6	<10	4,300	11	20.5	1.00
14	33, 29N, 23E	170	<10	1.0	8.2	184	*	<2,000	26	<10	6,400	10	<0.5	2.00
15	30, 29N, 23E	503	40	<0.5	7.8	1,744	*	<2,000	<2	<10	6,400	550	<0.5	25.00

* not sampled

Table 6. Cont.

SITE	LEGAL DESCRIPTION S T R	TOTAL Zn µg/L	TOTAL FLUORIDE mg/L	SPECIFIC CONDUCTANCE µmho/cm	TOTAL ALKALINITY mg/L	TEMP °C	TOTAL As µg/L	TOTAL Ca µg/L	TOTAL Cu µg/L	TOTAL Pb µg/L	TOTAL Mn µg/L	TOTAL Ni µg/L	TOTAL Na mg/L
1	25, 29N, 22E	590	0.18	3,400	1,089	15.0	<10	209	33	48	2,300	174	230
2	25, 29N, 22E	105	0.39	2,600	695	16.0	16	196	23	33	3,700	263	237
3a	13, 29N, 22E	600	0.26	2,600	29	15.0	13	43	56	71	5,900	303	<10
3b	13, 29N, 22E	26,700	270.00	4,500	279	16.0	21	36	24	<20	940	437	300
4	27, 29N, 23E	2,610	0.29	1,070	273	17.0	<10	124	29	<20	4,600	274	55
5	23, 29N, 23E	148	0.29	1,780	201	18.0	<10	139	22	<20	150	139	92
6	20, 29N, 23E	104	0.61	600	332	17.0	<10	30	12	<20	1,800	60	34
7	13, 29N, 23E	730	*	1,250	189	16.0	18	105	25	<20	6,200	180	29
8	18, 29N, 23E	9,300	1.03	3,400	32	17.0	24	395	18	<20	3,700	920	186
9	17, 29N, 23E	40	0.35	2,700	245	19.0	<10	139	20	64	900	140	360
10	16, 29N, 23E	252,000	8.80	5,000	117	19.0	38	328	18	124	4,500	3,530	100
11	29, 29N, 23E	21,100	0.87	2,600	41	18.0	24	347	123	53	9,800	670	57
12	15, 29N, 23E	1,130	0.46	2,300	351	16.0	<10	282	96	48	5,800	282	90
13	28, 29N, 23E	153	0.26	940	221	13.0	<10	107	10	<20	800	78	73
14	33, 29N, 23E	2,930	0.24	525	170	17.0	<10	93	16	<20	1,000	93	<10
15	30, 29N, 23E	332	0.37	3,500	503	11.0	<10	225	100	<20	1,000	11	330

* not sampled

Table 7. Boone aquifer wells and drill holes sampled in the Picher Mine Field, Ottawa County, Oklahoma.

DATE	LATITUDE	LONGITUDE	TOTAL DEPTH	STATIC WATER LEVEL	ALTITUDE	pH	SPECIFIC CONDUCTANCE	TEMPERATURE
9-23-80	36°58'49"	94°56'44"	347	18.00	800	8.2	1,500	19.0
	36°58'44"	94°56'54"	280	*	810	7.6	880	24.0
	36°58'07"	94°57'57"	82	31.40	790	7.7	1,110	19.0
9-24-80	36°56'34"	94°54'50"	23	12.45	802	7.9	210	18.0
	36°55'46"	94°56'39"	285	65.00	805	7.8	900	18.0
	36°55'46"	94°55'50"	300	62.18	808	8.0	725	18.0
	36°55'48"	94°56'55"	200	50.00	775	7.4	3,000	17.0
	36°55'16"	94°56'29"	290	84.45	785	7.9	790	18.0
	36°55'19"	94°55'31"	26	7.87	792	7.3	1,900	19.0
	36°54'28"	94°54'22"	385	53.68	780	8.0	725	23.0
	36°56'47"	94°52'53"	*	*	820	8.4	650	17.0
	36°59'38"	94°43'06"	47	44.45	835	*	*	*
	36°58'23"	94°43'40"	275	32.80	815	8.5	420	22.0
	36°58'19"	94°43'43"	*	*	800	8.4	550	23.0
	36°58'58"	94°44'27"	54	21.61	858	*	*	*
9-25-80	36°54'54"	94°49'22"	450	*	840	7.8	1,100	25.0
	36°54'54"	94°49'22"	135	46.98	840	*	*	*
	36°57'28"	94°43'54"	131	66.00	868	*	*	*
	36°57'05"	94°44'27"	82	56.80	852	*	*	*
	36°57'56"	94°44'26"	57	31.36	862	8.7	490	17.0
	36°59'34"	94°44'15"	195	39.05	870	8.3	760	18.0
9-26-80	36°59'11"	94°53'35"	136	21.27	825	*	*	*
	36°59'10"	94°54'27"	330	114.00	840	7.8	1,050	19.0
	36°59'50"	94°55'18"	362	134.40	830	8.2	680	17.0

* not sampled

Table 8. Oklahoma Department of Wildlife Conservation fish samples taken on June 21, 25, and 27, 1980, in Tar Creek and the Neosho River, Ottawa County, Oklahoma.

DATE	SITE	FISH SAMPLE	Cd IN FISH µg/gm	Zn-T µg/gm	Pb-T µg/m
6-21-80	Tributary to Tar Creek (Section 19, Township 28N, Range 23E)	Longear Composite (stressed)	<0.1	275.0	<1.0
		Carp Composite (stressed)	0.4	450.0	1.8
6-25-80 and 6-27-80	Site 1	White Bass	<0.1	8.0	<1.0
		Channel Cat	<0.1	8.0	<1.0
		Gizzard Shad	<0.1	20.0	<1.0
		River Carpsucker	<0.1	9.6	<1.0
	Site 2	River Carpsucker	<0.1	8.2	<1.0
		White Bass	<0.1	10.2	<1.0
		Channel Cat	<0.1	10.3	<1.0
	Site 3	Channel Cat	<0.1	7.5	<1.0
		White Bass	<0.1	8.4	<1.0

Table 9. Metal concentrations (µg/L) found in Tar Creek, Oklahoma. (Stations are listed in sequence from upstream to downstream. The metal/source is from nonpoint source mine tailing leachate which occurred throughout the stream. Concentrations reported represent mean values of three replicate samples. Values with single underline equal or exceed the water quality criteria; those with double underlines exceed the criteria by at least an order of magnitude.)

	STATION NUMBER					
	IMPACT					
METALS	141	142	143	144	145	CRITERIA
CD	32	123	277	88	144	1.2
Pb	275	275	279	311	511	100
Zn	10,700	27,700	37,800	41,700	24,100	100
Cu	8	12	16	63	39	20
Ni	75	110	113	11	155	100
Ag	40	44	51	108	151	1
Al***	1,320	1,340	1,270	1,120	950	1
As	50**	75**	85**	95**	255	50
Se	ND*	ND*	65	185	165	50

* ND - Concentrations were below detection limit.
** Large fluctuations among replicates exist.
*** Red book criteria have not been established.

Speculation has occurred on the effect of runoff events on the discharge of mine waters. Table 10 presents the daily and monthly precipitation data for the period from October 1979 to February 1981, from Miami, Oklahoma. Since that time, OWRB staff have established a minor meteorological station in Picher to more closely determine rainfall, evaporation and wind speed. It is hoped this data will allow a more detailed analysis of the relationship.

DISCUSSION

Physical considerations effecting streamwater data:

(1) Subsidence features in Kansas have occurred in the Tar Creek stream bed allowing Tar Creek headwaters to enter directly into the mine works. Three such open surface cave-ins exist within 1.5 miles of the Oklahoma-Kansas border. Rechanneling of Tar Creek by use of backhoe is reported to have occurred, allowing mining operations to progress beneath Tar Creek. After the mines were closed, gougers removed drift supports causing nearly spontaneous subsidence of the stream bed. In addition, a cased drill hole within 50 yards of the Oklahoma-Kansas border, drains all water from Tar Creek below the subsidence features. This drill hole was first observed on November 12, 1980. Tar Creek waters seldom enter Oklahoma from Kansas except in wet periods when rain in excess of two inches occur in the upper Tar Creek watershed. Site 7 was sampled only when water was observed flowing from Kansas to Oklahoma.

Table 10. Daily and monthly precipitation data for October 1979 to February 1981, from the City of Miami, Ottawa County, Oklahoma.

DAY	MONTH AND YEAR								
	OCTOBER 79	NOVEMBER 79	DECEMBER 79	JANUARY 80	FEBRUARY 80	MARCH 80	APRIL 80	MAY 80	JUNE 80
1	*	*	*	*	*	0.08	*	0.10	*
2	*	*	*	*	*	*	*	0.27	*
3	*	*	*	0.17	*	*	0.38	*	*
4	*	*	*	*	*	*	*	*	*
5	*	*	*	*	*	*	*	*	T
6	*	*	*	*	*	*	*	T	*
7	*	*	*	*	*	*	*	*	*
8	*	0.28	*	*	1.28	*	0.13	*	*
9	*	0.98	*	*	*	*	*	*	*
10	*	*	*	*	*	*	*	*	*
11	*	*	T	*	*	*	0.11	*	*
12	*	*	*	*	*	0.82	*	1.48	*
13	*	*	*	*	*	*	*	0.12	*
14	*	*	*	*	*	*	*	*	*
15	*	*	*	*	0.58	*	*	*	*
16	0.12	*	*	0.17	T	*	*	0.52	*
17	T	*	*	*	*	0.10	0.19	*	0.55
18	*	*	*	*	*	*	T	0.40	1.09
19	*	0.18	*	0.07	*	*	*	0.04	0.11
20	*	0.22	*	0.94	*	*	*	*	0.29
21	*	4.40	*	0.10	*	0.61	*	0.13	0.04
22	0.84	*	*	*	*	*	*	*	*
23	*	*	0.07	*	*	0.06	*	*	0.10
24	*	*	0.75	*	*	0.96	0.37	T	*
25	*	*	*	*	0.10	*	0.38	*	*
26	*	*	*	*	*	*	0.80	*	*
27	*	*	*	*	*	*	0.54	1.44	*
28	*	*	0.01	*	*	0.29	*	*	*
29	*	*	*	*	*	T	*	*	*
30	*	*	*	T	*	1.00	*	*	T
31	1.85	*	*	0.09	*	0.01	*	0.59	*
TOTAL	2.81	6.06	0.83	1.54	1.96	3.93	2.97	5.09	2.18

* No precipitation
T = Trace

Table 10. Cont.

	MONTH AND YEAR							
DAY	JULY 80	AUGUST 80	SEPTEMBER 80	OCTOBER 80	NOVEMBER 80	DECEMBER 80	JANUARY 81	FEBRUARY 81
1	0.10	T	*	*	*	*	*	0.63
2	*	*	0.47	*	*	*	*	*
3	*	T	0.07	*	*	*	*	*
4	*	T	*	*	*	*	*	*
5	*	1.37	*	*	*	*	*	T
6	*	*	*	*	*	T	*	0.05
7	*	*	*	*	*	0.04	*	*
8	*	*	*	*	*	1.28	*	*
9	*	*	*	*	*	0.07	*	*
10	*	*	0.02	*	*	*	*	0.75
11	*	*	*	*	*	*	*	0.12
12	*	*	*	*	*	*	*	*
13	*	*	T	*	*	*	*	*
14	*	0.96	*	*	0.04	*	*	*
15	*	0.04	*	*	0.09	*	*	*
16	*	*	*	4.95	T	*	*	*
17	*	*	0.25	0.12	0.10	*	*	*
18	*	1.43	*	*	0.20	*	*	*
19	*	*	*	*	*	*	*	*
20	*	*	*	*	*	*	0.19	*
21	*	0.28	*	*	*	*	0.11	*
22	0.20	*	*	*	*	*	*	0.22
23	*	*	*	*	0.37	*	*	*
24	*	*	*	0.48	0.29	T	*	*
25	*	*	0.03	*	*	*	*	*
26	0.70	*	*	*	*	T	*	*
27	*	*	*	0.74	*	0.13	*	*
28	*	*	0.18	1.10	0.08	*	*	0.12
29	*	*	*	*	*	*	*	*
30	*	*	*	*	*	*	*	*
31	*	T	*	*	*	*	*	*
TOTAL	1.00	4.08	1.02	7.39	1.17	1.52	0.30	1.89

* No precipitation
T = Trace

(2) Tar Creek stream flow in Oklahoma originates from chat pile seepage located on the Kansas border and from sewage treatment plant discharges from Cardin, Picher and Commerce, Oklahoma. Site 4 data, taken at the confluence of Lytle Creek and Tar Creek, reflects the effects of the Picher sewage treatment plant, which discharges into Lytle Creek. Site 4a data, collected 20 yards above the Tar Creek and Lytle Creek confluence and below a chat pile seepage discharge, reflects the Cardin sewage treatment plant discharge mixed with chat seepage above the confluence. The Cardin sewage treatment plant is not operated, due to the limited population in Cardin, and acts merely as a settling lagoon for sporadic discharges. The Miami sewage treatment plant discharges into the Neosho River and effects the Tar Creek-Neosho River confluence.

(3) Site 10 data reflects the effects of the chat substrate in Tar Creek below Site 4, and also the effects of an unnamed tributary which is located north of Highways 66 and 69 and south of the section line road running through Douthat. The substrate of Tar Creek south of Site 4 consists entirely of various grades of chat. Surface flow observed at Site 4 develops into a series (pools) which appear to be interconnected by subsurface flow through the chat. A very large pool exists at the confluence of the unnamed tributary and Tar Creek. This pool discharges mixed waters above Site 10 and appears to be fed from subsurface flow in Tar Creek and the tributary.

(4) The highest concentrations of lead, zinc, iron, and trace metals occurs at Site 14. Flow from this site enters Tar Creek below the Commerce Sewage Treatment Plant and Garret Creek, a major tributary to Tar Creek. At the present time, a weir has been installed to measure the flow of the Site 14 discharge. Flow data is also being collected on all tributaries along with base water quality data. Recent information indicates the Site 14 springs are actually old drill holes from the earliest part of the mining activity in the Picher Field. The low elevation of the Site 14 drainage, as well as the impoundment effect of the weir, allows great quantities of iron and zinc to crystallize out of the discharge and form on vegetation or the drainage substrate. Heavy rains add stormwater runoff to this discharge and could cause concentrated slugs of contaminated water to enter Tar Creek.

(5) Water samples in the Elm Creek basin, immediately west of Tar Creek, indicate similar water quality problems to that of Tar Creek. Mine works are not as numerous near this basin, though chat operations exist within the creek's watershed.

Physical considerations effecting mine and groundwater:

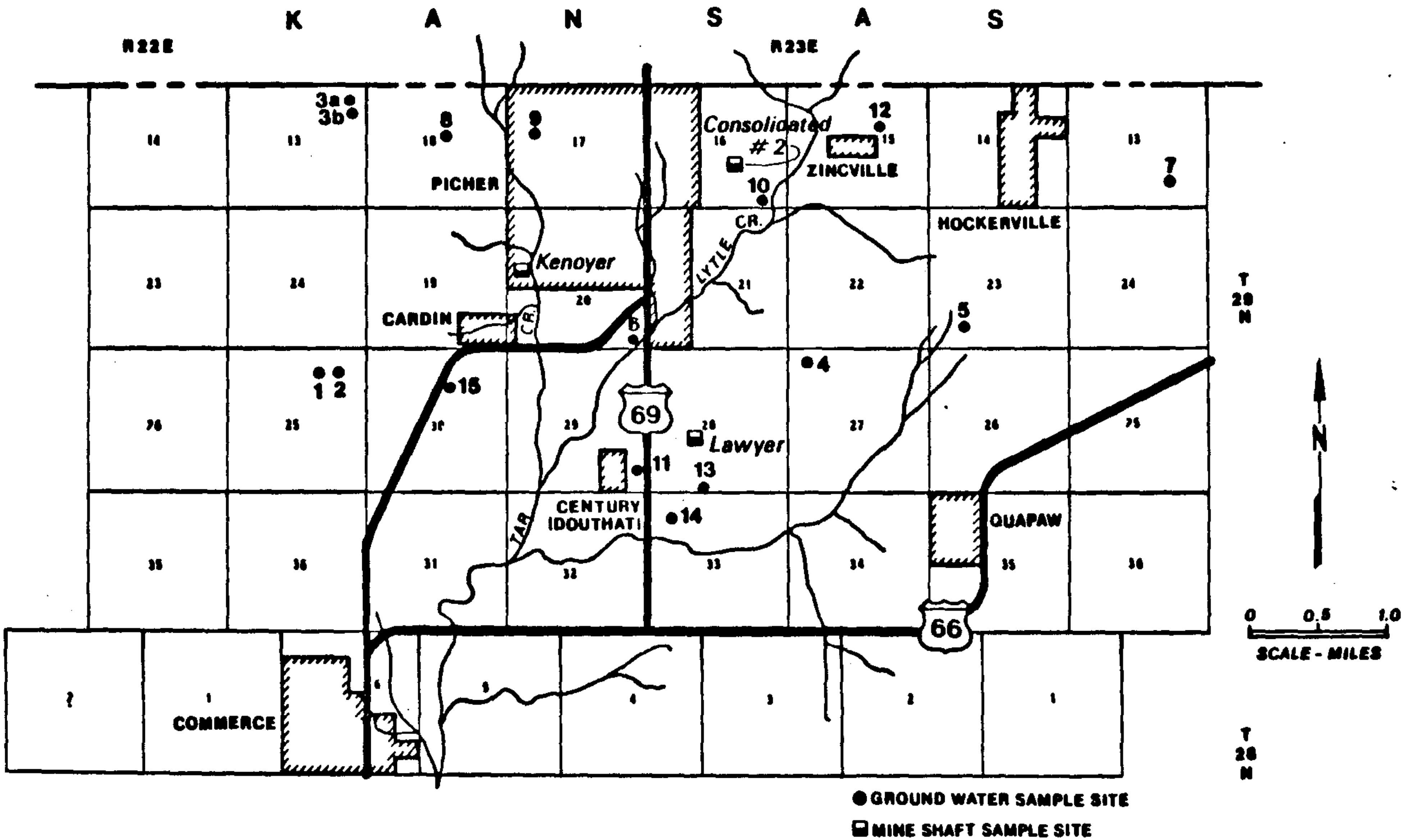
(1) No conclusions have been made as to the interconnection of the Cactus Mine, just southeast of Commerce, and the Picher Field workings. Recent data indicates water levels in the Cactus Mine are indentical to Blue Goose Mine water levels. Site 14 waters, across Highways 66 and 69 from the Cactus Mine, could

originate in this mine works, but dye studies necessary to determine the interconnection have not been implemented due to chemical problems between the acid mine water and the dye, and the overall cost of the dye. Likewise, confirmation of the interconnection of the Cactus Mine and the Blue Goose Mine faces similar problems, but on a larger scale.

(2) During this period of study, several subsidences occurred which were detected by field personnel. Rumbles were heard near the Lawyer Mine on March 26, 1981, and bubbles were seen rising from within the shaft's waters. Several subsidences were discovered throughout the study. One such subsidence which occurred just west of Lytle Creek above the confluence with Tar Creek, resulted in mine water discharge into Lytle Creek in late May.

(3) Mine shaft sampling at the Lawyer Mine often revealed mixing of the shaft's waters due to surface inflow into the shaft. On these occasions, dissolved oxygen levels would be homogenous throughout the shaft and would not exceed 1.0 mg/L. Consolidated #2 received subsurface water seeping from neighboring chat piles. The Kenoyer Mine was generally homogenous for D.O. at all samplings. This condition, along with minor pH flucuation, indicated the possibility of continual mixing within the shaft. One possible cause for this could be a connection between the inflow of Tar Creek in Kansas and the discharge of mine water from Site 14. These two phenomena could be interrelated, creating an underground flow in the western edge of the mine works.

Figure 2. Mine and groundwater sample sites of the Tar Creek Task Force in the Picher Mine Field, Ottawa County, Oklahoma.



APPENDIX A

TAR CREEK TASK FORCE

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**Co-chairman
*Technical Committee Member

APPENDIX B

WORK PLAN FOR
TAR CREEK-NEOSHO RIVER CONTAMNATION
FROM ABANDONED LEAD AND ZINC MINES

February 2, 1981

PHASE I
PROGRAM FOR DATA COLLECTION

Step I.

A monitoring system will be implemented to establish variations of flow and water quality of selected constituents. Sediment and benthos will be taken in the Neosho River.

The system will consist of selected sites on Tar Creek and the Neosho River.

Sites selected in Tar Creek are OWRB sites 4, 7 (if flowing), 10, and 20 (Central Blvd.), and in the Neosho River below its confluence with Tar Creek.

Parameters for Analyses:

[1, 2] Arsenic	)	
[1, 2] Chromium	)	due to drinking water maximum
[1, 2] Mercury	)	levels; to be measured in water
[1] Cadmium	)	and sediment.
[1] Fluoride	)	
[1] Lead	)	
[1] Iron	)	due to their high concentration;
[1] Zinc	)	to be measured in water and sediment.
Sulfate	)	due to decrease of water utility
Acidity-Alkalinity	)	for public use.
Dissolved Solids	)	
[1, 2] Aluminum	)	
[1, 2] Nickel	)	due to their probability of being
[1, 2] Manganese	)	present and for background
[1, 2] Boron	)	reference.
[1, 2] Copper	)	

[3] pH
[3] Specific Conductance
[3] Dissolved Oxygen
[3] Temperature

[1] analyzed for in dissolved, suspended, and bottom material phase; dissolved metals must be filtered on site.

[2] measured at inception and completion of sampling program in water and bottom material.

[3] measured on site (field parameters)

Sampling Frequency:

Site 4: Biweekly (monthly in January and February) measurement of field parameters and collection of samples for measurement of water constituents.

Site 4 Above Confluence: Biweekly (monthly in January and February) measurement of field parameters and collection of samples for measurement of water constituents.

Site 7: On a monthly basis, measurement of water constituents and field parameters.

Site 10: Monthly measurement of flow, biweekly measurement of water constituents, and monthly collection of bottom material and benthos. Continuous monitoring for pH, temperature, dissolved oxygen, and specific conductance.

Site 14: Biweekly (monthly in January and February) measurement of field parameters and collection of samples for measurement of water constituents.

Site 20 (Central Blvd.): Continuous measurement of flow, pH, temperature, dissolved oxygen, and specific conductance. Biweekly (monthly in January and February) collection of samples for measurement of water constituents.

Neosho River: Approximate location between Tar Creek-Neosho River confluence and the Will Rogers Turnpike Bridge. Monthly measurement of field parameters and collection of samples for bottom material, benthos, and measurement of water constituents. Initiate with conductivity profile.

Roles and Responsibilities:

The USGS has installed continuous and partial-record monitoring stations at sites 10 and 20.

The OWRB will sample, maintain stations, and accomplish field tasks.

The OSDH will provide laboratory analyses.

As information is collected and variations are observed, the program will be altered to assure best information.

Step II.

Groundwater Investigation:

A. Direction of Flow

(1) Wells in the Boone formation have been located by OWRB records, well drillers records, and a house to house inventory. Appropriate drill holes in the Boone will be located by Eagle Picher maps and a ground-truth survey.

(2) Sites (wells) will be selected by technical committee to represent the area for data collection (optimum density, one well per quarter section to one well per section).

(3) Water level, pH, conductivity, and temperature will be collected in the field.

To be accomplished by OWRB with USGS assistance.

B. Quantity of Flow

A weir with a continuous recorder will be constructed below site 14 (artesian springs) to monitor the mine works discharge. A meteorological station will be constructed and maintained to record rainfall and evaporation rates in the area to allow assessment of the role of surface inflow.

To assure that discharge at site 14 orginiates within the mine works, flaorescent dye will be injected into the Blue Goose mine, three miles north of the springs. Samples will be taken periodically to allow fluorometric detection.

C. Groundwater Quality

As wells or sites are selected in step A-2, each well will be sampled for Na, Ca, K, Mg, Cl, SO_4, alkalinity (calcium carbonate, and bicarbonate), NO_3-NO_2, Zn, Cd, Pb, F, total Fe, Al, As, Ni, Mn, B, Cr, Cu, Hg, pH, temperature, and specific conductance.

To be performed by OWRB (collection), OSDH (analyses), and USGS (assistance).

D. Roubidoux Formation

Presently the USGS is investigating the Roubidoux and will coordinate its activities with the OWRB.

Step III.

Mine Water Quality:

Sampling will be initiated in three sites as previously investigated by the USGS (open file 78-294). This will be compared with the previous information to observe changes, if any, within the mine water (quality and stratification). If needed, additional investigation will be conducted.

A. Sampling Scheme:

Monthly samples will be taken at the following sites:

(1) Consolidated #2, SE¼, NW¼, SE¼, Section 16, Township 29N, Range 23E.

(2) Lawyer, NE¼, NW¼, SW¼, Section 28, Township 29N, Range 23E.

(3) Kenoyer, NE¼, NW¼, SW¼, Section 20, Township 29N, Range 23E.

(4) Blue Goose, SE¼, SW¼, SW¼, Section 30, Township 29N, Range 23E.

B. Field Recordings:

1. Distance readings will be taken between ground surface and water level in each mine shaft sampled.

2. Specific conductance, pH, temperature (°C), and D.O. will be measured at 20 foot intervals.

3. Readings will be taken of water level at recorder on Blue Goose well.

C. Mine Shaft Sampling:

1. Samples will be taken at the surface and bottom of each mine shaft with additional samples taken at depths displaying a D.O., pH, temperature or specific conductance gradient.

2. Constituents for lab analysis:

   a. Metals:

      Monthly: Cd, total Fe, Fe++ (ferrous iron), Pb, Zn

      At inception and upon final sampling: As, Cr, Hg, Al, Ni, Mn, Cu

   b. Chemical Quality:

      Fluoride, Total Dissolved Solids, Sulfate, Acidity-Alkalinity, Total Hardness = each month (Acidity will be measured if pH <8.3)

      If mine shaft samples appear turbid, total solids will be analyzed.

3. Samples will be taken on a one time basis for ICAP analysis for trace metals.

Step IV.

Biological Monitoring:

ODWC will perform study and/or coordinate with Fish and Wildlife Service to accomplish task without duplication.

A. Bio-accumulation

Laboratory analysis of fish from Tar Creek, Neosho River and Grand Lake will continue as need is determined by technical committee.

B. Chronic Effects

Sampling will be designed to evaluate the following possible sublethal impacts on fish and invertebrates:

1. Species density

2. Species diversity

3. Species distribution

EPA-Las Vegas is tentatively planning in situ biological assaying in Tar Creek by mid-1981.

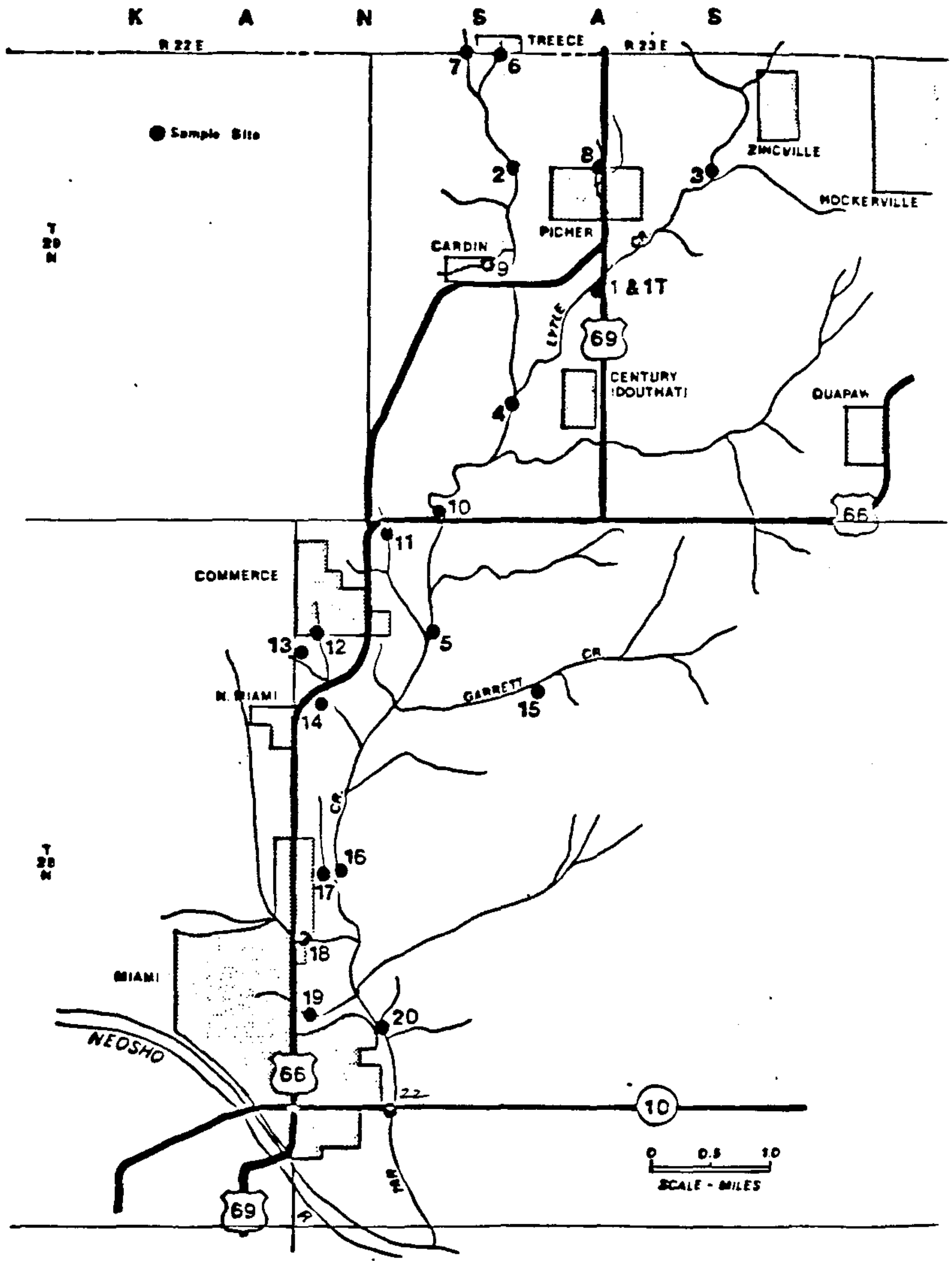

Figure 1. Sampling sites in Tar Creek drainage of Picher Mine Field.

PHASE II
PROGRAM FOR THE DETERMINATION OF CORRECTIVE ACTIONS

Step I.

Obtaining alternative Solutions to the Tar Creek - Neosho River Contamination Problem:

A. Decide upon the outputs required from the consultant to give the Task Force adequate information to assess alternative solutions (mid-January 1981).

B. Develop criteria which a consultant will be required to meet (mid-January 1981).

C. Determine funding available for the consulting work and time frame necessary (January 31, 1981).

D. Evaluate proposals and choose one (March 15, 1981).

E. Submit data to consultant (April 1, 1981).

F. Consultant will submit alternative solutions, their estimated cost, anticipated environmental impact, and an estimate of the time required to implement the solutions (September 30, 1981).

Step II.

Determination of the Best Alternative:

A. Alternative solutions obtained in Step I (September 30, 1981).

B. Numberical evaluations for alternatives to be presented in a ranking scheme.

C. Public input for decision making (November 30, 1981).

D. Funding sources available (November 30, 1981).

E. Allocation of costs (January 15, 1982).

F. Affected groups (those groups who wold pay for implementation of the approved solution) (January 15, 1982).

G. Designated management agency(s) (which would implement the solution) (January 15, 1982).

APPENDIX C

USGS-WRD
Form 9-1686-A
Rev. July 1975

U.S. GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

PROJECT DESCRIPTION - PART A

Project no. OK 80-058
Revision date ___/___/___ (yr mo day)
Proposal no. OK 80-E

(1) Project number A1A ◀ OK (State or region) 80 (FY) - 058 (Serial no.) ▶
Former Project no. ______ (If applicable)

(1a) Begins B6 ◀ 80/01 (yr mo) ▶ Ends B7 ◀ 82/12 (yr mo) ▶

(1b) (For MIS use only) A1 ◀ ▶ B8 ◀ ▶

(2) Project title A2 ◀ Geohydrology of the Roubidoux aquifer, northeastern Oklahoma ▶

(2a) Short title A2A ◀ (Do not exceed 35 spaces, use standard abbreviations) Roubidoux aquifer, OK ▶

(3) Region (For MIS use only) NR 4 SR 5 CR 6 WR 7 WD 0 A3 ◀ ▶

(4) Office (Project chief's headquarters) A4 ◀ 215 N.W. 3rd, Rm 621 ▶ (Street)
A4A ◀ Oklahoma City (City), OK (State (Alpha code)) ▶ A4B ◀ 73102 (Zip code) ▶

(5) Problem B1 ◀ Maximum and orderly development of ground water from the Roubidoux aquifer requires accurate knowledge of the quantity and quality of water available and the functioning of the hydrologic system; such information is not now available. Specific problems include: (1) potential over-development of the aquifer in the vicinity of the City of Miami, (2) potential contamination of the aquifer by toxic waters from the abandoned zinc mines a few hundred feet above the aquifer, and (3) excessive amounts of naturally-occurring radium in water from the aquifer in some areas. ▶

(6) Objectives B2 ◀ The objectives are to determine (1) availability of water from the aquifer and its suitability for municipal, domestic, and industrial supply, (2) extent of over-development and project the possible consequences of increasing stresses on the aquifer, (3) the hydrologic relationship between water in the aquifer and toxic waters in the abandoned zinc mines, and (4) extent and amount of radium in the water and its probable source. ▶

(7) Approach B3 ◀ (1) Standard geologic and hydrologic investigative techniques will be used to define the extent of the fresh-water part of the aquifer and its physical and hydraulic characteristics, (2) one or more models will be used to project the long-term effects of over-stressing the aquifer and to evaluate possible contamination by zinc-mine waters, and (3) collection and evaluation of chemical data to determine the extent and source of radium in the water. ▶

(8) Project chief C1 ◀ Fairchild (Last name), Roy (First name) W. (Initial) ▶

Codes: F = WRD; C - State; O Other Federal Agency; G - Other Div. of USGS

(8a) Soc. Sec. No. C3 ◀ 445 34 3523 ▶
(8b) Employer C4 ◀ F ▶

Approval date ___/___/___ (yr mo day)

______ Approved by (Signature)

APPENDIX D

PRELIMINARY BIOLOGICAL RECONNAISSANCE
OF
TAR CREEK

July 15-16, 1980

David Martinez

Field Report

Tar Creek was examined for aquatic life at 12 locations (Sites A-L). Tributaries to Tar Creek were checked at 5 additional locations (T-1 through T-5). Most sites were sampled for fish using portable shocking equipment (D,E,F); one and two-man seines (B,C,G,H,I,J,K,L and tributary sites). It was possible to use a small shocking boat at one site only (A). A number of fish were seen in the mouth of Tar Creek. Species observed included gizzard shad, Dorosoma cepedianum; carp, Cyprinus carpio; river carpsucker, Carpiodes carpio; flathead catfish, Pylodictis olivaris; and white crappie, Pomoxis annularis. Only unusual condition of fish observed was reddish ferrous oxide type material adhering to head and ventral fins (pelvic and pectoral) and within oral cavity of carp. Gills appeared normal, without unusual secretions of mucus, sediment material accumulations, discoloration, swelling or dehydration, or erosion. Most fish were small; crappie and shad <5", others <12-14". The most numerous species was shad. A small number of fish were preserved at Site A, representing all species observed except river carpsucker.

Site B and all other "upstream" sites exhibited limited fish and other aquatic life but comprised limited habitat at this time of year (mostly warm, shallow pools). Ferrous oxide deposits were visible at most sites. Small (YOY) Ictiobus sp. were found at Site B, as well as a few, very small bluegill (Lepomis macrochirus). The Ictiobus might be expected to have moved up into the creek from the Neosho River but bluegill have generally impressed me as not expressing this amount of mobility. I expect that these Lepomis were produced in Tar Creek or one of its tributaries this year. A small collection of fish was made at B. Insect life here, and for most upstream sites, is not well developed and consists mostly of corixids (water boatmen), gerrids and veliids (water striders), gyrinids (whirligigs) notonectids (backswimmers) and haliplids (crawling water beetles). Such forms are tolerant in being surface inhabitants or subsurface types which carry air bubbles with them. They are also very mobile forms and are typically the first to colonize previously decimated environments. Absence of strictly aquatic, gill-breathing forms is conspicuous; snails, crayfish,isopods, etc., should be here in numbers, with occasional odonates, mayflies, and caddisflies.

No fish life was found at Site C. Insect life was the same essentially as described for B. Shallow depth of the habitat is presently a limiting factor at this site.

Enriched conditions are again evident at J where Cardin lagoon discharges into Tar Creek. Because of low-flow conditions, a large pool formed at the point of discharge which consisted primarily of treated wastewater and extended upstream as well as downstream from the lagoon. Good growth of aquatic plants supported at bridge, where insect life (same forms as elsewhere) was also abundant. Gambusia affinis and Lepomis cyanellus, successful at bridge. Pools surrounded by low-lying areas, supporting stands of cattails. Riparian vegetation observed at downstream sites, mostly woody.

Long, deep, and narrow polls at K would appear to be good habitat, but aquatic life at this site was meager. No visible plankton was present, but should have been. Heavy growths of coontail and sedges were found in a dead and dying condition. Some of these along the shoreline were coated with a light-colored mineral material. Mineral deposits, otherwise not conspicuous at this site; bottom composed of small gravel, chat, and silt in loose bottom structure. Insect life was limited at K, consisting of beetles (Haliplidae, Gyrinidae, Hydrophilidae) and striders (Gerridae, Mesoveliidae). Crayfish and snail-life absent as elsewhere. Small numbers of Gambusia affinis and Lepomis cyanellus were the only fish life observed. Gambusia females with young were found at a very small size (< 1"). Rana pipiens and Natrix sipedon were also seen.

Site L sustains the best fish life at present for the sites examined except for the mouth of Tar Creek. The food base available at L is quite poor, however, and fish were obviously in a famished state. Fish species seen at L included topminnows, Fundulus notatus; mosquitofish, Gambusia affinis; golden shiner, Notemigonus crysoleucas; green sunfish, Lepomis cyanellus; bluegill, Lepomis macrochirus; and largemouth bass, Micropterus salmoides. The last of these species was seen only by personnel of the Oklahoma Water Resources Board; some specimens of all other species listed were collected. Ferrous oxide deposits were not prominent at this site.

Of the five tributary sites examined, three (T-1,T-4,&T-5) were completely dry. Another (T-3) contained a small amount of water covered with a heavy layer of oil, the latter likely to be associated with operations at Jones Diesel Service immediately N of the tributary. At the fifth site (T-2) water was plentiful and a small flow was detectable. Mosquitofish and bluegill sunfish were found at this site. In addition to the normal invertebrate forms noted elsewhere, numbers of crayfish, snails (Physa) and chironomids were present at this site. These forms were not encountered throughout Tar Creek.

Several different factors probably operate in the limitation of aquatic life observed at most sites in Tar Creek. Mineral

SITES EXAMINED FOR BIOLOGICAL CONDITIONS

Tar Creek Preliminary Survey

7-15 & 16 - 1980

A. Mouth of Tar Creek (From Mouth Upstream .25 Mi.)
B. Hwy 10 E. of Miami, N & S of Bridge
C. Road Crossing .25 Mi. N of Hwy 10, N & S of Bridge
D. Rockdale Ave. N of NEO College, N & S of Bridge
E. Low-Water Crossing SE of Torbert Park, S of High Power Lines N of crossing
F. NE 22nd St. Bridge and low-water bridge, N & S of Bridges
G. D St. E of Commerce, Border between sections 5 & 8, N of Bridge
H. Hwy 66-69 Bridge NE of Commerce, S. of Bridge
I. County Road E of Potter, 1 Mi N of Hwy 66-69, S of Bridge
J. County Road E of Cardin, S of Bridge
K. County Road W of Picher, 1 Mi S of OK-KS line, N of Bridge
L. County Road NW of Picher, at OK-KS line, N & S of low-water crossing
T-1. N. Elm St., 3/4 Mi. N. of Hwy 10
T-2. N. Elm St., 1/2 Mi. N. of Rockdale Ave.
T-3. NE. D St., S. of NE 9th
T-4. NE. 22nd St., W of Site F
T-5. Hwy 66-69, .3 Mi. S. of Commerce

If you have any questions or comments concerning these data feel free to call me at (FTS) 595-2382.

T. G. Miller

T. G. Miller
Research Biologist
Integrated Monitoring Systems Branch
Advanced Monitoring Systems Division

Enclosure