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OCCIDENTAL VERTICAL MODIFIED IN SITU PROCESS FOR THE RECOVERY OF OIL FROM OIL SHALE

Phase I, Quarterly Progress Report, November 1, 1978—January 31, 1979

MASTER

February 1979
Date Published

Work Performed Under Contract No. ET-78-C-03-1848

Occidental Oil Shale, Inc.
Grand Junction, Colorado

U. S. DEPARTMENT OF ENERGY

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OCCIDENTAL VERTICAL MODIFIED IN SITU PROCESS FOR THE RECOVERY OF OIL FROM OIL SHALE
Phase I

Quarterly Progress Report for the Period
November 1, 1978 through January 31, 1979

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C. L. L.

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I. INTRODUCTION

The Retort 6 operating conditions were steady for most of the quarter and oil production increased to an average three hundred barrels per day. Severe weather conditions caused numerous problems with steam and air injection to the retort as discussed in Section 1.1 for Retort 6. The construction activities centered on completion of the oil/water separation tank and installation of the off-gas condenser pilot plant.

The oil and gas analyses for the retort operation since start-up are included in the quarterly report. The process water analyses are part of the hydrology section of Appendix B, Environmental Data Analyses.

At the C-b Tract, the shaft sinking operation was begun at the Ventilation/ Escape Shaft on January 15, 1979. The construction activities continued in preparation for shaft sinking at the Production and Service Shafts.

II. LOGAN WASH

1. RETORT 6

1.1 Retorting

The retort operating conditions remained steady for most of the quarter. The total stack gas flow rate averaged 22,000 scfm and the off-gas temperature at the Product Level bulkhead slowly rose from 140°F to 165°F. By January 31, 1979, 26,420 barrels of oil and 33,735 barrels of water had been collected. Figure 1 illustrates the daily and accumulated oil production through January. During the quarter, 21,696 barrels of oil were purchased by DOE and shipped to Anvil Points for storage. The total oil shipped since Retort 6 start-up through January was 22,944 barrels.

On several occasions during the quarter, operations were temporarily hampered by steam plant outages or fluctuations totaling approximately 60 hours. These were caused by: steam plant instrumentation problems;

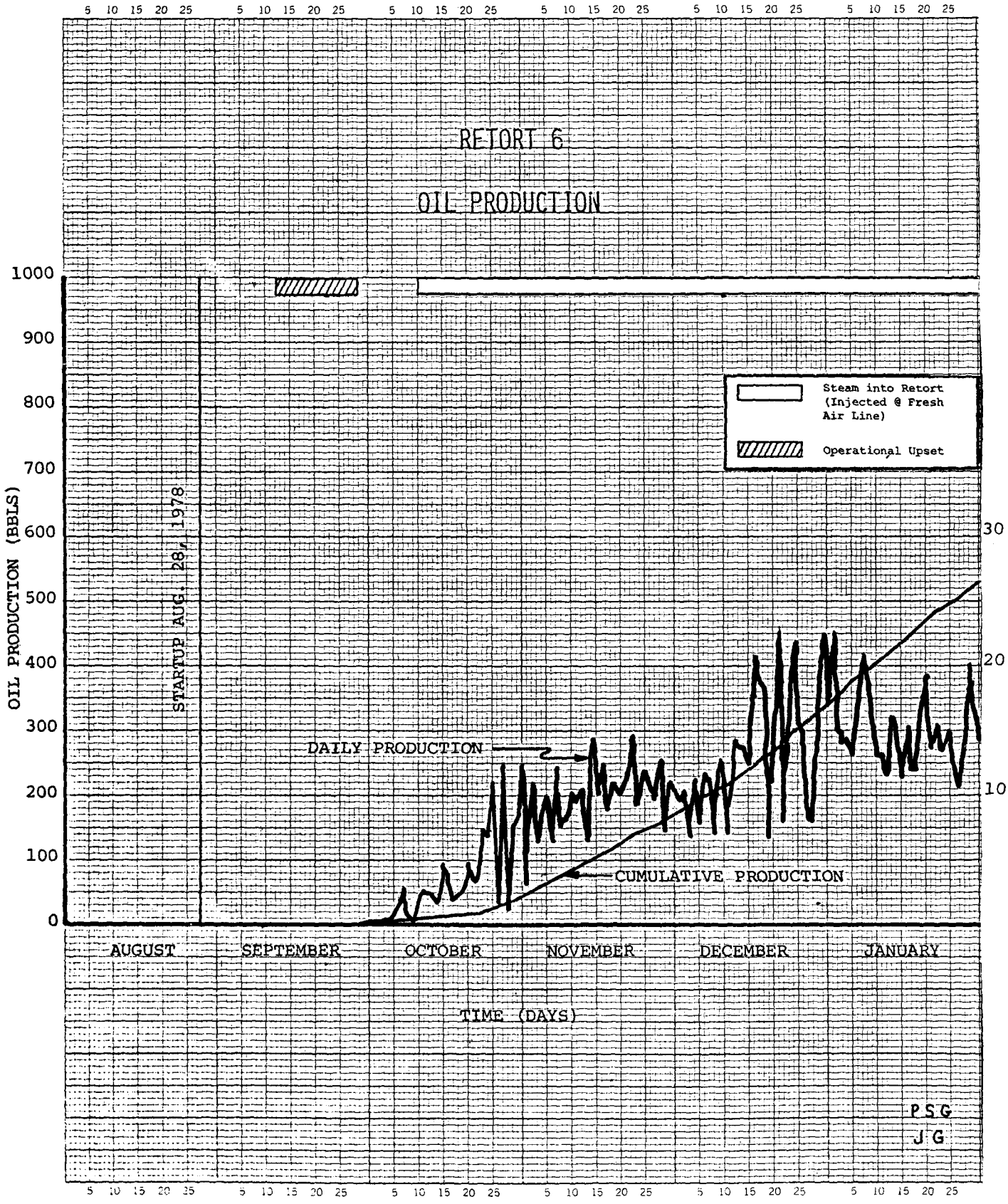


Figure 1. Oil Production

steam line gasket failure; power outages; fuel line blockages; water supply shortages; feedwater pump problems; and boiler descaling operations.

A planned steam plant outage was conducted for construction activities on the steam line at the Air Level bulkhead in early November. Advantage was taken of the downtime to perform miscellaneous maintenance jobs on the new boiler.

During the quarter, four additional krypton-85 tracer tests were run to determine if there had been any changes in gas flow patterns within the retort due to retorting. The data are being analyzed.

There were steam and air injection rate fluctuations during December. These were primarily due to reductions and outages of water and power caused by severe weather conditions. Early in December, freezing conditions caused problems with both steam plants because of fuel and feed water line freezing which resulted in abnormal retort operation. A heat tracing system, using steam as the medium, was installed on boiler piping for both plants to help prevent pipe freezing. On December 11th, design flow conditions to Retort 6 were re-established. On December 19th, an ice and wind storm caused a power outage on the Public Service Company distribution system to the mine. Several Public Service poles were down or damaged and three poles on the OXY distribution system were down. Public Service power was restored the evening of December 22nd and on the 23rd Retort 6 was again operating at design conditions. During the outage, the retort was operated on power supplied by the on site emergency power generation system. During this period, air injection to the retort was cut back to the limit of the emergency system.

Thermocouple measurements continued throughout the quarter. The Lower Intermediate Level thermocouples began showing a general temperature increase late in the quarter. The thermocouple almost directly under the Upper Intermediate Level area that had the initial temperature rise in late October, showed a greater temperature rise than the other thermocouples in January. The thermocouple data are presented in Appendix A along with illustrations of the thermocouple locations.

1.2 Analytical

The average daily off-gas analyses for Retort 6 from ignition, on August 28, 1978, through December 31, 1978, are listed on Tables I through IV. Measurements for carbonyl sulfide (COS), sulfur dioxide (SO_2) and ethane (C_2H_6) were taken, but the gases were undetected for most of the quarter and therefore not listed on these tables. (These will be presented in a subsequent report.) The percent of hydrogen, carbon monoxide, methane and carbon dioxide (from the tables) in the off-gas vs. time are plotted in Figures 2 through 5. Additionally, the dry off-gas flow rate, off-gas temperature and net heating value vs. time are plotted on Figures 6, 7 and 8. The start-up date and date when steam was introduced into the retort are noted on the plots. The upset conditions during September are represented by the peaks on the plots. Clearly, the curves show the return to normal conditions at the end of September.

Oil samples have been obtained at the oil load-out facility, Heater Treater area, for each 1000 barrels of production. The oil properties for the samples through the 20,000 barrel sample and the various ASTM methods used for the analyses are listed on Table V. OXY has observed that the pour points for Retort 6 oil samples have been changing with time. An extensive testing program is underway to determine the extent of and trends in the changes in pour point. Kinematic viscosity is also being investigated.

Since August 24th, four days before Retort 6 ignition, weekly water samples have been taken from behind the Product Level bulkhead and analyzed. The results of the process water analyses are included in the Environmental Support section along with the complete analyses of the samples collected at the Logan Wash area.

1.3 Construction Activities

The construction activities for the quarter centered on completion of the oil/water separation tank, Tank 6, and installation of the off-gas pilot plant facility.

OFF-GAS ANALYSES

August and September, 1978

Table I

DATE 1978	H_2	N_2	O_2	CO	CH_4	CO_2	$C_2^=$	C_2	$C_3^=$	C_3	IC_4	BUT-I	NC_4	C T	IC_5	NC_5	C_6	C_7	H_2S
	% Volume																		ppm
8-28	0	78.845	18.023	.044	0	2.114	0	0	0	0	0	0	0	0	.008	.012	.002	.015	--
8-29	.009	78.748	17.315	.195	.03	2.619	.018	0	0	0	0	0	0	0	.036	.030	.006	.045	--
8-30	.143	77.848	17.013	.261	.08	3.412	.034	0	0	.168	0	0	0	0	.003	.035	.006	.050	--
8-31	.823	75.873	15.610	.659	.205	5.621	.062	.046	.044	.215	0	.000	0	0	.035	.041	.005	.047	--
9-1	.862	75.680	14.790	.832	.279	6.638	.077	.038	0	.005	0	0	0	0	.005	.036	.002	.026	--
9-2	.796	76.434	11.560	.898	.310	8.830	.104	.047	0	.099	0	0	0	0	0	.032	.002	.025	--
9-3	.886	75.451	12.075	.815	.358	8.743	.150	.069	.106	.308	0	0	.001	.007	.025	.037	.002	.049	--
9-4	.941	75.168	12.725	.821	.331	8.409	.124	.072	.077	.359	0	0	.002	.009	.027	.033	.002	.039	--
9-5	1.165	74.254	11.179	1.119	.485	10.074	.206	.092	.117	.325	0	.007	.004	0	.024	.029	.002	.032	--
9-6	1.428	73.059	10.001	1.213	.521	12.107	.155	.100	.145	.254	0	.012	.008	0	.029	.030	.003	.039	--
9-7	1.624	73.766	8.653	1.410	.596	12.078	.206	.108	.143	.292	0	.013	.005	0	.002	.003	.004	.005	--
9-8	1.257	74.889	9.885	1.036	.434	10.858	.132	.090	.112	.385	.001	.007	.004	0	0	0	0	0	--
9-9	1.418	73.945	9.231	1.115	.488	12.057	.130	.104	.138	.432	.001	.013	.013	0	0	0	0	0	--
9-10	1.522	73.834	8.539	1.295	.530	12.650	.153	.111	.059	.379	.002	.015	.013	0	0	0	0	0	--
9-11	1.897	72.877	6.113	2.082	.703	14.516	.239	.126	.108	.340	.002	.022	.020	.001	.001	.001	.001	.001	--
9-12	2.353	71.102	4.418	2.138	.891	17.636	.269	.150	.072	.116	.002	.024	.023	.002	.002	.003	.003	.003	--
9-13	3.138	71.898	4.521	1.429	1.034	16.449	.249	.165	.077	.088	.002	.032	.034	.005	.002	.004	.004	.006	--
9-14	2.667	74.781	6.550	1.290	.837	12.387	.199	.106	.073	.044	.000	.012	.013	.000	.002	.003	.003	.005	--
9-15	4.566	71.593	2.385	2.531	1.649	14.974	.462	.146	.188	.077	.000	.018	.016	.018	.004	.001	.003	.004	--
9-16	5.158	69.839	1.852	3.133	1.920	16.282	.501	.158	.157	.075	.000	.019	.015	.013	.002	.003	.003	.004	--
9-17	4.801	71.244	1.141	2.419	1.896	16.584	.591	.180	.146	.073	.000	.028	.028	.003	.002	.004	.004	.004	--
9-18	5.182	71.149	.044	1.586	2.279	17.500	.868	.222	.159	.057	.001	.041	.050	.007	.002	.004	.003	.002	--
9-19	5.520	68.998	.079	2.089	2.308	18.796	.789	.237	.173	.053	.001	.044	.045	.013	.003	.004	.003	.002	--
9-20	6.503	66.403	.103	3.488	2.490	19.198	.553	.212	.152	.053	.000	.021	.008	.022	.003	.002	.003	.001	--
9-21	5.699	66.428	.079	3.280	2.417	19.697	.548	.205	.160	.051	.000	.027	.016	.000	.002	.008	.009	.004	--
9-22	5.750	67.363	.078	2.977	2.065	19.885	.667	.173	.169	.046	0	.018	.002	.009	.002	.007	.008	.003	--
9-23	5.354	67.619	.050	2.555	2.035	20.454	.679	.181	.121	.036	0	.018	.002	.021	.003	.005	.008	.004	--
9-24	5.611	67.404	.057	2.053	2.212	20.124	.722	.209	.166	.068	.000	.023	.003	.018	.003	.006	.008	.003	--
9-25	6.031	68.513	.426	2.104	2.251	18.607	.671	.250	.180	.080	.001	.031	.011	.021	.002	.006	.008	.003	--
9-26	5.179	70.340	.708	1.978	2.211	17.366	.707	.283	.179	.110	.004	.041	.022	.021	.004	.006	.008	.004	--
9-27	4.828	69.657	.446	1.927	2.007	18.227	.629	.301	.189	.125	.005	.047	.033	.008	.003	.008	.007	.004	--
9-28	4.419	67.336	.178	1.602	1.424	23.272	.355	.266	.125	.121	.007	.046	.036	.002	.002	.008	.005	.004	--
9-29	4.804	66.214	.134	1.114	1.285	24.801	.248	.239	.119	.129	.007	.046	.058	.011	.002	.005	.003	.005	--
9-30	5.165	64.293	.145	.970	1.218	26.629	.204	.226	.086	.104	.006	.043	.054	.009	.002	.006	.003	.005	--

OFF-GAS ANALYSES

October, 1978

Table II

DATE 1978	H_2	N_2	O_2	CO	CH_4	CO_2	$C_2^=$	C_2	$C_3^=$	C_3	IC_4	BUT-I	NC_4	C T	IC_5	NC_5	C_6	C_7	H_2S
	% Volume																		ppm
10-1	5.440	63.647	.039	.824	1.164	27.498	.181	.214	.076	.071	.001	.039	.052	.011	.002	.004	.001	.002	--
10-2	5.626	63.186	.033	.723	1.133	27.900	.156	.209	.077	.092	.001	.034	.051	.019	.004	.005	.001	0	--
10-3	5.671	62.962	.033	.662	1.131	28.322	.149	.208	.052	.059	.007	.036	.056	.020	.001	.004	.003	.002	--
10-4	5.694	62.801	.003	.514	1.115	28.555	.143	.201	.057	.062	.016	.037	.044	.008	.004	.005	.005	.006	--
10-5	5.866	62.452	.011	.484	1.100	28.773	.140	.197	.058	.069	.012	.033	.044	.002	.003	.004	.005	.004	--
10-6	6.129	62.401	.042	.458	1.127	28.546	.126	.192	.054	.086	.006	.026	.032	.013	.004	.008	.009	.005	--
10-7	6.565	61.177	.090	.443	1.166	29.315	.127	.185	.048	.068	.005	.025	.030	0	.004	.008	.008	.008	--
10-8	6.201	61.677	.086	.419	1.144	29.201	.121	.186	.055	.086	.006	.025	.031	0	.003	.007	.007	.007	--
10-9	6.336	61.171	.077	.389	1.155	28.462	.117	.184	.049	.071	.006	.024	.030	0	.004	.007	.005	.005	--
10-10	6.777	59.745	.092	.331	1.275	30.196	.135	.204	.059	.073	.006	.023	.035	0	.003	.006	.005	.006	--
10-11	6.027	60.539	.099	.337	1.238	30.495	.130	.198	.063	.069	.006	.020	.040	0	.003	.006	.006	.007	569
10-12	5.964	60.602	.096	.279	1.212	30.611	.114	.195	.052	.066	.006	.020	.039	0	.003	.006	.006	.006	--
10-13	6.009	60.008	.086	.256	1.214	31.196	.106	.193	.062	.071	.006	.020	.039	0	.003	.006	.007	.006	--
10-14	5.927	59.685	.093	.238	1.228	31.567	.105	.196	.062	.084	.006	.020	.039	0	.003	.005	.006	.007	--
10-15	5.824	59.593	.085	.227	1.203	31.861	.096	.191	.051	.061	.006	.019	.037	0	.003	.005	.006	.006	--
10-16	5.713	59.704	.076	.239	1.204	31.880	.095	.190	.057	.073	.006	.018	.036	0	.003	.006	.005	.006	--
10-17	5.662	59.639	.076	.232	1.193	31.771	.099	.183	.049	.070	.011	.018	.037	0	.002	.006	.005	.006	745
10-18	5.665	59.617	.112	.244	1.181	32.017	.094	.177	.045	.063	.006	.018	.036	0	.001	.007	.005	.005	--
10-19	5.546	59.809	.074	.231	1.186	32.141	.094	.175	.049	.064	.006	.018	.037	0	.003	.007	.005	.005	731
10-20	5.807	58.855	.117	.225	1.237	32.579	.099	.180	.060	.072	.006	.019	.037	0	.002	.008	.005	.004	760
10-21	5.914	58.470	.076	.203	1.258	32.760	.095	.178	.041	.054	.006	.019	.036	0	.002	.009	.006	.004	809
10-22	5.916	58.277	.072	.196	1.251	33.096	.090	.179	.041	.067	.007	.019	.037	0	.001	.007	.005	.003	809
10-23	5.825	57.943	.061	.190	1.239	33.279	.088	.175	.041	.055	.006	.016	.032	0	.003	.007	.004	.005	787
10-24	5.980	57.774	.061	.182	1.246	33.420	.084	.174	.029	.073	.006	.014	.024	0	.003	.005	.004	.002	816
10-25	5.453	58.326	.070	.181	1.177	32.988	.075	.207	.044	.062	.006	.017	.029	0	.002	.004	.004	.002	777
10-26	4.977	59.364	.052	.220	1.130	33.136	.075	.160	.050	.066	.006	.018	.034	0	.002	.004	.005	.002	754
10-27	5.783	56.833	.034	.193	1.253	34.805	.080	.173	.051	.068	.007	.020	.036	0	.001	.004	.004	.002	727
10-28	5.758	56.590	.039	.183	1.261	35.047	.078	.172	.049	.062	.007	.020	.036	0	.001	.004	.005	.002	767
10-29	5.575	57.130	.042	.174	1.236	34.420	.078	.171	.053	.070	.006	.019	.035	0	.001	.005	.005	.002	773
10-30	5.466	57.700	.044	.181	1.212	34.297	.076	.170	.050	.065	.005	.015	.028	0	.001	.002	.004	.001	786
10-31	5.618	57.290	.055	.180	1.232	34.413	.079	.172	.056	.065	.006	.018	.031	0	.001	.003	.007	.001	802

OFF-GAS ANALYSES

November, 1978

Table III

DATE 1978	H_2	N_2	O_2	CO	CH_4	CO_2	$C_2^=$	C_2	$C_3^=$	C_3	IC_4	BUT-I	NC_4	C T	IC_5	NC_5	C_6	C_7	H_2S
	% Volume																		PPM
11-1	5.566	57.330	.053	.203	1.223	34.549	.079	.172	.051	.065	.006	.019	.033	.002	.001	.003	.001	.002	785
11-2	5.130	58.430	.054	.204	1.183	33.916	.066	.165	.046	.066	.006	.018	.032	0	.001	.005	.004	.002	719
11-3	5.412	57.158	.081	.209	1.209	34.774	.068	.164	.046	.065	.006	.019	.034	0	.001	.004	.003	.001	638
11-4	5.315	57.482	.104	.217	1.189	34.585	.068	.166	.043	.058	.008	.021	.035	.001	.002	.005	.004	.001	767
11-5	5.340	57.249	.187	.233	1.211	34.830	.070	.166	.044	.061	.007	.021	.037	0	.002	.004	.006	.001	780
11-6	5.129	57.461	.077	.242	1.188	34.779	.072	.164	.053	.069	.007	.022	.038	0	.001	.005	.003	.001	722
11-7	5.145	57.194	.069	.261	1.165	35.031	.066	.161	.049	.069	.007	.021	.034	0	.001	.005	.002	.001	770
11-8	5.408	56.532	.087	.259	1.172	35.422	.067	.162	.041	.062	.007	.022	.039	.004	.002	.005	.003	.002	855
11-9	5.272	56.639	.054	.265	1.157	35.509	.069	.162	.048	.065	.007	.023	.039	0	.002	.005	.005	.002	851
11-10	5.241	57.019	.049	.260	1.147	35.191	.070	.161	.049	.066	.006	.020	.034	0	.001	.005	.006	.002	866
11-11	5.439	56.653	.030	.253	1.157	35.474	.068	.163	.047	.062	.005	.018	.032	0	.001	.004	.003	.002	887
11-12	5.072	57.916	.044	.253	1.103	34.527	.064	.159	.047	.057	.004	.018	.032	0	.001	.004	.006	.001	862
11-13	5.329	56.432	.043	.247	1.108	35.779	.065	.159	.046	.063	.006	.018	.032	0	.001	.004	.003	.002	823
11-14	5.436	56.216	.143	.247	1.129	35.710	.066	.160	.048	.067	.005	.022	.046	.001	.002	.004	.002	.002	818
11-15	5.426	56.173	.067	.246	1.116	35.901	.063	.158	.048	.066	.005	.018	.043	0	.002	.003	.002	.003	839
11-16	5.227	56.748	.105	.248	1.094	35.499	.063	.156	.049	.067	.005	.018	.043	0	.001	.004	.002	.003	814
11-17	5.258	56.706	.052	.257	1.090	35.571	.060	.155	.047	.067	.005	.018	.043	0	.001	.004	.002	.003	809
11-18	5.171	56.980	.075	.269	1.080	35.343	.059	.154	.042	.068	.006	.021	.050	0	.003	.005	.002	.004	786
11-19	5.226	56.620	.067	.236	1.092	35.639	.062	.157	.047	.064	.006	.022	.053	0	.002	.006	.001	.004	796
11-20	5.275	56.418	.054	.296	1.107	35.742	.064	.158	.047	.019	.007	.025	.060	0	.002	.006	.004	.004	789
11-21	5.341	56.225	.041	.303	1.133	35.847	.066	.163	.048	.069	.007	.024	.058	0	.001	.007	.002	.005	791
11-22	5.379	56.817	.045	.289	1.153	35.195	.067	.164	.030	.066	.007	.026	.062	0	.002	.007	.002	.005	851
11-23	5.446	56.504	.040	.295	1.152	35.410	.071	.164	.052	.067	.007	.027	.064	0	.001	.007	.004	.004	843
11-24	5.463	56.280	.046	.297	1.151	35.644	.075	.165	.051	.064	.007	.027	.064	0	.002	.006	.003	.004	850
11-25	5.389	56.228	.034	.306	1.140	35.801	.073	.164	.049	.064	.006	.023	.055	0	.002	.006	.003	.004	875
11-26	5.304	56.448	.029	.312	1.134	35.648	.074	.162	.052	.065	.005	.020	.047	0	.002	.005	.003	.004	884
11-27	5.485	56.012	.024	.326	1.155	35.905	.078	.164	.055	.069	.005	.020	.047	0	.001	.005	.002	.003	*
11-28	5.652	55.863	.027	.334	1.185	35.830	.080	.169	.055	.067	.005	.020	.049	0	.001	.004	.002	.003	924
11-29	5.664	56.304	.034	.336	1.194	35.343	.077	.171	.056	.072	.005	.020	.050	.009	.001	.004	.002	.003	952
11-30	5.287	57.988	.045	.392	1.156	34.030	.075	.165	.052	.066	.004	.019	.049	.003	.001	.003	.001	.001	*

* Equipment malfunction, no data.

OFF-GAS ANALYSES

December, 1978

Table IV

Date	H_2	N_2	O_2	CO	CH_4	CO_2	$C_2^=$	C_2	$C_3^=$	C_3	IC_4	BUT-I	NC_4	C T	IC_5	NC_5	C_6	C_7	H_2S
1978	% Volume																		PPM
12-1	5.490	57.372	.020	.402	1.186	34.430	.075	.169	.051	.068	.004	.021	.055	.005	.002	.003	.001	.001	940
12-2	5.516	57.293	.161	.420	1.231	34.287	.083	.173	.058	.060	.005	.022	.056	.005	.003	.002	.001	.001	912
12-3	5.710	56.940	.032	.464	1.259	34.291	.088	.180	.057	.071	.004	.020	.053	.004	.002	.002	.001	.001	*
12-4	5.964	56.683	.060	.492	1.304	34.332	.089	.188	.061	.075	.005	.023	.058	.005	.002	.003	.001	.002	984
12-5	6.017	56.590	.115	.527	1.293	34.275	.091	.188	.063	.076	.005	.023	.060	.005	.001	.003	.001	.002	829
12-6	5.921	56.625	.118	.544	1.268	34.272	.088	.186	.060	.074	.005	.025	.065	.005	.001	.003	.001	.002	*
12-7	5.871	56.814	.031	.552	1.222	34.350	.082	.182	.059	.074	.005	.025	.067	.005	.002	.005	.001	.001	964
12-8	5.501	57.858	.028	.578	1.183	33.755	.077	.177	.057	.073	.006	.024	.066	.005	.002	.004	.001	.001	926
12-9	4.837	59.169	.051	.769	1.100	32.828	.076	.170	.055	.070	.005	.025	.067	.005	.002	.003	.001	.002	839
12-10	5.536	56.589	.090	.728	1.179	34.641	.078	.178	.059	.074	.006	.027	.072	.005	.002	.005	.001	.002	890
12-11	5.912	55.953	.080	.677	1.244	34.955	.083	.186	.060	.078	.006	.028	.075	.006	.001	.003	.001	.002	*
12-12	6.148	55.688	.071	.682	1.272	35.017	.081	.191	.059	.074	.006	.022	.055	.005	.001	.003	.001	0	973
12-13	6.615	54.939	.082	.624	1.327	35.283	.084	.200	.155	.087	.008	.028	.063	.003	.001	.001	.001	.001	982
12-14	6.453	55.435	.134	.626	1.332	34.681	.089	.209	.151	.111	.013	.038	.068	0	0	0	0	0	1008
12-15	6.810	55.249	.111	.630	1.378	34.637	.084	.216	.063	.081	.010	.034	.055	.005	.003	.004	.001	.002	1025
12-16	6.909	54.693	.081	.642	1.397	34.290	.087	.223	.061	.042	.011	.034	.048	.005	.005	.002	.002	.002	1070
12-17	7.209	54.538	.093	.700	1.440	34.821	.095	.235	.080	.068	.006	.019	.027	.001	.006	.006	.001	0	1083
12-18	7.735	53.704	.028	.704	1.501	35.088	.091	.246	.072	.098	.012	.037	.047	.007	.003	.005	.002	.002	1236
12-19	7.686	55.086	.090	.670	1.443	33.736	.088	.233	.067	.089	.017	.047	.059	.007	.002	.005	.001	.001	*
12-20	8.390	55.119	.007	.300	1.771	32.835	.072	.210	.068	.165	.015	.040	.040	.006	.003	.005	.003	.002	645
12-21	8.166	55.010	.020	.316	1.754	33.501	.073	.207	.071	.110	.019	.043	.035	.005	.003	.007	.003	.002	665
12-22	8.231	55.352	.049	.319	1.627	33.221	.071	.201	.067	.103	.013	.033	.042	.003	.002	.006	.003	.002	727
12-23	7.079	58.055	.050	.533	1.238	31.906	.064	.168	.055	.079	.009	.032	.043	.003	.002	.004	.002	.001	603
12-24	7.248	56.105	.038	.608	1.324	33.523	.076	.181	.062	.087	.011	.040	.052	.007	.002	.003	.002	.001	517
12-25	7.333	55.192	.026	.622	1.411	34.260	.084	.191	.065	.087	.013	.043	.057	.006	.002	.004	.001	.001	540
12-26	7.969	58.814	.037	.638	1.376	33.969	.084	.190	.063	.086	.015	.043	.044	.006	.004	.004	.004	.001	540
12-27	7.806	54.690	.044	.564	1.427	34.263	.080	.197	.067	.094	.012	.038	.051	.005	.002	.006	.001	.002	637
12-28	7.564	55.315	.033	.555	1.394	33.978	.077	.194	.064	.092	.012	.036	.047	.005	.002	.006	.001	.001	710
12-29	6.719	57.675	.035	.670	1.312	32.376	.074	.186	.070	.092	.011	.033	.045	.004	.002	.006	.002	.001	650
12-30	7.317	55.452	.027	.643	1.369	34.021	.073	.192	.061	.090	.011	.031	.044	.004	.002	.005	.002	.001	661
12-31	7.254	55.727	.044	.625	1.378	33.763	.072	.194	.062	.094	.013	.036	.049	.004	.004	.005	.003	.001	580

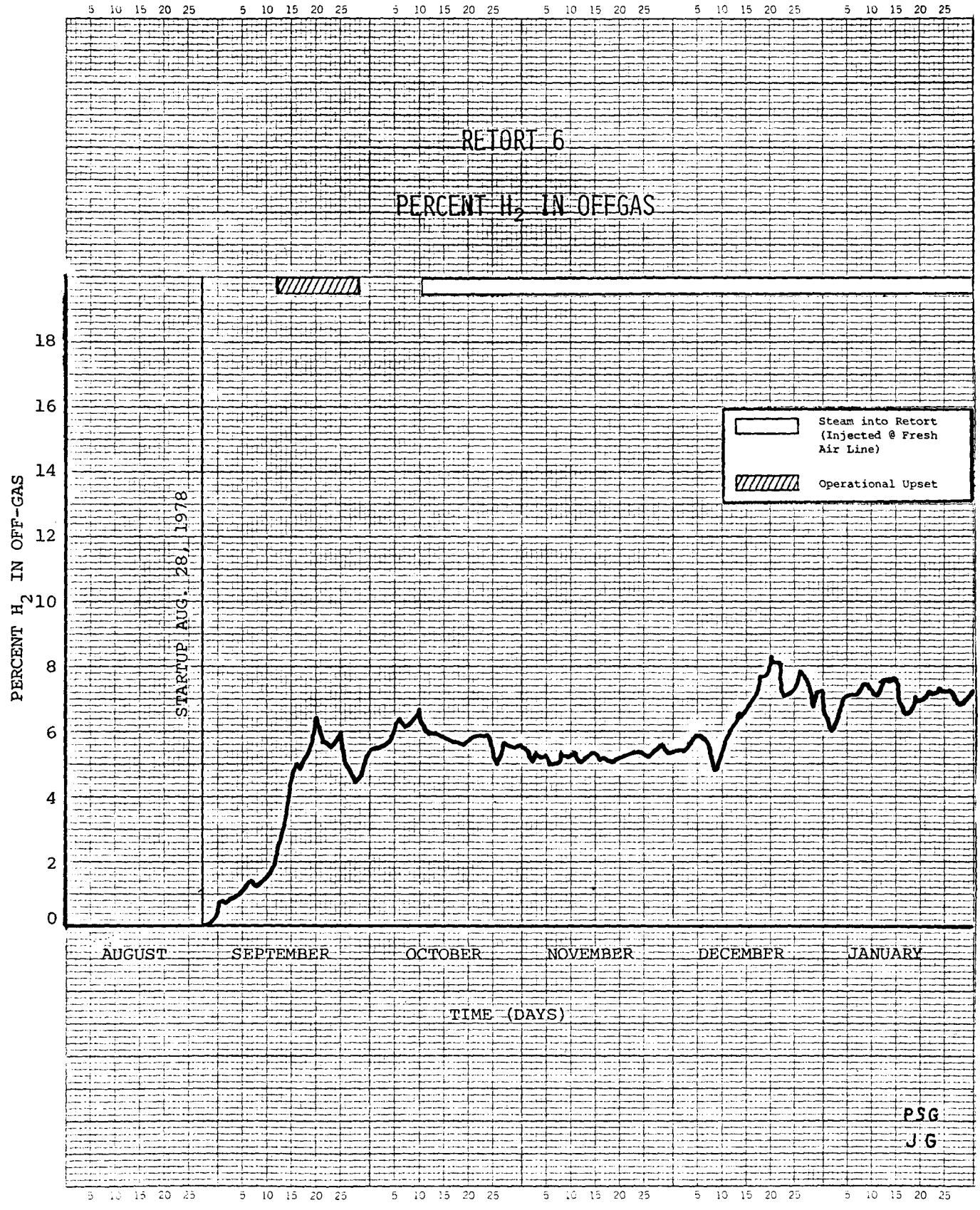


Figure 2. Percent hydrogen in off-gas.

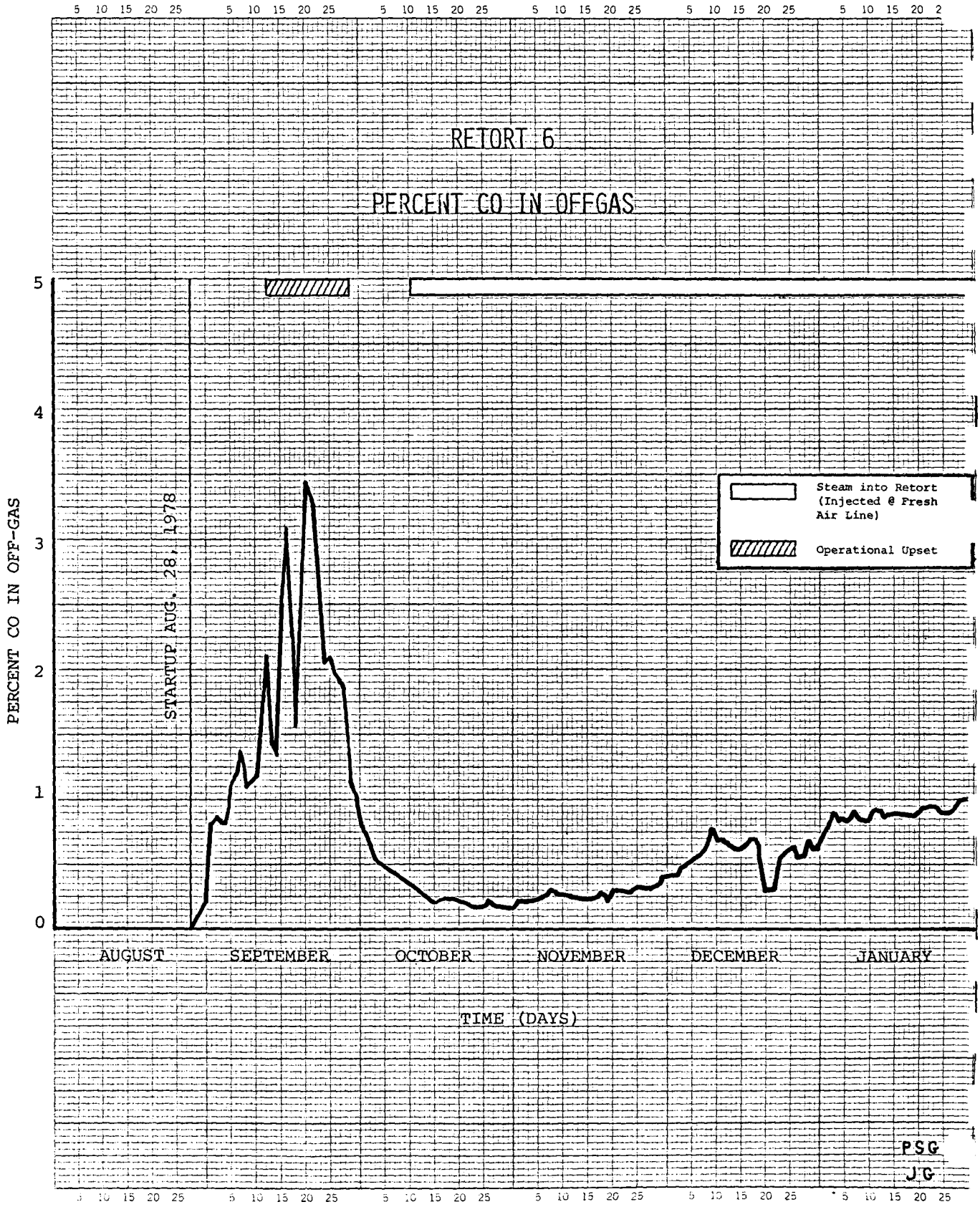


Figure 3. Percent carbon monoxide in off-gas.

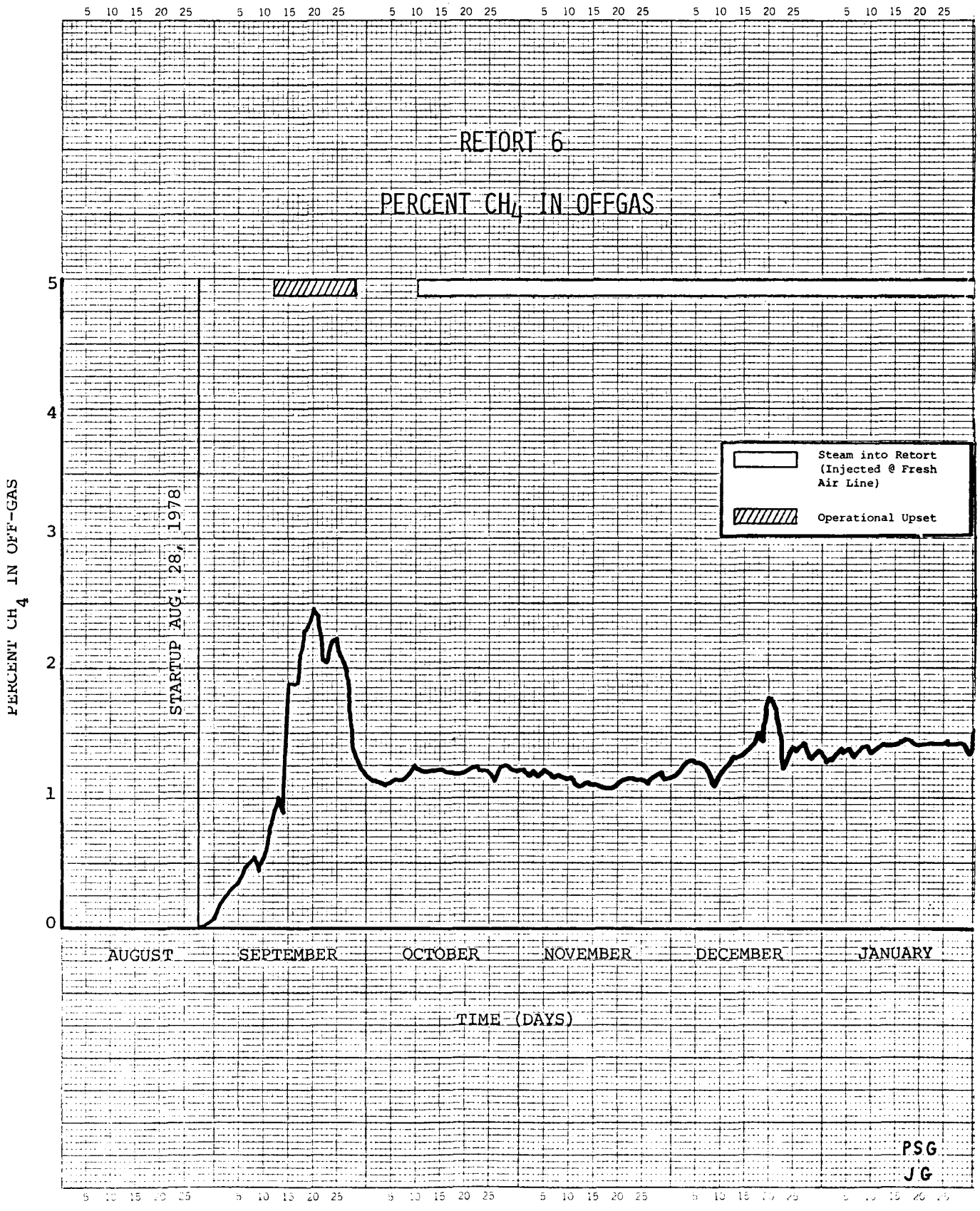


Figure 4. Percent methane in off-gas.

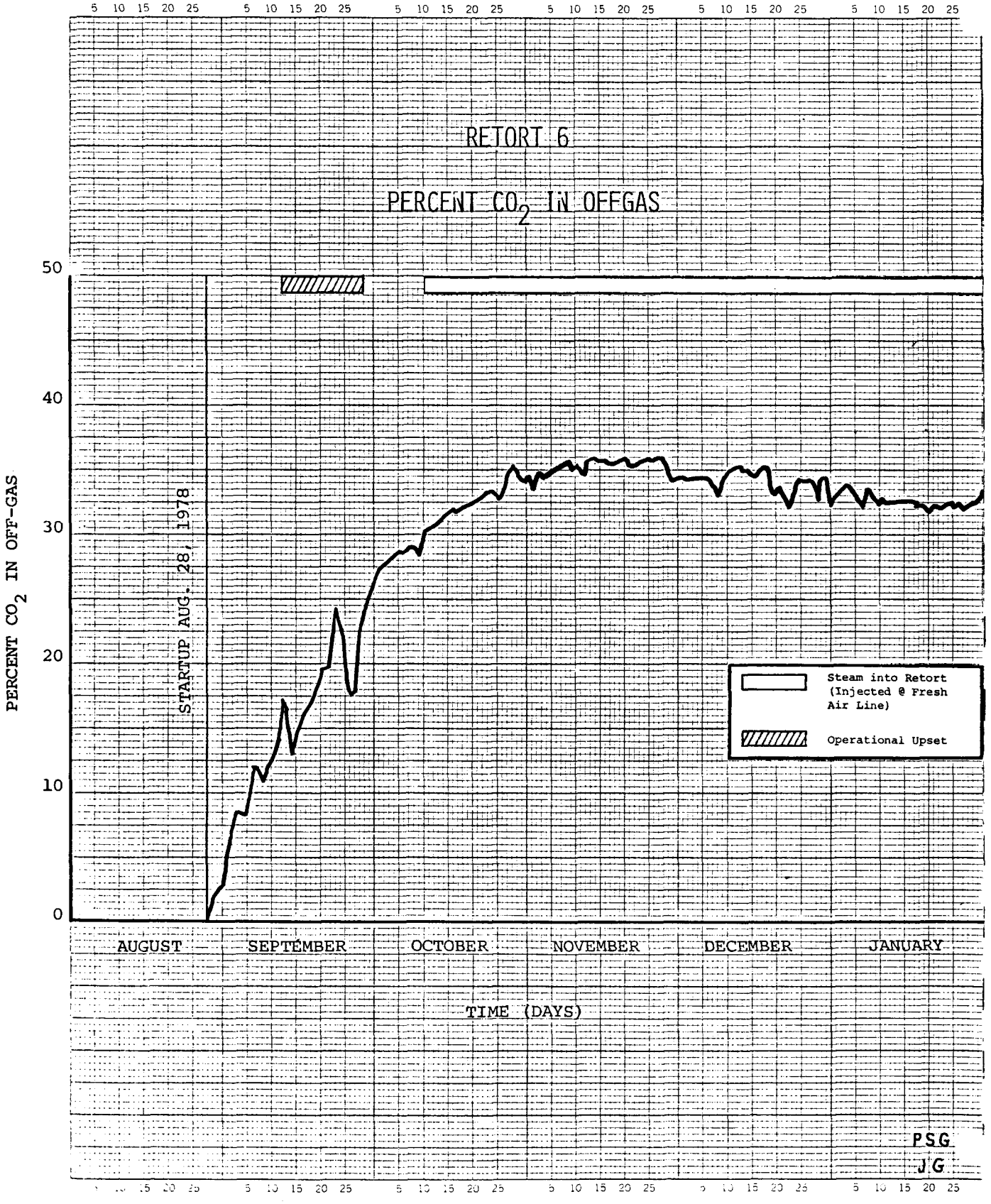


Figure 5. Percent carbon dioxide in off-gas.

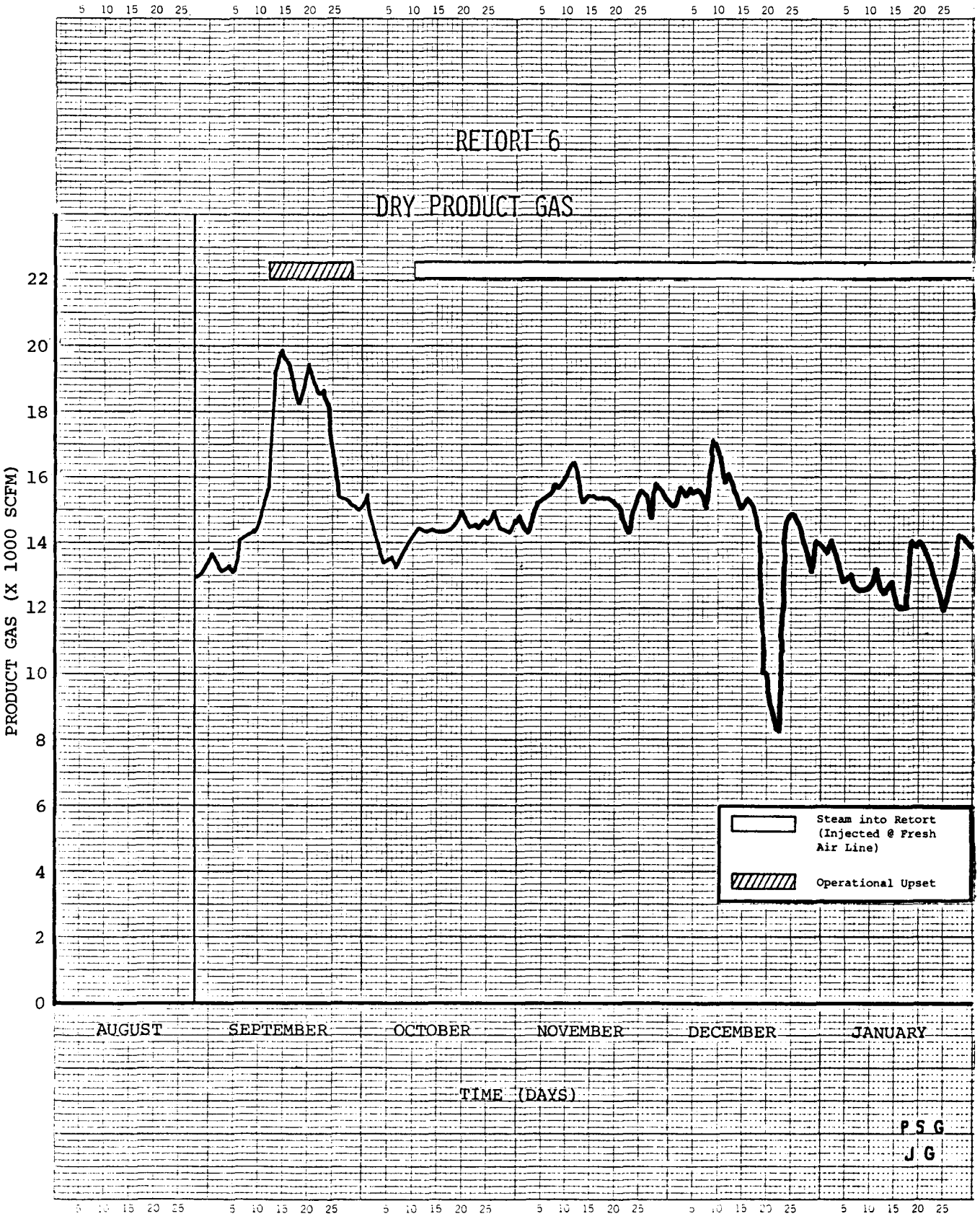
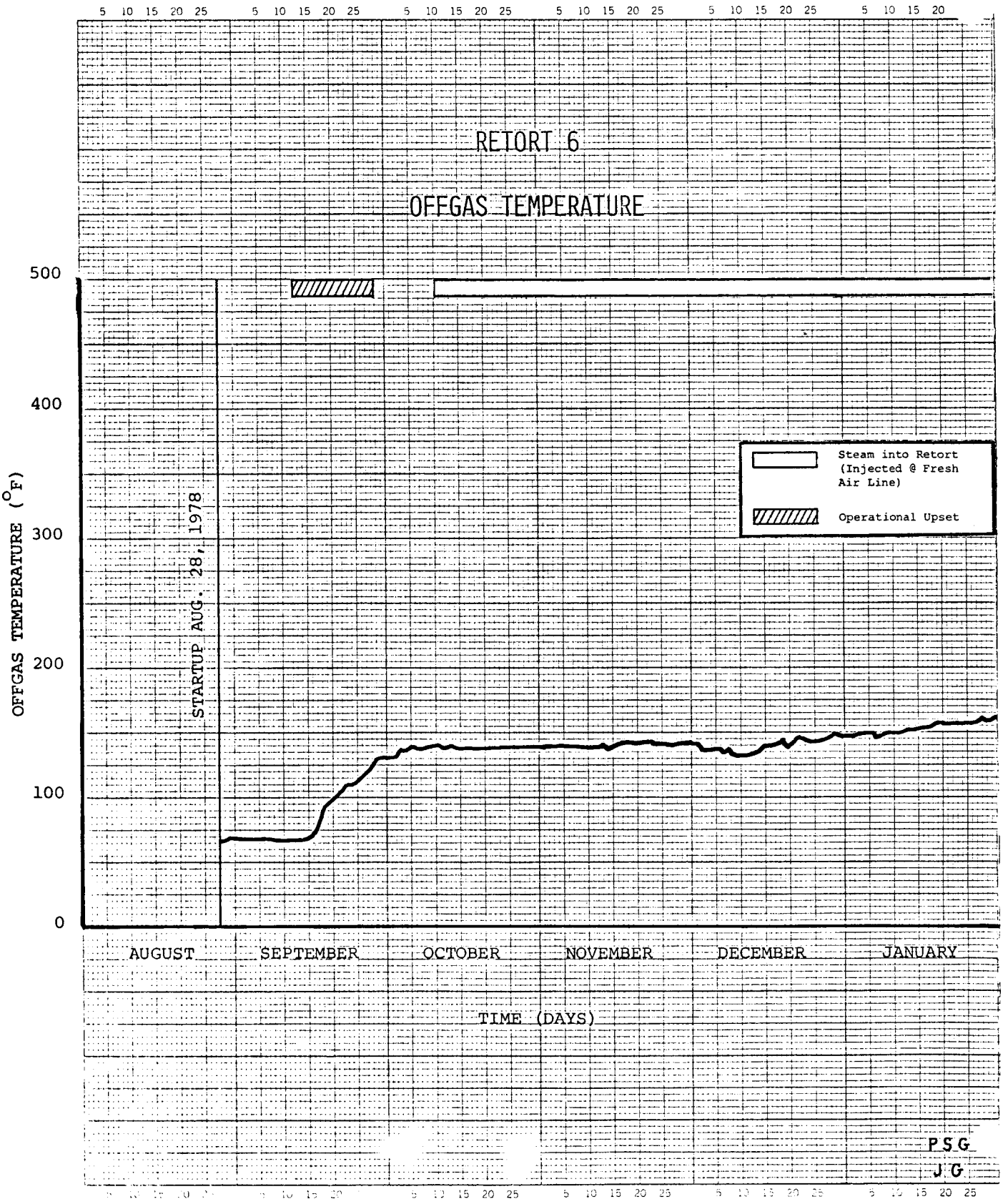


Figure 6. Dry off-gas flow rate.



igure 7. Off-gas temperature.

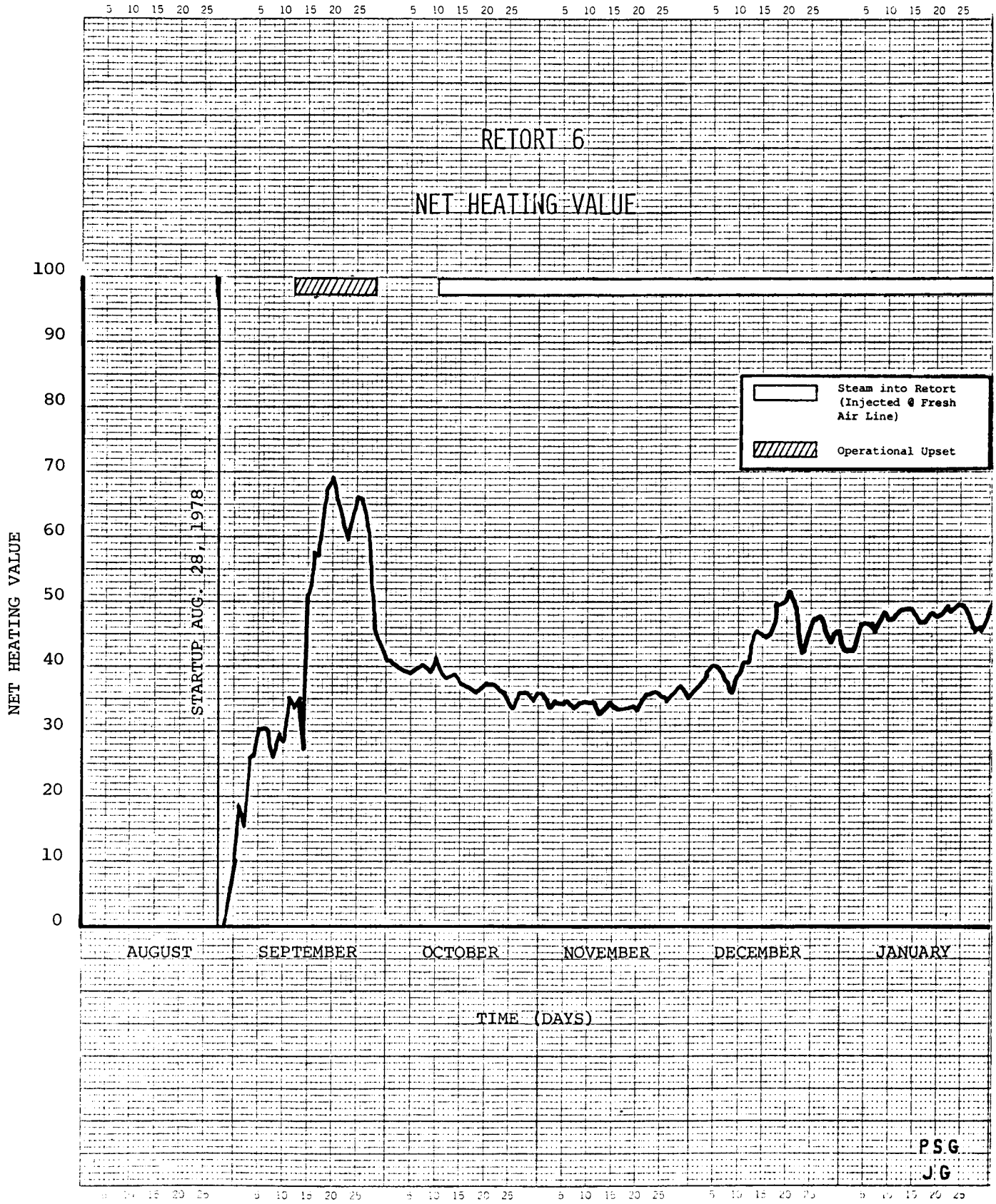


Figure 8. Net heating value.

RETORT 6 HEATER TREATER OIL ANALYSES

TABLE V

TEST	BS & W %	API GRAVITY 60°F	POUR POINT * °F	KINEMATIC VISCOSITY 100°F cST	CLEVELAND OPEN CUP FLASH & FIRE °F	PENSKY MARTIN FLASH POINT °F	SULFUR %	HEATING VALUE BTU/lb	ASPHALTENE %	NITROGEN %
Reference / Sample	ASTM-D-96-23	ASTM-D-1298-23	ASTM-D-97-23	ASTM-D-445-23	ASTM-D-92-23	ASTM-D-93-23	ASTM-D-129-23	ASTM-D-240-23	UOP-614-68	ASTM-D-3228-25
1,000 Bbl	Sample emulsion could not be broken; lab unable to determine oil properties									
2,000 Bbl	0.2	23.1	0	27.47	Flash 225 Fire 235	202	0.72	18,800	0.28	1.10
3,000 Bbl	0.2	23.4	5	27.58	Flash 220 Fire 240	208	0.65	18,700	0.68	0.98
4,000 Bbl	0.2	22.5	5	31.61	Flash 235 Fire 245	208	0.63	18,500	0.29	1.14
5,000 Bbl	0.2	22.2	10	37.75	Flash 235 Fire 250	204	0.58	18,700	0.26	1.21
6,000 Bbl	0.2	22.0	0	41.02	Flash 230 Fire 250	212	0.67	18,800	0.52	1.18
7,000 Bbl	0.1	22.1	5	44.38	Flash 230 Fire 250	215	0.55	18,900	0.59	1.42
8,000 Bbl	0.3	22.7	10	46.41	Flash 230 Fire 250	211	0.53	18,800	0.40	1.36
9,000 Bbl	0.1	22.4	5	43.72	Flash 230 Fire 225	216	0.55	18,700	0.32	1.36
10,000 Bbl	0.3	22.9	60	44.08	Flash 235 Fire 225	216	0.49	18,900	0.34	1.40
11,000 Bbl	0.1	23.4	40	39.48	Flash 220 Fire 245	194	0.54	18,700	0.52	1.52
12,000 Bbl	0.2	22.6	35	40.33	Flash 220 Fire 240	192	0.47	18,800	0.53	1.43
13,000 Bbl	0.1	23.0	45	35.49	Flash 225 Fire 240	191	0.42	19,000	0.53	1.45
14,000 Bbl	0.2	22.8	55	43.70	Flash 220 Fire 235	193	0.51	18,500	0.26	1.47
15,000 Bbl	0.3	23.3	60	39.17	Flash 220 Fire 230	185	0.45	18,800	0.53	1.44
16,000 Bbl	0.1	23.2	55	41.72	Flash 215 Fire 235	187	0.39	18,800	0.57	1.43
17,000 Bbl	0.1	23.5	60	39.73	Flash 220 Fire 235	188	0.38	18,900	0.56	1.44
18,000 Bbl	0.2	23.9	75	37.06	Flash 220 Fire 235	192	0.49	18,800	0.30	1.44
19,000 Bbl	0.1	23.8	70	33.18	Flash 225 Fire 240	194	0.48	18,800	0.24	1.45
20,000 Bbl	0.1	24.1	75	33.33	Flash 225 Fire 235	200	0.54	18,500	0.33	1.44

*C[illegible]es in pour point being investigated.

The construction accomplishments for the quarter were:

- The foundations for the major equipment for the off-gas pilot plant were poured; the equipment, contact condenser, hold-up tank, fin-fan cooler, and smog hog were installed; installation and testing of the piping was completed; and installation of the instrumentation was started.
- Completed construction of the oil/water separation tank, Tank 6, and insulated the tank. Began installation of protective covering over insulation.
- Sealed the manway raise at the Upper Intermediate Level with a grout plug, restoring vertical access to all levels except the Air Level using the original manway raise.
- Completed casing a 9" diameter hole for rerunning the main power feeder line into the mine. Ran the line into the mine but postponed the tie-in until February, 1979 in order to not interrupt the retort process.
- Installed and piped in a wet oil tank at the Heater Treater area to serve as an emulsion settling tank.
- Installed a permanent drain line from the off-gas piping drain taps at the surface so that the condensed water drains continuously and is piped to the process water tanks.
- An ice guard, to be located above the off-gas stack sampling platform to protect workers from ice falling from the top of the stack, was designed and issued for bids on fabrication.

1.4 Other Activities

The water sampling program for DOE was begun on January 11th with the first set of monthly samples taken and stored in the DOE supplied refrigerated trailer at the site. The samples will be taken monthly through the duration of the Retort 6 processing. Additionally, arrangements for DOE requested once only samples of oil and gas sampling were negotiated late in January.

In November, a transport company tanker truck, loaded with diesel fuel for delivery on site, ran off the road at the Heater Treater area spilling approximately 3800 gallons of fuel. Spill control measures were implemented using equipment and hay, stacked nearby, to contain the spill within 300 yards of the accident. There were no injuries. Clearance had been sought from the proper agencies to dispose of the saturated hay.

2. ENVIRONMENTAL SUPPORT

During the quarter, environmental monitoring continued on the Logan Wash site as specified in the Environmental Research Plan, which is part of the OXY/DOE Cooperative Agreement. This section presents highlights of the field activities and some limited analyses of the data. The environmental data, reported in Appendix B, are primarily a six month update of data presented in previous progress reports.

2.1 Field Activities

2.1.1 Air Quality

- The mechanical weather station, installed on October 10th near the Heater Treater plant, was inoperative for a short period while the batteries were changed.
- Snow, ice, and cold weather have caused malfunctions with wind speed and direction, acoustic radar sounding, rain gauge, and solar radiation instrumentation. Battery-powered mechanical devices are especially affected by extremely cold weather.

2.1.2 Hydrology

- Hydrologic monitoring of the D.A. Shale site and vicinity was increased both in number of sites and frequency of sampling.
- The ten observation wells drilled around the perimeter of Retort 6 prior to ignition are being sampled for water quality twice a month during retorting.
- Alluvial monitoring wells, drilled in Logan Wash and Bowdish Wash, are now sampled on a monthly basis.

2.1.3 Biology

- There was no field activity on flora or fauna surveys during the past quarter due to snow, ice and extreme cold. Normally field activities do not occur during the winter months.
- The report on the fauna survey conducted during the last field season will be included in the next quarterly report.

2.2 Environmental Data Analyses

Most of the data collected in the first half of the year have been reported in previous Quarterly Reports to DOE. Analyses presented in this report include:

1) For hydrology - Water quality samples of surface water and groundwater have been collected from 41 monitoring sites and analyzed for as many as 45 parameters since mid-August, 1978. Measurement of precipitation, temperature, evapotranspiration, and water levels in alluvial and bedrock wells were obtained to develop a hydrologic budget for the D. A. Shale Tract and vicinity.

2) For meteorology - Quarterly wind roses are presented for the meteorological tower and for the mechanical weather station. Inversion statistics for November and December are presented as probability of occurrence, expected duration, expected height, and peak values. Graphic presentation is used to show average and peak inversion heights in relation to elevations of key mine facilities.

3) For biology - There are no biological studies to report this quarter.

2.3 Societal Influences

The Development Guide for Rifle, Colorado, Appendix C, was funded by the C-b Shale Oil Venture as part of the management commitment to work closely and cooperatively with local communities and their citizenry. The threefold purpose of this guide is to provide the residents of Rifle with 1) a thorough inventory and analysis of existing community characteristics, 2) an assessment of existing facility and program needs, and 3) projections of changes in community characteristics and needs as a result of natural and rapid growth conditions.

It is hoped that the information in the guide will assist Rifle in its planning efforts so that the residents can design specific programs, seek funding, and generally better manage Rifle's growth.

3. SCHEDULE

Retort 6 processing is continuing and operating conditions are steady.

III. C-b TRACT

1. SHAFT SINKING

The major construction effort during the Quarter concentrated on preparation for shaft sinking operations. These activities included installation of: steel beams and floors in the Service Shaft Headframe, steel and concrete beams and floors in the Production Shaft Headframe, and sinking hoists and winches at all three shafts -- Production, Service and Ventilation/Escape (V/E). The V/E Shaft Headframe was enclosed in December; guides were installed; and clean-up work begun. In early January, the hoist was prepared for commissioning and inspected by MSHA as a courtesy inspection.

On Monday, January 15th, the shaft sinking operation was begun at the V/E Shaft. Good progress was made during the balance of January, and by the end of the month, 133 feet of excavation and 123 feet of concrete lining had been completed.

2. CONSTRUCTION ACTIVITIES

In addition to the construction discussed above, construction of support facilities continued. This work involved: construction of a natural gas line and metering station; installation of an electrical generating plant for shaft sinking; winterization of the concrete batch plant; installation of fencing at the security building area and at the Service Shaft Air Inlet Tunnel; clearing areas for and beginning construction of two water ponds in the V/E area; construction of an access road and pipeline from the V/E Shaft to the ponds; and installation of various facilities required for shaft sinking on the Service and Production Shafts.

3. ENVIRONMENTAL SUPPORT

The data collected throughout the past year at the C-b Tract will be presented in an annual report scheduled for release in April, 1979. The dis-

cussions in subsections 3.1 through 3.3 summarize the data collection activities for November, 1978 through January, 1979.

3.1 Air Quality

- A performance evaluation of the data acquisition systems for the two air quality monitoring stations was begun in November. System failures and improper recording problems experienced during the debugging phase persisted into December. The systems were repaired and put back into service in January and the evaluation program was resumed.
- Experiments were conducted to determine particulate size distribution of C-b mine run rock for air dispersion modeling.
- A new mechanical weather station was installed and has been operating satisfactorily.
- An EPA Quarterly audit was performed. All gaseous instruments were operating satisfactorily. An unexpected shift in the NO_x reading occurred during the audit which was not found during the followup multipoint calibration.
- Routine monitoring was continued.

3.2 Hydrology

- In November, a well swabbing program to obtain water samples was completed.
- Routine monitoring of alluvial wells, deep wells and springs for water quality and quantity was conducted.

3.3 Biology

- In November, a deer sex ratio study was performed to assess the deer population trends in the C-b Tract vicinity. During the quarter, deer road counts, for showing the deer distribution along the Piceance Creek highway; and deer road mortality counts, to aid in determining the impact of increased traffic on deer, were conducted. In January, observations were made on the deer and elk distribution on Tract and to the South.
- Seeding was completed on disturbed areas to initiate the reclamation program. Some sixty cages were put on recent transplants.
- Data were collected from microclimatic stations, with snow measurements, to aid in defining changes which affect plant growth and wildlife populations.

- In January, an outside consultant was contracted to evaluate and report on the biological productivity of Piceance Creek.

IV. MARKETING

The study conducted by Pace Engineering on the refining characteristics of shale oil was completed. The report on the study is in Appendix D.

The Pace report "Shale Oil Refining Analyses" examines the refining characteristics of Occidental's shale oil when processed in conjunction with crude oil in a refinery typical of those located in the Rocky Mountain Region. The main objective of the study was to define the areas where the refining economics are particularly sensitive to costs, yield estimates and processing requirements and to assess on an order of magnitude basis for the value of Occidental's shale oil relative to conventional crudes in the processing study.

For the study, both expansion and input substitution modes were examined. The major conclusions suggest:

1. Optimum hydrotreating severity lies somewhere below 87% denitrogenation;

2. On a conservative cost basis, value of Occidental shale oil is $1.30--$2.00/barrel below the conventional crude oils used for the comparison, including 10% DCF rate of return;

3. Shale oil refining economics are most sensitive to capital costs of upgrading facilities and characteristics of cracking stock produced as a function of severity.

Pace recommends specific future actions including pilot plant studies, engineering cost estimates and additional process economic optimization work to achieve a good level of coverage in the conclusions.

V. PLANS FOR THE COMING QUARTER

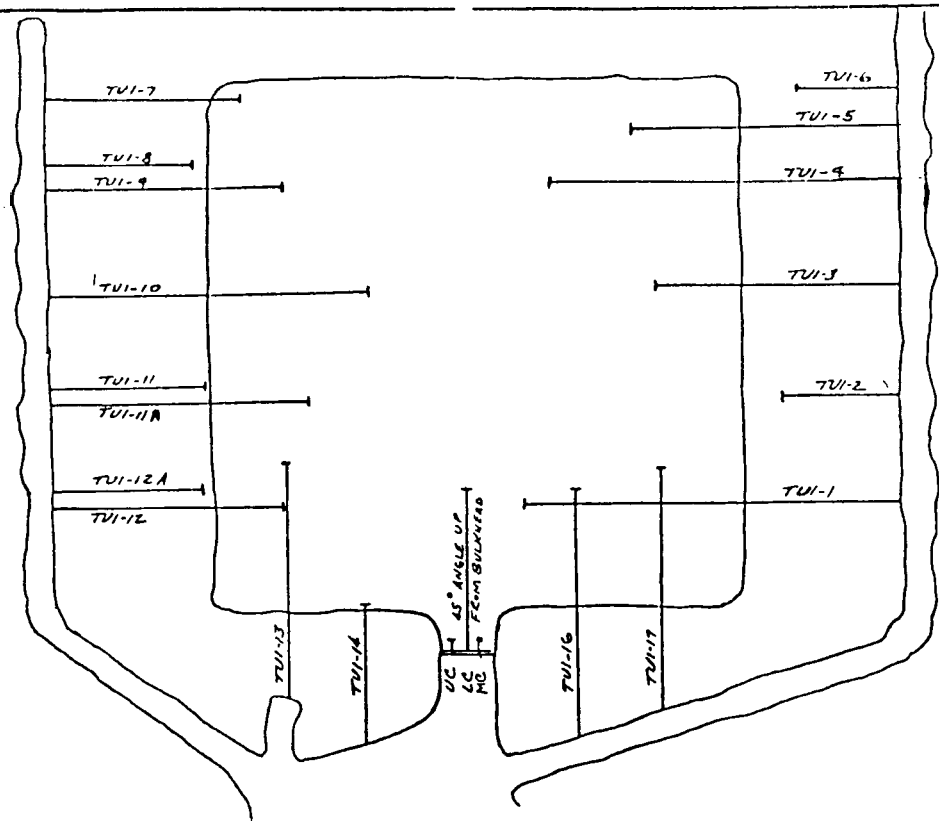
At Logan Wash, processing of Retort 6 and the shipment of production oil to Anvil Points for storage will continue. In addition, the other activities planned are:

- Run additional krypton tracer tests to measure the effect of retorting on gas flow.
- Continue the water sampling program for DOE and assist in collecting or collect various additional samples requested by DOE.
- Commission and operate the off-gas pilot plant facility to test the capability for removal of condensables and oil mist.
- Complete installation of a protective covering for the insulation on Tank 6.
- Fabricate and install an ice guard above the iso-kenetic sampling platform on the stack.
- Run a test program for breaking the oil emulsion sludge in the sludge tank at the Heater Treater facility using a Balston coalescing filter.
- Complete installation of the 12 inch off-gas vent line for Retort 6.

At the C-b Tract, shaft sinking at the V/E Shaft will continue and sinking of the 29' diameter Production Shaft and 34' diameter Service Shaft will begin. The definitive engineering design for the technical feasibility demonstration plant will be completed. Also, activities involving construction of surface facilities will continue.

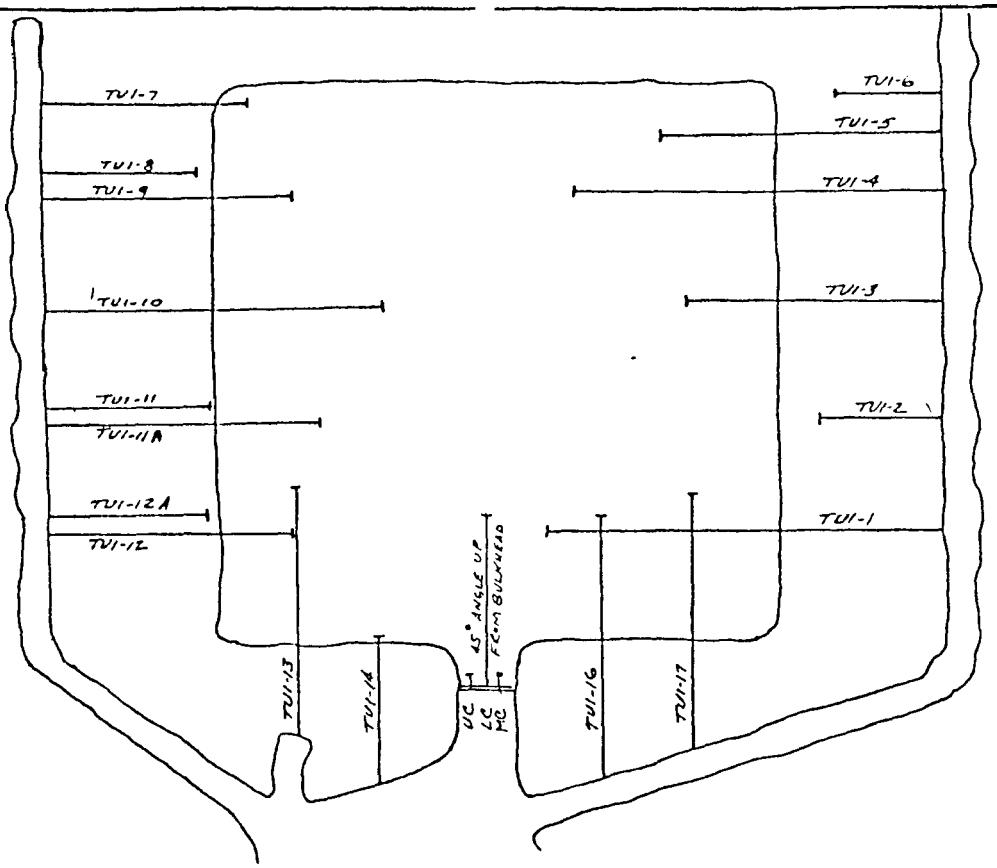
APPENDIX A

THERMOCOUPLE DATA



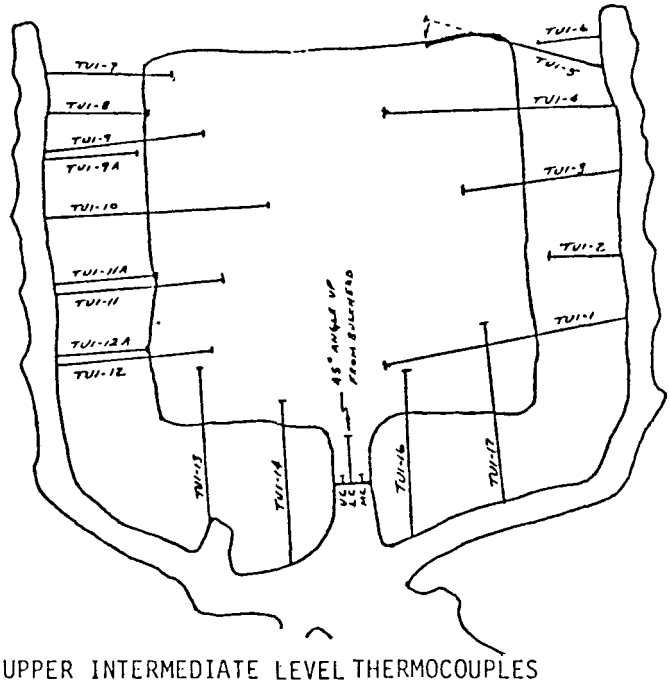
UPPER INTERMEDIATE LEVEL THERMOCOUPLES

DATE	9/18/78	9/19/78	9/20/78	9/21/78	9/22/78	9/23/78	9/23/78
TIME	1400	2330	1630	1400	1200	0900	2140
TUI-1	144	145	147	144	148	142	143
TUI-2	54	52	56	55	59	53	55
TUI-3	81	97	111	121	134	135	140
TUI-4	138	139	143	143	149	144	146
TUI-5	143	145	146	143	147	140	141
TUI-6	52	52	55	54	58	52	54
TUI-7	67	79	83	96	91	87	99
TUI-8	135	141	143	146	150	145	145
TUI-9	69	78	81	145	150	144	145
TUI-10	55	62	63	63	67	62	62
TUI-11-A	61	73	76	79	86	63	64
TUI-11	57	59	62	62	67	82	84
TUI-12-A	69	79	82	84	90	86	87
TUI-12	134	142	-	146	150	143	143
TUI-13	134	145	145	143	149	141	142
TUI-14	139	145	145	143	149	141	142
UC	70	65	80	67	65	67	68
LC	144	69	76	71	161	158	162
TUI-16	143	144	147	144	146	141	142
TUI-17	132	138	193	144	149	145	147
MC							
ORE PASS		144					
MANWAY							
NT RAISE							



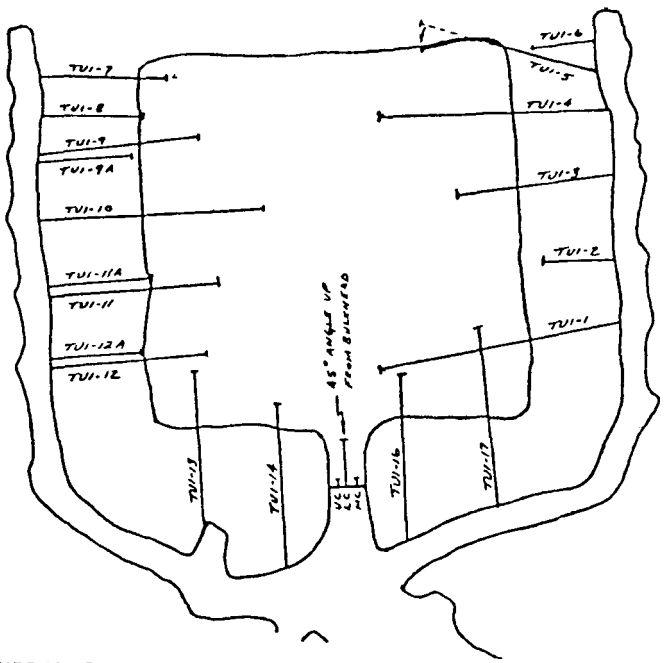
UPPER INTERMEDIATE LEVEL THERMOCOUPLES

DATE	9/24/78	9/25/78	9/26/78	9/28/78	9/30/78	10/1/78	
TIME	0800		0915		1420	0930	
TUI-1	144	146	157	160	128	139	
TUI-2	53	53	55	58	60	56	
TUI-3	142	146	149	152	136	152	
TUI-4	146	147	148	152	136	151	
TUI-5	146	145	152	154	141	147	
TUI-6	51	51	53	57	58	54	
TUI-7	89	91	94	99	110	110	
TUI-8	144	143	144	150	151	114	
TUI-9	144	144	145	149	97	96	
TUI-10	60	60	61	66	65	63	
TUI-11-A	84	86	88	93	100	99	
TUI-11	63	65	70	77	113	119	
TUI-12-A	87	88	90	95	101	101	
TUI-12	142	141	143	148	113	147	
TUI-13	141	145	157	161	101	142	
TUI-14	145	145	156	160	153	151	
UC	67	68	69	73	77	74	
LC	63	170	177	182	225	167	
TUI-16	142	146	154	159	144	142	
TUI-17	145	145	146	149	155	155	
MC		65	68	73	71	71	
ORE PASS		58	57	63		61	
MANWAY		56	55	63		65	
VENT RAISE	78	85	84	72		74	



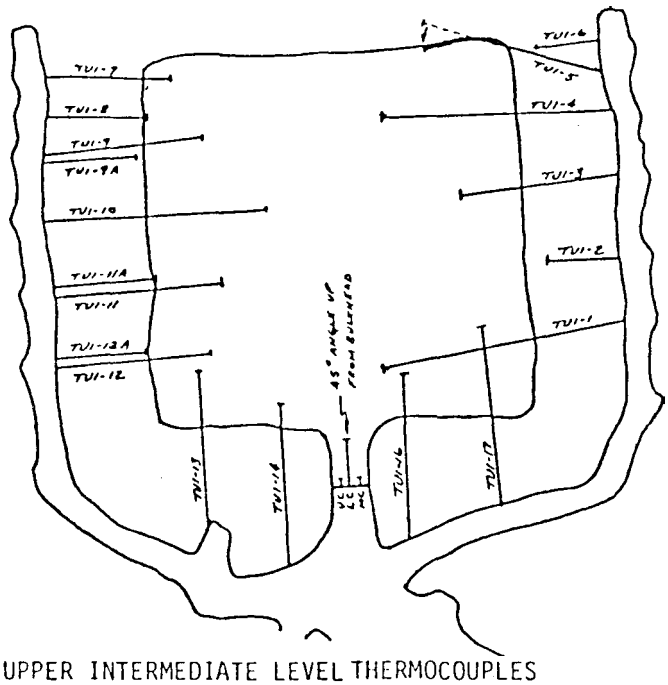
UPPER INTERMEDIATE LEVEL THERMOCOUPLES

DATE	10/2/78	10/3/78	10/4/78	10/5/78	10/6/78	10/7/78	10/8/78
TIME	1040	2000	1730	1800	1730	1020	1830
TUI-1	142	146	144	143	146	144	145
TUI-2	58	63	58	58	63	61	61
TUI-3	154	154	150	145	147	144	141
TUI-4	150	146	141	135	136	132	128
TUI-5	143	149	144	137	141	138	133
TUI-6	55	58	55	54	58	54	55
TUI-7	113	118	118	116	121	118	117
TUI-8	137	130	125	119	121	118	114
TUI-9	98	146	141	133	134	-	123
TUI-9A							
TUI-10	66	69	69	69	76	76	76
TUI-11-A	105	109	110	110	116	115	117
TUI-11	130	140	144	142	146	143	142
TUI-12-A	104	108	109	109	114	112	114
TUI-12	146	143	140	135	137	-	131
TUI-13	140	142	144	140	140	143	151
TUI-14	156	161	162	159	156	155	171
UC	77	77	77	76	80	79	78
LC	168	257	263	270	283	292	303
MC	72		72	72	72	77	74
TUI-16	144	144	144	142	144	141	141
TUI-17	158	159	157	153	156	154	153
ORE PASS	64					63	66
MANWAY	66					65	62
VENT RAISE	73					74	76



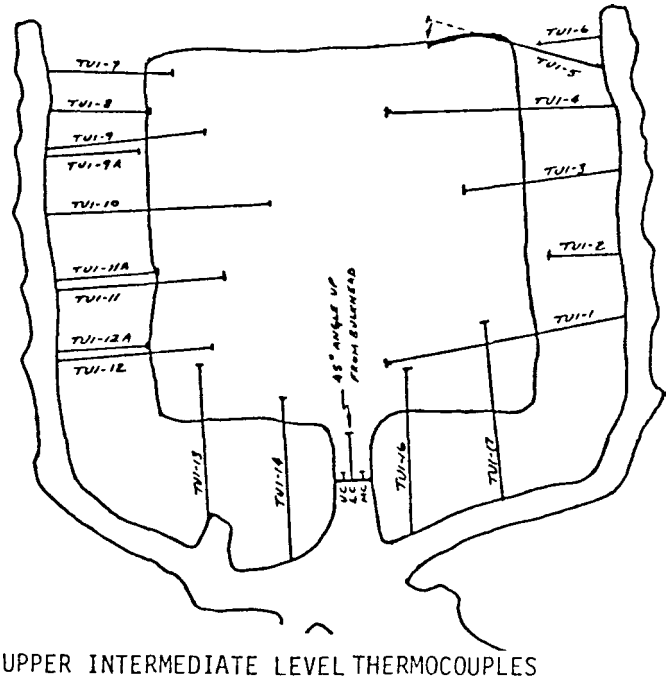
UPPER INTERMEDIATE LEVEL THERMOCOUPLES

DATE	10/9/78	10/10/78	10/11/78	10/12/78	10/13/78	10/14/78	10/15/78
TIME	1700	1615	2030	2200	1700	1630	-
TUI-1	148	155	152	154	155	157	155
TUI-2	61	66	61	63	64	66	64
TUI-3	141	146	146	141	143	144	141
TUI-4	128	130	125	125	125	130	131
TUI-5	141	159	156	159	163	167	169
TUI-6	55	61	54	55	54	58	56
TUI-7	114	118	114	116	121	118	117
TUI-8	111	115	115	120	131	136	135
TUI-9	118	108	104	117	109	119	121
TUI-9A	101	121	115	110	118	106	104
TUI-10	79	86	84	86	90	84	87
TUI-11-A	118	124	122	125	126	126	123
TUI-11	139	143	138	140	140	138	136
TUI-12-A	114	121	118	119	121	120	117
TUI-12	129	135	132	135	138	145	142
TUI-13	153	156	154	153	153	155	154
TUI-14	170	166	153	161	161	164	160
UC	81	85	81	82	80	84	83
LC	316	329	338	350	356	370	381
MC	75	84	76	77	77	77	78
TUI-16	149	155	153	156	153	160	158
TUI-17	152	151	142	141	140	149	145
ORE PASS					60		
MANWAY							
VENT RAISE							



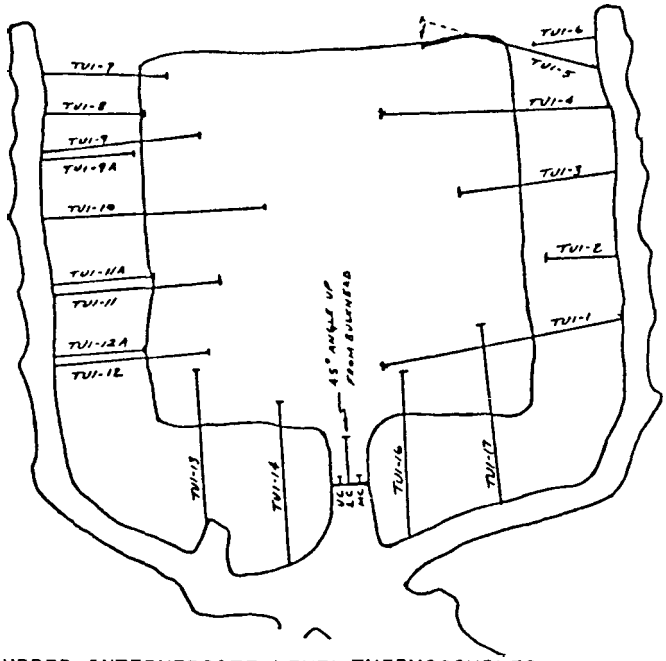
UPPER INTERMEDIATE LEVEL THERMOCOUPLES

DATE	10/16/78	10/17/78	10/18/78	10/19/78	10/20/78	10/21/78	10/22/78
TIME	2140	1605	2240	1930	1630	1640	1600
TUI-1	155	153	153	151	153	154	153
TUI-2	60	64	65	64	66	65	64
TUI-3	139	139	138	136	138	141	134
TUI-4	131	134	135	135	-	-	-
TUI-5	167	170	175	184	194	220	338
TUI-6	53	55	55	59	57	55	53
TUI-7	117	121	121	123	121	122	119
TUI-8	137	140	136	138	134	132	136
TUI-9	126	131	134	138	135	132	132
TUI-9A	104	109	106	110	108	105	106
TUI-10	88	91	91	94	93	88	93
TUI-11-A	123	124	126	129	128	126	127
TUI-11	135	136	135	138	136	133	135
TUI-12-A	119	120	118	122	120	118	118
TUI-12	146	148	144	146	143	140	140
TUI-13	152	150	150	157	167	196	198
TUI-14	160	161	155	159	158	159	161
UC	85	80	85	84	87	84	84
LC	390	391	400	404	412	412	418
MC	82	86	79	83	81	83	83
TUI-16	157	154	154	159	154	154	155
TUI-17	146	146	146	149	145	146	144
ORE PASS							
MANWAY							
VENT RAISE							



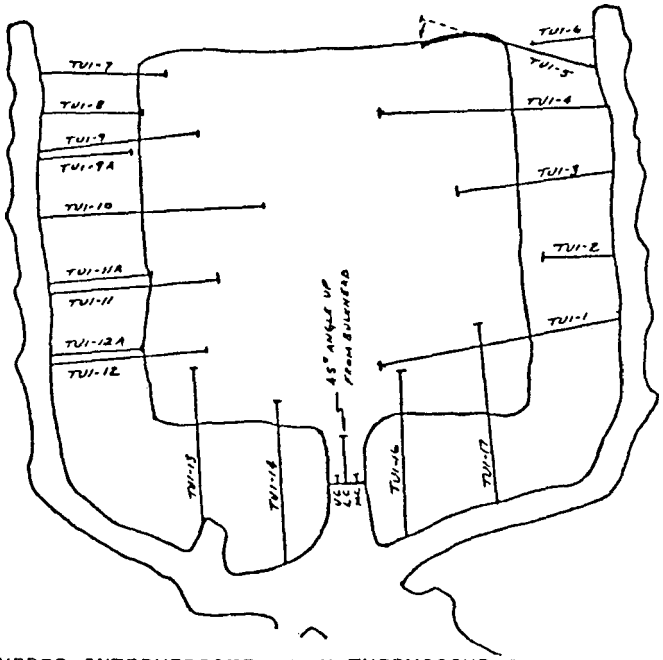
UPPER INTERMEDIATE LEVEL THERMOCOUPLES

DATE	10/23/78	10/24/78	10/25/78	10/26/78	10/27/78	10/28/78	10/29/78
TIME	1620	1625	1650	1700	2200	1700	1600
TUI-1	160	151	151	145	154	153	155
TUI-2	72	63	64	64	69	66	67
TUI-3	141	134	136	137	138	139	140
TUI-4	173	177	200	222	263	294	348
TUI-5	690	959	1,119	1,214	1257	1249	1200
TUI-6	61	52	52	52	70	55	54
TUI-7	126	118	119	135	123	125	124
TUI-8	146	141	114	144	140	142	144
TUI-9	114	107	137	140	142	138	141
TUI-9A	-	-	167	108	111	109	109
TUI-10	100	93	94	94	98	98	99
TUI-11-A	134	127	129	129	131	130	136
TUI-11	142	133	134	134	136	135	130
TUI-12-A	127	119	120	120	122	120	120
TUI-12	149	140	143	144	145	143	147
TUI-13	207	202	211	226	255	267	296
TUI-14	172	154	154	144	158	157	159
UC	93	84	84	83	85	86	88
LC	429	422	425	425	432	436	439
MC	83	83	84	83	84	85	86
TUI-16	162	152	152	146	154	154	57
TUI-17	152	145	146	146	147	143	144
ORE PASS							
MANWAY							
VENT RAISE							



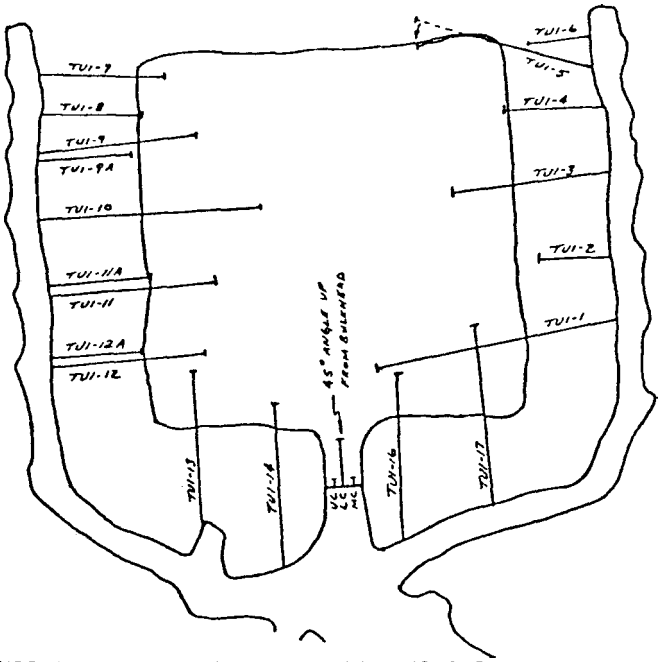
UPPER INTERMEDIATE LEVEL THERMOCOUPLES

DATE	10/30/78	10/31/78	11/1/78	11/2/78	11/3/78	11/4/78	11/5/78
TIME	2200	1840	1630	1700	1600	1700	1130
TUI-1	152	158	163	166	171	180	188
TUI-2	67	67	68	68	69	70	70
TUI-3	141	141	142	142	143	145	146
TUI-4	437	523	611	693	773	853	918
TUI-5	1108	1020	933	850	775	701	629
TUI-6	54	53	54	53	54	54	54
TUI-7	125	124	125	126	127	128	133
TUI-8	143	141	142	142	143	145	147
TUI-9	144	144	145	145	144	143	144
TUI-9A	111	111	112	113	115	115	117
TUI-10	101	101	103	103	105	104	105
TUI-11-A	131	131	132	132	133	132	133
TUI-11	137	137	139	139	140	140	140
TUI-12-A	122	121	123	122	123	122	122
TUI-12	151	150	153	153	150	147	147
TUI-13	323	339	357	372	387	402	416
TUI-14	159	159	163	158	165	174	187
UC	89	89	90	90	91	90	92
LC	448	433	459	464	472	481	491
MC	87	88	90	88	90	89	90
TUI-16	161	164	168	172	178	186	195
TUI-17	145	143	144	142	142	142	142
ORE PASS							
MANWAY							
VENT RAISE							



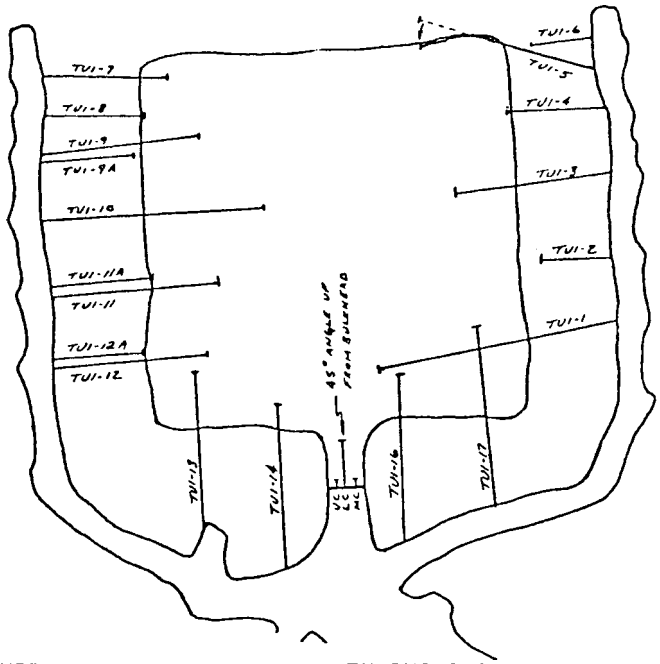
UPPER INTERMEDIATE LEVEL THERMOCOUPLES

DATE	11/6/78	11/7/78	11/8/78	11/9/78	11/10/78	11/11/78	11/12/78
TIME	1630	2100	1800	1640	1700	1700	2230
TUI-1	199	209	219	234	246	257	270
TUI-2	70	71	70	71	71	72	72
TUI-3	149	149	149	151	151	150	149
TUI-4	976	1,003	1,009	998	962	930	870
TUI-5	559	494	476	410	375	358	315
TUI-6	63	54	53	54	54	54	53
TUI-7	131	133	138	141	155	154	140
TUI-8	148	146	147	149	145	145	148
TUI-9	145	145	145	147	145	145	145
TUI-9A	118	120	121	122	123	124	125
TUI-10	107	109	109	111	112	113	114
TUI-11-A	133	134	135	135	133	134	134
TUI-11	141	142	141	144	142	144	144
TUI-12-A	123	123	125	124	124	125	126
TUI-12	149	149	153	161	146	153	175
TUI-13	428	444	446	463	472	481	490
TUI-14	201	223	238	261	280	291	316
UC	89	93	93	95	94	96	99
LC	499	510	515	526	534	547	550
MC	89	90	92	93	94	95	100
TUI-16	206	218	224	240	252	265	278
TUI-17	143	143	143	144	143	144	146
ORE PASS							
MANWAY							
VENT RAISE							



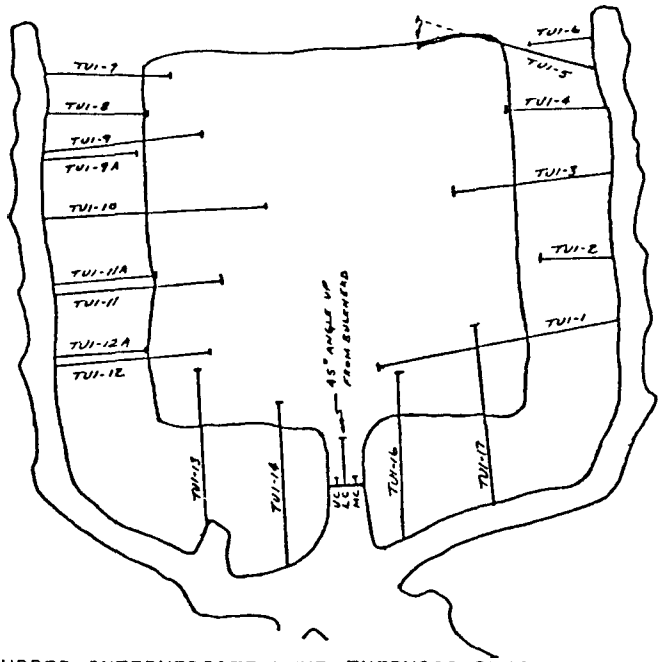
UPPER INTERMEDIATE LEVEL THERMOCOUPLES

DATE	11/13/78	11/14/78	11/15/78	11/16/78	11/17/78	11/18/78	11/19/78
TIME	1700	1900	1600	1650	1630	1645	--
TUI-1	277	294	-	313	--	--	--
TUI-2	73	71	-	74	--	--	--
TUI-3	144	147	-	149	--	--	--
TUI-4	857	808	-	771	--	--	--
TUI-5	306	280	-	251	--	--	--
TUI-6	54	53	-	54	--	--	--
TUI-7	150	141	147	156	165	173	181
TUI-8	144	148	148	148	186	308	599
TUI-9	145	144	147	147	141	147	149
TUI-9A	127	127	132	136	146	148	153
TUI-10	115	117	119	120	121	122	123
TUI-11-A	134	133	134	134	134	143	135
TUI-11	143	143	143	142	142	135	143
TUI-12-A	128	127	129	129	130	131	131
TUI-12	151	147	149	151	153	156	159
TUI-13	498	507	513	520	525	533	538
TUI-14	329	348	366	394	398	411	424
UC	101	98	101	101	102	103	104
LC	559	559	561	556	552	550	548
MC	98	99	100	99	100	101	103
TUI-16	287	301	311	329	340	353	364
TUI-17	145	145	145	147	148	149	152
ORE PASS							
MANWAY							
VENT RAISE							



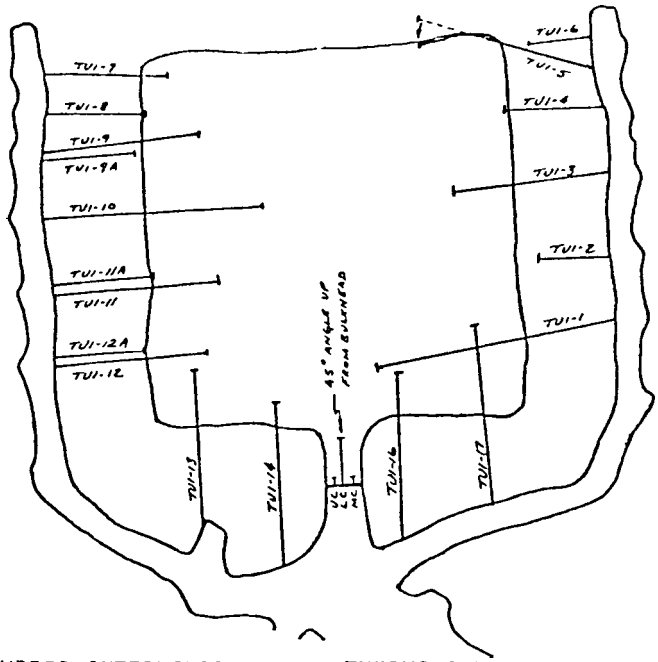
UPPER INTERMEDIATE LEVEL THERMOCOUPLES

DATE	11/20/78	11/21/78	11/22/78	11/23/78	11/24/78	11/25/78	11/26/78
TIME	1012	0115	1415	1630	930	1800	1800
TUI-1	--	374			400	411	422
TUI-2	--	74			81	78	81
TUI-3	--	141			153	150	152
TUI-4	--	681			659	642	628
TUI-5	--	--			227	229	239
TUI-6	--	52			60	56	58
TUI-7	185	195	198	204	210	235	292
TUI-8	800	1251	1369	1325	1281	1217	1176
TUI-9	156	160	153	154	155	160	182
TUI-9A	150	151	166	170	174	178	181
TUI-10	125	125	126	128	129	130	133
TUI-11-A	144	142	136	137	137	138	141
TUI-11	136	135	143	144	144	145	147
TUI-12-A	132	131	132	134	133	135	138
TUI-12	162	164	173	178	182	189	196
TUI-13	541	546	553	559	562	570	577
TUI-14	431	440	456	464	471	484	493
UC	104	106	105	106	109	107	109
LC	545	546	542	545	546	548	553
MC	103	105	103	105	108	105	107
TUI-16	373	381	397	408	418	429	442
TUI-17	150	152	152	157	165	170	180
ORE PASS							
MANWAY							
VENT RAISE							



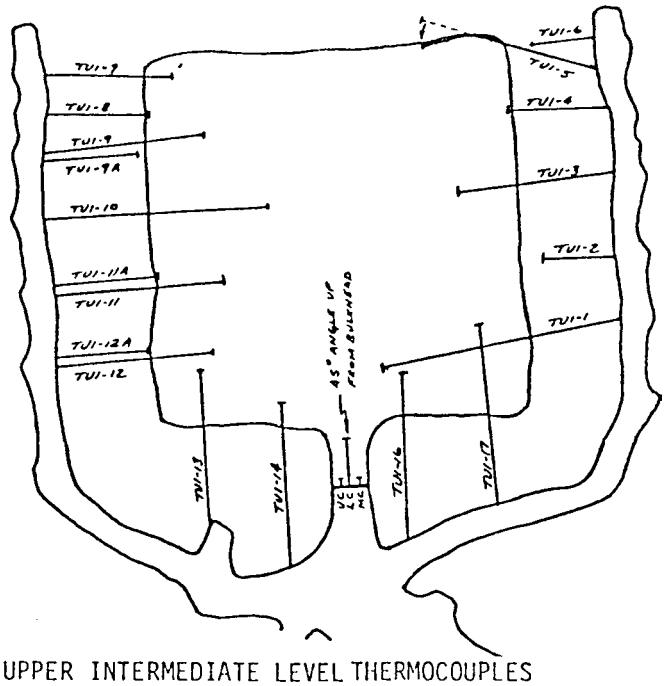
UPPER INTERMEDIATE LEVEL THERMOCOUPLES

DATE	11/27/78	11/28/78	11/29/78	11/30/78	12/1/78	12/2/78	12/3/78
TIME	1700	1730	1815	-	1700	1800	1730
TUI-1	429	438	445	452	456	461	469
TUI-2	80	79	78	82	80	79	82
TUI-3	150	148	148	150	144	141	143
TUI-4	620	604	595	584	544	552	565
TUI-5	250	262	276	292	309	326	344
TUI-6	58	57	54	59	57	57	60
TUI-7	315	360	351	370	369	385	408
TUI-8	1140	1113	1094	1078	1064	1056	1053
TUI-9	211	285	414	544	654	813	901
TUI-9A	184	187	184	198	198	198	203
TUI-10	132	132	135	139	136	138	140
TUI-11-A	139	139	141	144	140	140	142
TUI-11	146	146	148	151	147	146	146
TUI-12-A	137	136	139	142	138	138	141
TUI-12	201	206	216	226	227	235	245
TUI-13	580	585	592	600	600	607	612
TUI-14	501	507	514	520	518	525	526
UC	108	108	109	108	103	103	105
EC	554	554	555	557	553	554	554
MC	107	106	104	100	102	102	103
TUI-16	452	461	472	480	483	489	498
TUI-17	187	194	204	214	219	227	237
ORE PASS							
MANWAY							
ENT RAISE							



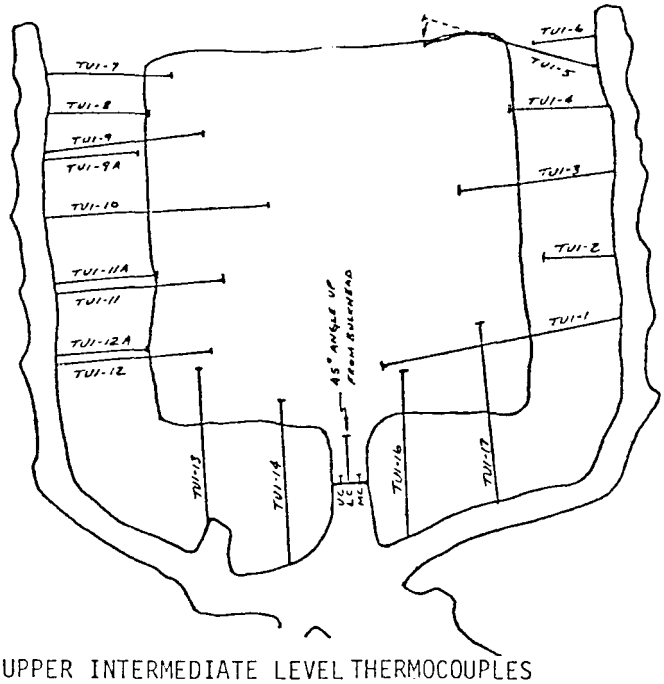
UPPER INTERMEDIATE LEVEL THERMOCOUPLES

DATE	12/4/78	12/5/78	12/6/78	12/7/78	12/8/78	12/9/78	12/10/78
TIME	2200	-	-	1725	1300	1900	0230
TUI-1	472	475	475	480	480	483	482
TUI-2	81	82	85	85	83	85	85
TUI-3	140	142	138	138	138	130	145
TUI-4	569	567	545	530	525	502	505
TUI-5	360	369	385	390	395	398	390
TUI-6	59	60	63	62	65	62	65
TUI-7	418	440	415	438	455	495	500
TUI-8	1044	1044	1032	1032	1,030	1,022	1,025
TUI-9	999	1015	1030	1045	1,065	1,250	1,282
TUI-9A	198	201	235	248	255	270	270
TUI-10	138	141	145	142	145	145	145
TUI-11-A	142	142	145	139	145	142	140
TUI-11	139	145	139	142	140	138	138
TUI-12-A	138	142	145	142	288	142	141
TUI-12	252	260	265	270	145	285	295
TUI-13	616	623	622	623	630	635	640
TUI-14	526	533	530	535	530	530	522
UC	103	108	105	108	105	100	102
LC	547	550	539	538	535	535	530
MC	99	100		101	--	--	103
TUI-16	502	506	512	518	520	520	515
TUI-17	244	250	258	260	265	272	281
ORE PASS							
MANWAY							
VENT RAISE							



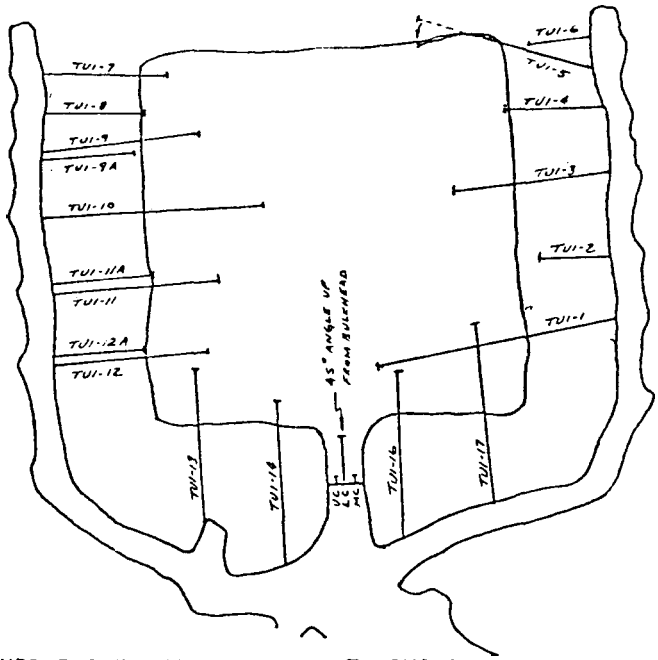
UPPER INTERMEDIATE LEVEL THERMOCOUPLES

DATE	12/11	12/12	12/13	12/14	12/15	12/16	12/17
TIME	-	2000	2000	2000	1700	1800	1735
TUI-1	485	500	505	510	515	524	523
TUI-2	90	88	90	90	85	91	89
TUI-3	130	135	140	145	142	150	147
TUI-4	485	475	465	250	223	251	319
TUI-5	410	418	420	420	424	435	435
TUI-6	62	68	65	90	60	67	65
TUI-7	522	542	555	565	580	574	549
TUI-8	1035	1038	1040	1050	1049	1052	1048
TUI-9	1355	1360	1355	1365	1338	1323	1302
TUI-9A	290	298	305	320	313	327	334
TUI-10	145	148	145	160	143	147	146
TUI-11-A	140	142	140	180	152	157	157
TUI-11	142	148	150	160	152	158	157
TUI-12-A	145	145	145	150	146	153	151
TUI-12	305	312	320	330	338	352	357
TUI-13	655	662	670	680	691	704	707
TUI-14	536	533	535	540	534	539	536
UC	108	108	115	130	108	115	114
LC	548	562	580	600	618	649	678
MC	101	101	105	106	107	114	112
TUI-16	528	530	535	540	543	548	548
TUI-17	290	298	305	310	318	331	334
ORE PASS							
MANWAY							
VENT RAISE							



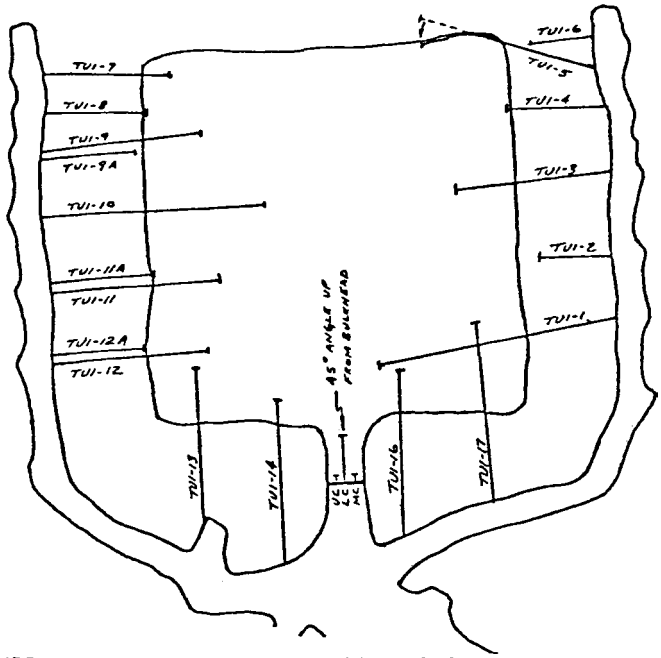
UPPER INTERMEDIATE LEVEL THERMOCOUPLES

DATE	12/18/78	12/19/78	12/20/78	12/21/78	12/22/78	12/23/78	12/24/78
TIME	2000	2000	2000	2000	2000	2000	2000
TUI-1	540	535	527	530	528	530	538
TUI-2	100	100	100	100	102	100	100
TUI-3	150	150	155	158	160	158	160
TUI-4	220	210	225	342	380	398	402
TUI-5	440	425	430	432	435	440	443
TUI-6	100	98	100	80	102	98	97
TUI-7	540	530	518	500	483	475	460
TUI-8	1040	1040	1038	1030	1035	1022	1017
TUI-9	1350	1280	1318	1247	1305	1262	1248
TUI-9A	350	360	365	375	380	385	402
TUI-10	170	160	168	162	178	178	178
TUI-11-A	210	185	203	177	220	203	202
TUI-11	200	180	205	182	222	217	250
TUI-12-A	160	160	162	163	165	163	163
TUI-12	360	375	378	385	395	398	402
TUI-13	710	710	713	715	718	722	728
TUI-14	540	540	542	540	540	540	540
UC	114	135	160	138	175	160	160
LC	702	715	745		787	840	885
MC	117						
TUI-16	545	550	545	547	550	552	555
TUI-17	338	340	345	355	360	365	368
ORE PASS							
MANWAY							
VENT RAISE							



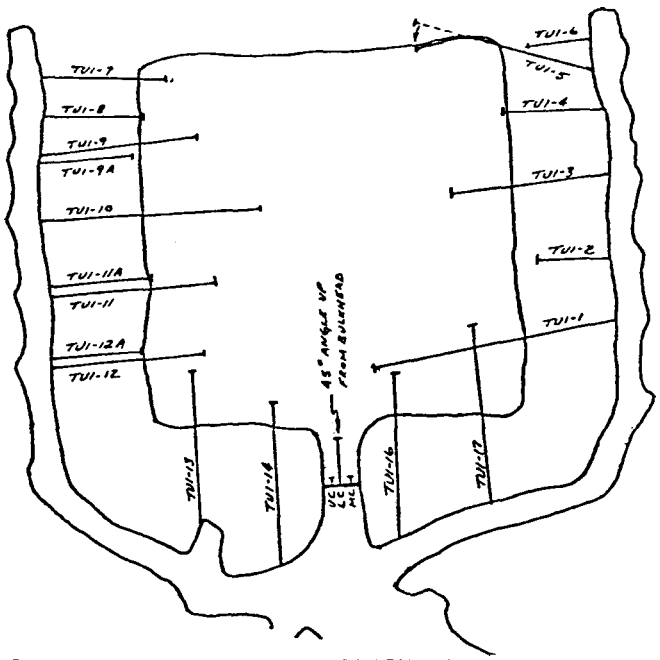
UPPER INTERMEDIATE LEVEL THERMOCOUPLES

DATE	12/25/78	12/26/78	12/27/78	12/28/78	12/29/78	12/30/78	12/31/78
TIME	2000	2000	2000	2000	2000	2000	2000
TUI-1	540	543	550	550	538	545	545
TUI-2	100	102	105	105	102	105	102
TUI-3	162	170	175	182	195	200	210
TUI-4	403	405	405	405	398	400	395
TUI-5	442	448	420	412	400	395	385
TUI-6	95	98	95	90	115	95	85
TUI-7	442	428	415	395	390	380	360
TUI-8	1002	995	980	965	955	955	935
TUI-9	1210	1205	1195	1185	1180	1160	1155
TUI-9A	408	427	440	425	450	455	465
TUI-10	178	183	185	182	180	190	185
TUI-11-A	200	203	205	195	205	200	210
TUI-11	278	315	365	400	460	500	542
TUI-12-A	167	170	178	172	168	170	175
TUI-12	410	417	425	422	430	435	435
TUI-13	738	742	755	755	755	760	770
TUI-14	542	545	560	555	560	565	565
UC	158	160	160	158	160	158	160
LC	928	980	990	1030	1075	1100	1130
MC	-	-	-	-	-	-	-
TUI-16	555	562	575	565	565	560	560
TUI-17	379	387	400	395	415	430	425
ORE PASS							
MANWAY							
VENT RAISE							



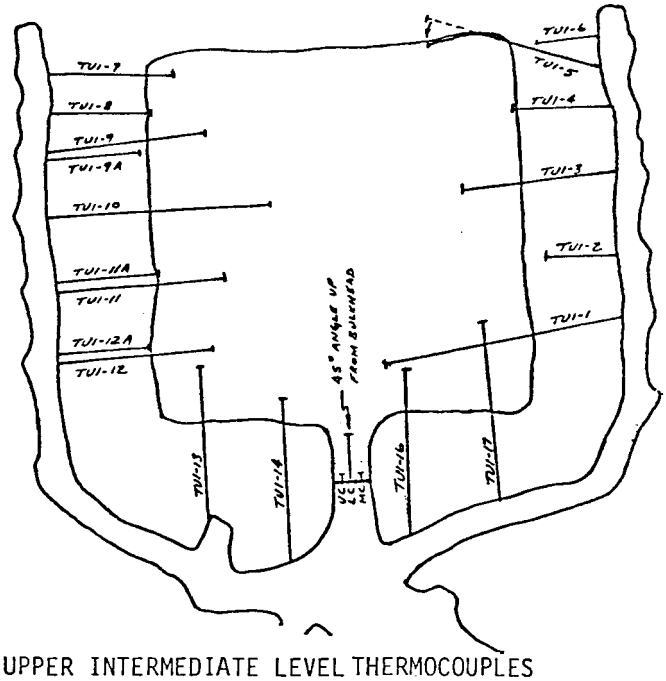
UPPER INTERMEDIATE LEVEL THERMOCOUPLES

DATE	1/1/79	1/2/79	1/3/79	1/4/79	1/5/79	1/6/79	1/7/79
TIME	2000	2000	2200	2000	2000	2000	2000
TUI-1	555	550	560	565	580	575	580
TUI-2	100	100	105	102	105	102	110
TUI-3	215	250	270	300	322	350	370
TUI-4	395	390	390	382	385	380	390
TUI-5	365	365	360	360	355	345	340
TUI-6	90	90	90	100	102	95	95
TUI-7	358	338	340	335	320	315	310
TUI-8	928	918	915	918	895	880	865
TUI-9	1135	1130	1140	1125	1135	1080	1080
TUI-9A	470	485	490	490	498	500	502
TUI-10	178	180	180	185	185	180	180
TUI-11-A	200	205	220	225	242	235	240
TUI-11	590	630	685	725	775	810	860
TUI-12-A	168	170	178	172	178	180	180
TUI-12	440	438	445	455	455	460	462
TUI-13	778	785	800	810	820	825	835
TUI-14	575	585	585	595	600	605	618
UC	158	160	165	172	190	180	180
LC	1175	1205	1218	1215	1230	1240	1260
MC	-	-					
TUI-16	565	572	575	580	585	590	590
TUI-17	445	460	470	500	510	528	550
ORE PASS							
MANWAY							
VENT RAISE							



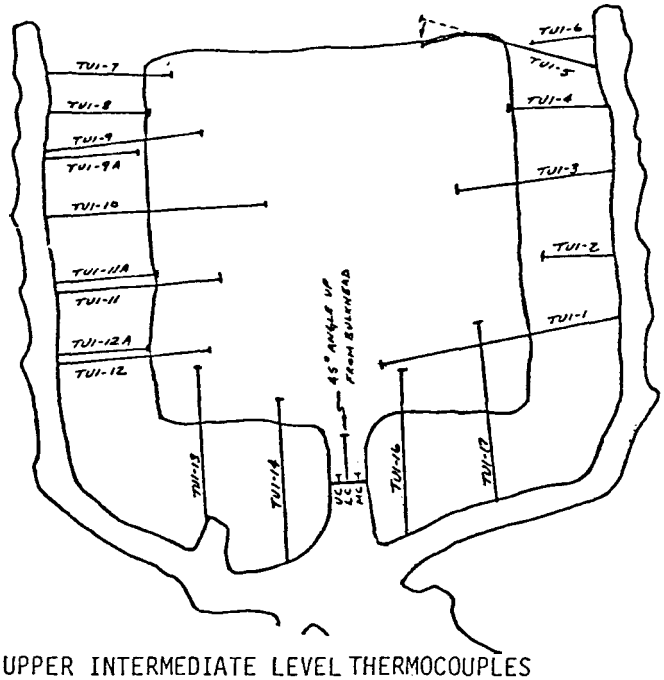
UPPER INTERMEDIATE LEVEL THERMOCOUPLES

DATE	1/8	1/9	1/10	1/11	1/12	1/13	1/14
TIME	2000	2000	2000	2000	2000	2000	2000
TUI-1	560	560	600	610	610	600	590
TUI-2	110	106	105	110	105	110	110
TUI-3	400	435	465	490	515	535	550
TUI-4	400	395	495	410	420	430	440
TUI-5	340	340	340	330	335	335	330
TUI-6	95	85	100	100	100	95	85
TUI-7	300	295	290	285	285	280	275
TUI-8	840	818	790	770	740	715	685
TUI-9	1400	1140	1160	1045	1120	940	700
TUI-9A	505	510	510	505	515	505	500
TUI-10	180	175	185	195	185	185	175
TUI-11-A	225	220	260	270	265	235	220
TUI-11	880	905	945	1070	980	1000	1020
TUI-12-A	180	185	190	190	185	190	185
TUI-12	465	470	475	480	480	480	485
TUI-13	845	860	870	885	900	915	920
TUI-14	625	640	650	665	685	710	730
UC	170	170	180	190	195	180	175
LC	1240	1240	1260	1255	1245	1230	1210
MC							
TUI-16	600	605	615	625	635	645	655
TUI-17	575	595	620	640	675	705	735
ORE PASS							
MANWAY							
VENT RAISE							



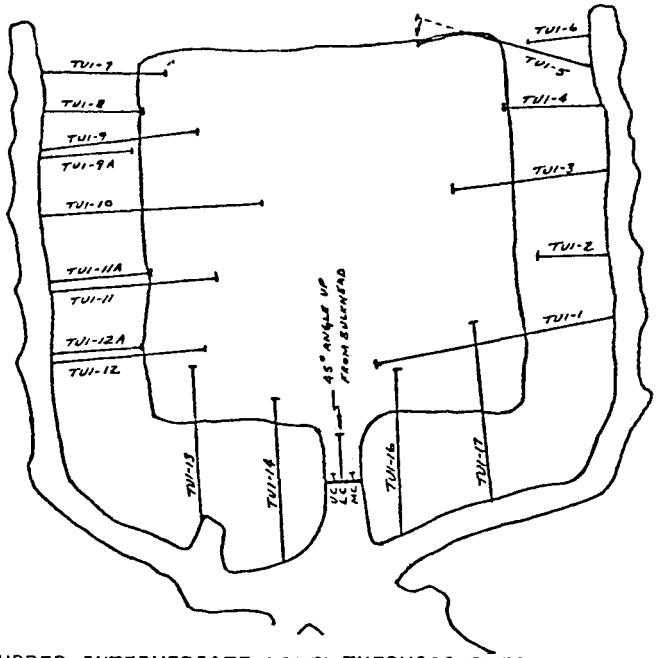
UPPER INTERMEDIATE LEVEL THERMOCOUPLES

DATE	1/15/79	1/16/79	1/17/79	1/18/79	1/19/79	1/20/79	1/21/79
TIME	2000	2000	2000	20000	2000	2000	2000
TUI-1	595	595	605	608	615	618	625
TUI-2	110	110	110	108	118	118	118
TUI-3	575	600	628	660	700	745	800
TUI-4	445	460	470	480	485	500	505
TUI-5	325	320	320	308	315	308	305
TUI-6	80	80	82	85	82	82	82
TUI-7	270	265	265	262	260	258	255
TUI-8	650	620	593	562	525	595	460
TUI-9	610	495	455		440	360	275
TUI-9A	495	490	487	482	478	468	465
TUI-10	185	175	178	178	178	177	178
TUI-11-A	220	220	240	275	290	298	305
TUI-11	1045	1070	1090	1108	1123	1142	1150
TUI-12-A	185	190	193	195	195	195	198
TUI-12	490	495	500	502	508	515	520
TUI-13	930	930	932	938	945	962	992
TUI-14	755	780	798	815	830	842	855
UC	175	175	178	180	180	178	178
LC	1195	1180	1165	1148	1140	1122	1118
MC							
TUI-16	665	675	685	700	705	720	730
TUI-17	765	800	815	855	878	900	918
ORE PASS							
MANWAY							
VENT RAISE							



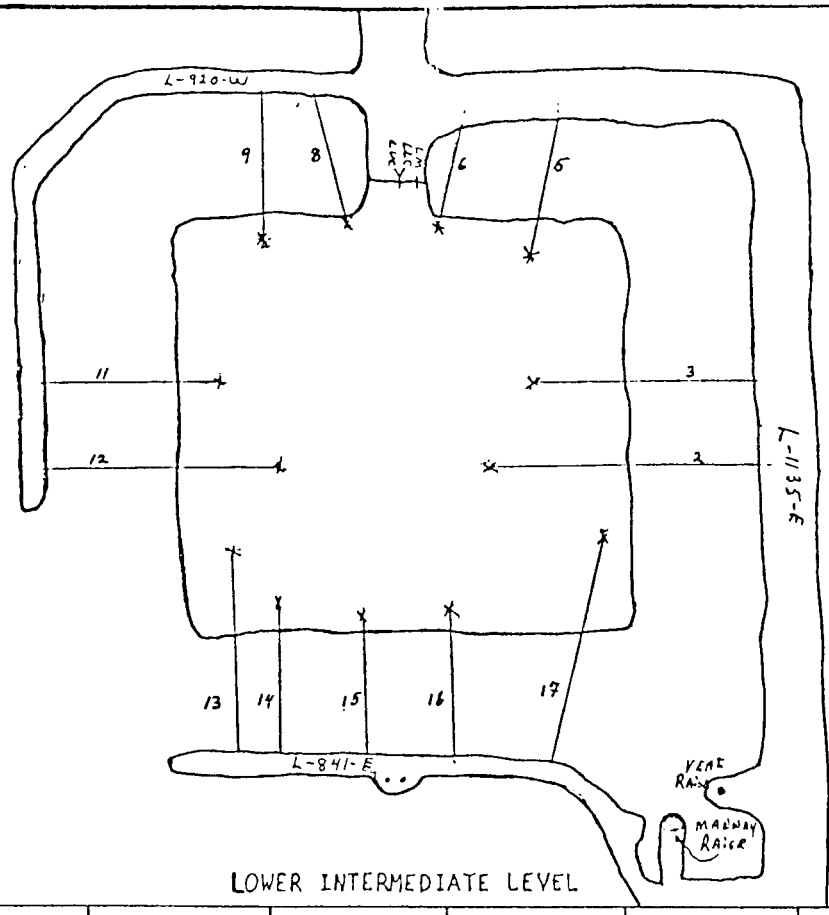
UPPER INTERMEDIATE LEVEL THERMOCOUPLES

DATE	1/22/79	1/23/79	1/24/79	1/25/79	1/26/79	1/27/79	1/28/79
TIME	2000	2000	1200	1900	1900	1900	1900
TUI-1	635	640	640	655	662	670	680
TUI-2	118	120	120	115	118	120	120
TUI-3	855	900	925	970	990	1020	1050
TUI-4	518	518	520	515	510	515	505
TUI-5	303	302	300	300	290	290	285
TUI-6	85	82	85	80	90	85	80
TUI-7	255	250	245	245	240	242	235
TUI-8	445	242	240	265		245	270
TUI-9	280						
TUI-9A	463	460	455	450	445	438	438
TUI-10	180	180	180	180	190	185	190
TUI-11-A	318	322	325	345	350	350	360
TUI-11	1150	1160	1160	1160	1160	1160	1160
TUI-12-A	198	200	200	200	200	200	205
TUI-12	522	525	530	535	540	545	550
TUI-13	1020	1042	1055	1070	1085	1100	1130
TUI-14	863	873	875	880	880	885	885
UC	180	178	180	180	185	180	175
LC	1100	1085	1075	1060	1045	1030	1030
MC							
TUI-16	742	753	760	770	782	792	805
TUI-17	938	958	970	990	1005	1022	1050
ORE PASS							
MANWAY							
VENT RAISE							



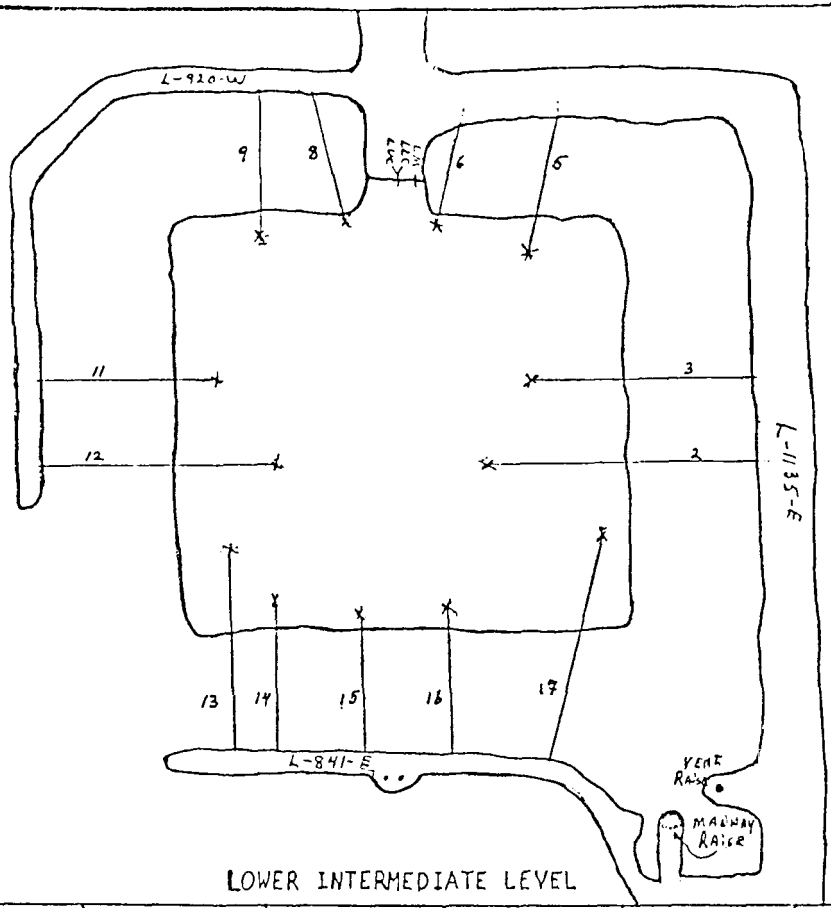
UPPER INTERMEDIATE LEVEL THERMOCOUPLES

DATE	1/29	1/30	1/31				
TIME	2000	1900	1900				
TUI-1	685	698	695				
TUI-2	120	122	125				
TUI-3	1095	1118	1130				
TUI-4	510	507	515				
TUI-5	285	280	285				
TUI-6	85	85	85				
TUI-7	238	215	235				
TUI-8	260	230	235				
TUI-9							
TUI-9A	435	425	430				
TUI-10	190	200	200				
TUI-11-A	365	370	375				
TUI-11	1160	1150	1145				
TUI-12-A	200	200	200				
TUI-12	555	560	570				
TUI-13	1140	1150	1160				
TUI-14	892	895	895				
UC	170	170	172				
LC	1020	1015	1000				
MC							
TUI-16	807	818	820				
TUI-17	1080	1105	1125				
ORE PASS							
MANWAY							
VENT RAISE							



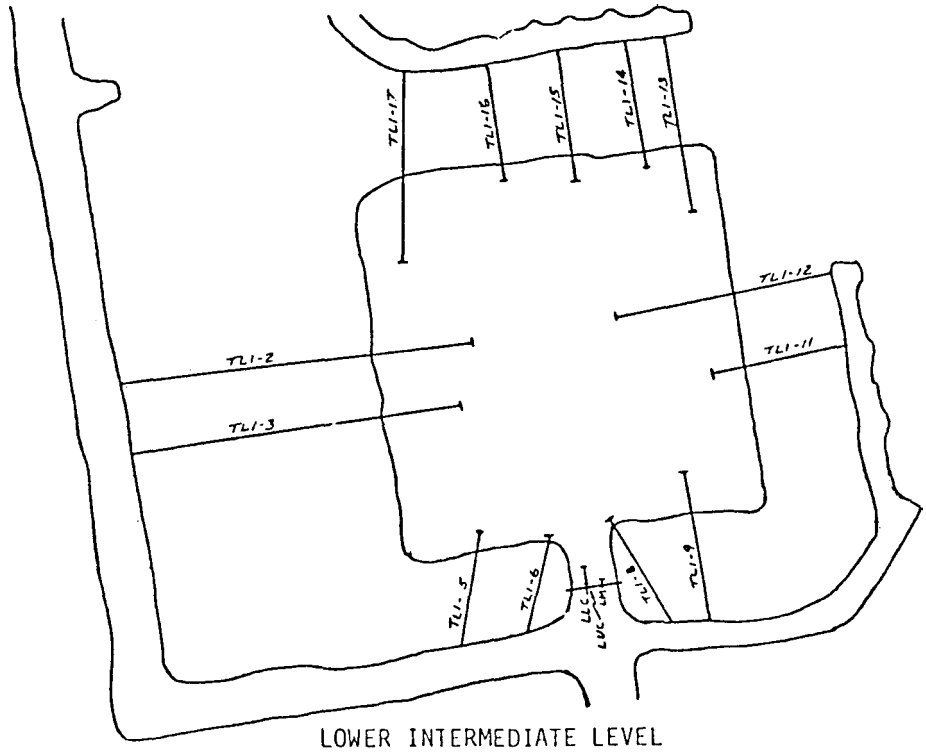
LOWER INTERMEDIATE LEVEL

DATE	9/21/78	9/22/78	9/23/78	9/24/78	9/25/78	9/26/78	9/27/78
TIME		1130	0900	0800		0845	0810
T-LI-2	69	70	69	76	67	66	67
T-LI-3	66	67	-	-	63	63	65
T-LI-5	61	62	60	58	58	58	60
T-LI-6	140	140	137	135	136	140	147
T-LI-8	149	125	125	125	126	129	139
T-LI-9	61	62	59	58	58	58	60
T-LI-11	62	69	65	63	62	63	65
T-LI-12	70	72	68	66	66	66	66
T-LI-13	123	135	134	135	135	-	142
T-LI-14	133	144	141	141	140	143	150
T-LI-15	67	128	129	130	130	132	137
T-LI-16	138	139	136	136	134	136	145
T-LI-17	67	69	66	66	67	69	73
LC						124	132
LUC						57	58
LM						52	52



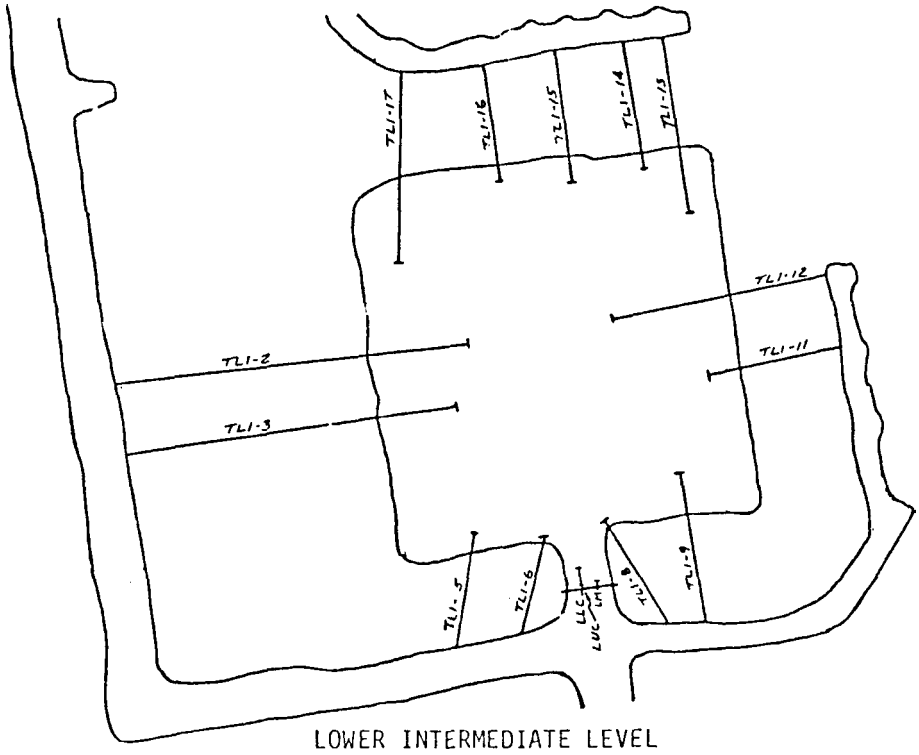
LOWER INTERMEDIATE LEVEL

DATE	10/2	10/3	10/4	10/5	10/6	10/7	10/8
TIME	1430	1936	1800	-	1700	1000	1850
T-LI-2	73	65	70	74	74	75	68
T-LI-3	86	82	98	107	118	124	123
T-LI-5	81	78	94	103	116	119	117
T-LI-6	140	121	137	139	139	136	130
T-LI-8	137	117	135	140	137	135	130
T-LI-9	71	65	77	85	91	94	97
T-LI-11	80	78	95	105	112	115	117
T-LI-12	68	61	68	73	74	73	69
T-LI-13	151	135	151	153	154	152	147
T-LI-14	153	137	154	156	158	156	151
T-LI-15	150	129	152	155	157	156	152
T-LI-16	152	132	155	157	159	157	152
T-LI-17	86	78	88	92	97	98	107
LLC	61	83	93	97	63	89	87
LUC		61	62		89	71	64
LM		56		65	66	62	82



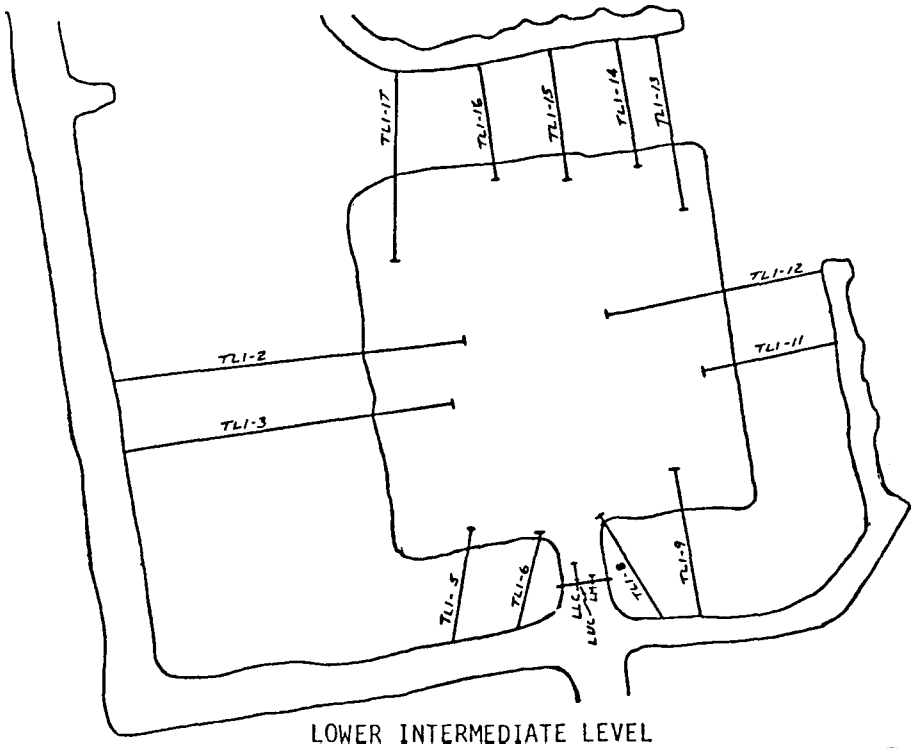
LOWER INTERMEDIATE LEVEL

DATE	10/9/78	10/10/78	10/11/78	10/12/78	10/13/78	10/14/78	10/15/78
TIME	1745	1730	2000	-	1930	1650	-
T-LI-2	68	73	68	69	69	71	72
T-LI-3	127	135	131	130	131	137	136
T-LI-5	117	124	122	122	124	126	127
T-LI-6	127	130	128	132	134	138	137
T-LI-8	128	129	126	124	129	134	135
T-LI-9	102	110	112	115	117	122	123
T-LI-11	120	125	125	125	127	132	131
T-LI-12	68	71	69	70	-	74	72
T-LI-13	146	150	152	149	148	151	149
T-LI-14	152	158	160	156	154	160	156
T-LI-15	153	158	160	156	156	158	158
T-LI-16	155	162	162	158	156	160	157
T-LI-17	107	115	121	124	125	132	132
LUC	80	82	80	80	82	85	84
LLC	56	70	69	66	66	74	66
LM	64	62	56	57	57	65	62



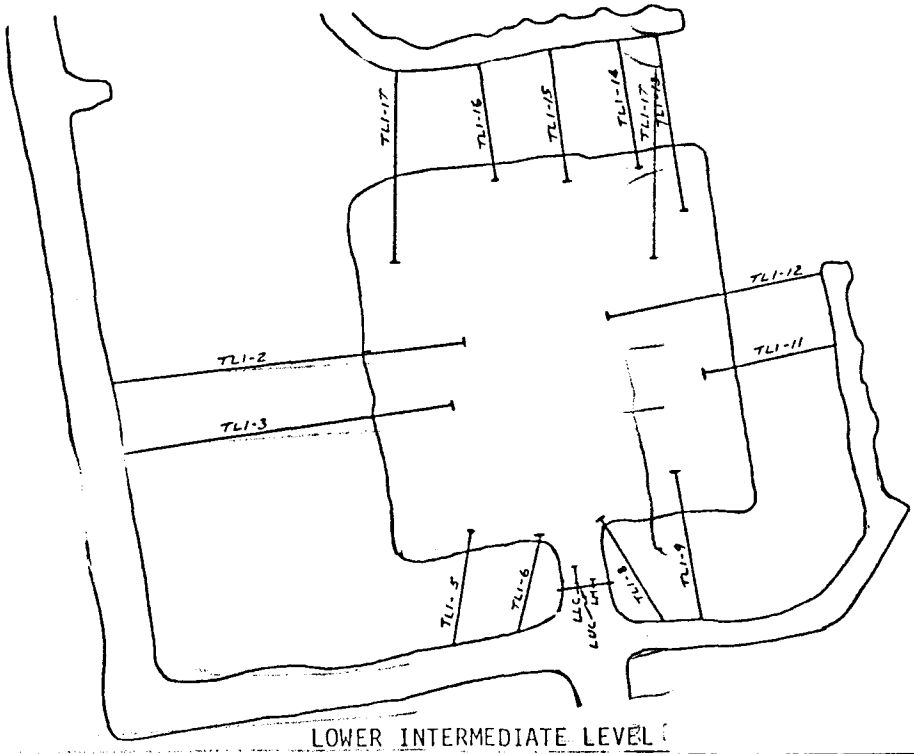
LOWER INTERMEDIATE LEVEL

DATE	10/16/78	10/17/78	10/18/78	10/19/78	10/20/78	10/21/78	10/22/78
TIME	2110	1800	1630	1930	1630	2020	2035
T-LI-2	70	70	69	78	79	72	75
T-LI-3	135	137	136	145	146	140	143
T-LI-5	124	124	125	132	130	137	129
T-LI-6	127	135	134	141	138	126	142
T-LI-8	134	135	132	141	137	137	140
T-LI-9	122	122	124	133	130	125	132
T-LI-11	128	128	129	138	135	132	137
T-LI-12	70	75	68	77	74	71	75
T-LI-13	146	149	148	152	152	146	142
T-LI-14	154	150	153	157	159	152	156
T-LI-15	155	156	155	158	159	152	155
T-LI-16	155	157	155	158	160	153	136
T-LI-17	131	136	137	141	147	141	154
LUC	79	80	80	88	85	82	86
LLC	72	68	67	68	69	69	69
LM	56	58	57	66	64	59	63



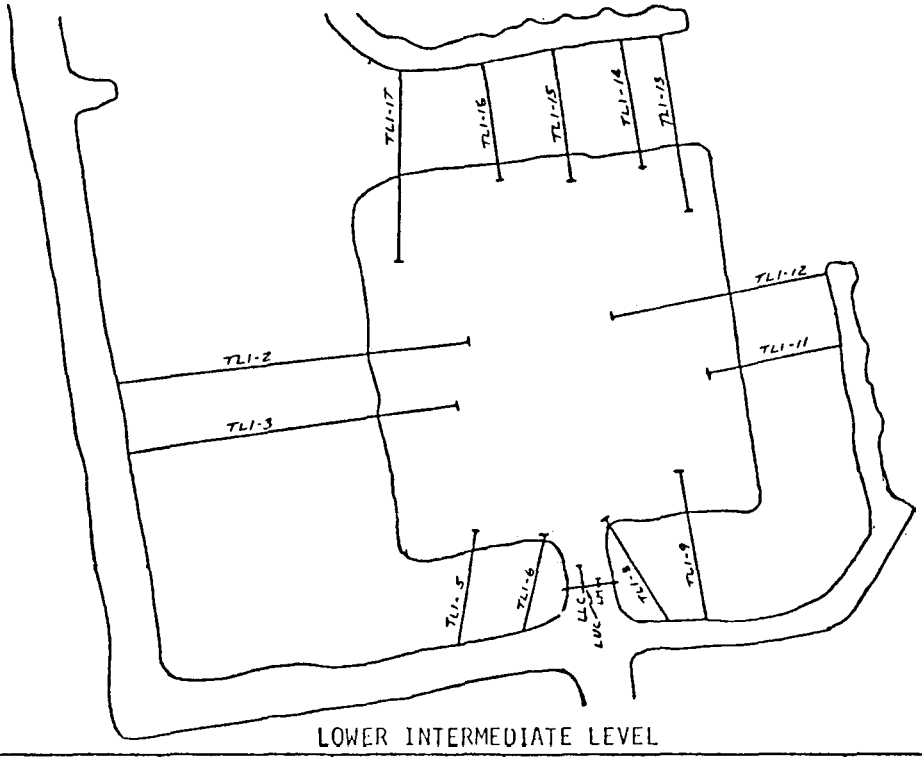
LOWER INTERMEDIATE LEVEL

DATE	10/23/78	10/24/78	10/25/78	10/26/78	10/27/78	10/28/78	10/29/78
TIME	1700	1645	1900	1900	1730	1830	1630
T-LI-2	77	72	71	74	76	77	78
T-LI-3	145	140	141	142	143	143	144
T-LI-5	131	124	127	129	134	133	132
T-LI-6	146	142	144	140	138	141	143
T-LI-8	140	137	139	139	138	139	140
T-LI-9	132	129	129	130	132	133	134
T-LI-11	136	131	132	132	134	135	136
T-LI-12	75	70	72	72	75	76	77
T-LI-13	149	147	146	145	146	145	146
T-LI-14	157	154	152	150	149	150	152
T-LI-15	157	154	153	152	152	151	151
T-LI-16	157	154	153	152	152	150	152
T-LI-17	144	140	139	139	141	138	138
LUC	83	83	84	84	85	86	86
LLC	73	70	71	71	71	72	71
LM	64	68	84	64	59	56	-



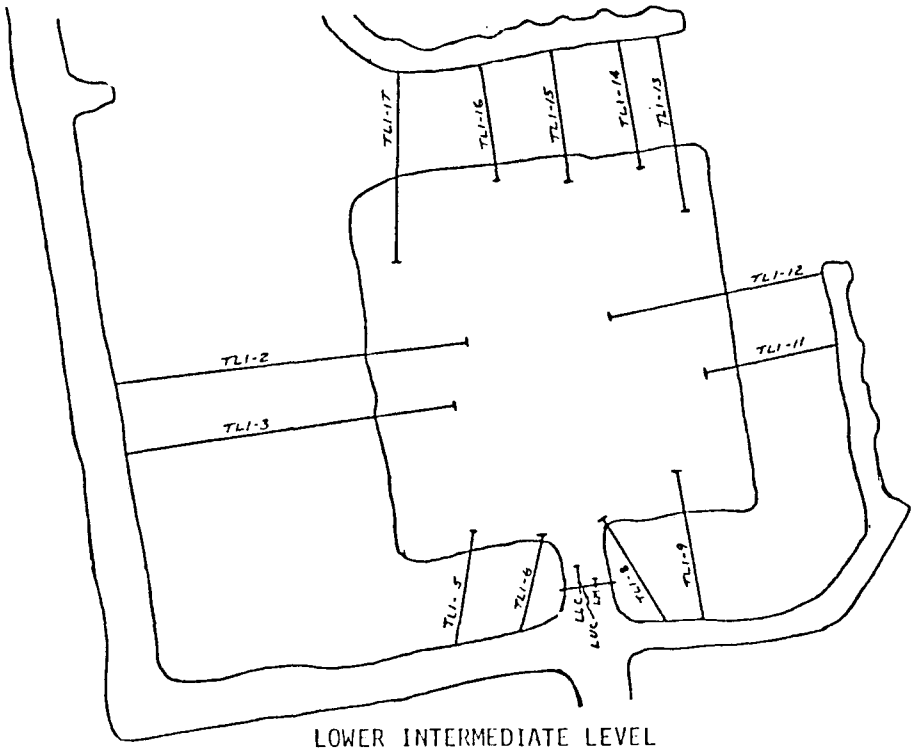
LOWER INTERMEDIATE LEVEL

DATE	10/30/78	10/31/78	11/1/78	11/2/78 1/	11/3/78	11/4/78	11/5/78
TIME	0135	1900	1730	1600 1/	1645	1900	1900
T-LI-2	80	81	83	84	85	87	88
T-LI-3	145	146	146	147	147	148	148
T-LI-5	134	135	136	136	136	137	137
T-LI-6	142	143	144	145	144	147	147
T-LI-8	140	140	140	141	141	143	143
T-LI-9	135	135	136	137	137	138	138
T-LI-11	136	136	137	137	139	139	139
T-LI-12	79	80	81	83	84	87	88
T-LI-13	148	147	147	148	148	147	146
T-LI-14	154	154	154	155	152	152	151
T-LI-15	153	154	154	155	155	154	153
T-LI-16	153	153	153	154	153	152	151
T-LI-17	140	139	139	140	140	141	141
LUC	86	86	86	87	87	87	87
LLC	71	70	70	72	71	72	70
LM							



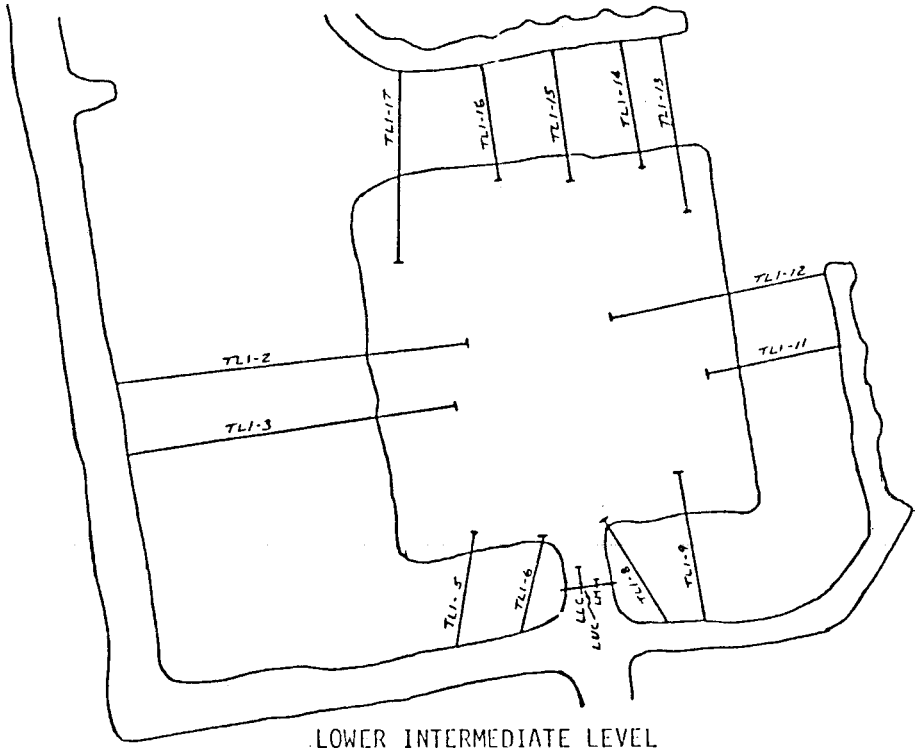
LOWER INTERMEDIATE LEVEL

DATE	11/6/78	11/7/78	11/8/78	11/9/78	11/10/78	11/11/78	11/12/78
TIME	1600	2200	1830	1620	1830	1600	2140
T-LI-2	90	91	92	93	95	98	98
T-LI-3	149	149	148	149	149	149	150
T-LI-5	139	141	141	142	143	143	144
T-LI-6	148	146	147	149	146	145	148
T-LI-8	145	144	144	145	145	144	145
T-LI-9	139	140	139	140	141	140	142
T-LI-11	140	141	142	142	143	142	144
T-LI-12	90	93	93	95	98	98	102
T-LI-13	147	146	146	146	147	146	147
T-LI-14	152	151	152	152	152	152	154
T-LI-15	153	153	154	153	154	154	156
T-LI-16	157	150	150	150	151	151	152
T-LI-17	141	142	142	143	144	144	145
LUC	87	76	87	87	87	87	84
LLC	70	70	70	70	70	69	68
LM		87					



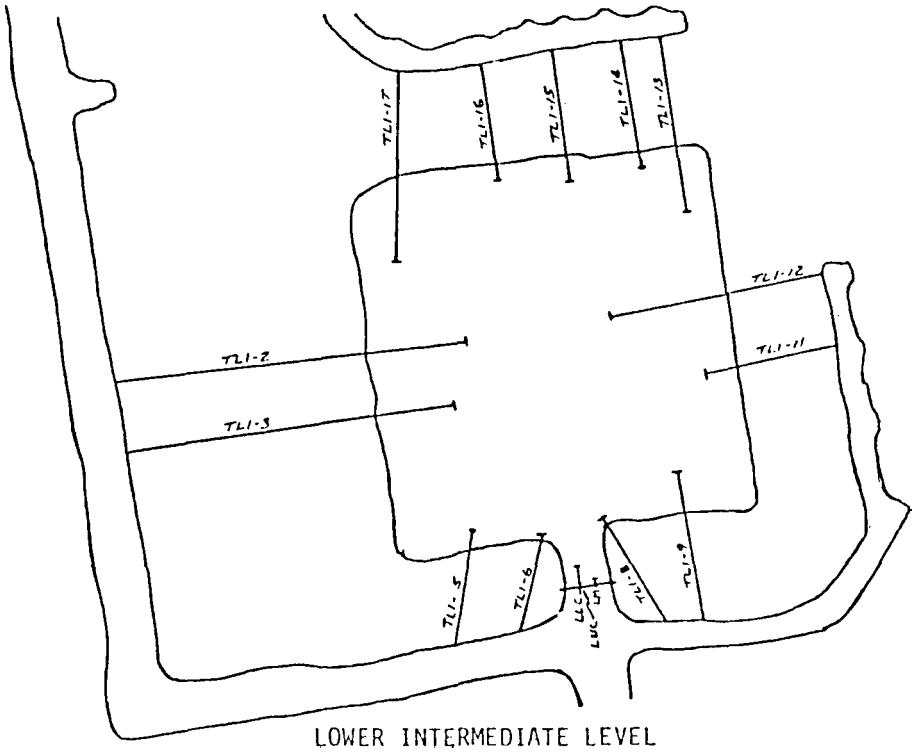
LOWER INTERMEDIATE LEVEL

DATE	11/13/78	11/14/78	11/15/78	11/16/78	11/17/78	11/18/78	11/19/78
TIME	1840	1700	1730	1745	1600	1640	1635
T-LI-2	98	102	102	102	105	106	108
T-LI-3	145	147	148	148	149	149	151
T-LI-5	142	143	144	144	145	145	147
T-LI-6	145	147	148	147	148	149	149
T-LI-8	144	145	145	145	146	146	148
T-LI-9	142	142	143	144	145	135	137
T-LI-11	143	145	143	144	145	146	147
T-LI-12	102	104	107	109	111	113	115
T-LI-13	148	146	147	148	148	149	149
T-LI-14	152	152	154	154	154	155	157
T-LI-15	154	154	157	157	157	159	159
T-LI-16	152	153	155	156	155	157	157
T-LI-17	144	144	145	144	145	146	146
LUC	87	86	86	85	88	89	87
LLC	70	70	68	68	69	70	69
LM							



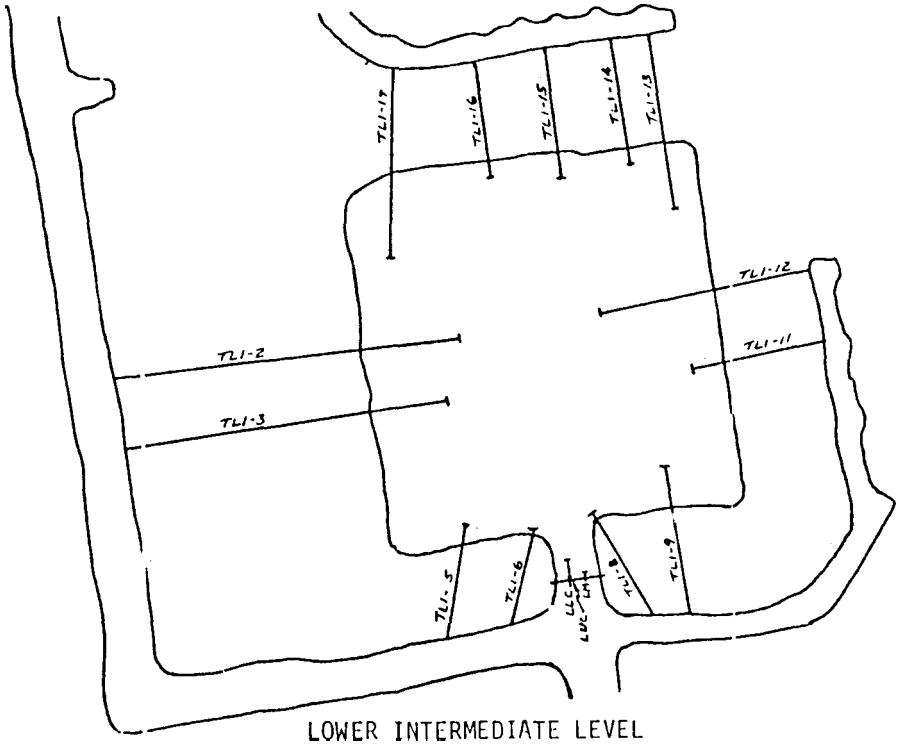
LOWER INTERMEDIATE LEVEL

DATE	11/20/78	11/21/78	11/22/78	11/23/78	11/24/78	11/25/78	11/26/78
TIME	0130	0600	1830	1815	1645	2100	1700
T-LI-2	109	109	112	111	116	117	118
T-LI-3	149	150	149	148	150	150	151
T-LI-5	146	148	147	146	149	147	149
T-LI-6	149	150	149	148	151	148	147
T-LI-8	146	147	147	146	149	147	147
T-LI-9	137	147	147	146	149	148	149
T-LI-11	146	148	147	147	148	149	150
T-LI-12	115	118	119	118	122	122	125
T-LI-13	149		149	148	150	150	151
T-LI-14	155		153	152	153	153	154
T-LI-15	158		157	156	157	157	158
T-LI-16	157		156	155	156	156	157
T-LI-17	146		146	145	147	147	149
LUC	89	90	91	90	94	93	93
LLC	69	71	71	69	74	74	74
LM					61	61	62



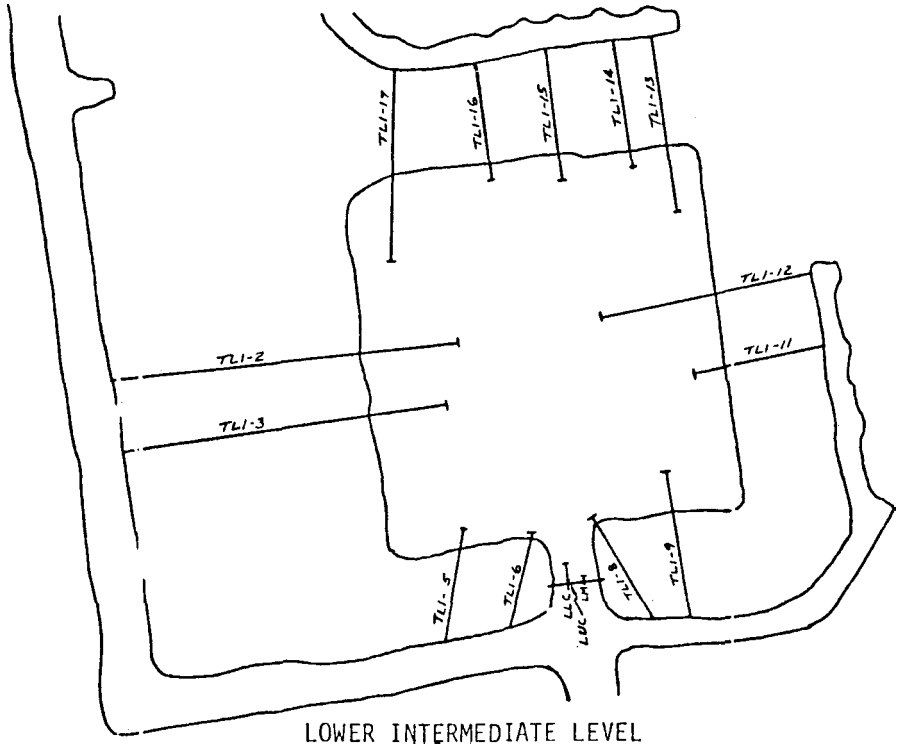
LOWER INTERMEDIATE LEVEL

DATE	11/27/78	11/28/78	11/29/78	11/30/78	12/1/78	12/2/78	12/3/78
TIME	1830	905	1700	-	0400	1700	1830
T-LI-2	117	120	119	121	123	125	127
T-LI-3	149	151	149	150	151	152	122
T-LI-5	147	148	149	148	148	151	145
T-LI-6	147	148	150	142	412	147	142
T-LI-8	146	147	149	145	144	148	143
T-LI-9	149	149	151	151	151	155	151
T-LI-11	149	142	153	152	151	153	150
T-LI-12	123	127	130	131	131	134	132
T-LI-13	148	149	150	149	146	145	
T-LI-14	150	150	157	151	145	145	
T-LI-15	155	156	156	157	152	151	
T-LI-16	154	155	135	156	150	149	
T-LI-17	147	153	154	150	148	148	
LUC	92	95	97	93	97	103	96
LLC	73	76	76	73	77	80	73
LM	61				56	56	



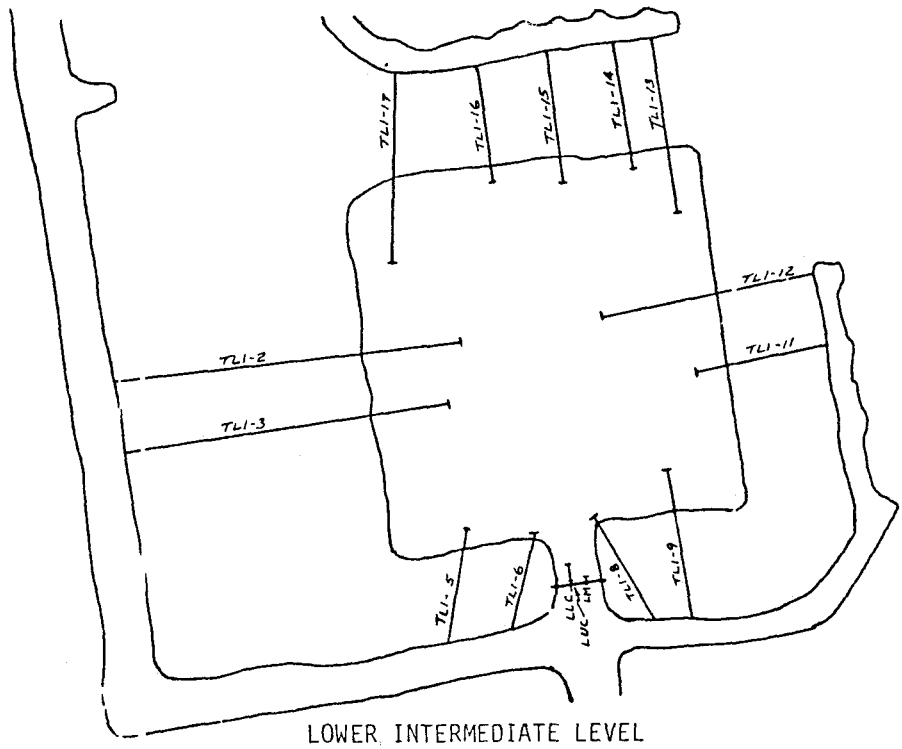
LOWER INTERMEDIATE LEVEL

DATE	12/4/78	12/5/78	12/6/78	12/7/78	12/8/78	12/9/78	12/10/78
TIME	1800	-	1700	1800	1800	2000	2100
T-LI-2	125	127	126	125	126	124	126
T-LI-3	149	147	150	147	148	145	146
T-LI-5	145	147	146	144	143	141	142
T-LI-6	143	144	146	142	140	134	141
T-LI-8	141	145	145	142	142	138	137
T-LI-9	149	154	143	150	152	150	149
T-LI-11	144	149	157	147	148	145	145
T-LI-12	131	133	136	134	138	132	138
T-LI-13					145	136	138
T-LI-14					145	137	137
T-LI-15					148	144	146
T-LI-16					145	142	141
T-LI-17					149	140	145
LUC	94	94	97	91	92	92	92
LLC	68	69	74	68	66	66	66
LM	44		56		46		



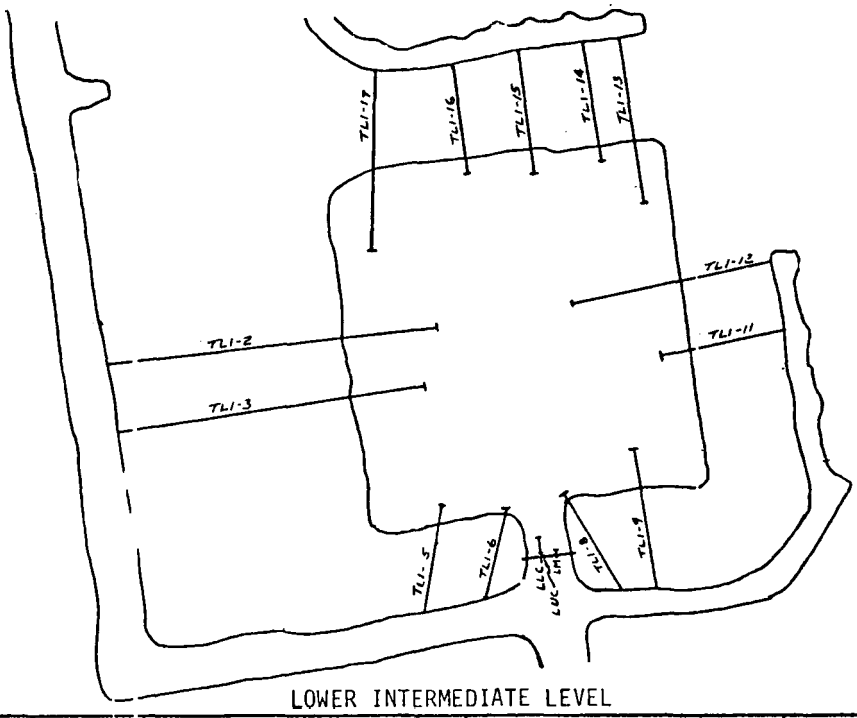
LOWER INTERMEDIATE LEVEL

DATE	12/11	12/12	12/13	12/14	12/15	12/16	12/17
TIME	1700	2000	2000	1200	1630	1700	2114
T-LI-2	122	122	125	125	129	131	132
T-LI-3	142	140	140	142	143	144	146
T-LI-5	139	139	140	142	144	147	147
T-LI-6	142	142	145	148	150	155	154
T-LI-8	138	139	140	143	143	145	146
T-LI-9	145	143	145	145	147	150	146
T-LI-11	142	138	140	142	139	144	142
T-LI-12	138	138	135	140	139	143	141
T-LI-13	140	139	140	142	148	150	150
T-LI-14	139	140	140	145	149	150	149
T-LI-15	143	142	145	152	153	155	153
T-LI-16	140	142	145	147	152	154	152
T-LI-17	140	138	140	152	142	144	143
LUC	72	72	80	61	92	89	92
LLC	65	78	75	72	68	71	71
LM		59	55	60	50	55	-



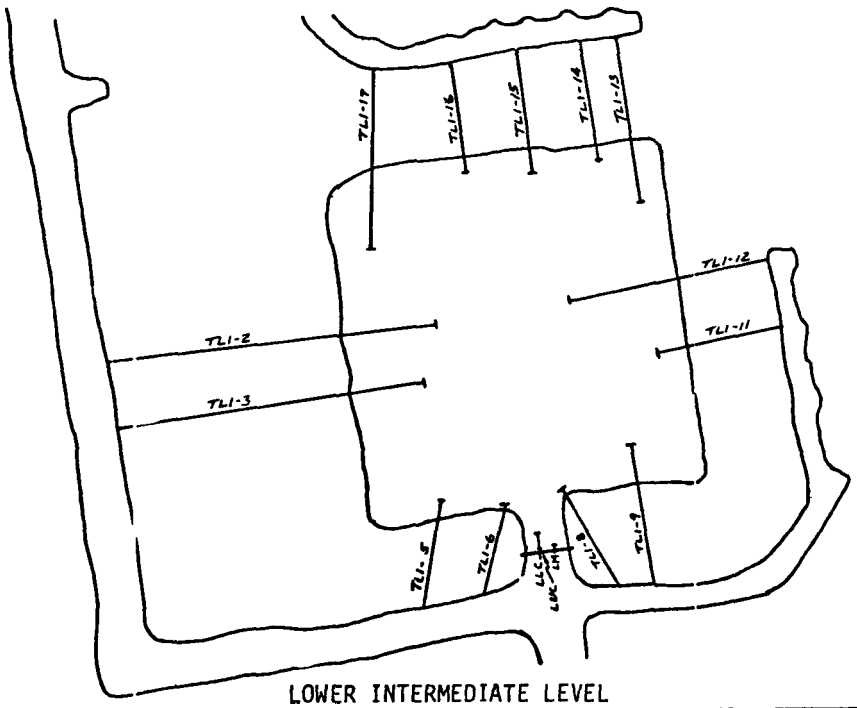
LOWER INTERMEDIATE LEVEL

DATE	12/18/78	12/19/78	12/20/78	12/21/78	12/22/78	12/23/78	12/24/78
TIME	2000	2000	2000	2000	2000	2000	2000
T-LI-2	135	130	138	137	138	142	140
T-LI-3	145	145	147	145	150	157	157
T-LI-5	155	140	155	155	158	160	158
T-LI-6	160	160	165	161	167	160	163
T-LI-8	170	160	162	160	170	160	162
T-LI-9	150	145	155	153	155	158	158
T-LI-11	160	150	158	155	162	162	160
T-LI-12	160	150	160	158	160	158	158
T-LI-13	151	160	158	158	160	155	160
T-LI-14	151	150	155	158	162	160	158
T-LI-15	153	160	160	160	162	158	160
T-LI-16	152	160	160	160	162	160	160
T-LI-17	143	140	141	142	142	142	143
LUC	93			142			
LLC	93	100		92	225	182	192
LM							



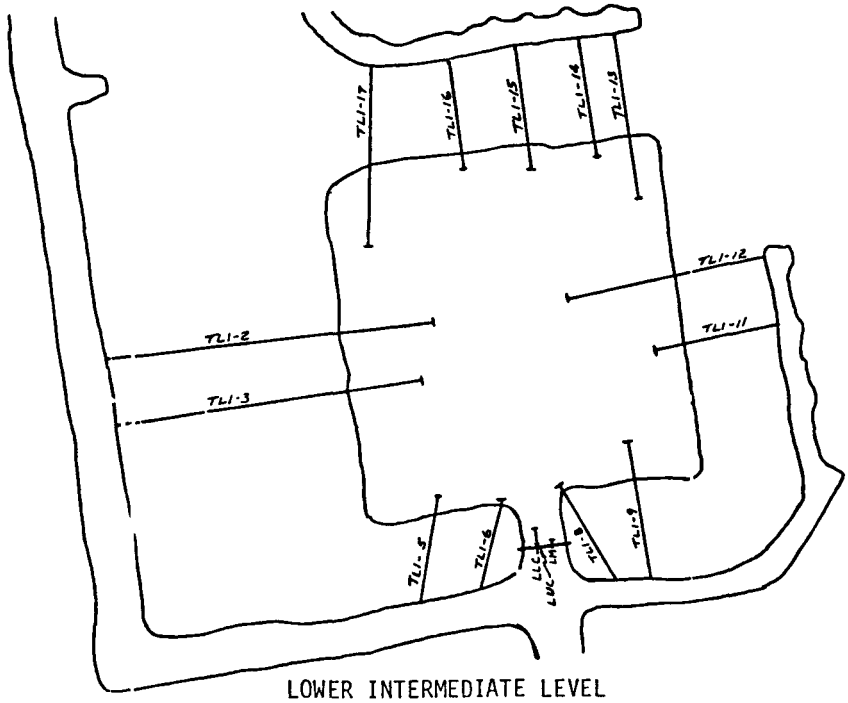
LOWER INTERMEDIATE LEVEL

DATE	12/25/78	12/26/78	12/27/78	12/28/78	12/29/78	12/30/78	12/31/78
TIME	2000	2000	2000	2000	2000	2000	2000
T-LI-2	141	142	138	139	140	140	140
T-LI-3	150	153	145	150	150	150	150
T-LI-5	159	160	158	160	160	155	152
T-LI-6	162	168	170	165	165	165	165
T-LI-8	162	168	165	162	162	155	158
T-LI-9	158	158	160	155	155	150	160
T-LI-11	159	160	160	150	152	155	160
T-LI-12	157	160	158	155	155	155	155
T-LI-13	158	158	155	155	155	155	155
T-LI-14	158	160	158	155	150	155	155
T-LI-15	158	158	158	160	163	155	160
T-LI-16	157	158	162	158	150	150	155
T-LI-17	143	150	150	150	158	148	150
LUC	-	-	-	-	-	-	-
LLC	165	168	163	153	165	140	150
LM	-	-	-	-	-	-	-



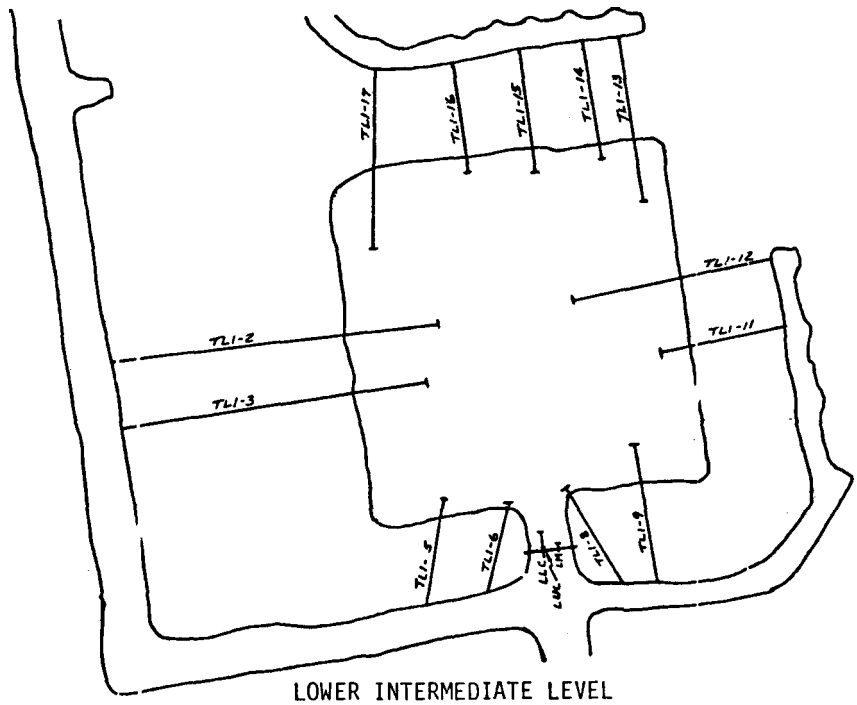
LOWER INTERMEDIATE LEVEL

DATE	1/1/79	1/2/79	1/3/79	1/4/79	1/5/79	1/6/79	1/7/79
TIME	2000	2000	2215	2000	2000	2000	2000
T-LI-2	145	142	140	140	140	142	145
T-LI-3	145	150	145	155	150	155	158
T-LI-5	150	145	150	155	150	150	155
T-LI-6	160	160	165	165	170	170	170
T-LI-8	160	165	160	160	160	162	165
T-LI-9	158	145	155	155	150	150	150
T-LI-11	147	150	155	160	160	155	155
T-LI-12	158	162	155	160	150	155	155
T-LI-13	145	145	155	155	155	150	155
T-LI-14	158	155	155	155	155	158	160
T-LI-15	158	158	155	155	150	158	158
T-LI-16	158	150	155	158	155	155	155
T-LI-17	150	162	155	158	150	155	150
LUC							
LLC	130	130	142	160	175	155	160
LM							



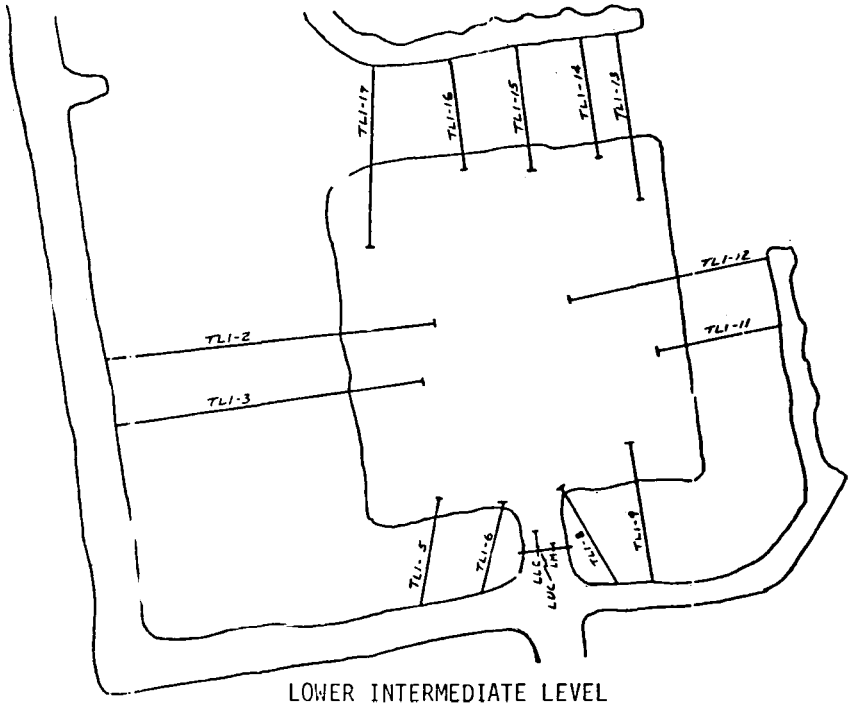
LOWER INTERMEDIATE LEVEL

DATE	1/8	1/9	1/10	1/11	1/12	1/13	1/14
TIME	2000	2000	2000	2000	2000	2000	2000
T-LI-2	142	150	155	145	155	145	145
T-LI-3	150	150	155	155	160	155	150
T-LI-5	148	150	180	155	140	160	150
T-LI-6	175	175	175	175	175	175	170
T-LI-8	165	165	170	175	180	180	175
T-LI-9	150	150	160	145	155	170	160
T-LI-11	150	155	155	160	155	160	155
T-LI-12	155	158	160	160	155	160	150
T-LI-13	160	158	160	160	165	180	180
T-LI-14	160	160	160	160	165	175	180
T-LI-15	160	160	160	160	155	160	160
T-LI-16	160	160	160	155	155	160	160
T-LI-17	148	150	150	155	150	145	145
LUC							
LLC	102	85	160	170	165	120	90
LM							



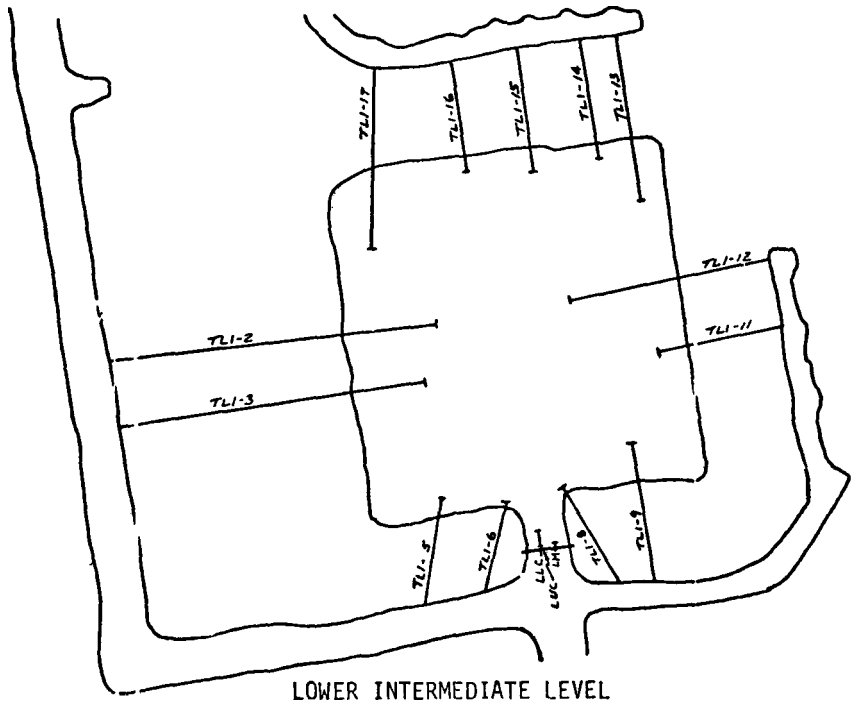
LOWER INTERMEDIATE LEVEL

DATE	1/15/79	1/16/79	1/17/79	1/18/79	1/19/79	1/20/79	1/21/79
TIME	2000	2000	2000	2000	2000	2000	2000
T-LI-2	145	145	145	147	145	147	145
T-LI-3	155	150	155	152	157	153	155
T-LI-5	155	155	158	160	160	160	162
T-LI-6	205	290	385	480	598	775	897
T-LI-8	180	190	190	192	195	202	213
T-LI-9	160	160	165	165	170	175	175
T-LI-11	155	155	158	160	160	162	160
T-LI-12	150	155	150	155	150	153	152
T-LI-13	180	190	195	198	202	205	210
T-LI-14	195	205	215	225	238	245	255
T-LI-15	160	160	163	162	163	165	162
T-LI-16	165	160	160	162	163	162	162
T-LI-17	145	145	145	145	143	145	145
LUC							
LLC	90	90	90	90	90	90	90
LM							



LOWER INTERMEDIATE LEVEL

DATE	1/22/79	1/23/79	1/24/79	1/25/79	1/26/79	1/27/79	1/28/79
TIME	2000	2000	2000	1900	1900	1900	1900
T-LI-2	148	147	150	150	150	155	155
T-LI-3	155	155	150	155	152	160	158
T-LI-5	162	163	175	170	170	175	172
T-LI-6	980	1070	1185	1295	1365	1375	1370
T-LI-8	258	280	300	320	350	365	400
T-LI-9	183	180	180	185	195	218	255
T-LI-11	165	182	170	165	175	175	180
T-LI-12	157	152	145	150	145	155	150
T-LI-13	215	218	220	220	225	225	238
T-LI-14	263	273	275	285	290	298	300
T-LI-15	165	165	165	165	165	165	165
T-LI-16	165	165	160	160	160	160	160
T-LI-17	145	145	145	150	145	145	145
LUC							
LLC	95	92	85	160		145	150
LM				175	190		155



LOWER INTERMEDIATE LEVEL

DATE	1/29	1/30	1/31				
TIME	2000	1900	1900				
T-LI-2	150	150	150				
T-LI-3	155	155	160				
T-LI-5	175	182	185				
T-LI-6	1358	1355	1360				
T-LI-8	430	455	465				
T-LI-9	308	350	400				
T-LI-11	190	190	200				
T-LI-12	150	145	145				
T-LI-13	238	240	240				
T-LI-14	310	315	320				
T-LI-15	160	162	165				
T-LI-16	155	155	160				
T-LI-17	145	142	150				
LUC							
LLC	150	160	158				
LM	140	150	170				

APPENDIX B

ENVIRONMENTAL DATA ANALYSES

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ENVIRONMENTAL DATA ANALYSES

I. INTRODUCTION

Environmental data collected at the Logan Wash mine site during 1978 are shown as collection frequency and operational timelines in Figures 1 and 2. These figures reflect the periods of time for which data were actually collected. In the case of water quality sampling, frequency of sampling at each site is reflected rather than duration of sample collection. Figure 3 is a map of the mine area showing the location of the meteorological and hydrological data collection sites. Figure 4 shows an elevation profile through the principal activity centers.

Most of the data collected in the first half of the year have been reported in previous Quarterly Reports to DOE. Analyses presented in this report include:

1) For hydrology - Water quality samples of surface water and groundwater have been collected from 41 monitoring sites and analyzed for as many as 45 parameters since mid-August, 1978. Measurement of precipitation, temperature, evapotranspiration, and water levels in alluvial and bedrock wells were obtained to develop a hydrologic budget for the D. A. Shale Tract and vicinity.

2) For meteorology - Quarterly wind roses are presented for the meteorological tower and for the mechanical weather station. Inversion statistics for November and December are presented as probability of occurrence, expected duration, expected height, and peak values. Graphic presentation is used to show average and peak inversion heights in relation to elevations of key mine facilities.

II. HYDROLOGIC STUDIES - D.A. SHALE TRACT AND VICINITY

Hydrologic monitoring of D.A. Shale Tract and vicinity includes water quality sampling as well as measurement of precipitation, temperature, evapotranspiration, streamflow, and water levels in alluvial and bedrock wells. All hydrologic data gathered in 1978 except water quality analyses are reported by Geo-

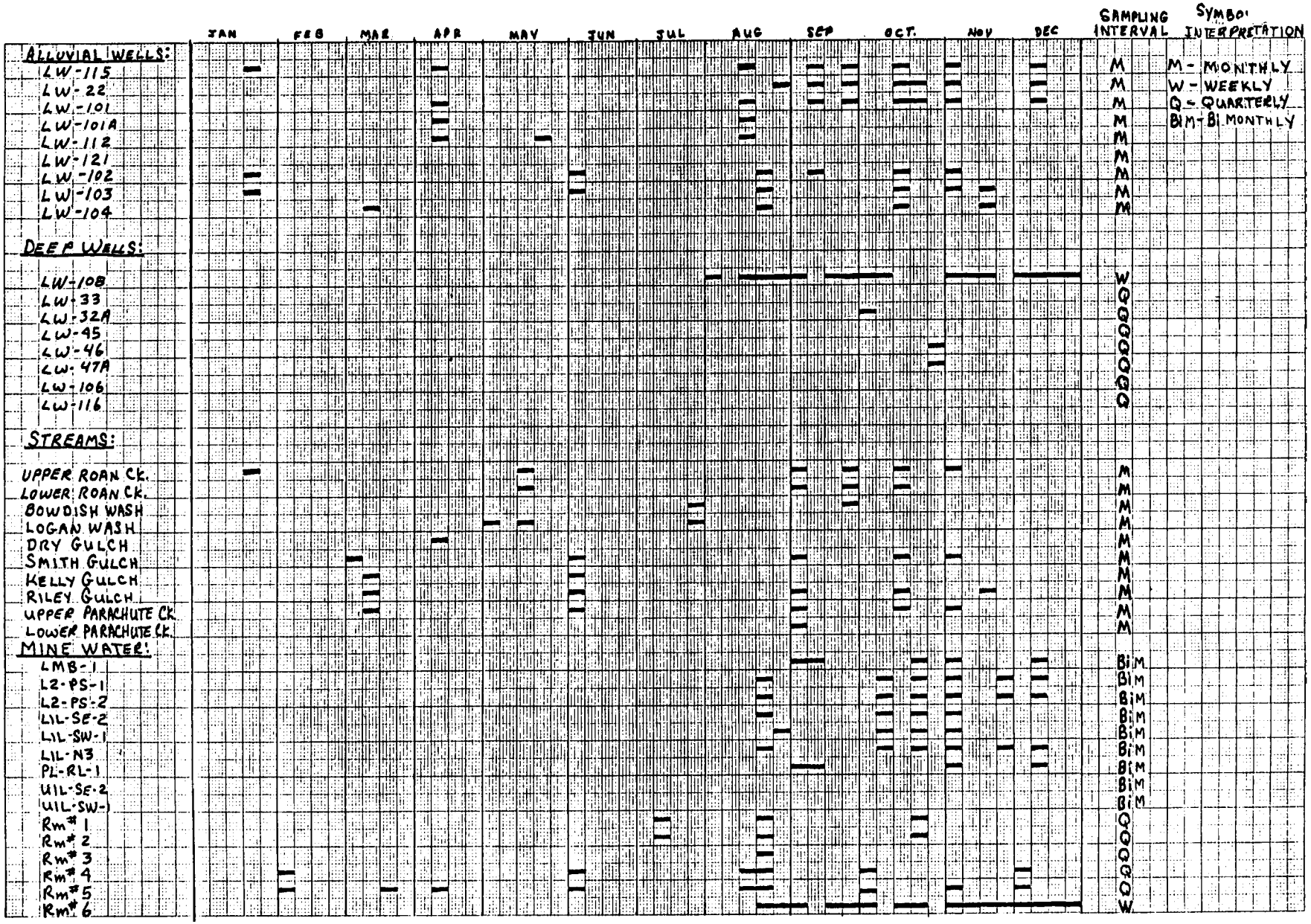


Figure 1. Water quality sampling frequency by site (1978).

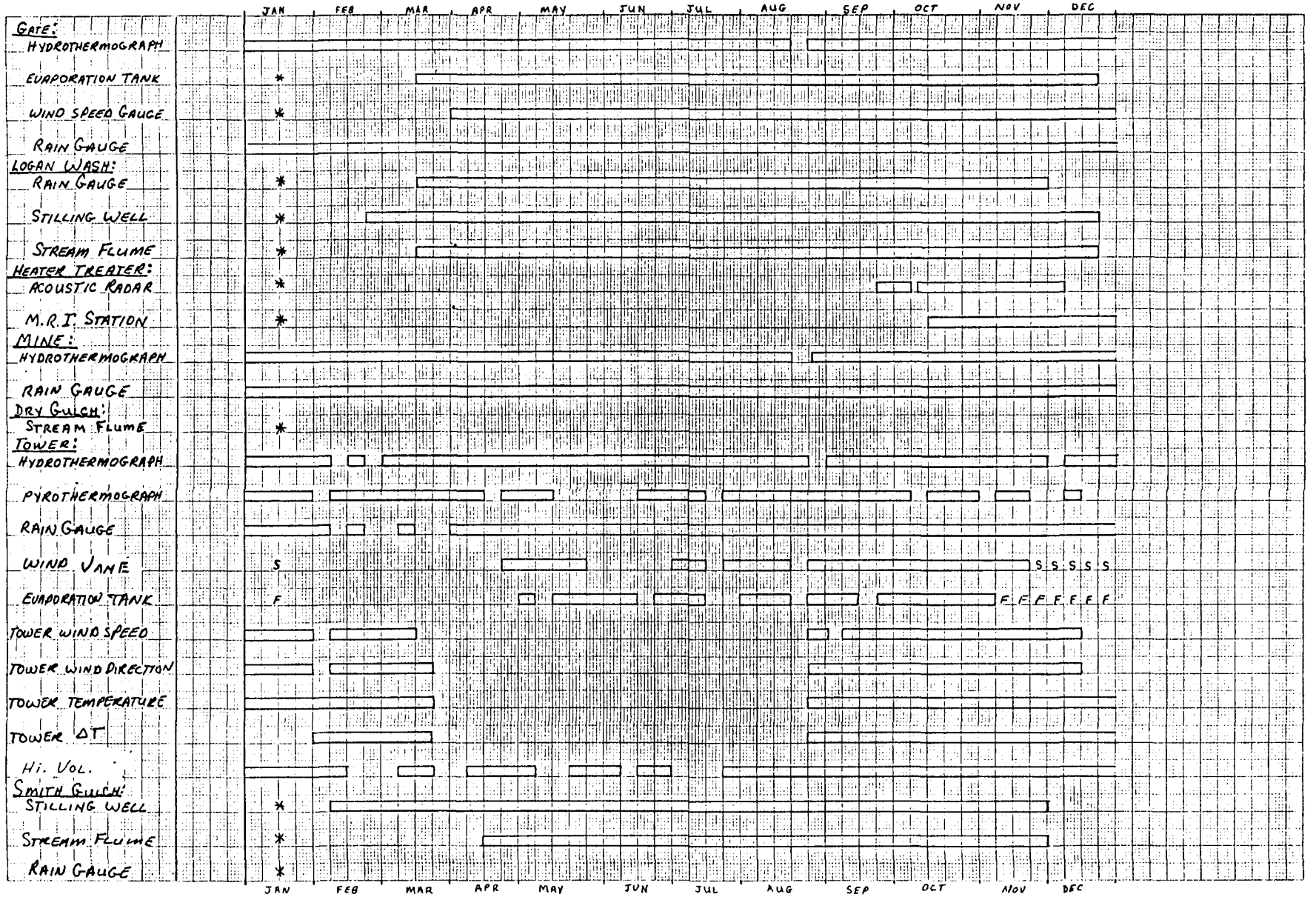


Figure 2. Environmental site operational timeline (1978).

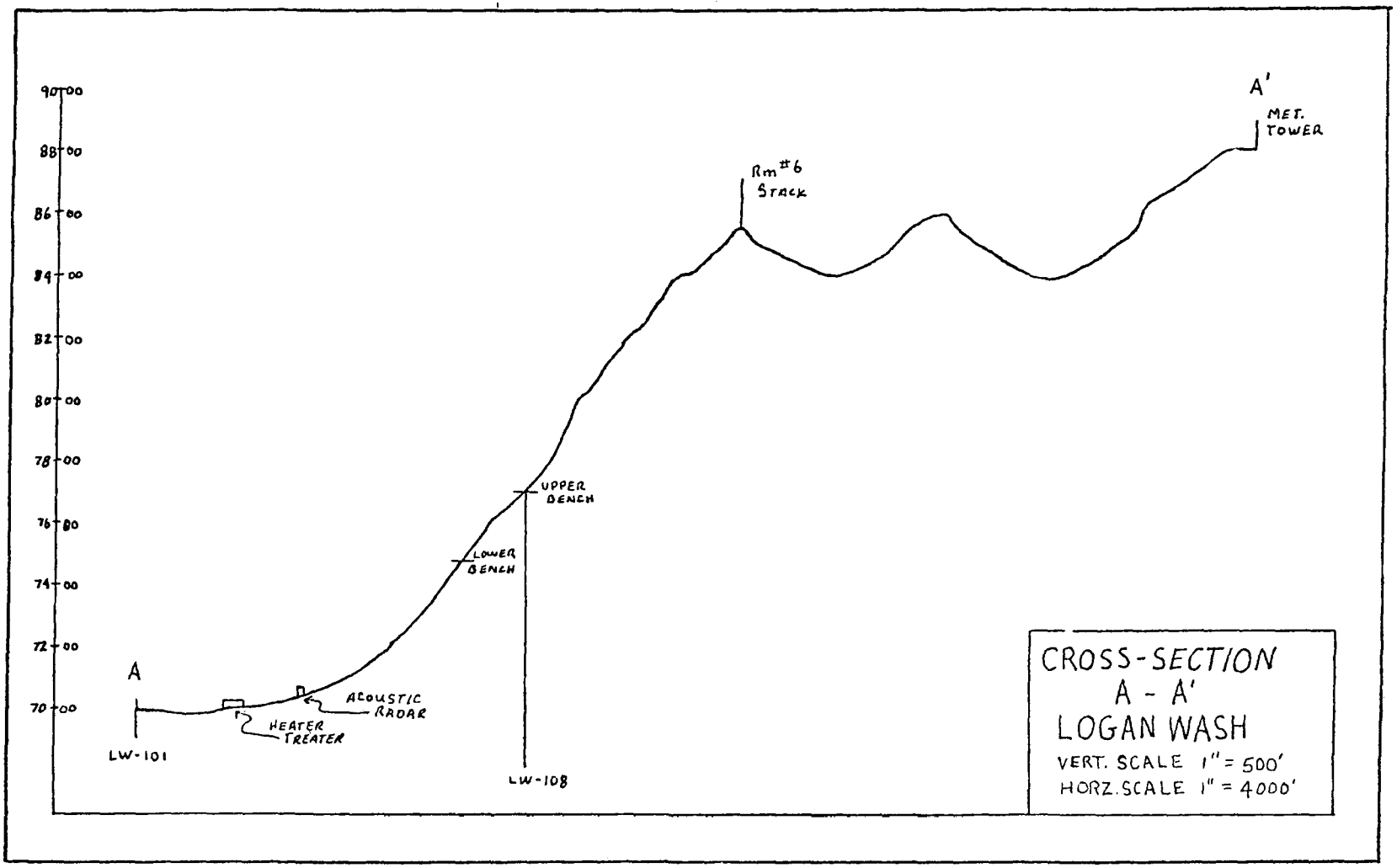


Figure 4. Elevation profile for Logan Wash mine area.

thermal Surveys, Inc., in Hydrology of the Occidental Oil Shale, Inc., D.A. Shale Area, A Progress Report, November 1, 1977 to October 31, 1978 (Appendix B1).

Samples of surface water and groundwater have been collected from 41 monitoring sites and analyzed for as many as 45 parameters since mid-August, 1978. Two new alluvial monitoring sites, LW-22 in Logan Wash and LW-21 in Bowdish Wash, were completed in the summer of 1978. The water quality analyses are provided in Appendices B2 and B3.

Sampling frequency for surface and groundwater quality studies is governed by "Exhibit A," Permit for In-Situ Oil Shale Report Number 6, Logan Wash Site, Colorado Department of Health, July 7, 1978. The analytical techniques utilized prior to November 29, 1978, were in accordance with the Environmental Protection Agency's approved method (EPA 625-16-74-003a). A modification of the EPA-approved method was then implemented which involves a series of filtrations of each sample prior to placement in the glass sample container. "Standard Methods" are employed where EPA specifications are not available. Analyses for all but five of the parameters listed in the permit are done by the Occidental Oil Shale, Inc. laboratory in Grand Junction. Coors Spectro-Chemical Laboratory in Golden, Colorado, analyzes the samples for Kjeldahl nitrogen, bacteriology, total organic carbon, radiology, mercury, and selenium (Appendix B4).

Six chemical parameters were selected as good indicators of water contamination due to mining and retorting activities. The indicator variables chosen are fluoride, phenol, boron, ammonia, total organic carbon, and nitrate. Any changes in water quality resulting from mining and processing activities, particularly since the ignition of Retort 6 on August 28, 1978, will be reflected in the increased concentrations of the indicator variables determined during the course of the ongoing monitoring program. The following discussions of surface and subsurface water quality data are confined to the values obtained for the indicator variables since mid-August, 1978.

1. SURFACE WATER

Water quality data for Smith Gulch, Roan Creek, Parachute Creek, and Riley Gulch (Figure 3) obtained during the period August-December, 1978 were studied

to determine if any trends could be established with respect to the indicator variables fluoride, phenol, boron, ammonia, total organic carbon, and nitrate. Logan Wash, Kelly Gulch, Bowdish Wash, and Dry Gulch are ephemeral drainages and were dry during this period (Table I).

Fluoride concentrations for all of the surface site samples were generally less than 2 mg/liter during the reporting period. Fluoride values were similarly low for the period May, 1975 - March, 1978 as reported in Water Quality Studies of D.A. Tract and Vicinity, A Baseline Report, August 28, 1978.

Values of phenol concentration obtained since August, 1978 are in the same range of values observed for surface water samples since March, 1978 and have generally remained below 0.02 mg/liter.

As was observed during the first three years of record, boron concentrations in surface water samples are generally of the same order of magnitude. The maximum value recorded since August, 1978, was a sample from Parachute Creek, upstream of Riley Gulch. Samples obtained one month before and after the sample contain considerably lower concentrations of boron.

Surface water data concerning ammonia concentrations are sparse at the present time. However, the data obtained since August, 1978 show the lowest concentrations of ammonia to occur in Riley Gulch, a tributary of Parachute Creek. The highest concentration for ammonia (30 mg/liter) was obtained in a sample from Parachute Creek, upstream of Riley Gulch. Values for ammonia concentration for all other surface sites are within the same order of magnitude reflected in the August 1978 baseline report.

Analyses for total organic carbon (TOC) by Coors Spectro-Chemical Laboratory are incomplete for 1978 samples. TOC concentrations for samples analyzed thus far are all of the same order of magnitude and considerably less than 100 mg/liter.

The range of nitrate values obtained from analyses of surface waters during the present reporting period compare favorably with the range observed for surface sites since March, 1976, and are all less than 7 mg/liter.

INDICATOR VARIABLE ANALYSES, SURFACE SITES

D. A. SHALE TRACT AND VICINITY

Table I

SITE LOCATION	SAMPLING FREQUENCY	SAMPLE DATE	FLUORIDE mg/l	PHENOL mg/l	BORON mg/l	AMMONIA AS N mg/l	TOTAL ORGANIC CARBON mg/l	NITRATE mg/l
SMITH GULCH	MONTHLY	09/06/78	1.9	0.003	0.32	1.4	31	29
		10/18/78	2.4	0.002	0.63	0.7	--	40
LOGAN WASH	MONTHLY	08/78-12/78	DRY					
BOWDISH WASH	MONTHLY	08/78-12/78	DRY					
DRY GULCH	WHEN FLOWING	08/78-12/78	DRY					
KELLY GULCH	QUARTERLY	08/78-12/78	DRY					
ROAN CREEK UPSTREAM	MONTHLY	09/06/78	0.90	0.016	0.54	5.6	42	3.9
		09/28/78	0.76	0.005	<0.04	--	50	3.5
		10/17/78	0.82	0.02	0.24	1.8	17	6.4
		11/08/78	0.87	0.005	1.3	2.4	--	<0.1
DOWNSTREAM	MONTHLY	09/06/78	1.1	0.004	0.11	3.9	24	3.9
		09/28/78	0.76	0.001	<0.04	--	--	8.9
		10/17/78	0.83	<0.001	0.39	0.40	17	4.8
PARACHUTE CREEK UPSTREAM	QUARTERLY	09/08/78	1.2	0.026	0.04	1.5	21	6.2
		10/18/78	1.0	0.004	3.6	2.5	--	0.2
		11/08/78	1.0	0.012	0.27	30	--	<0.1
DOWNSTREAM	QUARTERLY	09/08/78	1.6	0.016	<0.04	<0.04	52	7.1
RILEY GULCH	QUARTERLY	09/07/78	0.90	0.018	0.11	<0.04	28	2.2
		10/18/78	0.58	0.014	0.19	<0.04	15	<0.1
		11/22/78	0.53	0.005	0.1	<0.04	--	0.2

2. SUBSURFACE DATA

2.1 Alluvial Wells

Monitoring wells in the alluvium of Logan Wash are sampled monthly in order to detect any changes in water quality which might be attributed to mining and retorting activities. The alluvial wells in Logan Wash include LW-101, LW-22, and LW-115 (Figure 3). The alluvium in Dry Gulch, a small tributary of Logan Wash near the head of the drainage, is monitored by LW-112. The Dry Gulch well has been dry since late summer, 1978. Alluvial wells in Smith Gulch (LW-102), Bowdish Wash (LW-121), Kelly Gulch (LW-103), and Riley Gulch (LW-104), provide baseline data for the purposes of comparison with water quality data obtained in Logan Wash.

Analyses of water samples obtained from alluvial sites since mid-August, 1978, are provided in Appendix B2. Interpretation of alluvial well data is confined to a discussion of the indicator variables - fluoride, phenol, boron, ammonia, total organic carbon, and nitrate (Table II).

Fluoride concentrations in samples obtained from the alluvial sites are generally below the 2 mg/liter screening limit. The data compares favorably with baseline data obtained since 1975 and reported in the August, 1978 baseline report. Values of fluoride concentration measured in the alluvial aquifer of Logan Wash fall within the range of values observed at the control sites. The data indicate that variation in fluoride concentrations is minimal at any given site. Fluoride concentrations in retort water are one or two orders of magnitude higher (Table III) than those exhibited by groundwater in the alluviated drainages of D.A. Shale Tract and vicinity. The steady state condition of fluoride under baseline conditions supports its value as an indicator in assessing potential water quality degradation due to retorting activities.

Phenol values for samples obtained from control sites are typically less than 1×10^{-2} mg/liter and show little variation over time. Samples from Logan Wash alluvial wells obtained during the last five months of 1978

INDICATOR VARIABLE ANALYSES, ALLUVIAL WELLS

D. A. SHALE TRACT AND VICINITY

Table II

SITE DESIGNATION	SITE LOCATION	SAMPLING FREQUENCY	SAMPLE DATE	FLUORIDE mg/l	PHENOL mg/l	BORON mg/l	AMMONIA AS N mg/l	TOTAL ORGANIC CARBON mg/l	NITRATE mg/l
LW-22	LOGAN WASH	MONTHLY	08/29/78	1.1	0.026	0.4	0.8	108	51
			09/12/78	1.1	0.012	0.2	1.5	47	34
			11/10/78	0.8	0.015	0.33	0.40	--	82
			12/12/78*	0.4	0.003	0.5	0.47	--	170
LW-101	LOGAN WASH	MONTHLY	08/15/78	0.85	0.028	0.66	2.84	47	160
			09/12/78	0.90	0.017	1.30	0.45	46	6.7
			10/17/78	0.63	0.030	1.40	0.92	31	210.0
			11/07/78	0.68	0.016	1.60	0.03	--	110.0
			12/13/78*	3.0	0.003	2	<0.04	--	310
LW-102	SMITH GULCH	MONTHLY	08/22/78	1.28	--	0.09	6.65	40	7.9
			09/13/78	1.40	0.018	0.03	1.40	22	15.0
			09/18/78	1.40	0.005	0.41	0.30	--	11.0
			11/03/78	1.30	0.003	0.39	--	--	15
			11/08/78	1.50	0.008	2.10	0.10	--	12.0
LW-103	KELLY GULCH	QUARTERLY	08/22/78	1.10	0.002	0.86	21.2	48	7.5
			10/18/78	1.2	0.001	0.22	6.3	--	11
			11/03/78	1.1	0.001	0.29	--	--	13
			11/08/78	1.2	0.003	0.23	1.8	--	20
			11/22/78	1.1	0.006	0.3	<0.04	--	9.5
LW-104	RILEY GULCH	QUARTERLY	08/22/78	0.74	0.01	2.2	5.45	--	330
			10/18/78	0.8	0.002	0.26	1.5	--	3.4
			11/22/78	0.62	0.007	0.46	9.6	--	11
LW-112	DRY GULCH	MONTHLY	08/15/78	INSUFFICIENT WATER IN WELL TO COLLECT COMPLETE SAMPLE.					
LW-115	LOGAN WASH	MONTHLY	08/15/78	0.92	0.02	0.87	--	73	6.7
			09/13/78	1.2	0.016	0.43	1.4	50	9.2
			09/27/78	1.2	0.014	0.65	--	108	16
			10/17/78	1.4	0.046	1.5	3.6	45	35
			11/03/78	1.1	0.046	1.6	--	--	8.6
			11/10/78	1.1	0.038	1.6	0.40	--	6.0
			12/15/78*	0.8	0.059	1	1.7	--	1
LW-121	BOWDISH WASH	MONTHLY	09/28/78	0.84	0.002	0.65	--	41	14
			10/78-12/78	NOT SAMPLED DUE TO CAVING OF HOLE; REDRILLED 12/01/78.					

*Filtered

INDICATOR VARIABLE ANALYSES, RETORTS

D. A. SHALE TRACT AND VICINITY

Table III

SITE DESIGNATION	SITE LOCATION	SAMPLING FREQUENCY	SAMPLE DATE	FLUORIDE mg/l	PHENOL mg/l	BORON mg/l	AMMONIA AS N mg/l	TOTAL ORGANIC CARBON mg/l	NITRATE mg/l
RETORT 6		WEEKLY	08/24/78	11.8	0.068	13	--	34	140
			08/31/78	12	0.11	< 0.04	28	30	170
			09/08/78	10	0.12	30	7.7	204	380
			09/15/78	NOT SAMPLED DUE TO UPSET IN CONDITIONS					
			09/22/78	8.3	0.35	0.22	--	886	75
			09/29/78	15	8.7	< 0.04	3.1	1110	62
			10/05/78						
			10/12/78	NO SAMPLE					
			10/20/78	21	7.2	3.9	200	1235	490
			10/26/78	24	18	9.4	850	--	710
			11/02/78	27	20	3.7	2000	--	640
			11/10/78	29	27	12	1300	--	330
			11/16/78	30	20	11	1800	--	390
			11/21/78	34	44	8.5	1800	--	390
			11/30/78*	34	24	15	1600	--	540
			12/07/78*	37	56	17	1500	--	640
RETORT 5		QUARTERLY	08/17/78	185	2.9	< 0.04	1.2	952	28
			08/26/78	200	3.12	3.0	1.7	798	20
			10/06/78	86	8.5	16	--	460	700
			11/09/78	1.8	22	4.7	2100	--	260
			12/07/78*	5.3	1.9	73	500	--	220
RETORT 4		QUARTERLY	08/17/78	36	7.6	2.2	10.9	1011	18
			08/26/78	40	23.7	16	2.25	1232	210
			10/06/78	26	12	7.4	--	297	570
RETORT 3		QUARTERLY	08/12/78	DRY					
RETORT 2		QUARTERLY	10/25/78	13.4	0.43	5.3	18	--	80
RETORT 1		QUARTERLY	10/25/78	11.5	0.31	6.7	46	--	19

*Filtered Sample

yield phenol concentrations which are generally less than $5x10^{-2}$ mg/liter. As given in the baseline report, phenol values for samples from alluvial wells have generally remained below 0.05 mg/liter since July, 1976. The concentrations of phenol in water drawn from an active retort are two to three orders of magnitude larger (Table III) than those associated with baseline conditions of the alluvial aquifers.

Boron levels in water samples from the alluviated drainages in the tract vicinity show considerable variability. Among the control sites, boron concentrations range from an observed minimum of 0.03 mg/liter to a maximum of 2.2 mg/liter. The observed maximum (2 mg/liter) and minimum (0.2 mg/liter) in Logan Wash differ by an order of magnitude. Values observed in Logan Wash thus fall within the range observed under baseline conditions.

Analysis of control site samples showed ammonia concentrations to range from less than the detection limit (0.04 mg/liter) upwards of 21 mg/liter. In Logan Wash, alluvial monitoring wells yielded samples which contained ammonia in concentrations below the screening limit up to 3.6 mg/liter. Water produced during the retorting process yields ammonia concentrations one to two orders of magnitude greater than the highest values observed in groundwater of the alluvial aquifers.

Analyses performed for total organic carbon by Coors Spectro-Chemical Laboratory are as yet incomplete for 1978. However, TOC values obtained from groundwater in the alluvial aquifers are generally less than 100 mg/liter. Values of TOC are typically greater than 800 mg/liter in retort water.

Nitrate concentrations are typically an order of magnitude lower in samples obtained from Smith Gulch, Riley Gulch, Bowdish Wash, and Kelly Gulch when compared to those obtained from LW-101 in Logan Wash. Nitrate concentration appears to decrease in the downstream direction as shown in analyses from LW-22 and LW-115.

2.2 Bedrock Wells

Ten new "satellite" wells were drilled within the Logan Wash mine (Figures 5, 6 & 7) prior to the ignition of Retort 6 to sample groundwater in close proximity to the retort. The wells are sampled twice a month. One of the wells, AL-N1, is no longer accessible because it is situated behind a bulkhead erected during the retort upset condition which occurred on September 12, 1978.

Analyses of indicator variables fluoride, phenol, boron, ammonia, total organic carbon, and nitrate for the wells on the periphery of Retort 6 are given in Table IV. The analyses for the new wells may be and have been compared in the following discussions to those obtained for LW-108, an uncased well drilled from the upper mine bench to a depth of approximately 950 feet (Table V). LW-108 is sampled on a weekly basis. Analyses of all water samples obtained from mid-August, 1978 through December, 1978 are given in Appendix B2.

Values of fluoride concentration are generally in the range of 10-20 mg/liter for water samples drawn from LW-108. Fluoride values in water obtained from the satellite wells are mostly of the same order of magnitude. The maximum value of fluoride in samples from the satellite wells was 12.8 mg/liter, which falls within the range of values recorded for LW-108. Fluoride concentrations in water drawn from Retort 6 are typically in the range of 20-40 mg/liter.

Phenol concentrations in water samples from LW-108 during the period August-December, 1978 are an order of magnitude higher than the two samples obtained from Retort 6 (0.068 mg/liter, 0.11 mg/liter) prior to ignition. One sample from LW-108 yielding a phenol value of 6.5 mg/liter is suspect since no other samples of such magnitude were recorded. Water from the satellite wells during the same period yielded phenol concentrations ranging from less than the detection limit (.001 mg/liter) to 0.93 mg/liter. A concentration of 11.6 mg/liter obtained from LIL-N3 during August, 1978 is not consistent with the values obtained for the satellite wells during the five months of record. Within a month after ignition

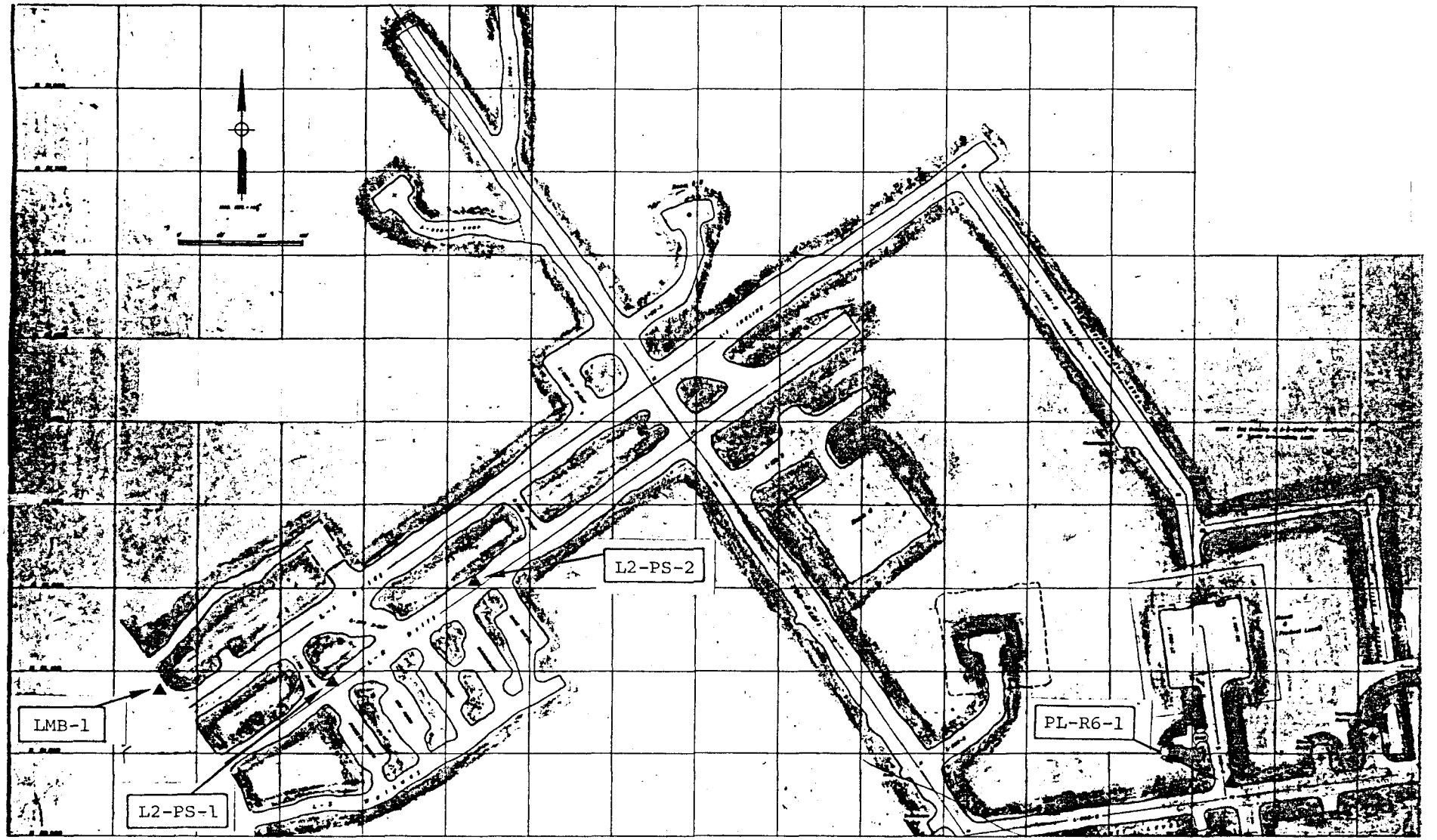
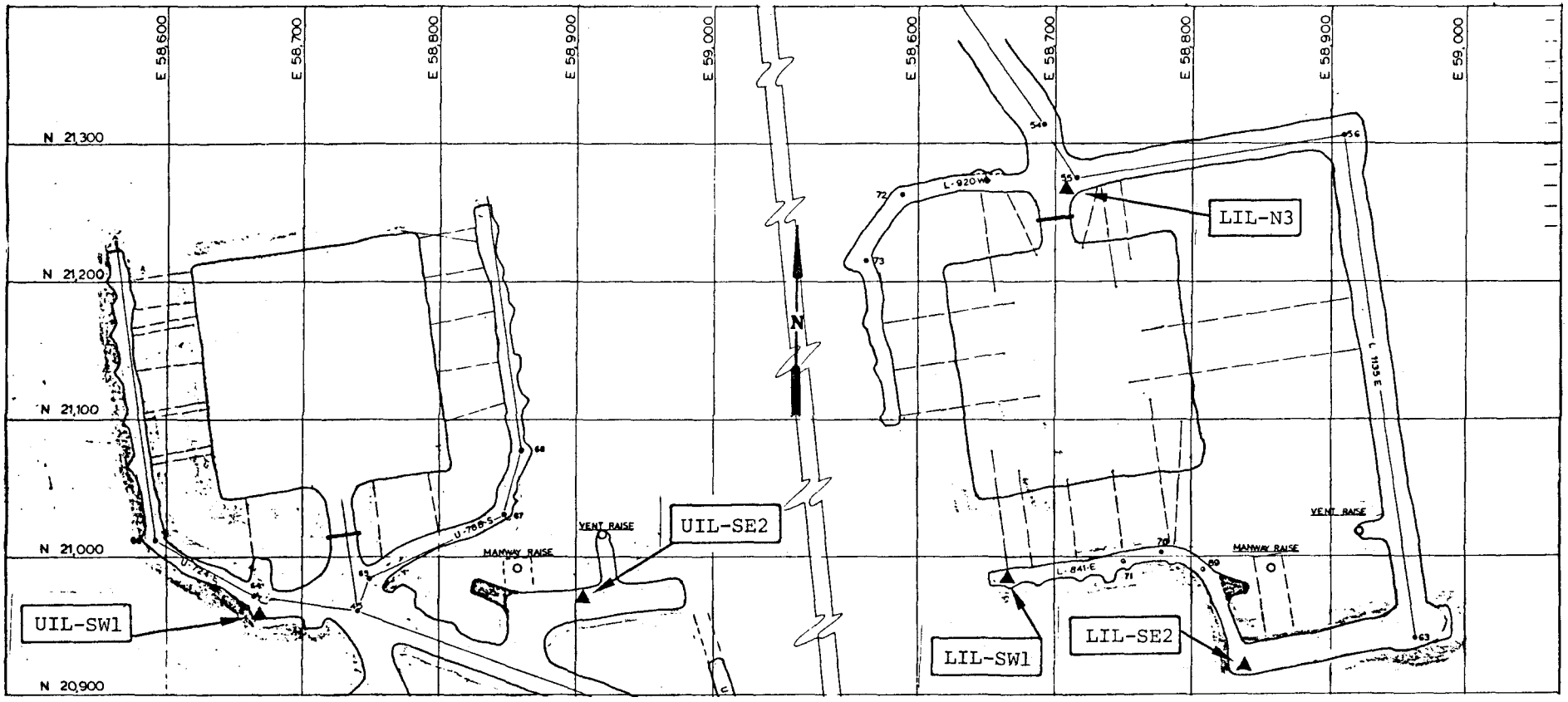


Figure 5. Retort 6 and process water monitoring wells, Product Level.



Upper Intermediate Level

Lower Intermediate Level

Figure 6. Retort 6 and process water monitoring wells, Upper and Lower Intermediate Levels.

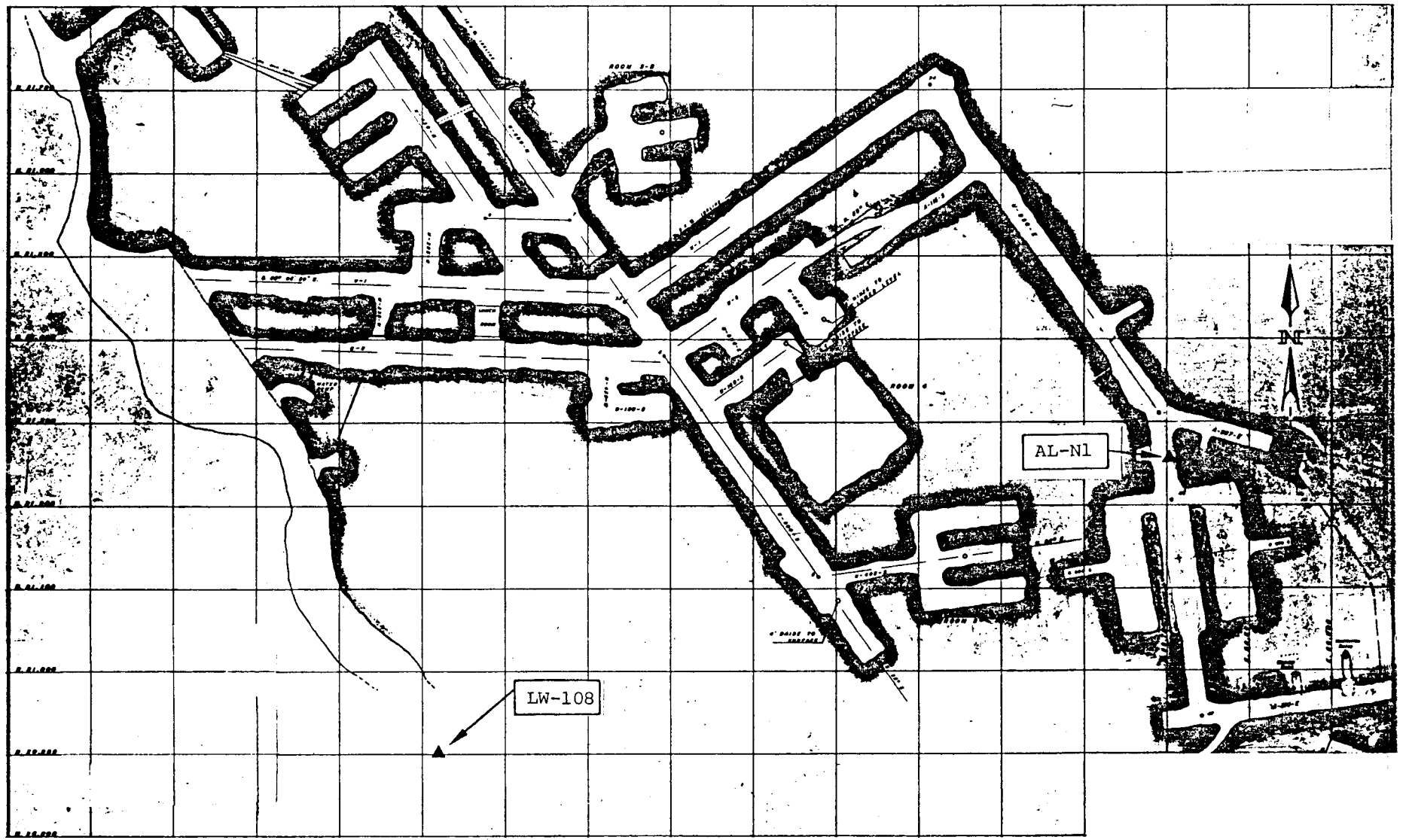


Figure 7. Retort 6 and process water monitoring wells, Air and Upper Level.

INDICATOR VARIABLE ANALYSES, BEDROCK WELLS ON PERIPHERY OF RETORT 6

D. A. SHALE TRACT AND VICINITY

Table IV

SITE DESIGNATION	SITE LOCATION	SAMPLING FREQUENCY	SAMPLE DATE	FLUORIDE mg/l	PHENOL mg/l	BORON mg/l	AMMONIA AS N mg/l	TOTAL ORGANIC CARBON mg/l	NITRATE mg/l
L2-PS-1	PRODUCT LEVEL	2X MONTHLY	08/26/78	1.45	0.93	0.1	2.75	27	4.4
			09/78	NOT SAMPLED DUE TO UPSET IN CONDITIONS					
			10/11/78	0.94	0.031	0.43	310**	25	27
			10/25/78	0.53	0.009	0.55	1.1	--	15
			11/09/78	0.41	0.015	0.3	13	--	3.3
			11/30/78*	0.52	0.007	0.32	0.10	--	6
			12/13/78*	0.5	0.008	0.7	1.0	--	24
L2-PS-2	PRODUCT LEVEL	2X MONTHLY	08/26/78	2.30	<0.001	2	43.5	34	21.7
			09/78	NOT SAMPLED DUE TO UPSET IN CONDITIONS					
			10/11/78	2.5	0.011	2.6	210**	46	24
			10/25/78	2.1	0.012	2.3	4.7	--	40
			11/09/78	1.6	0.016	2.1	12	--	32
			12/13/78*	4	0.009	2	5.8	--	30
LMB-1	PRODUCT LEVEL	2X MONTHLY	09/01/78	3.5	0.007	9.5	2.35	38	85
			09/13/78	2.0	0.004	<0.04	3.7	37	27
			10/26/78	2.8	0.006	7.2	0.2	--	30
			11/10/78	2.4	0.02	4.3	0.25	--	40
			12/13/78*	2	0.004	7	0.43	--	14
PL-RL-1	PRODUCT LEVEL	2X MONTHLY	09/01/78	5.10	0.006	5.2	3.15	49	26
			09/08/78	4.2	0.08	0.42	<0.02	36	42
			11/10/78	1.1	0.023	0.35	1.5	--	< 0.1
			12/13/78*	1	0.002	0.5	1.4	--	3
U1L-SW-1	UPPER INTERME-DIATE LEVEL	2X MONTHLY	08/12/78	DRY					
U1L-SE-2	UPPER INTERME-DIATE LEVEL	2X MONTHLY	08/ /78-12/ /78	DRY					

*Filtered Sample

** Data Suspect

INDICATOR VARIABLE ANALYSES, BEDROCK WELLS ON PERIPHERY OF RETORT 6

D. A. SHALE TRACT AND VICINITY

Table IV (Cont'd)

SITE DESIGNATION	SITE LOCATION	SAMPLING FREQUENCY	SAMPLE DATE	FLUORIDE mg/l	PHENOL mg/l	BORON mg/l	AMMONIA AS N mg/l	TOTAL ORGANIC CARBON mg/l	NITRATE mg/l
1L-SW-1	LOWER INTERME-DIATE LEVEL	2X MONTHLY	08/29/78	12.8	0.004	3.0	6.7	42	410
			10/11/78	7.4	0.08	2.8	6	672**	11
			10/25/78	6.4	0.018	3.3	15	--	110
			11/09/78	4.8	0.024	3.6	9.6	--	120
L1L-SE-2	LOWER INTERME-DIATE LEVEL	2X MONTHLY	08/24/78	1.33	<0.001	2.3	--	67	24
			09/ 78	NOT SAMPLED DUE TO UPSET IN CONDITIONS					
			10/11/78	1.4	0.024	1.7	<1	28	<0.1
			10/25/78	1.5	0.005	2	<0.04	--	<0.1
			11/09/78	1.5	0.003	5.3	1.2	--	0.8
L1L-N_3	LOWER INTERME-DIATE LEVEL	2X MONTHLY	08/24/78	6.44	11.6**	1.5	--	53	7.5
			09/ /78	NOT SAMPLED DUE TO UPSET IN CONDITIONS					
			10/11/78	4.1	0.024	1.0	<1	41	5.9
			10/25/78	4.4	0.002	2	0.7	--	4.3
			11/09/78	4.3	0.003	1.4	0.65	--	4
			11/30/78*	4.3	0.006	1.4	2.4	--	2.8
			12/13/78*	4.2	0.05	2	19	--	>

*Filtered Sample
**Data Suspect

INDICATOR VARIABLE ANALYSES, BEDROCK WELLS

D. A. SHALE TRACT AND VICINITY

Table V

SITE DESIGNATION	SITE LOCATION	SAMPLING FREQUENCY	SAMPLE DATE	FLUORIDE mg/l	PHENOL mg/l	BORON mg/l	AMMONIA AS N mg/l	TOTAL ORGANIC CARBON mg/l	NITRATE mg/l
LW-108	UPPER MINE BENCH	WEEKLY	08/15/78	18	0.025	13.4	32	--	8.9
			08/24/78	17.8	1.6	33	2.06	106	46
			08/31/78	32.5	0.835	27	2	71	14.4
			09/08/78	18.5	6.53**	36	1.84	192	18
			09/15/78	NOT SAMPLED DUE TO UPSET IN CONDITIONS.					
			09/22/78	19	0.079	33	1.7	155	19
			09/29/78	19	0.079	20	12	105	14
			10/04/78	17	0.11	37	1.7	158	22
			10/12/78	18	0.060	35	2.4	134	--
			11/02/78	16	0.013	29	4.1	--	35
			11/10/78	15	0.018	31	1.9	--	8.0
			11/16/78	18	0.02	32	4.9	--	16
			11/21/78	14	0.008	32	2.7	--	20
			12/01/78*	15	0.008	33	2.3	--	8
			12/08/78*	11	0.007	33	2.4	--	160
			12/15/78*	11	0.08	31	4.9	--	11
			12/21/78*	18	1.9	37	3.4	--	25
			12/29/78*	15	0.8	31	3.5	--	12
LW-32	RIDGETOP	QUARTERLY	10/04/78	0.18	0.033	0.09	2.6	67	40
LW-46	RIDGETOP	QUARTERLY	10/31/78	0.49	0.024	0.18	1.2	--	24
LW-47A	RIDGETOP	QUARTERLY	10/31/78	0.18	0.013	0.12	0.06	--	17
LW-106	RIDGETOP		NOT SAMPLED DUE TO INACCESSIBILITY CAUSED BY DEEP SNOWPACK.						
LW-116	RIDGETOP		NOT SAMPLED DUE TO INACCESSIBILITY CAUSED BY DEEP SNOWPACK.						
LW-45	RIDGETOP		NOT SAMPLED DUE TO INACCESSIBILITY CAUSED BY DEEP SNOWPACK.						
LW-33	RIDGETOP		NOT SAMPLED DUE TO INACCESSIBILITY CAUSED BY DEEP SNOWPACK.						

*Filtered Sample
**Data Suspect

phenol concentrations in retort water exhibited a range of 3.7 mg/liter to 56 mg/liter. Phenol levels in samples from the satellite wells have remained in the range 0.002 mg/liter to 0.08 mg/liter during retorting in the last four months of 1978.

Boron concentrations appear lower in samples from the nine wells around Retort 6 than in samples obtained from LW-108 or the retort. Water from the satellite wells yielded boron values of less than 0.04 mg/liter to 9.5 mg/liter. Water obtained from Retort 6 contained boron in concentrations ranging from less than the detection limit (0.04 mg/liter) to 30 mg/liter. LW-108 exhibited higher boron concentrations at 13.4 mg/liter to 37 mg/liter.

Concentrations of ammonia in water samples drawn from LW-108, ranging from 1.7 mg/liter to 32 mg/liter, exhibit considerable variability. Values of ammonia concentration in water from Retort 6 prior to ignition are within the range observed in samples from LW-108. After less than two months of retorting, ammonia levels in retort water rose to 1300-2000 mg/liter. Ammonia concentrations in water from the satellite wells generally ranged from less than 0.04 mg/liter to 19 mg/liter. Higher values of 210 mg/liter and 310 mg/liter for two of the wells on the product level are not consistent with data from other wells sampled on that date and drop sharply by the next sampling date.

Total organic carbon analyses performed by Coors Spectro-Chemical Laboratory are incomplete for 1978 samples but preliminary analyses indicate that TOC concentrations in LW-108 are generally less than 200 mg/liter whereas, concentrations in retort water are generally greater than 800 mg/liter. TOC levels in the satellite wells ranged from 25 mg/liter to 67 mg/liter.

Nitrate values in all of the bedrock wells around Retort 6 were generally of the same order of magnitude as those observed for LW-108. Concentrations of nitrate in LW-108 samples ranged from 8 mg/liter to 160 mg/liter. Nitrate levels in Retort 6 water ranged from 62 mg/liter to 640 mg/liter, with values of 140 mg/liter and 170 mg/liter observed prior to ignition.

The monitoring date from the satellite wells surrounding Retort 6 indicate that process water (water produced in the retort) did not contaminate

the wells. Boron and ammonia did show significant increases, but if process water had entered the wells, substantial increases in fluoride, phenol, and nitrate would also have been observed.

III. AIR QUALITY AND METEOROLOGY

1. GASEOUS CONSTITUENTS AND PARTICULATE MATTER

Air quality monitoring activities, with the exception of particulates, were suspended with the completion of baseline monitoring in October of 1977. These baseline measurements, which began in February, 1975, consisted of discrete samples taken on six-day intervals. Techniques employed are summarized in Table VI. The data gathered during this period, considering the intermittent sampling scheme and the techniques employed, are not suitable to truly represent mean ambient concentrations, and therefore have not been subject to analysis.

Particulate monitoring has been continued on a six-day interval through the period of this report. The date are presented in Appendix B5 and plotted in Figure 8.

Preparations are being made at this time to establish a continuous monitoring station near the 100 foot meteorological tower. This station will be operative in late Spring of 1979, and will employ Federal reference or equivalent methods for particulates, sulfur dioxide, hydrogen sulfide, carbon monoxide, and ozone.

2. METEOROLOGICAL TOWER

Wind speed, wind direction, temperature, and delta temperature are measured at the 100 foot level on the meteorological tower. The instruments were repaired and reactivated in late August after five months of down-time for repair. Data not previously reported are contained in Appendices B6 and B7.

Quarterly windroses are presented in Figure 9 to provide visibility to the wind direction and wind speed data. Since considerable down-time has been experienced and not all data have been reduced from strip charts, only the most recent

AIR SAMPLE ACQUISITION TECHNIQUES AND ANALYTICAL METHODS EMPLOYED DURING LOGAN WASH BASELINE STUDY

Table VI

Pollutant	Acquisition Technique (24-Hour Samples)	Analytical Method	Threshold Sensitivity
Sulfur Dixoide	Gas Bubbler (0.2 liters per minute)	"Pararosaniline" Fed. Reg. Vol. 36, No. 84, 04-30-71	10 ppb
Suspended Particulates	Hi-Vol Sampler	Gravimetric Fed. Reg. Vol. 36, No. 84, 04-30-71	1 $\mu g/m^{-3}$
Carbon Monoxide	Bag Sample	Gas Chromatographic Flame Ionization Detector Fed. Reg. Vol. 36, No. 84, 04-30-71	50 ppb
Hydrocarbons	Bag Sample	Gas Chromatographic Flame Ionization Detector Fed. Reg. Vol. 36, No. 84, 04-30-71	50 ppb
Nitrogen Dioxide	Gas Bubbler (0.2 liters per minute)	Modified Saltzman Colorimetric ASTM 1607-69	5 ppb
Hydrogen Sulfide	Impregnated Filter	$AgNO_3$ Impregnated Filter Analytical Chemistry Vol. 44, No. 12, 1972	$\approx$0.7 $\mu g/m$

FIGURE 8

HISTOGRAMS OF PARTICULATE MEASUREMENTS

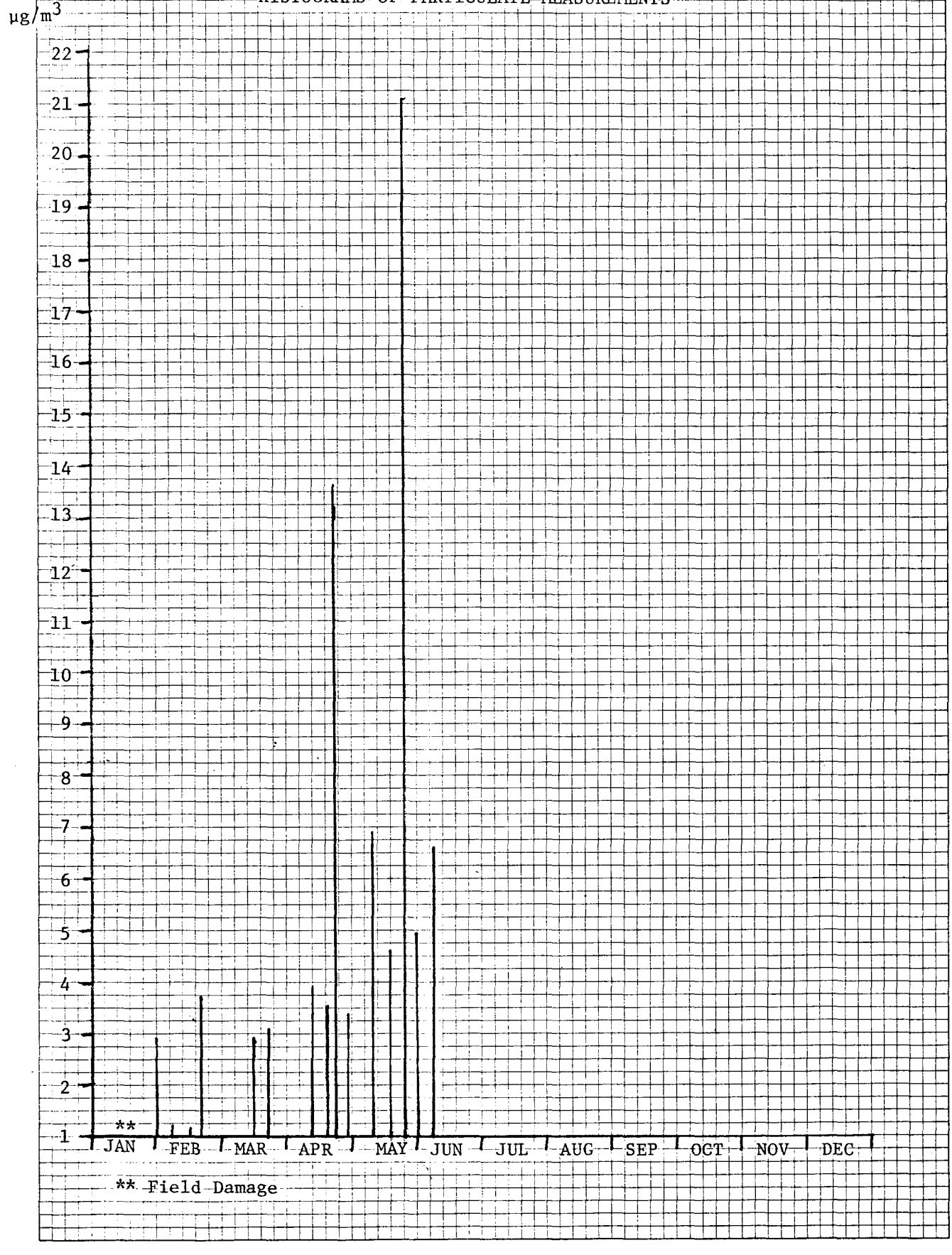


Figure 8. Histogram of particulate measurements.

LOGAN WASH QUARTERLY WIND ROSE

DEC'77 - FEB '78

TOTAL % OF CALMS DISTRIBUTED (3.81%)
TOTAL NO. OF 1 HOUR SAMPLES - 1207

MAR '77 - MAY '77

TOTAL % OF CALMS DISTRIBUTED (10.1%)
TOTAL NO. OF 1 HOUR SAMPLES - 1835

JUN '75 - AUG '75

TOTAL % OF CALMS DISTRIBUTED (0.54%)
TOTAL NO. OF 1 HOUR SAMPLES - 2231

SEPT '78 - NOV '78

TOTAL % OF CALMS DISTRIBUTED (0.00%)
TOTAL NO. OF 1 HOUR SAMPLES - 944

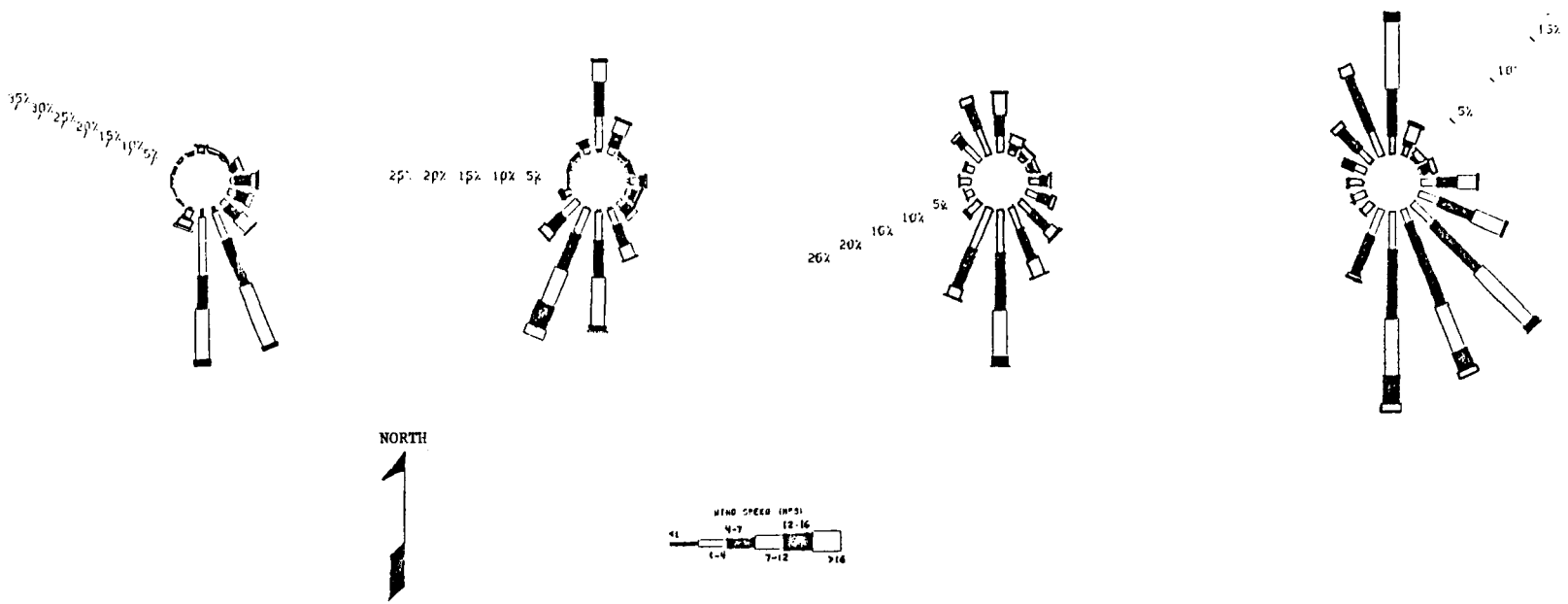


Figure 9. Quarterly windroses for meteorological tower site.

available data for a given quarter have been used. Figure 10 shows data timeline of the meteorological data collected at the 100 foot level on the tower.

The windroses show that the predominant wind direction is from the south-southeast at speeds of 7-12 meters per second. Southerly winds predominate throughout the year with moderate-to-high velocities.

3. MECHANICAL WEATHER STATION

Wind speed, wind direction, and temperature have been recorded continuously on the mechanical-weather-station strip charts located near the heater treater facility. The instrument was installed in October. Data are reduced from the strip charts by means of a digitizer and entered into a computer base. Diurnal tables of hourly values by day for each month are generated by the computer. These tables are shown in Appendix B9. A windrose of the wind direction and wind speed has been plotted for this station is shown in Figure 11. Prevailing wind direction is from the east at speeds of 1-3 meters/second.

4. ACOUSTIC RADAR DATA

Temperature inversion heights are measured by means of an AeroVironment Model 300 Acoustic Radar. The instrument was installed at the Heater Treater (valley bottom) location in September, 1978. The output of the instrument is a continuous strip chart record showing inversion height as derived from reflected sound signals associated with thermal turbulence signatures; such signatures vary in character depending on whether the atmosphere is stable or unstable. The chart provides a means for determining height in meters of temperature inversions and mixing layers above the instrument radar antenna dish.

For each day, hourly inversion heights obtained from the strip chart interpretation are shown in Appendix B10. First data were taken on September 28, 1978 at 1200 noon. The data continue through 1300 hours of January 18, 1979. The absence of an entry for a given hour means that the temperature lapse

FIGURE 10

METEOROLOGICAL TOWER DATA TIMELINE

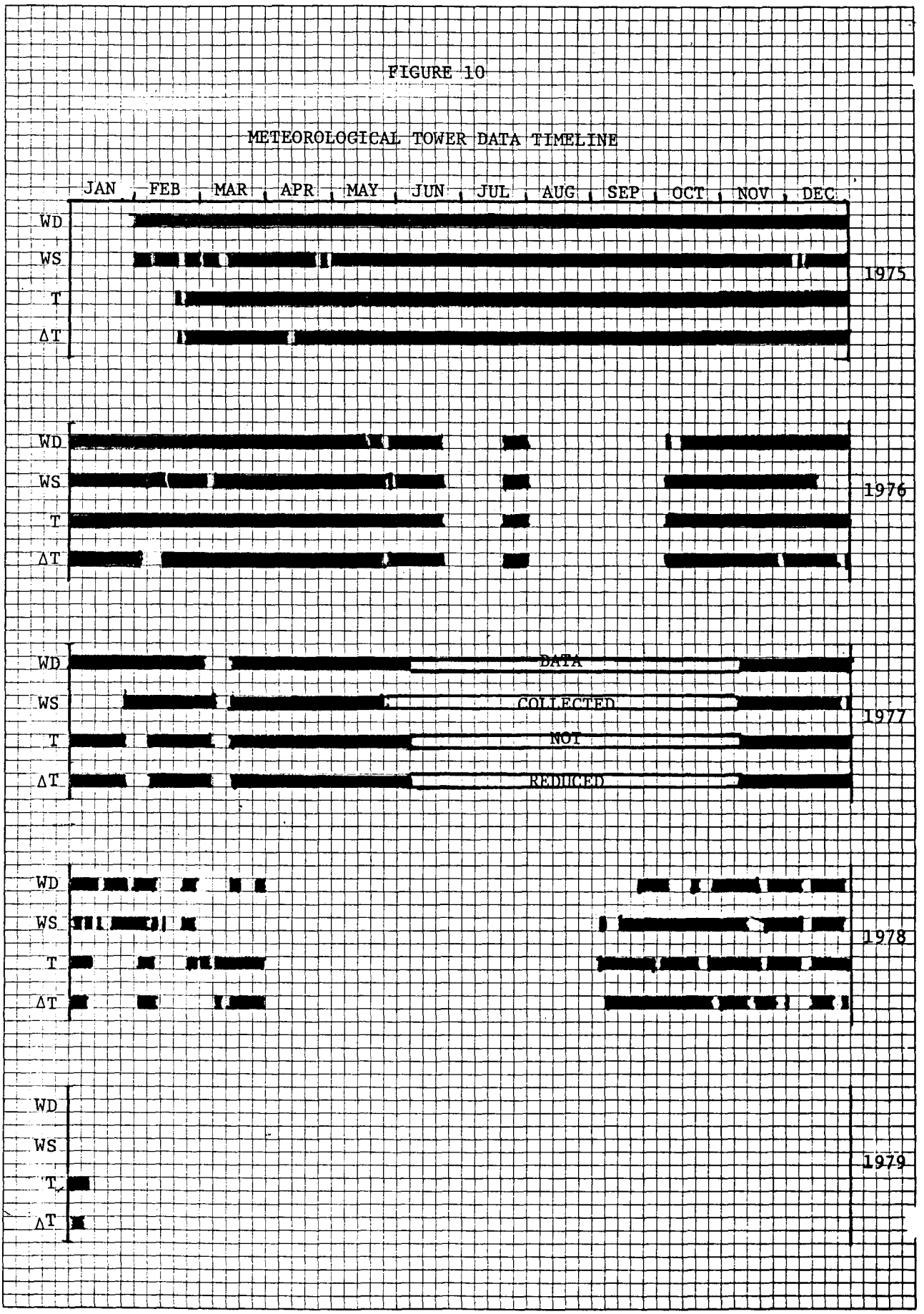


Figure 10. Meteorological tower data timeline.

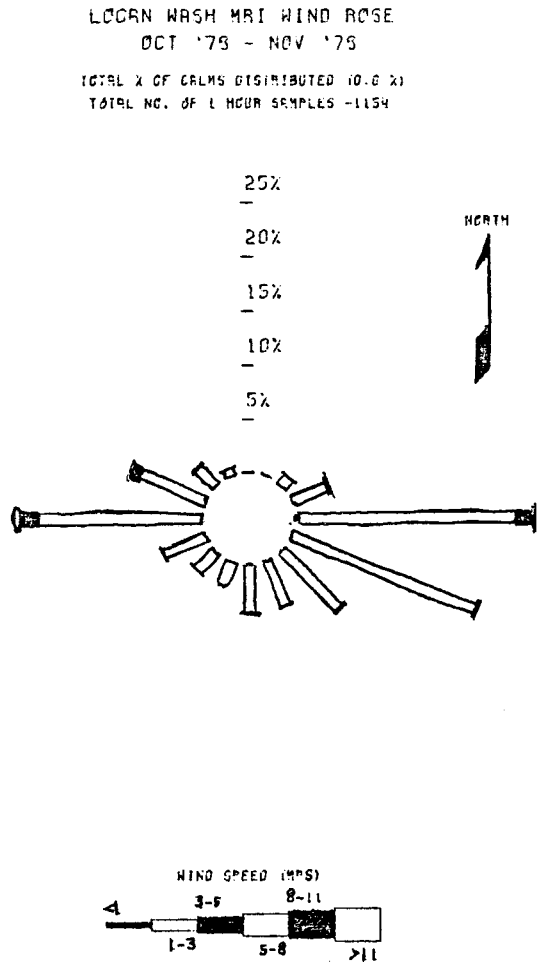


Figure 11. Quarterly windrose for MRI site.

rate was unstable and no inversion was detected. An instrument malfunction code (IM) has been entered to indicate loss of data. The most common cause of the IM code is snow in the dish. The instrument was turned off on January 18, 1979 for repair.

Data for October and November have been used to determine by month the average inversion height, duration, and probability of occurrence. These calculations are shown at the bottom of the tables for those months.

The average inversion height is plotted in Figure 12 as a function of hour of day. The average height of approximately 240 meters is lower than the elevation of the steam plant as shown along the left margin of the figure. Figure 12 also shows the inversion containing the highest peak value for each month. Note that these peaks are above elevations of the stack top for short durations. Inversions below the stack top prevent stack emissions from coming below it, while inversions above the stack top act as an emission lid.

Figure 13 shows the probability of inversion occurrence as a function of hour of day. From these plots, one can conclude that the typical ("expected") October and November inversion onset time is at 1730 hours and breakup is about 0900 hours for a duration of 15½ hours. An average or "expected" inversion exists when probability of occurrence is equal to or greater than 0.5

Figure 14 shows an elevation profile of the D.A. Shale site. Elevations of the acoustic radar, lower and upper mine benches, Retort 6 stack, and meteorological tower are shown. Also shown in the figure are time versus inversion height plots for the November average and the inversion starting November 2, 1978. The latter contains the peak value for the month. The figure provides visibility to the duration and height of these inversions in relation to the elevation and location of key mine facilities.

IV. BIOLOGY

There are no biological studies to report this quarter.

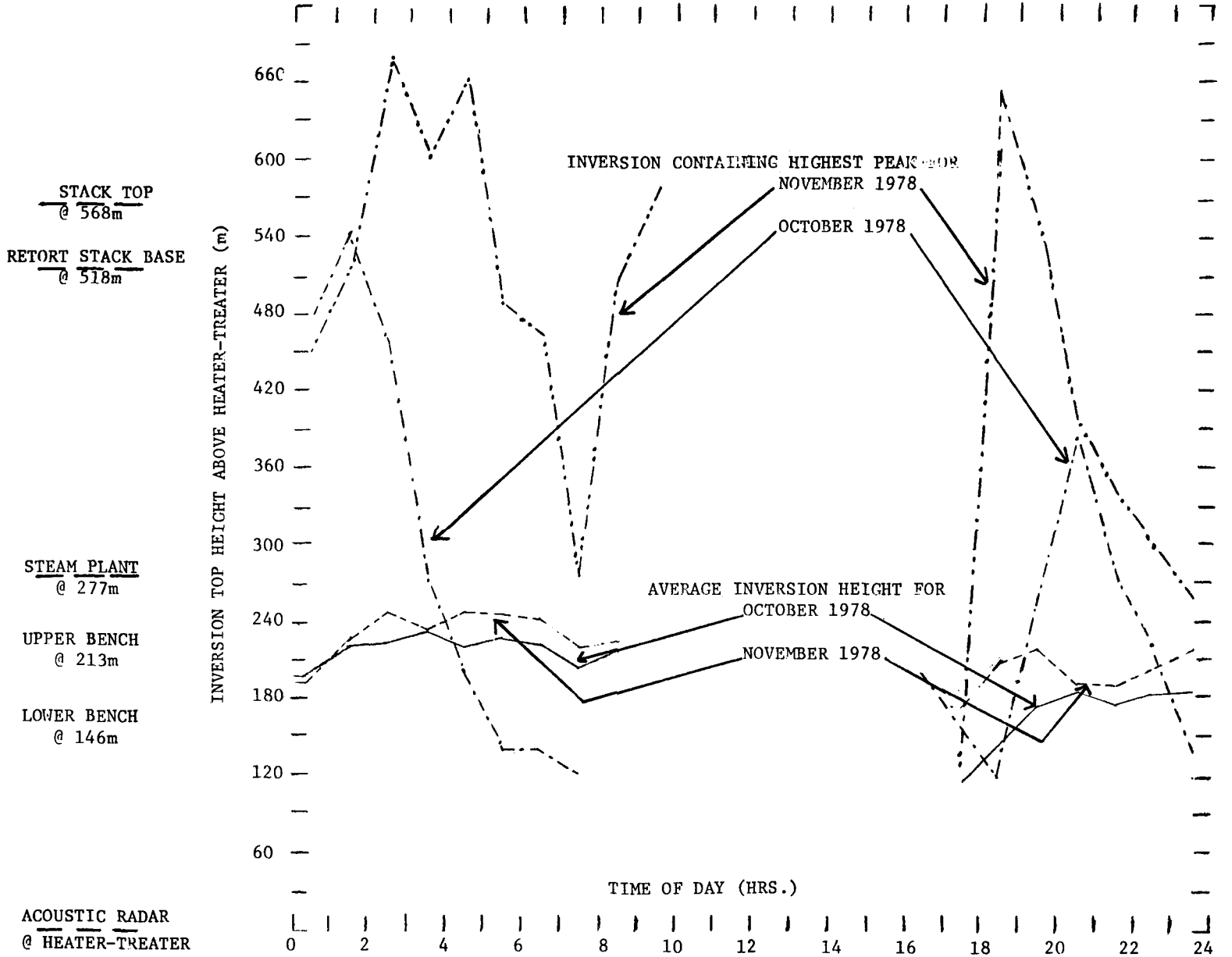


Figure 12. Average and peak inversion heights for October and November.

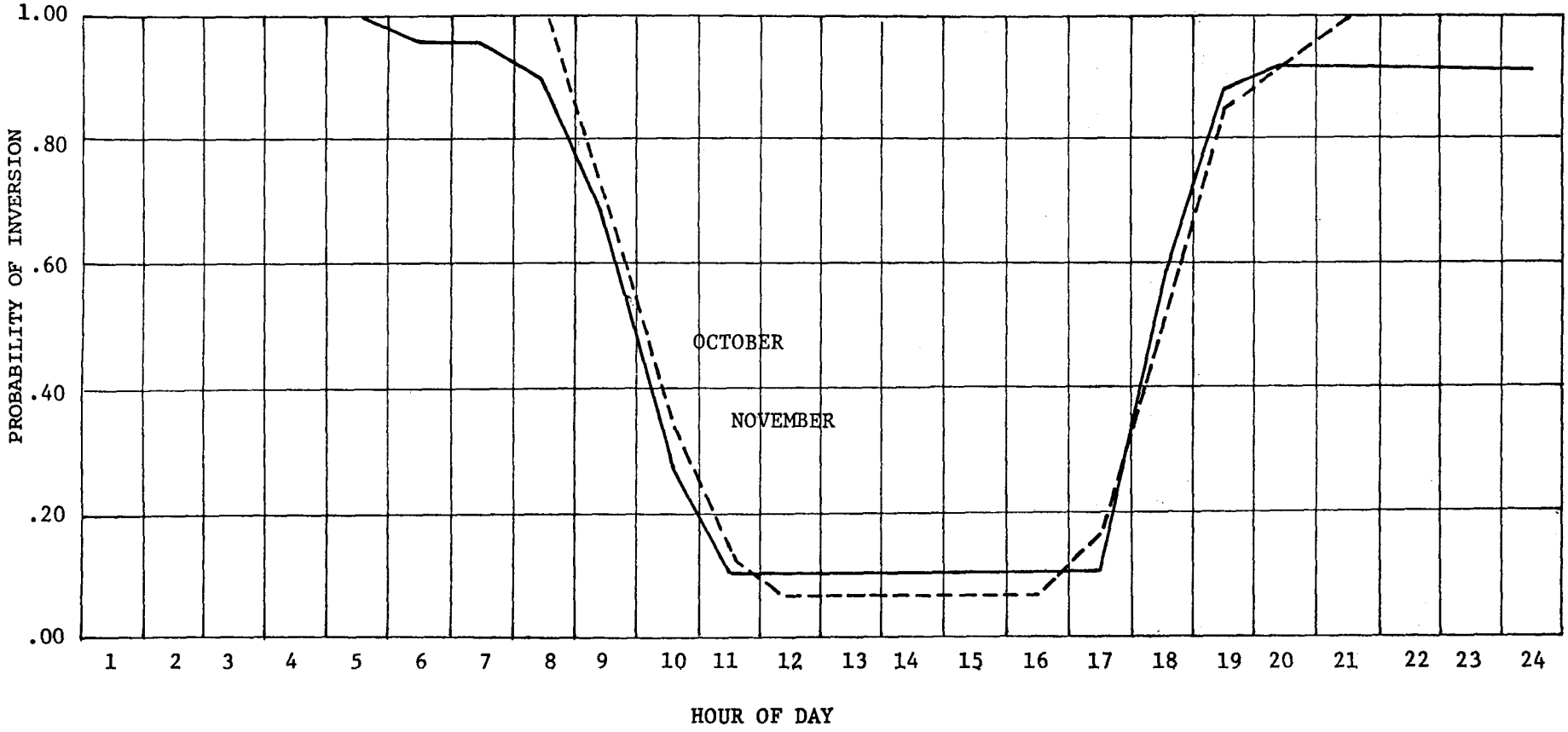


Figure 13. Probability of inversion occurrence for October and November.

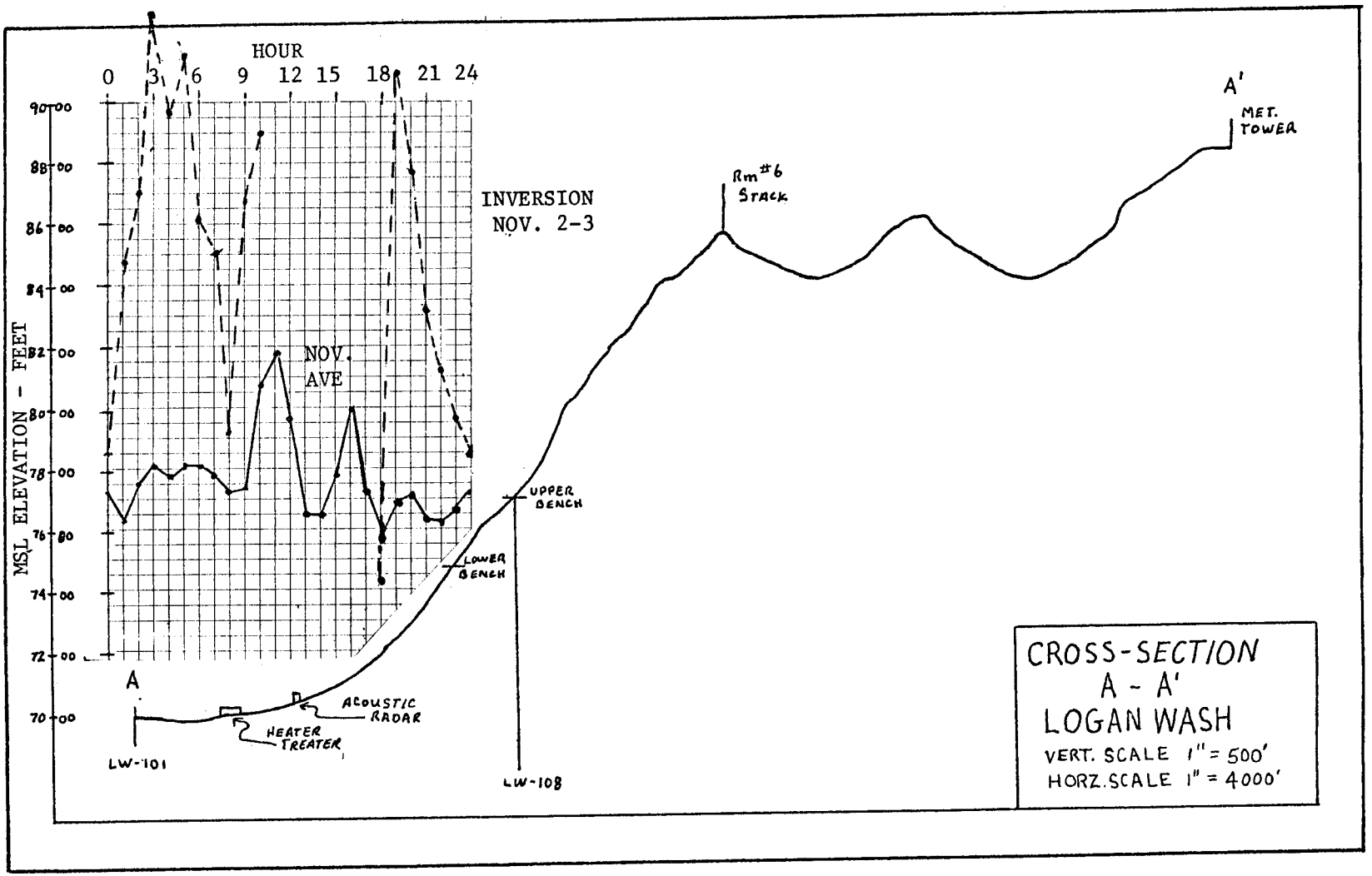


Figure 14. Typical Fall Quarter inversion heights related to Logan Wash elevation points.

APPENDIX B1

HYDROLOGY OF THE OCCIDENTAL OIL SHALE, INC.
D. A. SHALE AREA

(HYDROLOGY OF THE
OCCIDENTAL OIL SHALE, INC. D.A. SHALE AREA)

A PROGRESS REPORT

1 NOVEMBER 1977 TO 31 OCTOBER 1978

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INTRODUCTION

This is a progress report of a continuing surface and subsurface hydrologic study of the D.A. Shale/Callahan Trust Lands in Garfield County, Colorado, for Occidental Oil Shale, Inc. The study area, referred to as the D.A. Shale Area, is in northwestern Colorado, between Parachute and Roan Creeks north of the Colorado River, and near the towns of DeBeque and Grand Valley (Figure 1).

This report presents the hydrologic model determined for the time period from 1 November 1977 to 31 October 1978. Data used in the model were collected from the meteorological stations, stream gages and observation wells shown on Figure 2 (in pocket). The data have been used to determine values for the elements of the hydrologic equation as discussed in the next section. The validity of these values have been assessed and specific recommendations made for improvement of the data collection necessary to improve these values.

For the present, hydrological and meteorological monitoring has been concentrated in the western half of the D.A. Shale Area, which is drained by Logan Wash, Bowdish Gulch and Smith Gulch. Current mining activities are located at the head of the Logan Wash drainage with raw shale being placed into a gulch at the head of Logan Wash. Therefore, any effects on water quality or quantity will be most evident in the surface and subsurface drainage of Logan Wash. Since this wash is flanked by Bowdish Gulch and Smith Gulch, these two drainages can be used to establish background data. Bowdish Gulch is especially important

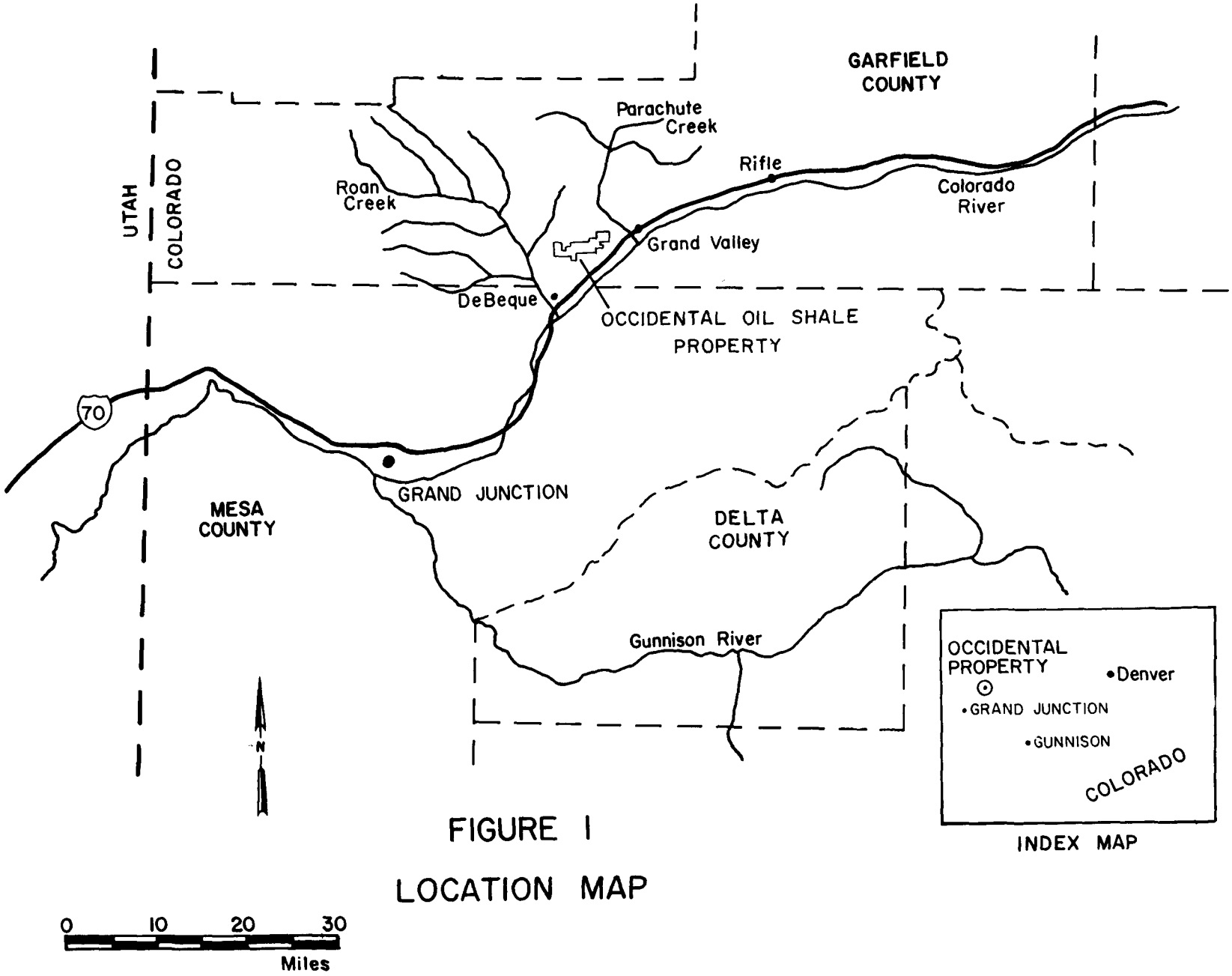


FIGURE 1

LOCATION MAP

since its orientation, valley shape and character of alluviation are similar to Logan Wash. Data from Bowdish Wash, therefore, may serve as surrogate information for Logan Wash since background hydrologic data were not established in the Logan Wash drainage.

HYDROLOGIC MODEL

The hydrologic model of the D.A. Shale area, on which this continuing study is based, makes use of the basic hydrologic balance where inflow minus outflow equals change in storage. As presented in our previous report (Geothermal Surveys, Inc., 1977), this balance is expressed by the following equation:

$$P = Et + Rt + Gwa_o + Gwb_o + \Delta Sga + \Delta Sgb$$

Where:

- P = precipitation
- Et = actual evapotranspiration
- Rt = total runoff (surface outflow)
- Gwa_o = subsurface alluvial outflow
- Gwb_o = subsurface bedrock outflow
- ΔSga = change in alluvial ground water storage
- ΔSgb = change in bedrock ground water storage

Our previous reports have presented the numerical results for the elements of this equation, both as estimated long-term values and as 1977 water-year values. These numerical results were presented previously as a point value in inches rather than a volume of water over the entire drainage area. This report will present the results both as a volume and a point value.

Precipitation, total runoff and actual evapotranspiration are surface hydrologic parameters. Values for these elements have been determined for each of the drainages

being studied, Logan Wash, Bowdish Gulch, and Smith Gulch. Subsurface alluvial outflow and change in alluvial ground water storage are subsurface hydrologic parameters of the alluvial channel deposits in each of the three drainages. A value has been determined for alluvial outflow but there are insufficient data to determine change in alluvial storage. Subsurface bedrock outflow and change in bedrock ground water storage are subsurface hydrologic parameters of the entire study area as a whole. The presence and movement of the ground water in the fractured bedrock of the D.A. Shale Area can not be segretated into any distinct drainage being studied, unlike the other parameters of the hydrologic equation. The parameters of bedrock outflow and storage, therefore, are difficult to measure. Insufficient data are available to determine either of these parameters for this study but estimates will be made in future reports with the collection of more data.

SURFACE HYDROLOGY

Precipitation

On-site precipitation data were collected by Occidental Oil Shale, Inc. personnel from 1 November 1977 to 31 October 1978 from five precipitation gages: non-recording gages at (1) the meteorological tower, (2) the mine bench, and (3) the guard gate and recording gages at (4) LW-22, and (5) LW-102 (Figure 1, in pocket). The data are presented in Appendix 1.

Data collected from the recording precipitation gages near the stream gages and alluvial wells in Logan Wash and Smith Gulch were incomplete for the time period analyzed. The gages were installed in the middle of March and some operational problems were encountered after installation. Values for the entire year were calculated for these two

gages by extrapolation. The ratios of data collected between these two gages and the non-recording gages at the tower, mine, and gage were determined and then extrapolated over the periods when no data were collected at the two recording gages. Eventually, data from the recording precipitation gages will be used to extrapolate missing runoff data from the stream gages.

Annual precipitation values for the three drainages have been determined for 1 November 1977 to 31 October 1978. Data collected at the tower and mine were averaged with the extrapolated value at LW-22 to determine an annual figure for Logan Wash. Data collected at the tower were averaged with the extrapolated value at LW-102 to determine an annual figure for Smith Gulch. Since there is presently no gage in Bowdish Gulch, an annual value for Bowdish is assumed to be equal to Logan Wash. The values thus determined for the three drainages are 17.14 inches for Logan Wash and Bowdish Gulch and 16.34 inches for Smith Gulch. These values were then multiplied by the drainage area of the stream gages in each drainage to determine the volume of precipitation contributed to the hydrologic balance in each drainage. Annual precipitation in the drainages for 1 November 1977 to 31 October 1978 is:

Logan Wash	=	3866 acre-feet
Bowdish Gulch	=	3121 acre-feet
Smith Gulch	=	2233 acre-feet

Actual Evapotranspiration

On-site data utilized in the evaluation of evapotranspiration consisted of the following data collected by Occidental Oil Shale, Inc. personnel from 1 November 1977 to 31 October 1978: (1) evaporation data collected from Class A evaporation pans at the meteorological tower and the

guard gate, and (2) air temperature data collected from hygrothermographs at the meteorological tower, mine bench and guard gate.

Evaporation pan data are used to determine equivalent lake evaporation which is calculated by multiplying the total evaporation by a suitable coefficient. A coefficient of 0.7 has been determined for the D.A. Shale Area (Geothermal Surveys, Inc., 1977, p.16). The total evaporation measured at the tower and gate were 46.44 inches and 44.87 inches, respectively, as shown in Appendix 2. The average of these two values, 45.66, was multiplied by 0.7 and the result, 32.0 inches, represents equivalent lake elevation in the D.A. Shale Area. This value is useful in evaluating the relationship between potential and actual evapotranspiration but there is no term in the hydrologic equation for equivalent lake evaporation or potential evapotranspiration.

Actual evapotranspiration can not be measured directly but the simplified Turc equation (Gray, 1970, p.3.59) can be used to estimate a value. The Turc equation utilizes parameters of annual precipitation and mean annual air temperature. Expressed mathematically:

$$E = \frac{P}{\left(0.9 + \left(\frac{P}{L(t)}\right)^2\right)^{\frac{1}{2}}}$$

Where: E = annual evapotranspiration
P = annual precipitation
$L(t) = 300 + 25t + 0.05\ t^3$
t = mean annual air temperature

This equation has been solved for all three drainages. Values of annual precipitation for Logan Wash, Bowdish Gulch and Smith Gulch were presented in the last section. Mean monthly air temperature for the tower, mine and gate

are presented in Appendix 3. These data were averaged and the resultant value, 45.7°F, was used in the Turc equation. Evapotranspiration values thus determined for the three drainages are 13.33 inches for Logan Wash and Bowdish Gulch and 12.98 inches for Smith Gulch. These values were then multiplied by the drainage areas. Annual actual evapotranspiration in the drainages for 1 November 1977 to 31 October 1978 is:

Logan Wash = 2978 acre-feet
Bowdish Gulch = 2404 acre-feet
Smith Gulch = 1771 acre-feet

Total Runoff

Surface flow is gaged in the three drainages at the stream gaging stations shown on Figure 2, in pocket. In Logan Wash and Smith Gulch, the stream gaging stations consist of a stilling well stream gage and a H-flume. In Bowdish Gulch, a stilling well and the relocation of the flume are planned, but at this time only a flume is present. The H-flumes are designed to record low-flow runoff up to a depth of two feet. The stilling well stream gages are designed to record flood flow when runoff is greater than flume capacity.

The runoff data collected from these stream gaging stations are incomplete for the time period from 1 November 1977 to 31 October 1978. Partial data are available for Logan Wash and Smith Gulch but there are no data available for Bowdish Gulch.

The data collected in Logan Wash in 1978 were compared with runoff data collected in 1976 and 1977. An extrapolation was then made to estimate runoff which was not measured in 1978. Runoff in Logan Wash was thus estimated to be 87,000 cubic feet or 2 acre-feet. When divided by the drainage area, the total runoff is calculated to be less than 0.01 in.

Runoff data in Smith Gulch were collected in 1976 but not in 1977. The flume was filled with debris on many occasions and was not cleaned in 1977. The stilling well was not installed until 1978. Therefore, data collected prior to 1978 are insufficient to allow extrapolation of missing data. No attempt, therefore, has been made to estimate total runoff in Smith Gulch for 1 November 1977 to 31 October 1978.

SUBSURFACE HYDROLOGY

Subsurface Alluvial Outflow

Subsurface alluvial outflow is that ground water which leaves the D.A. Shale Area within the alluvium of Logan Wash, Bowdish Gulch and Smith Gulch. To determine the amount of ground water leaving the study area through the alluvium of each canyon, Darcy's Law can be applied (Todd, 1959, p.46). Expressed mathematically:

$$Q = K I A$$

Where: Q = flow rate of alluvial outflow
K = permeability coefficient
I = hydraulic gradient
A = saturated cross-sectional area

The permeability is determined through analysis of test pumping results from existing wells. Since there are no test results at the present, the unconsolidated alluvium is considered to be a typical soil with mostly sand, silt and clay. The permeability is estimated from standard tables (Todd, 1959, p.53) as 10 gallons per day per square foot for the alluvium in all three drainages.

The hydraulic gradient is the slope of the water table and thus can be determined as the difference in static water

level between two observation wells. The hydraulic gradient in Logan Wash is therefore the difference in water level elevation between LW-22 and LW-101, 0.07 foot per foot. The hydraulic gradient can not be determined directly in either Bowdish Gulch or Smith Gulch since there is only one observation well in each drainage. The gradient in these drainages has been estimated to be equal to the slope of the ground surface. The hydraulic gradient in thus 0.08 foot per foot in Bowdish Gulch and 0.06 foot per foot in Smith Gulch.

The saturated cross-sectional area is determined from topographic maps, well logs and seismic refraction profiles. A seismic refraction profile was made across the canyon bottom in Logan Wash in order to locate a site for LW-22 in the deepest part of the alluvium. Based on the seismic results, the saturated cross-sectional area at LW-22 is calculated to be 39,500 square feet. Another seismic refraction profile was made at LW-101 and the results for both profiles are presented in Appendix 5. The saturated cross-sectional areas for Bowdish Gulch and Smith Gulch were estimated from the drilling results for LW-121 and LW-102, respectively. Bedrock was reported at 150 feet in LW-121 and at 80 feet in LW-102. Assuming a "vee"-shaped alluvial channel, the saturated cross-sectional area in Bowdish Gulch at LW-121 is 31,250 square feet and in Smith Gulch at LW-102 is 28,250 square feet.

Using Darcy's Law, annual subsurface alluvial outflow values in the three drainages for 1 November 1977 to 31 October 1978 are:

Logan Wash = 31 acre-feet
Bowdish Gulch = 28 acre-feet
Smith Gulch = 19 acre-feet

When divided by the drainage area in each drainage, subsurface alluvial outflow is 0.01 inch in each of the three drainages.

Subsurface Bedrock Outflow

Subsurface bedrock outflow is that ground water which leaves the D.A. Shale Area within fractures of the bedrock Green River Formation. The occurrence and movement of the bedrock water is not fully understood and is much more difficult to analyze than distinct alluvial units within each drainage. The bedrock water can not be segregated into each of the three drainages because flow in the bedrock is not constrained to distinct valley bottoms. Therefore, the flow of bedrock water must be considered for the study area as a whole.

Darcy's Law can not be easily applied, as in alluvial outflow, because the equation refers to the flow rate of water through a porous medium. Another problem in the analysis of bedrock outflow is that the lateral and vertical extent of the bedrock water is not fully known and therefore can not be quantified for use in any type of equation. At this time insufficient information exists for determination of subsurface bedrock outflow.

In order to evaluate bedrock water occurrence and movement, the extent of the saturated fractured zones must be determined. Electical resistivity soundings and downhole temperature logs have been recommended. Resistivity will determine the occurrence of water and temperature logs will determine the zones which have signifigant movement of bedrock water. Sufficient water level data are also necessary to evaluate bedrock water movement.

Change in Alluvial and Bedrock Ground Water Storage

The change in storage of a ground water body is determined by multiplying the change in saturated volume of the ground water body by the specific yield of the aquifer. The change in saturated volume is determined by multiplying the change in static water level by the area of the ground water body.

Insufficient static water level data and alluvial dimension information are available at this time to determine the change in storage of the alluvial deposits in either Logan Wash, Bowdish Gulch or Smith Gulch. As explained in the previous section, the nature of the bedrock ground water is not fully understood at this time. The saturated volume of the bedrock is difficult to determine because water occurs in fractures rather than voids in a saturated porous material. Therefore, the changes in alluvial and bedrock ground water storage have not been determined for the time period from 1 November 1977 to 31 October 1978.

SUMMARY

The parameters of the hydrologic equation which have been determined for 1 November 1977 to 31 October 1978 are presented in Table 1. No attempt has been made at this time to estimate the remaining parameters of the equation. However, recommendations will be made to improve the data collection program and also to install new monitoring installations to allow collection of additional information.

Since the D.A. Shale Area is the topographic and hydrologic head of the drainage systems in the study area, precipitation is the only inflow parameter in the hydrologic equation. The sum of all the other parameters, therefore, should be equal to precipitatin. As shown on Table 1, using the values for Logan Wash, the sum of actual evapotranspiration, total runoff and subsurface alluvial outflow subtracted from precipitation leaves a large residual of 855 acre-feet. The sum of the remaining parameters, change in alluvial ground water storage and a percentage of subsurface bedrock outflow and change in bedrock ground water storage, will be only a small fraction of this residual figure. Since the hydrologic equation should balance, the residual figure of approximately

TABLE 1

HYDROLOGIC BUDGET

1 NOVEMBER 1977 TO 31 OCTOBER 1978

	Logan		Bowdish		Smith	
	ac-ft	(in)	ac-ft	(in)	ac-ft	(in)
Precipitation	3866	(17.14)	3121	(17.14)	2233	(16.34)
Actual Evapotranspiration	2978	(13.33)	2404	(13.33)	1711	(12.98)
Total Runoff	2	(<0.01)	-		-	
Subsurface Alluvial Outflow	31	(0.01)	28	(0.01)	19	(0.01)

850 acre-feet is due to the error involved in the determination of all of the quantities which comprise the hydrologic model. This error is equal to approximately 25% of the precipitation determined for Logan Wash. An adequate data collection program, therefore, is necessary to reduce this error to within acceptable limits.

RECOMMENDATIONS

The recommendations for calendar year 1979 are based on recommendations made in our last report (Geothermal Surveys, Inc., 1978, Appendix 6) and on recommendations made in our last correspondence dated 25 October 1978. These recommendations are included in the following outline of the hydrological and meteorological monitoring system of the D.A. Shale Area.

Hydrological Monitoring of the D.A. Shale Area

1. Precipitation
    - A. present gages
        1. non-recording type (should be checked at least twice per week)
            - a. meteorological tower
            - b. mine bench
            - c. guard gate
        2. recording type (charts changed once per month)
            - a. near LW-22 in Logan Wash
            - b. near LW-102 in Smith Gulch
    - B. recommendations
        1. install recording type gage near LW-121 in Bowdish Gulch
        2. install non-recording type gage near LW-101 in Logan Wash
        3. set up snow survey course so that depth of snow and water content are measured at each station at least once per month when snow is on ground

2. Evapotranspiration
    A. present gaging
        1. evaporation pan stations (should be checked at least once per week)
            a. meteorological tower
            b. guard gate
        2. hygrothermographs (charts changed once per month)
            a. meteorological tower
            b. mine bench
            c. guard gate
    B. recommendations
        1. install evaporation pan station near LW-101 in Logan Wash.
        2. soil moisture surveys in Logan Wash

3. Surface Water
    A. present gaging
        1. stilling well stream gages (Steven's recorder charts changed once per month)
            a. Logan Wash near LW-22
            b. Smith Gulch near LW-102
        2. H-flumes (Steven's recorder charts changed once per month)
            a. Logan Wash near LW-22
            b. Bowdish Gulch
            c. Smith Gulch near LW-102
            d. "Dry Gulch" near LW-112
    B. recommendations
        1. install stilling well stream gage in Bowdish Gulch near LW-121
        2. relocate H-flume in Bowdish Gulch to the site of the stilling well near LW-121

4. Alluvial Ground Water
    A. present alluvial observation wells
        1. LW-112, LW-101, LW-101A, LW-22 and LW-115 in Logan Wash
        2. LW-121 in Bowdish Gulch
        3. LW-102 in Smith Gulch
        4. LW-103 in Kelly Gulch
        5. LW-104 in Riley Gulch
    B. recommendations
        1. install Steven's recorders (charts changed once per month) and platform and cover for recorders on LW-22 in Logan Wash, LW-121 in Bowdish Gulch and LW-102 in Smith Gulch
        2. test pump LW-22 in Logan Wash, LW-121 in Bowdish Gulch and LW-102 in Smith Gulch
        3. measure static water levels in all other alluvial observation wells at least once per month; LW-112, LW-101 and 101A, and LW-115 in Logan Wash, LW-103 in Kelly Gulch and LW-104 in Riley Gulch

5. Bedrock Ground Water
    A. present bedrock observation wells
        1. LW-32A, LW-33, LW-45, LW-46, LW-47, LW-106, LW-108 and LW-116
    B. recommendations
        1. measure static water levels in all bedrock observation wells at least once per month, when possible
        2. install a Steven's recorder (charts changed once per month) and platform and cover for recorder on LW-32A
        3. downhole temperature logging of all bedrock observation wells
        4. electrical resisitivity soundings

A detailed data collection schedule based on this outline will be submitted after consultation with Occidental Oil Shale, Inc. personnel.

REFERENCES

Geothermal Surveys, Inc.,1977,Hydrology of the Occidental Oil Shale, Inc. D.A. Shale Area Near DeBeque, Colorado, prepared for Claremont Engineering Company, Claremont, California.

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Gray, Donald M., 1970, Handbook on the Principles of Hydrology, Water Information Center, Inc., Port Washington, N.Y.

Todd, David K., 1959, Ground Water Hydrology, John Wiley and Sons, Inc., New York.

APPENDIX 1

MONTHLY PRECIPITATION DATA

Month	Tower (in)	Mine (in)	Gate (in)	LW-22 (in)	LW-102 (in)
November 1977	0.74	1.16	0.84	-	-
December	0.98	2.03	0.57	-	-
January 1978	2.49	3.48	1.83	-	-
February	2.20	3.58	1.95	-	-
March	4.20	4.25	2.56	0.70[1]	0.75[1]
April	5.61	1.67	0.84	0.90	1.25
May	1.74	2.56	1.23	1.40	0.15[2]
June	0.43	0.57	0.08	0.20	0.15[3]
July	0.29	0.10	0.03	0	no data
August	0.69	0.67	0.31	0.20	no data
September	0.77	0.78	0.15	-	-
October	0.23	TR	TR	-	-
TOTAL	20.37	20.85	10.39		

1 no data, March 1-17
2 no data, May 5-19
3 no data, June 8-30

APPENDIX 2

EVAPORATION PAN DATA

Month	Tower (in)	Gate (in)
November 1977	-	-
December	-	-
January 1978	-	-
February	-	-
March	-	-
April	4.39	-
May	4.58	6.46
June	7.98	8.78
July	4.76	8.43
August	11.09	8.69
September	6.77	7.26
October	6.87	5.25
TOTAL	46.44	44.87

APPENDIX 3

MEAN MONTHLY TEMPERATURE DATA

Month	Tower (°F)	Mine (°F)	Gate (°F)
November 1977	27.3	34.9	41.1[1]
December	24.7	28.9	no data
January 1978	19.4[2]	23.2	27.4
February	20.0[3]	22.2	31.3
March	31.1	36.1	42.7
April	37.3	40.9	49.8
May	42.8	44.7	56.4
June	57.3	63.1	73.9
July	52.7	70.2	74.0
August	59.6	65.7	69.6
September	52.1	59.0	66.0
October	-	-	-

[1] no data November 15-30

[2] no data January 1-9, 15-17, 24-25

[3] no data February 14-28

APPENDIX 4

STATIC WATER LEVEL DATA

Observation Well	Date 2-78 (ft)	5-78 (ft)	8-78 (ft)	10-78 (ft)
Bedrock Well				
LW-32A	-	340	-	-
LW-46	-	-	-	612
LW-108	-	-	-	355
Alluvial Well				
LW-22	-	-	-	18
LW-101	-	68.5	87	92
LW-101A	59.6	66	80.3	-
LW-102	72	42	32	42
LW-103	102	85	73.5	86.5
LW-104	-	-	31.5	35
LW-112	65	66.5	72	76
LW-115	67	69	69	76
LW-121	-	-	-	65

APPENDIX 5

SEISMIC REFRACTION RESULTS

AT

LW-22 AND LW-101

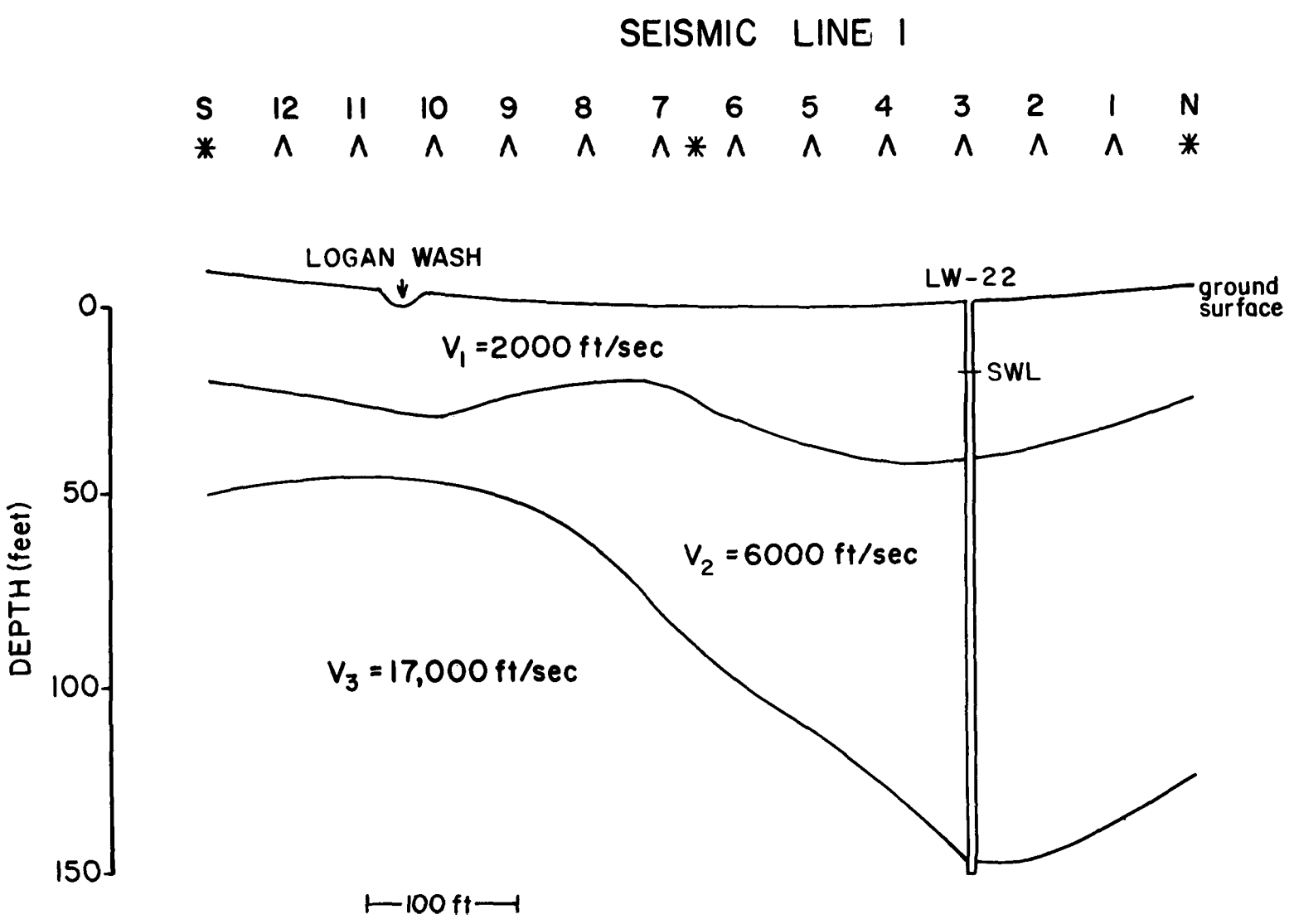

SEISMIC LINE I
S 12 11 10 9 8 7 6 5 4 3 2 1 N
LOGAN WASH
LW-22
ground surface
SWL
V_1 =2000 ft/sec
V_2 =6000 ft/sec
V_3 =17,000 ft/sec
DEPTH (feet)
0
50
100
150
100 ft

FIGURE 3

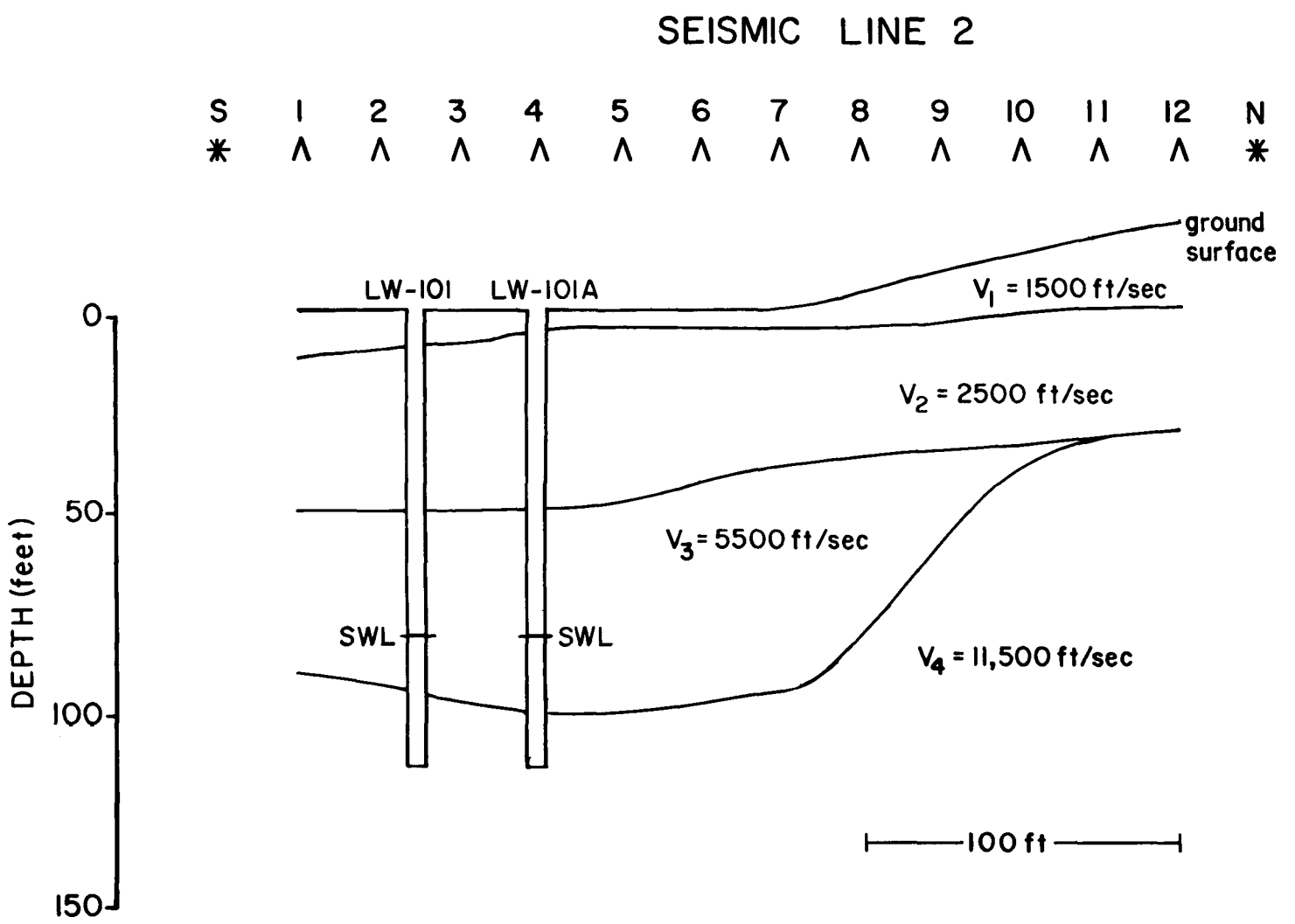

SEISMIC LINE 2
S 1 2 3 4 5 6 7 8 9 10 11 12 N
ground surface
LW-101
LW-101A
V_1 = 1500 ft/sec
V_2 = 2500 ft/sec
V_3 = 5500 ft/sec
V_4 = 11,500 ft/sec
SWL
SWL
DEPTH (feet)
0
50
100
150
100 ft

FIGURE 4

APPENDIX B2

WATER ANALYSIS - ALLUVIAL, BEDROCK,
AND SURFACE SITES

SITE SAMPLED WEEKLY

LW-108 (Bedrock)

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: Oct. 18, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-166-78 LW-108 8-15-78

LAB NO: DA-73

Color	---
Odor	---
Temperature, °C	21
Conductivity, µmhos	4100
pH	7.4
Oxygen, mg/l	---

Total Alkalinity, mg/l as $CaCO_3$	1300	Arsenic, mg/l	0.07
Carbonate, mg/l as $CaCO_3$	< 1	Iron, mg/l	2
Bicarbonate, mg/l as $CaCO_3$	1300	Magnesium, mg/l	44
Total Dissolved Solids, mg/l	5200	Calcium, mg/l	47
Suspended Solids, mg/l	---	Boron, mg/l	13.4
Turbidity, NTU	---	Vanadium, mg/l	< 0.1
Sulfate, mg/l	490	Copper, mg/l	< 0.02
Chloride, mg/l	360	Molybdenum, mg/l	1
Fluoride, mg/l	18	Lithium, mg/l	0.7
Chemical Oxygen Demand, mg/l	80	Zinc, mg/l	0.2
Phenol, mg/l	0.025	Aluminum, mg/l	0.8
Nitrate, mg/l	8.9	Barium, mg/l	< 0.5
BOD_5, mg/l	42	Strontium, mg/l	6
Oil & Grease, mg/l	36	Ammonia, as N, mg/l	32
Silica, mg/l	11	Sulfite, mg/l	---
Sodium, mg/l	1000		
Potassium, mg/l	2.7		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: Oct. 18, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-171-78 LW-108 8-24-78

LAB NO: DA-79

Color	---
Odor	---
Temperature, °C	17
Conductivity, µmhos	3200
pH	6.4
Oxygen, mg/l	---

Total Alkalinity, mg/l as $CaCO_3$	1400	Arsenic, mg/l	0.15
Carbonate, mg/l as $CaCO_3$	10	Iron, mg/l	8
Bicarbonate, mg/l as $CaCO_3$	1390	Magnesium, mg/l	57
Total Dissolved Solids, mg/l	2900	Calcium, mg/l	77
Suspended Solids, mg/l	---	Boron, mg/l	33
Turbidity, NTU	---	Vanadium, mg/l	< 0.1
Sulfate, mg/l	690	Copper, mg/l	0.02
Chloride, mg/l	100	Molybdenum, mg/l	2
Fluoride, mg/l	17.8	Lithium, mg/l	0.7
Chemical Oxygen Demand, mg/l	230	Zinc, mg/l	7
Phenol, mg/l	1.60	Aluminum, mg/l	3
Nitrate, mg/l	46	Barium, mg/l	1
BOD_5, mg/l	100	Strontium, mg/l	7
Oil & Grease, mg/l	210	Ammonia, as N, mg/l	2.06
Silica, mg/l	17	Sulfite, mg/l	---
Sodium, mg/l	900		
Potassium, mg/l	3.8		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: Oct. 18, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-187-78 LW-108 8-31-78

LAB NO: DA-91

Color	---
Odor	---
Temperature, °C	15
Conductivity, µmhos	3600
pH	7.4
Oxygen, mg/l	---
Total Alkalinity, mg/l as $CaCO_3$	850
Carbonate, mg/l as $CaCO_3$	< 1
Bicarbonate, mg/l as $CaCO_3$	850
Total Dissolved Solids, mg/l	2100
Suspended Solids, mg/l	620
Turbidity, NTU	66
Sulfate, mg/l	620
Chloride, mg/l	160
Fluoride, mg/l	32.5
Chemical Oxygen Demand, mg/l	320
Phenol, mg/l	0.835
Nitrate, mg/l	14.4
BOD_5, mg/l	60
Oil & Grease, mg/l	600
Silica, mg/l	19
Sodium, mg/l	920
Potassium, mg/l	2.6
Arsenic, mg/l	0.13
Iron, mg/l	7
Magnesium, mg/l	53
Calcium, mg/l	68
Boron, mg/l	27
Vanadium, mg/l	< 0.1
Copper, mg/l	< 0.02
Molybdenum, mg/l	2
Lithium, mg/l	0.7
Zinc, mg/l	3
Aluminum, mg/l	2
Barium, mg/l	0.9
Strontium, mg/l	8
Ammonia, as N, mg/l	2
Sulfite, mg/l	---

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: Oct. 18, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-198-78 LW-108 9-8-78

LAB NO: DA-98

Color	Gray
Odor	Oily
Temperature, °C	14
Conductivity, µmhos	3500
pH	6.7
Oxygen, mg/l	---

Total Alkalinity, mg/l as $CaCO_3$	120	Arsenic, mg/l	<0.02
Carbonate, mg/l as $CaCO_3$	< 1	Iron, mg/l	11
Bicarbonate, mg/l as $CaCO_3$	120	Magnesium, mg/l	54
Total Dissolved Solids, mg/l	2900	Calcium, mg/l	65
Suspended Solids, mg/l	1100	Boron, mg/l	36
Turbidity, NTU	340	Vanadium, mg/l	< 0.1
Sulfate, mg/l	720	Copper, mg/l	<0.02
Chloride, mg/l	240	Molybdenum, mg/l	2
Fluoride, mg/l	18.5	Lithium, mg/l	0.7
Chemical Oxygen Demand, mg/l	350	Zinc, mg/l	2
Phenol, mg/l	6.53	Aluminum, mg/l	2
Nitrate, mg/l	18	Barium, mg/l	1
BOD_5, mg/l	60	Strontium, mg/l	7
Oil & Grease, mg/l	400	Ammonia, as N, mg/l	1.84
Silica, mg/l	17	Sulfite, mg/l	<1.0
Sodium, mg/l	880		
Potassium, mg/l	2.5		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: November 3, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-204-78 LW-108 9-22-78

LAB NO: DA-109

Color	Gray
Odor	Oily
Temperature, °C	13
Conductivity, µmhos	3500
pH	7.4
Oxygen, mg/l	----

Total Alkalinity, mg/l as $CaCO_3$	1300	Arsenic, mg/l	0.11
Carbonate, mg/l as $CaCO_3$	<1	Iron, mg/l	4
Bicarbonate, mg/l as $CaCO_3$	1300	Magnesium, mg/l	51
Total Dissolved Solids, mg/l	3000	Calcium, mg/l	67
Suspended Solids, mg/l	700	Boron, mg/l	33
Turbidity, NTU	90	Vanadium, mg/l	<0.1
Sulfate, mg/l	640	Copper, mg/l	<0.02
Chloride, mg/l	200	Molybdenum, mg/l	3
Fluoride, mg/l	19	Lithium, mg/l	0.6
Chemical Oxygen Demand, mg/l	400	Zinc, mg/l	3
Phenol, mg/l	0.079	Aluminum, mg/l	1
Nitrate, mg/l	19	Barium, mg/l	1
BOD_5, mg/l	100	Strontium, mg/l	8
Oil & Grease, mg/l	600	Ammonia, as N, mg/l	1.7
Silica, mg/l	22	Sulfite, mg/l	<1
Sodium, mg/l	930		
Potassium, mg/l	2.5		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: November 3, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-216-78 LW-108 9-29-78

LAB NO: DA-119

Color	Clear
Odor	Oily
Temperature, °C	16
Conductivity, µmhos	3500
pH	7.5
Oxygen, mg/l	----

Total Alkalinity, mg/l as $CaCO_3$	1280	Arsenic, mg/l	0.11
Carbonate, mg/l as $CaCO_3$	<1	Iron, mg/l	3
Bicarbonate, mg/l as $CaCO_3$	1280	Magnesium, mg/l	49
Total Dissolved Solids, mg/l	3000	Calcium, mg/l	61
Suspended Solids, mg/l	350	Boron, mg/l	20
Turbidity, NTU	50	Vanadium, mg/l	<0.1
Sulfate, mg/l	680	Copper, mg/l	<0.02
Chloride, mg/l	160	Molybdenum, mg/l	2
Fluoride, mg/l	19	Lithium, mg/l	0.7
Chemical Oxygen Demand, mg/l	70	Zinc, mg/l	0.9
Phenol, mg/l	0.079	Aluminum, mg/l	0.5
Nitrate, mg/l	14	Barium, mg/l	<0.5
BOD_5, mg/l	400	Strontium, mg/l	9
Oil & Grease, mg/l	400	Ammonia, as N, mg/l	12
Silica, mg/l	22	Sulfite, mg/l	<1.0
Sodium, mg/l	900		
Potassium, mg/l	2.1		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: November 3, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-215-78 LW-108 10-4-78

LAB NO: DA-120

Color	Clear		
Odor	Oily		
Temperature, °C	17		
Conductivity, µmhos	3400		
pH	7.1		
Oxygen, mg/l	2		
Total Alkalinity, mg/l as $CaCO_3$	1300	Arsenic, mg/l	0.11
Carbonate, mg/l as $CaCO_3$	<1	Iron, mg/l	4
Bicarbonate, mg/l as $CaCO_3$	1300	Magnesium, mg/l	50
Total Dissolved Solids, mg/l	3000	Calcium, mg/l	62
Suspended Solids, mg/l	300	Boron, mg/l	37
Turbidity, NTU	60	Vanadium, mg/l	<0.1
Sulfate, mg/l	480	Copper, mg/l	<0.02
Chloride, mg/l	200	Molybdenum, mg/l	2
Fluoride, mg/l	17	Lithium, mg/l	0.7
Chemical Oxygen Demand, mg/l	300	Zinc, mg/l	1
Phenol, mg/l	0.11	Aluminum, mg/l	0.6
Nitrate, mg/l	22	Barium, mg/l	0.9
BOD_5, mg/l	100	Strontium, mg/l	9
Oil & Grease, mg/l	700	Ammonia, as N, mg/l	1.7
Silica, mg/l	20	Sulfite, mg/l	<1.0
Sodium, mg/l	900		
Potassium, mg/l	2		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE: November 20, 1978

SAMPLE: A-239-78 LW-108 10-12-78

LAB NO: DA-133

Color	Gray
Odor	Oily
Temperature, °C	22
Conductivity, µmhos	3500
pH	7.1
Oxygen, mg/l	1

Total Alkalinity, mg/l as $CaCO_3$	1140	Arsenic, mg/l	0.09
Carbonate, mg/l as $CaCO_3$	60	Iron, mg/l	6
Bicarbonate, mg/l as $CaCO_3$	1080	Magnesium, mg/l	52
Total Dissolved Solids, mg/l	3000	Calcium, mg/l	66
Suspended Solids, mg/l	600	Boron, mg/l	35
Turbidity, NTU	80	Vanadium, mg/l	< 0.1
Sulfate, mg/l	690	Copper, mg/l	<0.02
Chloride, mg/l	200	Molybdenum, mg/l	2
Fluoride, mg/l	18	Lithium, mg/l	0.6
Chemical Oxygen Demand, mg/l	200	Zinc, mg/l	2
Phenol, mg/l	0.060	Aluminum, mg/l	2
Nitrate, mg/l	---	Barium, mg/l	0.8
BOD_5, mg/l	100	Strontium, mg/l	8
Oil & Grease, mg/l	1000	Ammonia, as N, mg/l	2.4
Silica, mg/l	22	Sulfite, mg/l	<1
Sodium, mg/l	920		
Potassium, mg/l	2.4		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom B.A. Romig
J.F. Denham R.E. Thomason
C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE: December 18, 1978

SAMPLE: A-261-78 LW-108 11-2-78

LAB NO: DA-160

Color	Clear
Odor	Oily
Temperature, °C	17
Conductivity, µmhos	3600
pH	7.7
Oxygen, mg/l	3

Total Alkalinity, mg/l as $CaCO_3$	1100	Arsenic, mg/l	0.14
Carbonate, mg/l as $CaCO_3$	40	Iron, mg/l	8
Bicarbonate, mg/l as $CaCO_3$	1060	Magnesium, mg/l	63
Total Dissolved Solids, mg/l	3100	Calcium, mg/l	70
Suspended Solids, mg/l	1900	Boron, mg/l	29
Turbidity, NTU	40	Vanadium, mg/l	<0.1
Sulfate, mg/l	800	Copper, mg/l	<0.02
Chloride, mg/l	190	Molybdenum, mg/l	0.9
Fluoride, mg/l	16	Lithium, mg/l	0.7
Chemical Oxygen Demand, mg/l	300	Zinc, mg/l	1
Phenol, mg/l	0.013	Aluminum, mg/l	1
Nitrate, mg/l	35	Barium, mg/l	1
BOD_5, mg/l	100	Strontium, mg/l	8
Oil & Grease, mg/l	400	Ammonia, as N, mg/l	4.1
Silica, mg/l	22	Sulfite, mg/l	<1
Sodium, mg/l	940		
Potassium, mg/l	2.5		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE: December 18, 1978

SAMPLE: A-281-78 LW-108 11-10-78

LAB NO: DA-180

Color	Clear
Odor	0
Temperature, °C	16
Conductivity, µmhos	3500
pH	7.6
Oxygen, mg/l	3
Total Alkalinity, mg/l as $CaCO_3$	960
Carbonate, mg/l as $CaCO_3$	70
Bicarbonate, mg/l as $CaCO_3$	890
Total Dissolved Solids, mg/l	3300
Suspended Solids, mg/l	640
Turbidity, NTU	20
Sulfate, mg/l	1700
Chloride, mg/l	200
Fluoride, mg/l	15
Chemical Oxygen Demand, mg/l	300
Phenol, mg/l	0.018
Nitrate, mg/l	8.0
BOD_5, mg/l	100
Oil & Grease, mg/l	90
Silica, mg/l	21
Sodium, mg/l	1000
Potassium, mg/l	2.7
Arsenic, mg/l	0.12
Iron, mg/l	3
Magnesium, mg/l	61
Calcium, mg/l	54
Boron, mg/l	31
Vanadium, mg/l	< 0.1
Copper, mg/l	0.03
Molybdenum, mg/l	1
Lithium, mg/l	0.7
Zinc, mg/l	0.5
Aluminum, mg/l	0.9
Barium, mg/l	< 0.5
Strontium, mg/l	9
Ammonia, as N, mg/l	1.9
Sulfite, mg/l	< 1

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE: December 18, 1978

SAMPLE: A-285-78 LW-108 11-16-78

LAB NO: DA-184

Color	Milky
Odor	Oily
Temperature, °C	10
Conductivity, µmhos	3400
pH	6.9
Oxygen, mg/l	4

Total Alkalinity, mg/l as $CaCO_3$	1100	Arsenic, mg/l	0.25
Carbonate, mg/l as $CaCO_3$	80	Iron, mg/l	20
Bicarbonate, mg/l as $CaCO_3$	1020	Magnesium, mg/l	75
Total Dissolved Solids, mg/l	3400	Calcium, mg/l	110
Suspended Solids, mg/l	1100	Boron, mg/l	32
Turbidity, NTU	40	Vanadium, mg/l	0.1
Sulfate, mg/l	1100	Copper, mg/l	0.2
Chloride, mg/l	190	Molybdenum, mg/l	2
Fluoride, mg/l	18	Lithium, mg/l	0.8
Chemical Oxygen Demand, mg/l	400	Zinc, mg/l	3
Phenol, mg/l	0.02	Aluminum, mg/l	6
Nitrate, mg/l	16	Barium, mg/l	<0.5
BOD_5, mg/l	200	Strontium, mg/l	9
Oil & Grease, mg/l	200	Ammonia, as N, mg/l	4.9
Silica, mg/l	22	Sulfite, mg/l	--
Sodium, mg/l	1100		
Potassium, mg/l	11		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: December 18, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-286-78 LW-108 11-21-78

LAB NO: DA-185

Color	Milky
Odor	Oily
Temperature, °C	10
Conductivity, µmhos	3400
pH	6.9
Oxygen, mg/l	4

Total Alkalinity, mg/l as $CaCO_3$	980	Arsenic, mg/l	0.13
Carbonate, mg/l as $CaCO_3$	< 1	Iron, mg/l	10
Bicarbonate, mg/l as $CaCO_3$	980	Magnesium, mg/l	60
Total Dissolved Solids, mg/l	3200	Calcium, mg/l	68
Suspended Solids, mg/l	200	Boron, mg/l	32
Turbidity, NTU	50	Vanadium, mg/l	< 0.1
Sulfate, mg/l	980	Copper, mg/l	0.04
Chloride, mg/l	180	Molybdenum, mg/l	2
Fluoride, mg/l	14	Lithium, mg/l	0.8
Chemical Oxygen Demand, mg/l	400	Zinc, mg/l	1
Phenol, mg/l	0.008	Aluminum, mg/l	2
Nitrate, mg/l	20	Barium, mg/l	0.8
BOD_5, mg/l	500	Strontium, mg/l	9
Oil & Grease, mg/l	10	Ammonia, as N, mg/l	2.7
Silica, mg/l	21	Sulfite, mg/l	- -
Sodium, mg/l	1000		
Potassium, mg/l	6.1		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: January 11, 1979

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-299-78 LW-108 12-1-78

LAB NO: DA-194

Color	Gray
Odor	Oily
Temperature, °C	14
Conductivity, µmhos	3500
pH	6.5
Oxygen, mg/l	4
Total Alkalinity, mg/l as $CaCO_3$	1300
Carbonate, mg/l as $CaCO_3$	< 1
Bicarbonate, mg/l as $CaCO_3$	1300
Total Dissolved Solids, mg/l	4200
Suspended Solids, mg/l	530
Turbidity, NTU	60
Sulfate, mg/l	1500
Chloride, mg/l	160
Fluoride, mg/l	15
Chemical Oxygen Demand, mg/l	20
Phenol, mg/l	0.008
Nitrate, mg/l	8
BOD_5, mg/l	70
Oil & Grease, mg/l	20
Silica, mg/l	21
Sodium, mg/l	1400
Potassium, mg/l	8.2
Arsenic, mg/l	0.08
Iron, mg/l	< 0.5
Magnesium, mg/l	68
Calcium, mg/l	65
Boron, mg/l	33
Vanadium, mg/l	< 0.1
Copper, mg/l	< 0.02
Molybdenum, mg/l	2
Lithium, mg/l	0.9
Zinc, mg/l	0.06
Aluminum, mg/l	0.08
Barium, mg/l	1
Strontium, mg/l	10
Ammonia, as N, mg/l	2.3
Sulfite, mg/l	< 1

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: January 23, 1979

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-300-78 LW-108 12-8-78

LAB NO: DA-199

Color	Gray
Odor	Oily
Temperature, °C	5
Conductivity, µmhos	4300
pH	4.9
Oxygen, mg/l	6

Total Alkalinity, mg/l as $CaCO_3$	1210	Arsenic, mg/l	0.05
Carbonate, mg/l as $CaCO_3$	30	Iron, mg/l	< 0.5
Bicarbonate, mg/l as $CaCO_3$	1180	Magnesium, mg/l	54
Total Dissolved Solids, mg/l	3100	Calcium, mg/l	56
Suspended Solids, mg/l	280	Boron, mg/l	33
Turbidity, NTU	80	Vanadium, mg/l	< 0.1
Sulfate, mg/l	910	Copper, mg/l	< 0.02
Chloride, mg/l	180	Molybdenum, mg/l	1
Fluoride, mg/l	11	Lithium, mg/l	0.8
Chemical Oxygen Demand, mg/l	300	Zinc, mg/l	0.2
Phenol, mg/l	0.007	Aluminum, mg/l	0.2
Nitrate, mg/l	160	Barium, mg/l	< 0.5
BOD_5, mg/l	170	Strontium, mg/l	9
Oil & Grease, mg/l	2	Ammonia, as N, mg/l	2.4
Silica, mg/l	22	Sulfite, mg/l	< 1
Sodium, mg/l	920		
Potassium, mg/l	5		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE: 26 January, 1979

SAMPLE: A-311-79 LW-108 12-15-78

LAB NO: DA-210

Color	Cloudy
Odor	Oily
Temperature, °C	5
Conductivity, µmhos	4900
pH	7.8
Oxygen, mg/l	5

Total Alkalinity, mg/l as $CaCO_3$	1300	Arsenic, mg/l	---
Carbonate, mg/l as $CaCO_3$	40	Iron, mg/l	< 0.5
Bicarbonate, mg/l as $CaCO_3$	1260	Magnesium, mg/l	52
Total Dissolved Solids, mg/l	3600	Calcium, mg/l	33
Suspended Solids, mg/l	180	Boron, mg/l	31
Turbidity, NTU	140	Vanadium, mg/l	0.1
Sulfate, mg/l	1200	Copper, mg/l	0.02
Chloride, mg/l	180	Molybdenum, mg/l	3
Fluoride, mg/l	11	Lithium, mg/l	0.8
Chemical Oxygen Demand, mg/l	260	Zinc, mg/l	< 0.02
Phenol, mg/l	0.08	Aluminum, mg/l	< 0.1
Nitrate, mg/l	11	Barium, mg/l	< 0.5
BOD_5, mg/l	210	Strontium, mg/l	6
Oil & Grease, mg/l	30	Ammonia, as N, mg/l	4.9
Silica, mg/l	20	Sulfite, mg/l	< 1
Sodium, mg/l	1200		
Potassium, mg/l	15		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: January 23, 1979

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-312-78 LW-108 12-21-78

LAB NO: DA-211

Color	Yellow
Odor	0
Temperature, °C	11
Conductivity, µmhos	5800
pH	9.3
Oxygen, mg/l	4

Total Alkalinity, mg/l as $CaCO_3$	2180	Arsenic, mg/l	0.5
Carbonate, mg/l as $CaCO_3$	550	Iron, mg/l	< 0.5
Bicarbonate, mg/l as $CaCO_3$	1630	Magnesium, mg/l	58
Total Dissolved Solids, mg/l	6800	Calcium, mg/l	46
Suspended Solids, mg/l	130	Boron, mg/l	37
Turbidity, NTU	10	Vanadium, mg/l	0.2
Sulfate, mg/l	2200	Copper, mg/l	< 0.02
Chloride, mg/l	200	Molybdenum, mg/l	4
Fluoride, mg/l	18	Lithium, mg/l	1
Chemical Oxygen Demand, mg/l	440	Zinc, mg/l	0.02
Phenol, mg/l	1.9	Aluminum, mg/l	< 0.1
Nitrate, mg/l	25	Barium, mg/l	< 0.5
BOD_5, mg/l	280	Strontium, mg/l	7
Oil & Grease, mg/l	40	Ammonia, as N, mg/l	3.4
Silica, mg/l	23	Sulfite, mg/l	3
Sodium, mg/l	2300		
Potassium, mg/l	48		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: January 23, 1979

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-314-78 LW-108 12-29-78

LAB NO: DA-213

Color	Yellow
Odor	0
Temperature, °C	11
Conductivity, µmhos	5000
pH	8.2
Oxygen, mg/l	2

Total Alkalinity, mg/l as $CaCO_3$	1600	Arsenic, mg/l	0.18
Carbonate, mg/l as $CaCO_3$	170	Iron, mg/l	< 0.5
Bicarbonate, mg/l as $CaCO_3$	1430	Magnesium, mg/l	56
Total Dissolved Solids, mg/l	4300	Calcium, mg/l	53
Suspended Solids, mg/l	90	Boron, mg/l	31
Turbidity, NTU	3	Vanadium, mg/l	< 0.1
Sulfate, mg/l	1400	Copper, mg/l	< 0.02
Chloride, mg/l	190	Molybdenum, mg/l	2
Fluoride, mg/l	15	Lithium, mg/l	1
Chemical Oxygen Demand, mg/l	460	Zinc, mg/l	< 0.02
Phenol, mg/l	0.8	Aluminum, mg/l	< 0.1
Nitrate, mg/l	12	Barium, mg/l	< 0.5
BOD_5, mg/l	70	Strontium, mg/l	6
Oil & Grease, mg/l	20	Ammonia, as N, mg/l	3.5
Silica, mg/l	23	Sulfite, mg/l	7
Sodium, mg/l	1500		
Potassium, mg/l	25		

SITES SAMPLED TWICE A MONTH

LS-PS-1
LS-PS-2
LMB-1
PL-RL-1
UIL-SW1
UIL-SE2
LIL-SW1
LIL-SE2
LIL-N3
AL-N1

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: January 23, 1979

SUBJECT: D.A. Water Analysis - Alluvial, Bedrock & Surface Water

SAMPLE: A-312-78 LW-108 12-21-78

LAB NO: DA-211

Color	Yellow
Odor	0
Temperature, °C	11
Conductivity, µmhos	5800
pH	9.3
Oxygen, mg/l	4

Total Alkalinity, mg/l as $CaCO_3$	2180	Arsenic, mg/l	0.5
Carbonate, mg/l as $CaCO_3$	550	Iron, mg/l	< 0.5
Bicarbonate, mg/l as $CaCO_3$	1630	Magnesium, mg/l	58
Total Dissolved Solids, mg/l	6800	Calcium, mg/l	46
Suspended Solids, mg/l	130	Boron, mg/l	37
Turbidity, NTU	10	Vanadium, mg/l	0.2
Sulfate, mg/l	2200	Copper, mg/l	< 0.02
Chloride, mg/l	200	Molybdenum, mg/l	4
Fluoride, mg/l	18	Lithium, mg/l	1
Chemical Oxygen Demand, mg/l	440	Zinc, mg/l	0.02
Phenol, mg/l	1.9	Aluminum, mg/l	< 0.1
Nitrate, mg/l	25	Barium, mg/l	< 0.5
BOD_5, mg/l	280	Strontium, mg/l	7
Oil & Grease, mg/l	40	Ammonia, as N, mg/l	3.4
Silica, mg/l	23	Sulfite, mg/l	3
Sodium, mg/l	2300		
Potassium, mg/l	48		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE: January 23, 1979

SAMPLE: A-314-78 LW-108 12-29-78

LAB NO: DA-213

Color	Yellow
Odor	0
Temperature, °C	11
Conductivity, µmhos	5000
pH	8.2
Oxygen, mg/l	2
Total Alkalinity, mg/l as $CaCO_3$	1600
Carbonate, mg/l as $CaCO_3$	170
Bicarbonate, mg/l as $CaCO_3$	1430
Total Dissolved Solids, mg/l	4300
Suspended Solids, mg/l	90
Turbidity, NTU	3
Sulfate, mg/l	1400
Chloride, mg/l	190
Fluoride, mg/l	15
Chemical Oxygen Demand, mg/l	460
Phenol, mg/l	0.8
Nitrate, mg/l	12
BOD_5, mg/l	70
Oil & Grease, mg/l	20
Silica, mg/l	23
Sodium, mg/l	1500
Potassium, mg/l	25
Arsenic, mg/l	0.18
Iron, mg/l	< 0.5
Magnesium, mg/l	56
Calcium, mg/l	53
Boron, mg/l	31
Vanadium, mg/l	< 0.1
Copper, mg/l	< 0.02
Molybdenum, mg/l	2
Lithium, mg/l	1
Zinc, mg/l	< 0.02
Aluminum, mg/l	< 0.1
Barium, mg/l	< 0.5
Strontium, mg/l	6
Ammonia, as N, mg/l	3.5
Sulfite, mg/l	7

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Water

DATE: October 17,1978

SAMPLE: A-189-78 L2-PS-1 8-26-78

LAB NO. DA-86

Total Alkalinity, mg/l as $CaCO_3$	100	Lithium, mg/l	0.3
Carbonate, mg/l as $CaCO_3$	50	Zinc, mg/l	0.1
Bicarbonate, mg/l as $CaCO_3$	50	Aluminum, mg/l	0.3
Total Dissolved Solids, mg/l	1200	Barium, mg/l	<0.5
Total Suspended Solids, mg/l	----	Strontium, mg/l	0.1
Sulfate, mg/l	540	Lead, mg/l	0.03
Chloride, mg/l	16	Nickel, mg/l	<0.02
Fluoride, mg/l	1.45	Cadmium, mg/l	<0.02
Phenol, mg/l	0.93	Ammonia, as N, mg/l	2.75
Nitrate, mg/l	4.4	Sulfite, mg/l	----
Oil & Grease, mg/l	18		
Silica, mg/l	10		
Sodium, mg/l	350		
Potassium, mg/l	2.6		
Arsenic, mg/l	0.05		
Iron, mg/l	<0.5		
Magnesium, mg/l	1.2		
Manganese, mg/l	<0.2		
Calcium, mg/l	3.3		
Boron, mg/l	0.1		
Vanadium, mg/l	<0.1		
Copper, mg/l	<0.02		
Molybdenum, mg/l	0.1		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Water

DATE: Nov. 8, 1978

SAMPLE: A-232-78 L 2-PS-1 10-11-78

LAB NO. DA-132

Total Alkalinity, mg/l as $CaCO_3$	420
Carbonate, mg/l as $CaCO_3$	70
Bicarbonate, mg/l as $CaCO_3$	350
Total Dissolved Solids, mg/l	1200
Total Suspended Solids, mg/l	170
Sulfate, mg/l	1700
Chloride, mg/l	24
Fluoride, mg/l	0.94
Phenol, mg/l	0.031
Nitrate, mg/l	27
Oil & Grease, mg/l	20
Silica, mg/l	9.8
Sodium, mg/l	420
Potassium, mg/l	1.9
Arsenic, mg/l	0.05
Iron, mg/l	0.7
Magnesium, mg/l	1.6
Manganese, mg/l	< 0.02
Calcium, mg/l	5.4
Boron, mg/l	0.43
Vanadium, mg/l	0.1
Copper, mg/l	< 0.02
Molybdenum, mg/l	< 0.02

Lithium, mg/l	0.3
Zinc, mg/l	0.02
Aluminum, mg/l	0.3
Barium, mg/l	< 0.5
Strontium, mg/l	0.2
Lead, mg/l	0.02
Nickel, mg/l	< 0.02
Cadmium, mg/l	< 0.02
Ammonia, as N, mg/l	310
Sulfite, mg/l	< 1

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial. Bedrock, and Surface Water

DATE: December 1, 1978

SAMPLE: A-251-78 L2-PS-1 10-25-78

LAB NO. DA-150

Total Alkalinity, mg/l as $CaCO_3$	420	Lithium, mg/l	0.2
Carbonate, mg/l as $CaCO_3$	80	Zinc, mg/l	0.05
Bicarbonate, mg/l as $CaCO_3$	340	Aluminum, mg/l	0.6
Total Dissolved Solids, mg/l	1000	Barium, mg/l	0.6
Total Suspended Solids, mg/l	530	Strontium, mg/l	0.2
Sulfate, mg/l	410	Lead, mg/l	0.04
Chloride, mg/l	14	Nickel, mg/l	< 0.02
Fluoride, mg/l	0.53	Cadmium, mg/l	< 0.02
Phenol, mg/l	0.009	Ammonia, as N, mg/l	1.1
Nitrate, mg/l	15	Sulfite, mg/l	---
Oil & Grease, mg/l	10		
Silica, mg/l	10		
Sodium, mg/l	400		
Potassium, mg/l	1.4		
Arsenic, mg/l	0.04		
Iron, mg/l	5		
Magnesium, mg/l	1.7		
Manganese, mg/l	0.03		
Calcium, mg/l	6.2		
Boron, mg/l	0.55		
Vanadium, mg/l	< 0.1		
Copper, mg/l	0.03		
Molybdenum, mg/l	0.03		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Sites

DATE: December 18, 1978

SAMPLE: A-276-78 L2-PS-1 11-9-78

LAB NO. DA-175

Total Alkalinity, mg/l as $CaCO_3$	360
Carbonate, mg/l as $CaCO_3$	90
Bicarbonate, mg/l as $CaCO_3$	270
Total Dissolved Solids, mg/l	1100
Total Suspended Solids, mg/l	20
Sulfate, mg/l	420
Chloride, mg/l	13
Fluoride, mg/l	0.41
Phenol, mg/l	0.015
Nitrate, mg/l	3.3
Oil & Grease, mg/l	70
Silica, mg/l	9.0
Sodium, mg/l	380
Potassium, mg/l	1.2
Arsenic, mg/l	< 0.02
Iron, mg/l	< 0.5
Magnesium, mg/l	0.7
Manganese, mg/l	<0.02
Calcium, mg/l	2.4
Boron, mg/l	0.3
Vanadium, mg/l	< 0.1
Copper, mg/l	< 0.02
Molybdenum, mg/l	0.04
Lithium, mg/l	0.2
Zinc, mg/l	< 0.02
Aluminum, mg/l	0.2
Barium, mg/l	0.8
Strontium, mg/l	1
Lead, mg/l	0.02
Nickel, mg/l	< 0.02
Cadmium, mg/l	< 0.02
Ammonia, as N, mg/l	13
Sulfite, mg/l	< 1

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: January 11, 1979

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-297-78 L2-PS-1 11-30-78

LAB NO: DA-193

Color	Clear
Odor	0
Temperature, °C	6
Conductivity, µmhos	1600
pH	8.5
Oxygen, mg/l	4

Total Alkalinity, mg/l as $CaCO_3$	370	Arsenic, mg/l	0.5
Carbonate, mg/l as $CaCO_3$	80	Iron, mg/l	< 0.5
Bicarbonate, mg/l as $CaCO_3$	290	Magnesium, mg/l	2.5
Total Dissolved Solids, mg/l	1200	Calcium, mg/l	4.8
Suspended Solids, mg/l	80	Boron, mg/l	0.32
Turbidity, NTU	20	Vanadium, mg/l	< 0.1
Sulfate, mg/l	440	Copper, mg/l	< 0.02
Chloride, mg/l	16	Molybdenum, mg/l	0.08
Fluoride, mg/l	0.52	Lithium, mg/l	0.3
Chemical Oxygen Demand, mg/l	10	Zinc, mg/l	0.03
Phenol, mg/l	0.007	Aluminum, mg/l	0.2
Nitrate, mg/l	6	Barium, mg/l	< 0.5
BOD_5, mg/l	10	Strontium, mg/l	0.3
Oil & Grease, mg/l	10	Ammonia, as N, mg/l	0.10
Silica, mg/l	10	Sulfite, mg/l	< 1
Sodium, mg/l	430		
Potassium, mg/l	2.2		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: January 23, 1979

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-306-78 L2-PS1 12-13-78

LAB NO: DA-205

Color	Clear
Odor	0
Temperature, °C	8
Conductivity, µmhos	1600
pH	8.6
Oxygen, mg/l	4
Total Alkalinity, mg/l as $CaCO_3$	390
Carbonate, mg/l as $CaCO_3$	60
Bicarbonate, mg/l as $CaCO_3$	330
Total Dissolved Solids, mg/l	1200
Suspended Solids, mg/l	90
Turbidity, NTU	20
Sulfate, mg/l	430
Chloride, mg/l	70
Fluoride, mg/l	0.5
Chemical Oxygen Demand, mg/l	8
Phenol, mg/l	0.008
Nitrate, mg/l	24
BOD_5, mg/l	8
Oil & Grease, mg/l	2
Silica, mg/l	14
Sodium, mg/l	400
Potassium, mg/l	2
Arsenic, mg/l	0.05
Iron, mg/l	< 0.5
Magnesium, mg/l	1
Calcium, mg/l	4
Boron, mg/l	0.7
Vanadium, mg/l	< 0.1
Copper, mg/l	< 0.02
Molybdenum, mg/l	1
Lithium, mg/l	0.2
Zinc, mg/l	0.03
Aluminum, mg/l	0.5
Barium, mg/l	0.5
Strontium, mg/l	0.2
Ammonia, as N, mg/l	1.0
Sulfite, mg/l	< 1

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Water

DATE: October 17, 1978

SAMPLE: A-191-78 L-2-PS-2 8-26-78

LAB NO. DA-87

Total Alkalinity, mg/l as $CaCO_3$	430	Lithium, mg/l	0.4
Carbonate, mg/l as $CaCO_3$	40	Zinc, mg/l	0.02
Bicarbonate, mg/l as $CaCO_3$	390	Aluminum, mg/l	<0.1
Total Dissolved Solids, mg/l	3100	Barium, mg/l	<0.5
Total Suspended Solids, mg/l	----	Strontium, mg/l	1
Sulfate, mg/l	760	Lead, mg/l	0.02
Chloride, mg/l	15	Nickel, mg/l	<0.02
Fluoride, mg/l	2.30	Cadmium, mg/l	<0.02
Phenol, mg/l	<0.001	Ammonia, as N, mg/l	43.5
Nitrate, mg/l	21.7	Sulfite, mg/l	----
Oil & Grease, mg/l	13		
Silica, mg/l	10		
Sodium, mg/l	480		
Potassium, mg/l	13		
Arsenic, mg/l	0.05		
Iron, mg/l	<0.5		
Magnesium, mg/l	8.8		
Manganese, mg/l	<0.2		
Calcium, mg/l	12		
Boron, mg/l	2		
Vanadium, mg/l	<0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	0.8		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Water

DATE: November 10, 1978

SAMPLE: A-229-78 L2-PS-2 10-11-78

LAB NO. DA-131

Total Alkalinity, mg/l as $CaCO_3$	390	Lithium, mg/l	0.4
Carbonate, mg/l as $CaCO_3$	30	Zinc, mg/l	0.02
Bicarbonate, mg/l as $CaCO_3$	360	Aluminum, mg/l	0.2
Total Dissolved Solids, mg/l	2000	Barium, mg/l	0.6
Total Suspended Solids, mg/l	200	Strontium, mg/l	1
Sulfate, mg/l	770	Lead, mg/l	0.04
Chloride, mg/l	200	Nickel, mg/l	<0.02
Fluoride, mg/l	2.5	Cadmium, mg/l	<0.02
Phenol, mg/l	0.011	Ammonia, as N, mg/l	210
Nitrate, mg/l	24	Sulfite, mg/l	<1
Oil & Grease, mg/l	40		
Silica, mg/l	12		
Sodium, mg/l	750		
Potassium, mg/l	9.4		
Arsenic, mg/l	0.09		
Iron, mg/l	0.9		
Magnesium, mg/l	8.6		
Manganese, mg/l	0.04		
Calcium, mg/l	19		
Boron, mg/l	2.6		
Vanadium, mg/l	<0.1		
Copper, mg/l	<0.02		
Molybdenum, mg/l	0.4		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Water

DATE: December 1, 1978

SAMPLE: A-250-78 L2-PS-2 10-25-78

LAB NO. DA-149

Total Alkalinity, mg/l as $CaCO_3$	360	Lithium, mg/l	0.4
Carbonate, mg/l as $CaCO_3$	30	Zinc, mg/l	0.2
Bicarbonate, mg/l as $CaCO_3$	330	Aluminum, mg/l	4
Total Dissolved Solids, mg/l	2000	Barium, mg/l	< 0.05
Total Suspended Solids, mg/l	70	Strontium, mg/l	2
Sulfate, mg/l	840	Lead, mg/l	0.07
Chloride, mg/l	160	Nickel, mg/l	0.05
Fluoride, mg/l	2.1	Cadmium, mg/l	< 0.02
Phenol, mg/l	0.012	Ammonia, as N, mg/l	4.7
Nitrate, mg/l	40	Sulfite, mg/l	---
Oil & Grease, mg/l	20		
Silica, mg/l	12		
Sodium, mg/l	660		
Potassium, mg/l	11		
Arsenic, mg/l	0.04		
Iron, mg/l	5		
Magnesium, mg/l	13		
Manganese, mg/l	0.05		
Calcium, mg/l	27		
Boron, mg/l	2.3		
Vanadium, mg/l	< 0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	0.4		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Sites

DATE: December 18, 1978

SAMPLE: A-275-78 L2-PS-2 11-9-78

LAB NO. DA-174

Total Alkalinity, mg/l as $CaCO_3$	330	Lithium, mg/l	0.4
Carbonate, mg/l as $CaCO_3$	40	Zinc, mg/l	0.07
Bicarbonate, mg/l as $CaCO_3$	290	Aluminum, mg/l	0.6
Total Dissolved Solids, mg/l	1900	Barium, mg/l	< 0.5
Total Suspended Solids, mg/l	14	Strontium, mg/l	1
Sulfate, mg/l	800	Lead, mg/l	0.04
Chloride, mg/l	180	Nickel, mg/l	< 0.02
Fluoride, mg/l	1.6	Cadmium, mg/l	< 0.02
Phenol, mg/l	0.016	Ammonia, as N, mg/l	12
Nitrate, mg/l	32	Sulfite, mg/l	< 1
Oil & Grease, mg/l	10		
Silica, mg/l	10		
Sodium, mg/l	640		
Potassium, mg/l	11		
Arsenic, mg/l	0.02		
Iron, mg/l	4		
Magnesium, mg/l	9		
Manganese, mg/l	0.03		
Calcium, mg/l	16		
Boron, mg/l	2.1		
Vanadium, mg/l	< 0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	0.6		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: January 11, 1979

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-292-78 L2-PS-2 11-30-78

LAB NO: DA-191

Color	Clear
Odor	0
Temperature, °C	11
Conductivity, µmhos	3100
pH	8.5
Oxygen, mg/l	4
Total Alkalinity, mg/l as $CaCO_3$	350
Carbonate, mg/l as $CaCO_3$	40
Bicarbonate, mg/l as $CaCO_3$	310
Total Dissolved Solids, mg/l	2000
Suspended Solids, mg/l	260
Turbidity, NTU	100
Sulfate, mg/l	860
Chloride, mg/l	190
Fluoride, mg/l	1.8
Chemical Oxygen Demand, mg/l	40
Phenol, mg/l	0.003
Nitrate, mg/l	24
BOD_5, mg/l	20
Oil & Grease, mg/l	80
Silica, mg/l	12
Sodium, mg/l	700
Potassium, mg/l	10
Arsenic, mg/l	0.04
Iron, mg/l	< 0.5
Magnesium, mg/l	8
Calcium, mg/l	15
Boron, mg/l	2.2
Vanadium, mg/l	< 0.1
Copper, mg/l	< 0.02
Molybdenum, mg/l	0.7
Lithium, mg/l	0.4
Zinc, mg/l	0.04
Aluminum, mg/l	0.5
Barium, mg/l	< 0.5
Strontium, mg/l	1
Ammonia, as N, mg/l	1.0
Sulfite, mg/l	< 1

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Water

DATE: October 17, 1978

SAMPLE: A-176-78 LMB-1 9-1-78

LAB NO. DA-93

Total Alkalinity, mg/l as $CaCO_3$	620	Lithium, mg/l	0.6
Carbonate, mg/l as $CaCO_3$	210	Zinc, mg/l	0.1
Bicarbonate, mg/l as $CaCO_3$	410	Aluminum, mg/l	0.9
Total Dissolved Solids, mg/l	1100	Barium, mg/l	0.6
Total Suspended Solids, mg/l	----	Strontium, mg/l	1.0
Sulfate, mg/l	1700	Lead, mg/l	0.04
Chloride, mg/l	130	Nickel, mg/l	0.03
Fluoride, mg/l	3.5	Cadmium, mg/l	<0.02
Phenol, mg/l	0.007	Ammonia, as N, mg/l	2.35
Nitrate, mg/l	85	Sulfite, mg/l	----
Oil & Grease, mg/l	58		
Silica, mg/l	16		
Sodium, mg/l	1000		
Potassium, mg/l	3.3		
Arsenic, mg/l	0.02		
Iron, mg/l	2		
Magnesium, mg/l	6		
Manganese, mg/l	<0.2		
Calcium, mg/l	12		
Boron, mg/l	9.5		
Vanadium, mg/l	<0.1		
Copper, mg/l	<0.02		
Molybdenum, mg/l	1		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Water

DATE: Nov. 8, 1978

SAMPLE: A-211-78 LMB-1 9-13-78

LAB NO. DA-107

Total Alkalinity, mg/l as $CaCO_3$	390	Lithium, mg/l	0.6
Carbonate, mg/l as $CaCO_3$	40	Zinc, mg/l	0.2
Bicarbonate, mg/l as $CaCO_3$	350	Aluminum, mg/l	4
Total Dissolved Solids, mg/l	3000	Barium, mg/l	2
Total Suspended Solids, mg/l	700	Strontium, mg/l	2
Sulfate, mg/l	1500	Lead, mg/l	0.05
Chloride, mg/l	140	Nickel, mg/l	< 0.02
Fluoride, mg/l	2.0	Cadmium, mg/l	< 0.02
Phenol, mg/l	0.004	Ammonia, as N, mg/l	3.7
Nitrate, mg/l	27	Sulfite, mg/l	< 1
Oil & Grease, mg/l	8		
Silica, mg/l	22		
Sodium, mg/l	990		
Potassium, mg/l	2.6		
Arsenic, mg/l	0.03		
Iron, mg/l	9		
Magnesium, mg/l	23		
Manganese, mg/l	0.3		
Calcium, mg/l	65		
Boron, mg/l	< 0.04		
Vanadium, mg/l	< 0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	2		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Water

DATE: December 1, 1978

SAMPLE: A-253-78 LMB-1 10-26-78

LAB NO. DA-153

Total Alkalinity, mg/l as $CaCO_3$	370
Carbonate, mg/l as $CaCO_3$	40
Bicarbonate, mg/l as $CaCO_3$	330
Total Dissolved Solids, mg/l	2900
Total Suspended Solids, mg/l	140
Sulfate, mg/l	1600
Chloride, mg/l	110
Fluoride, mg/l	2.8
Phenol, mg/l	0.006
Nitrate, mg/l	30
Oil & Grease, mg/l	2
Silica, mg/l	18
Sodium, mg/l	1000
Potassium, mg/l	2.8
Arsenic, mg/l	0.04
Iron, mg/l	7
Magnesium, mg/l	16
Manganese, mg/l	0.16
Calcium, mg/l	43
Boron, mg/l	7.2
Vanadium, mg/l	< 0.1
Copper, mg/l	< 0.02
Molybdenum, mg/l	0.8

Lithium, mg/l	0.5
Zinc, mg/l	0.08
Aluminum, mg/l	2
Barium, mg/l	0.5
Strontium, mg/l	2
Lead, mg/l	0.08
Nickel, mg/l	< 0.02
Cadmium, mg/l	0.04
Ammonia, as N, mg/l	0.2
Sulfite, mg/l	< 1

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Sites

DATE: December 18, 1978

SAMPLE: A-278-78 LMB-1 11-10-78

LAB NO. DA-177

Total Alkalinity, mg/l as $CaCO_3$	350	Lithium, mg/l	0.6
Carbonate, mg/l as $CaCO_3$	70	Zinc, mg/l	0.1
Bicarbonate, mg/l as $CaCO_3$	280	Aluminum, mg/l	2
Total Dissolved Solids, mg/l	3000	Barium, mg/l	< 0.5
Total Suspended Solids, mg/l	150	Strontium, mg/l	1
Sulfate, mg/l	1500	Lead, mg/l	< 0.02
Chloride, mg/l	120	Nickel, mg/l	< 0.02
Fluoride, mg/l	2.4	Cadmium, mg/l	< 0.02
Phenol, mg/l	0.02	Ammonia, as N, mg/l	0.25
Nitrate, mg/l	40	Sulfite, mg/l	< 1
Oil & Grease, mg/l	3		
Silica, mg/l	16		
Sodium, mg/l	1000		
Potassium, mg/l	2.9		
Arsenic, mg/l	0.04		
Iron, mg/l	3		
Magnesium, mg/l	11		
Manganese, mg/l	0.07		
Calcium, mg/l	24		
Boron, mg/l	4.3		
Vanadium, mg/l	< 0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	1		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE: January 23, 1979

SAMPLE: A-308-78 LMB-1 12-13-78

LAB NO: DA-207

Color	Clear
Odor	o
Temperature, °C	11
Conductivity, µmhos	4000
pH	8.2
Oxygen, mg/l	5
Total Alkalinity, mg/l as $CaCO_3$	380
Carbonate, mg/l as $CaCO_3$	40
Bicarbonate, mg/l as $CaCO_3$	340
Total Dissolved Solids, mg/l	3000
Suspended Solids, mg/l	60
Turbidity, NTU	10
Sulfate, mg/l	1500
Chloride, mg/l	120
Fluoride, mg/l	2
Chemical Oxygen Demand, mg/l	30
Phenol, mg/l	0.004
Nitrate, mg/l	14
BOD_5, mg/l	7
Oil & Grease, mg/l	8
Silica, mg/l	18
Sodium, mg/l	940
Potassium, mg/l	2
Arsenic, mg/l	0.04
Iron, mg/l	1
Magnesium, mg/l	8
Calcium, mg/l	14
Boron, mg/l	7
Vanadium, mg/l	< 0.1
Copper, mg/l	< 0.02
Molybdenum, mg/l	2
Lithium, mg/l	0.5
Zinc, mg/l	0.2
Aluminum, mg/l	< 0.1
Barium, mg/l	0.7
Strontium, mg/l	1
Ammonia, as N, mg/l	0.43
Sulfite, mg/l	< 1

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Water

DATE: October 17, 1978

SAMPLE: A-175-78 PL-RL-1 9-1-78

LAB NO. DA-92

Total Alkalinity, mg/l as $CaCO_3$	630
Carbonate, mg/l as $CaCO_3$	10
Bicarbonate, mg/l as $CaCO_3$	620
Total Dissolved Solids, mg/l	1500
Total Suspended Solids, mg/l	----
Sulfate, mg/l	280
Chloride, mg/l	120
Fluoride, mg/l	5.10
Phenol, mg/l	0.006
Nitrate, mg/l	26
Oil & Grease, mg/l	15
Silica, mg/l	9
Sodium, mg/l	530
Potassium, mg/l	3.7
Arsenic, mg/l	0.04
Iron, mg/l	6
Magnesium, mg/l	6
Manganese, mg/l	<0.2
Calcium, mg/l	17
Boron, mg/l	5.2
Vanadium, mg/l	< 0.1
Copper, mg/l	< 0.02
Molybdenum, mg/l	0.1
Lithium, mg/l	0.3
Zinc, mg/l	0.3
Aluminum, mg/l	4
Barium, mg/l	1
Strontium, mg/l	0.4
Lead, mg/l	0.1
Nickel, mg/l	0.03
Cadmium, mg/l	<0.02
Ammonia, as N, mg/l	3.15
Sulfite, mg/l	----

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Water

DATE: Nov. 8, 1978

SAMPLE: A-197-78 pL-RL-1 9-8-78

LAB NO. DA-100

Total Alkalinity, mg/l as $CaCO_3$	510	Lithium, mg/l	0.3
Carbonate, mg/l as $CaCO_3$	110	Zinc, mg/l	0.2
Bicarbonate, mg/l as $CaCO_3$	400	Aluminum, mg/l	4
Total Dissolved Solids, mg/l	1500	Barium, mg/l	1.0
Total Suspended Solids, mg/l	360	Strontium, mg/l	0.4
Sulfate, mg/l	400	Lead, mg/l	< 0.05
Chloride, mg/l	140	Nickel, mg/l	< 0.02
Fluoride, mg/l	4.2	Cadmium, mg/l	< 0.02
Phenol, mg/l	0.08	Ammonia, as N, mg/l	< 0.02
Nitrate, mg/l	42	Sulfite, mg/l	1
Oil & Grease, mg/l	40		
Silica, mg/l	7.8		
Sodium, mg/l	520		
Potassium, mg/l	3.3		
Arsenic, mg/l	0.05		
Iron, mg/l	10		
Magnesium, mg/l	5.8		
Manganese, mg/l	0.1		
Calcium, mg/l	19		
Boron, mg/l	0.42		
Vanadium, mg/l	< 0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	0.2		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Sites

DATE: December 18, 1978

SAMPLE: A-279-78 PL-RL-1 11-10-78

LAB NO. DA-178

Total Alkalinity, mg/l as $CaCO_3$	430	Lithium, mg/l	0.2
Carbonate, mg/l as $CaCO_3$	70	Zinc, mg/l	0.1
Bicarbonate, mg/l as $CaCO_3$	360	Aluminum, mg/l	0.4
Total Dissolved Solids, mg/l	1300	Barium, mg/l	< 0.5
Total Suspended Solids, mg/l	50	Strontium, mg/l	0.2
Sulfate, mg/l	410	Lead, mg/l	< 0.02
Chloride, mg/l	66	Nickel, mg/l	< 0.02
Fluoride, mg/l	1.1	Cadmium, mg/l	< 0.02
Phenol, mg/l	0.023	Ammonia, as N, mg/l	1.5
Nitrate, mg/l	< 0.1	Sulfite, mg/l	< 1
Oil & Grease, mg/l	8		
Silica, mg/l	8		
Sodium, mg/l	480		
Potassium, mg/l	1.8		
Arsenic, mg/l	0.09		
Iron, mg/l	3		
Magnesium, mg/l	2.2		
Manganese, mg/l	0.03		
Calcium, mg/l	7.1		
Boron, mg/l	0.35		
Vanadium, mg/l	0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	0.04		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom B.A. Romig
J.F. Denham R.E. Thomason
C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE: January 23, 1979

SAMPLE: A-307-78 PL-RL-1 12-13-78

LAB NO: DA-206

Color	Milky
Odor	0
Temperature, °C	12
Conductivity, µmhos	1800
pH	8.2
Oxygen, mg/l	4

Total Alkalinity, mg/l as $CaCO_3$	470	Arsenic, mg/l	0.03
Carbonate, mg/l as $CaCO_3$	50	Iron, mg/l	< 0.5
Bicarbonate, mg/l as $CaCO_3$	420	Magnesium, mg/l	1
Total Dissolved Solids, mg/l	1200	Calcium, mg/l	3
Suspended Solids, mg/l	70	Boron, mg/l	0.5
Turbidity, NTU	2	Vanadium, mg/l	< 0.1
Sulfate, mg/l	400	Copper, mg/l	< 0.02
Chloride, mg/l	68	Molybdenum, mg/l	0.1
Fluoride, mg/l	1	Lithium, mg/l	0.2
Chemical Oxygen Demand, mg/l	8	Zinc, mg/l	0.03
Phenol, mg/l	0.002	Aluminum, mg/l	< 0.1
Nitrate, mg/l	3	Barium, mg/l	< 0.5
BOD_5, mg/l	6	Strontium, mg/l	0.2
Oil & Grease, mg/l	10	Ammonia, as N, mg/l	1.4
Silica, mg/l	9	Sulfite, mg/l	< 1
Sodium, mg/l	450		
Potassium, mg/l	2		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Water

DATE: October 17, 1978

SAMPLE: A-190-78 LIL-SW-1 8-29-78

LAB NO. DA-88

Total Alkalinity, mg/l as $CaCO_3$	650	Lithium, mg/l	2
Carbonate, mg/l as $CaCO_3$	340	Zinc, mg/l	0.8
Bicarbonate, mg/l as $CaCO_3$	310	Aluminum, mg/l	6
Total Dissolved Solids, mg/l	2400	Barium, mg/l	3
Total Suspended Solids, mg/l	----	Strontium, mg/l	9
Sulfate, mg/l	650	Lead, mg/l	0.2
Chloride, mg/l	130	Nickel, mg/l	0.1
Fluoride, mg/l	12.8	Cadmium, mg/l	<0.02
Phenol, mg/l	0.004	Ammonia, as N, mg/l	6.7
Nitrate, mg/l	410	Sulfite, mg/l	----
Oil & Grease, mg/l	13		
Silica, mg/l	14		
Sodium, mg/l	780		
Potassium, mg/l	15		
Arsenic, mg/l	0.02		
Iron, mg/l	19		
Magnesium, mg/l	170		
Manganese, mg/l	1.7		
Calcium, mg/l	600		
Boron, mg/l	3.0		
Vanadium, mg/l	<0.1		
Copper, mg/l	<0.02		
Molybdenum, mg/l	5		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Water

DATE: Nov. 8, 1978

SAMPLE: A-225-78 LIL-SW-1 10-11-78

LAB NO. DA-128

Total Alkalinity, mg/l as $CaCO_3$	870	Lithium, mg/l	1
Carbonate, mg/l as $CaCO_3$	200	Zinc, mg/l	0.02
Bicarbonate, mg/l as $CaCO_3$	670	Aluminum, mg/l	0.7
Total Dissolved Solids, mg/l	2100	Barium, mg/l	0.6
Total Suspended Solids, mg/l	200	Strontium, mg/l	0.9
Sulfate, mg/l	560	Lead, mg/l	0.03
Chloride, mg/l	240	Nickel, mg/l	< 0.02
Fluoride, mg/l	7.4	Cadmium, mg/l	< 0.02
Phenol, mg/l	0.08	Ammonia, as N, mg/l	6
Nitrate, mg/l	11	Sulfite, mg/l	< 1
Oil & Grease, mg/l	9		
Silica, mg/l	20		
Sodium, mg/l	750		
Potassium, mg/l	10		
Arsenic, mg/l	0.11		
Iron, mg/l	1		
Magnesium, mg/l	5.4		
Manganese, mg/l	0.03		
Calcium, mg/l	12		
Boron, mg/l	2.8		
Vanadium, mg/l	< 0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	1		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Water

DATE: December 1, 1978

SAMPLE: A-249-78 LIL-SW-1 10-25-78

LAB NO. DA-148

Total Alkalinity, mg/l as $CaCO_3$	860	Lithium, mg/l	1
Carbonate, mg/l as $CaCO_3$	80	Zinc, mg/l	0.7
Bicarbonate, mg/l as $CaCO_3$	780	Aluminum, mg/l	8
Total Dissolved Solids, mg/l	2800	Barium, mg/l	4
Total Suspended Solids, mg/l	70	Strontium, mg/l	6
Sulfate, mg/l	520	Lead, mg/l	0.1
Chloride, mg/l	100	Nickel, mg/l	< 0.02
Fluoride, mg/l	6.4	Cadmium, mg/l	< 0.02
Phenol, mg/l	0.018	Ammonia, as N, mg/l	15
Nitrate, mg/l	110	Sulfite, mg/l	---
Oil & Grease, mg/l	20		
Silica, mg/l	24		
Sodium, mg/l	740		
Potassium, mg/l	11		
Arsenic, mg/l	0.15		
Iron, mg/l	60		
Magnesium, mg/l	94		
Manganese, mg/l	1.2		
Calcium, mg/l	370		
Boron, mg/l	3.3		
Vanadium, mg/l	< 0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	0.3		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Sites

DATE: December 18, 1978

SAMPLE: A-267-78 LIL-SW-1 11-9-78

LAB NO. DA-171

Total Alkalinity, mg/l as $CaCO_3$	830	Lithium, mg/l	1
Carbonate, mg/l as $CaCO_3$	120	Zinc, mg/l	< 0.02
Bicarbonate, mg/l as $CaCO_3$	710	Aluminum, mg/l	7
Total Dissolved Solids, mg/l	1900	Barium, mg/l	1
Total Suspended Solids, mg/l	10	Strontium, mg/l	0.6
Sulfate, mg/l	510	Lead, mg/l	< 0.02
Chloride, mg/l	150	Nickel, mg/l	< 0.02
Fluoride, mg/l	4.8	Cadmium, mg/l	< 0.02
Phenol, mg/l	0.024	Ammonia, as N, mg/l	9.6
Nitrate, mg/l	120	Sulfite, mg/l	< 1
Oil & Grease, mg/l	4		
Silica, mg/l	26		
Sodium, mg/l	700		
Potassium, mg/l	15		
Arsenic, mg/l	0.1		
Iron, mg/l	4		
Magnesium, mg/l	4.9		
Manganese, mg/l	< 0.02		
Calcium, mg/l	97		
Boron, mg/l	3.6		
Vanadium, mg/l	< 0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	0.4		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Water

DATE: October 17, 1978

SAMPLE: A-180-78 LIL-SE-2 8-24-78

LAB NO. DA-82

Total Alkalinity, mg/l as $CaCO_3$	590	Lithium, mg/l	1
Carbonate, mg/l as $CaCO_3$	20	Zinc, mg/l	0.7
Bicarbonate, mg/l as $CaCO_3$	570	Aluminum, mg/l	30
Total Dissolved Solids, mg/l	1500	Barium, mg/l	4
Total Suspended Solids, mg/l	----	Strontium, mg/l	10
Sulfate, mg/l	550	Lead, mg/l	<0.02
Chloride, mg/l	53	Nickel, mg/l	0.1
Fluoride, mg/l	1.33	Cadmium, mg/l	<0.02
Phenol, mg/l	<0.001	Ammonia, as N, mg/l	----
Nitrate, mg/l	24	Sulfite, mg/l	----
Oil & Grease, mg/l	20		
Silica, mg/l	93		
Sodium, mg/l	400		
Potassium, mg/l	4.0		
Arsenic, mg/l	0.03		
Iron, mg/l	90		
Magnesium, mg/l	260		
Manganese, mg/l	2		
Calcium, mg/l	720		
Boron, mg/l	2.3		
Vanadium, mg/l	0.6		
Copper, mg/l	0.02		
Molybdenum, mg/l	0.1		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Water

DATE: Nov. 8, 1978

SAMPLE: A-226-78 LIL-SE-2 10-11-78

LAB NO. DA-129

Total Alkalinity, mg/l as $CaCO_3$	560
Carbonate, mg/l as $CaCO_3$	20
Bicarbonate, mg/l as $CaCO_3$	540
Total Dissolved Solids, mg/l	1300
Total Suspended Solids, mg/l	130
Sulfate, mg/l	1000
Chloride, mg/l	52
Fluoride, mg/l	1.4
Phenol, mg/l	0.024
Nitrate, mg/l	< 0.1
Oil & Grease, mg/l	4
Silica, mg/l	32
Sodium, mg/l	330
Potassium, mg/l	1.9
Arsenic, mg/l	< 0.02
Iron, mg/l	< 0.5
Magnesium, mg/l	59
Manganese, mg/l	< 0.02
Calcium, mg/l	58
Boron, mg/l	1.7
Vanadium, mg/l	< 0.1
Copper, mg/l	< 0.02
Molybdenum, mg/l	< 0.02
Lithium, mg/l	0.8
Zinc, mg/l	0.03
Aluminum, mg/l	0.1
Barium, mg/l	0.6
Strontium, mg/l	8
Lead, mg/l	0.02
Nickel, mg/l	< 0.02
Cadmium, mg/l	< 0.02
Ammonia, as N, mg/l	< 1
Sulfite, mg/l	< 1

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis Alluvial. Bedrock, and Surface Water

DATE: December 1, 1978

SAMPLE: A-248-78 LIL-SE-2 10-25-78

LAB NO. Da-147

Total Alkalinity, mg/l as $CaCO_3$	660	Lithium, mg/l	0.8
Carbonate, mg/l as $CaCO_3$	<1	Zinc, mg/l	0.05
Bicarbonate, mg/l as $CaCO_3$	660	Aluminum, mg/l	0.3
Total Dissolved Solids, mg/l	1500	Barium, mg/l	< 0.5
Total Suspended Solids, mg/l	60	Strontium, mg/l	10
Sulfate, mg/l	410	Lead, mg/l	0.1
Chloride, mg/l	57	Nickel, mg/l	< 0.02
Fluoride, mg/l	1.5	Cadmium, mg/l	< 0.02
Phenol, mg/l	0.005	Ammonia, as N, mg/l	<0.04
Nitrate, mg/l	<0.1	Sulfite, mg/l	---
Oil & Grease, mg/l	20		
Silica, mg/l	28		
Sodium, mg/l	380		
Potassium, mg/l	2.0		
Arsenic, mg/l	<0.02		
Iron, mg/l	2		
Magnesium, mg/l	74		
Manganese, mg/l	< 0.02		
Calcium, mg/l	64		
Boron, mg/l	2		
Vanadium, mg/l	<0.1		
Copper, mg/l	<0.02		
Molybdenum, mg/l	0.3		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Water

DATE: December 1, 1978

SAMPLE: A-273-78 LEL-SE-2 11-9-78

LAB NO. DA-172

Total Alkalinity, mg/l as $CaCO_3$	910	Lithium, mg/l	0.9
Carbonate, mg/l as $CaCO_3$	< 1	Zinc, mg/l	0.08
Bicarbonate, mg/l as $CaCO_3$	910	Aluminum, mg/l	0.3
Total Dissolved Solids, mg/l	1900	Barium, mg/l	1
Total Suspended Solids, mg/l	20	Strontium, mg/l	10
Sulfate, mg/l	410	Lead, mg/l	< 0.02
Chloride, mg/l	81	Nickel, mg/l	< 0.02
Fluoride, mg/l	1.5	Cadmium, mg/l	< 0.02
Phenol, mg/l	0.003	Ammonia, as N, mg/l	1.2
Nitrate, mg/l	0.8	Sulfite, mg/l	< 1
Oil & Grease, mg/l	3		
Silica, mg/l	30		
Sodium, mg/l	470		
Potassium, mg/l	2.1		
Arsenic, mg/l	< 0.02		
Iron, mg/l	3		
Magnesium, mg/l	120		
Manganese, mg/l	0.02		
Calcium, mg/l	64		
Boron, mg/l	5.3		
Vanadium, mg/l	< 0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	0.7		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Water

DATE: October 17, 1978

SAMPLE: A-174-78 LIL-N_3 8-24-78

LAB NO. DA-80

Total Alkalinity, mg/l as $CaCO_3$	500	Lithium, mg/l	1.6
Carbonate, mg/l as $CaCO_3$	10	Zinc, mg/l	0.2
Bicarbonate, mg/l as $CaCO_3$	490	Aluminum, mg/l	9
Total Dissolved Solids, mg/l	1100	Barium, mg/l	1
Total Suspended Solids, mg/l	----	Strontium, mg/l	2
Sulfate, mg/l	400	Lead, mg/l	0.08
Chloride, mg/l	810	Nickel, mg/l	< 0.02
Fluoride, mg/l	6.44	Cadmium, mg/l	< 0.02
Phenol, mg/l	11.6	Ammonia, as N, mg/l	----
Nitrate, mg/l	7.5	Sulfite, mg/l	----
Oil & Grease, mg/l	30		
Silica, mg/l	16		
Sodium, mg/l	360		
Potassium, mg/l	4.3		
Arsenic, mg/l	0.03		
Iron, mg/l	8		
Magnesium, mg/l	24		
Manganese, mg/l	< 0.2		
Calcium, mg/l	35		
Boron, mg/l	1.5		
Vanadium, mg/l	< 0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	0.1		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Water

DATE: Nov. 8, 1978

SAMPLE: A-227-78 LIL-N-3 10-11-78

LAB NO. DA-130

Total Alkalinity, mg/l as $CaCO_3$	520
Carbonate, mg/l as $CaCO_3$	20
Bicarbonate, mg/l as $CaCO_3$	500
Total Dissolved Solids, mg/l	1100
Total Suspended Solids, mg/l	40
Sulfate, mg/l	550
Chloride, mg/l	36
Fluoride, mg/l	4.1
Phenol, mg/l	0.024
Nitrate, mg/l	5.9
Oil & Grease, mg/l	20
Silica, mg/l	19
Sodium, mg/l	360
Potassium, mg/l	1.2
Arsenic, mg/l	< 0.02
Iron, mg/l	< 0.5
Magnesium, mg/l	17
Manganese, mg/l	< 0.02
Calcium, mg/l	14
Boron, mg/l	1.0
Vanadium, mg/l	< 0.1
Copper, mg/l	< 0.02
Molybdenum, mg/l	0.4
Lithium, mg/l	2
Zinc, mg/l	0.02
Aluminum, mg/l	0.04
Barium, mg/l	< 0.5
Strontium, mg/l	2
Lead, mg/l	< 0.02
Nickel, mg/l	< 0.02
Cadmium, mg/l	< 0.02
Ammonia, as N, mg/l	< 1
Sulfite, mg/l	< 1

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Water

DATE: December 1, 1978

SAMPLE: A-247-78 LIL-N3 10-25-78

LAB NO. DA-146

Total Alkalinity, mg/l as $CaCO_3$	540	Lithium, mg/l	2
Carbonate, mg/l as $CaCO_3$	40	Zinc, mg/l	< 0.02
Bicarbonate, mg/l as $CaCO_3$	500	Aluminum, mg/l	0.1
Total Dissolved Solids, mg/l	1100	Barium, mg/l	< 0.5
Total Suspended Solids, mg/l	200	Strontium, mg/l	2
Sulfate, mg/l	290	Lead, mg/l	0.03
Chloride, mg/l	33	Nickel, mg/l	<0.02
Fluoride, mg/l	4.4	Cadmium, mg/l	<0.02
Phenol, mg/l	0.002	Ammonia, as N, mg/l	0.7
Nitrate, mg/l	4.3	Sulfite, mg/l	---
Oil & Grease, mg/l	9		
Silica, mg/l	16		
Sodium, mg/l	380		
Potassium, mg/l	1.0		
Arsenic, mg/l	< 0.02		
Iron, mg/l	< 0.5		
Magnesium, mg/l	15		
Manganese, mg/l	< 0.02		
Calcium, mg/l	13		
Boron, mg/l	2		
Vanadium, mg/l	< 0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	0.07		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Water

DATE: December 1, 1978

SAMPLE: A-274-78 LIL-N3 11-9-78

LAB NO. DA-173

Total Alkalinity, mg/l as $CaCO_3$	490	Lithium, mg/l	2
Carbonate, mg/l as $CaCO_3$	50	Zinc, mg/l	< 0.02
Bicarbonate, mg/l as $CaCO_3$	440	Aluminum, mg/l	0.1
Total Dissolved Solids, mg/l	980	Barium, mg/l	< 0.5
Total Suspended Solids, mg/l	10	Strontium, mg/l	2
Sulfate, mg/l	270	Lead, mg/l	0.04
Chloride, mg/l	35	Nickel, mg/l	0.02
Fluoride, mg/l	4.3	Cadmium, mg/l	< 0.02
Phenol, mg/l	0.003	Ammonia, as N, mg/l	0.65
Nitrate, mg/l	3	Sulfite, mg/l	< 1
Oil & Grease, mg/l	10		
Silica, mg/l	16		
Sodium, mg/l	380		
Potassium, mg/l	1.2		
Arsenic, mg/l	< 0.02		
Iron, mg/l	0.9		
Magnesium, mg/l	10		
Manganese, mg/l	< 0.02		
Calcium, mg/l	10		
Boron, mg/l	1.4		
Vanadium, mg/l	< 0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	0.1		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom B.A. Romig
J.F. Denham R.E. Thomason
C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: January 11, 1979

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-291-78 LIL-N3 11-30-78

LAB NO: DA-190

Color	Clear
Odor	0
Temperature, °C	11
Conductivity, µmhos	1500
pH	8.8
Oxygen, mg/l	6
Total Alkalinity, mg/l as $CaCO_3$	590
Carbonate, mg/l as $CaCO_3$	60
Bicarbonate, mg/l as $CaCO_3$	530
Total Dissolved Solids, mg/l	1100
Suspended Solids, mg/l	90
Turbidity, NTU	2
Sulfate, mg/l	270
Chloride, mg/l	36
Fluoride, mg/l	4.3
Chemical Oxygen Demand, mg/l	40
Phenol, mg/l	0.006
Nitrate, mg/l	2.8
BOD_5, mg/l	10
Oil & Grease, mg/l	3
Silica, mg/l	18
Sodium, mg/l	410
Potassium, mg/l	2.4
Arsenic, mg/l	< 0.02
Iron, mg/l	< 0.5
Magnesium, mg/l	12
Calcium, mg/l	10
Boron, mg/l	1.4
Vanadium, mg/l	< 0.1
Copper, mg/l	< 0.02
Molybdenum, mg/l	0.04
Lithium, mg/l	2
Zinc, mg/l	0.04
Aluminum, mg/l	0.4
Barium, mg/l	0.8
Strontium, mg/l	2
Ammonia, as N, mg/l	2.4
Sulfite, mg/l	< 1

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE: January 23, 1979

SAMPLE: A-305-78 LIL-N3 12-13-78

LAB NO: DA-204

Color	Clear
Odor	o
Temperature, °C	8
Conductivity, µmhos	1600
pH	7.2
Oxygen, mg/l	4

Total Alkalinity, mg/l as $CaCO_3$	670	Arsenic, mg/l	< 0.02
Carbonate, mg/l as $CaCO_3$	110	Iron, mg/l	< 0.5
Bicarbonate, mg/l as $CaCO_3$	560	Magnesium, mg/l	12
Total Dissolved Solids, mg/l	1200	Calcium, mg/l	10
Suspended Solids, mg/l	70	Boron, mg/l	2
Turbidity, NTU	2	Vanadium, mg/l	0.1
Sulfate, mg/l	270	Copper, mg/l	< 0.02
Chloride, mg/l	38	Molybdenum, mg/l	0.1
Fluoride, mg/l	4.2	Lithium, mg/l	2
Chemical Oxygen Demand, mg/l	20	Zinc, mg/l	0.04
Phenol, mg/l	0.05	Aluminum, mg/l	< 0.1
Nitrate, mg/l	7	Barium, mg/l	0.6
BOD_5, mg/l	10	Strontium, mg/l	2
Oil & Grease, mg/l	20	Ammonia, as N, mg/l	19
Silica, mg/l	18	Sulfite, mg/l	< 1
Sodium, mg/l	430		
Potassium, mg/l	3		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock, and Surface Water

DATE: Nov. 8, 1978

SAMPLE: A-199-78 9-8-78 AL-N1

LAB NO. DA-99

Total Alkalinity, mg/l as $CaCO_3$	1470	Lithium, mg/l	0.3
Carbonate, mg/l as $CaCO_3$	640	Zinc, mg/l	0.07
Bicarbonate, mg/l as $CaCO_3$	830	Aluminum, mg/l	2
Total Dissolved Solids, mg/l	4500	Barium, mg/l	0.8
Total Suspended Solids, mg/l	800	Strontium, mg/l	0.3
Sulfate, mg/l	500	Lead, mg/l	< 0.05
Chloride, mg/l	300	Nickel, mg/l	0.03
Fluoride, mg/l	23	Cadmium, mg/l	< 0.02
Phenol, mg/l	0.054	Ammonia, as N, mg/l	6.8
Nitrate, mg/l	35	Sulfite, mg/l	---
Oil & Grease, mg/l	40		
Silica, mg/l	41		
Sodium, mg/l	1500		
Potassium, mg/l	13		
Arsenic, mg/l	0.10		
Iron, mg/l	10		
Magnesium, mg/l	2.6		
Manganese, mg/l	0.04		
Calcium, mg/l	17		
Boron, mg/l	27		
Vanadium, mg/l	< 0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	3		

APPENDIX B3

WATER ANALYSIS
SITES SAMPLED MONTHLY

SITES SAMPLED MONTHLY

LW-22	(ALLUVIAL)
LW-101	(ALLUVIAL)
LW-102	(ALLUVIAL)
LW-112	(ALLUVIAL)
LW-115	(ALLUVIAL)
LW-121	(ALLUVIAL)
SMITH GULCH	(SURFACE)
LOGAN WASH	(SURFACE)
BOWDISH WASH	(SURFACE)
ROAN CREEK	(UPSTREAM OF LOGAN WASH)
ROAN CREEK	(DOWNSTREAM OF LOGAN WASH)

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE: October 27, 1978

SAMPLE: A-188-78 LW-22 8-29-78

LAB NO: DA-89

Color	----
Odor	----
Temperature, °C	21
Conductivity, µmhos	4100
pH	6.4
Oxygen, mg/l	----
Total Alkalinity, mg/l as $CaCO_3$	370
Carbonate, mg/l as $CaCO_3$	<1
Bicarbonate, mg/l as $CaCO_3$	370
Total Dissolved Solids, mg/l	5300
Suspended Solids, mg/l	----
Turbidity, NTU	34,000
Sulfate, mg/l	3500
Chloride, mg/l	38
Fluoride, mg/l	1.10
Chemical Oxygen Demand, mg/l	150
Phenol, mg/l	0.026
Nitrate, mg/l	51
BOD_5, mg/l	60
Oil & Grease, mg/l	30
Silica, mg/l	10
Sodium, mg/l	630
Potassium, mg/l	44

Arsenic, mg/l	<0.02
Iron, mg/l	<0.5
Magnesium, mg/l	570
Calcium, mg/l	2000
Boron, mg/l	0.4
Vanadium, mg/l	<0.1
Copper, mg/l	<0.02
Molybdenum, mg/l	0.05
Lithium, mg/l	0.3
Zinc, mg/l	0.2
Aluminum, mg/l	5
Barium, mg/l	4
Strontium, mg/l	30
Ammonia, as N, mg/l	0.80
Sulfite, mg/l	----

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom B.A. Romig
J.F. Denham R.E. Thomason
C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: October 27. 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-194-78 LW-22 9-12-78

LAB NO: DA-105

Color	Clear to Sandy
Odor	None
Temperature, °C	16
Conductivity, µmhos	2000
pH	6.6
Oxygen, mg/l	----

Total Alkalinity, mg/l as $CaCO_3$	420	Arsenic, mg/l	<0.02
Carbonate, mg/l as $CaCO_3$	<1	Iron, mg/l	20
Bicarbonate, mg/l as $CaCO_3$	420	Magnesium, mg/l	150
Total Dissolved Solids, mg/l	1900	Calcium, mg/l	190
Suspended Solids, mg/l	80	Boron, mg/l	0.20
Turbidity, NTU	30	Vanadium, mg/l	<0.1
Sulfate, mg/l	950	Copper, mg/l	<0.02
Chloride, mg/l	20	Molybdenum, mg/l	0.05
Fluoride, mg/l	1.1	Lithium, mg/l	0.1
Chemical Oxygen Demand, mg/l	20	Zinc, mg/l	0.1
Phenol, mg/l	0.012	Aluminum, mg/l	2
Nitrate, mg/l	34	Barium, mg/l	0.7
BOD_5, mg/l	10	Strontium, mg/l	7
Oil & Grease, mg/l	20	Ammonia, as N, mg/l	1.5
Silica, mg/l	16	Sulfite, mg/l	<1.0
Sodium, mg/l	180		
Potassium, mg/l	4.4		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom
R.E. Thomason
C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: October 27. 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: IN HOUSE
A-205-78 LW-22 9-27-78

LAB NO: DA-112

Color	Sandy		
Odor	Earthy		
Temperature, °C	17		
Conductivity, µmhos	2000		
pH	6.8		
Oxygen, mg/l			
Total Alkalinity, mg/l as $CaCO_3$		Arsenic, mg/l	
Carbonate, mg/l as $CaCO_3$		Iron, mg/l	
Bicarbonate, mg/l as $CaCO_3$		Magnesium, mg/l	
Total Dissolved Solids, mg/l		Calcium, mg/l	
Suspended Solids, mg/l		Boron, mg/l	0.22
Turbidity, NTU		Vanadium, mg/l	
Sulfate, mg/l		Copper, mg/l	
Chloride, mg/l		Molybdenum, mg/l	
Fluoride, mg/l	0.88	Lithium, mg/l	
Chemical Oxygen Demand, mg/l		Zinc, mg/l	
Phenol, mg/l	<0.001	Aluminum, mg/l	
Nitrate, mg/l	31	Barium, mg/l	
BOD_5, mg/l		Strontium, mg/l	
Oil & Grease, mg/l		Ammonia, as N, mg/l	
Silica, mg/l		Sulfite, mg/l	
Sodium, mg/l			
Potassium, mg/l			

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom
R.E. Thomason
C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE: November 20, 1978

SAMPLE: A-257-78 LW-22 10-27-78
IN HOUSE

LAB NO: DA-158

Color			
Odor			
Temperature, °C			
Conductivity, µmhos			
pH			
Oxygen, mg/l			
Total Alkalinity, mg/l as $CaCO_3$		Arsenic, mg/l	
Carbonate, mg/l as $CaCO_3$		Iron, mg/l	
Bicarbonate, mg/l as $CaCO_3$		Magnesium, mg/l	
Total Dissolved Solids, mg/l		Calcium, mg/l	
Suspended Solids, mg/l		Boron, mg/l	0.30
Turbidity, NTU		Vanadium, mg/l	
Sulfate, mg/l		Copper, mg/l	
Chloride, mg/l		Molybdenum, mg/l	
Fluoride, mg/l	0.92	Lithium, mg/l	
Chemical Oxygen Demand, mg/l		Zinc, mg/l	
Phenol, mg/l	0.003	Aluminum, mg/l	
Nitrate, mg/l	74	Barium, mg/l	
BOD_5, mg/l		Strontium, mg/l	
Oil & Grease, mg/l		Ammonia, as N, mg/l	
Silica, mg/l		Sulfite, mg/l	<1
Sodium, mg/l			
Potassium, mg/l			

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: December 18, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-282-78 LW-22 11-10-78

LAB NO: DA-181

Color	Sandy
Odor	o
Temperature, °C	13
Conductivity, µmhos	2200
pH	7.3
Oxygen, mg/l	4
Total Alkalinity, mg/l as $CaCO_3$	410
Carbonate, mg/l as $CaCO_3$	< 1
Bicarbonate, mg/l as $CaCO_3$	410
Total Dissolved Solids, mg/l	2100
Suspended Solids, mg/l	1500
Turbidity, NTU	240
Sulfate, mg/l	920
Chloride, mg/l	31
Fluoride, mg/l	0.80
Chemical Oxygen Demand, mg/l	50
Phenol, mg/l	0.015
Nitrate, mg/l	82
BOD_5, mg/l	30
Oil & Grease, mg/l	2
Silica, mg/l	18
Sodium, mg/l	200
Potassium, mg/l	8.8
Arsenic, mg/l	< 0.02
Iron, mg/l	50
Magnesium, mg/l	230
Calcium, mg/l	850
Boron, mg/l	0.33
Vanadium, mg/l	< 0.1
Copper, mg/l	0.06
Molybdenum, mg/l	0.08
Lithium, mg/l	0.2
Zinc, mg/l	0.2
Aluminum, mg/l	20
Barium, mg/l	2
Strontium, mg/l	10
Ammonia, as N, mg/l	0.40
Sulfite, mg/l	< 1

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: January 23, 1979

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-301-78 LW-22 12-12-78

LAB NO: DA-201

Color	Red
Odor	0
Temperature, °C	7
Conductivity, µmhos	2400
pH	6.0
Oxygen, mg/l	4

Total Alkalinity, mg/l as $CaCO_3$	460	Arsenic, mg/l	< 0.02
Carbonate, mg/l as $CaCO_3$	< 1	Iron, mg/l	1
Bicarbonate, mg/l as $CaCO_3$	460	Magnesium, mg/l	160
Total Dissolved Solids, mg/l	2000	Calcium, mg/l	200
Suspended Solids, mg/l	2500	Boron, mg/l	0.5
Turbidity, NTU	220	Vanadium, mg/l	< 0.1
Sulfate, mg/l	980	Copper, mg/l	< 0.02
Chloride, mg/l	31	Molybdenum, mg/l	0.2
Fluoride, mg/l	0.4	Lithium, mg/l	0.1
Chemical Oxygen Demand, mg/l	20	Zinc, mg/l	0.03
Phenol, mg/l	0.003	Aluminum, mg/l	0.1
Nitrate, mg/l	170	Barium, mg/l	< 0.5
BOD_5, mg/l	20	Strontium, mg/l	8
Oil & Grease, mg/l	5	Ammonia, as N, mg/l	0.47
Silica, mg/l	16	Sulfite, mg/l	< 1
Sodium, mg/l	240		
Potassium, mg/l	6.4		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: Oct. 18, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-164-78 . LW-101 8-15-78

LAB NO: DA-71

Color	---
Odor	---
Temperature, °C	21
Conductivity, µmhos	2600
pH	6.9
Oxygen, mg/l	---
Total Alkalinity, mg/l as $CaCO_3$	420
Carbonate, mg/l as $CaCO_3$	< 1
Bicarbonate, mg/l as $CaCO_3$	420
Total Dissolved Solids, mg/l	720
Suspended Solids, mg/l	---
Turbidity, NTU	---
Sulfate, mg/l	1200
Chloride, mg/l	42
Fluoride, mg/l	0.85
Chemical Oxygen Demand, mg/l	32
Phenol, mg/l	0.028
Nitrate, mg/l	160
BOD_5, mg/l	10
Oil & Grease, mg/l	24
Silica, mg/l	---
Sodium, mg/l	250
Potassium, mg/l	11
Arsenic, mg/l	0.04
Iron, mg/l	28
Magnesium, mg/l	150
Calcium, mg/l	150
Boron, mg/l	0.66
Vanadium, mg/l	< 0.1
Copper, mg/l	< 0.02
Molybdenum, mg/l	0.5
Lithium, mg/l	0.1
Zinc, mg/l	0.09
Aluminum, mg/l	0.8
Barium, mg/l	< 0.5
Strontium, mg/l	7
Ammonia, as N, mg/l	2.84
Sulfite, mg/l	---

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: October 27, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-182-78 LW-101 9-13-78

LAB NO: DA-104

Color	Light Yellow
Odor	None
Temperature, °C	19
Conductivity, µmhos	2500
pH	6.6
Oxygen, mg/l	----

Total Alkalinity, mg/l as $CaCO_3$	410	Arsenic, mg/l	<0.02
Carbonate, mg/l as $CaCO_3$	<1	Iron, mg/l	10
Bicarbonate, mg/l as $CaCO_3$	410	Magnesium, mg/l	170
Total Dissolved Solids, mg/l	2400	Calcium, mg/l	180
Suspended Solids, mg/l	120	Boron, mg/l	1.3
Turbidity, NTU	30	Vanadium, mg/l	<0.1
Sulfate, mg/l	1100	Copper, mg/l	<0.02
Chloride, mg/l	46	Molybdenum, mg/l	0.7
Fluoride, mg/l	0.90	Lithium, mg/l	0.1
Chemical Oxygen Demand, mg/l	60	Zinc, mg/l	0.1
Phenol, mg/l	0.017	Aluminum, mg/l	0.5
Nitrate, mg/l	6.7	Barium, mg/l	0.8
BOD_5, mg/l	6	Strontium, mg/l	10
Oil & Grease, mg/l	20	Ammonia, as N, mg/l	0.45
Silica, mg/l	18	Sulfite, mg/l	<1.0
Sodium, mg/l	31		
Potassium, mg/l	8.5		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom
R.E. Thomason
C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: October 27, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: IN HOUSE
A-202-78 LW-101 9-27-78

LAB NO: DA-111

Color	Clear
Odor	None
Temperature, °C	13
Conductivity, µmhos	2300
pH	6.4
Oxygen, mg/l	
Total Alkalinity, mg/l as $CaCO_3$	
Carbonate, mg/l as $CaCO_3$	
Bicarbonate, mg/l as $CaCO_3$	
Total Dissolved Solids, mg/l	
Suspended Solids, mg/l	
Turbidity, NTU	
Sulfate, mg/l	
Chloride, mg/l	
Fluoride, mg/l	0.7
Chemical Oxygen Demand, mg/l	
Phenol, mg/l	0.011
Nitrate, mg/l	6.2
BOD_5, mg/l	
Oil & Grease, mg/l	
Silica, mg/l	
Sodium, mg/l	
Potassium, mg/l	
Arsenic, mg/l	
Iron, mg/l	
Magnesium, mg/l	
Calcium, mg/l	
Boron, mg/l	1.3
Vanadium, mg/l	
Copper, mg/l	
Molybdenum, mg/l	
Lithium, mg/l	
Zinc, mg/l	
Aluminum, mg/l	
Barium, mg/l	
Strontium, mg/l	
Ammonia, as N, mg/l	
Sulfite, mg/l	<1

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: November 10, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-233-78 LW-101 10-17-78

LAB NO: DA-134

Color	Clear
Odor	None
Temperature, °C	12
Conductivity, µmhos	2700
pH	8.1
Oxygen, mg/l	5
Total Alkalinity, mg/l as $CaCO_3$	380
Carbonate, mg/l as $CaCO_3$	50
Bicarbonate, mg/l as $CaCO_3$	330
Total Dissolved Solids, mg/l	2000
Suspended Solids, mg/l	60
Turbidity, NTU	20
Sulfate, mg/l	1200
Chloride, mg/l	57
Fluoride, mg/l	0.63
Chemical Oxygen Demand, mg/l	80
Phenol, mg/l	0.030
Nitrate, mg/l	210
BOD_5, mg/l	9
Oil & Grease, mg/l	50
Silica, mg/l	21
Sodium, mg/l	310
Potassium, mg/l	10
Arsenic, mg/l	< 0.02
Iron, mg/l	20
Magnesium, mg/l	180
Calcium, mg/l	180
Boron, mg/l	1.4
Vanadium, mg/l	0.2
Copper, mg/l	0.03
Molybdenum, mg/l	0.5
Lithium, mg/l	0.1
Zinc, mg/l	0.7
Aluminum, mg/l	0.3
Barium, mg/l	0.7
Strontium, mg/l	10
Ammonia, as N, mg/l	0.92
Sulfite, mg/l	< 1

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom
R.E. Thomason
C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: November 20, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-256-78 LW-101 10-27-78
IN HOUSE

LAB NO: DA-157

Color			
Odor			
Temperature, ^{o}C			
Conductivity, µmhos			
pH			
Oxygen, mg/l			
Total Alkalinity, mg/l as $CaCO_3$		Arsenic, mg/l	
Carbonate, mg/l as $CaCO_3$		Iron, mg/l	
Bicarbonate, mg/l as $CaCO_3$		Magnesium, mg/l	
Total Dissolved Solids, mg/l		Calcium, mg/l	
Suspended Solids, mg/l		Boron, mg/l	1.6
Turbidity, NTU		Vanadium, mg/l	
Sulfate, mg/l		Copper, mg/l	
Chloride, mg/l		Molybdenum, mg/l	
Fluoride, mg/l	0.75	Lithium, mg/l	
Chemical Oxygen Demand, mg/l		Zinc, mg/l	
Phenol, mg/l	0.006	Aluminum, mg/l	
Nitrate, mg/l	120	Barium, mg/l	
BOD_5, mg/l		Strontium, mg/l	
Oil & Grease, mg/l		Ammonia, as N, mg/l	
Silica, mg/l		Sulfite, mg/l	
Sodium, mg/l			
Potassium, mg/l			

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE:

SAMPLE: A-266-78 LW 101 11-7-78

LAB NO: DA-165

Color	Clear
Odor	o
Temperature, °C	12
Conductivity, µmhos	2400
pH	7.5
Oxygen, mg/l	4

Total Alkalinity, mg/l as $CaCO_3$	420	Arsenic, mg/l	< 0.02
Carbonate, mg/l as $CaCO_3$	< 1	Iron, mg/l	20
Bicarbonate, mg/l as $CaCO_3$	420	Magnesium, mg/l	190
Total Dissolved Solids, mg/l	2600	Calcium, mg/l	170
Suspended Solids, mg/l	20	Boron, mg/l	1.6
Turbidity, NTU	20	Vanadium, mg/l	< 0.1
Sulfate, mg/l	1200	Copper, mg/l	< 0.02
Chloride, mg/l	60	Molybdenum, mg/l	0.5
Fluoride, mg/l	0.68	Lithium, mg/l	0.1
Chemical Oxygen Demand, mg/l	40	Zinc, mg/l	0.04
Phenol, mg/l	0.016	Aluminum, mg/l	0.06
Nitrate, mg/l	110	Barium, mg/l	< 0.5
BOD_5, mg/l	4	Strontium, mg/l	7
Oil & Grease, mg/l	20	Ammonia, as N, mg/l	< 0.04
Silica, mg/l	19	Sulfite, mg/l	< 1
Sodium, mg/l	300		
Potassium, mg/l	10		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: January 23, 1979

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-303-78 LW-101 12-13-78

LAB NO: DA-202

Color	Sandy
Odor	0
Temperature, °C	9
Conductivity, µmhos	3000
pH	7.0
Oxygen, mg/l	5

Total Alkalinity, mg/l as $CaCO_3$	440	Arsenic, mg/l	< 0.02
Carbonate, mg/l as $CaCO_3$	1	Iron, mg/l	2
Bicarbonate, mg/l as $CaCO_3$	440	Magnesium, mg/l	200
Total Dissolved Solids, mg/l	2600	Calcium, mg/l	190
Suspended Solids, mg/l	530	Boron, mg/l	2
Turbidity, NTU	120	Vanadium, mg/l	< 0.1
Sulfate, mg/l	1300	Copper, mg/l	< 0.02
Chloride, mg/l	64	Molybdenum, mg/l	0.6
Fluoride, mg/l	3	Lithium, mg/l	0.1
Chemical Oxygen Demand, mg/l	20	Zinc, mg/l	0.05
Phenol, mg/l	0.003	Aluminum, mg/l	0.2
Nitrate, mg/l	310	Barium, mg/l	< 0.5
BOD_5, mg/l	10	Strontium, mg/l	9
Oil & Grease, mg/l	70	Ammonia, as N, mg/l	<0.04
Silica, mg/l	21	Sulfite, mg/l	< 1
Sodium, mg/l	320		
Potassium, mg/l	10		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: Oct. 18, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-172-78 LW-102 8-22-78

LAB NO: DA-77

Color	---
Odor	---
Temperature, °C	17
Conductivity, µmhos	2100
pH	6.7
Oxygen, mg/l	---
Total Alkalinity, mg/l as $CaCO_3$	410
Carbonate, mg/l as $CaCO_3$	< 1
Bicarbonate, mg/l as $CaCO_3$	410
Total Dissolved Solids, mg/l	1800
Suspended Solids, mg/l	---
Turbidity, NTU	---
Sulfate, mg/l	810
Chloride, mg/l	9
Fluoride, mg/l	1.28
Chemical Oxygen Demand, mg/l	94
Phenol, mg/l	---
Nitrate, mg/l	7.9
BOD_5, mg/l	6
Oil & Grease, mg/l	6
Silica, mg/l	13
Sodium, mg/l	190
Potassium, mg/l	16
Arsenic, mg/l	< 0.02
Iron, mg/l	20
Magnesium, mg/l	98
Calcium, mg/l	160
Boron, mg/l	< 0.1
Vanadium, mg/l	< 0.1
Copper, mg/l	< 0.02
Molybdenum, mg/l	0.2
Lithium, mg/l	0.2
Zinc, mg/l	0.06
Aluminum, mg/l	0.2
Barium, mg/l	0.5
Strontium, mg/l	4
Ammonia, as N, mg/l	6.65
Sulfite, mg/l	---

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: October 27. 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-212-78 LW-102 9-13-78

LAB NO: DA-108

Color	Clear
Odor	None
Temperature, °C	16
Conductivity, µmhos	2100
pH	7.0
Oxygen, mg/l	----

Total Alkalinity, mg/l as $CaCO_3$	300	Arsenic, mg/l	<0.02
Carbonate, mg/l as $CaCO_3$	<1	Iron, mg/l	40
Bicarbonate, mg/l as $CaCO_3$	300	Magnesium, mg/l	100
Total Dissolved Solids, mg/l	2000	Calcium, mg/l	190
Suspended Solids, mg/l	200	Boron, mg/l	<0.04
Turbidity, NTU	60	Vanadium, mg/l	<0.1
Sulfate, mg/l	920	Copper, mg/l	<0.02
Chloride, mg/l	14	Molybdenum, mg/l	0.2
Fluoride, mg/l	1.4	Lithium, mg/l	0.2
Chemical Oxygen Demand, mg/l	40	Zinc, mg/l	0.08
Phenol, mg/l	0.018	Aluminum, mg/l	2
Nitrate, mg/l	15	Barium, mg/l	0.7
BOD_5, mg/l	300	Strontium, mg/l	5
Oil & Grease, mg/l	5	Ammonia, as N, mg/l	1.4
Silica, mg/l	16	Sulfite, mg/l	<1
Sodium, mg/l	240		
Potassium, mg/l	15		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE: November 20, 1978

SAMPLE: A-243-78 LW-102 10-18-78

LAB NO: DA-142

Color	Cloudy
Odor	0
Temperature, °C	15
Conductivity, µmhos	2200
pH	7.2
Oxygen, mg/l	4

Total Alkalinity, mg/l as $CaCO_3$	340	Arsenic, mg/l	<0.02
Carbonate, mg/l as $CaCO_3$	<1	Iron, mg/l	80
Bicarbonate, mg/l as $CaCO_3$	340	Magnesium, mg/l	100
Total Dissolved Solids, mg/l	600	Calcium, mg/l	180
Suspended Solids, mg/l	900	Boron, mg/l	0.41
Turbidity, NTU	20	Vanadium, mg/l	<0.1
Sulfate, mg/l	910	Copper, mg/l	<0.02
Chloride, mg/l	8.4	Molybdenum, mg/l	0.2
Fluoride, mg/l	1.4	Lithium, mg/l	0.2
Chemical Oxygen Demand, mg/l	30	Zinc, mg/l	0.1
Phenol, mg/l	0.005	Aluminum, mg/l	1
Nitrate, mg/l	11	Barium, mg/l	1
BOD_5, mg/l	7	Strontium, mg/l	7
Oil & Grease, mg/l	3	Ammonia, as N, mg/l	0.30
Silica, mg/l	17	Sulfite, mg/l	<1
Sodium, mg/l	240		
Potassium, mg/l	15		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom
R.E. Thomason
C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: November 20, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface water

SAMPLE: A-264-78 LW-102 11-3-78
IN HOUSE

LAB NO: DA-163

Color			
Odor			
Temperature, °C			
Conductivity, µmhos			
pH			
Oxygen, mg/l			
Total Alkalinity, mg/l as $CaCO_3$		Arsenic, mg/l	
Carbonate, mg/l as $CaCO_3$		Iron, mg/l	
Bicarbonate, mg/l as $CaCO_3$		Magnesium, mg/l	
Total Dissolved Solids, mg/l		Calcium, mg/l	
Suspended Solids, mg/l		Boron, mg/l	0.39
Turbidity, NTU		Vanadium, mg/l	
Sulfate, mg/l		Copper, mg/l	
Chloride, mg/l		Molybdenum, mg/l	
Fluoride, mg/l	1.3	Lithium, mg/l	
Chemical Oxygen Demand, mg/l		Zinc, mg/l	
Phenol, mg/l	0.003	Aluminum, mg/l	
Nitrate, mg/l	15	Barium, mg/l	
BOD_5, mg/l		Strontium, mg/l	
Oil & Grease, mg/l		Ammonia, as N, mg/l	
Silica, mg/l		Sulfite, mg/l	<1
Sodium, mg/l			
Potassium, mg/l			

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE:

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-270-78 LW-102 11-8-78

LAB NO: DA-168

Color	Clear
Odor	o
Temperature, °C	14
Conductivity, µmhos	1800
pH	7.7
Oxygen, mg/l	3

Total Alkalinity, mg/l as $CaCO_3$	360	Arsenic, mg/l	< 0.02
Carbonate, mg/l as $CaCO_3$	< 1	Iron, mg/l	80
Bicarbonate, mg/l as $CaCO_3$	360	Magnesium, mg/l	100
Total Dissolved Solids, mg/l	1900	Calcium, mg/l	160
Suspended Solids, mg/l	120	Boron, mg/l	2.1
Turbidity, NTU	50	Vanadium, mg/l	< 0.1
Sulfate, mg/l	920	Copper, mg/l	< 0.02
Chloride, mg/l	16	Molybdenum, mg/l	0.2
Fluoride, mg/l	1.5	Lithium, mg/l	0.2
Chemical Oxygen Demand, mg/l	10	Zinc, mg/l	0.1
Phenol, mg/l	0.008	Aluminum, mg/l	0.6
Nitrate, mg/l	12	Barium, mg/l	< 0.5
BOD_5, mg/l	40	Strontium, mg/l	5
Oil & Grease, mg/l	20	Ammonia, as N, mg/l	0.1
Silica, mg/l	15	Sulfite, mg/l	< 1
Sodium, mg/l	230		
Potassium, mg/l	16		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: Oct. 17, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-162-78 LW-115 8-15-78

LAB NO: DA-69

Color	---
Odor	---
Temperature, °C	24
Conductivity, µmhos	2350
pH	6.3
Oxygen, mg/l	---
Total Alkalinity, mg/l as $CaCO_3$	570
Carbonate, mg/l as $CaCO_3$	< 1
Bicarbonate, mg/l as $CaCO_3$	570
Total Dissolved Solids, mg/l	2100
Suspended Solids, mg/l	---
Turbidity, NTU	---
Sulfate, mg/l	1100
Chloride, mg/l	15
Fluoride, mg/l	0.92
Chemical Oxygen Demand, mg/l	16
Phenol, mg/l	0.02
Nitrate, mg/l	6.7
BOD_5, mg/l	28
Oil & Grease, mg/l	25
Silica, mg/l	---
Sodium, mg/l	280
Potassium, mg/l	6.8
Arsenic, mg/l	< 0.02
Iron, mg/l	7.6
Magnesium, mg/l	140
Calcium, mg/l	210
Boron, mg/l	0.87
Vanadium, mg/l	< 0.1
Copper, mg/l	<0.02
Molybdenum, mg/l	0.1
Lithium, mg/l	0.2
Zinc, mg/l	0.2
Aluminum, mg/l	7
Barium, mg/l	0.6
Strontium, mg/l	5
Ammonia, as N, mg/l	---
Sulfite, mg/l	---

OXY INTER-OFFICE MEMORANDUM

TO H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: October 27, 1978

SUBJECT: D.A. Water Analysis, Alluvial, Bedrock & Surface Water

SAMPLE: A-203-78 LW-115 9-13-78

LAB NO: DA-106

Color	Light Gray
Odor	Oily
Temperature, °C	17
Conductivity, µmhos	2400
pH	6.6
Oxygen, mg/l	----

Total Alkalinity, mg/l as $CaCO_3$	570	Arsenic, mg/l	<0.02
Carbonate, mg/l as $CaCO_3$	<1	Iron, mg/l	8
Bicarbonate, mg/l as $CaCO_3$	570	Magnesium, mg/l	150
Total Dissolved Solids, mg/l	2100	Calcium, mg/l	200
Suspended Solids, mg/l	90	Boron, mg/l	0.43
Turbidity, NTU	60	Vanadium, mg/l	<0.1
Sulfate, mg/l	1000	Copper, mg/l	<0.02
Chloride, mg/l	24	Molybdenum, mg/l	0.1
Fluoride, mg/l	1.2	Lithium, mg/l	0.1
Chemical Oxygen Demand, mg/l	60	Zinc, mg/l	0.1
Phenol, mg/l	0.016	Aluminum, mg/l	5
Nitrate, mg/l	9.2	Barium, mg/l	1
BOD_5, mg/l	20	Strontium, mg/l	7
Oil & Grease, mg/l	7	Ammonia, as N, mg/l	1.4
Silica, mg/l	18	Sulfite, mg/l	<1.0
Sodium, mg/l	300		
Potassium, mg/l	4.2		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom
R.E. Thomason
C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: October 27. 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: IN HOUSE
A-206-78 LW-115 9-27-78

LAB NO: DA-113

Color	Gray
Odor	Soapy
Temperature, °C	15
Conductivity, µmhos	2400
pH	6.7
Oxygen, mg/l	

Total Alkalinity, mg/l as $CaCO_3$		Arsenic, mg/l	
Carbonate, mg/l as $CaCO_3$		Iron, mg/l	
Bicarbonate, mg/l as $CaCO_3$		Magnesium, mg/l	
Total Dissolved Solids, mg/l		Calcium, mg/l	
Suspended Solids, mg/l		Boron, mg/l	0.65
Turbidity, NTU		Vanadium, mg/l	
Sulfate, mg/l		Copper, mg/l	
Chloride, mg/l		Molybdenum, mg/l	
Fluoride, mg/l	1.2	Lithium, mg/l	
Chemical Oxygen Demand, mg/l		Zinc, mg/l	
Phenol, mg/l	0.014	Aluminum, mg/l	
Nitrate, mg/l	16	Barium, mg/l	
BOD_5, mg/l		Strontium, mg/l	
Oil & Grease, mg/l		Ammonia, as N, mg/l	
Silica, mg/l		Sulfite, mg/l	<1
Sodium, mg/l			
Potassium, mg/l			

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom B.A. Romig
J.F. Denham R.E. Thomason
C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE: November 20, 1978

SAMPLE: A-241-78 LW-115 10-17-78

LAB NO: DA-137

Color	Cloudy
Odor	None
Temperature, °C	15
Conductivity, µmhos	3000
pH	6.9
Oxygen, mg/l	4

Total Alkalinity, mg/l as $CaCO_3$	340	Arsenic, mg/l	0.09
Carbonate, mg/l as $CaCO_3$	<1	Iron, mg/l	6
Bicarbonate, mg/l as $CaCO_3$	340	Magnesium, mg/l	160
Total Dissolved Solids, mg/l	3000	Calcium, mg/l	230
Suspended Solids, mg/l	70	Boron, mg/l	1.5
Turbidity, NTU	100	Vanadium, mg/l	<0.1
Sulfate, mg/l	1300	Copper, mg/l	<0.02
Chloride, mg/l	46	Molybdenum, mg/l	0.5
Fluoride, mg/l	1.4	Lithium, mg/l	0.2
Chemical Oxygen Demand, mg/l	200	Zinc, mg/l	0.08
Phenol, mg/l	0.046	Aluminum, mg/l	4
Nitrate, mg/l	35	Barium, mg/l	1
BOD_5, mg/l	7	Strontium, mg/l	8
Oil & Grease, mg/l	6	Ammonia, as N, mg/l	3.6
Silica, mg/l	20	Sulfite, mg/l	7
Sodium, mg/l	440		
Potassium, mg/l	6.8		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom
R.E. Thomason
C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water
IN HOUSE

DATE: December 18, 1978

SAMPLE: A-262-78 LW - 115 11-3-78

LAB NO: DA-161

Color			
Odor			
Temperature, °C			
Conductivity, µmhos			
pH			
Oxygen, mg/l			
Total Alkalinity, mg/l as $CaCO_3$		Arsenic, mg/l	
Carbonate, mg/l as $CaCO_3$		Iron, mg/l	
Bicarbonate, mg/l as $CaCO_3$		Magnesium, mg/l	
Total Dissolved Solids, mg/l		Calcium, mg/l	
Suspended Solids, mg/l		Boron, mg/l	1.6
Turbidity, NTU		Vanadium, mg/l	
Sulfate, mg/l		Copper, mg/l	
Chloride, mg/l		Molybdenum, mg/l	
Fluoride, mg/l	1.1	Lithium, mg/l	
Chemical Oxygen Demand, mg/l		Zinc, mg/l	
Phenol, mg/l	0.046	Aluminum, mg/l	
Nitrate, mg/l	8.6	Barium, mg/l	
BOD_5, mg/l		Strontium, mg/l	
Oil & Grease, mg/l		Ammonia, as N, mg/l	
Silica, mg/l		Sulfite, mg/l	
Sodium, mg/l			
Potassium, mg/l			

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE: December 18, 1978

SAMPLE: A-283-78 LW-115 11-10-78

LAB NO: DA-182

Color	Milky
Odor	Oily
Temperature, °C	14
Conductivity, µmhos	3100
pH	7.4
Oxygen, mg/l	5

Total Alkalinity, mg/l as $CaCO_3$	550	Arsenic, mg/l	0.11
Carbonate, mg/l as $CaCO_3$	< 1	Iron, mg/l	7
Bicarbonate, mg/l as $CaCO_3$	550	Magnesium, mg/l	150
Total Dissolved Solids, mg/l	2700	Calcium, mg/l	200
Suspended Solids, mg/l	240	Boron, mg/l	1.6
Turbidity, NTU	150	Vanadium, mg/l	0.2
Sulfate, mg/l	1200	Copper, mg/l	<0.02
Chloride, mg/l	70	Molybdenum, mg/l	0.3
Fluoride, mg/l	1.1	Lithium, mg/l	0.2
Chemical Oxygen Demand, mg/l	100	Zinc, mg/l	0.07
Phenol, mg/l	0.038	Aluminum, mg/l	4
Nitrate, mg/l	6.0	Barium, mg/l	0.6
BOD_5, mg/l	30	Strontium, mg/l	9
Oil & Grease, mg/l	10	Ammonia, as N, mg/l	0.40
Silica, mg/l	17	Sulfite, mg/l	< 1
Sodium, mg/l	430		
Potassium, mg/l	6.6		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: January 23, 1979

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-310-78 LW-115 12-15-78

LAB NO: DA-209

Color	Clear
Odor	None
Temperature, °C	10
Conductivity, µmhos	2800
pH	7.6
Oxygen, mg/l	4
Total Alkalinity, mg/l as $CaCO_3$	600
Carbonate, mg/l as $CaCO_3$	25
Bicarbonate, mg/l as $CaCO_3$	575
Total Dissolved Solids, mg/l	2200
Suspended Solids, mg/l	45
Turbidity, NTU	20
Sulfate, mg/l	960
Chloride, mg/l	52
Fluoride, mg/l	0.8
Chemical Oxygen Demand, mg/l	130
Phenol, mg/l	0.59
Nitrate, mg/l	1
BOD_5, mg/l	40
Oil & Grease, mg/l	10
Silica, mg/l	20
Sodium, mg/l	420
Potassium, mg/l	5

Arsenic, mg/l	< 0.02
Iron, mg/l	< 0.5
Magnesium, mg/l	140
Calcium, mg/l	100
Boron, mg/l	1
Vanadium, mg/l	< 0.1
Copper, mg/l	< 0.02
Molybdenum, mg/l	0.4
Lithium, mg/l	0.1
Zinc, mg/l	< 0.02
Aluminum, mg/l	< 0.1
Barium, mg/l	< 0.5
Strontium, mg/l	5
Ammonia, as N, mg/l	1.7
Sulfite, mg/l	< 1

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom
R.E. Thomason
C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: October 27. 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: IN HOUSE LW-121
A-207-78 Bowdish Alluvial Well 9-28-78

LAB NO: DA-114

Color	Clear
Odor	None
Temperature, °C	15
Conductivity, µmhos	2300
pH	6.8
Oxygen, mg/l	
Total Alkalinity, mg/l as $CaCO_3$	
Carbonate, mg/l as $CaCO_3$	
Bicarbonate, mg/l as $CaCO_3$	
Total Dissolved Solids, mg/l	
Suspended Solids, mg/l	
Turbidity, NTU	
Sulfate, mg/l	
Chloride, mg/l	
Fluoride, mg/l	0.84
Chemical Oxygen Demand, mg/l	
Phenol, mg/l	0.002
Nitrate, mg/l	14
BOD_5, mg/l	
Oil & Grease, mg/l	
Silica, mg/l	
Sodium, mg/l	
Potassium, mg/l	
Arsenic, mg/l	
Iron, mg/l	
Magnesium, mg/l	
Calcium, mg/l	
Boron, mg/l	0.65
Vanadium, mg/l	
Copper, mg/l	
Molybdenum, mg/l	
Lithium, mg/l	
Zinc, mg/l	
Aluminum, mg/l	
Barium, mg/l	
Strontium, mg/l	
Ammonia, as N, mg/l	
Sulfite, mg/l	<1

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE: Oct. 18, 1978

SAMPLE: A-178-78 Smith Gulch 9-6-78

LAB NO: DA-95

Color	---
Odor	---
Temperature, °C	28
Conductivity, µmhos	1350
pH	8.2
Oxygen, mg/l	---
Total Alkalinity, mg/l as $CaCO_3$	160
Carbonate, mg/l as $CaCO_3$	20
Bicarbonate, mg/l as $CaCO_3$	140
Total Dissolved Solids, mg/l	1200
Suspended Solids, mg/l	26
Turbidity, NTU	1.8
Sulfate, mg/l	530
Chloride, mg/l	10
Fluoride, mg/l	1.9
Chemical Oxygen Demand, mg/l	30
Phenol, mg/l	0.003
Nitrate, mg/l	29
BOD_5, mg/l	3
Oil & Grease, mg/l	20
Silica, mg/l	7
Sodium, mg/l	140
Potassium, mg/l	28

Arsenic, mg/l	< 0.02
Iron, mg/l	< 0.5
Magnesium, mg/l	70
Calcium, mg/l	54
Boron, mg/l	0.32
Vanadium, mg/l	< 0.1
Copper, mg/l	< 0.02
Molybdenum, mg/l	0.2
Lithium, mg/l	0.2
Zinc, mg/l	< 0.02
Aluminum, mg/l	< 0.1
Barium, mg/l	< 0.5
Strontium, mg/l	3
Ammonia, as N, mg/l	1.4
Sulfite, mg/l	---

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: November 20, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-244-78 Smith Gulch 10-18-78

LAB NO: DA-143

Color	Clear
Odor	0
Temperature, °C	19
Conductivity, µmhos	1200
pH	8.6
Oxygen, mg/l	5

Total Alkalinity, mg/l as $CaCO_3$	220	Arsenic, mg/l	< 0.02
Carbonate, mg/l as $CaCO_3$	40	Iron, mg/l	< 0.5
Bicarbonate, mg/l as $CaCO_3$	180	Magnesium, mg/l	68
Total Dissolved Solids, mg/l	800	Calcium, mg/l	56
Suspended Solids, mg/l	300	Boron, mg/l	0.63
Turbidity, NTU	200	Vanadium, mg/l	0.2
Sulfate, mg/l	530	Copper, mg/l	<0.2
Chloride, mg/l	4.2	Molybdenum, mg/l	0.2
Fluoride, mg/l	2.4	Lithium, mg/l	0.2
Chemical Oxygen Demand, mg/l	30	Zinc, mg/l	<0.02
Phenol, mg/l	0.002	Aluminum, mg/l	0.2
Nitrate, mg/l	40	Barium, mg/l	< 0.5
BOD_5, mg/l	1	Strontium, mg/l	4
Oil & Grease, mg/l	6	Ammonia, as N, mg/l	0.7
Silica, mg/l	12	Sulfite, mg/l	< 1
Sodium, mg/l	150		
Potassium, mg/l	24		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom
R.E. Thomason
C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE: November 20, 1978

SAMPLE: A-263-78 Smith Gulch 11-3-78
IN HOUSE

LAB NO: DA-162

Color			
Odor			
Temperature, °C			
Conductivity, µmhos			
pH			
Oxygen, mg/l			
Total Alkalinity, mg/l as $CaCO_3$		Arsenic, mg/l	
Carbonate, mg/l as $CaCO_3$		Iron, mg/l	
Bicarbonate, mg/l as $CaCO_3$		Magnesium, mg/l	
Total Dissolved Solids, mg/l		Calcium, mg/l	
Suspended Solids, mg/l		Boron, mg/l	0.47
Turbidity, NTU		Vanadium, mg/l	
Sulfate, mg/l		Copper, mg/l	
Chloride, mg/l		Molybdenum, mg/l	
Fluoride, mg/l	1.5	Lithium, mg/l	
Chemical Oxygen Demand, mg/l		Zinc, mg/l	
Phenol, mg/l	0.005	Aluminum, mg/l	
Nitrate, mg/l	12	Barium, mg/l	
BOD_5, mg/l		Strontium, mg/l	
Oil & Grease, mg/l		Ammonia, as N, mg/l	
Silica, mg/l		Sulfite, mg/l	<1
Sodium, mg/l			
Potassium, mg/l			

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE:

SAMPLE: A-271-78 Smith Gulch 11-8-78

LAB NO: DA-169

Color	Clear
Odor	o
Temperature, °C	9
Conductivity, µmhos	1300
pH	8.9
Oxygen, mg/l	8

Total Alkalinity, mg/l as $CaCO_3$	240	Arsenic, mg/l	0.03
Carbonate, mg/l as $CaCO_3$	40	Iron, mg/l	< 0.5
Bicarbonate, mg/l as $CaCO_3$	200	Magnesium, mg/l	82
Total Dissolved Solids, mg/l	1100	Calcium, mg/l	70
Suspended Solids, mg/l	20	Boron, mg/l	0.86
Turbidity, NTU	2	Vanadium, mg/l	< 0.1
Sulfate, mg/l	550	Copper, mg/l	< 0.02
Chloride, mg/l	11	Molybdenum, mg/l	0.2
Fluoride, mg/l	1.6	Lithium, mg/l	0.2
Chemical Oxygen Demand, mg/l	20	Zinc, mg/l	< 0.02
Phenol, mg/l	0.004	Aluminum, mg/l	0.1
Nitrate, mg/l	25	Barium, mg/l	0.8
BOD_5, mg/l	6	Strontium, mg/l	3
Oil & Grease, mg/l	20	Ammonia, as N, mg/l	1.2
Silica, mg/l	11	Sulfite, mg/l	< 1
Sodium, mg/l	150		
Potassium, mg/l	21		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: October 27, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-184-78 Upper Roan 9-6-78

LAB NO: DA-96

Color	----
Odor	----
Temperature, °C	19
Conductivity, µmhos	1500
pH	7.9
Oxygen, mg/l	----
Total Alkalinity, mg/l as $CaCO_3$	370
Carbonate, mg/l as $CaCO_3$	40
Bicarbonate, mg/l as $CaCO_3$	330
Total Dissolved Solids, mg/l	1200
Suspended Solids, mg/l	87
Turbidity, NTU	3
Sulfate, mg/l	480
Chloride, mg/l	10
Fluoride, mg/l	0.90
Chemical Oxygen Demand, mg/l	40
Phenol, mg/l	0.016
Nitrate, mg/l	3.9
BOD_5, mg/l	3
Oil & Grease, mg/l	10
Silica, mg/l	13
Sodium, mg/l	180
Potassium, mg/l	4.0
Arsenic, mg/l	<0.02
Iron, mg/l	<0.5
Magnesium, mg/l	93
Calcium, mg/l	77
Boron, mg/l	0.54
Vanadium, mg/l	<0.1
Copper, mg/l	<0.02
Molybdenum, mg/l	0.06
Lithium, mg/l	0.06
Zinc, mg/l	<0.02
Aluminum, mg/l	0.2
Barium, mg/l	<0.5
Strontium, mg/l	3
Ammonia, as N, mg/l	5.6
Sulfite, mg/l	----

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom
R.E. Thomason
C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: October 27.78

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: IN HOUSE
A-209-78 Upper Roan Creek 9-28-78

LAB NO: DA-116

Color	Clear
Odor	None
Temperature, °C	19
Conductivity, µmhos	1450
pH	8.8
Oxygen, mg/l	
Total Alkalinity, mg/l as $CaCO_3$	
Carbonate, mg/l as $CaCO_3$	
Bicarbonate, mg/l as $CaCO_3$	
Total Dissolved Solids, mg/l	
Suspended Solids, mg/l	
Turbidity, NTU	
Sulfate, mg/l	
Chloride, mg/l	
Fluoride, mg/l	0.76
Chemical Oxygen Demand, mg/l	
Phenol, mg/l	0.005
Nitrate, mg/l	3.5
BOD_5, mg/l	
Oil & Grease, mg/l	
Silica, mg/l	
Sodium, mg/l	
Potassium, mg/l	

Arsenic, mg/l	
Iron, mg/l	
Magnesium, mg/l	
Calcium, mg/l	
Boron, mg/l	<0.04
Vanadium, mg/l	
Copper, mg/l	
Molybdenum, mg/l	
Lithium, mg/l	
Zinc, mg/l	
Aluminum, mg/l	
Barium, mg/l	
Strontium, mg/l	
Ammonia, as N, mg/l	
Sulfite, mg/l	<1

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom B.A. Romig
J.F. Denham R.E. Thomason
C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: November 10, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-235-78 Upper Roan Creek 10-17-78 LAB NO: DA-135

Color	Clear
Odor	None
Temperature, °C	13
Conductivity, µmhos	1400
pH	9.1
Oxygen, mg/l	8

Total Alkalinity, mg/l as $CaCO_3$	420	Arsenic, mg/l	<0.02
Carbonate, mg/l as $CaCO_3$	30	Iron, mg/l	<0.5
Bicarbonate, mg/l as $CaCO_3$	390	Magnesium, mg/l	94
Total Dissolved Solids, mg/l	1000	Calcium, mg/l	92
Suspended Solids, mg/l	50	Boron, mg/l	0.24
Turbidity, NTU	10	Vanadium, mg/l	<0.1
Sulfate, mg/l	540	Copper, mg/l	<0.02
Chloride, mg/l	15	Molybdenum, mg/l	0.02
Fluoride, mg/l	0.82	Lithium, mg/l	0.05
Chemical Oxygen Demand, mg/l	20	Zinc, mg/l	0.04
Phenol, mg/l	0.02	Aluminum, mg/l	0.2
Nitrate, mg/l	6.4	Barium, mg/l	<0.5
BOD_5, mg/l	5	Strontium, mg/l	4
Oil & Grease, mg/l	1	Ammonia, as N, mg/l	1.8
Silica, mg/l	13	Sulfite, mg/l	<1
Sodium, mg/l	200		
Potassium, mg/l	4		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE:

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-272-78 Upper Roan Creek 11-8-78

LAB NO: DA-170

Color	Clear
Odor	o
Temperature, °C	13
Conductivity, µmhos	1600
pH	8.7
Oxygen, mg/l	8

Total Alkalinity, mg/l as $CaCO_3$	450	Arsenic, mg/l	0.02
Carbonate, mg/l as $CaCO_3$	50	Iron, mg/l	< 0.5
Bicarbonate, mg/l as $CaCO_3$	400	Magnesium, mg/l	100
Total Dissolved Solids, mg/l	2000	Calcium, mg/l	97
Suspended Solids, mg/l	10	Boron, mg/l	1.3
Turbidity, NTU	4	Vanadium, mg/l	< 0.1
Sulfate, mg/l	560	Copper, mg/l	< 0.02
Chloride, mg/l	21	Molybdenum, mg/l	0.03
Fluoride, mg/l	0.87	Lithium, mg/l	0.05
Chemical Oxygen Demand, mg/l	20	Zinc, mg/l	< 0.02
Phenol, mg/l	0.005	Aluminum, mg/l	0.2
Nitrate, mg/l	< 0.1	Barium, mg/l	1
BOD_5, mg/l	8	Strontium, mg/l	3
Oil & Grease, mg/l	2	Ammonia, as N, mg/l	2.4
Silica, mg/l	12	Sulfite, mg/l	< 1
Sodium, mg/l	190		
Potassium, mg/l	3.6		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: October 27, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-177-78 Lower Roan 9/6/78

LAB NO: DA-94

Color	----
Odor	----
Temperature, °C	19
Conductivity, µmhos	1450
pH	7.7
Oxygen, mg/l	----

Total Alkalinity, mg/l as $CaCO_3$	380	Arsenic, mg/l	<0.02
Carbonate, mg/l as $CaCO_3$	40	Iron, mg/l	<0.5
Bicarbonate, mg/l as $CaCO_3$	340	Magnesium, mg/l	98
Total Dissolved Solids, mg/l	3100	Calcium, mg/l	76
Suspended Solids, mg/l	72	Boron, mg/l	0.11
Turbidity, NTU	31	Vanadium, mg/l	<0.1
Sulfate, mg/l	400	Copper, mg/l	<0.02
Chloride, mg/l	8	Molybdenum, mg/l	0.03
Fluoride, mg/l	1.1	Lithium, mg/l	0.06
Chemical Oxygen Demand, mg/l	10	Zinc, mg/l	<0.02
Phenol, mg/l	0.004	Aluminum, mg/l	0.2
Nitrate, mg/l	3.9	Barium, mg/l	<0.5
BOD_5, mg/l	<1	Strontium, mg/l	3
Oil & Grease, mg/l	2	Ammonia, as N, mg/l	3.9
Silica, mg/l	10	Sulfite, mg/l	----
Sodium, mg/l	180		
Potassium, mg/l	3.8		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom
R.E. Thomason
C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: October 27, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: IN HOUSE
A-208-78 Lower Roan Creek 9-28-78

LAB NO: DA-115

Color	Brown		
Odor	None		
Temperature, °C	19		
Conductivity, µmhos	1600		
pH	9.1		
Oxygen, mg/l			
Total Alkalinity, mg/l as $CaCO_3$		Arsenic, mg/l	
Carbonate, mg/l as $CaCO_3$		Iron, mg/l	
Bicarbonate, mg/l as $CaCO_3$		Magnesium, mg/l	
Total Dissolved Solids, mg/l		Calcium, mg/l	
Suspended Solids, mg/l		Boron, mg/l	<0.04
Turbidity, NTU		Vanadium, mg/l	
Sulfate, mg/l		Copper, mg/l	
Chloride, mg/l		Molybdenum, mg/l	
Fluoride, mg/l	0.76	Lithium, mg/l	
Chemical Oxygen Demand, mg/l		Zinc, mg/l	
Phenol, mg/l	0.001	Aluminum, mg/l	
Nitrate, mg/l	8.9	Barium, mg/l	
BOD_5, mg/l		Strontium, mg/l	
Oil & Grease, mg/l		Ammonia, as N, mg/l	
Silica, mg/l		Sulfite, mg/l	<1
Sodium, mg/l			
Potassium, mg/l			

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE: November 20, 1978

SAMPLE: A-242-78 Lower Roan Creek 10-17-78 LAB NO: DA-138

Color	Clear
Odor	None
Temperature, °C	13
Conductivity, µmhos	1400
pH	9.1
Oxygen, mg/l	8

Total Alkalinity, mg/l as $CaCO_3$	400	Arsenic, mg/l	<0.02
Carbonate, mg/l as $CaCO_3$	40	Iron, mg/l	<0.5
Bicarbonate, mg/l as $CaCO_3$	360	Magnesium, mg/l	94
Total Dissolved Solids, mg/l	1000	Calcium, mg/l	93
Suspended Solids, mg/l	40	Boron, mg/l	0.39
Turbidity, NTU	10	Vanadium, mg/l	<0.1
Sulfate, mg/l	550	Copper, mg/l	<0.02
Chloride, mg/l	11	Molybdenum, mg/l	<0.02
Fluoride, mg/l	0.83	Lithium, mg/l	0.05
Chemical Oxygen Demand, mg/l	8	Zinc, mg/l	<0.02
Phenol, mg/l	<0.001	Aluminum, mg/l	0.2
Nitrate, mg/l	4.8	Barium, mg/l	0.8
BOD_5, mg/l	40	Strontium, mg/l	4
Oil & Grease, mg/l	5	Ammonia, as N, mg/l	0.40
Silica, mg/l	16	Sulfite, mg/l	<1
Sodium, mg/l	210		
Potassium, mg/l	3.8		

SITES SAMPLED QUARTERLY

LW-103	(ALLUVIAL)
LW-104	(ALLUVIAL)
LW-33	(BEDROCK)
LW-45	(BEDROCK)
LW-116	(BEDROCK)
LW-32	(BEDROCK)
LW-46	(BEDROCK)
LW-47	(BEDROCK)
LW-106	(BEDROCK)
KELLY GULCH	(SURFACE)
RILEY GULCH	(SURFACE)
PARACHUTE CREEK	(SURFACE-UPSTREAM OF ROAN CREEK)
PARACHUTE CREEK	(SURFACE-DOWNSTREAM OF ROAN CREEK)

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom B.A. Romig
J.F. Denham R.E. Thomason
C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: Oct. 18, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-170-78 LW-103 8-22-78

LAB NO: DA-76

Color	---
Odor	---
Temperature, °C	16
Conductivity, µmhos	2200
pH	6.5
Oxygen, mg/l	---

Total Alkalinity, mg/l as $CaCO_3$	420	Arsenic, mg/l	< 0.02
Carbonate, mg/l as $CaCO_3$	< 1	Iron, mg/l	39
Bicarbonate, mg/l as $CaCO_3$	420	Magnesium, mg/l	120
Total Dissolved Solids, mg/l	2200	Calcium, mg/l	220
Suspended Solids, mg/l	---	Boron, mg/l	~~43.3~~ 0.86
Turbidity, NTU	---	Vanadium, mg/l	< 0.1
Sulfate, mg/l	730	Copper, mg/l	< 0.02
Chloride, mg/l	11	Molybdenum, mg/l	0.1
Fluoride, mg/l	1.10	Lithium, mg/l	0.1
Chemical Oxygen Demand, mg/l	46	Zinc, mg/l	0.05
Phenol, mg/l	0.002	Aluminum, mg/l	< 0.1
Nitrate, mg/l	7.5	Barium, mg/l	< 0.5
BOD_5, mg/l	8	Strontium, mg/l	5
Oil & Grease, mg/l	1	Ammonia, as N, mg/l	21.2
Silica, mg/l	9	Sulfite, mg/l	---
Sodium, mg/l	210		
Potassium, mg/l	3.6		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: November 20, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-240-78 LW-103 10-18-78

LAB NO: DA-141

Color	Red
Odor	0
Temperature, °C	16
Conductivity, µmhos	2200
pH	6.4
Oxygen, mg/l	3

Total Alkalinity, mg/l as $CaCO_3$	340	Arsenic, mg/l	<0.02
Carbonate, mg/l as $CaCO_3$	<1	Iron, mg/l	120
Bicarbonate, mg/l as $CaCO_3$	340	Magnesium, mg/l	120
Total Dissolved Solids, mg/l	2200	Calcium, mg/l	240
Suspended Solids, mg/l	600	Boron, mg/l	0.22
Turbidity, NTU	50	Vanadium, mg/l	<0.1
Sulfate, mg/l	700	Copper, mg/l	<0.02
Chloride, mg/l	5.2	Molybdenum, mg/l	0.1
Fluoride, mg/l	1.2	Lithium, mg/l	0.1
Chemical Oxygen Demand, mg/l	30	Zinc, mg/l	0.3
Phenol, mg/l	0.001	Aluminum, mg/l	0.7
Nitrate, mg/l	11	Barium, mg/l	<0.5
BOD_5, mg/l	10	Strontium, mg/l	8
Oil & Grease, mg/l	4	Ammonia, as N, mg/l	6.3
Silica, mg/l	15	Sulfite, mg/l	<1.0
Sodium, mg/l	260		
Potassium, mg/l	4.0		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom
R.E. Thomason
C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE: November 20, 1978

SAMPLE: A-265-78 LW-103 11-3-78
IN HOUSE

LAB NO: DA-164

Color			
Odor			
Temperature, °C			
Conductivity, µmhos			
pH			
Oxygen, mg/l			
Total Alkalinity, mg/l as $CaCO_3$		Arsenic, mg/l	
Carbonate, mg/l as $CaCO_3$		Iron, mg/l	
Bicarbonate, mg/l as $CaCO_3$		Magnesium, mg/l	
Total Dissolved Solids, mg/l		Calcium, mg/l	
Suspended Solids, mg/l		Boron, mg/l	0.29
Turbidity, NTU		Vanadium, mg/l	
Sulfate, mg/l		Copper, mg/l	
Chloride, mg/l		Molybdenum, mg/l	
Fluoride, mg/l	1.1	Lithium, mg/l	
Chemical Oxygen Demand, mg/l		Zinc, mg/l	
Phenol, mg/l	0.001	Aluminum, mg/l	
Nitrate, mg/l	13	Barium, mg/l	
BOD_5, mg/l		Strontium, mg/l	
Oil & Grease, mg/l		Ammonia, as N, mg/l	
Silica, mg/l		Sulfite, mg/l	<1
Sodium, mg/l			
Potassium, mg/l			

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE:

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-269-78 LW-103 11-8-78

LAB NO: DA-167

Color	Clear
Odor	o
Temperature, °C	11
Conductivity, µmhos	2400
pH	7.6
Oxygen, mg/l	3

Total Alkalinity, mg/l as $CaCO_3$	370	Arsenic, mg/l	< 0.02
Carbonate, mg/l as $CaCO_3$	< 1	Iron, mg/l	60
Bicarbonate, mg/l as $CaCO_3$	370	Magnesium, mg/l	120
Total Dissolved Solids, mg/l	2200	Calcium, mg/l	220
Suspended Solids, mg/l	120	Boron, mg/l	0.23
Turbidity, NTU	40	Vanadium, mg/l	< 0.1
Sulfate, mg/l	1200	Copper, mg/l	< 0.02
Chloride, mg/l	12	Molybdenum, mg/l	0.1
Fluoride, mg/l	1.2	Lithium, mg/l	0.1
Chemical Oxygen Demand, mg/l	8	Zinc, mg/l	0.04
Phenol, mg/l	0.003	Aluminum, mg/l	0.2
Nitrate, mg/l	20	Barium, mg/l	< 0.5
BOD_5, mg/l	50	Strontium, mg/l	6
Oil & Grease, mg/l	20	Ammonia, as N, mg/l	1.8
Silica, mg/l	15	Sulfite, mg/l	1
Sodium, mg/l	250		
Potassium, mg/l	3.8		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: December 18, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-290-78 LW-103 11-22-78

LAB NO: DA-189

Color	Red
Odor	Irony
Temperature, °C	12
Conductivity, µmhos	2400
pH	6.9
Oxygen, mg/l	4
Total Alkalinity, mg/l as $CaCO_3$	360
Carbonate, mg/l as $CaCO_3$	1
Bicarbonate, mg/l as $CaCO_3$	360
Total Dissolved Solids, mg/l	2300
Suspended Solids, mg/l	1100
Turbidity, NTU	80
Sulfate, mg/l	1100
Chloride, mg/l	9.4
Fluoride, mg/l	1.1
Chemical Oxygen Demand, mg/l	10
Phenol, mg/l	0.006
Nitrate, mg/l	9.5
BOD_5, mg/l	< 1
Oil & Grease, mg/l	9
Silica, mg/l	16
Sodium, mg/l	260
Potassium, mg/l	4.4

Arsenic, mg/l	<0.02
Iron, mg/l	6
Magnesium, mg/l	130
Calcium, mg/l	280
Boron, mg/l	0.3
Vanadium, mg/l	< 0.1
Copper, mg/l	< 0.02
Molybdenum, mg/l	0.1
Lithium, mg/l	0.1
Zinc, mg/l	0.08
Aluminum, mg/l	2
Barium, mg/l	1
Strontium, mg/l	7
Ammonia, as N, mg/l	< 0.04
Sulfite, mg/l	< 1

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: Oct. 18, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-173-78 LW-104 8-22-78

LAB NO: DA-78

Color	---
Odor	---
Temperature, °C	17
Conductivity, µmhos	2600
pH	6.3
Oxygen, mg/l	---

Total Alkalinity, mg/l as $CaCO_3$	480	Arsenic, mg/l	< 0.02
Carbonate, mg/l as $CaCO_3$	< 1	Iron, mg/l	60
Bicarbonate, mg/l as $CaCO_3$	480	Magnesium, mg/l	96
Total Dissolved Solids, mg/l	2300	Calcium, mg/l	290
Suspended Solids, mg/l	---	Boron, mg/l	2.2
Turbidity, NTU	---	Vanadium, mg/l	< 0.1
Sulfate, mg/l	2400	Copper, mg/l	< 0.02
Chloride, mg/l	14	Molybdenum, mg/l	< 0.1
Fluoride, mg/l	0.74	Lithium, mg/l	0.1
Chemical Oxygen Demand, mg/l	220	Zinc, mg/l	0.7
Phenol, mg/l	0.01	Aluminum, mg/l	1
Nitrate, mg/l	330	Barium, mg/l	0.8
BOD_5, mg/l	12	Strontium, mg/l	4
Oil & Grease, mg/l	2	Ammonia, as N, mg/l	5.45
Silica, mg/l	18	Sulfite, mg/l	---
Sodium, mg/l	200		
Potassium, mg/l	3.1		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE: November 10,1978

SAMPLE: A-237-78 LW-104 10-18-78

LAB NO: DA-140

Color	Gray
Odor	Rotten
Temperature, °C	15
Conductivity, µmhos	2400
pH	6.1
Oxygen, mg/l	2

Total Alkalinity, mg/l as $CaCO_3$	250	Arsenic, mg/l	<0.02
Carbonate, mg/l as $CaCO_3$	<1	Iron, mg/l	100
Bicarbonate, mg/l as $CaCO_3$	250	Magnesium, mg/l	90
Total Dissolved Solids, mg/l	2000	Calcium, mg/l	260
Suspended Solids, mg/l	400	Boron, mg/l	0.26
Turbidity, NTU	100	Vanadium, mg/l	0.1
Sulfate, mg/l	1200	Copper, mg/l	<0.02
Chloride, mg/l	14	Molybdenum, mg/l	<0.02
Fluoride, mg/l	0.80	Lithium, mg/l	0.05
Chemical Oxygen Demand, mg/l	40	Zinc, mg/l	0.07
Phenol, mg/l	0.002	Aluminum, mg/l	0.2
Nitrate, mg/l	3.4	Barium, mg/l	1
BOD_5, mg/l	7	Strontium, mg/l	6
Oil & Grease, mg/l	1	Ammonia, as N, mg/l	1.5
Silica, mg/l	4.5	Sulfite, mg/l	<1
Sodium, mg/l	240		
Potassium, mg/l	2.3		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: December 18, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-287-78 LW-104 11-22-78

LAB NO: DA-187

Color	Green		
Odor	Rotten		
Temperature, °C	11		
Conductivity, µmhos	2300		
pH	7.1		
Oxygen, mg/l	2		
Total Alkalinity, mg/l as $CaCO_3$	210	Arsenic, mg/l	< 0.02
Carbonate, mg/l as $CaCO_3$	1	Iron, mg/l	130
Bicarbonate, mg/l as $CaCO_3$	210	Magnesium, mg/l	43
Total Dissolved Solids, mg/l	2000	Calcium, mg/l	230
Suspended Solids, mg/l	430	Boron, mg/l	0.46
Turbidity, NTU	120	Vanadium, mg/l	<0.1
Sulfate, mg/l	1100	Copper, mg/l	<0.02
Chloride, mg/l	23	Molybdenum, mg/l	<0.02
Fluoride, mg/l	0.62	Lithium, mg/l	0.06
Chemical Oxygen Demand, mg/l	50	Zinc, mg/l	0.1
Phenol, mg/l	0.007	Aluminum, mg/l	1
Nitrate, mg/l	11	Barium, mg/l	0.5
BOD_5, mg/l	1	Strontium, mg/l	5
Oil & Grease, mg/l	6	Ammonia, as N, mg/l	9.6
Silica, mg/l	4.5	Sulfite, mg/l	3
Sodium, mg/l	220		
Potassium, mg/l	2.5		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: November 10, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-218-78 LW-32 10-4-78

LAB NO: DA-121

Color	Yellow
Odor	None
Temperature, °C	15
Conductivity, µmhos	500
pH	6.7
Oxygen, mg/l	7.0

Total Alkalinity, mg/l as $CaCO_3$	290	Arsenic, mg/l	<0.02
Carbonate, mg/l as $CaCO_3$	<1	Iron, mg/l	20
Bicarbonate, mg/l as $CaCO_3$	290	Magnesium, mg/l	22
Total Dissolved Solids, mg/l	500	Calcium, mg/l	49
Suspended Solids, mg/l	300	Boron, mg/l	0.09
Turbidity, NTU	100	Vanadium, mg/l	<0.1
Sulfate, mg/l	520	Copper, mg/l	<0.02
Chloride, mg/l	180	Molybdenum, mg/l	<0.02
Fluoride, mg/l	0.18	Lithium, mg/l	0.05
Chemical Oxygen Demand, mg/l	2	Zinc, mg/l	0.5
Phenol, mg/l	0.033	Aluminum, mg/l	2
Nitrate, mg/l	40	Barium, mg/l	0.5
BOD_5, mg/l	100	Strontium, mg/l	9
Oil & Grease, mg/l	20	Ammonia, as N, mg/l	2.6
Silica, mg/l	26	Sulfite, mg/l	<1
Sodium, mg/l	80		
Potassium, mg/l	0.4		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE: December 1, 1978

SAMPLE: A-258-78 LW-46 10-31-78

LAB NO: DA-155

Color	Milky
Odor	Soapy
Temperature, °C	14
Conductivity, µmhos	800
pH	7.6
Oxygen, mg/l	4

Total Alkalinity, mg/l as $CaCO_3$	360	Arsenic, mg/l	0.05
Carbonate, mg/l as $CaCO_3$	120	Iron, mg/l	7
Bicarbonate, mg/l as $CaCO_3$	240	Magnesium, mg/l	21
Total Dissolved Solids, mg/l	600	Calcium, mg/l	28
Suspended Solids, mg/l	60	Boron, mg/l	0.18
Turbidity, NTU	50	Vanadium, mg/l	< 0.1
Sulfate, mg/l	170	Copper, mg/l	< 0.02
Chloride, mg/l	2.0	Molybdenum, mg/l	< 0.02
Fluoride, mg/l	0.49	Lithium, mg/l	0.1
Chemical Oxygen Demand, mg/l	30	Zinc, mg/l	0.3
Phenol, mg/l	0.024	Aluminum, mg/l	1
Nitrate, mg/l	24	Barium, mg/l	< 0.5
BOD_5, mg/l	100	Strontium, mg/l	9
Oil & Grease, mg/l	100	Ammonia, as N, mg/l	1.2
Silica, mg/l	12	Sulfite, mg/l	1
Sodium, mg/l	160		
Potassium, mg/l	0.84		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: December 1, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-259-78 LW-47A 10-31-78

LAB NO: DA-156

Color	Clear
Odor	Soapy
Temperature, °C	12
Conductivity, µmhos	800
pH	7.1
Oxygen, mg/l	3

Total Alkalinity, mg/l as $CaCO_3$	310	Arsenic, mg/l	0.1
Carbonate, mg/l as $CaCO_3$	< 1	Iron, mg/l	5
Bicarbonate, mg/l as $CaCO_3$	310	Magnesium, mg/l	32
Total Dissolved Solids, mg/l	600	Calcium, mg/l	74
Suspended Solids, mg/l	50	Boron, mg/l	0.12
Turbidity, NTU	20	Vanadium, mg/l	< 0.1
Sulfate, mg/l	180	Copper, mg/l	< 0.02
Chloride, mg/l	5.2	Molybdenum, mg/l	< 0.02
Fluoride, mg/l	0.18	Lithium, mg/l	0.04
Chemical Oxygen Demand, mg/l	30	Zinc, mg/l	0.1
Phenol, mg/l	0.013	Aluminum, mg/l	0.8
Nitrate, mg/l	17	Barium, mg/l	< 0.5
BOD_5, mg/l	40	Strontium, mg/l	6
Oil & Grease, mg/l	10	Ammonia, as N, mg/l	0.06
Silica, mg/l	30	Sulfite, mg/l	1
Sodium, mg/l	110		
Potassium, mg/l	0.52		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: October 27, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-192-78 Riley Gulch 9-7-78

LAB NO: DA-97

Color	----
Odor	----
Temperature, °C	26
Conductivity, µmhos	1200
pH	7.9
Oxygen, mg/l	----
Total Alkalinity, mg/l as $CaCO_3$	350
Carbonate, mg/l as $CaCO_3$	50
Bicarbonate, mg/l as $CaCO_3$	300
Total Dissolved Solids, mg/l	640
Suspended Solids, mg/l	10
Turbidity, NTU	4
Sulfate, mg/l	260
Chloride, mg/l	2
Fluoride, mg/l	0.90
Chemical Oxygen Demand, mg/l	30
Phenol, mg/l	0.018
Nitrate, mg/l	2.2
BOD_5, mg/l	30
Oil & Grease, mg/l	10
Silica, mg/l	14
Sodium, mg/l	140
Potassium, mg/l	4.0
Arsenic, mg/l	<0.02
Iron, mg/l	<0.5
Magnesium, mg/l	74
Calcium, mg/l	55
Boron, mg/l	0.11
Vanadium, mg/l	<0.1
Copper, mg/l	<0.02
Molybdenum, mg/l	<0.02
Lithium, mg/l	0.1
Zinc, mg/l	<0.02
Aluminum, mg/l	<0.1
Barium, mg/l	0.5
Strontium, mg/l	2
Ammonia, as N, mg/l	<0.04
Sulfite, mg/l	----

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: November 10, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-236-78 Riley Gulch 10-18-78

LAB NO: DA-139

Color	Clear
Odor	None
Temperature, °C	13
Conductivity, µmhos	1200
pH	8.2
Oxygen, mg/l	6

Total Alkalinity, mg/l as $CaCO_3$	510	Arsenic, mg/l	0.02
Carbonate, mg/l as $CaCO_3$	80	Iron, mg/l	<0.5
Bicarbonate, mg/l as $CaCO_3$	430	Magnesium, mg/l	72
Total Dissolved Solids, mg/l	700	Calcium, mg/l	56
Suspended Solids, mg/l	60	Boron, mg/l	0.19
Turbidity, NTU	4	Vanadium, mg/l	0.1
Sulfate, mg/l	350	Copper, mg/l	<0.02
Chloride, mg/l	5.4	Molybdenum, mg/l	0.05
Fluoride, mg/l	0.58	Lithium, mg/l	0.05
Chemical Oxygen Demand, mg/l	30	Zinc, mg/l	<0.02
Phenol, mg/l	0.014	Aluminum, mg/l	0.1
Nitrate, mg/l	<0.1	Barium, mg/l	<0.5
BOD_5, mg/l	4	Strontium, mg/l	3
Oil & Grease, mg/l	10	Ammonia, as N, mg/l	<0.04
Silica, mg/l	18	Sulfite, mg/l	<1
Sodium, mg/l	140		
Potassium, mg/l	3.5		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE: December 18, 1978

SAMPLE: A-289-78 Riley Gulch 11-22-78

LAB NO: DA-188

Color	Milky
Odor	0
Temperature, °C	5
Conductivity, µmhos	1000
pH	8.1
Oxygen, mg/l	7

Total Alkalinity, mg/l as $CaCO_3$	310	Arsenic, mg/l	<0.02
Carbonate, mg/l as $CaCO_3$	30	Iron, mg/l	3
Bicarbonate, mg/l as $CaCO_3$	280	Magnesium, mg/l	71
Total Dissolved Solids, mg/l	950	Calcium, mg/l	100
Suspended Solids, mg/l	70	Boron, mg/l	0.1
Turbidity, NTU	350	Vanadium, mg/l	<0.1
Sulfate, mg/l	350	Copper, mg/l	<0.02
Chloride, mg/l	4.4	Molybdenum, mg/l	<0.02
Fluoride, mg/l	0.53	Lithium, mg/l	0.04
Chemical Oxygen Demand, mg/l	30	Zinc, mg/l	0.03
Phenol, mg/l	0.005	Aluminum, mg/l	3
Nitrate, mg/l	0.2	Barium, mg/l	1
BOD_5, mg/l	< 1	Strontium, mg/l	3
Oil & Grease, mg/l	10	Ammonia, as N, mg/l	<0.04
Silica, mg/l	14	Sulfite, mg/l	<1
Sodium, mg/l	120		
Potassium, mg/l	3.5		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: October 24, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-201-78 Upper Parachute Creek 9-8-78

LAB NO: DA-103

Color	Milky
Odor	None
Temperature, °C	20
Conductivity, µmhos	1000
pH	7.8
Oxygen, mg/l	----

Total Alkalinity, mg/l as $CaCO_3$	380	Arsenic, mg/l	<0.02
Carbonate, mg/l as $CaCO_3$	20	Iron, mg/l	2
Bicarbonate, mg/l as $CaCO_3$	360	Magnesium, mg/l	60
Total Dissolved Solids, mg/l	610	Calcium, mg/l	81
Suspended Solids, mg/l	40	Boron, mg/l	0.04
Turbidity, NTU	160	Vanadium, mg/l	<0.1
Sulfate, mg/l	240	Copper, mg/l	<0.02
Chloride, mg/l	10	Molybdenum, mg/l	<0.02
Fluoride, mg/l	1.2	Lithium, mg/l	0.03
Chemical Oxygen Demand, mg/l	40	Zinc, mg/l	<0.02
Phenol, mg/l	0.026	Aluminum, mg/l	0.8
Nitrate, mg/l	6.2	Barium, mg/l	1
BOD_5, mg/l	60	Strontium, mg/l	2
Oil & Grease, mg/l	30	Ammonia, as N, mg/l	1.5
Silica, mg/l	15	Sulfite, mg/l	<1.0
Sodium, mg/l	100		
Potassium, mg/l	4.7		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE: December 1, 1978

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-246-78 Upper Parachute Creek 10-18-78

LAB NO: DA-144

Color	Clear
Odor	0
Temperature, °C	14
Conductivity, µmhos	1100
pH	7.1
Oxygen, mg/l	6

Total Alkalinity, mg/l as $CaCO_3$	400	Arsenic, mg/l	< 0.002
Carbonate, mg/l as $CaCO_3$	20	Iron, mg/l	< 0.5
Bicarbonate, mg/l as $CaCO_3$	380	Magnesium, mg/l	68
Total Dissolved Solids, mg/l	800	Calcium, mg/l	84
Suspended Solids, mg/l	800	Boron, mg/l	3.6
Turbidity, NTU	5	Vanadium, mg/l	< 0.1
Sulfate, mg/l	320	Copper, mg/l	< 0.02
Chloride, mg/l	12	Molybdenum, mg/l	0.05
Fluoride, mg/l	1.0	Lithium, mg/l	< 0.02
Chemical Oxygen Demand, mg/l	8	Zinc, mg/l	0.03
Phenol, mg/l	0.004	Aluminum, mg/l	0.2
Nitrate, mg/l	0.2	Barium, mg/l	0.5
BOD_5, mg/l	4	Strontium, mg/l	4
Oil & Grease, mg/l	9	Ammonia, as N, mg/l	2.5
Silica, mg/l	17	Sulfite, mg/l	< 1
Sodium, mg/l	140		
Potassium, mg/l	3.9		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

DATE:

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

SAMPLE: A-268-78 Upper Parachute Creek 11-8-78

LAB NO: DA-166

Color	Clear		
Odor	o		
Temperature, °C	6		
Conductivity, µmhos	1200		
pH	8.2		
Oxygen, mg/l	7		
Total Alkalinity, mg/l as $CaCO_3$	440	Arsenic, mg/l	< 0.02
Carbonate, mg/l as $CaCO_3$	40	Iron, mg/l	< 0.5
Bicarbonate, mg/l as $CaCO_3$	400	Magnesium, mg/l	82
Total Dissolved Solids, mg/l	1000	Calcium, mg/l	89
Suspended Solids, mg/l	20	Boron, mg/l	0.27
Turbidity, NTU	2	Vanadium, mg/l	< 0.1
Sulfate, mg/l	330	Copper, mg/l	< 0.02
Chloride, mg/l	17	Molybdenum, mg/l	0.04
Fluoride, mg/l	1.0	Lithium, mg/l	0.04
Chemical Oxygen Demand, mg/l	20	Zinc, mg/l	< 0.02
Phenol, mg/l	0.012	Aluminum, mg/l	< 0.02
Nitrate, mg/l	< 0.1	Barium, mg/l	< 0.5
BOD_5, mg/l	4	Strontium, mg/l	3
Oil & Grease, mg/l	10	Ammonia, as N, mg/l	30
Silica, mg/l	16	Sulfite, mg/l	< 1
Sodium, mg/l	130		
Potassium, mg/l	4.6		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen
cc: R.R. Bloom, B.A. Romig, J.F. Denham, R.E. Thomason, C. Nieuwenhuis

FROM: J. Greer

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Alluvial, Bedrock & Surface Water

DATE: October 27, 1978

SAMPLE: A-196-78 Lower Parachute Creek 9-8-78

LAB NO: DA-102

Color	Milky
Odor	None
Temperature, °C	20
Conductivity, µmhos	1000
pH	7.7
Oxygen, mg/l	----
Total Alkalinity, mg/l as $CaCO_3$	380
Carbonate, mg/l as $CaCO_3$	20
Bicarbonate, mg/l as $CaCO_3$	360
Total Dissolved Solids, mg/l	750
Suspended Solids, mg/l	50
Turbidity, NTU	40
Sulfate, mg/l	270
Chloride, mg/l	12
Fluoride, mg/l	1.6
Chemical Oxygen Demand, mg/l	30
Phenol, mg/l	0.016
Nitrate, mg/l	7.1
BOD_5, mg/l	60
Oil & Grease, mg/l	20
Silica, mg/l	18
Sodium, mg/l	100
Potassium, mg/l	4.5
Arsenic, mg/l	<0.2
Iron, mg/l	2
Magnesium, mg/l	61
Calcium, mg/l	81
Boron, mg/l	<0.04
Vanadium, mg/l	0.1
Copper, mg/l	<0.02
Molybdenum, mg/l	<0.02
Lithium, mg/l	0.03
Zinc, mg/l	<0.02
Aluminum, mg/l	0.9
Barium, mg/l	1
Strontium, mg/l	2
Ammonia, as N, mg/l	<0.04
Sulfite, mg/l	< 1.0

PROCESS WATER

SITE SAMPLED WEEKLY

RETORT 6

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Process Water

DATE: October 17, 1978

SAMPLE: A-179-78 Retort 6 8-24-78

LAB NO. DA-81

Total Alkalinity, mg/l as $CaCO_3$	720	Lithium, mg/l	2
Carbonate, mg/l as $CaCO_3$	20	Zinc, mg/l	0.03
Bicarbonate, mg/l as $CaCO_3$	700	Aluminum, mg/l	0.4
Total Dissolved Solids, mg/l	7000	Barium, mg/l	< 0.5
Total Suspended Solids, mg/l	----	Strontium, mg/l	5
Sulfate, mg/l	3700	Lead, mg/l	0.1
Chloride, mg/l	300	Nickel, mg/l	< 0.02
Fluoride, mg/l	11.8	Cadmium, mg/l	< 0.02
Phenol, mg/l	0.068	Ammonia, as N, mg/l	----
Nitrate, mg/l	140	Sulfite, mg/l	----
Oil & Grease, mg/l	20		
Silica, mg/l	17		
Sodium, mg/l	1700		
Potassium, mg/l	23		
Arsenic, mg/l	< 0.02		
Iron, mg/l	< 0.5		
Magnesium, mg/l	40		
Manganese, mg/l	< 0.2		
Calcium, mg/l	65		
Boron, mg/l	13		
Vanadium, mg/l	< 0.1		
Copper, mg/l	0.1		
Molybdenum, mg/l	6		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Process Water

DATE: October 31, 1978

SAMPLE: A-181-78 Room 6 8-31-78

LAB NO. DA-90

Total Alkalinity, mg/l as $CaCO_3$	950	Lithium, mg/l	2
Carbonate, mg/l as $CaCO_3$	<1	Zinc, mg/l	0.03
Bicarbonate, mg/l as $CaCO_3$	950	Aluminum, mg/l	0.3
Total Dissolved Solids, mg/l	6000	Barium, mg/l	<0.5
Total Suspended Solids, mg/l	----	Strontium, mg/l	6
Sulfate, mg/l	3100	Lead, mg/l	0.05
Chloride, mg/l	400	Nickel, mg/l	<0.02
Fluoride, mg/l	12	Cadmium, mg/l	<0.02
Phenol, mg/l	0.11	Ammonia, as N, mg/l	28
Nitrate, mg/l	170	Sulfite, mg/l	----
Oil & Grease, mg/l	20		
Silica, mg/l	14		
Sodium, mg/l	2000		
Potassium, mg/l	13		
Arsenic, mg/l	<0.02		
Iron, mg/l	<0.5		
Magnesium, mg/l	37		
Manganese, mg/l	<0.2		
Calcium, mg/l	79		
Boron, mg/l	<0.04		
Vanadium, mg/l	<0.1		
Copper, mg/l	<0.02		
Molybdenum, mg/l	6		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Process Water

DATE: Nov. 8, 1978

SAMPLE: A-195-78 Retort 6 9-8-78

LAB NO. DA-101

Total Alkalinity, mg/l as $CaCO_3$	1460
Carbonate, mg/l as $CaCO_3$	< 1
Bicarbonate, mg/l as $CaCO_3$	1460
Total Dissolved Solids, mg/l	9400
Total Suspended Solids, mg/l	400
Sulfate, mg/l	4200
Chloride, mg/l	100
Fluoride, mg/l	10
Phenol, mg/l	0.12
Nitrate, mg/l	380
Oil & Grease, mg/l	20
Silica, mg/l	9.2
Sodium, mg/l	2400
Potassium, mg/l	15
Arsenic, mg/l	0.15
Iron, mg/l	150
Magnesium, mg/l	64
Manganese, mg/l	0.7
Calcium, mg/l	90
Boron, mg/l	30
Vanadium, mg/l	< 0.1
Copper, mg/l	< 0.02
Molybdenum, mg/l	10

Lithium, mg/l	2
Zinc, mg/l	0.03
Aluminum, mg/l	0.4
Barium, mg/l	0.7
Strontium, mg/l	8
Lead, mg/l	< 0.05
Nickel, mg/l	0.04
Cadmium, mg/l	< 0.02
Ammonia, as N, mg/l	7.7
Sulfite, mg/l	---

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Process Water

DATE: Nov. 8, 1978

SAMPLE: A-193-78 Retort 6 9-22-78

LAB NO. DA-110

Total Alkalinity, mg/l as $CaCO_3$	2600	Lithium, mg/l	4
Carbonate, mg/l as $CaCO_3$	< 1	Zinc, mg/l	5
Bicarbonate, mg/l as $CaCO_3$	2600	Aluminum, mg/l	0.2
Total Dissolved Solids, mg/l	13,000	Barium, mg/l	0.7
Total Suspended Solids, mg/l	260	Strontium, mg/l	21
Sulfate, mg/l	4000	Lead, mg/l	0.1
Chloride, mg/l	230	Nickel, mg/l	0.3
Fluoride, mg/l	8.3	Cadmium, mg/l	< 0.02
Phenol, mg/l	0.35	Ammonia, as N, mg/l	---
Nitrate, mg/l	75	Sulfite, mg/l	---
Oil & Grease, mg/l	10		
Silica, mg/l	13		
Sodium, mg/l	3600		
Potassium, mg/l	43		
Arsenic, mg/l	< 0.02		
Iron, mg/l	2		
Magnesium, mg/l	230		
Manganese, mg/l	0.10		
Calcium, mg/l	330		
Boron, mg/l	0.22		
Vanadium, mg/l	< 0.1		
Copper, mg/l	0.2		
Molybdenum, mg/l	20		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis Process Water

DATE: Nov.8, 1978

SAMPLE: A-210-78 Retort 6 9-29-78

LAB NO. DA-117

Total Alkalinity, mg/l as $CaCO_3$	540	Lithium, mg/l	3
Carbonate, mg/l as $CaCO_3$	< 1	Zinc, mg/l	0.1
Bicarbonate, mg/l as $CaCO_3$	540	Aluminum, mg/l	0.1
Total Dissolved Solids, mg/l	13,000	Barium, mg/l	0.8
Total Suspended Solids, mg/l	100	Strontium, mg/l	20
Sulfate, mg/l	4000	Lead, mg/l	< 0.02
Chloride, mg/l	240	Nickel, mg/l	0.1
Fluoride, mg/l	15	Cadmium, mg/l	< 0.02
Phenol, mg/l	8.7	Ammonia, as N, mg/l	3.1
Nitrate, mg/l	62	Sulfite, mg/l	---
Oil & Grease, mg/l	30		
Silica, mg/l	16		
Sodium, mg/l	3700		
Potassium, mg/l	61		
Arsenic, mg/l	0.07		
Iron, mg/l	2		
Magnesium, mg/l	140		
Manganese, mg/l	0.05		
Calcium, mg/l	150		
Boron, mg/l	< 0.04		
Vanadium, mg/l	< 0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	10		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Process Water

DATE: Nov. 8, 1978

SAMPLE: A-213-78 Retort 6 10-5-78

LAB NO. DA-122

Total Alkalinity, mg/l as $CaCO_3$	3500	Lithium, mg/l	3
Carbonate, mg/l as $CaCO_3$	< 1	Zinc, mg/l	0.02
Bicarbonate, mg/l as $CaCO_3$	3500	Aluminum, mg/l	0.4
Total Dissolved Solids, mg/l	18,000	Barium, mg/l	2
Total Suspended Solids, mg/l	300	Strontium, mg/l	20
Sulfate, mg/l	4000	Lead, mg/l	< 0.02
Chloride, mg/l	85	Nickel, mg/l	0.03
Fluoride, mg/l	14	Cadmium, mg/l	< 0.02
Phenol, mg/l	3.7	Ammonia, as N, mg/l	---
Nitrate, mg/l	150	Sulfite, mg/l	---
Oil & Grease, mg/l	20		
Silica, mg/l	22		
Sodium, mg/l	3700		
Potassium, mg/l	54		
Arsenic, mg/l	0.05		
Iron, mg/l	2		
Magnesium, mg/l	140		
Manganese, mg/l	0.04		
Calcium, mg/l	120		
Boron, mg/l	16		
Vanadium, mg/l	0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	2		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Process Water

DATE: December 1, 1978

SAMPLE: A-245-78 Retort 6 10-20-78

LAB NO. DA-145

Total Alkalinity, mg/l as $CaCO_3$	1600	Lithium, mg/l	2
Carbonate, mg/l as $CaCO_3$	300	Zinc, mg/l	< 0.02
Bicarbonate, mg/l as $CaCO_3$	1200	Aluminum, mg/l	0.2
Total Dissolved Solids, mg/l	1300	Barium, mg/l	< 0.5
Total Suspended Solids, mg/l	140	Strontium, mg/l	7
Sulfate, mg/l	3400	Lead, mg/l	0.1
Chloride, mg/l	64	Nickel, mg/l	0.02
Fluoride, mg/l	21	Cadmium, mg/l	< 0.02
Phenol, mg/l	7.2	Ammonia, as N, mg/l	200
Nitrate, mg/l	490	Sulfite, mg/l	---
Oil & Grease, mg/l	150		
Silica, mg/l	24		
Sodium, mg/l	4000		
Potassium, mg/l	67		
Arsenic, mg/l	0.17		
Iron, mg/l	< 0.5		
Magnesium, mg/l	67		
Manganese, mg/l	< 0.02		
Calcium, mg/l	29		
Boron, mg/l	3.9		
Vanadium, mg/l	< 0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	0.1		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis

DATE: December 1, 1978

SAMPLE: A-255-78 Retort 6 10-26-78
Process Water

LAB NO. DA-154

Total Alkalinity, mg/l as $CaCO_3$	8600	Lithium, mg/l	2
Carbonate, mg/l as $CaCO_3$	500	Zinc, mg/l	< 0.02
Bicarbonate, mg/l as $CaCO_3$	8100	Aluminum, mg/l	0.04
Total Dissolved Solids, mg/l	2200	Barium, mg/l	0.7
Total Suspended Solids, mg/l	640	Strontium, mg/l	4
Sulfate, mg/l	3000	Lead, mg/l	0.1
Chloride, mg/l	80	Nickel, mg/l	0.05
Fluoride, mg/l	24	Cadmium, mg/l	< 0.02
Phenol, mg/l	18	Ammonia, as N, mg/l	850
Nitrate, mg/l	710	Sulfite, mg/l	---
Oil & Grease, mg/l	150		
Silica, mg/l	23		
Sodium, mg/l	4200		
Potassium, mg/l	80		
Arsenic, mg/l	0.28		
Iron, mg/l	< 0.5		
Magnesium, mg/l	44		
Manganese, mg/l	< 0.02		
Calcium, mg/l	8.7		
Boron, mg/l	9.4		
Vanadium, mg/l	< 0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	0.6		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Process Water

DATE: December 18, 1978

SAMPLE: A-260-78 Retort 6 11-2-78

LAB NO. DA-159

Total Alkalinity, mg/l as $CaCO_3$	10,200	Lithium, mg/l	2
Carbonate, mg/l as $CaCO_3$	1,000	Zinc, mg/l	< 0.02
Bicarbonate, mg/l as $CaCO_3$	9,200	Aluminum, mg/l	< 0.02
Total Dissolved Solids, mg/l	13,000	Barium, mg/l	2
Total Suspended Solids, mg/l	9,900	Strontium, mg/l	4
Sulfate, mg/l	2,500	Lead, mg/l	< 0.02
Chloride, mg/l	66	Nickel, mg/l	< 0.02
Fluoride, mg/l	27	Cadmium, mg/l	< 0.02
Phenol, mg/l	20	Ammonia, as N, mg/l	2000
Nitrate, mg/l	640	Sulfite, mg/l	--
Oil & Grease, mg/l	300		
Silica, mg/l	26		
Sodium, mg/l	4,000		
Potassium, mg/l	81		
Arsenic, mg/l	0.23		
Iron, mg/l	< 0.5		
Magnesium, mg/l	29		
Manganese, mg/l	< 0.02		
Calcium, mg/l	70		
Boron, mg/l	3.7		
Vanadium, mg/l	< 0.1		
Copper, mg/l	0.04		
Molybdenum, mg/l	0.4		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Process Water

DATE: December 18, 1978

SAMPLE: A-280-78 Retort 6 11-10-78

LAB NO. DA-179

Total Alkalinity, mg/l as $CaCO_3$	11,000	Lithium, mg/l	2
Carbonate, mg/l as $CaCO_3$	1200	Zinc, mg/l	<0.02
Bicarbonate, mg/l as $CaCO_3$	9800	Aluminum, mg/l	0.07
Total Dissolved Solids, mg/l	2500	Barium, mg/l	2
Total Suspended Solids, mg/l	350	Strontium, mg/l	3
Sulfate, mg/l	2000	Lead, mg/l	<0.02
Chloride, mg/l	71	Nickel, mg/l	0.04
Fluoride, mg/l	29	Cadmium, mg/l	<0.02
Phenol, mg/l	27	Ammonia, as N, mg/l	1300
Nitrate, mg/l	330	Sulfite, mg/l	--
Oil & Grease, mg/l	200		
Silica, mg/l	27		
Sodium, mg/l	4400		
Potassium, mg/l	88		
Arsenic, mg/l	0.23		
Iron, mg/l	< 0.5		
Magnesium, mg/l	20		
Manganese, mg/l	< 0.02		
Calcium, mg/l	4.2		
Boron, mg/l	12		
Vanadium, mg/l	0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	0.2		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Process Water

DATE: December 18, 1978

SAMPLE: A-284-78 Retort 6 11-16-78

LAB NO. DA-183

Total Alkalinity, mg/l as $CaCO_3$	11,500	Lithium, mg/l	2
Carbonate, mg/l as $CaCO_3$	1600	Zinc, mg/l	< 0.02
Bicarbonate, mg/l as $CaCO_3$	9900	Aluminum, mg/l	0.07
Total Dissolved Solids, mg/l	2500	Barium, mg/l	2
Total Suspended Solids, mg/l	350	Strontium, mg/l	2
Sulfate, mg/l	1700	Lead, mg/l	< 0.02
Chloride, mg/l	180	Nickel, mg/l	0.02
Fluoride, mg/l	30	Cadmium, mg/l	<0.02
Phenol, mg/l	20	Ammonia, as N, mg/l	1800
Nitrate, mg/l	390	Sulfite, mg/l	--
Oil & Grease, mg/l	300		
Silica, mg/l	26		
Sodium, mg/l	4400		
Potassium, mg/l	88		
Arsenic, mg/l	0.25		
Iron, mg/l	2		
Magnesium, mg/l	13		
Manganese, mg/l	< 0.02		
Calcium, mg/l	2.7		
Boron, mg/l	11		
Vanadium, mg/l	<0.1		
Copper, mg/l	<0.02		
Molybdenum, mg/l	0.1		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Process Water

DATE: December 18, 1978

SAMPLE: A-288-78 Retort 6 11-21-78

LAB NO. DA-186

Total Alkalinity, mg/l as $CaCO_3$	12,600	Lithium, mg/l	2
Carbonate, mg/l as $CaCO_3$	2800	Zinc, mg/l	<0.02
Bicarbonate, mg/l as $CaCO_3$	9800	Aluminum, mg/l	<0.02
Total Dissolved Solids, mg/l	12,000	Barium, mg/l	2
Total Suspended Solids, mg/l	160	Strontium, mg/l	2
Sulfate, mg/l	1600	Lead, mg/l	<0.02
Chloride, mg/l	110	Nickel, mg/l	<0.02
Fluoride, mg/l	34	Cadmium, mg/l	<0.02
Phenol, mg/l	44	Ammonia, as N, mg/l	1800
Nitrate, mg/l	390	Sulfite, mg/l	
Oil & Grease, mg/l	200		
Silica, mg/l	26		
Sodium, mg/l	4400		
Potassium, mg/l	92		
Arsenic, mg/l	0.23		
Iron, mg/l	< 0.5		
Magnesium, mg/l	9.6		
Manganese, mg/l	< 0.02		
Calcium, mg/l	2.7		
Boron, mg/l	8.5		
Vanadium, mg/l	< 0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	0.2		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Mine & Process Water

DATE: January 11, 1979

SAMPLE: A-296-78 Retort 6 11-30-78

LAB NO. DA-192

Total Alkalinity, mg/l as $CaCO_3$	11,800	Lithium, mg/l	2
Carbonate, mg/l as $CaCO_3$	2400	Zinc, mg/l	0.03
Bicarbonate, mg/l as $CaCO_3$	9400	Aluminum, mg/l	0.2
Total Dissolved Solids, mg/l	12,000	Barium, mg/l	3.3
Total Suspended Solids, mg/l	280	Strontium, mg/l	2
Sulfate, mg/l	1200	Lead, mg/l	< 0.02
Chloride, mg/l	58	Nickel, mg/l	< 0.02
Fluoride, mg/l	34	Cadmium, mg/l	< 0.02
Phenol, mg/l	24	Ammonia, as N, mg/l	1600
Nitrate, mg/l	540	Sulfite, mg/l	90
Oil & Grease, mg/l	240		
Silica, mg/l	28		
Sodium, mg/l	4400		
Potassium, mg/l	97		
Arsenic, mg/l	0.38		
Iron, mg/l	< 0.5		
Magnesium, mg/l	6		
Manganese, mg/l	< 0.02		
Calcium, mg/l	4		
Boron, mg/l	15		
Vanadium, mg/l	< 0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	0.07		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Mine & Process Water

DATE: January 11, 1979

SAMPLE: A-298-78 Retort 6 12-7-78

LAB NO. DA-198

Total Alkalinity, mg/l as $CaCO_3$	10,900
Carbonate, mg/l as $CaCO_3$	2100
Bicarbonate, mg/l as $CaCO_3$	8800
Total Dissolved Solids, mg/l	12,300
Total Suspended Solids, mg/l	280
Sulfate, mg/l	1300
Chloride, mg/l	39
Fluoride, mg/l	37
Phenol, mg/l	56
Nitrate, mg/l	640
Oil & Grease, mg/l	230
Silica, mg/l	28
Sodium, mg/l	4400
Potassium, mg/l	97
Arsenic, mg/l	5.2
Iron, mg/l	< 0.5
Magnesium, mg/l	6
Manganese, mg/l	0.03
Calcium, mg/l	3
Boron, mg/l	17
Vanadium, mg/l	0.1
Copper, mg/l	< 0.02
Molybdenum, mg/l	0.07

Lithium, mg/l	2
Zinc, mg/l	< 0.02
Aluminum, mg/l	0.4
Barium, mg/l	3
Strontium, mg/l	2
Lead, mg/l	< 0.02
Nickel, mg/l	< 0.02
Cadmium, mg/l	< 0.02
Ammonia, as N, mg/l	1500
Sulfite, mg/l	90

SITES SAMPLED QUARTERLY

RETORT 1
RETORT 2
RETORT 3
RETORT 4
RETORT 5

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis

DATE: December 1, 1978

SAMPLE: A-254-78 Retort 1 10-25-78
Process Water

LAB NO. DA-152

Total Alkalinity, mg/l as $CaCO_3$	550	Lithium, mg/l	2
Carbonate, mg/l as $CaCO_3$	90	Zinc, mg/l	0.06
Bicarbonate, mg/l as $CaCO_3$	460	Aluminum, mg/l	0.2
Total Dissolved Solids, mg/l	12,000	Barium, mg/l	0.6
Total Suspended Solids, mg/l	200	Strontium, mg/l	10
Sulfate, mg/l	1500	Lead, mg/l	0.1
Chloride, mg/l	92	Nickel, mg/l	< 0.02
Fluoride, mg/l	11.5	Cadmium, mg/l	< 0.02
Phenol, mg/l	0.31	Ammonia, as N, mg/l	46
Nitrate, mg/l	19	Sulfite, mg/l	---
Oil & Grease, mg/l	3		
Silica, mg/l	14		
Sodium, mg/l	1100		
Potassium, mg/l	670		
Arsenic, mg/l	0.12		
Iron, mg/l	80		
Magnesium, mg/l	340		
Manganese, mg/l	0.24		
Calcium, mg/l	280		
Boron, mg/l	6.7		
Vanadium, mg/l	< 0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	4		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Process Water

DATE: December 1, 1978

SAMPLE: A-252-78 Retort 2 10-25-78

LAB NO. DA-151

Total Alkalinity, mg/l as $CaCO_3$	560	Lithium, mg/l	2
Carbonate, mg/l as $CaCO_3$	300	Zinc, mg/l	< 0.02
Bicarbonate, mg/l as $CaCO_3$	260	Aluminum, mg/l	0.2
Total Dissolved Solids, mg/l	6000	Barium, mg/l	< 0.5
Total Suspended Solids, mg/l	100	Strontium, mg/l	2
Sulfate, mg/l	3200	Lead, mg/l	0.1
Chloride, mg/l	19	Nickel, mg/l	0.02
Fluoride, mg/l	13.4	Cadmium, mg/l	<0.02
Phenol, mg/l	0.43	Ammonia, as N, mg/l	18
Nitrate, mg/l	80	Sulfite, mg/l	----
Oil & Grease, mg/l	20		
Silica, mg/l	15		
Sodium, mg/l	1100		
Potassium, mg/l	1000		
Arsenic, mg/l	0.06		
Iron, mg/l	4		
Magnesium, mg/l	0.7		
Manganese, mg/l	< 0.02		
Calcium, mg/l	5.1		
Boron, mg/l	5.3		
Vanadium, mg/l	< 0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	0.4		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Process Water

DATE: October 17, 1978

SAMPLE: A-167-78 Retort 4 8-17-78

LAB NO. DA-74

Total Alkalinity, mg/l as $CaCO_3$	3600	Lithium, mg/l	1.3
Carbonate, mg/l as $CaCO_3$	400	Zinc, mg/l	0.02
Bicarbonate, mg/l as $CaCO_3$	3200	Aluminum, mg/l	<0.1
Total Dissolved Solids, mg/l	3500	Barium, mg/l	0.7
Total Suspended Solids, mg/l	----	Strontium, mg/l	0.8
Sulfate, mg/l	400	Lead, mg/l	0.04
Chloride, mg/l	5	Nickel, mg/l	<0.02
Fluoride, mg/l	36	Cadmium, mg/l	<0.02
Phenol, mg/l	7.6	Ammonia, as N, mg/l	10.9
Nitrate, mg/l	18	Sulfite, mg/l	----
Oil & Grease, mg/l	50		
Silica, mg/l	41		
Sodium, mg/l	1200		
Potassium, mg/l	32		
Arsenic, mg/l	0.33		
Iron, mg/l	<0.5		
Magnesium, mg/l	0.72		
Manganese, mg/l	<0.2		
Calcium, mg/l	2.0		
Boron, mg/l	2.2		
Vanadium, mg/l	<0.1		
Copper, mg/l	<0.02		
Molybdenum, mg/l	0.4		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Process Water

DATE: October 17, 1978

SAMPLE: A-185-78 Retort 4 8-26-78

LAB NO. DA-84

Total Alkalinity, mg/l as $CaCO_3$	5400	Lithium, mg/l	2
Carbonate, mg/l as $CaCO_3$	500	Zinc, mg/l	0.02
Bicarbonate, mg/l as $CaCO_3$	4900	Aluminum, mg/l	0.2
Total Dissolved Solids, mg/l	3700	Barium, mg/l	0.9
Total Suspended Solids, mg/l	--	Strontium, mg/l	0.9
Sulfate, mg/l	600	Lead, mg/l	0.04
Chloride, mg/l	40	Nickel, mg/l	<0.02
Fluoride, mg/l	40.0	Cadmium, mg/l	<0.02
Phenol, mg/l	23.7	Ammonia, as N, mg/l	2.25
Nitrate, mg/l	210	Sulfite, mg/l	--
Oil & Grease, mg/l	3		
Silica, mg/l	39		
Sodium, mg/l	1400		
Potassium, mg/l	32		
Arsenic, mg/l	<0.02		
Iron, mg/l	<0.5		
Magnesium, mg/l	0.6		
Manganese, mg/l	<0.2		
Calcium, mg/l	1.7		
Boron, mg/l	16		
Vanadium, mg/l	<0.1		
Copper, mg/l	<0.02		
Molybdenum, mg/l	0.02		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Process Water

DATE: Nov. 8, 1978

SAMPLE: A-217-78 Retort 4 10-6-78

LAB NO. DA-123

Total Alkalinity, mg/l as $CaCO_3$	2800	Lithium, mg/l	1
Carbonate, mg/l as $CaCO_3$	500	Zinc, mg/l	0.04
Bicarbonate, mg/l as $CaCO_3$	2300	Aluminum, mg/l	< 0.02
Total Dissolved Solids, mg/l	7500	Barium, mg/l	1
Total Suspended Solids, mg/l	100	Strontium, mg/l	0.6
Sulfate, mg/l	190	Lead, mg/l	0.02
Chloride, mg/l	450	Nickel, mg/l	< 0.02
Fluoride, mg/l	26	Cadmium, mg/l	< 0.02
Phenol, mg/l	12	Ammonia, as N, mg/l	---
Nitrate, mg/l	570	Sulfite, mg/l	140
Oil & Grease, mg/l	300		
Silica, mg/l	41		
Sodium, mg/l	830		
Potassium, mg/l	19		
Arsenic, mg/l	0.05		
Iron, mg/l	< 0.5		
Magnesium, mg/l	1.1		
Manganese, mg/l	< 0.02		
Calcium, mg/l	3.1		
Boron, mg/l	7.4		
Vanadium, mg/l	< 0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	< 0.02		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Mine & Process Water

DATE: January 11, 1979

SAMPLE: A-294-78 Retort 4 12-7-78

LAB NO. DA-196

Total Alkalinity, mg/l as $CaCO_3$	3190
Carbonate, mg/l as $CaCO_3$	580
Bicarbonate, mg/l as $CaCO_3$	2610
Total Dissolved Solids, mg/l	2800
Total Suspended Solids, mg/l	190
Sulfate, mg/l	210
Chloride, mg/l	44
Fluoride, mg/l	22
Phenol, mg/l	13
Nitrate, mg/l	240
Oil & Grease, mg/l	30
Silica, mg/l	38
Sodium, mg/l	1000
Potassium, mg/l	29
Arsenic, mg/l	0.23
Iron, mg/l	< 0.5
Magnesium, mg/l	1
Manganese, mg/l	< 0.02
Calcium, mg/l	4
Boron, mg/l	13
Vanadium, mg/l	< 0.1
Copper, mg/l	< 0.02
Molybdenum, mg/l	< 0.02

Lithium, mg/l	1
Zinc, mg/l	0.03
Aluminum, mg/l	< 0.02
Barium, mg/l	1
Strontium, mg/l	0.8
Lead, mg/l	< 0.02
Nickel, mg/l	< 0.02
Cadmium, mg/l	< 0.02
Ammonia, as N, mg/l	420
Sulfite, mg/l	220

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Process Water

DATE: October 17, 1978

SAMPLE: A-169-78 Retort 5 8-17-78

LAB NO. DA-75

Total Alkalinity, mg/l as $CaCO_3$	2100
Carbonate, mg/l as $CaCO_3$	1000
Bicarbonate, mg/l as $CaCO_3$	1100
Total Dissolved Solids, mg/l	6300
Total Suspended Solids, mg/l	----
Sulfate, mg/l	2200
Chloride, mg/l	54
Fluoride, mg/l	185
Phenol, mg/l	2.9
Nitrate, mg/l	28
Oil & Grease, mg/l	60
Silica, mg/l	130
Sodium, mg/l	1100
Potassium, mg/l	1000
Arsenic, mg/l	0.16
Iron, mg/l	0.5
Magnesium, mg/l	0.85
Manganese, mg/l	<0.2
Calcium, mg/l	4.6
Boron, mg/l	<0.04
Vanadium, mg/l	<0.1
Copper, mg/l	0.04
Molybdenum, mg/l	0.6
Lithium, mg/l	0.5
Zinc, mg/l	0.1
Aluminum, mg/l	0.3
Barium, mg/l	0.5
Strontium, mg/l	0.5
Lead, mg/l	0.1
Nickel, mg/l	<0.02
Cadmium, mg/l	<0.02
Ammonia, as N, mg/l	1.2
Sulfite, mg/l	----

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Process Water

DATE: October 17,1978

SAMPLE: A-183-78 Retort 5 8-26-78

LAB NO. DA-83

Total Alkalinity, mg/l as $CaCO_3$	1600	Lithium, mg/l	0.4
Carbonate, mg/l as $CaCO_3$	720	Zinc, mg/l	< 0.02
Bicarbonate, mg/l as $CaCO_3$	880	Aluminum, mg/l	0.2
Total Dissolved Solids, mg/l	6100	Barium, mg/l	0.5
Total Suspended Solids, mg/l	----	Strontium, mg/l	0.5
Sulfate, mg/l	2000	Lead, mg/l	0.05
Chloride, mg/l	35	Nickel, mg/l	<0.02
Fluoride, mg/l	200	Cadmium, mg/l	<0.02
Phenol, mg/l	3.12	Ammonia, as N, mg/l	1.7
Nitrate, mg/l	20	Sulfite, mg/l	----
Oil & Grease, mg/l	60		
Silica, mg/l	86		
Sodium, mg/l	1200		
Potassium, mg/l	980		
Arsenic, mg/l	0.05		
Iron, mg/l	<0.5		
Magnesium, mg/l	0.3		
Manganese, mg/l	<0.2		
Calcium, mg/l	2.2		
Boron, mg/l	3.0		
Vanadium, mg/l	<0.1		
Copper, mg/l	<0.02		
Molybdenum, mg/l	0.1		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Process Water

DATE: Nov. 8, 1978

SAMPLE: A-228-78 Retort 5 10-6-78

LAB NO. DA-124

Total Alkalinity, mg/l as $CaCO_3$	4600	Lithium, mg/l	0.8
Carbonate, mg/l as $CaCO_3$	1300	Zinc, mg/l	0.06
Bicarbonate, mg/l as $CaCO_3$	3300	Aluminum, mg/l	0.05
Total Dissolved Solids, mg/l	1800	Barium, mg/l	1
Total Suspended Solids, mg/l	100	Strontium, mg/l	0.5
Sulfate, mg/l	500	Lead, mg/l	< 0.02
Chloride, mg/l	70	Nickel, mg/l	< 0.02
Fluoride, mg/l	86	Cadmium, mg/l	< 0.02
Phenol, mg/l	8.5	Ammonia, as N, mg/l	---
Nitrate, mg/l	700	Sulfite, mg/l	210
Oil & Grease, mg/l	30		
Silica, mg/l	61		
Sodium, mg/l	1500		
Potassium, mg/l	650		
Arsenic, mg/l	0.02		
Iron, mg/l	< 0.5		
Magnesium, mg/l	0.45		
Manganese, mg/l	< 0.02		
Calcium, mg/l	2.2		
Boron, mg/l	16		
Vanadium, mg/l	< 0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	0.2		

INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Process Water

DATE: December 18, 1978

SAMPLE: A-277-78 Retort 5 11-9-78

LAB NO. DA-176

Total Alkalinity, mg/l as $CaCO_3$	7500	Lithium, mg/l	0.2
Carbonate, mg/l as $CaCO_3$	1600	Zinc, mg/l	0.1
Bicarbonate, mg/l as $CaCO_3$	5900	Aluminum, mg/l	< 0.02
Total Dissolved Solids, mg/l	1300	Barium, mg/l	< 0.5
Total Suspended Solids, mg/l	70	Strontium, mg/l	0.03
Sulfate, mg/l	130	Lead, mg/l	< 0.02
Chloride, mg/l	150	Nickel, mg/l	< 0.02
Fluoride, mg/l	1.8	Cadmium, mg/l	< 0.02
Phenol, mg/l	22	Ammonia, as N, mg/l	2100
Nitrate, mg/l	260	Sulfite, mg/l	30
Oil & Grease, mg/l	9		
Silica, mg/l	13		
Sodium, mg/l	360		
Potassium, mg/l	160		
Arsenic, mg/l	0.04		
Iron, mg/l	< 0.5		
Magnesium, mg/l	0.4		
Manganese, mg/l	0.05		
Calcium, mg/l	1.6		
Boron, mg/l	4.7		
Vanadium, mg/l	< 0.1		
Copper, mg/l	0.05		
Molybdenum, mg/l	< 0.02		

OXY INTER-OFFICE MEMORANDUM

TO: H.S. Skogen

FROM: J. Greer

cc: R.R. Bloom B.A. Romig C. Nieuwenhuis
J.F. Denham R.E. Thomason

PROJECT: Oil Shale

SUBJECT: D.A. Water Analysis
Mine & Process Water

DATE: January 11, 1979

SAMPLE: A-295-78 Retort 5 12-7-78

LAB NO. DA-197

Total Alkalinity, mg/l as $CaCO_3$	1200	Lithium, mg/l	0.2
Carbonate, mg/l as $CaCO_3$	240	Zinc, mg/l	0.02
Bicarbonate, mg/l as $CaCO_3$	1060	Aluminum, mg/l	0.1
Total Dissolved Solids, mg/l	5000	Barium, mg/l	< 0.5
Total Suspended Solids, mg/l	640	Strontium, mg/l	0.2
Sulfate, mg/l	800	Lead, mg/l	< 0.02
Chloride, mg/l	94	Nickel, mg/l	0.02
Fluoride, mg/l	5.3	Cadmium, mg/l	< 0.02
Phenol, mg/l	1.9	Ammonia, as N, mg/l	500
Nitrate, mg/l	220	Sulfite, mg/l	10
Oil & Grease, mg/l	70		
Silica, mg/l	45		
Sodium, mg/l	790		
Potassium, mg/l	69		
Arsenic, mg/l	0.03		
Iron, mg/l	< 0.5		
Magnesium, mg/l	2		
Manganese, mg/l	< 0.02		
Calcium, mg/l	5		
Boron, mg/l	73		
Vanadium, mg/l	< 0.1		
Copper, mg/l	< 0.02		
Molybdenum, mg/l	0.7		

APPENDIX B4

WATER QUALITY ANALYSIS PERFORMED BY
COORS SPECTRO-CHEMICAL LABORATORY

Coors / SPECTRO-CHEMICAL LABORATORY
DIVISION OF COORS PORCELAIN COMPANY
GOLDEN, COLORADO, U.S.A.
303-278-4000 Ext. 2302

Mailing Address:
P.O. Box 500
Golden, Colorado 80401

Analytical Report

CI-1317-A

TO: . Occidental Oil Shale, Inc.
P. O. Box 2687
. Grand Junction, CO 81501

Attention: Carol A. Nieuwenhuis

LABORATORY NUMBER	96541
DATE	1-24-79
CUSTOMER ORDER NO.	AFE 8779-01

Water Samples Received 10-5-78

	Sample I.D.	TOC mg/l	DOC mg/l	Fecal Coliform colonies/ 100 ml	Kjeldahl Nitrogen mg/l	S_2O_3 mg/l	Mercury mg/l	Selenium mg/l
09-01-78	A-175-78 PL-RL-1	49	20	120	4.1	55	< 0.02	< 0.02
09-01-78	A-176-78 LMB-1	38	29	< 1	2.9	52	< 0.02	< 0.02
09-06-78	A-177-78 L.Roan Cr.	24	19	4	2.7	34	< 0.02	0.02
09-06-78	A-178-78 Smith C.	31	20	120	1.4	35	< 0.02	< 0.02
09-06-78	A-184-78 U. Roan Cr.	42	34	7	0.4	40	< 0.02	< 0.02
09-07-78	A-192-78 Riley Gulch	28	19	6	0.4	26	< 0.02	0.02
09-08-78	A-195-78 Room 6	204	188	< 1	39.9	38	< 0.02	0.04
09-08-78	A-196-78 L. Parachute	52	23	2	4.6	60	< 0.02	< 0.02
09-08-78	A-197-78 PL-RL-1	36	33	< 1	1.0	30	< 0.02	0.02
09-08-78	A-198-78 CW-108	192	135	20	2.4	33	< 0.02	0.03
09-08-78	A-201-78 U. Parachute	21	19	< 1	1.9	26	< 0.02	< 0.02

< = Less than

CORRECTION COPY

Coors / SPECTRO-CHEMICAL LABORATORY

BY _____
LABORATORY MANAGER

Coors / SPECTRO-CHEMICAL LABORATORY
DIVISION OF COORS PORCELAIN COMPANY
GOLDEN, COLORADO, U.S.A.
303-278-4000 Ext. 2302

Mailing Address:
P.O. Box 500
Golden, Colorado 80401

Analytical Report

CI-1317-A

TO: . Occidental Oil Shale, Inc.
P.O. Box 2687
. Grand Junction, CO 81501

. Attention: Carol A. Niewenhuis

LABORATORY NUMBER	96544
DATE	12-4-78
CUSTOMER ORDER NO.	AFE 8779-01

Water sampled received 10-5-78

	Sample I.D.	TOC mg/l	DOC mg/l	Fecal Coliform colonies/ 100 ml	Kjeldahl Nitrogen mg/l	S_2O_3 mg/l	Mercury mg/l	Selenium mg/l
9-12-78	A-182-78 (LW101)	46	37	< 1	1.8	19	< 0.02	< 0.02
9-22-78	A-193-78 (R. #6)	886	817	< 1	270	628	< 0.02	0.03
9-12-78	A-194-78 (LW-22)	47	34	2	0.7	23	< 0.02	< 0.02
9-08-78	A-199-78 (AL-N1)	529	498	< 1	17.1	97	< 0.02	< 0.02
9-27-78	A-202-78 (LW-101)	42	41	< 1	3.0	17	< 0.02	0.03
9-12-78	A-203-78 (LW-115)	50	32	9	1.7	36	< 0.02	< 0.02
9-22-78	A-204-78 (LW-108)	155	132	20	3.7	57	< 0.02	< 0.02
9-27-78	A-205-78 (LW-22)	30	28	4	3.5	32	< 0.02	< 0.02
9-27-78	A-206-78 (LW-115)	108	43	5	5.0	20	< 0.02	0.02
9-28-78	A-207-78 (LW-121)	41	38	< 1	5.4	29	< 0.02	< 0.02
9-28-78	A-209-78 U. Roan	50	39	< 1	3.4	27	< 0.02	< 0.02
9-24-78	A-210-78 (R. #6)	1110	986	1	451	748	< 0.02	< 0.02
9-13-78	A-211-78 (LMB-1)	37	36	3	1.8	29	< 0.02	0.02
9-13-78	A-212-78 (LW-102)	22	20	1	1.4	18	< 0.02	0.02
9-29-78	A-216-78 (LW-108	105	99	5	7.8	23	< 0.02	0.03

< = less than

Coors / SPECTRO-CHEMICAL LABORATORY

BY _____
LABORATORY MANAGER

Coors / SPECTRO-CHEMICAL LABORATORY
DIVISION OF COORS PORCELAIN COMPANY
GOLDEN, COLORADO, U.S.A.
303-278-4000 Ext. 2302

Mailing Address:
P.O. Box 500
Golden, Colorado 80401

Analytical Report

CI-1317-A

TO: . Occidental Oil Shale, Inc.

.

.

LABORATORY NUMBER	96544
DATE	12-4-78
CUSTOMER ORDER NO.	AFE-8779-01

Water samples received 10-5-78

Sample I.D.	Total Alpha pCi/l	Total Beta pCi/l	Radium 226 pCi/l
A-182-78	24 ± 5	130 ± 16	2.8 ± 1.9
A-193-78	27 ± 6	54 ± 25	0 ± 1.4
A-194-78	23 ± 4	44 ± 14	0 ± 1.4
A-199-78	27 ± 7	47 ± 23	1.5 ± 2.1
A-202-78	9.2 ± 4.8	71 ± 17	3.6 ± 2.3
A-203-78	26 ± 4	0 ± 15	
A-204-78	33 ± 5	6 ± 17	4.1 ± 2.6
A-205-78	6.1 ± 4.3	0 ± 13	
A-206-78	25 ± 5	0 ± 16	
A-207-78	0 ± 3	0 ± 11	
A-209-78	3.3 ± 3.8	0 ± 10	
A-210-78	0 ± 4	7 ± 12	
A-211-78	20 ± 5	5 ± 20	
A-212-78	10 ± 4	0 ± 10	
A-216-78	16 ± 5	0 ± 16	

Coors / SPECTRO-CHEMICAL LABORATORY

BY _____
LABORATORY MANAGER

Coors / SPECTRO-CHEMICAL LABORATORY
DIVISION OF COORS PORCELAIN COMPANY
GOLDEN, COLORADO, U.S.A.
303-278-4000 Ext. 2302

Mailing Address:
P.O. Box 500
Golden, Colorado 80401

Analytical Report

CI-1317-A

TO: · Occidental Oil Shale, Inc.
P. O. Box 2687
· Grand Junction, CO 81501

· Attention: Carol A. Niewenhuis

LABORATORY NUMBER	96274
DATE	1-5-79
CUSTOMER ORDER NO.	AFE 8779-01

Water Samples Received 9-13-78

	A-162-78 (LW-115 8/15/78)	A-163-78 (not required by permit)	A-164-78 (LW 101 8/15/78)
TOC (mg/l)	73	62	47
DOC (mg/l)	28	28	19
Fecal Coliform (colonies/100 ml)	3	5	3
Nitrogen-Kjeldahl (mg/l)	2.2	3.4	3.8
S_2O_3 (mg/l)	43	37	47
Total Alpha (pCi/l)	15 ± 9	32 ± 10	5.1 ± 6.0
Total Beta (pCi/l)	0 ± 30	30 ± 22	0 ± 30
Radium 226 (pCi/l)		0 ± 0.8	
Mercury (mg/l)	< 0.02	< 0.02	< 0.02
Selenium (mg/l)	< 0.02	0.03	< 0.02

< = Less than

Coors / SPECTRO-CHEMICAL LABORATORY

BY _____
LABORATORY MANAGER

274

Coors / SPECTRO-CHEMICAL LABORATORY
DIVISION OF COORS PORCELAIN COMPANY
GOLDEN, COLORADO, U.S.A.
303-278-4000 Ext. 2302

Mailing Address:
P.O. Box 500
Golden, Colorado 80401

Analytical Report

CI-1317-A

TO: . Occidental Oil Shale, Inc.
P. O. Box 2687
. Grand Junction, CO 81501

. Attention: Carol A. Niewenhuis

LABORATORY NUMBER	96274
DATE	1-5-79
CUSTOMER ORDER NO.	AFE 8779-01

Water Samples Received 9-13-78

	A-165-78 (Sample incomplete)	A-166-78 (LW-108 8/15/78)	A-167-78 (Room 4 8/17/78)
TOC (mg/l)	568	*	1011
DOC (mg/l)	103	*	994
Fecal Coliform (colonies/100 ml)	11	5	2
Nitrogen-Kjeldahl (mg/l)	33.6	5.8	296
S_2O_3 (mg/l)	39	*	788
Total Alpha (pCi/l)	39 ± 9.0	8.4 ± 6.9	0 ± 5.7
Total Beta (pCi/l)	0 ± 30	14 ± 35	0 ± 30
Radium 226 (pCi/l)	1.8 ± 0.9		
Mercury (mg/l)	< 0.02	< 0.02	< 0.02
Selenium (mg/l)	< 0.02	< 0.02	< 0.02

* Sample broken in shipment.

< = Less than

Coors / SPECTRO-CHEMICAL LABORATORY

BY _____
LABORATORY MANAGER

Coors / SPECTRO-CHEMICAL LABORATORY
DIVISION OF COORS PORCELAIN COMPANY
GOLDEN, COLORADO, U.S.A.
303-278-4000 Ext. 2302

Mailing Address:
P.O. Box 500
Golden, Colorado 80401

Analytical Report

CI-1317-A

TO: Occidental Oil Shale, Inc.

LABORATORY NUMBER	96274
DATE	1-5-79
CUSTOMER ORDER NO.	AFE 8779-01

Water Samples Received 9-13-78

	A-169-78 (Room 5 8/17/78)	A-170-78 (LW-103 8/22/78)	A-171-78 (LW-108 8/24/78
TOC (mg/l)	952	48	106
DOC (mg/l)	907	22	39
Fecal Coliform (colonies/100 ml)	2	1	< 1
Nitrogen-Kjeldahl (mg/l)	74	0.6	6.6
S_2O_3 (mg/l)	673	20	40
Total Alpha (pCi/l)	14 ± 9.0	6.1 ± 6.0	59 ± 10
Total Beta (pCi/l)	0 ± 30	0 ± 25	96 ± 40
Radium 226 (pCi/l)			0 ± 0.8
Mercury (mg/l)	< 0.02	< 0.02	< 0.02
Selenium (mg/l)	< 0.02	< 0.02	< 0.02

< = Less than

Coors / SPECTRO-CHEMICAL LABORATORY

BY _____
LABORATORY MANAGER

276

Coors / SPECTRO-CHEMICAL LABORATORY
DIVISION OF COORS PORCELAIN COMPANY
GOLDEN, COLORADO, U.S.A.
303-278-4000 Ext. 2302

Mailing Address:
P.O. Box 500
Golden, Colorado 80401

Analytical Report

CI-1317-A

TO: . Occidental Oil Shale, Inc.

LABORATORY NUMBER	96274
DATE	1-5-79
CUSTOMER ORDER NO.	AFE 8779-01

Water Samples Received 9-13-78

	A-172-78 (LW-102 8/22/78)	A-173-78 (LW-104 8/22/78)	A-174-78 (LIL-N3 8/24/78)
TOC (mg/l)	40	977	53
DOC (mg/l)	22	406	49
Fecal Coliform (colonies/100 ml)	1	1	< 1
Nitrogen-Kjeldahl (mg/l)	1.7	8.4	3.1
S_2O_3 (mg/l)	31	33	37
Total Alpha (pCi/l)	15 ± 6.6	281 ± 17	35 ± 8.1
Total Beta (pCi/l)	0 ± 25	0 ± 30	175 ± 30
Radium 226 (pCi/l)		0.4 ± 0.8	1.4 ± 0.9
Mercury (mg/l)	< 0.02	< 0.02	< 0.02
Selenium (mg/l)	< 0.02	< 0.02	< 0.02

< = Less than

Coors / SPECTRO-CHEMICAL LABORATORY

BY _____
LABORATORY MANAGER

Coors / SPECTRO-CHEMICAL LABORATORY
DIVISION OF COORS PORCELAIN COMPANY
GOLDEN, COLORADO, U.S.A.
303-278-4000 Ext. 2302

Mailing Address:
P.O. Box 500
Golden, Colorado 80401

Analytical Report

CI-1317-A

TO: . Occidental Oil Shale, Inc.

LABORATORY NUMBER	96274
DATE	1-5-79
CUSTOMER ORDER NO.	AFE 8779-01

Water Samples Received 9-13-78

	A-179-78 (Room 6 8/24/78)	A-180-78 (41L-SE-2 8/24/78)	A-181-78 (Room 6 8/31/78)
TOC (mg/l)	34	67	30
DOC (mg/l)	29	29	26
Fecal Coliform (colonies/100 ml)	< 1	< 1	< 1
Nitrogen-Kjeldahl (mg/l)	28.7	3.6	30.6
S_2O_3 (mg/l)	28	43	30
Total Alpha (pCi/l)	72 ± 8.9	14 ± 8.0	0 ± 8.0
Total Beta (pCi/l)	170 ± 40	0 ± 30	0 ± 25
Radium 226 (pCi/l)	5.5 ± 1.9		
Mercury (mg/l)	< 0.02	< 0.02	< 0.02
Selenium (mg/l)	< 0.02	< 0.02	< 0.02

< = Less than

Coors / SPECTRO-CHEMICAL LABORATORY

BY _____
LABORATORY MANAGER

278

Coors / SPECTRO-CHEMICAL LABORATORY
DIVISION OF COORS PORCELAIN COMPANY
GOLDEN, COLORADO, U.S.A.
303-278-4000 Ext. 2302

Mailing Address:
P.O. Box 500
Golden, Colorado 80401

Analytical Report

CI-1317-A

TO: . Occidental Oil Shale, Inc.

LABORATORY NUMBER	96274
DATE	1-5-79
CUSTOMER ORDER NO.	AFE 8779-01

Water Samples Received 9-13-78

	A-183-78 (Room 5 8/24/78)	A-185-78 (Room 4 8/24/78)	A-186-78 (not required by permit)
TOC (mg/l)	798	1232	582
DOC (mg/l)	709	1110	490
Fecal Coliform (colonies/100 ml)	< 1	1	< 1
Nitrogen-Kjeldahl (mg/l)	225	210	64.4
S_2O_3 (mg/l)	670	778	31
Total Alpha (pCi/l)	0 ± 6.1	54 ± 10	0 ± 8.0
Total Beta (pCi/l)	16 ± 25	0 ± 25	0 ± 30
Radium 226 (pCi/l)		4.5 ± 1.8	
Mercury (mg/l)	< 0.02	< 0.02	< 0.02
Selenium (mg/l)	< 0.02	< 0.02	< 0.02

< = Less than

Coors / SPECTRO-CHEMICAL LABORATORY

BY _____
LABORATORY MANAGER

279

Coors / SPECTRO-CHEMICAL LABORATORY
DIVISION OF COORS PORCELAIN COMPANY
GOLDEN, COLORADO, U.S.A.
303-278-4000 Ext. 2302

Mailing Address:
P.O. Box 500
Golden, Colorado 80401

Analytical Report

CI-1317-A

TO: . Occidental Oil Shale, Inc.

.

.

LABORATORY NUMBER	96274
DATE	1-5-79
CUSTOMER ORDER NO.	AFE 8779-01

Water Samples Received 9-13-78

	A-187-78 (LW-10S 8/31/78)	A-188-78 (LW-22 08/29/78)	A-189-78 (L2-PS-1 8/26/78)
TOC (mg/l)	71	108	27
DOC (mg/l)	33	24	18
Fecal Coliform (colonies/100 ml)	47	< 1	< 1
Nitrogen-Kjeldahl (mg/l)	5.4	1.9	3.3
S_2O_3 (mg/l)	32	22	48
Total Alpha (pCi/l)	0 ± 7.2	12 ± 7.7	0 ± 7.2
Total Beta (pCi/l)	0 ± 35	0 ± 25	28 ± 25
Mercury (mg/l)	< 0.02	< 0.02	< 0.02
Selenium (mg/l)	< 0.02	< 0.02	< 0.02

< = Less than

Coors / SPECTRO-CHEMICAL LABORATORY

BY _____
LABORATORY MANAGER

280

Coors / SPECTRO-CHEMICAL LABORATORY
DIVISION OF COORS PORCELAIN COMPANY
GOLDEN, COLORADO, U.S.A.
303-278-4000 Ext. 2302

Mailing Address:
P.O. Box 500
Golden, Colorado 80401

Analytical Report

CI-1317-A

TO: . Occidental Oil Shale, Inc.

LABORATORY NUMBER	96274
DATE	1-5-79
CUSTOMER ORDER NO.	AFE 8779-01

Water Samples Received 9-13-78

	A-190-78 (LIL-SW-1 8/29/78)	A-191-78 (L2-PS-2 8/26/78)
TOC (mg/l)	42	34
DOC (mg/l)	33	18
Fecal Coliform (colonies/100 ml)	1	< 1
Nitrogen-Kjeldahl (mg/l)	18.2	2.1
S_2O_3 (mg/l)	82	22
Total Alpha (pCi/l)	0 ± 6.1	39 ± 8.4
Total Beta (pCi/l)	0 ± 20	39 ± 26
Radium 226 (pCi/l)		0 ± 0.8
Mercury (mg/l)	< 0.02	< 0.02
Selenium (mg/l)	< 0.02	< 0.02

< = Less than

Coors / SPECTRO-CHEMICAL LABORATORY

BY _____
LABORATORY MANAGER

Coors / SPECTRO-CHEMICAL LABORATORY
DIVISION OF COORS PORCELAIN COMPANY
GOLDEN, COLORADO, U.S.A.
303-278-4000 Ext. 2302

Mailing Address:
P.O. Box 500
Golden, Colorado 80401

Analytical Report

CI-1317-A

TO: . Occidental Oil Shale, Inc.
P. O. Box 2687
. Grand Junction, CO 81501

. Attention: Carol A. Niewenhuis

LABORATORY NUMBER	96829
DATE	1-5-79
CUSTOMER ORDER NO.	AFE 8779-01

Water Samples Received 11-1-78

	A-213 (Room 6 10/05/78)	A-215 (Lab-108 10/4/78)	A-217 (Room 4 10/06/78)
TOC (mg/l)	949	158	297
DOC (mg/l)	496	94	164
Nitrogen-Kjeldahl (mg/l)	588	5.4	380
S_2O_3 (mg/l)	107	23	201
Total Alpha (pCi/l)	48 ± 18	22 ± 11	0 ± 3.5
Total Beta (pCi/l)	0 ± 16	13 ± 18	0 ± 16
Radium 226 (pCi/l)	0.4 ± 1.4	0.4 ± 0.8	
Fecal Coliform (colonies/100 ml)	< 1	< 1	< 1
Mercury (mg/l)	< 0.02	< 0.02	< 0.02
Selenium (mg/l)	< 0.02	< 0.02	< 0.02

< = Less than

Coors / SPECTRO-CHEMICAL LABORATORY

BY _____
LABORATORY MANAGER

282

Coors / SPECTRO-CHEMICAL LABORATORY
DIVISION OF COORS PORCELAIN COMPANY
GOLDEN, COLORADO, U.S.A.
303-278-4000 Ext. 2302

Mailing Address:
P.O. Box 500
Golden, Colorado 80401

Analytical Report

CI-1317-A

TO: Occidental Oil Shale, Inc.

LABORATORY NUMBER	96829
DATE	1-5-79
CUSTOMER ORDER NO.	AFE 8779-01

Water Samples Received 11-1-78

	A-218 (LW-32 10/4/78)	A-225 (LIL-SW-1 10/11/78)	A-226 (LIL-SE-2 10/11/78)
TOC (mg/l)	67	672	28
DOC (mg/l)	26	31	23
Nitrogen-Kjeldahl (mg/l)	0.7	10.1	1.7
S_2O_3 (mg/l)	12	14	7
Total Alpha (pCi/l)	0 ± 2.7	19 ± 11	0 ± 5.3
Total Beta (pCi/l)	37 ± 12	28 ± 13	4 ± 14
Radium 226 (pCi/l)	0.4 ± 1.4	1.0 ± 1.6	
Fecal Coliform (colonies/100 ml)	< 1	< 1	< 1
Mercury (mg/l)	< 0.02	< 0.02	< 0.02
Selenium (mg/l)	< 0.02	< 0.02	< 0.02

< = Less than

Coors / SPECTRO-CHEMICAL LABORATORY

BY _____
LABORATORY MANAGER

Coors / SPECTRO-CHEMICAL LABORATORY
DIVISION OF COORS PORCELAIN COMPANY
GOLDEN, COLORADO, U.S.A.
303-278-4000 Ext. 2302

Mailing Address:
P.O. Box 500
Golden, Colorado 80401

Analytical Report

CI-1317-A

TO: Occidental Oil Shale, Inc.

LABORATORY NUMBER	96829
DATE	1-5-79
CUSTOMER ORDER NO.	AFE 8779-01

Water Samples Received 11-1-78

	A-227 (LIL-N3 10/11/78)	A-228 (Room 5 10/06/78)	A-229 (L2-PS-2 10/11/78)
TOC (mg/l)	41	460	46
DOC (mg/l)	21	326	41
Nitrogen-Kjeldahl (mg/l)	2.8	197	3.7
S_2O_3 (mg/l)	6	20	5
Total Alpha (pCi/l)	0 ± 2.4	3.0 ± 4.6	30 ± 12
Total Beta (pCi/l)	108 ± 39	7 ± 17	0 ± 17
Radium 226 (pCi/l)	0.5 ± 0.8		
Fecal Coliform (colonies/100 ml)	< 1	< 1	< 1
Mercury (mg/l)	< 0.02	< 0.02	< 0.02
Selenium (mg/l)	< 0.02	< 0.02	< 0.02

< = Less than

Coors / SPECTRO-CHEMICAL LABORATORY

BY _____
LABORATORY MANAGER

Coors / SPECTRO-CHEMICAL LABORATORY
DIVISION OF COORS PORCELAIN COMPANY
GOLDEN, COLORADO, U.S.A.
303-278-4000 Ext. 2302

Mailing Address:
P.O. Box 500
Golden, Colorado 80401

Analytical Report

CI-1317-A

TO: . Occidental Oil Shale, Inc.

LABORATORY NUMBER	96829
DATE	1-5-79
CUSTOMER ORDER NO.	AFE 8779-01

Water Samples Received 11-1-78

	A-232 (L-2-PS-1 10/11/78)	A-233 (LW 101 10/17/78)	A-235 (U. Ruan 10/17/78)
TOC (mg/l)	25	31	17
DOC (mg/l)	20	26	14
Nitrogen-Kjeldahl (mg/l)	3.0	3.5	1.8
S_2O_3 (mg/l)	7	6	6
Total Alpha (pCi/l)	10 ± 7.1	10 ± 6.3	8.8 ± 5.3
Total Beta (pCi/l)	44 ± 22	75 ± 48	0 ± 14
Radium 226 (pCi/l)	1.3 ± 1.7	1.6 ± 1.9	
Fecal Coliform (colonies/100 ml)	< 1	< 1	< 1
Mercury (mg/l)	< 0.02	< 0.02	< 0.02
Selenium (mg/l)	< 0.02	< 0.02	< 0.02

< = Less than

Coors / SPECTRO-CHEMICAL LABORATORY

BY _____
LABORATORY MANAGER

285

ARY - Customer Files

Coors / SPECTRO-CHEMICAL LABORATORY
DIVISION OF COORS PORCELAIN COMPANY
GOLDEN, COLORADO, U.S.A.
303-278-4000 Ext. 2302

Mailing Address:
P.O. Box 500
Golden, Colorado 80401

Analytical Report

CI-1317-A

TO: Occidental Oil Shale, Inc.

LABORATORY NUMBER	96829
DATE	1-5-79
CUSTOMER ORDER NO.	AFE 8779-01

Water Samples Received 11-1-78

	A-236 (Riley Gulch 10/18/78)	A-238 (LW-22 10/17/78)	A-239 (LW-108 10/12/78)
TOC (mg/l)	15	14	134
DOC (mg/l)	13	12	65
Nitrogen-Kjeldahl (mg/l)	1.5	1.7	8.1
S_2O_3	8	4	7
Total Alpha (pCi/l)	37 ± 14	20 ± 10	6.0 ± 6.4
Total Beta (pCi/l)	17 ± 17	0 ± 11	145 ± 55
Radium 226 (pCi/l)	2.0 ± 1.8		2.6 ± 2.0
Fecal Coliform (colonies/100 ml)	< 1	< 1	< 1
Mercury (mg/l)	< 0.02	< 0.02	< 0.02
Selenium (mg/l)	< 0.02	< 0.02	< 0.02

< = Less than

Coors / SPECTRO-CHEMICAL LABORATORY

BY _____
LABORATORY MANAGER

286

Coors / SPECTRO-CHEMICAL LABORATORY
DIVISION OF COORS PORCELAIN COMPANY
GOLDEN, COLORADO, U.S.A.
303-278-4000 Ext. 2302

Mailing Address:
P.O. Box 500
Golden, Colorado 80401

Analytical Report

CI-1317-A

TO: . Occidental Oil Shale, Inc.

LABORATORY NUMBER	96829
DATE	1-5-79
CUSTOMER ORDER NO.	AFE 8779-01

Water Samples Received 11-1-78

	A-241 (LW-115 10/17/78)	A-242 (L. Rean 10/17/78)	A-245 (Room 6 10/20/78)
TOC (mg/l)	45	17	1235
DOC (mg/l)	44	12	1073
Nitrogen-Kjeldahl (mg/l)	3.4	1.5	2.8
S_2O_3 (mg/l)	6	5	111
Total Alpha (pCi/l)	5.0 ± 4.3	5.4 ± 6.3	24 ± 13
Total Beta (pCi/l)	84 ± 27	0 ± 10	0 ± 13
Radium 226 (pCi/l)	1.6 ± 0.8		
Fecal Coliform (colonies/100 ml)	< 1	< 1	< 1
Mercury (mg/l)	< 0.02	< 0.02	< 0.02
Selenium (mg/l)	< 0.02	< 0.02	< 0.02

< = Less than

Coors / SPECTRO-CHEMICAL LABORATORY

BY _____
LABORATORY MANAGER

287

APPENDIX B5

PARTICULATE MATTER

DATE	PARTICULATES
1-11	Field Damage
1-18	Field Damage
2-1	2.95 $\mu g/m^3$
2-8	1.20 $\mu g/m^3$
2-16	1.16 $\mu g/m^3$
2-22	3.71 $\mu g/m^3$
3-15	2.90 $\mu g/m^3$
3-22	3.10 $\mu g/m^3$
4-12	3.93 $\mu g/m^3$
4-19	3.52 $\mu g/m^3$
4-22	13.59 $\mu g/m^3$
4-29	3.41 $\mu g/m^3$
5-10	6.97 $\mu g/m^3$
5-18	4.56 $\mu g/m^3$
5-24	21.084$\mu g/m^3$
6-1	4.91 $\mu g/m^3$
6-7	6.63 $\mu g/m^3$

APPENDIX B6

METEOROLOGICAL TOWER WIND -
FREQUENCY TABLES - 30 METER LEVEL

FREQUENCY TABLE OF WIND SPEED BY DIRECTION

PERIOD (6 / 1 /75 to 8 /31 /75)

STATION L-W MET LEVEL 30m

WIND DIRECTION

WIND SPEED INTERVAL (MP)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
GT 16							1	1	2	1							5
12-16	4	4	7	1	2		5	2	32	4							61
7-12	66	26	16	12	9	12	28	56	149	34		1	1		11	21	442
4-7	71	22	13	17	28	48	79	107	189	138	16	2	4	8	35	85	862
1-4	52	13	11	8	34	38	47	74	137	140	49	25	36	24	66	90	844
LT 1					1							1	1	1	1		5
TOTAL	193	65	47	38	74	98	160	240	509	317	65	29	42	33	113	196	2219
PERCENT	9	3	2	2	3	4	7	11	23	14	3	1	2	1	5	9	2231
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL

12 - Calms = 1%

FREQUENCY TABLE OF WIND SPEED BY DIRECTION

PERIOD (3 / 1 /77 to 5 /31 /77)

STATION L-W MET LEVEL 30m

WIND DIRECTION

WIND SPEED INTERVAL (MPS)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
GT 16						1			4	28							33
12-16	7	7		1				2	13	65	2						97
7-12	53	35	4	3	5	9	11	36	130	101	24		2		1	1	451
4-7	91	37	7	9	14	15	26	59	99	104	46	12		1	7	18	545
1-4	88	21	7	7	27	13	17	44	75	71	57	18	2	4	8	17	476
LT 1.	9	1	2		6	2		5	5	4	1	3	2	6		2	48
TOTAL	248	101	20	20	52	40	54	146	326	409	130	33	6	11	16	38	1650
PERCENT	14	6	1	1	3	2	3	8	18	22	7	2	0	1	1	2	1835
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL

185 Calms = 10%

FREQUENCY TABLE OF WIND SPEED BY DIRECTION

PERIOD (12/ 1 /77to 2 / 28/78)

STATION L-W MET LEVEL 30m

WIND DIRECTION

WIND SPEED INTERVAL (MPS)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
GT 16					2					6							8
12-16		1		1	5		1	11	18	3							40
7-12	3	8	5	12	12	13	41	156	125	17			1				393
4-7	4	3	4	19	43	31	38	121	81	5	3	1	2			1	356
1-4	12	2	2	3	8	18	17	74	143	20	4	2	3	2	5	5	320
LT 1	1		1	1	1	1	1	13	19	6							44
TOTAL	20	14	12	36	71	63	98	375	386	57	7	3	6	2	5	6	1161
PERCENT	2	1	1	3	6	5	8	31	32	5	1	0	0	0	0	0	1207
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL

46 Calms = 4%

FREQUENCY TABLE OF WIND SPEED BY DIRECTION

PERIOD (9 /21/78 to 11/30/78)

STATION L-W MET LEVEL 30m

WIND DIRECTION

	WIND SPEED INTERVAL (MPS)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
GT	> 16							1	5	7								13
	12-16	8	3	1		2	2	5	17	23	1							62
	7-12	55	13	5	5	16	27	61	41	47	3					5	9	287
	4-7	39	5	4	8	17	31	54	73	57	35	1	2	3	11	23	48	411
	1-4	14	8	1	2	13	18	24	12	31	23	11	11	11	10	14	22	225
LT	1.													1				1
	TOTAL	116	29	11	15	48	78	145	148	165	62	12	13	15	21	42	79	999
	PERCENT	12	3	1	2	5	8	15	15	16	6	1	1	2	2	4	8	
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL

APPENDIX B7

METEOROLOGICAL TOWER DATA

LOCATIONS OF METEOROLOGICAL AND HYDROLOGICAL MONITORING INSTALLATIONS FEBRUARY 1979

LEGEND

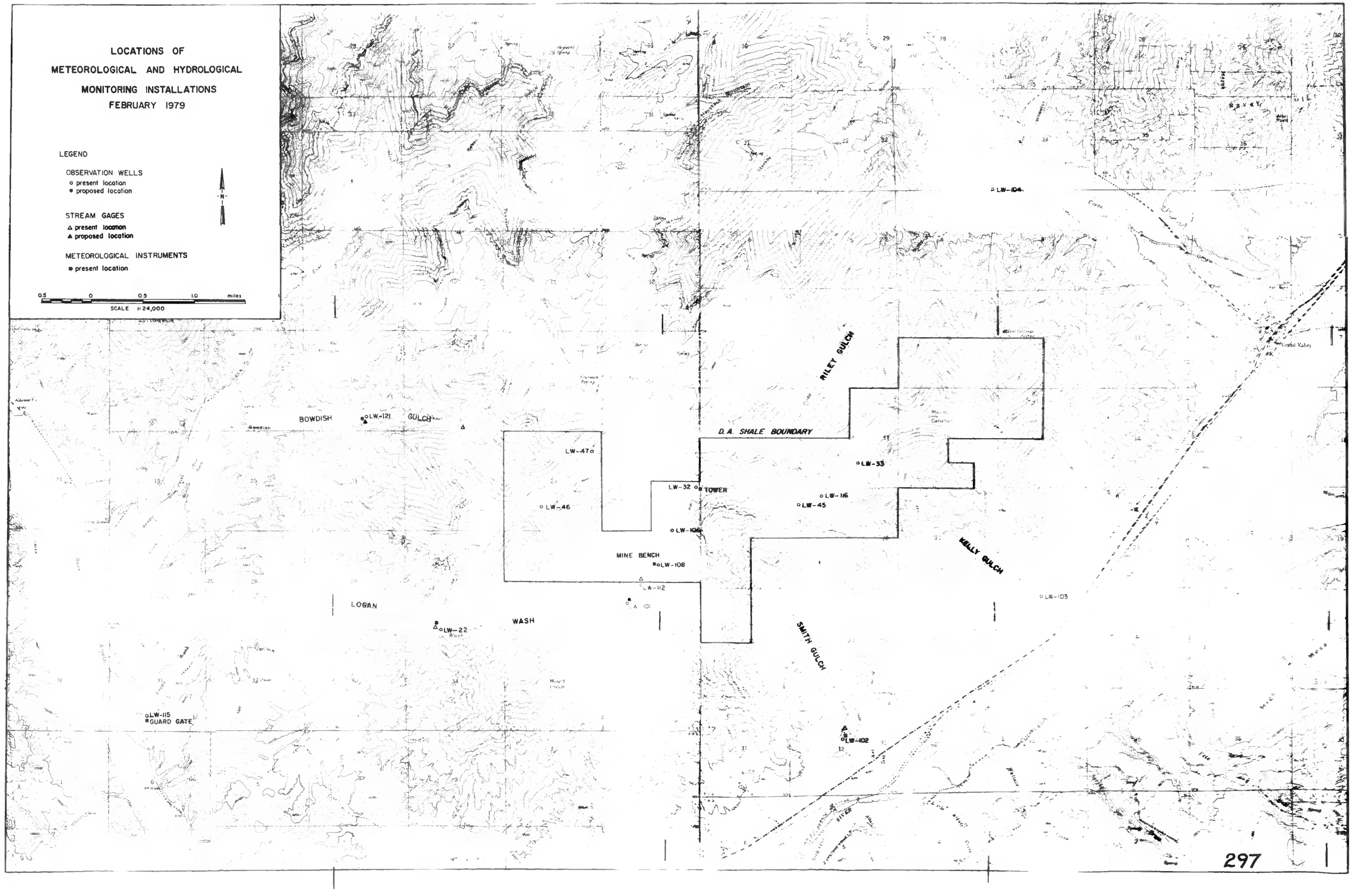
OBSERVATION WELLS
- o present location
- • proposed location

STREAM GAGES
- △ present location
- ▲ proposed location

METEOROLOGICAL INSTRUMENTS
- ■ present location

0.5 0 0.5 1.0 miles

SCALE 1:24,000



METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/8/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				
10-11				
11-12				
12-13				
13-14				-2.5
14-15	240	30	14	-2.0
15-16	250	30	14	-2.0
16-17	240	31	12	-1.0
17-18	240	36	10	-0.5
18-19	240	24	10	0
19-20	240	20	9	0
20-21	260	22	8	0
21-22	255	23	7	+0.5
22-23	250	22	6	+0.5
23-24	250	20	6	+0.5

DATE: 11/9/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	240	12	4	+1.5
1-2	255	6	2	+2.0
2-3	270	8	2	+2.5
3-4	260	9	3	+2.0
4-5	270	8	2	+3.0
5-6	260	6	2	+3.0
6-7	270	4	2	+1.0
7-8	110	3	10	-2.5
8-9	75	7	20	-5.0
9-10	75	9	22	-10.0
10-11	70	10	22	-8.0
11-12	70	10	24	-11.0
12-13	80	12	24	-10.0
13-14	80	10	25	-9.0
14-15	90	10	22	-7.0
15-16	90	10	20	-3.5
16-17	90	11	18	-2.0
17-18	90	8	14	0
18-19	110	10	14	+1.0
19-20	120	12	15	+1.0
20-21	135	13	18	0
21-22	130	13	16	0
22-23	120	13	18	+0.5
23-24	120	10	18	+1.0

M-missing data D-doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/10/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	110	10	16	+1.0
1-2	125	12	18	+0.5
2-3	120	10	18	+0.5
3-4	120	10	16	+1.0
4-5	130	10	16	+2.5
5-6	110	8	18	+3.0
6-7	120	9	18	+2.5
7-8	130	11	23	+1.0
8-9	180	6	30	-1.5
9-10	120	8	28	-3.0
10-11	120	10	28	-3.0
11-12	210	6	30	-2.5
12-13	220	8	33	-2.5
13-14	225	7	34	-2.5
14-15	240	3	34	-1.5
15-16	270	2	36	-1.0
16-17	280	2	35	+0.5
17-18	300	2	34	+0.5
18-19	160	5	34	+1.0
19-20	180	6	34	+1.5
20-21	185	8	36	+1.5
21-22	180	8	36	+2.0
22-23	180	6	34	+2.0
23-24	195	4	35	+2.5

DATE: 11/11/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	180	2	33	+2.5
1-2	210	2	30	+5.0
2-3	250	2	30	+5.0
3-4	210	3	32	+5.0
4-5	255	4	31	+7.0
5-6	270	4	31	+5.5
6-7	360	6	30	+4.5
7-8	30	5	32	+3.5
8-9	180	2	37	+2.0
9-10	120	3	40	-2.0
10-11	150	7	46	-3.5
11-12	210	6	44	-2.5
12-13	225	6	44	-2.5
13-14	220	7	46	-2.0
14-15	230	9	42	-2.0
15-16	250	10	40	0
16-17	225	14	40	+0.5
17-18	210	14	39	+1.0
18-19	190	14	38	+1.5
19-20	180	17	38	+1.0
20-21	195	18	38	+1.0
21-22	210	17	38	+1.0
22-23	220	18	38	+1.0
23-24	210	21	37	+1.5

M-missing data D-doubtful data

DATE: 11/12/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	210	21	37	+1.0
1-2	210	20	38	+0.5
2-3	200	18	38	+1.0
3-4	200	18	38	+1.0
4-5	210	17	38	+0.5
5-6	210	14	38	+0.5
6-7	200	14	38	+0.5
7-8	205	15	38	+0.5
8-9	225	15	39	-0.5
9-10	220	15	44	-3.0
10-11	220	14	45	-3.5
11-12	210	14	46	-3.5
12-13	200	10	46	-3.5
13-14	225	8	46	-2.5
14-15	210	10	45	-2.5
15-16	210	10	42	-1.5
16-17	230	10	41	0
17-18	235	11	39	+2.0
18-19	240	10	38	+1.5
19-20	240	10	38	+1.5
20-21	250	10	38	+1.5
21-22	250	10	39	+2.0
22-23	260	10	38	+2.5
23-24	255	10	38	+2.5

DATE: 11/13/77

0-1	260	11	38	+1.5
1-2	210	10	38	+2.0
2-3	180	6	37	+2.5
3-4	180	6	38	+1.0
4-5	180	5	38	+1.0
5-6	180	6	35	+2.5
6-7	150	4	34	+5.0
7-8	180	4	42	-0.5
8-9	270	2	38	0
9-10	160	5	45	-2.5
10-11	175	7	49	-4.0
11-12	180	10	50	-
12-13	210	10	50	-3.0
13-14	210	14	49	-3.0
14-15	225	14	46	-1.0
15-16	225	14	43	-1.5
16-17	220	15	42	-1.5
17-18	230	16	41	-1.5
18-19	220	17	40	+1.0
19-20	210	20	40	+1.0
20-21	220	20	39	+1.5
21-22	210	18	38	+1.0
22-23	210	18	38	+1.0
23-24	240	18	38	+0.5

M=missing data D=doubtful data

DATE: 11/14/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	240	16	38	+0.5
1-2	240	15	37	+0.5
2-3	230	15	36	+1.0
3-4	240	13	35	+0.5
4-5	250	14	34	+0.5
5-6	250	12	34	+1.0
6-7	240	10	33	+1.0
7-8	220	9	36	-1.5
8-9	210	8	38	-2.0
9-10	240	6	40	-2.5
10-11	225	6	42	-2.0
11-12	165	6	42	-3.0
12-13	160	8	44	-5.0
13-14	165	12	44	-6.5
14-15	190	10	42	-2.5
15-16	180	10	41	-2.0
16-17	210	10	38	0
17-18	260	13	37	+0.5
18-19	225	10	38	0
19-20	270	9	38	+0.5
20-21	285	7	38	+0.5
21-22	280	4	38	0
22-23	300	10	37	0
23-24	330	8	35	+0.5

DATE: 11/15/77

0-1	290	6	34	+1.0
1-2	270	6	34	+1.0
2-3	300	8	34	+1.0
3-4	270	3	33	+1.0
4-5	240	4	33	+0.5
5-6	330	9	32	+0.5
6-7	360	10	31	+1.5
7-8	320	4	31	+0.5
8-9	210	1	30	-1.0
9-10	215	8	34	-2.5
10-11	210	12	36	-3.5
11-12	180	10	35	-4.5
12-13	150	10	35	-5.0
13-14	150	12	39	-6.5
14-15	165	15	39	-5.5
15-16	170	12	36	-2.0
16-17	180	13	34	0
17-18	210	10	31	+0.5
18-19	240	12	31	+0.5
19-20	240	17	32	+0.5
20-21	240	18	31	+0.5
21-22	240	17	30	+0.5
22-23	235	19	30	+0.5
23-24	240	20	30	+0.5

M=missing data D=doubtful data

300

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/16/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	250	20	30	+0.5
1-2	240	13	30	+0.5
2-3	240	10	30	+0.5
3-4	240	14	30	+0.5
4-5	195	10	30	+0.5
5-6	225	11	27	+0.5
6-7	230	14	26	+1.5
7-8	210	10	30	-1.5
8-9	210	14	34	-2.5
9-10	220	16	36	-3.5
10-11	210	18	38	-4.0
11-12	190	16	40	-5.0
12-13	195	20	40	-4.5
13-14	190	25	39	-3.0
14-15	190	24	38	-2.0
15-16	190	23	38	-1.0
16-17	200	16	36	0
17-18	210	14	34	+0.5
18-19	220	16	34	+0.5
19-20	225	18	34	+0.5
20-21	220	16	34	+0.5
21-22	No Data	14	34	+0.5
22-23	No Data	16	34	+0.5
23-24	No Data	12	35	+0.5

DATE: 11/17/77

0-1	No Data	18	34	+0.5
1-2	No Data	15	34	+0.5
2-3	No Data	14	34	+0.5
3-4	No Data	15	34	0
4-5	No Data	7	32	+0.5
5-6	No Data	8	31	+0.5
6-7	No Data	6	31	+0.5
7-8	No Data	3	30	0
8-9	No Data	3	36	-2.5
9-10	No Data	6	38	-2.0
10-11	No Data	9	35	-1.5
11-12	210	12	34	-1.5
12-13	200	14	34	-1.0
13-14	210	10	34	-1.0
14-15	210	10	34	-1.0
15-16	195	16	34	-1.0
16-17	200	17	34	0
17-18	210	16	34	+0.5
18-19	220	18	34	+0.5
19-20	210	16	34	+0.5
20-21	200	20	36	0
21-22	200	19	36	0
22-23	180	24	36	0
23-24	180	20	35	0

M=missing data D=doubtful data

301

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/18/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	180	25	35	0
1-2	175	24	35	0
2-3	180	20	35	0
3-4	180	20	35	0
4-5	190	18	34	0
5-6	190	20	34	0
6-7	185	20	34	0
7-8	195	22	33	0
8-9	185	30 - 58	31	0
9-10	180	25	30	-0.5
10-11	160	21	30	-0.5
11-12	150	23	30	-0.5
12-13	150	21	30	-1.0
13-14	150	20	33	-0.5
14-15	150	25	33	-0.5
15-16	160	21	32	-0.5
16-17	150	18	32	0
17-18	165	20	33	0
18-19	165	16	34	0
19-20	165	26	35	0
20-21	170	24	34	0
21-22	170	28	34	0
22-23	160	28	35	0
23-24	170	30	34	0

DATE: 11/19/77

0-1	170	30 - 56	34	0
1-2	150	24 - 58	33	0
2-3	180	32 - 62	31	-0.5
3-4	180	30	30	-0.5
4-5	180	30	30	0
5-6	160	30 - 56	30	0
6-7	155	34 - 58	30	0
7-8	155	36 - 58	30	-0.5
8-9	150	40 - 68	30	-0.5
9-10	150	40 - 69	30	-0.5
10-11	180	44 - 78	31	-0.5
11-12	150	34	27	-1.0
12-13	180	40 - 81	24	-1.0
13-14	180	30 - 72	26	-0.5
14-15	220	32 - 64	24	-1.0
15-16	230	28	24	-1.0
16-17	300	22	17	-0.5
17-18	280	14	17	-0.5
18-19	190	4	16	0
19-20	180	10	14	0
20-21	150	14	16	-0.5
21-22	180	10	14	-0.5
22-23	180	7	14	-0.5
23-24	220	5	10	0

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/20/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	220	6	7	0
1-2	210	6	6	-0.5
2-3	240	6	6	-0.5
3-4	200	6	4	-0.5
4-5	190	10	2	0
5-6	195	10	2	0
6-7	210	9	2	0
7-8	200	8	2	-1.5
8-9	190	8	6	-2.5
9-10	200	9	6	-3.0
10-11	180	9	9	-4.0
11-12	150	10	10	-5.0
12-13	140	10	10	-5.0
13-14	180	8	10	-2.5
14-15	195	12	10	-2.0
15-16	210	15	8	-0.5
16-17	220	14	8	0
17-18	235	14	6	+0.5
18-19	210	14	6	+0.5
19-20	200	19	6	+2.5
20-21	200	20	8	+2.0
21-22	190	20	10	+1.5
22-23	180	21	11	+1.0
23-24	175	20	11	+1.5

DATE: 11/21/77

0-1	170	24	13	+1.5
1-2	170	26	14	+1.0
2-3	165	28	16	+1.0
3-4	170	27	17	+0.5
4-5	170	28	18	+0.5
5-6	165	27	18	0
6-7	170	28	19	0
7-8	170	26	20	0
8-9	170	25	20	-0.5
9-10	165	30	22	-1.0
10-11	160	30	24	-1.5
11-12	160	30	24	-1.0
12-13	170	31	26	-1.0
13-14	180	30	26	-0.5
14-15	180	30	26	-0.5
15-16	180	30	26	0
16-17	175	26	25	0
17-18	170	27	26	+0.5
18-19	180	28	24	+0.5
19-20	180	30	25	0
20-21	170	30	25	0
21-22	180	30	25	0
22-23	180	28	25	0
23-24	185	26	25	0

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/22/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	180	26	26	+0.5
1-2	180	28	26	0
2-3	180	27	26	0
3-4	180	25	26	0
4-5	170	25	26	-0.5
5-6	170	25	24	0
6-7	170	24	26	0
7-8	180	26	26	0
8-9	180	25	24	-0.5
9-10	180	22	24	-0.5
10-11	190	18	25	-1.0
11-12	180	18	26	-1.0
12-13	180	20	28	-1.0
13-14	180	20	30	-2.0
14-15	180	20	30	-1.5
15-16	180	20	29	-1.5
16-17	200	18	27	0
17-18	210	17	26	0
18-19	200	17	26	+0.5
19-20	200	17	26	+0.5
20-21	200	16	26	+0.5
21-22	210	18	26	+0.5
22-23	200	16	26	+0.5
23-24	190	22	26	+0.5

DATE: 11/23/77

0-1	180	20	27	+0.5
1-2	180	20	26	+0.5
2-3	180	20	26	0
3-4	190	20	26	0
4-5	200	20	27	0
5-6	210	24	26	0
6-7	210	14	25	0
7-8	240	10	24	0
8-9	260	7	23	0
9-10	270	6	26	-0.5
10-11	270	8	26	-1.0
11-12	280	6	26	-1.0
12-13	270	8	26	-1.0
13-14	120	6	26	-2.5
14-15	150	4	26	-1.5
15-16	170	4	27	-2.0
16-17	190	7	26	0
17-18	180	9	25	0
18-19	180	10	25	0
19-20	180	10	24	+0.5
20-21	190	17	24	+0.5
21-22	170	20	24	+0.5
22-23	190	20	24	0
23-24	180	16	23	+0.5

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/24/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	180	19	23	+0.5
1-2	210	20	22	0
2-3	210	17	23	0
3-4	210	18	23	0
4-5	200	18	24	0
5-6	200	20	23	0
6-7	210	20	23	0
7-8	200	24	24	0
8-9	220	20	25	0
9-10	220	20	27	-1.0
10-11	230	22	29	-1.0
11-12	230	24	30	-1.5
12-13	230	20	30	-1.0
13-14	210	18	30	-1.5
14-15	210	16	30	-1.0
15-16	240	20	30	-0.5
16-17	210	18	28	0
17-18	230	20	28	0
18-19	220	20	30	0
19-20	220	18	30	0
20-21	220	16	30	0
21-22	230	17	30	0
22-23	230	16	30	0
23-24	220	14	30	0

DATE: 11/25/77

0-1	240	8	30	+0.5
1-2	210	7	30	+0.5
2-3	240	7	30	+1.5
3-4	250	10	30	+2.0
4-5	270	14	30	+1.0
5-6	240	20	30	+0.5
6-7	240	20	31	+0.5
7-8	240	16	32	0
8-9	230	18	34	-0.5
9-10	240	18	37	-2.0
10-11	240	16	38	-2.0
11-12	220	14	38	-2.5
12-13	240	16	38	-2.5
13-14	220	12	37	-1.0
14-15	230	16	36	-0.5
15-16	240	19	35	-1.0
16-17	240	20	35	0
17-18	230	18	34	0
18-19	240	20	34	+0.5
19-20	230	20	34	+0.5
20-21	230	18	34	+0.5
21-22	230	20	34	+0.5
22-23	225	17	36	+0.5
23-24	225	16	35	+0.5

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/26/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	220	18	35	+0.5
1-2	220	20	35	+0.5
2-3	220	16	34	+1.0
3-4	210	15	34	+1.0
4-5	210	16	34	+0.5
5-6	190	18	34	+1.0
6-7	200	18	35	+1.0
7-8	200	23	35	0
8-9	200	22	35	0
9-10	195	20	36	-0.5
10-11	190	16	40	-2.5
11-12	180	11	40	-5.0
12-13	180	12	40	-5.0
13-14	210	12	38	-2.5
14-15	230	11	40	-2.0
15-16	260	16	38	-0.5
16-17	270	18	36	0
17-18	270	16	35	+0.5
18-19	270	23	34	+0.5
19-20	270	24	32	+0.5
20-21	320	16	30	+0.5
21-22	300	20	29	+0.5
22-23	300	13	27	+0.5
23-24	290	11	27	+2.0

DATE: 11/27/77

0-1	360	6	26	+1.0
1-2	30	6	26	+1.0
2-3	270	5	26	+0.5
3-4	360	10	26	+2.0
4-5	180	2	27	+0.5
5-6	180	10	27	+1.0
6-7	180	10	28	+0.5
7-8	180	10	28	0
8-9	210	10	29	0
9-10	240	14	27	-0.5
10-11	270	10	26	-0.5
11-12	180	8	26	-1.0
12-13	150	4	26	-2.0
13-14	210	10	26	-0.5
14-15	170	8	26	-1.0
15-16	160	8	26	-1.0
16-17	160	8	26	-0.5
17-18	180	8	26	-0.5
18-19	210	8	26	-0.5
19-20	210	4	26	-0.5
20-21	180	6	26	-0.5
21-22	220	10	26	-0.5
22-23	220	10	26	-0.5
23-24	270	10	26	-0.5

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/28/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	310	8	26	-0.5
1-2	330	8	25	-0.5
2-3	300	6	24	0
3-4	330	10	23	-0.5
4-5	330	6	22	0
5-6	280	4	22	0
6-7	290	4	22	0
7-8	280	8	22	-0.5
8-9	270	6	22	-0.5
9-10	270	4	24	-0.5
10-11	300	4	26	-0.5
11-12	90	2	24	-0.5
12-13	360	6	24	-1.0
13-14	360	6	25	-2.0
14-15	360	8	24	-1.0
15-16	360	4	22	-0.5
16-17	330	8	22	0
17-18	350	16	22	-0.5
18-19	340	14	21	0
19-20	360	18	20	0
20-21	360	16	20	0
21-22	360	14	20	0
22-23	360	14	20	0
23-24	360	13	19	0

DATE: 11/29/77

0-1	360	12	18	+0.5
1-2	360	10	18	+1.0
2-3	360	6	18	+1.0
3-4	90	4	18	+0.5
4-5	100	8	18	+2.5
5-6	150	6	18	+1.0
6-7	170	8	18	+0.5
7-8	180	8	20	0
8-9	180	9	18	-1.0
9-10	185	10	21	-1.5
10-11	200	14	20	-2.0
11-12	190	18	22	-2.0
12-13	185	20	21	-1.0
13-14	200	18	20	-0.5
14-15	200	15	21	-0.5
15-16	210	14	21	0
16-17	210	18	22	0
17-18	220	17	22	0
18-19	210	16	22	0
19-20	200	14	22	+0.5
20-21	215	16	22	0
21-22	200	14	22	0
22-23	210	10	22	0
23-24	210	11	22	0

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/30/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	210	14	22	0
1-2	240	10	22	+0.5
2-3	260	11	20	+2.5
3-4	270	10	20	+1.0
4-5	270	14	20	+0.5
5-6	320	17	22	+0.5
6-7	330	18	20	+0.5
7-8	350	16	18	0
8-9	340	24	20	-1.0
9-10	360	20	22	-2.0
10-11	360	8	22	-2.5
11-12	310	7	23	-1.5
12-13	180	6	22	-1.0
13-14	270	10	23	-0.5
14-15	300	10	22	0
15-16	180	5	22	-0.5
16-17	200	4	21	0
17-18	180	5	21	0
18-19	270	6	21	0
19-20	320	24	18	0
20-21	330	24	16	+1.0
21-22	330	20	16	+1.0
22-23	320	20	14	+1.5
23-24	310	20	14	+1.0

DATE: 12/1/77

0-1	310	16	14	+1.0
1-2	300	14	12	+1.0
2-3	280	16	11	+1.0
3-4	285	19	12	+1.0
4-5	320	16	12	+0.5
5-6	310	16	12	+0.5
6-7	300	17	12	+0.5
7-8	290	18	13	+0.5
8-9	270	8	14	0
9-10	210	5	16	-1.0
10-11	170	9	18	-2.5
11-12	150	10	20	-3.0
12-13	180	12	19	-2.5
13-14	170	13	18	-2.5
14-15	180	15	18	-1.0
15-16	210	14	17	-0.5
16-17	210	22	17	0
17-18	205	20	16	0
18-19	200	17	18	0
19-20	205	18	19	0
20-21	210	21	20	0
21-22	210	23	20	0
22-23	210	26	20	0
23-24	210	22	21	0

M=missing data D=doubtful data

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METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/2/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	210	25	21	0
1-2	210	24	21	0
2-3	210	27	21	0
3-4	210	26	22	0
4-5	210	28	23	0
5-6	210	25	24	0
6-7	215	26	24	0
7-8	220	23	26	0
8-9	210	22	26	-0.5
9-10	210	27	30	-0.5
10-11	210	24	30	-1.0
11-12	195	20	30	-1.0
12-13	190	24	30	-1.5
13-14	190	26	32	-1.5
14-15	200	20	33	-1.0
15-16	200	16	32	-0.5
16-17	210	23	32	0
17-18	190	25	33	0
18-19	195	23	33	0
19-20	190	22	34	0
20-21	195	26	34	0
21-22	200	23	34	0
22-23	200	24	34	0
23-24	210	20	34	0

DATE: 12/3/77

0-1	210	21	34	0
1-2	210	20	34	0
2-3	210	20	34	0
3-4	200	20	34	0
4-5	195	14	34	0
5-6	200	16	33	0
6-7	210	10	33	0
7-8	270	6	34	0
8-9	300	8	34	0
9-10	210	10	36	0
10-11	200	16	34	-0.5
11-12	200	17	36	-0.5
12-13	190	20	37	-0.5
13-14	195	22	36	-0.5
14-15	195	18	34	0
15-16	240	20	34	0
16-17	210	16	35	+0.5
17-18	210	12	34	0
18-19	200	18	34	0
19-20	200	13	34	0
20-21	190	14	34	0
21-22	210	18	32	0
22-24	220	15	33	0
23-24	200	20	30	-0.5

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/4/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	180	14	28	0
1-2	210	11	28	0
2-3	230	16	29	0
3-4	240	15	28	0
4-5	220	14	30	0
5-6	230	14	28	0
6-7	240	15	28	0
7-8	210	11	28	0
8-9	210	8	29	0
9-10	180	10	29	-0.5
10-11	190	10	30	-1.0
11-12	190	15	30	-2.0
12-13	200	19	31	-1.0
13-14	190	24	32	-1.0
14-15	195	20	30	-1.0
15-16	200	15	30	-0.5
16-17	215	14	30	0
17-18	230	18	30	0
18-19	230	20	30	0
19-20	220	22	31	0
20-21	220	20	31	0
21-22	240	20	30	0
22-23	240	16	30	0
23-24	260	24	28	0

DATE: 12/5/77

0-1	255	22	28	0
1-2	260	30	26	0
2-3	260	30	26	0
3-4	260	26	25	0
4-5	260	26	23	+0.5
5-6	270	27	22	+0.5
6-7	260	22	22	+0.5
7-8	260	20	22	0
8-9	240	17	26	-1.0
9-10	195	9	26	-2.0
10-11	180	10	30	-1.5
11-12	190	12	30	-2.5
12-13	180	14	32	-2.5
13-14	190	14	31	-2.0
14-15	195	15	31	-1.0
15-16	230	14	30	-0.5
16-17	240	16	30	+0.5
17-18	270	8	26	+0.5
18-19	260	10	26	+1.0
19-20	250	12	26	+1.0
20-21	250	10	26	+0.5
21-22	220	10	25	+0.5
22-23	225	12	24	+0.5
23-24	210	10	24	+0.5

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/6/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	195	10	24	+1.0
1-2	195	10	23	+1.0
2-3	190	13	23	+1.0
3-4	195	16	23	+1.5
4-5	190	17	24	+0.5
5-6	190	19	24	+1.0
6-7	190	20	25	+0.5
7-8	180	18	28	-1.0
8-9	180	20	30	-2.5
9-10	170	20	28	-1.0
-11	180	20	30	-3.5
-12	190	22	34	-3.0
-13	195	23	35	-2.5
14				
15				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

DATE: ___

0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				
10-11				
11-12				
12-13				
13-14				
14-15				
15-16				
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/6/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				
10-11				
11-12				
12-13				
13-14	180	20	32	-1
14-15	200	20	32	-0.5
15-16	210	18	31	0
16-17	210	23	31	0
17-18	180	16	30	0
18-19	180	12	30	+0.5
19-20	220	18	32	+0.5
20-21	210	20	32	+0.5
21-22	220	20	32	+0.5
22-23	210	21	31	+0.5
23-24	210	19	31	+0.5

DATE: 12/7/77

0-1	200	15	31	+0.5
1-2	190	16	30	+1
2-3	210	18	30	+1
3-4	210	19	30	+1
4-5	180	16	30	+1
5-6	180	20	30	+0.5
6-7	180	20	30	+1
7-8	180	20	34	0
8-9	180	22	36	-1.5
9-10	180	20	39	-2
10-11	180	19	38	-3.5
11-12	190	22	35	-2.5
12-13	190	23	34	-1
13-14	180	22	35	-0.5
14-15	190	20	34	-0.5
15-16	200	20	34	0
16-17	190	19	32	0
17-18	210	20	32	+0.5
18-19	210	20	32	0
19-20	170	20	32	+0.5
20-21	200	18	32	+0.5
21-22	210	14	32	0
22-23	210	22	32	0
23-24	230	13	32	0

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/8/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	270	10	31	0
1-2	270	20	30	0
2-3	265	32-58	28	0
3-4	270	30-50	26	+0.5
4-5	270	18	24	+0.5
5-6	260	21	22	0
6-7	260	20	20	0
7-8	250	18	20	0
8-9	240	16	21	-1
9-10	245	20	22	-1.5
10-11	230	15	23	-2
11-12	210	14	24	-2.5
12-13	220	17	24	-2.5
13-14	210	13	25	-2
14-15	180	16	26	-2
15-16	180	20	26	-1.5
16-17	180	16	24	-0.5
17-18	210	17	22	0
18-19	200	14	22	+0.5
19-20	200	12	22	+0.5
20-21	190	13	22	+0.5
21-22	200	14	22	+0.5
22-23	210	14	22	+0.5
23-24	200	17	22	+1

DATE: 12/9/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	200	16	22	+1
1-2	210	15	23	+1
2-3	210	14	25	+1
3-4	210	14	26	+1
4-5	190	13	27	+1
5-6	180	12	27	+1
6-7	190	12	27	+1
7-8	190	13	28	+0.5
8-9	200	14	30	0
9-10	190	12	33	-2.5
10-11	190	14	36	-2.5
11-12	190	14	36	-2.5
12-13	220	15	34	-1
13-14	220	16	34	-1
14-15	210	14	34	-1
15-16	240	15	33	0
16-17	220	14	33	+0.5
17-18	210	15	34	+1
18-19	200	16	34	+0.5
19-20	200	16	34	+0.5
20-21	200	15	34	+0.5
21-22	210	16	34	+0.5
22-23	210	16	34	+0.5
23-24	220	17	33	+1

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/10/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	220	17	33	+1
1-2	220	16	33	+1
2-3	230	14	33	+1
3-4	215	14	33	+1.5
4-5	220	12	32	+1
5-6	220	11	32	+1
6-7	225	10	33	+1.5
7-8	230	10	34	+0.5
8-9	210	10	38	-1.5
9-10	210	10	42	-2.5
10-11	210	12	42	-2.5
11-12	210	14	42	-3
12-13	220	16	42	-3.5
13-14	220	8	40	-2.5
14-15	230	6	38	-1
15-16	240	8	36	0
16-17	250	10	35	-0.5
17-18	255	10	34	+1
18-19	210	12	34	+2.5
19-20	215	18	34	+1.5
20-21	210	18	35	+1
21-22	210	16	35	+1
22-23	210	17	35	+1
23-24	210	18	34	+1

DATE: 12/11/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	210	18	34	+1.5
1-2	210	20	33	+2
2-3	200	21	34	+1.5
3-4	200	16	33	+1
4-5	210	18	33	+1
5-6	200	21	32	+1.5
6-7	200	20	33	+1
7-8	200	20	36	-1
8-9	190	16	38	-2.5
9-10	180	16	40	-3
10-11	190	18	41	-3.5
11-12	190	17	42	-4
12-13	210	18	41	-3
13-14	210	15	40	-2.5
14-15	210	17	39	-1.5
15-16	210	17	38	-1
16-17	210	16	35	+0.5
17-18	200	16	36	+1
18-19	185	17	36	-1
19-20	190	18	36	+0.5
20-21	210	20	34	+0.5
21-22	190	20	34	+0.5
22-23	180	22	34	+0.5
23-24	170	24	34	+0.5

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/12/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	165	25	34	+0.5
1-2	170	24	34	0
2-3	170	20	34	0
3-4	180	20	34	0
4-5	180	20	34	0
5-6	210	20	33	0
6-7	210	24	30	-0.5
7-8	240	16	27	-0.5
8-9	180	8	26	-1
9-10	180	10	25	-1
10-11	190	10	25	-1
11-12	220	13	24	-1
12-13	270	10	26	-1.5
13-14	300	12	26	-1.5
14-15	330	14	26	-2
15-16	320	14	26	0
16-17	330	6	25	+1
17-18	300	10	24	+1
18-19	210	3	24	+0.5
19-20	180	4	24	+0.5
20-21	180	4	24	+0.5
21-22	210	5	23	+1
22-23	210	6	23	+0.5
23-24	220	6	23	+0.5

DATE: 12/13/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	220	6	23	+0.5
1-2	170	12	23	0
2-3	180	10	23	0
3-4	180	10	22	0
4-5	180	10	22	-0.5
5-6	190	12	21	-0.5
6-7	210	14	21	0
7-8	200	14	22	0
8-9	180	12	26	-1.5
9-10	180	10	27	-2.5
10-11	180	10	27	-2.5
11-12	180	10	26	-1.5
12-13	180	10	27	-2.5
13-14	200	14	30	-2
14-15	200	15	29	-1.5
15-16	190	16	28	-0.5
16-17	220	16	27	0
17-18	210	14	27	+0.5
18-19	210	12	26	+0.5
19-20	180	18	28	+1
20-21	180	18	27	+1
21-22	210	16	28	+0.5
22-23	210	18	28	+0.5
23-24	210	17	27	+1.5

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/14/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	210	18	26	+2
1-2	230	15	26	+0.5
2-3	230	19	26	+1
3-4	240	17	26	+1
4-5	230	18	26	+1
5-6	240	15	28	+0.5
6-7	190	12	28	+1
7-8	210	10	29	+1
8-9	210	12	30	-1
9-10	220	16	34	-1.5
10-11	210	17	34	-2
11-12	210	17	36	-3
12-13	210	16	36	-3
13-14	210	14	37	-3
14-15	220	12	34	-2
15-16	210	14	35	-1
16-17	210	16	34	+1
17-18	210	17	33	+1
18-19	210	14	33	+1
19-20	210	16	33	+1
20-21	210	17	32	+1
21-22	210	16	32	+1
22-23	200	15	34	+0.5
23-24	210	16	33	+0.5

DATE: 12/15/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	210	14	33	+0.5
1-2	200	15	33	0
2-3	200	14	33	0
3-4	185	16	32	+0.5
4-5	190	20	32	+0.5
5-6	190	21	31	+0.5
6-7	170	25	31	0
7-8	180	24	32	0
8-9	180	25	33	0
9-10	180	23	33	-0.5
10-11	160	18	33	-0.5
11-12	155	22	38	-4
12-13	150	24	38	-3
13-14	170	22	38	-3
14-15	160	24	34	-0.5
15-16	180	23	34	-0.5
16-17	210	20	30	-0.5
17-18	180	19	28	-1
18-19	150	23	28	-1.5
19-20	330	30	24	-1.5
20-21	330	17	23	-1.5
21-22	360	6	22	-1
22-23	330	6	22	-1
23-24	310	16	22	-1

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/16/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	285	13	21	-0.5
1-2	300	16	20	-0.5
2-3	300	14	19	-0.5
3-4	290	20	18	-1
4-5	300	22	15	-1
5-6	300	20	14	-1
6-7	290	22	13	-0.5
7-8	290	23	11	0
8-9	300	21	14	-1
9-10	270	11	14	-1.5
10-11	240	10	15	-1.5
11-12	240	10	15	-2
12-13	240	12	14	-1.5
13-14	240	10	14	-1.5
14-15	260	15	14	-1
15-16	270	13	14	-0.5
16-17	270	14	13	-0.5
17-18	280	16	11	+0.5
18-19	270	12	11	0
19-20	260	13	12	+0.5
20-21	260	13	12	+0.5
21-22	270	12	10	+0.5
22-23	240	10	10	+0.5
23-24	210	8	10	+0.5

DATE: 12/17/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	210	10	10	+1.5
1-2	220	16	10	+1
2-3	230	15	10	+1
3-4	230	16	10	+1
4-5	210	16	10	+1
5-6	200	15	10	+1.5
6-7	210	14	11	+1.5
7-8	190	16	13	+0.5
8-9	180	15	14	0
9-10	180	12	14	-0.5
10-11	190	18	18	-2
11-12	195	17	18	-1.5
12-13	190	17	20	-1.5
13-14	210	20	22	-2
14-15	220	20	21	-0.5
15-16	210	23	21	0
16-17	220	23	21	0
17-18	220	22	21	0
18-19	200	20	18	-0.5
19-20	210	18	18	-0.5
20-21	190	22	18	-1
21-22	180	23	18	-1
22-23	170	22	20	-1
23-24	180	21	22	-1.5

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/18/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	165	26	22	-1.5
1-2	165	28	22	-1.5
2-3	170	29	22	-1.5
3-4	160	31-51	22	-1
4-5	160	30	22	-1
5-6	170	30	22	-1.5
6-7	165	35-53	23	-1
7-8	160	34-50	23	-1.5
8-9	160	30-47	23	-1.5
9-10	160	30-50	24	-1.5
10-11	155	22-52	24	-2
11-12	200	22	24	-2.5
12-13	290	28	19	-2.5
13-14	300	24	18	-1.5
14-15	270	10	20	-0.5
15-16	180	6	19	-1
16-17	180	6	19	+1.5
17-18	240	8	18	+1.5
18-19	210	6	18	+1
19-20	300	16	16	-1
20-21	300	12	14	-0.5
21-22	300	15	14	-0.5
22-23	290	20	12	-0.5
23-24	300	18	11	-0.5

DATE: 12/19/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	300	14	10	0
1-2	330	11	10	+0.5
2-3	350	4	10	+1
3-4	360	5	10	+1
4-5	20	3	10	+0.5
5-6	360	6	10	+0.5
6-7	360	10	10	0
7-8	360	10	10	+0.5
8-9	360	6	10	0
9-10	360	4	13	-1
10-11	20	6	13	-1.5
11-12	30	4	14	-1
12-13	----	8	14	-2
13-14	----	5	15	-2
14-15	210	6	14	-1
15-16	40	5	10	-1
16-17	300	9	10	-0.5
17-18	310	10	9	+0.5
18-19	300	17	7	+0.5
19-20	330	16	7	0
20-21	340	19	6	0
21-22	340	19	6	+0.5
22-23	350	18	5	+0.5
23-24	345	16	4	+0.5

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: ~~12/20/77~~

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	350	17	4	+1
1-2	330	15	2	+0.5
2-3	330	20	3	+0.5
3-4	335	18	3	+0.5
4-5	345	19	3	+0.5
5-6	350	17	3	+0.5
6-7	360	14	2	+1
7-8	360	12	3	
8-9	50	5	6	
9-10	40	6	8	
10-11	30	7	9	
11-12				
12-13				
13-14				
14-15				
15-16				
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

DATE: _____

0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				
10-11				
11-12				
12-13				
13-14				
14-15				
15-16				
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

M=missing data D=doubtful data

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METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/20/77

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				
10-11				
11-12				
12-13	180	7	10	-2
13-14	180	6	10	-2
14-15	190	6	10	-0.5
15-16	180	6	10	-1
16-17	200	5	8	0
17-18	180	6	6	+0.5
18-19	150	4	6	+1
19-20	180	7	6	+1
20-21	140	4	6	+1
21-22	210	9	6	+1
22-23	180	7	6	+1.5
23-24	120	4	6	+2.5

DATE: 12/21/77

0-1	90	3	2	+5
1-2	360	2	2	+5
2-3	360	6	2	+5
3-4	170	4	4	+3
4-5	170	7	10	+2
5-6	120	4	10	+2
6-7	140	3	9	+7
7-8	90	5	6	+7.5
8-9	130	4	10	+7.5
9-10	150	6	19	0
10-11	210	10	18	0
11-12	200	15	19	-0.5
12-13	200	16	18	-0.5
13-14	210	17	19	-0.5
14-15	210	16	16	+2.5
15-16	190	16	18	+2.5
16-17	180	16	18	+2.5
17-18	170	10	22	+2.5
18-19	150	9	26	+2.5
19-20	160	8	22	+5
20-21	200	10	14	+2.5
21-22	180	23	20	+3
22-23	160	24	24	+2.5
23-24	100	24	22	+2.5

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/22/77

HOUR	WIND DIR.(°)	WIND SPEED (mph)	TEMP.(°F)	ΔT(°F)
0-1	200	28	15	+2.5
1-2	190	30	16	+2.5
2-3	180	26	22	+0.5
3-4	190	26	22	+0.5
4-5	195	28	18	+0.5
5-6	180	30	19	+0.5
6-7	195	26	18	0
7-8	180	28	18	0
8-9	195	27	18	0
9-10	210	26	18	-0.5
10-11	210	23	18	-0.5
11-12	215	24	19	-1.5
12-13	210	20	20	-1
13-14	215	25	20	-1
14-15	210	24	21	-1
15-16	220	20	21	-0.5
16-17	210	20	19	0
17-18	210	20	19	0
18-19	220	18	18	+0.5
19-20	210	20	18	+0.5
20-21	210	20	18	+0.5
21-22	195	20	18	+0.5
22-23	190	20	19	0
23-24	190	18	19	0

DATE: 12/23/77

0-1	195	20	20	0
1-2	190	18	19	0
2-3	180	16	20	0
3-4	175	16	20	0
4-5	170	18	21	0
5-6	165	20	21	0
6-7	175	20	21	0
7-8	175	25	22	0
8-9	175	26	22	-0.5
9-10	170	28	23	-0.5
10-11	180	31	23	-0.5
11-12	180	30	24	-0.5
12-13	180	27	24	-0.5
13-14	170	26	24	-0.5
14-15	195	21	23	-0.5
15-16	200	20	22	-0.5
16-17	210	23	22	-0.5
17-18	200	22	22	-0.5
18-19	210	20	22	-0.5
19-20	210	14	22	0
20-21	210	13	23	0
21-22	200	12	24	0
22-23	200	9	23	+1
23-24	200	10	23	+1

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/24/77

HOUR	WIND DIR.(°)	WIND SPEED (mph)	TEMP.(°F)	ΔT(°F)
0-1	195	8	23	+1
1-2	190	6	22	+0.5
2-3	190	5	21	+0.5
3-4	190	5	20	0
4-5	180	4	20	0
5-6	190	4	19	0
6-7	200	5	19	0
7-8	200	5	18	0
8-9	220	4	21	-0.5
9-10	210	4	22	-1
10-11	210	4	22	-1
11-12	210	5	22	-1.5
12-13	240	5	20	-1
13-14	240	6	20	-1
14-15	210	6	21	-0.5
15-16	240	6	22	-0.5
16-17	250	7	22	0
17-18	250	9	22	0
18-19	250	10	22	0
19-20	250	11	22	+0.5
20-21	240	8	21	+0.5
21-22	270	10	20	+0.5
22-23	275	9	19	+1
23-24	270	10	18	+1

DATE: 12/25/77

0-1	270	14	19	+0.5
1-2	250	8	19	0
2-3	240	9	19	0
3-4	200	10	19	0
4-5	240	10	18	0
5-6	250	4	18	0
6-7	180	4	18	0
7-8	210	6	18	0
8-9	205	7	18	-0.5
9-10	210	5	22	-1
10-11	180	6	22	-2.5
11-12	180	10	25	-3.5
12-13	180	10	26	-3
13-14	210	13	25	-2.5
14-15	210	14	24	-2
15-16	205	14	24	-1
16-17	210	16	22	0
17-18	210	16	20	+0.5
18-19	210	15	19	+0.5
19-20	240	16	19	+0.5
20-21	230	15	19	+0.5
21-22	240	10	18	+0.5
22-23	210	10	18	+0.5
23-24	210	10	18	+1

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/26/77

HOUR	WIND DIR.(°)	WIND SPEED (mph)	TEMP.(°F)	ΔT(°F)
0-1	210	8	18	+0.5
1-2	210	6	18	+0.5
2-3	270	7	18	+1
3-4	310	10	18	+2
4-5	280	6	18	+0.5
5-6	310	8	17	+0.5
6-7	310	11	17	0
7-8	290	9	17	-0.5
8-9	240	3	18	-0.5
9-10	160	5	22	-2.5
10-11	160	6	22	-2.5
11-12	170	6	23	-2.5
12-13	160	8	24	-2.5
13-14	160	6	22	-2
14-15	180	8	22	-2.5
15-16	270	2	22	-1
16-17	260	4	18	+0.5
17-18	200	6	19	+1
18-19	210	9	18	+1
19-20	210	8	18	+1
20-21	180	5	19	0
21-22	170	4	19	0
22-23	230	7	21	+1
23-24	180	8	20	0

DATE: 12/27/77

0-1	180	8	20	+0.5
1-2	210	11	20	0
2-3	195	12	20	0
3-4	200	14	21	0
4-5	220	14	20	0
5-6	220	17	20	0
6-7	220	15	21	0
7-8	210	12	22	0
8-9	200	16	22	-0.5
9-10	190	15	22	-1
10-11	200	14	20	-1
11-12	210	15	20	-1
12-13	220	14	20	-0.5
13-14	230	10	20	-0.5
14-15	210	12	20	-1
15-16	220	14	20	-0.5
16-17	220	14	20	0
17-18	220	cups frozen	20	-0.5
18-19	215	----	21	0
19-20	230	----	21	0
20-21	240	----	21	-0.5
21-22	225	----	22	-0.5
22-23	230	----	22	-0.5
23-24	240	----	22	-0.5

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/28/77

HOUR	WIND DIR.(°)	WIND SPEED (mph)	TEMP.(°F)	ΔT(°F)
0-1	230	cups frozen	22	-0.5
1-2	240	----	22	-0.5
2-3	240	----	22	-0.5
3-4	240	----	22	-0.5
4-5	240	----	22	0
5-6	240	----	22	-0.5
6-7	240	----	22	-0.5
7-8	240	----	22	-0.5
8-9	230	----	22	-0.5
9-10	240	----	25	-0.5
10-11	360	----	26	0
11-12	210	----	28	-1
12-13	230	----	27	-1.5
13-14	220	----	26	-1
14-15	225	----	27	-1.5
15-16	245	----	26	-1
16-17	240	----	24	0
17-18	220	----	26	+0.5
18-19	225	----	26	+1
19-20	200	----	26	+1
20-21	205	----	25	+1
21-22	225	----	25	+0.5
22-23	210	----	26	0
23-24	210	----	26	0

DATE: 12/29/77

0-1	220	cups frozen	25	0
1-2	220	----	25	+0.5
2-3	220	----	25	0
3-4	220	----	24	0
4-5	230	----	23	0
5-6	220	----	23	0
6-7	220	----	23	0
7-8	225	----	24	0
8-9	230	----	24	-0.5
9-10	230	----	23	-0.5
10-11	240	----	25	-0.5
11-12	240	----	26	-0.5
12-13	240	----	26	-0.5
13-14	240	----	26	-0.5
14-15	240	----	26	-0.5
15-16	240	----	25	-0.5
16-17	270	----	25	0
17-18	210	----	24	+0.5
18-19	240	----	24	0
19-20	230	----	24	0
20-21	225	----	23	-0.5
21-22	220	----	24	-0.5
22-23	225	----	24	0
23-24	240	----	24	0

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/30/77

HOUR	WIND DIR.(°)	WIND SPEED (mph)	TEMP.(°F)	ΔT(°F)
0-1	220	cups frozen	24	-0.5
1-2	225	----	24	-0.5
2-3	200	----	24	-0.5
3-4	220	----	24	-0.5
4-5	215	----	23	-0.5
5-6	220	----	23	-0.5
6-7	195	----	23	-0.5
7-8	190	----	24	-0.5
8-9	190	----	24	-0.5
9-10	190	----	24	-0.5
10-11	180	----	24	-0.5
11-12	180	----	25	-0.5
12-13	180	----	26	-0.5
13-14	180	----	26	-0.5
14-15	170	----	26	-0.5
15-16	180	0	26	0
16-17	160	1	26	0
17-18	160	6	26	-0.5
18-19	160	6	26	-0.5
19-20	150	5	26	0
20-21	160	5	27	----
21-22	160	4	26	----
22-23	190	1	26	----
23-24	190	2	26	----

DATE: _____

0-1	300	1	24	-0.5
1-2	305	1	20	----
2-3	300	cups frozen	18	-0.5
3-4	270		18	-0.5
4-5	195		18	-0.5
5-6	270		18	-0.5
6-7	285		14	+1
7-8	270		12	+1
8-9	270		14	-1.5
9-10	270		17	-2.5
10-11	110		19	-2
11-12	140		18	-2.5
12-13	150	2	20	-3.5
13-14	180	2	18	-3
14-15	210	2	17	-1.5
15-16	210	2	16	-1.5
16-17	210	2	14	-1
17-18	210	2	14	0
18-19	210	3	13	+0.5
19-20	210	3	13	+0.5
20-21	220	2	13	+0.5
21-22	210	2	14	+0.5
22-23	180	cups frozen	14	+0.5
23-24	170	----	14	+1

M=missing data D=doubtful data

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METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 1/1/78

HOUR	WIND DIR.(°)	WIND SPEED (mph)	TEMP.(°F)	ΔT(°F)
0-1	180	cups frozen	14	+1
1-2	180	----	14	+1
2-3	360	----	12	+1
3-4	360	----	11	+0.5
4-5	360	----	10	+1.5
5-6	360	----	10	+2
6-7	360	----	10	+1
7-8	360	----	10	+1
8-9	360	----	10	0
9-10	360	----	12	0
10-11	360	----	13	-0.5
11-12	360	----	14	-0.5
12-13	360	----	14	-1
13-14	360	----	14	-1
14-15	360	----	13	0
15-16	350	----	14	0
16-17	360	----	13	0
17-18	350	----	11	+1
18-19	360	----	12	+1
19-20	60	----	10	+2
20-21	360	----	10	+1
21-22	60	----	10	+1
22-23	360	----	10	+2.5
23-24	360	----	10	+1

DATE: 1/2/78

0-1	30	cups frozen	9	+2.5
1-2	30		8	+2.5
2-3	360		9	+3
3-4	180		10	+2.5
4-5	180		10	+1
5-6	190		10	+1
6-7	180		10	+1.5
7-8	180		12	0
8-9	190		14	-1
9-10	180	3	18	-2
10-11	180	4	18	-1
11-12	210	6	18	-1
12-13	210	6	18	-1.5
13-14	210	7	15	-0.5
14-15	210	8	15	+1
15-16	225	8	15	+1
16-17	210	10	14	+1.5
17-18	195	11	16	+1
18-19	195	12	16	+1
19-20	210	16	16	+1.5
20-21	225	18	15	0
21-22	225	20	17	+1
22-23	225	17	18	+0.5
23-24	230	18	18	+0.5

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 1/3/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	230	18	18	+0.5
1-2	240	19	18	+0.5
2-3	220	18	19	+0.5
3-4	230	18	19	+0.5
4-5	225	18	19	+0.5
5-6	215	18	18	+1
6-7	210	12	18	+0.5
7-8	210	15	16	+0.5
8-9	195	17	20	-1
9-10	200	16	22	-0.5
10-11	210	16	22	-0.5
11-12	210	16	22	
12-13		20		
13-14				
14-15				
15-16				
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

DATE: _____

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				
10-11				
11-12				
12-13				
13-14				
14-15				
15-16				
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

M=missing data D=doubtful data

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METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: _____

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				
10-11				
11-12				
12-13				
13-14				
14-15				
15-16				
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

DATE: 1/3/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				
10-11				
11-12				
12-13	210	20	22	+0.5
13-14	210	17	23	+0.5
14-15	210	17	24	+0.5
15-16	190	13	25	+0.5
16-17	195	12	26	0
17-18	190	15	26	+1
18-19	165	10	24	+1.5
19-20	170	10	26	+0.5
20-21	175	15	27	0
21-22	180	16	27	+0.5
22-23	180	17	26	0
23-24	175	16	26	0

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 1/4/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	180	18	28	0
1-2	180	17	24	-0.5
2-3	170	16	24	-0.5
3-4	165	20	24	-0.5
4-5	180	18	26	----
5-6	160	20	26	----
6-7	160	17	26	----
7-8	180	16	25	----
8-9	210	12	24	----
9-10	210	14	22	----
10-11	220	10	22	----
11-12	210	8	22	----
12-13	210	6	22	----
13-14	230	3	22	----
14-15	210	3	22	----
15-16	210	3	22	----
16-17	200	2	23	----
17-18	200	2	23	+1.5
18-19	185	2	24	+1.5
19-20	190	2	25	+1.5
20-21	165	4	24	----
21-22	165	6	24	----
22-23	170	5	24	----
23-24	180	4	25	----

DATE: 1/5/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	175	5	25	----
1-2	170	5	24	----
2-3	170	6	25	----
3-4	170	5	25	----
4-5	180	5	25	----
5-6	190	4	24	----
6-7	190	4	24	----
7-8	195	4	24	----
8-9	200	3	24	----
9-10	180	4	25	----
10-11	180	4	25	----
11-12	180	4	25	----
12-13	175	----	26	----
13-14	190	----	26	----
14-15	180	----	24	----
15-16	180	----	25	----
16-17	170	----	25	----
17-18	170	----	24	----
18-19	180	----	24	+0.5
19-20	170	----	25	0
20-21	170	----	25	0
21-22	165	----	25	+0.5
22-23	170	----	25	+0.5
23-24	165	----	25	+0.5

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 1/6/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	160	----	24	+0.5
1-2	170	----	24	----
2-3	180	----	24	----
3-4	160	----	26	----
4-5	160	1	26	----
5-6	150	2	25	----
6-7	170	2	25	----
7-8	180	2	25	----
8-9	190	1	25	----
9-10	195	2	26	----
10-11	190	----	26	----
11-12	190	----	26	----
12-13	200	----	26	----
13-14	190	----	26	0
14-15	290	----	22	----
15-16	270	----	22	-0.5
16-17	200	----	22	-0.5
17-18	180	----	22	-0.5
18-19	180	----	22	0
19-20	250	----	22	0
20-21	----	----	21	-0.5
21-22	250	----	20	0
22-23	240	----	20	0
23-24	255	----	19	+0.5

DATE: 1/7/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	270	----	18	+1
1-2	270	----	18	+1
2-3	300	----	17	+1
3-4	310	----	16	+1.5
4-5	330	----	16	+1.5
5-6	340	----	15	+1
6-7	330	----	16	+0.5
7-8	330	----	16	+0.5
8-9	90	----	18	-1
9-10	120	----	21	-1
10-11	165	----	21	-1.5
11-12	160	----	21	-1
12-13	180	----	22	-1
13-14	230	----	20	-1
14-15	----	----	21	-1
15-16	----	----	20	-1
16-17	----	----	19	0
17-18	285	----	18	0
18-19	----	----	18	0
19-20	180	----	19	+0.5
20-21	210	----	18	+0.5
21-22	200	----	18	+1
22-23	180	----	18	+1.5
23-24	150	----	18	+1

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 1/8/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	170	----	19	+1
1-2	180	----	18	+0.5
2-3	170	----	18	+1
3-4	170	----	18	+0.5
4-5	160	----	18	+1
5-6	170	----	18	+3
6-7	185	----	19	+2.5
7-8	180	----	22	+2.5
8-9	170	----	26	0
9-10	160	2	28	-1.5
10-11	180	2	30	-2
11-12	190	4	28	-1.5
12-13	200	8	26	-2
13-14	200	12	26	-1
14-15	195	16	27	0
15-16	195	18	26	+1.5
16-17	195	18	26	+2
17-18	200	17	26	+2
18-19	190	18	26	+2.5
19-20	190	20	26	+3
20-21	190	23	26	----
21-22	190	22	26	----
22-23	200	22	24	----
23-24	210	18	22	-0.5

DATE: 1/9/78

0-1	190	23	22	----
1-2	195	20	23	----
2-3	200	21	22	----
3-4	195	20	24	+0.5
4-5	200	16	24	+1
5-6	200	20	26	+0.5
6-7	200	18	26	+0.5
7-8	195	20	26	----
8-9	200	20	27	+0.5
9-10	200	19	28	0
10-11	210	15	29	-0.5
11-12	200	16	28	0
12-13	210	17	29	-1
13-14	225	16	28	-0.5
14-15	220	16	28	0
15-16	210	16	27	0
16-17	200	12	28	+0.5
17-18	185	16	29	+0.5
18-19	180	20	29	+0.5
19-20	185	18	29	+0.5
20-21	190	20	27	+0.5
21-22	200	24	26	----
22-23	180	28	25	----
23-24	180	27	23	----

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 1/10/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	180	22	24	----
1-2	180	21	24	----
2-3	190	19	24	----
3-4	170	18	24	----
4-5	160	20	25	----
5-6	170	20	25	----
6-7	160	20	25	----
7-8	165	16	26	----
8-9	160	17	26	----
9-10	180	15	26	----
10-11	170	14	26	----
11-12	160	16	26	----
12-13	170	15	Clock stopped	
13-14	190	12		
14-15	180	12		
15-16	170	10		
16-17	165	10		
17-18	160	10		
18-19	180	9		
19-20	180	10		
20-21	190	8		
21-22	180	8		
22-23	180	8		
23-24	180	8		

DATE: 1/11/78

0-1	190	6		
1-2	200	5		
2-3	210	Frost		
3-4	210	----		
4-5	210	----		
5-6	210	----		
6-7	----	----		
7-8	----	----		
8-9	----	----		
9-10	----	----		
10-11	210	----		
11-12	----	----		
12-13	----	----		
13-14	----	----		
14-15	270	----		
15-16	230	----		
16-17	270	----		
17-18	280	----		
18-19	270	----		
19-20	240	----		
20-21	230	----		
21-22	240	----		
22-23	210	----		
23-24	200	----		

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 1/12/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	210	Frost		
1-2	185	----		
2-3	190	----		
3-4	180	----		
4-5	190	----		
5-6	180	----		
6-7	250	----		
7-8	240	----		
8-9	240	----		
9-10	230	----		
10-11	200	----		
11-12	180	----		
12-13	190	----		
13-14	190	----		
14-15	180	----		
15-16	180	----		
16-17	180	----		
17-18	200	----		
18-19	270	----		
19-20	260	----		
20-21	270	----		
21-22	270	----		
22-23	280	----		
23-24	275	----		

DATE: 1/13/78

0-1	280	Frost		
1-2	300	----		
2-3	280	----		
3-4	270	----		
4-5	300	----		
5-6	270	----		
6-7	270	----		
7-8	230	----		
8-9	200	----		
9-10	185	----		
10-11	195	----		
11-12	220	----		
12-13	210	----		
13-14	200	----		
14-15	200	----		
15-16	Clock	----		
16-17	Stopped	----		
17-18		----		
18-19		----		
19-20		----		
20-21		----		
21-22		----		
22-23		----		
23-24		----		

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 1/14/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1		Frost		
1-2		----		
2-3		----		
3-4		----		
4-5		8		
5-6		6		
6-7		9		
7-8		12		
8-9		11		
9-10		12		
10-11		13		
11-12		17		
12-13		16		
13-14		18		
14-15		Clock		
15-16		Stopped		
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

DATE: _____

0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				
10-11				
11-12				
12-13				
13-14				
14-15				
15-16				
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 1/21/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	10	Frost		
1-2	360	----		
2-3	360	----		
3-4	360	----		
4-5	10	----		
5-6	10	----		
6-7	10	----		
7-8	360	----		
8-9	360	----		
9-10	360	----		
10-11	360	----		
11-12	360	----		
12-13	30	----		
13-14	360	----		
14-15	360	----		
15-16	180	----		
16-17	220	----		
17-18	210	----		
18-19	230	----		
19-20	200	----		
20-21	180	4		
21-22	170	4		
22-23	180	4		
23-24	190	3		

DATE: 1/22/78

0-1	210	3		
1-2	190	4		
2-3	180	4		
3-4	180	5		
4-5	180	5		
5-6	180	3		
6-7	180	4		
7-8	170	4		
8-9	180	5		
9-10	170	6		
10-11	210	5		
11-12	200	6		
12-13	180	6		
13-14	180	7		
14-15	170	5		
15-16	180	6		
16-17	170	6		
17-18	180	6		
18-19	180	6		
19-20	180	7		
20-21	200	8		
21-22	190	8		
22-23	180	8		
23-24	180	8		

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 1/23/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	170	8		
1-2	170	8		
2-3	170	7		
3-4	180	7		
4-5	165	7		
5-6	160	6		
6-7	170	4		
7-8	170	4		
8-9	45	Frost		
9-10	45	----		
10-11	50	----		
11-12	90	----		
12-13	60	----		
13-14	50	----		
14-15	40	----		
15-16	20	----		
16-17	20	----		
17-18	20	----		
18-19	10	8		
19-20	360	7		
20-21	15	6		
21-22	20	Frost		
22-23	10	----		
23-24	360	----		

DATE: 1/24/78

0-1	Clock Stopped	Frost		
1-2	----	----		
2-3	----	----		
3-4	----	----		
4-5	----	----		
5-6	----	----		
6-7	----	----		
7-8	----	----		
8-9	----	----		
9-10	----	----		
10-11	220	----		
11-12	220	----		
12-13	220	----		
13-14	220	6		
14-15	210	6		
15-16	240	2		
16-17	230	6		
17-18	230	4		
18-19	230	Frost		
19-20	230	----		
20-21	240	----		
21-22	230	----		
22-23	240	----		
23-24	240	----		

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 1/25/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	240	Frost		
1-2	270	----		
2-3	290	----		
3-4	270	----		
4-5	280	----		
5-6	300	----		
6-7	280	----		
7-8	300	----		
8-9	150	----		
9-10	180	8		
10-11	190	7		
11-12	180	7		
12-13	200	6		
13-14	240	7		
14-15	240	5		
15-16	180	5		
16-17	180	4		
17-18	180	5		
18-19	180	6		
19-20	170	7		
20-21	180	8		
21-22	180	8		
22-23	180	8		
23-24	180	8		

DATE: 1/26/78

0-1	170	8		
1-2	170	8		
2-3	175	10		
3-4	170	10		
4-5	180	8		
5-6	180	8		
6-7	180	8		
7-8	180	5		
8-9	190	6		
9-10	200	6		
10-11	200	12		
11-12	190	14		
12-13	195	18		
13-14	200	17		
14-15	210	15		
15-16	200	14		
16-17	190	14		
17-18	200	16		
18-19	180	15		
19-20	200	11		
20-21	180	8		
21-22	180	8		
22-23	190	7		
23-24	180	7		

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 1/27/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	200	6		
1-2	200	5		
2-3	190	8		
3-4	210	7		
4-5	210	7		
5-6	210	6		
6-7	200	6		
7-8	200	5		
8-9	200	2		
9-10	190	1		
10-11	200	3		
11-12	210	4		
12-13	210	5		
13-14	210	11		
14-15	210	12		
15-16	200	12		
16-17	210	11		
17-18	220	12		
18-19	220	14		
19-20	210	12		
20-21	200	14		
21-22	200	12		
22-23	190	10		
23-24	210	10		

DATE: 1/28/78

0-1	200	10		
1-2	210	10		
2-3	210	12		
3-4	210	12		
4-5	200	10		
5-6	235	12		
6-7	230	13		
7-8	190	12		
8-9	200	8		
9-10	200	10		
10-11	180	7		
11-12	240	9		
12-13	190	10		
13-14	240	12		
14-15	270	12		
15-16	300	10		
16-17	200	13		
17-18	30	13		
18-19	190	11		
19-20	180	12		
20-21	170	17		
21-22	180	19		
22-23	150	17		
23-24	170	20		

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 1/29/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	170	20		
1-2	150	18		
2-3	170	20		
3-4	180	16		
4-5	180	15		
5-6	180	14		
6-7	180	14		
7-8	180	16		
8-9	180	15		
9-10	190	16		
10-11	200	16		
11-12	Frost on Tower	15		
12-13		16		
13-14		14		
14-15		16		
15-16		15		
16-17		15		
17-18		15		
18-19		14		
19-20		13		
20-21		14		
21-22		14		
22-23		16		
23-24		20		

DATE: 1/30/78

0-1		15		
1-2		14		
2-3		12		
3-4		9		
4-5		8		
5-6		8		
6-7		6		
7-8		6		
8-9		5		
9-10		6		
10-11		8		
11-12		8		
12-13		9		
13-14		7		
14-15		5		
15-16		3		
16-17		2		
17-18		2		
18-19		4		
19-20		4		
20-21		5		
21-22		6		
22-23		8		
23-24		8		

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 1/31/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1		8		
1-2		10		
2-3		12		
3-4		14		
4-5		14		
5-6		12		
6-7		12		
7-8		12		
8-9		10		
9-10		10		
10-11		14		
11-12				
12-13				
13-14				
14-15				
15-16				
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

DATE: _____

0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				
10-11				
11-12				
12-13				
13-14				
14-15				
15-16				
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 1/31/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9		Frost on Tower		
9-10		3		
10-11		3		
11-12		4		
12-13	210	14		
13-14	210	11		
14-15	200	10		
15-16	190	10		
16-17	200	10		
17-18	210	10		
18-19	200	8		
19-20	190	10		
20-21	180	8		
21-22	210	7		
22-23	240	6		
23-24	220	5		

DATE: 2/1/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	220	4		
1-2	200	4		
2-3	210	4		
3-4	200	3		
4-5	210	3		
5-6	210	3		
6-7	180	Frost on Tower		
7-8	180	----		
8-9	180	----		
9-10	----	----		
10-11	----	----		
11-12	----	----		
12-13	----	----		
13-14	----	----		
14-15	180	----		
15-16	210	----		
16-17	260	----		
17-18	210	----		
18-19	200	4		
19-20	210	4		
20-21	210	3		
21-22	180	Frost on Tower		
22-23	180	----		
23-24	180	----		

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 2/2/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	190	Frost on Tower		
1-2	210	----		
2-3	220	----		
3-4	210	----		
4-5	180	----		
5-6	180	----		
6-7	180	----		
7-8	220	----		
8-9	220	----		
9-10	220	----		
10-11	240	----		
11-12	230	----		
12-13	180	2	22	-1
13-14	240	3	22	-1
14-15	220	4	22	-1
15-16	180	4	21	-1
16-17	180	4	20	0
17-18	180	3	19	+1
18-19	190	4	20	+1.5
19-20	200	4	19	+1.5
20-21	190	5	19	+1
21-22	190	4	18	+1
22-23	190	3	18	0
23-24	180	2	18	0

DATE: 2/3/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	180	2	18	0
1-2	180	Frost on Tower	18	0
2-3	240	----	17	0
3-4	270	----	15	+2.5
4-5	250	----	16	+2.5
5-6	240	3	18	+1.5
6-7	220	5	19	+2
7-8	210	6	22	+1.5
8-9	210	6	25	0
9-10	210	7	27	-2.5
10-11	180	9	28	-1.5
11-12	180	10	28	-2
12-13	190	12	25	-1
13-14	190	13	26	-1
14-15	200	14	27	-1
15-16	190	17	26	+1
16-17	200	18	26	+0.5
17-18	200	17	25	+1.5
18-19	200	14	25	+0.5
19-20	190	13	24	+2
20-21	190	14	26	+1.5
21-22	200	11	26	+1
22-23	200	12	26	+1.5
23-24	210	11	26	+2

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 2/4/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	230	12	25	+2.5
1-2	270	10	24	+4
2-3	310	8	25	+3
3-4	360	4	26	+2.5
4-5	40	7	27	+2.5
5-6	60	7	26	+2.5
6-7	90	5	22	+6.5
7-8	10	6	24	+5
8-9	40	7	26	+2
9-10	60	8	30	+1
10-11	110	10	29	0
11-12	9	6	30	0
12-13	----	8	33	0
13-14	----	30	35	0
14-15	----	2	34	0
15-16	220	6	31	+0.5
16-17	180	5	31	+15.
17-18	170	7	32	+1.5
18-19	170	4	32	+2
19-20	170	8	30	+2
20-21	170	7	30	+2.5
21-22	170	8	31	+2
22-23	170	6	30	+2.5
23-24	180	10	31	+2.5

DATE: 2/5/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	180	14	32	+2
1-2	180	12	32	+1.5
2-3	190	18	30	+1.5
3-4	180	18	30	+1
4-5	180	19	30	+1
5-6	190	18	30	+1
6-7	190	16	30	+2.5
7-8	180	18	32	+2
8-9	140	10	34	+1
9-10	140	10	36	-0.5
10-11	180	17	38	-1.5
11-12	180	18	38	-1.5
12-13	180	20	38	0
13-14	200	20	37	0
14-15	200	22	35	+0.5
15-16	200	20	34	+0.5
16-17	180	23	34	+1
17-18	180	20	33	+0.5
18-19	170	21	32	+1
19-20	170	24	32	+1
20-21	180	25	30	+1
21-22	200	23	22	0
22-23	180	26	26	0
23-24	170	25	26	0

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 2/6/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	170	26	26	0
1-2	170	25	27	0
2-3	180	18	27	0
3-4	180	17	27	0
4-5	210	14	26	0
5-6	230	10	26	0
6-7	240	10	26	0
7-8	240	Frost on Tower	26	0
8-9	260	----	26	0
9-10	240	----	26	-0.5
10-11	240	----	26	-0.5
11-12	270	----	26	-0.5
12-13	250	----	27	-0.5
13-14	240	----	28	-0.5
14-15	240	----	27	-0.5
15-16	260	----	27	-0.5
16-17	240	----	26	0
17-18	210	----	26	0
18-19	235	----	26	0
19-20	235	----	27	0
20-21	240	----	26	0
21-22	240	----	26	0
22-23	240	----	26	0
23-24	260	----	26	0

DATE: 2/7/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	270	Frost on Tower	25	0
1-2	270	----	24	0
2-3	300	----	24	0
3-4	290	----	23	0
4-5	320	----	23	0
5-6	270	----	22	+1
6-7	260	----	23	0
7-8	255	----	23	-0.5
8-9	255	----	24	-1
9-10	255	----	26	-1.5
10-11	150	----	27	-2.5
11-12	190	----	28	-2.5
12-13	240	----	25	-1
13-14	190	----	25	-1
14-15	210	----	25	-1.5
15-16	220	----	24	-1
16-17	220	----	23	-0.5
17-18	210	----	23	-0.5
18-19	210	----	24	0
19-20	210	----	24	0
20-21	200	----	24	0
21-22	190	----	25	0
22-23	170	----	25	0
23-24	170	----	25	0

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 2/8/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	170	Frost on tower	26	0
1-2	180	----	26	0
2-3	180	----	26	0
3-4	200	----	26	0
4-5	200	----	26	0
5-6	220	----	26	0
6-7	210	----	25	0
7-8	240	----	24	0
8-9	290	----	23	0
9-10	290	----	22	0
10-11	280	----	23	0
11-12	260	----	24	0
12-13	280	----	23	0
13-14	280	----	24	0
14-15	270	----	23	0
15-16	270	----	22	0
16-17	----	----	22	0
17-18	290	----	20	+0.5
18-19	300	----	19	+1
19-20	330	----	19	+1
20-21	40	----	18	+0.5
21-22	320	----	18	+0.5
22-23	220	----	19	0
23-24	240	----	20	0

DATE: 2/9/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	230	Frost on Tower	18	+0.5
1-2	200	----	18	+1
2-3	180	----	17	+1
3-4	170	----	16	+1
4-5	150	----	16	+1.5
5-6	----	----	17	+1
6-7	120	----	17	+1.5
7-8	150	----	18	+1
8-9	160	5	18	0
9-10	180	4	20	0
10-11	170	5	20	-0.5
11-12	170	3	22	-1.5
12-13	180	3	21	-1
13-14	190	4	22	0
14-15	190	4	23	0
15-16	200	2	24	0
16-17	210	Frost on Tower	24	0
17-18	210	----	25	0
18-19	215	----	25	0
19-20	210	----	26	Ossilication of needle
20-21	200	----	26	----
21-22	200	----	26	----
22-23	195	----	26	----
23-24	195	----	26	----

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 2/10/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	190	Frost on Tower	26	Ossilication of needle
1-2	195	----	27	0
2-3	200	----	28	0
3-4	190	----	29	0
4-5	200	----	29	0
5-6	200	----	29	0
6-7	190	2	28	0
7-8	200	2	28	0
8-9	190	2	29	0
9-10	200	2	29	-0.5
10-11	200	2	29	-0.5
11-12	180	4	29	-1
12-13	160	2	Ran out of paper	-2.5
13-14	160	Frost on Tower		-1
14-15	160	----		Ran Out of Paper
15-16	170	----		
16-17	160	----		
17-18	180	----		
18-19	150	----		
19-20	150	----		
20-21	170	----		
21-22	180	----		
22-23	160	----		
23-24	140	----		

DATE: 2/11/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	150	Frost on Tower		
1-2	120	----		
2-3	140	----		
3-4	135	----		
4-5	130	----		
5-6	230	----		
6-7	180	----		
7-8	180	----		
8-9	200	----		
9-10	190	----		
10-11	190	----		
11-12	190	----		
12-13	180	----		
13-14	200	----		
14-15	210	----		
15-16	210	----		
16-17	220	----		
17-18	230	----		
18-19	240	----		
19-20	270	----		
20-21	----	----		
21-22	240	----		
22-23	210	----		
23-24	180	----		

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 2/12/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	210	Frost on Tower		
1-2	220	----		
2-3	190	----		
3-4	190	----		
4-5	210	----		
5-6	230	----		
6-7	240	----		
7-8	260	----		
8-9	250	----		
9-10	240	----		
10-11	240	----		
11-12	240	----		
12-13	225	----		
13-14	210	----		
14-15	210	----		
15-16	220	----		
16-17	220	----		
17-18	200	----		
18-19	210	----		
19-20	200	----		
20-21	200	----		
21-22	200	----		
22-23	200	----		
23-24	210	----		

DATE: 2/13/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	220	Frost on Tower		
1-2	200	----		
2-3	200	----		
3-4	180	----		
4-5	180	----		
5-6	200	----		
6-7	190	----		
7-8	190	----		
8-9	190	----		
9-10	190	2		
10-11	200	4		
11-12	190	3		
12-13	180	2		
13-14	170	3		
14-15	180	2		
15-16	180	Frost on tower		
16-17	200	----		
17-18	180	----		
18-19	210	----		
19-20	200	----		
20-21	210	----		
21-22	190	----		
22-23	190	----		
23-24	190	----		

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 2/14/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	180	Frost on Tower		
1-2	180	----		
2-3	230	----		
3-4	240	----		
4-5	250	----		
5-6	210	----		
6-7	220	----		
7-8	220	----		
8-9	----	----		
9-10	240	----		
10-11	240	----		
11-12	----	----		
12-13	360	----		
13-14	250	----		
14-15	----	----		
15-16	280	----		
16-17	270	----		
17-18	270	----		
18-19	260	----		
19-20	270	----		
20-21	270	----		
21-22	270	----		
22-23	260	----		
23-24	260	----		

DATE: 2/15/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	260	Frost on Tower		
1-2	260	----		
2-3	260	----		
3-4	270	----		
4-5	----	----		
5-6	90	----		
6-7	100	----		
7-8	140	----		
8-9	150	----		
9-10	160	----		
10-11	170	----		
11-12	180	----		
12-13	180	----		
13-14	180	----		
14-15				
15-16				
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 2/15/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				
10-11				
11-12				
12-13		Frost on Tower		
13-14		----	Frost on Tower	No Data
14-15	Frost	----	----	----
15-16	----	----	----	----
16-17	----	----	----	----
17-18	----	----	----	----
18-19	----	----	----	----
19-20	----	----	----	----
20-21	----	----	----	----
21-22	----	----	----	----
22-23	----	----	----	----
23-24	----	----	----	----

DATE: 2/16/78

0-1	Frost	Frost on Tower	Frost on Tower	No Data
1-2	----	----	----	----
2-3	----	----	----	----
3-4	----	----	----	----
4-5	----	----	----	----
5-6	----	----	----	----
6-7	----	----	----	----
7-8	----	----	----	----
8-9	----	----	----	----
9-10	----	----	----	----
10-11	----	----	----	----
11-12	----	----	----	----
12-13	----	----	----	----
13-14	----	----	----	----
14-15	----	----	----	----
15-16	----	----	----	----
16-17	----	----	----	----
17-18	----	----	----	----
18-19	----	----	----	----
19-20	----	----	----	----
20-21	----	----	----	----
21-22	----	----	----	----
22-23	----	----	----	----
23-24	----	----	----	----

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 2/16/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	Frost	Frost on Tower	Frost on Tower	No Data
1-2	----	----	----	----
2-3	----	----	----	----
3-4	----	----	----	----
4-5	----	----	----	----
5-6	----	----	----	----
6-7	----	----	----	----
7-8	----	----	----	----
8-9	----	----	----	----
9-10	----	----	----	----
10-11	----	----	----	----
11-12	----	----	----	----
12-13	----	----	----	----
13-14	----	----	----	----
14-15	----	----	----	----
15-16	----	----	----	----
16-17	----	----	----	----
17-18	----	----	----	----
18-19	----	----	----	----
19-20	----	----	----	----
20-21	----	----	----	----
21-22	----	----	----	----
22-23	----	----	----	----
23-24	----	----	----	----

DATE: 2/17/78

0-1	----	----	Frost on Tower	----
1-2	----	----	----	----
2-3	----	----	----	----
3-4	----	----	----	----
4-5	----	----	----	----
5-6	----	----	----	----
6-7	----	----	----	----
7-8	----	----	----	----
8-9	----	----	----	----
9-10	----	----	----	----
10-11	----	----	----	----
11-12	----	----	----	----
12-13	----	----	----	----
13-14	----	----	----	----
14-15	----	----	----	----
15-16	----	----	----	----
16-17	----	----	----	----
17-18	----	----	----	----
18-19	----	----	----	----
19-20	----	----	----	----
20-21	----	----	----	----
21-22	----	----	----	----
22-23	----	----	----	----
23-24	----	----	----	----

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 2/18/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	----	----	Frost on Tower	----
1-2	----	----	----	----
2-3	----	----	----	----
3-4	----	----	----	----
4-5	----	----	----	----
5-6	----	----	----	----
6-7	----	----	----	----
7-8	----	----	----	----
8-9	----	----	----	----
9-10	----	----	----	----
10-11	----	----	----	----
11-12	----	----	----	----
12-13	----	----	----	----
13-14	----	----	----	----
14-15	----	----	----	----
15-16	----	----	----	----
16-17	----	----	----	----
17-18	----	----	----	----
18-19	----	----	----	----
19-20	----	----	----	----
20-21	----	----	----	----
21-22	----	----	----	----
22-23	----	----	----	----
23-24	----	----	----	----

DATE: 2/19/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	----	----	Frost on Tower	----
1-2	----	----	----	----
2-3	----	----	----	----
3-4	----	----	----	----
4-5	----	----	----	----
5-6	----	----	----	----
6-7	----	----	----	----
7-8	----	----	----	----
8-9	----	----	----	----
9-10	----	----	----	----
10-11	----	----	----	----
11-12	----	----	----	----
12-13	----	----	----	----
13-14	----	----	----	----
14-15	----	----	----	----
15-16	----	----	----	----
16-17	----	----	----	----
17-18	----	----	----	----
18-19	----	----	----	----
19-20	----	----	----	----
20-21	----	----	----	----
21-22	----	----	----	----
22-23	----	----	----	----
23-24	----	----	----	----

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 2/20/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	----	----	Frost on Tower	----
1-2	----	----	----	----
2-3	----	----	----	----
3-4	----	----	----	----
4-5	----	----	----	----
5-6	----	----	----	----
6-7	----	----	----	----
7-8	----	----	----	----
8-9	----	----	----	----
9-10	----	----	----	----
10-11	----	----	----	----
11-12	----	----	----	----
12-13	----	----	----	----
13-14	----	----	----	----
14-15	----	----	----	----
15-16	----	----	----	----
16-17	----	----	----	----
17-18	----	----	----	----
18-19	----	----	----	----
19-20	----	----	----	----
20-21	----	----	----	----
21-22	----	----	----	----
22-23	----	----	----	----
23-24	----	----	----	----

DATE: 2/21/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	----	----	Frost on Tower	----
1-2	----	----	----	----
2-3	----	----	----	----
3-4	----	----	----	----
4-5	----	----	----	----
5-6	----	----	----	----
6-7	----	----	----	----
7-8	----	----	----	----
8-9	----	----	----	----
9-10	----	----	----	----
10-11	----	----	----	----
11-12	----	----	----	----
12-13	----	----	----	----
13-14	----	----	----	----
14-15	----	----	----	----
15-16	----	----	----	----
16-17	----	----	----	----
17-18	----	----	----	----
18-19	----	----	----	----
19-20	----	----	----	----
20-21	----	----	----	----
21-22	----	----	----	----
22-23	----	----	----	----
23-24	----	----	----	----

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 2/22/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1		----	Frost on Tower	----
1-2		----	----	----
2-3		----	----	----
3-4		----	----	----
4-5		----	----	----
5-6		----	----	----
6-7		----	----	----
7-8		----	----	----
8-9		----	----	----
9-10		-----	----	----
10-11		----	----	----
11-12		----	----	----
12-13		----	----	----
13-14		----	----	----
14-15		----	----	----
15-16		----	----	----
16-17		----	----	----
17-18		----	----	----
18-19		----	----	----
19-20		----	----	----
20-21		----	----	----
21-22		----	----	----
22-23		----	----	----
23-24		----	----	----

DATE: 2/23/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	Frost	Frost on Tower	Frost on Tower	----
1-2	----	----	----	----
2-3	----	----	----	----
3-4	----	----	----	----
4-5	----	----	----	----
5-6	----	----	----	----
6-7	----	----	----	----
7-8	----	----	----	----
8-9	----	----	----	----
9-10	----	----	----	----
10-11	200	12	----	----
11-12	210	12	----	----
12-13	210	10	----	----
13-14	180	8	----	----
14-15	190	8	----	----
15-16	200	8	----	----
16-17	190	12	----	----
17-18	210	16	----	----
18-19	210	18	----	----
19-20	190	16	----	----
20-21	180	15	----	----
21-22	190	16	----	----
22-23	190	16	----	----
23-24	180	15	----	----

M=missing data D=doubtful data

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METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 2/24/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	190	12	Frost on Tower	
1-2	200	13	----	
2-3	190	13	----	
3-4	180	12	----	
4-5	180	12	----	
5-6	180	11	----	
6-7	180	14	----	
7-8	200	15	----	
8-9	240	13	----	
9-10	240	12	----	
10-11	250	12	31	
11-12	180	10	31	
12-13	130	10	31	
13-14	140	9	30	
14-15	100	11	31	
15-16	90	10	30	
16-17	----	10	29	
17-18	280	8	28	
18-19	285	12	28	
19-20	300	15	26	
20-21	290	12	26	
21-22	300	14	26	
22-23	310	14	26	
23-24	300	15	26	

DATE: 2/25/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	280	14	26	
1-2	280	14	25	
2-3	270	12	24	
3-4	280	11	25	
4-5	280	11	24	
5-6	270	12	24	
6-7	285	12	23	
7-8	280	14	28	
8-9	270	12	30	
9-10	260	10	30	
10-11	280	13	30	
11-12	270	14	30	
12-13	270	12	31	
13-14	270	11	31	
14-15	280	12	30	
15-16	280	13	30	
16-17	280	12	30	
17-18	290	12	28	
18-19	270	16	26	
19-20	270	14	28	
20-21	270	15	27	
21-22	270	10	27	
22-23	280	10	26	
23-24	280	10	26	

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 2/26/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	270	10	26	
1-2	260	12	26	
2-3	240	12	26	
3-4	270	16	26	
4-5	290	11	26	
5-6	270	12	26	
6-7	300	11	26	
7-8	----	13	27	
8-9	250	10	28	
9-10	----	10	30	
10-11	240	15	32	
11-12	240	12	34	
12-13	255	14	34	
13-14	----	16	31	
14-15	250	14	32	
15-16	240	13	32	
16-17	230	12	30	
17-18	240	15	30	
18-19	230	14	29	
19-20	230	20	29	
20-21	220	10	29	
21-22	----	Frost on Tower-Data Doubtful	30	
22-23	----	3	29	
23-24	----	3	30	

DATE: ~~2/27/78~~

0-1	----	Frost on Tower	30	
1-2	----	----	30	
2-3	240	----	30	
3-4	250	----	29	
4-5	260	----	27	
5-6	240	----	28	
6-7	----	----	28	
7-8	210	----	28	
8-9	210	----	30	
9-10	220	----	32	
10-11	----	----	33	
11-12	240	----	34	
12-13	270	----	34	
13-14	260	----	34	
14-15	90	----	34	
15-16	180	----	34	
16-17	190	----	33	
17-18	200	----	31	
18-19	210	----	30	
19-20	Ran out of ink	----	30	
20-21	----	----	30	
21-22	----	----	29	
22-23	----	----	29	
23-24	----	----	29	

M=missing data D=doubtful data

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METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 2/28/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	----	Frost	28	
1-2	----	----	28	
2-3	----	----	27	
3-4	----	----	27	
4-5	----	----	27	
5-6	----	----	27	
6-7	----	----	26	
7-8	----	----	26	
8-9	----	----	26	
9-10	----	----	26	
10-11	----	----	26	
11-12	----	----	26	
12-13	----	----	26	
13-14	----	----	27	
14-15	----	----	28	
15-16	----	----	27	
16-17	----	----	27	
17-18	----	----	27	
18-19	----	----	27	
19-20	----	----	26	
20-21	----	----	26	
21-22	----	----	26	
22-23	----	----	24	
23-24	----	----	22	

DATE: 3/1/78

0-1	----	Frost	21	
1-2	----	----	19	
2-3	----	----	19	
3-4	----	----	20	
4-5	----	----	19	
5-6	----	----	18	
6-7	----	----	17	
7-8	----	----	18	
8-9	----	----	20	
9-10	----	----	20	
10-11	----	----	22	
11-12	----	----	23	
12-13	----	----	26	
13-14	----	----	26	
14-15	----	----	25	
15-16	----	----	26	
16-17	----	----	26	
17-18	----	----	25	
18-19	----	----	25	
19-20	----	----	26	
20-21	----	----	26	
21-22	----	----	26	
22-23	----	----	26	
23-24	----	----	26	

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 3/2/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	----	Frost	27	
1-2	----	----	26	
2-3	----	----	27	
3-4	----	----	28	
4-5	----	----	28	
5-6	----	----	28	
6-7	----	----	28	
7-8	----	----	30	
8-9	----	----	30	
9-10	----	----	30	
10-11	----	----	30	
11-12	----	----	31	
12-13	----	----	30	
13-14	----	----	31	
14-15	----	----	30	
15-16	----	----	30	
16-17	----	----	30	
17-18	----	----	30	
18-19	----	----	30	
19-20	----	----	30	
20-21	----	----	30	
21-22	----	----	30	
22-23	----	----	31	
23-24	----	----	30	

DATE: 3/3/78

0-1	----	Frost	30	
1-2	----	----	30	
2-3	----	----	30	
3-4	----	----	30	
4-5	----	----	30	
5-6	----	----	30	
6-7	----	----	30	
7-8	----	----	30	
8-9	----	----	30	
9-10	----	----	31	
10-11	----	----	31	
11-12	----	----	32	
12-13	----	----	32	
13-14	----	----	32	
14-15	----	----	30	
15-16	----	----	31	
16-17	----	----	31	
17-18	----	----	31	
18-19	----	----	30	
19-20	----	----	30	
20-21	----	----	31	
21-22	----	----	31	
22-23	----	----	30	
23-24	----	----	31	

M=missing data D=doubtful data

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METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 3/4/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	----	Frost	31	
1-2	----	----	30	
2-3	----	----	30	
3-4	----	----	29	
4-5	----	----	27	
5-6	----	----	27	
6-7	----	----	26	
7-8	----	----	26	
8-9	----	----	26	
9-10	----	----	29	
10-11	----	----	28	
11-12	----	----	29	
12-13	----	----	28	
13-14	----	----	28	
14-15	----	----		
15-16	----	----		
16-17	----	----		
17-18	----	----		
18-19	----	----		
19-20	----	----		
20-21	----	----		
21-22	----	----		
22-23	----	----		
23-24	----	----		

DATE: _____

0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				
10-11				
11-12				
12-13				
13-14				
14-15				
15-16				
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 3/7/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				
10-11	M	Two cups missing on wind Sp. Indicator.	28	
11-12			28	
12-13			28	0
13-14			30	0
14-15			30	0
15-16			29	0
16-17			28	-0.5
17-18			27	0
18-19			24	+1
19-20			24	-1
20-21			26	-1
21-22			26	0
22-23			26	-1.5
23-24			26	-2

DATE: 3/8/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	M		25	0
1-2			23	0
2-3			26	0
3-4			24	0
4-5			22	+2.5
5-6			23	+2
6-7			23	+2.5
7-8			26	+1.5
8-9			26	0
9-10			30	-1
10-11			31	-0.5
11-12			32	-0.5
12-13			33	-0.5
13-14			34	0
14-15			34	0
15-16			34	+1
16-17			34	+1.5
17-18			33	+2.5
18-19			32	+3
19-20			31	+3.5
20-21			30	+2.5
21-22			30	+4
22-23			30	+2.5
23-24			30	+3

M=missing data D=doubtful data

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METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 3/8/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	M		25	0
1-2			23	0
2-3			26	0
3-4			24	0
4-5			22	+2.5
5-6			23	+2
6-7			23	+2.5
7-8			26	+1.5
8-9			26	0
9-10			30	-1
10-11			31	-0.5
11-12			32	-0.5
12-13			33	-0.5
13-14			34	0
14-15			34	0
15-16			34	+1
16-17			34	+1.5
17-18			33	+2.5
18-19			32	+3
19-20			31	+3.5
20-21			30	+2.5
21-22			30	+4
22-23			30	+2.5
23-24			30	+3

DATE: 3/9/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	M		30	+2.5
1-2			30	+2
2-3			30	+2
3-4			30	+2
4-5			29	+2
5-6			28	+2.5
6-7			30	+2
7-8			34	0
8-9			36	-0.5
9-10			36	0
10-11			37	-1
11-12			38	-1.5
12-13			37	-0.5
13-14			36	-0.5
14-15			36	0
15-16			36	0
16-17			36	+0.5
17-18			35	+1.5
18-19			35	+1.5
19-20			34	+2.5
20-21			34	+2
21-22			34	+2
22-23			34	+1.5
23-24			34	-

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 3/10/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	M		33	Ink Stopped Flowing
1-2			32	
2-3			33	
3-4			34	
4-5			34	
5-6			33	
6-7			30	
7-8			31	
8-9			31	
9-10			31	
10-11			31	
11-12			32	
12-13			32	
13-14			33	
14-15			34	
15-16			34	
16-17			33	
17-18			29	
18-19			27	
19-20			26	
20-21			26	
21-22			26	
22-23			24	
23-24			23	

DATE: 3/11/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	M		22	
1-2			22	
2-3			22	
3-4			25	
4-5			22	
5-6			22	
6-7			22	
7-8			24	
8-9			25	
9-10			26	
10-11			27	
11-12			29	
12-13			30	
13-14			31	
14-15			32	
15-16			30	
16-17			29	
17-18			28	
18-19			26	
19-20			27	
20-21			27	
21-22			27	
22-23			26	
23-24			26	

M=missing data D=doubtful data

331

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 3/12/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	90		27	
1-2	M		26	
2-3			26	
3-4			26	
4-5			26	
5-6			25	
6-7			25	
7-8			25	
8-9			25	
9-10			26	
10-11			26	
11-12			26	
12-13			26	
13-14			26	
14-15			25	
15-16			25	
16-17			24	
17-18			24	
18-19			22	
19-20			22	
20-21			23	
21-22			22	
22-23			22	
23-24				

DATE: 3/13/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	M		22	
1-2			23	
2-3			23	
3-4			23	
4-5			23	
5-6			22	
6-7			20	
7-8			19	
8-9			19	
9-10			20	
10-11			21	
11-12			22	
12-13			22	
13-14			23	
14-15			23	
15-16			23	
16-17			23	
17-18			23	
18-19			23	
19-20			22	
20-21			22	
21-22			21	
22-23			20	
23-24			20	

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 3/14/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	M		19	
1-2			19	
2-3			19	
3-4			18	
4-5			18	
5-6			19	
6-7			18	
7-8			18	
8-9			18	
9-10			20	
10-11			20	
11-12			20	
12-13			21	-2.5
13-14			19	-1
14-15			21	-2
15-16			19	-1.5
16-17			19	-1.5
17-18			18	-0.5
18-19			16	0
19-20			15	-0.5
20-21			14	-0.5
21-22			13	0
22-23			12	-0.5
23-24			12	-0.5

DATE: 3/15/78

0-1	M		10	+0.5
1-2			10	0
2-3			10	0
3-4			10	0
4-5			10	0
5-6			10	+0.5
6-7	40		10	+0.5
7-8	30		12	-1.5
8-9	M		14	-2.5
9-10			14	-2.5
10-11			17	-3.5
11-12			18	-4
12-13			18	-4
13-14	210		18	-3.5
14-15	210		21	-3.5
15-16	210		20	-4
16-17	210		20	-3
17-18	210		19	-2.5
18-19	200		18	-1
19-20	M		18	0
20-21	90		18	0
21-22	80		16	-1.5
22-23	60		15	-1.5
23-24	80		14	-1

M=missing data D=doubtful data

332

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 3/16/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	75		14	-1
1-2	50		17	-1
2-3	50		16	0
3-4	40		16	+0.5
4-5	40		16	+1
5-6	35		15	+1.5
6-7	30		16	+1.5
7-8	30		18	+1.5
8-9	30		20	0
9-10	30		22	-1.5
10-11	180		24	-2.5
11-12	170		26	-2.5
12-13	240		28	-2.5
13-14	240		30	-3
14-15	240		30	-2
15-16	240		30	-1
16-17	150		30	0
17-18	M		28	+1
18-19	120		26	+2
19-20	140		28	+1.5
20-21	150		27	+1.5
21-22	130		27	+1.5
22-23	M		26	+3
23-24	180		26	+2.5

DATE: 3/17/78

0-1	170		27	+2
1-2	170		27	+2
2-3	170		27	+2.5
3-4	140		26	+2
4-5	130		27	+1
5-6	110		26	+2
6-7	120		30	+1
7-8	120		32	0
8-9	110		34	-2.5
9-10	120		34	-0.5
10-11	120		34	-1
11-12	270		35	-1
12-13	240		35	-1
13-14	240		37	-0.5
14-15	270		38	-1
15-16	260		38	-0.5
16-17	M		38	0
17-18	70		38	+0.5
18-19	80		35	+1.5
19-20	70		35	+1.5
20-21	40		34	+2
21-22	30		32	+1.5
22-23	50		32	+2
23-24	60		34	+1.5

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 3/18/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	60		34	+2
1-2	50		33	+1.5
2-3	40		32	+2
3-4	35		31	+2.5
4-5	300		32	+1.5
5-6	290		32	+1.5
6-7	240		34	+2
7-8	M		36	0
8-9	260		38	-1
9-10	150		40	-1
10-11	100		39	0
11-12	110		39	-0.5
12-13	M		40	-0.5
13-14			40	-0.5
14-15			42	-1
15-16			41	+0.5
16-17			40	+1
17-18			38	+2.5
18-19			38	+1.5
19-20			38	+2
20-21			38	+2
21-22			38	+3
22-23			37	+3
23-24			36	+2.5

DATE: 3/19/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	M		37	+2
1-2			37	+1.5
2-3			38	+1.5
3-4			38	+2
4-5			36	+2
5-6			37	+1.5
6-7			36	+1.5
7-8			36	+0.5
8-9			38	-1
9-10			39	-1
10-11			38	-1
11-12			39	-1
12-13			38	-0.5
13-14			39	-0.5
14-15			38	-0.5
15-16			36	-0.5
16-17			34	-0.5
17-18			33	0
18-19			33	-0.5
19-20			33	-0.5
20-21			33	-0.5
21-22			31	0
22-23			32	0
23-24			31	0

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 3/20/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	M		30	0
1-2			30	0
2-3			30	0
3-4			30	0
4-5			30	0
5-6			30	0
6-7			30	0
7-8			30	0
8-9			30	0
9-10			31	-10
10-11			33	-10
11-12			34	-2.5
12-13			36	-1.5
13-14			38	-2
14-15			38	-1
15-16			38	-0.5
16-17			38	-0.5
17-18			38	+0.5
18-19			36	+1
19-20			36	+2
20-21			36	+1
21-22			36	+1
22-23			35	+1.5
23-24			36	+1.5

DATE: 3/21/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	M		36	+1
1-2			36	+0.5
2-3			36	+0.5
3-4			36	+2
4-5			34	+2.5
5-6			34	+1
6-7			34	+1
7-8			34	0
8-9			39	-1.5
9-10			40	-2
10-11			40	-1.5
11-12			41	-1
12-13				
13-14				
14-15				
15-16				
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 3/21/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				0
10-11				0
11-12	No Data	No Data	43	0
12-13			42	-1.0
13-14			42	-1.0
14-15			42	-0.5
15-16			41	0
16-17			40	+1.0
17-18			39	+0.5
18-19			41	+1.5
19-20			40	+1.0
20-21			40	+1.5
21-22			40	+1.5
22-23			39	+0.5
23-24			39	+0.5

DATE: 3/22/78

0-1			40	+1.5
1-2			39	+1.0
2-3			38	+0.5
3-4			37	+0.5
4-5			36	0
5-6			36	0
6-7			35	0
7-8			33	-0.5
8-9			31	-0.5
9-10			30	-0.5
10-11			29	-0.5
11-12			30	-0.5
12-13			30	-1.0
13-14			31	-1.5
14-15			31	?
15-16			31	?
16-17			30	+2.0
17-18			29	+0.5
18-19			30	+2.5
19-20			30	?
20-21			30	0
21-22			30	?
22-23			29	+1.0
23-24			30	?

M=missing data D=doubtful data

234

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 3/23/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1			30	?
1-2			30	?
2-3			30	?
3-4			30	?
4-5			29	?
5-6			29	?
6-7			30	?
7-8			30	-0.5
8-9			30	-0.5
9-10			30	?
10-11			32	?
11-12			34	0
12-13			34	?
13-14			36	?
14-15			33	?
15-16			35	?
16-17			34	-2.5
17-18			34	-0.5
18-19			33	0
19-20			34	0
20-21			34	0
21-22			34	+0.5
22-23			33	0
23-24			33	0

DATE: 3/24/78

0-1			30	-0.5
1-2			31	0
2-3			31	+0.5
3-4			31	+0.5
4-5			31	0
5-6			30	-0.5
6-7			29	-0.5
7-8			29	-0.5
8-9			29	-1.0
9-10			26	-1.0
10-11			29	-2.0
11-12			28	-2.5
12-13			31	-2.5
13-14			30	-2.5
14-15			30	-2.5
15-16			30	-2.5
16-17			30	-1.0
17-18			29	-1.0
18-19			27	-1.0
19-20			26	+0.5
20-21			26	0
21-22			26	+0.5
22-23			26	+0.5
23-24			25	+0.5

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 3/25/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1			24	0
1-2			23	+0.5
2-3			22	+0.5
3-4			22	+0.5
4-5			22	+1.0
5-6			22	+1.5
6-7			22	+1.0
7-8			24	0
8-9			26	-0.5
9-10			27	-1.0
10-11			30	-1.5
11-12			32	-1.5
12-13			33	-1.5
13-14			34	-1.0
14-15			35	-1.0
15-16			36	-1.0
16-17			34	-0.5
17-18			34	-0.5
18-19			33	-0.5
19-20			34	0
20-21			34	0
21-22			34	0
22-23			34	0
23-24			33	+0.5

DATE: 3/26/78

0-1			33	+0.5
1-2			31	+1.0
2-3			30	+1.5
3-4			31	+0.5
4-5			31	+1.0
5-6			31	+0.5
6-7			32	+0.5
7-8			34	0
8-9			34	-0.5
9-10			35	-0.5
10-11			38	-1.5
11-12			38	-1.0
12-13			40	-1.0
13-14			42	-1.0
14-15			42	0
15-16			42	-0.5
16-17			41	0
17-18			40	0
18-19			39	+0.5
19-20			40	+0.5
20-21			39	+1.0
21-22			38	+1.0
22-23			39	+1.0
23-24			38	+1.0

M=missing data D=doubtful data

335

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 3/27/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1			35	+1.5
1-2			35	+2.0
2-3			35	+2.0
3-4			38	+2.0
4-5			37	+2.5
5-6			36	+2.5
6-7			38	+2.5
7-8			38	+2.5
8-9			42	0
9-10			42	-0.5
10-11			43	-0.5
11-12	210		44	-1.0
12-13	210		45	-1.0
13-14	190		45	-0.5
14-15	200		46	0
15-16	170		46	0
16-17	190		46	+0.5
17-18	260		46	+0.5
18-19	260		45	+1.5
19-20	260		44	+1.0
20-21	260		42	+1.0
21-22	260		42	+1.0
22-23	260		42	+1.0
23-24	260		40	+1.5

DATE: 3/28/78

0-1	260		40	+1.0
1-2	260		39	+1.0
2-3	260		38	+0.5
3-4	260		38	+1.0
4-5	250		40	+1.0
5-6	260		40	+2.5
6-7	260		37	+1.0
7-8	260		38	+0.5
8-9	260		42	0
9-10	250		42	-0.5
10-11	300		44	-0.5
11-12	180		46	0
12-13	180		46	-0.5
13-14	180		46	0
14-15	180		45	0
15-16	170		46	+0.5
16-17	40		46	+0.5
17-18	80		44	+1.0
18-19	90		42	+1.5
19-20	90		42	+1.5
20-21	80		41	+2.0
21-22	360		41	+2.5
22-23	360		42	+1.5
23-24	360		42	+1.0

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 3/29/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	360		42	+1.0
1-2	360		40	+1.0
2-3	350		39	+1.5
3-4	360		39	+1.0
4-5	360		38	+2.5
5-6	360		36	+4.0
6-7	350		41	+3.0
7-8	330		42	+2.0
8-9	180		45	-0.5
9-10	180		46	-1.0
10-11	360		46	-1.0
11-12	360		46	-0.5
12-13	M		48	0
13-14	" "		49	0
14-15	" "		50	-0.5
15-16	" "		50	0
16-17	300		49	+0.5
17-18	270		48	+1.0
18-19	260		46	+2.5
19-20	240		46	+1.0
20-21	120		47	+1.0
21-22	360		47	+0.5
22-23	M		46	+0.5
23-24	340		45	+1.5

DATE: 3/30/78

0-1	330		44	+2.5
1-2	330		44	+2.5
2-3	270		42	+3.0
3-4	270		42	+2.5
4-5	200		42	+2.5
5-6	190		42	+2.5
6-7	110		43	+1.0
7-8	340		45	0
8-9	350		46	-1.0
9-10	340		47	-2.0
10-11	330		48	-2.0
11-12	250		50	-2.0
12-13	350		50	-1.0
13-14	M		50	-0.5
14-15	M		50	0
15-16	350		49	+0.5
16-17	M		47	+1.0
17-18	M		46	+1.5
18-19	M		46	+2.0
19-20	360		45	+1.5
20-21	30		45	+1.5
21-22	240		44	+1.0
22-23	M		39	+0.5
23-24	190		42	+1.0

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 3/31/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	190		41	+1.0
1-2	360		41	+0.5
2-3	M		41	+1.0
3-4	360		40	+1.0
4-5	320		40	+1.0
5-6	320		39	+1.0
6-7	M		40	0
7-8	320		42	-1.5
8-9	310		45	-2.0
9-10	M		46	-1.5
10-11	270		46	-1.5
11-12	200		47	-1.5
12-13	M		50	-2.0
13-14	" "		50	0
14-15	" "		50	0
15-16	" "		50	+0.5
16-17	" "		50	+1.0
17-18	" "		48	+2.5
18-19	" "		46	+0.5
19-20	" "		38	?
20-21	" "		38	?
21-22	" "		37	0
22-23	" "		36	+2.5
23-24	" "		38	+2.5

DATE: 4/1/78

0-1			38	+1.0
1-2			36	0
2-3			37	+1.0
3-4			37	+0.5
4-5			37	+1.0
5-6			37	+1.0
6-7			36	0
7-8			33	-2.0
8-9			33	-1.5
9-10			34	+2.5
10-11			35	-1.0
11-12			34	-1.0
12-13			Lightning Strike	
13-14				
14-15				
15-16				
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

M=missing data D=doubtful data

INSTRUMENTS DOWN

4-1-78 THRU 9-5-78

DUE TO LIGHTNING

337

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 9-5-78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				
10-11				
11-12				
12-13		13	78	+9
13-14		12	76	+7
14-15		14	76	+5
15-16		12	74	+3
16-17		12	74	+2
17-18				
18-19		15	70	+1.5
19-20		15	69	0
20-21		14	67	-1.5
21-22		12	67	-1
22-23		12	66	-1
23-24		13	66	-0.5

DATE: 9-6-78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1		15	64	-0.5
1-2		14	63	-0.5
2-3		14	62	-2
3-4		15	62	-2
4-5		19	61	-1
5-6		20	60	-0.5
6-7		18	58	0
7-8		19	60	+2.5
8-9		14	63	+5
9-10		15	67	+7.5
10-11		14	70	+9
11-12		11	70	+8
12-13		12	74	+10
13-14		13	77	+10
14-15		16	77	+7.5
15-16		Ink stopped flowing	73	+5.5
16-17			73	+3.5
17-18			71	+3
18-19			70	+2
19-20			66	0
20-21			66	-1
21-22			64	-1
22-23			64	-1
23-24			66	-0.5

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 9-7-78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1		Ink stopped	62	-1.5
1-2			62	+1
2-3			62	-0.5
3-4			62	0
4-5			60	0
5-6			57	0
6-7			56	0
7-8			56	+0.5
8-9			62	+2.5
9-10			62	+5
10-11			66	+10
11-12		15	70	+10
12-13		16	70	+7
13-14		Ink stopped	68	+5
14-15			66	+4
15-16			54	+3
16-17			50	0
17-18			50	-1
18-19			50	0
19-20			50	-1
20-21			50	0
21-22			50	-4
22-23			48	-2.5
23-24			50	-2.5

DATE: 9-8-78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1		Ink stopped	50	-2.5
1-2			50	-3
2-3			51	-2.5
3-4			52	-1.5
4-5			51	-1.5
5-6			50	-1
6-7			50	-1
7-8			50	0
8-9			55	+2.5
9-10			58	+4
10-11			59	+6
11-12			58	+5
12-13			62	+7.5
13-14			64	+7.5
14-15			62	+5
15-16			64	+5
16-17			62	+3.5
17-18			60	+2
18-19			60	+1.5
19-20			58	0
20-21			58	-1
21-22			57	-1
22-23			57	-1
23-24			57	-0.5

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 9-9-78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1		Ink stopped	55	-2
1-2			54	-1.5
2-3			54	-1.5
3-4			52	-2
4-5			51	-2.5
5-6			51	-2.5
6-7			54	-1
7-8			55	0
8-9			56	+2.5
9-10			66	+5
10-11			70	+8
11-12			70	+7.5
12-13			70	+7.5
13-14			69	+8
14-15			70	+7.5
15-16			69	+5
16-17			65	+5
17-18			64	+2.5
18-19			62	+1
19-20			60	+0.5
20-21			59	0
21-22			58	0
22-23			58	0
23-24			57	-0.5

DATE: 9-10-78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1		Ink stopped	57	-0.5
1-2			56	-1
2-3			55	-1.5
3-4			54	-1
4-5			54	-0.5
5-6			54	-1
6-7			54	0
7-8			54	0
8-9			58	+4.5
9-10			58	+5
10-11			61	+7.5
11-12			62	+6
12-13			62	+4
13-14			64	+3
14-15			63	+4
15-16			62	+2.5
16-17			62	+2
17-18			63	+1
18-19			62	+1
19-20			60	+0.5
20-21			59	+0.5
21-22			59	+0.5
22-23			58	+0.5
23-24			57	0

M=missing data D=doubtful data

339

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 9-11-78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1		Ink stopped	56	0
1-2			54	+0.5
2-3			48	+0.5
3-4			42	+0.5
4-5			41	+0.5
5-6			40	+1
6-7			34	0
7-8			34	0
8-9			34	+2
9-10			35	+3
10-11			44	+5
11-12			44	+5
12-13			48	+6
13-14			50	+7.5
14-15			50	+6
15-16			50	+6
16-17			46	+2.5
17-18			46	+2.5
18-19			46	+1.5
19-20			41	0
20-21			40	0
21-22			35	-2
22-23			36	0
23-24			34	-0.5

DATE: 9-12-78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1		Ink stopped	34	0
1-2			34	0
2-3			34	0
3-4			34	0
4-5			33	-1
5-6			33	-0.5
6-7			32	-0.5
7-8			34	+1
8-9			36	+2.5
9-10			40	+5
10-11			45	+8
11-12		16	46	+7.5
12-13		14	47	+6
13-14		18	48	+7
14-15		16	48	+6
15-16		14	47	+5
16-17		14	46	+3
17-18		10	45	+2.5
18-19		10	44	+1.5
19-20		10	42	0
20-21		14	40	-1
21-22		14	40	-0.5
22-23		12	40	-0.5
23-24		13	40	-1

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 9-13-78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1		13	40	-1
1-2		8	40	-1
2-3		6	36	-1
3-4		6	36	-1.5
4-5		12	32	-1
5-6		16	34	-1
6-7		10	34	-1
7-8		7	38	+1
8-9		8	42	+3
9-10		8	43	+4
10-11		10	46	+5
11-12		10	48	+7.5
12-13		14	52	+8
13-14		16	54	+8
14-15		20	54	+7.5
15-16		20	52	+5
16-17		16	51	+3
17-18		17	51	+2.5
18-19		16	50	+1
19-20		14	47	0
20-21		14	46	-0.5
21-22		14	46	-0.5
22-23		15	46	-1
23-24		15	45	-1

DATE: 9-14-78

0-1		14	45	-0.5
1-2		11	45	-0.5
2-3		10	44	-1.5
3-4		8	43	-2
4-5		10	44	-2.5
5-6		9	44	-2
6-7		8	42	-3
7-8		10	47	0
8-9		8	50	+2.5
9-10		10	54	+5
10-11		12	56	+7.5
11-12		20	53	+7.5
12-13		28	59	+8
13-14		25	58	+6
14-15		20	57	+4
15-16		15	56	+3
16-17		16	54	+2.5
17-18		20-44	48	+2
18-19		14	46	+1
19-20		16	45	0
20-21		12	44	0
21-22		14	44	-2
22-23		10	46	-1
23-24		8	46	-1

M=missing data D=doubtful data

340

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 9-15-78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1		10	46	-2.5
1-2		10	44	-2.5
2-3		14	45	-2.5
3-4		16	46	-1.5
4-5		18	46	-1.5
5-6		18	46	-1
6-7		17	46	-1
7-8		19	47	0
8-9		17	52	+2.5
9-10		17	54	+5
10-11		18	56	+6
11-12		20	58	+7.5
12-13		22	62	+10
13-14		20	59	+6
14-15		20	62	+7
15-16		18	59	+2.5
16-17		16	58	+4
17-18		14	57	+2.5
18-19		13	54	+1.5
19-20		14	52	0
20-21		16	50	0
21-22		16	50	0
22-23		13	49	0
23-24		18	48	0

DATE: 9-16-78

0-1		19	47	0
1-2		20	47	0
2-3		17	47	0
3-4		13	46	-0.5
4-5		13	46	-0.5
5-6		10	46	-0.5
6-7		10	46	0
7-8		10	48	+1.5
8-9		8	50	+3
9-10		8	54	+5
10-11		10	56	+7.5
11-12		12	60	+8
12-13		15	62	+9
13-14		16	58	+5
14-15		20	61	+5
15-16		20	60	+4
16-17		20	60	+4
17-18		14	57	+2
18-19		12	56	+1
19-20		13	54	0
20-21		14	53	0
21-22		14	53	0
22-23		14	52	+0.5
23-24		13	52	+0.5

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 9-17-78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1		16	50	+0.5
1-2		16	49	0
2-3		17	46	0
3-4		12	44	+1
4-5		14	43	+0.5
5-6		12	42	+0.5
6-7		11	42	0
7-8		12	42	0
8-9		12	42	+2
9-10		18	42	+1
10-11		20	41	0
11-12		16	42	+1
12-13		14	44	+2.5
13-14		14	46	+1.5
14-15		20	47	+1
15-16		24	46	0
16-17		25	48	0
17-18		28	50	0
18-19		30	50	0
19-20		30	50	0
20-21		26	50	0
21-22		30	48	0
22-23		40	48	0
23-24		40-58	49	0

DATE: 9-18-78

0-1		44-64	48	0
1-2		46-74	48	0
2-3		44-60	46	0
3-4		40-56	46	+0.5
4-5		40-60	44	+0.5
5-6		40-60	44	+0.5
6-7		34	38	+0.5
7-8		30	33	-0.5
8-9		4	28	-1
9-10		4	28	0
10-11		4	28	+0.5
11-12		4	28	+0.5
12-13		4	30	+1
13-14		28	30	+1
14-15		30	32	+0.5
15-16		25	34	+0.5
16-17		20	34	+0.5
17-18		15	36	+0.5
18-19		13	34	0
19-20		10	34	0
20-21		10	34	0
21-22		13	30	+0.5
22-23		15	30	+0.5
23-24		14	30	+0.5

M=missing data D=doubtful data

3411

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 9-19-78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1		16	29	+0.5
1-2		17	29	0
2-3		14	28	+0.5
3-4		14	27	0
4-5		15	27	0
5-6		14	26	0
6-7		16	26	-0.5
7-8		14	26	+0.5
8-9		15	27	+1.5
9-10		12	30	+2.5
10-11		11	34	+4
11-12		8	40	+5
12-13		8	42	+5
13-14		10	44	+7
14-15		10	38	+4
15-16		20	30	+2
16-17		23	27	+1
17-18		20	26	+1
18-19		18	25	+0.5
19-20		14	24	0
20-21		12	24	-1
21-22		8	26	-1
22-23		10	24	-1.5
23-24		17	23	-2

DATE: 9-20-78

0-1		18	22	-2
1-2		16	22	0
2-3		12	22	+0.5
3-4		13	22	0
4-5		16	22	0
5-6		15	22	0
6-7		14	22	0
7-8		14	22	+0.5
8-9		13	22	+1
9-10		12	25	+2.5
10-11		15	26	+3.5
11-12		10	30	+3
12-13		9	32	+2.5
13-14		8	34	+3
14-15		9	38	+5
15-16		8	34	+3
16-17		8	36	+3
17-18		11	38	+2.5
18-19		14	32	0
19-20		15	29	-0.5
20-21		14	29	-1
21-22		10	30	-1
22-23		8	29	-0.5
23-24		9	29	-1.5

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 9-21-78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1		6	30	-1
1-2		7	30	-2
2-3		6	28	-1
3-4		10	26	-1
4-5		14	26	-1.5
5-6		14	26	-1.5
6-7		13	26	-1.5
7-8		10	30	0
8-9		10	34	+2.5
9-10		12	36	+3
10-11		12	38	+4
11-12				
12-13				
13-14				
14-15				
15-16				
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

DATE: _____

0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				
10-11				
11-12				
12-13				
13-14				
14-15				
15-16				
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 9/21/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				
10-11		NO DATA	NO DATA	NO DATA
11-12		"	"	"
12-13		"	"	"
13-14		"	"	"
14-15		"	"	"
15-16		"	"	"
16-17		"	"	"
17-18		"	"	"
18-19		"	"	"
19-20		"	"	"
20-21		"	"	"
21-22		"	"	"
22-23		"	"	"
23-24		"	"	"

DATE: 9/22/78

0-1		NO DATA	NO DATA	NO DATA
1-2		"	"	"
2-3		"	"	"
3-4		"	"	"
4-5		"	"	"
5-6		"	"	"
6-7		"	"	"
7-8		"	"	"
8-9		"	"	"
9-10		"	"	"
10-11	180	10	56	+7.5
11-12	150	14	54	+7.5
12-13	180	10	56	+7.5
13-14	160	14	60	+8
14-15	180	12	58	+6
15-16	200	14	58	+5
16-17	230	12	58	+4
17-18	240	14	56	+2
18-19	240	16	54	+1
19-20	250	14	50	-0.5
20-21	250	11	50	-1
21-22	250	10	50	-1
22-23	240	12	50	-1
23-24	180	10	50	-1

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 9/23/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	180	10	49	-1
1-2	180	9	49	-1.5
2-3	180	9	50	-2
3-4	180	8	50	-1
4-5	180	8	50	-1
5-6	180	7	50	-0.5
6-7	180	7	50	-0.5
7-8	150	5	46	-4
8-9	360	5	50	+2.5
9-10	150	6	56	+2.5
10-11	150	8	58	+5
11-12	150	7	60	+4
12-13	130	6	61	+5
13-14	9	6	62	+5
14-15	110	8	63	+4
15-16	150	8	65	+5
16-17	40	10	63	+3
17-18	360	15	60	+1
18-19	350	22	59	0
19-20	350	25	57	0
20-21	360	26	55	0
21-22	360	26	54	0.5
22-23	10	25	54	-0.5
23-24	20	13	51	-2

DATE: 9/24/78

0-1	30	14	52	-2.5
1-2	50	16	53	-1
2-3	50	17	52	-0.5
3-4	60	14	51	-1
4-5	40	12	50	-1.5
5-6	30	10	50	-1
6-7	30	11	50	-1
7-8	30	11	50	0
8-9	30	11	50	0
9-10	30	13	56	+4
10-11	30	12	58	+4
11-12	30	8	58	+3
12-13	90	8	60	+4
13-14	160	8	60	+3
14-15	180	7	61	+5
15-16	160	8	62	+5
16-17	150	14	62	+6
17-18	180	14	57	+2.5
18-19	220	14	56	+0.5
19-20	190	14	54	+0.5
20-21	220	10	53	+0.5
21-22	270	9	50	-1
22-23	-	8	48	-1
23-24	40	11	47	-1

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 9/25/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	40	13	47	-1
1-2	30	11	46	-0.5
2-3	30	11	45	-0.5
3-4	30	12	45	-1
4-5	50	10	44	-1.5
5-6	40	8	44	-1
6-7	30	6	44	-1.5
7-8	330	4	46	0
8-9	30	6	50	+2.5
9-10	30	8	50	+3
10-11	20	8	54	+4
11-12	110	8	56	+4
12-13	110	7	58	+5
13-14	110	8	60	+5
14-15	100	8	62	+5
15-16	160	8	60	+5
16-17	270	8	62	+2.5
17-18	270	6	62	+2.5
18-19	270	8	60	+1
19-20	280	15	56	-1
20-21	360	12	54	-1.5
21-22	360	20	54	-1
22-23	10	20	54	-1
23-24	20	17	53	-1.5

DATE: 9/26/78

0-1	30	10	52	-2
1-2	40	10	52	-2
2-3	40	8	52	-2
3-4	270	10	50	-1.5
4-5	300	10	50	-1.5
5-6	330	5	49	-2
6-7	240	6	48	-1.5
7-8	240	6	50	0
8-9	140	6	52	+2.5
9-10	140	7	54	+3
10-11	130	7	53	+3
11-12	90	6	58	+4
12-13	90	8	62	+5
13-14	140	10	62	+6
14-15	150	8	64	+5
15-16	70	10	64	+5
16-17	30	12	62	+2.5
17-18	350	16	62	+1.5
18-19	340	18	58	0
19-20	350	21	57	-1
20-21	360	23	56	-1
21-22	360	22	54	-1
22-23	10	20	54	-1.5
23-24	10	18	54	-1.5

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 9/27/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	20	16	52	-2
1-2	20	14	51	-2
2-3	30	13	51	-1.5
3-4	50	12	50	-2.5
4-5	40	10	50	-2
5-6	40	10	50	-1.5
6-7	30	11	50	-1.5
7-8	30	8	50	0
8-9	330	6	56	+2
9-10	360	6	60	+3
10-11	150	8	60	+5
11-12	180	8	62	+5
12-13	150	10	66	+6
13-14	160	12	66	+7.5
14-15	160	16	66	+10
15-16	160	13	68	+7.5
16-17	180	12	63	+5
17-18	230	11	62	+2.5
18-19	280	14	60	+1
19-20	290	15	58	0
20-21	300	17	56	-1.5
21-22	270	16	55	-1.5
22-23	250	16	56	-1
23-24	250	14	54	-1

DATE: 9/28/78

0-1	240	14	54	-1
1-2	220	13	53	-1
2-3	240	15	53	-1
3-4	240	14	52	-1
4-5	230	11	52	-1
5-6	230	12	52	-1
6-7	220	12	51	-1
7-8	210	12	54	0
8-9	210	10	58	+2.5
9-10	220	11	59	+3
10-11	220	14	59	+4
11-12	220	13	62	+5
12-13	200	12	62	+5
13-14	180	10	66	+5
14-15	190	16	68	+7.5
15-16	200	15	66	+5
16-17	210	17	63	+2.5
17-18	220	16	62	+1
18-19	240	15	60	+0.5
19-20	260	16	58	0
20-21	260	16	58	0
21-22	260	16	58	0
22-23	270	17	56	-0.5
23-24	320	20	56	0

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 9/29/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	310	18	56	-0.5
1-2	300	20	54	-1
2-3	290	18	54	-1.5
3-4	270	14	54	-1
4-5	240	8	54	-0.5
5-6	300	12	52	-1
6-7	310	17	50	-0.5
7-8	330	18	50	0
8-9	360	13	50	+2.5
9-10	30	10	54	+4
10-11	30	8	58	+3
11-12	120	9	60	+6
12-13	150	10	62	+7.5
13-14	150	10	66	+7.5
14-15	150	10	63	+6
15-16	150	10	62	+5
16-17	90	0	61	+3.5
17-18	360	15	58	+2
18-19	360	18	54	0
19-20	360	21	52	-0.5
20-21	360	20	50	-1
21-22	360	22	50	1.5
22-23	360	22	50	-1
23-24	10	20	48	-2

DATE: 9/30/78

0-1	10	14	49	-2
1-2	10	15	48	-1
2-3	20	13	INK STOPPED	-2.5
3-4	20	14	-	-1
4-5	30	14	-	-1
5-6	40	14	-	-1
6-7	40	12	-	-2.5
7-8	30	12	-	-1.5
8-9	20	9	-	+2.5
9-10	360	5	-	+2.5
10-11	180	7	-	+3
11-12	210	9	-	+4
12-13	180	8	-	+5
13-14	180	10	-	+7.5
14-15	170	15	-	+9
15-16	180	14	-	+6
16-17	210	16	-	+3
17-18	210	16	-	+2
18-19	240	15	-	0
19-20	270	16	-	-2
20-21	240	9	-	-0.5
21-22	240	10	-	-1
22-23	240	14	-	-1
23-24	240	14	-	-1

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 10/1/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	270	13	INK STOPPED	-1.5
1-2	240	12	-	-1
2-3	210	13	-	-0.5
3-4	210	12	-	-1
4-5	230	12	-	-1
5-6	210	12	-	-1
6-7	210	12	-	-1
7-8	190	13	-	+1
8-9	180	11	-	+4
9-10	190	10	-	+5
10-11	210	13	-	+5
11-12	210	14	-	+5
12-13	210	14	-	+5
13-14	210	16	-	+6
14-15	190	18	-	+5
15-16	190	23	-	+3
16-17	200	21	-	+2.5
17-18	210	20	-	+1
18-19	210	22	-	+0.5
19-20	210	18	-	0
20-21	330	24	-	0
21-22	320	27	-	0
22-23	330	27	-	0
23-24	330	26	-	0

DATE: 10/2/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	360	25	INK STOPPED	0
1-2	350	29	-	0
2-3	360	26	-	0
3-4	360	23	-	-0.5
4-5	360	20	-	-0.5
5-6	350	19	-	-0.5
6-7	360	16	-	-1.5
7-8	360	14	-	0
8-9	20	14	-	+2.5
9-10	30	10	-	+3
10-11	60	10	-	+4
11-12	120	8	-	+5
12-13	90	10	-	+5
13-14	90	8	-	+6
14-15	90	10	-	+5
15-16	70	10	-	+3
16-17	40	10	-	+3
17-18	10	11	-	+1.5
18-19	360	20	-	-0.5
19-20	360	22	-	-1
20-21	360	22	-	-1
21-22	360	23	-	-1
22-23	360	23	-	-0.5
23-24	10	20	-	-0.5

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 10/3/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	10	21	INK STOPPED	-1
1-2	10	27	-	-0.5
2-3	10	25	-	-0.5
3-4	10	20	-	-1.5
4-5	30	13	-	-2
5-6	360	12	-	-1.5
6-7	360	12	-	-2
7-8	30	13	-	-2.5
8-9	30	10	-	+2.5
9-10	50	9	-	+3
10-11	60	8	-	+3.5
11-12	90	8	50	+5
12-13	140	8	50	+5
13-14	150	10	53	+5
14-15	150	10	54	+7.5
15-16	165	12	56	+7.5
16-17	170	11	54	+7.5
17-18	180	10	52	+5
18-19	240	10	50	+2
19-20	260	11	49	0
20-21	270	9	49	-1
21-22	270	10	49	-0.5
22-23	210	12	47	-1
23-24	230	13	46	-2

DATE: 10/4/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	240	14	46	-1.5
1-2	250	16	46	-1
2-3	240	16	46	-1
3-4	260	16	45	-2
4-5	260	16	45	-1
5-6	240	13	44	-1
6-7	250	13	43	-1.5
7-8	260	14	46	0
8-9	270	10	50	+1.5
9-10	250	8	52	+2.5
10-11	170	8	52	+4
11-12	170	9	55	+5
12-13	160	9	56	+5
13-14	160	10	58	+7.5
14-15	150	13	60	+8
15-16	170	14	60	+7.5
16-17	180	13	60	+5
17-18	INK STOPPED	13	56	+1
18-19	-	12	52	0
19-20	-	9	50	-1
20-21	-	8	50	-2.5
21-22	-	8	50	-0.5
22-23	-	10	49	-1.5
23-24	-	8	49	-0.5

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 10/5/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	INK STOPPED	12	48	-2
1-2	-	20	45	-1.5
2-3	-	20	44	-1
3-4	-	21	43	-1
4-5	-	20	42	-1
5-6	-	16	41	-1.5
6-7	-	18	40	-1.5
7-8	-	14	42	0
8-9	-	12	46	+2.5
9-10	-	10	48	+3
10-11	-	10	50	+5
11-12	-	10	52	+5
12-13				
13-14				
14-15				
15-16				
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

DATE: _____

0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				
10-11				
11-12				
12-13				
13-14				
14-15				
15-16				
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 10/5/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				
10-11	STARTED CHARTS			
11-12			53	
12-13	110	9	54	+4
13-14	90	8	55	+4
14-15	60	10	57	+3
15-16	80	12	56	+4
16-17	40	16	55	+3
17-18	20	17	52	+1
18-19	350	18	50	-0.5
19-20	350	16	48	-1
20-21	340	16	47	-1
21-22	10	17	46	-1
22-23	10	14	45	-1.5
23-24	10	12	45	-2

DATE: 10/6/78

0-1	5	12	45	-2
1-2	10	11	45	-1.5
2-3	10	11	45	-1.5
3-4	10	10	45	-1.5
4-5	15	13	45	-2
5-6	20	11	45	-2
6-7	30	10	45	-1.5
7-8	60	9	46	-0.5
8-9	150	6	50	+1.5
9-10	160	6	52	+2.5
10-11	170	8	54	+5
11-12	170	9	56	+6
12-13	170	11	57	+7.5
13-14	160	12	58	+8
14-15	160	16	60	+9.5
15-16	160	15	60	+7.5
16-17	180	14	58	+5
17-18	200	14	54	+1.5
18-19	210	11	53	0
19-20	270	12	51	-1
20-21	300	14	50	-1.5
21-22	Ink Stopped	11	50	-1.5
22-23		13	49	-1.5
23-24		11	50	-1.5

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 10/7/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1		11	49	-2
1-2		10	49	-1
2-3		5	50	0
3-4		10	49	-0.5
4-5		8	49	-0.5
5-6		7	48	-0.5
6-7		8	47	-1.5
7-8		8	49	-0.5
8-9		9	51	+1.5
9-10		10	54	+2.5
10-11		9	54	+3.5
11-12		9	55	+3.5
12-13		8	58	+5
13-14		11	60	+7
14-15		16	61	+8.5
15-16		18	60	+6.5
16-17		17	58	+5
17-18		15	56	+2.5
18-19		10	54	+0.5
19-20		9	52	-1
20-21		11	50	-1.5
21-22		12	50	-1.5
22-23		15	50	-1.5
23-24		13	50	-1.5

DATE: 10/8/78

0-1		11	50	-1
1-2		9	50	-0.5
2-3		10	49	-1
3-4		9	49	-1
4-5		12	49	-1
5-6		11	48	-1
6-7		14	48	-1
7-8		13	48	-0.5
8-9		12	50	+1
9-10		12	52	+2.5
10-11		12	54	+4
11-12		11	56	+5
12-13		12	60	+8
13-14		15	61	+8
14-15		17	60	+7
15-16		17	58	+6
16-17		17	56	+2.5
17-18		18	55	+1.5
18-19		14	54	0
19-20		14	52	-1
20-21		15	52	-1
21-22		16	52	-0.5
22-23		17	52	-0.5
23-24		17	50	-0.5

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 10/9/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1		21	48	-1
1-2		22	47	-0.5
2-3		24	46	-0.5
3-4		18	46	-1.5
4-5		18	45	-1.5
5-6		14	44	-1
6-7		10	43	-1
7-8		8	44	-0.5
8-9		10	46	+1.5
9-10		9	50	+3
10-11		7	54	+3.5
11-12		8	56	+5.5
12-13		12	57	+6
13-14		15	58	+7
14-15		16	62	+9
15-16		13	60	+7.5
16-17		10	56	+5.5
17-18		12	56	+2
18-19		11	54	0
19-20		10	52	-0.5
20-21		14	50	-1.5
21-22		16	50	-1
22-23		8	50	-0.5
23-24		9	50	-1.5

DATE: 10/10/78

0-1		13	50	-1
1-2		14	50	-1
2-3		14	50	-1.5
3-4		18	47	-1
4-5		18	46	-1.5
5-6		16	46	-1.5
6-7		18	46	-1
7-8		16	46	0
8-9		12	50	+2.5
9-10		9	54	+3.5
10-11		10	56	+4
11-12	Ink Started	8	56	+4
12-13	160	8	58	+5
13-14	Stopped	9	62	+5.5
14-15		9	58	+5
15-16		8	58	+4
16-17		12	58	+4
17-18		13	54	+2
18-19		12	53	0
19-20		11	52	-0.5
20-21		16	50	-0.5
21-22		16	50	-0.5
22-23		16	50	-0.5
23-24		21	50	0

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 10/11/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1		24	49	.0
1-2		23	48	0
2-3		18	46	-1
3-4		12	46	-1
4-5		7	46	-0.5
5-6		9	46	-0.5
6-7		10	46	-0.5
7-8		10	46	-0.5
8-9		9	50	+1.5
9-10		7	51	+3.5
10-11		7	54	+4
11-12		9	54	+6
12-13		12	56	+7
13-14		13	58	+6
14-15		16	60	+8.5
15-16		14	54	+6
16-17		16	54	+4.5
17-18		15	55	+2
18-19		14	54	+0.5
19-20		18	53	-0.5
20-21		18	52	-1.5
21-22		20	51	-1
22-23		20	50	-1
23-24		16	50	-0.5

DATE: 10/12/78

0-1		22	49	-0.5
1-2		20	48	-1
2-3		12	46	-1.5
3-4		9	46	-1
4-5		13	45	-1.5
5-6		15	44	-1.5
6-7		14	44	-1.5
7-8		18	44	0
8-9		13	47	+1.5
9-10		9	50	+2.5
10-11		10	51	+3
11-12		10	54	+6
12-13		13	56	+8
13-14		15	58	+10
14-15		16	58	+7.5
15-16		19	58	+7.5
16-17		16	56	+3.5
17-18		16	54	+1.5
18-19		12	52	+0.5
19-20		16	50	-1
20-21		24	49	-0.5
21-22		30	46	0
22-23		30	45	0
23-24		33	42	-0.5

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 10/13/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1		28	40	-0.5
1-2		29	38	0
2-3		26	36	0
3-4		29	35	0
4-5		28	34	0
5-6		27	34	-1
6-7		22	34	0
7-8		22	34	-0.5
8-9		21	36	+0.8
9-10		20	39	+2.5
10-11		16	41	+3.5
11-12		14	42	+4
12-13		12	48	+5.5
13-14		11	50	+5
14-15		12	50	+5
15-16		11	50	+4
16-17		16	50	+2.5
17-18		16	46	+1
18-19		15	44	-0.5
19-20		16	43	-1
20-21		15	42	-1.5
21-22		15	42	-1.5
22-23		16	42	-1.5
23-24		12	41	-2

DATE: 10/14/78

0-1		10	42	-1
1-2		6	42	-0.5
2-3		8	41	-1
3-4		8	41	-1
4-5		12	40	-2
5-6		12	40	-2
6-7		9	41	-0.5
7-8		8	41	-1
8-9		9	44	-2
9-10		8	48	-3.5
10-11		10	50	+4
11-12		8	50	+2.5
12-13		10	52	+6
13-14		12	55	+6
14-15		13	56	+7.5
15-16		10	54	+5
16-17		10	54	+1.5
17-18		12	55	+1.5
18-19		11	50	0
19-20		11	50	-1.5
20-21		10	50	-0.5
21-22		9	50	-1
22-23		10	49	-1.5
23-24		9	49	-1.5

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 10/15/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1		11	48	-1.5
1-2		10	48	-0.5
2-3		8	47	-1
3-4		7	46	-0.5
4-5		6	46	0
5-6		4	46	0
6-7		7	46	-0.5
7-8		6	46	-1
8-9		6	48	+0.5
9-10		11	52	+4
10-11		9	53	+3.5
11-12		8	56	+4
12-13		9	55	+4
13-14		10	57	+6
14-15		10	58	+5
15-16		8	58	+4
16-17		9	54	+4
17-18		12	52	+1.5
18-19		11	50	-0.5
19-20		9	52	-1.5
20-21		8	52	-0.5
21-22		7	51	-0.5
22-23		7	50	-1.5
23-24		6	49	-2

DATE: 10/16/78

0-1		10	48	-2
1-2		10	48	-1
2-3		9	48	-0.5
3-4		8	47	-1
4-5		9	47	-1
5-6		14	46	-1.5
6-7		14	46	-1.5
7-8		13	46	-1
8-9		12	52	+3.5
9-10		18	52	+4
10-11		15	54	+4
11-12		13	54	+5.5
12-13		16	58	+6
13-14		19	59	+6
14-15		18	58	+5
15-16		16	55	+5.5
16-17		15	57	+3
17-18		18	54	+1
18-19		14	52	-0.5
19-20		15	51	-0.5
20-21		13	50	-1
21-22		14	50	-1.5
22-23		13	50	-1
23-24		16	50	-1

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 10/17/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1		14	49	-1
1-2		13	49	-1
2-3		15	49	-1
3-4		16	48	-1
4-5		13	48	-1
5-6		13	47	-1
6-7		14	46	-0.5
7-8		16	47	0
8-9		14	48	+1.5
9-10		16	50	+3.5
10-11	Started	11	51	+3.5
11-12	220	14	52	+3.5
12-13	220	14	52	+4
13-14	230	16	54	+4
14-15	240	26	53	+3
15-16	240	16	53	+2.5
16-17	160	20	52	+2.5
17-18	180	16	50	+0.5
18-19	200	16	50	+0.5
19-20	200	13	50	+0.5
20-21	200	12	49	+0.5
21-22	300	10	48	0
22-23	340	10	48	-0.5
23-24	335	12	48	-0.5

DATE: 10/18/78

0-1	320	14	46	+0.5
1-2	350	18	44	+0.5
2-3	340	16	40	0
3-4	210	10	42	-0.5
4-5	30	10	40	0
5-6	320	12	40	-0.5
6-7	270	9	40	-0.5
7-8	180	7	42	0
8-9	320	8	39	-0.5
9-10	15	10	39	+0.5
10-11	270	10	40	+1.5
11-12	170	6	44	+3
12-13	150	9	46	+4
13-14	Stopped	12	48	+6
14-15		8	46	+4
15-16		9	46	+2
16-17		8	48	+2
17-18		7	46	+0.5
18-19		7	45	-0.5
19-20		7	45	-1
20-21		6	45	-0.5
21-22		11	43	-0.5
22-23		10	43	-1
23-24		11	41	-2

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 10/19/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1		11	41	-1.5
1-2		8	41	-1.5
2-3		8	40	-2.5
3-4		6	40	-3.5
4-5		6	40	-4
5-6		8	40	-4.5
6-7		8	40	-4
7-8		8	44	-2
8-9		8	50	+1.5
9-10		8	52	+2.5
10-11		10	56	+5
11-12		CHANGED CHARTS		
12-13				
13-14				
14-15				
15-16				
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

DATE: _____

0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				
10-11				
11-12				
12-13				
13-14				
14-15				
15-16				
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 10/19/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7			56	
7-8			56	
8-9			56	
9-10			56	
10-11		16	56	
11-12	180	15.	56	+5
12-13	180	13	56	+5.5
13-14	180	13	58	+6.5
14-15	190	12	57	+6
15-16	180	12	57	+5
16-17	210	14	57	+2.5
17-18	230	16	54	+1.5
18-19	270	14	Ink Stopped	0
19-20	300	14		-1.5
20-21	270	13		-1
21-22	230	11		-0.5
22-23	180	9		-1
23-24	180	9		-1

DATE: 10/20/78

0-1	160	7	Ink Stopped	-1
1-2	150	7		-1
2-3	150	8		-1.5
3-4	150	8		-1.5
4-5	180	10		-2.5
5-6	180	12		-1.5
6-7	180	13		-2
7-8	180	12		-1.5
8-9	170	12		0
9-10	180	30		+2
10-11	190	20		+2
11-12	190	25		+2
12-13	190	23		+2
13-14	200	20		+2.5
14-15	210	25		+0.5
15-16	Pen Pluged	14		+2
16-17		13		+1
17-18		18		+0.5
18-19		20		0
19-20		22		+0.5
20-21		21		+0.5
21-22		20		+0.5
22-23		14		+0.5
23-24		15		+1

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 10/21/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	Pen Pluge	16	Ink Stopped	+0.5
1-2		15		+0.5
2-3		13		+0.5
3-4		12		-1
4-5		14		-1.5
5-6		14		-2.5
6-7		15		-2.5
7-8		15		-2.5
8-9		12		+2
9-10		12		+2
10-11		13		+1.5
11-12		10		+2.5
12-13		8		+3
13-14		8		+2.5
14-15		12		+2
15-16		12		+2
16-17		12		+1.5
17-18		12		+1
18-19		18		+0.5
19-20		20		+0.5
20-21		25		+0.5
21-22		26		0
22-23		24		0
23-24		26		-0.5

DATE: 10/22/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	Pen Pluged	28	Ink Stopped	-1
1-2		30		-1.5
2-3		20		0
3-4		22		+0.5
4-5		29		+0.5
5-6		25		0
6-7		26		0
7-8		28		0
8-9		25		-0.5
9-10		26		-0.5
10-11		19		-0.5
11-12		18		-2.5
12-13		20		-5
13-14		17		-7.5
14-15		16		-7.5
15-16		18		-2.5
16-17		18		-1.5
17-18		20		-1.5
18-19		16		-1
19-20		20		-1
20-21		20		-0.5
21-22		15		-1
22-23		12		-1
23-24		14		-1.5

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 10/23/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	Pen Pluged	16	Ink Stopped	-2
1-2		16		-2
2-3		15		-1.5
3-4		16		-1.5
4-5		14		-1
5-6		14		-1.5
6-7		14		-1.5
7-8		14		-2.5
8-9		12		0
9-10		13		+1
10-11		12		+2
11-12		10		+3
12-13		8		+2.5
13-14		8		+2.5
14-15		10		+3
15-16		12		+2.5
16-17		10		+1.5
17-18		6		+1
18-19		8		-1
19-20		12		-1
20-21		11		-1.5
21-22		12		-1.5
22-23		10		-1
23-24		8		-1.5

DATE: 10/24/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	Pen Pluged	8	Ink Stopped	-2
1-2		9		-1
2-3		7		-1.5
3-4		8		-1
4-5		9		-2.5
5-6		6		-3
6-7		7		-2
7-8		6		-2.5
8-9		7		-1
9-10		8		0
10-11		10	41	+1.5
11-12		12	41	+2
12-13		12	40	+2
13-14		14	40	+2
14-15		10	42	+2
15-16		10	42	+1.5
16-17		16	40	+1.5
17-18		14	38	+0.5
18-19		16	36	-0.5
19-20		17	35	0
20-21		20	34	0
21-22		18	34	+0.5
22-23		18	34	0
23-24		20	34	0

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 10/25/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1		18	34	.0
1-2		12	34	-0.5
2-3		14	34	-1
3-4		18	33	-3
4-5		18	31	-3.5
5-6		16	30	-4
6-7		12	28	-4.5
7-8		10	26	-5
8-9		4	24	0
9-10		4	26	0
10-11		4	26	0
11-12		4	28	+2
12-13		4	30	+1.5
13-14		20	31	+2.5
14-15		20	32	+2.5
15-16		17	32	+1.5
16-17		24	30	+1.
17-18		26	28	-0.5
18-19		27	27	0
19-20		22	26	Clock Stopped
20-21		21	26	
21-22		20	26	
22-23		13	26	
23-24		15	26	

DATE: 10/26/78

0-1	Pen Pluged	12	26	Clock Stopped
1-2		11	27	
2-3		10	26	
3-4		11	26	
4-5		10	28	
5-6		10	28	
6-7		10	26	
7-8		10	26	
8-9		10	30	
9-10		8	35	
10-11		9	38	
11-12		7	38	
12-13		6	40	
13-14		7	40	
14-15	160	8	42	
15-16	150	8	43	
16-17	210	11	44	
17-18	235	12	42	
18-19	240	11	38	
19-20	220	11	39	
20-21	220	12	38	
21-22	200	10	37	
22-23	200	10	36	
23-24	210	12	35	

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 10/27/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	210	10	35	Clock Stopped
1-2	200	9	36	
2-3	190	10	36	
3-4	200	10	36	
4-5	210	9	36	
5-6	180	7	34	
6-7	200	7	37	
7-8	180	8	38	
8-9	170	8	42	
9-10	150	9	46	
10-11	160	6	47	
11-12	170	7	49	
12-13	200	9	48	
13-14	210	10	48	
14-15	210	9	49	
15-16	210	8	49	
16-17	210	10	48	
17-18	230	10	45	
18-19	210	10	43	
19-20	200	12	42	
20-21	200	11	42	
21-22	210	13	40	
22-23	230	16	40	
23-24	225	17	41	

DATE: 10/28/78

0-1	220	16	41	Clock Stopped
1-2	215	16	39	
2-3	215	18	38	
3-4	220	18	38	
4-5	220	16	38	
5-6	220	16	38	
6-7	175	16	38	
7-8	205	16	38	
8-9	220	13	44	
9-10	210	13	46	
10-11	210	14	48	
11-12	210	13	48	
12-13	210	12	50	
13-14	220	12	48	
14-15	200	10	49	
15-16	210	11	49	
16-17	220	12	49	
17-18	230	12	47	
18-19	235	13	43	
19-20	230	16	43	
20-21	230	14	42	
21-22	225	15	42	
22-23	190	15	44	
23-24	190	16	43	

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 10/29/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	200	15	42	Clock Stopped
1-2	200	14	42	
2-3	200	11	42	
3-4	180	12	42	
4-5	190	18	42	
5-6	200	20	41	
6-7	190	23	40	
7-8	190	25	40	
8-9	180	24	44	
9-10	180	30	46	
10-11	180	26	49	
11-12	170	25	50	
12-13	170	24	53	
13-14	165	26	52	
14-15	170	27	51	
15-16	170	25	50	
16-17	180	22	50	
17-18	190	19	48	
18-19	210	18	46	
19-20	220	17	44	
20-21	200	23	44	
21-22	200	18	42	
22-23	190	18	42	
23-24	190	18	42	

DATE: 10/30/78

0-1	190	17	42	Clock Stopped
1-2	185	20	42	
2-3	180	16	42	
3-4	190	15	42	
4-5	180	16	42	
5-6	180	16	42	
6-7	190	15	42	
7-8	200	14	42	
8-9	190	12	42	
9-10	180	15	42	
10-11	180	16	42	
11-12	180	14	45	
12-13	185	14	45	
13-14	180	10	44	
14-15	180	9	44	
15-16	210	10	44	
16-17	190	18	42	
17-18	210	10	38	
18-19	150	12	38	
19-20	160	13	38	
20-21	170	7	37	
21-22	30	8	36	
22-23	30	8	36	
23-24	360	8	36	

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 10/31/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	30	10	35	Clock Stopped
1-2	20	8	34	
2-3	30	8	34	
3-4	120	8	34	
4-5	165	10	35	
5-6	160	12	35	
6-7	160	14	36	
7-8	170	11	36	
8-9	180	10	42	
9-10	140	9	43	
10-11	160	10	45	
11-12	170	10	46	
12-13	170	12	49	+7.5
13-14	150	14	50	+7.5
14-15	170	16	50	+5
15-16	180	16	48	+2.5
16-17	200	12	47	0
17-18	190	10	44	-1
18-19	200	12	43	-1
19-20	170	8	43	-0.5
20-21	150	6	43	-1
21-22	45	6	42	-0.5
22-23	50	5	42	-1
23-24	60	7	42	-1

DATE: 11/1/78

0-1	90	6	41	-1.5
1-2	80	6	40	-1
2-3	120	6	42	-2
3-4	120	6	40	-2
4-5		5	40	-2
5-6	10	7	40	-2.5
6-7	20	10	38	-2.5
7-8	30	10	38	-2.5
8-9	350	5	40	-1.5
9-10	340	6	42	+0.5
10-11	45	5	44	+3
11-12	30	7	46	+3
12-13	170	6	47	+2.5
13-14	190	8	47	+4
14-15	180	10	50	+2
15-16	210	8	47	+2.5
16-17	130	8	47	0
17-18	120	5	45	0
18-19	180	6	45	-2
19-20	60	5	43	-1
20-21	90	8	43	-2.5
21-22	120	10	43	-3
22-23	150	12	42	-3
23-24	160	12	41	-2.5

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/2/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	170	10	42	-2.5
1-2	150	10	41	-1.5
2-3	160	10	42	-1.5
3-4	175	12	42	-1
4-5	175	14	42	-2
5-6	165	12	41	-3
6-7	160	11	40	-2.5
7-8	160	12	40	0
8-9	160	10	46	+2
9-10	150	10	46	+2.5
10-11	130	8	49	+7.5
11-12	150	13	52	+7.5
12-13	150	12	52	+6
13-14	150		52	
14-15				
15-16				
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

DATE: _____

0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				
10-11				
11-12				
12-13				
13-14				
14-15				
15-16				
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/2/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1				-1
1-2				-0.5
2-3				-0.5
3-4				-0.5
4-5				-0.5
5-6				-0.5
6-7				-0.5
7-8				-0.5
8-9				-0.5
9-10				-1
10-11				-1.5
11-12				-2
12-13				-1.5
13-14				-2
14-15				0
15-16				+5
16-17				+5
17-18				+4.5
18-19				+4.5
19-20				+3
20-21				
21-22				
22-23				
23-24				

DATE: 11/2/78

0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10	170	7	50	
10-11	160	7	50	
11-12	150	8	50	
12-13	160	8	50	
13-14	300	7	50	+2.5
14-15	40	8	50	+2.5
15-16	20	8	49	+0.5
16-17	0	8	48	0
17-18	340	8	48	-1
18-19	290	10	38	-2
19-20	280	20	35	+0.5
20-21	280	30	34	+0.5
21-22	270	26	34	+0.5
22-23	260	14	34	0
23-24	340	16	34	-1

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/3/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	10	16	33	-1
1-2	20	20	32	0
2-3	20	22	33	-0.5
3-4	10	24	34	-0.5
4-5	0	22	34	0
5-6	0	28	34	-0.5
6-7	350	30	34	-1
7-8	350	26	35	0
8-9	0	20	35	+0.5
9-10	30	22	40	+2
10-11	40	20	42	+2.5
11-12	40	21	45	+2.5
12-13	30	20	47	+2.5
13-14	30	22	49	+1.5
14-15	30	20	50	+1.5
15-16	10	18	50	+1
16-17	350	18	49	0
17-18	350	24	47	-0.5
18-19	340	26	46	-0.5
19-20	350	24	45	-1
20-21	0	24	44	-1
21-22	0	23	42	-1
22-23	350	22	42	-1.5
23-24	10	18	42	-1.5

DATE: 11/4/78

0-1	60	15	42	-1.5
1-2	60	14	41	-1.0
2-3	60	10	40	-1
3-4	200	8	40	-1.5
4-5	270	6	39	-2.5
5-6	40	10	38	-2.5
6-7	300	8	36	-2.5
7-8	220	8	42	+0.5
8-9	270	6	45	+2
9-10	240	7	46	+2.5
10-11	230	10	48	+3
11-12	230	15	47	+3
12-13	210	16	48	+4.5
13-14	210	16	50	+5
14-15	210	17	48	+3
15-16	210	16	46	+1
16-17	210	16	44	+0.5
17-18	230	16	41	-0.5
18-19	250	14	41	-1
19-20	240	16	40	-1
20-21	240	15	40	-0.5
21-22	250	16	40	0
22-23	250	12	39	0
23-24	240	10	30	-1

M-missing data D-doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/5/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	240	12	38	-0.5
1-2	240	12	38	-0.5
2-3	270	13	38	-0.5
3-4	260	12	38	-0.5
4-5	230	10	36	-1
5-6	250	10	36	-1
6-7	270	9	36	-1
7-8	300	10	36	-1
8-9	280	9	38	+0.5
9-10	190	8	42	+2.5
10-11	200	10	44	+6
11-12	210	11	46	+6
12-13	180	16	48	+8
13-14	200	15	47	+6
14-15	210	14	46	+3.5
15-16	220	18	46	+2.5
16-17	230	16	42	+1.5
17-18	330	21	39	0
18-19	330	20	38	0
19-20	340	22	36	0
20-21	340	24	34	0
21-22	340	20	33	-1.5
22-23	350	23	31	0
23-24	330	22	31	0

DATE: 11/6/78

0-1	350	20	30	-0.5
1-2	10	16	29	-1
2-3	350	20	28	-1
3-4	340	20	27	-1
4-5	10	17	27	-1
5-6	350	16	27	-1.5
6-7	350	13	26	-1.5
7-8	0	15	30	-1
8-9	10	10	34	+3
9-10	30	10	35	+2.5
10-11	270	7	38	+5
11-12	170	10	40	+6.5
12-13	180	10	40	+6
13-14	170	12	42	+6
14-15	220	10	42	+3
15-16	240	10	39	+1.5
16-17	270	10	38	-0.5
17-18	300	11	36	-1.5
18-19	310	12	35	-1.5
19-20	310	20	36	-1
20-21	320	22	36	0
21-22	350	16	35	-0.5
22-23	340	16	34	-1
23-24	20	11	34	-1.5

M-missing data D-doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/7/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	10	10	32	-1
1-2	30	11	33	-1
2-3	60	10	32	-1
3-4	10	10	32	-1
4-5	10	10	32	-1
5-6	20	10	30	-2.5
6-7	30	12	30	-1.5
7-8	40	12	32	0
8-9	50	10	38	+2.5
9-10	40	11	42	+2.5
10-11	70	10	44	+3
11-12	50	10	46	+3.5
12-13	90	8	46	+3
13-14	60	8	50	+3.5
14-15	30	8	50	+2.5
15-16	350	6	50	+1
16-17	340	8	46	-1
17-18	350	9	45	-1
18-19	270	8	45	-0.5
19-20	200	10	44	-2.5
20-21	210	15	42	-3.5
21-22	210	14	42	-3
22-23	210	12	40	-4
23-24	220	14	39	-3

DATE: 11/8/78

0-1	220	16	39	-1.5
1-2	230	15	38	-1
2-3	230	16	38	-2
3-4	220	14	38	-2.5
4-5	220	16	38	-2.5
5-6	230	16	38	-2.5
6-7	230	14	39	-2
7-8	190	12	42	+3.5
8-9	210	12	46	+3
9-10	220	11	47	+3
10-11	220	13	48	+4.5
11-12	220	15	48	+5
12-13	220	16	50	+5
13-14	210	14	50	+4.5
14-15	220	16	50	+3
15-16	230	17	48	+2.5
16-17	240	15	46	+1
17-18	240	16	43	-1
18-19	230	20	42	-0.5
19-20	230	18	42	-0.5
20-21	230	18	40	-1
21-22	230	19	40	-1.5
22-23	230	19	40	-1
23-24	240	18	39	-0.5

Remissing data Doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/9/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	240	17	38	-1
1-2	230	18	38	-1
2-3	240	17	38	-1
3-4	240	18	38	-0.5
4-5	220	21	36	-2
5-6	220	18	37	-1
6-7	230	17	36	-1
7-8	210	20	38	+2.5
8-9	210	20	42	+4.5
9-10	210	25	46	+4.5
10-11	210	26	46	+5
11-12	210	23	48	+6
12-13	220	22	48	+6
13-14	220	23	50	+5
14-15	220	22	48	+3
15-16	220	26	46	+2.5
16-17	200	31	46	+1
17-18	200	30	43	0
18-19	200	30	42	+0.5
19-20	190	30	42	+0.5
20-21	200	27	42	0
21-22	190	28	42	-0.5
22-23	190	30	41	-0.5
23-24	190	30	41	-0.5

DATE: 11/10/78

0-1	200	30	41	-0.5
1-2	200	28	40	0
2-3	190	27	40	0
3-4	190	23	40	+0.5
4-5	220	24	38	+0.5
5-6	220	23	38	+0.5
6-7	230	25	35	+0.5
7-8	230	23	34	+1
8-9	190	28	36	+1
9-10	200	33	36	+1
10-11	190	37	38	+1
11-12	190	36	39	+1
12-13	220	33	40	+1
13-14	210	31	39	+1
14-15	210	30	39	+0.5
15-16	190	32	39	+0.5
16-17	190	30	38	+0.5
17-18	220	38	36	+0.5
18-19	190	26	37	+0.5
19-20	200	21	37	+0.5
20-21	220	19	36	+0.5
21-22	210	12	33	0
22-23	180	10	32	+0.5
23-24	210	22	34	-0.5

Remissing data Doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/11/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	200	20	34	-0.5
1-2	170	18	34	-0.5
2-3	170	15	33	-0.5
3-4	190	19	35	-0.5
4-5	190	20	34	0
5-6	190	20	32	+0.5
6-7	200	30	32	T
7-8	200	26	33	0
8-9	200	20	33	0
9-10	180	20	33	0
10-11	180	18	32	-0.5
11-12	180	24	34	-1.5
12-13	180	18	38	+1.5
13-14	190	20	38	0
14-15	180	26	37	0
15-16	180	22	38	0
16-17	190	20	38	0
17-18	170	20	39	-0.5
18-19	170	22	39	0
19-20	170	20	36	0
20-21	170	24	34	0
21-22	190	30	32	+0.5
22-23	200	NO DATA	31	0
23-24	190		30	0

DATE: 11/12/78

0-1	190		30	0
1-2	190		30	0
2-3	200		30	0
3-4	200		30	0
4-5	210		30	0
5-6	190		30	0
6-7	240		28	0
7-8	230		26	0
8-9	220		26	+0.5
9-10	200		26	+0.5
10-11	200		26	+0.5
11-12	220		26	+1
12-13	200		25	+0.5
13-14	210		25	+0.5
14-15	230		22	+1
15-16	230		22	+0.5
16-17	220		22	+0.5
17-18	210		22	+0.5
18-19	200		22	+0.5
19-20	210		22	+0.5
20-21	220		22	+0.5
21-22	220		21	Clock Stopped
22-23	220		20	
23-24	220		20	

Hemissing data Pedoubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/13/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	220		20	Clock Stopped
1-2	220		19	
2-3	230		18	
3-4	230		18	
4-5	210		18	
5-6	210		18	
6-7	210		18	
7-8	210		18	
8-9	200		18	
9-10	210		20	
10-11	200		20	
11-12	210		17	
12-13	230		20	
13-14	250		20	
14-15	240		20	
15-16	250		20	
16-17	260		18	
17-18	220		19	
18-19	220		20	
19-20	220		20	
20-21	220		20	
21-22	220		20	
22-23	215		20	
23-24	215		20	

DATE: 11/14/78

0-1	215		20	Clock Stopped
1-2	215		20	
2-3	215		20	
3-4	270		19	
4-5	330		18	
5-6	330		18	
6-7	0		18	
7-8	0		20	
8-9	0		23	
9-10	20		24	
10-11	20		25	
11-12	30		24	
12-13	30		24	
13-14	30		23	
14-15	270		22	
15-16	280		21	
16-17	280		20	
17-18	280		20	
18-19	280		20	
19-20	350		18	
20-21	350		18	
21-22	280		18	
22-23	200		18	
23-24	200		18	

Hemissing data Pedoubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/15/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	200		18	Clock Stopped
1-2	20		18	
2-3	20		18	
3-4	20		18	
4-5	20		20	
5-6	20		22	
6-7	20		23	
7-8	20		23	
8-9	20		24	
9-10	20		24	
10-11	20		24	
11-12	20		25	
12-13	30		25	
13-14	30		26	
14-15	30		25	
15-16	30		23	
16-17	30		22	
17-18	30		22	
18-19	60		22	
19-20	70		22	
20-21	70		22	
21-22	70		20	
22-23	70		20	
23-24	70		20	

DATE: 11/16/78

0-1	300		20	Clock Stopped
1-2	270		20	
2-3	250		20	
3-4	240		20	
4-5	230		22	
5-6	230		24	
6-7	230		25	
7-8	240		26	
8-9	240		26	
9-10	230		27	
10-11	230		27	
11-12	220		28	
12-13	220		27	
13-14	210		26	
14-15	210		26	
15-16	210		26	
16-17	210		26	
17-18	225		26	
18-19	230		25	
19-20	240		25	Clock Stopped
20-21	220		25	+1
21-22	210		24	+0.5
22-23	210		24	+0.5
23-24	210		24	0

Memissime data Pedoubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/17/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	210		24	0
1-2	210		25	0
2-3	210		25	0
3-4	210		26	0
4-5	210		26	-1
5-6	210		30	-1
6-7	220		30	0
7-8	230		32	0
8-9	210		33	0
9-10	220		33	0
10-11	220		34	0
11-12	240		34	0
12-13	220		33	-0.5
13-14	230		32	-0.5
14-15	260		30	+1
15-16	220		30	+1
16-17	200		30	+1
17-18	210		30	+1
18-19	210		30	+1
19-20	220		30	+1.5
20-21	220		30	+1.5
21-22	200		30	+1
22-23	210		30	+1
23-24	220		30	+0.5

DATE: 11/18/78

0-1	220		30	+0.5
1-2	230		30	0
2-3	240		30	0
3-4	230		30	0
4-5	210		30	0
5-6	200		36	0
6-7	210		37	0
7-8	210		38	0
8-9	220		38	+0.5
9-10	220		38	0
10-11	230		38	0
11-12	220		38	0
12-13	230		38	0
13-14	Clock Stopped		36	0
14-15			34	+1
15-16			34	+2
16-17			34	+1.5
17-18			34	+2
18-19			33	+3.5
19-20			33	+3.5
20-21			32	+3
21-22			32	+3.5
22-23			32	+3
23-24			32	+2.5

Memissime data Pedoubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/19/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1				
1-2			33	+1
2-3			32	+1.5
3-4			Clock Stopped	+1.5
4-5				+1
5-6				+1
6-7				+1
7-8				+1
8-9				+0.5
9-10				+0.5
10-11				0
11-12				+0.5
12-13				+0.5
13-14				+0.5
14-15				+2.5
15-16				+3
16-17				+3.5
17-18				+5
18-19				+4.5
19-20				+4.5
20-21				+3.5
21-22				+2.5
22-23				+1.5
23-24				+0.5

DATE: 11/20/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1				0
1-2				+0.5
2-3				0
3-4				0
4-5				0
5-6				0
6-7				0
7-8				0
8-9				0
9-10				0
10-11				0
11-12				-0.5
12-13				-0.5
13-14				-0.5
14-15				+2.5
15-16				+3
16-17				+3.5
17-18				+3.5
18-19				+3.5
19-20				+2.5
20-21				+2.5
21-22				+2
22-23				+0.5
23-24				-0.5

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/21/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				
10-11				
11-12	STARTED CHARTS			
12-13	180			
13-14	180	26	43	+2.5
14-15	185	32	42	+2.0
15-16	195	32	42	+1.0
16-17	190	26	37	-0.5
17-18	190	32	36	-1.0
18-19	190	28	35	-1.0
19-20	190	28	35	-1.0
20-21	180	25	34	-1.5
21-22	180	26	34	-1.0
22-23	180	34	35	-0.5
23-24	185	36	36	0

DATE: 11/22/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	190	38	35	0
1-2	190	40	33	0
2-3	190	37	31	0
3-4	200	48	30	0
4-5	210	30	30	+2.5
5-6	210	33	30	+0.5
6-7	200	35	30	+0.5
7-8	195	38	29	+0.5
8-9	190	36	28	+1.0
9-10	200	38	30	+1.5
10-11	210	38	29	+1.0
11-12	210	38	31	+1.0
12-13	220	34	30	+2.5
13-14	225	26	32	+2.0
14-15	245	30	31	+1.0
15-16	230	30	30	+1.0
16-17	240	22	29	0
17-18	240	22	28	0
18-19	230	23	28	0
19-20	225	20	27	0
20-21	220	22	26	0
21-22	235	17	26	0
22-23	230	16	26	-0.5
23-24	230	17	25	0

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/23/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	240	17	26	0
1-2	240	16	25	0
2-3	230	16	25	0
3-4	230	16	24	0
4-5	230	14	23	0
5-6	230	14	23	0
6-7	230	16	23	-0.5
7-8	240	13	23	-0.5
8-9	220	11	26	+2.0
9-10	230	12	29	+2.5
10-11	230	11	30	+3.5
11-12	230	18	31	+3.5
12-13	230	15	31	+3.5
13-14	210	13	30	+2.5
14-15	210	13	28	+1.0
15-16	210	16	28	+0.5
16-17	210	10	27	+0.5
17-18	200	11	26	+2.5
18-19	220	11	26	-0.5
19-20	230	11	25	-0.5
20-21	210	12	25	-0.5
21-22	200	12	25	-0.5
22-23	210	12	26	-0.5
23-24	210	10	26	0

DATE: 11/24/78

0-1	205	10	26	0
1-2	200	10	25	-1.0
2-3	135	7	24	-1.0
3-4	60	8	22	-1.5
4-5	60	9	22	-1.5
5-6	20	11	22	-2.0
6-7	20	11	24	-1.0
7-8	25	12	25	0
8-9	30	13	26	0
9-10	25	10	29	+1.5
10-11	40	8	29	+1.5
11-12	60	7	30	+1.0
12-13	30	10	30	+1.0
13-14	330	7	32	+1.0
14-15	70	10	34	+2.0
15-16	50	10	32	+0.5
16-17	10	12	30	-0.5
17-18	30	14	30	-1.0
18-19	40	13	30	-0.5
19-20	30	11	30	-1.0
20-21	35	14	30	-1.0
21-22	35	15	30	-1.5
22-23	40	13	30	-1.0
23-24	110	11	31	-2.0

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/25/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	180	13	32	-1.5
1-2	215	16	32	0
2-3	210	12	29	0
3-4	170	10	30	+0.5
4-5	155	10	30	+0.25
5-6	160	9	30	+0.5
6-7	220	24	28	+0.25
7-8	205	27	27	+0.5
8-9	200	18	27	+0.5
9-10	210	18	28	+1.0
10-11	210	17	27	+1.0
11-12	210	20	28	+1.0
12-13	210	18	27	+0.75
13-14	200	18	26	+1.0
14-15	200	18	26	+0.75
15-16	250	14	26	+0.5
16-17	210	12	26	+0.5
17-18	210	12	24	+0.5
18-19	200	13	25	+0.5
19-20	210	13	25	+0.5
20-21	210	11	24	+0.5
21-22	210	10	24	+0.5
22-23	210	9	24	+0.5
23-24	220	12	24	+0.5

DATE: 11/26/78

0-1	220	11	24	+0.5
1-2	240	8	23	+0.5
2-3	330	8	21	-1.0
3-4	345	11	19	+0.5
4-5	340	12	18	+0.5
5-6	340	14	17	+0.5
6-7	350	14	16	+0.5
7-8	5	14	16	0
8-9	10	14	16	0
9-10	10	12	16	+0.5
10-11	30	12	16	+0.5
11-12	35	10	16	+0.75
12-13	40	9	18	+0.75
13-14	30	9	18	+0.75
14-15	35	8	18	+0.75
15-16	355	11	17	+0.5
16-17	10	10	16	+0.5
17-18	10	10	16	+0.5
18-19	10	10	16	+0.5
19-20	10	12	15	+0.5
20-21	355	12	15	+0.5
21-22	355	12	15	+0.5
22-23	345	14	14	+0.5
23-24	350	14	14	+0.5

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/27/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	350	12	14	CLOCK STOPPED
1-2	5	12	14	
2-3	10	7	13	
3-4	30	8	12	
4-5	20	10	12	
5-6	5	8	12	
6-7	15	8	11	
7-8	5	7	12	
8-9	15	7	14	
9-10	20	5	14	
10-11	60	5	14	
11-12	130	5	17	
12-13	150	5	16	
13-14	75	7	17	
14-15	35	6	17	
15-16	10	6	16	
16-17	15	6	16	
17-18	30	6	16	
18-19	50	6	16	
19-20	45	6	17	
20-21	90	5	17	
21-22	225	7	14	
22-23	220	7	15	
23-24	225	9	16	

DATE: 11/28/78

0-1	225	9	16	
1-2	230	11	16	
2-3	225	12	16	
3-4	210	12	15	
4-5	225	12	15	
5-6	270	13	15	
6-7	230	13	15	
7-8	225	14	16	
8-9	235	13	17	
9-10	240	13	17	
10-11	230	17	18	
11-12	220	18	18	
12-13	235	17	18	
13-14	245	18	18	
14-15	250	22	18	
15-16	255	22	18	
16-17	260	20	18	
17-18	260	20	18	
18-19	255	20	18	
19-20	260	16	18	
20-21	255	21	18	
21-22	255	20	18	
22-23	260	22	18	
23-24	260	20	19	

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 11/29/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	260	18	20	
1-2	265	18	19	
2-3	245	18	19	
3-4	240	17	19	
4-5	240	16	19	
5-6	240	16	19	
6-7	220	16	19	
7-8	215	17	CLOCK STOPPED	
8-9	215	17		
9-10	225	16		
10-11	225	15		
11-12	210	15		
12-13	225	18		
13-14	235	15		
14-15	240	12		
15-16	235	12		
16-17	235	8		
17-18	240	8		
18-19	270	8		
19-20	235	9		
20-21	240	8		
21-22	245	7		
22-23	240	6		
23-24	240	7		

DATE: 11/30/78

0-1	250	7	
1-2	245	6	
2-3	225	7	
3-4	225	7	
4-5	220	8	
5-6	215	8	
6-7	220	8	
7-8	225	6	
8-9	235	4	
9-10	225	4	
10-11	230	4	
11-12	230	4	
12-13	225	4	RESET
13-14	240	4	27
14-15	240	4	27
15-16	240	4	28
16-17	240	4	28
17-18	225	4	27
18-19	230	4	27
19-20	230	4	24
20-21	220	4	22
21-22	220	4	22
22-23	215	4	22
23-24	200	4	20

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/1/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	210	5	20	
1-2	215	5	19	
2-3	220	4	19	
3-4	210	9	18	
4-5	200	8	18	
5-6	200	9	16	
6-7	200	9	14	
7-8	200	10	12	
8-9	210	9	10	
9-10	215	9	9	
10-11	220	9	9	
11-12	225	9	9	
12-13	230	9	8	RESET
13-14	220	11	8	+0.5
14-15	220	11	6	+0.5
15-16	220	10	6	+0.5
16-17	230	10	4	+0.5
17-18	225	10	4	+0.5
18-19	220	9	2	+0.5
19-20	345	7	2	+0.5
20-21	350	8	1	+0.5
21-22	345	8	0	+0.5
22-23	350	8	-1	+0.5
23-24	340	8	-1	+0.5

DATE: 12/2/78

0-1	340	10	0	+0.5
1-2	345	10	0	+0.5
2-3	345	10	0	+0.5
3-4	345	11	2	0
4-5	355	11	1	0
5-6	345	11	2	0
6-7	350	10	2	+0.5
7-8	350	10	2	-0.5
8-9	340	10	3	-1.0
9-10	340	10	8	0
10-11	340	11	10	+0.5
11-12	340	11	12	-0.5
12-13	350	11	10	CLOCK STOPPED
13-14	5	11	10	
14-15	10	10	8	
15-16	10	11	6	
16-17	0	10	6	
17-18	5	9	6	
18-19	340	9	6	
19-20	350	10	7	
20-21	15	10	8	
21-22	10	10	8	
22-23	10	8	8	
23-24	5	8	8	

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/3/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	10	9	9	
1-2	20	9	9	
2-3	10	9	10	
3-4	20	10	10	
4-5	15	8	10	
5-6	15	8	10	
6-7	15	8	10	
7-8	15	7	12	
8-9	15	6	13	
9-10	340	6	14	
10-11	340	6	16	
11-12	20	6	17	
12-13	240	5	16	
13-14	220	6	16	
14-15	240	6	16	
15-16	220	6	18	
16-17	210	8	18	
17-18	230	8	21	
18-19	245	8	22	
19-20	250	8	22	
20-21	230	8	23	
21-22	225	8	25	
22-23	230	7	25	
23-24	220	7	25	

DATE: 12/4/78

0-1	220	6	24
1-2	200	6	23
2-3	225	7	23
3-4	230	7	24
4-5	220	7	24
5-6	220	7	24
6-7	210	7	24
7-8	220	7	23
8-9	230	8	23
9-10	230	10	23
10-11	220	10	22
11-12	235	10	21
12-13	235	11	18
13-14	235	11	16
14-15	235	12	14
15-16	235	12	12
16-17	230	10	10
17-18	225	10	8
18-19	210	10	7
19-20	230	11	6
20-21	225	12	6
21-22	220	13	4
22-23	220	12	4
23-24	230	18	2

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/5/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	230	18	2	
1-2	235	14	2	
2-3	230	14	2	
3-4	220	13	2	
4-5	210	12	2	
5-6	230	12	2	
6-7	210	15	2	
7-8	220	14	2	
8-9	270	11	3	
9-10	310	12	5	
10-11	320	10	6	
11-12	330	13	6	
12-13	340	15	6	
13-14	350	14	6	
14-15	340	17	9	
15-16	340	17	10	
16-17	340	18	8	
17-18	350	18	6	
18-19	350	16	6	
19-20	0	14	6	
20-21	0	14	4	
21-22	350	14	4	
22-23	350	15	3	
23-24	340	14	2	

DATE: 12-6-78

0-1	340	15	2	
1-2	350	15	2	
2-3	350	14	2	
3-4	5	14	2	
4-5	10	14	0	
5-6	10	14	-2.0	
6-7	10	14	-6.0	
7-8	20	14	-6.0	
8-9	30	16	-6.0	
9-10	40	15	-4.0	
10-11	45	14	-4.0	
11-12	45	13	-4.0	
12-13	40	12	-2.0	
13-14	40	11	-2.0	
14-15	200	10	-4.0	
15-16	200	15	-6.0	
16-17	180	14	-8.0	
17-18	190	12	-10.0	
18-19	200	11	-10.0	
19-20	200	10	-10.0	
20-21	200	11	-10.0	
21-22	190	10	-10.0	
22-23	190	9	-10.0	
23-24	220	8	-10.0	

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 12-7-78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	235	8	-11.0	
1-2	240	9	-12.0	
2-3	250	10	-12.0	
3-4	240	9	-12.0	
4-5	210	7	-12.0	
5-6	320	5	-12.0	
6-7	350	7	-12.0	
7-8	350	7	-10.0	
8-9	350	7	-8.0	
9-10	350	8	-6.0	
10-11	350	8	-4.0	
11-12	350	9	-4.0	
12-13	350	9	-4.0	
13-14	350	9	-4.0	
14-15	350	10	-5.0	
15-16	350	10	-6.0	
16-17	350	11	CLOCK STOPPED	
17-18	350	11		
18-19	350	11		
19-20	350	11		
20-21	350	11		
21-22	355	12		
22-23	355	11		
23-24	5	10		

DATE: 12/8/78

0-1	CLOCK STOPPED	10		
1-2		11		
2-3		11		
3-4		11		
4-5		13		
5-6		12		
6-7		12		
7-8		CLOCK STOPPED		
8-9				
9-10				
10-11				
11-12				
12-13				
13-14				
14-15				
15-16				
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/12/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				
10-11				
11-12			26	
12-13	235	22	26	0
13-14	240	18	26	+0.5
14-15	250	16	26	+0.5
15-16	250	13	26	0
16-17	255	14	25	-0.5
17-18	245	14	24	-1.0
18-19	240	12	25	-1.0
19-20	240	11	25	-0.5
20-21	260	12	25	-1.0
21-22	290	13	24	-2.0
22-23	350	16	19	-2.0
23-24	330	17	16	-3.0

DATE: 12/13/78

0-1	0	14	16	-1.5
1-2	0	16	15	-1.5
2-3	350	22	14	-1.0
3-4	350	20	14	-1.5
4-5	10	14	14	-2.5
5-6	30	15	15	-2.5
6-7	20	14	16	-2.0
7-8	30	13	17	-1.5
8-9	40	12	19	-1.0
9-10	60	9	22	-2.0
10-11	300	6	22	-3.5
11-12	200	9	28	+2.0
12-13	210	9	28	+2.0
13-14	210	10	29	+2.0
14-15	220	12	28	+1.0
15-16	230	14	27	0
16-17	230	16	26	-0.5
17-18	235	18	24	-1.5
18-19	230	19	24	-1.5
19-20	220	21	24	-2.5
20-21	230	20	24	-1.0
21-22	230	21	22	-1.0
22-23	240	20	22	-0.5
23-24	230	20	22	-1.0

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/14/79

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	240	19	22	-1.0
1-2	230	20	21	-1.0
2-3	225	21	21	-1.0
3-4	225	22	21	-1.5
4-5	235	20	20	-1.5
5-6	240	19	20	-1.0
6-7	230	19	20	-1.5
7-8	240	22	21	-1.5
8-9	240	21	23	-0.5
9-10	240	18	24	0
10-11	235	18	26	+0.5
11-12	230	16	26	+1.5
12-13	230	19	26	+1.0
13-14	235	19	26	+0.5
14-15	230	18	24	+0.5
15-16	250	16	25	0
16-17	250	16	24	-0.5
17-18	245	17	22	-1.0
18-19	240	16	21	-1.0
19-20	220	20	20	-3.0
20-21	230	20	22	-1.5
21-22	245	20	20	-1.5
22-23	220	18	20	-1.0
23-24	215	15	21	-1.5

DATE: 12/15/79

0-1	200	14	22	-1.5
1-2	200	16	22	-2.0
2-3	215	21	20	-2.5
3-4	230	21	18	-2.0
4-5	225	23	18	-2.5
5-6	220	21	19	-2.5
6-7	220	16	19	-1.0
7-8	240	16	18	-1.5
8-9	235	16	22	-2.5
9-10	220	16	26	-1.0
10-11	225	18	26	0
11-12	230	18	26	+0.5
12-13	235	16	26	+0.5
13-14	245	16	24	+0.5
14-15	240	15	22	+0.5
15-16	250	16	22	0
16-17	250	16	20	-0.5
17-18	255	14	20	-0.5
18-19	260	16	20	-2.0
19-20	265	14	20	-1.5
20-21	315	13	20	-1.0
21-22	315	20	19	-0.5
22-23	300	22	18	-1.0
23-24	300	18	16	-1.0

M=missing data D=doubtful data

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/16/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	340	16	14	-1.0
1-2	5	20	12	-0.5
2-3	5	20	11	-0.5
3-4	10	18	10	-1.0
4-5	10	13	10	-1.0
5-6	25	9	10	-1.5
6-7	45	10	10	-1.5
7-8	90	9	11	0
8-9	120	9	15	+1.0
9-10	170	10	18	+1.0
10-11	200	12	21	+0.5
11-12	220	15	22	0
12-13	230	17	22	0
13-14	235	14	22	0
14-15	230	15	22	-0.5
15-16	225	16	22	-0.5
16-17	190	12	22	-0.5
17-18	195	12	22	-1.0
18-19	205	16	25	-1.0
19-20	205	20	24	-1.0
20-21	215	28	22	-1.0
21-22	215	28	22	-1.5
22-23	210	28	23	-1.0
23-24	205	28	24	-0.5

DATE: 12/17/78

0-1	200	28	24	-0.5
1-2	200	30	25	-0.5
2-3	200	28	26	+1.5
3-4	200	32	26	+1.5
4-5	190	30	28	+2.0
5-6	190	24	30	+1.5
6-7	185	26	30	+2.5
7-8	190	36	30	+1.5
8-9	190	40	32	+1.0
9-10	195	38	30	+0.5
10-11	210	36	25	0
11-12	210	28	26	-0.5
12-13	210	32	28	-0.5
13-14	200	26	29	-0.5
14-15	210	22	28	-0.5
15-16	205	18	27	-0.5
16-17	200	18	27	-0.5
17-18	195	18	27	0
18-19	190	17	27	-0.5
19-20	200	17	27	-0.5
20-21	190	15	28	-0.5
21-22	190	14	29	-1.0
22-23	195	17	29	-0.5
23-24	200	16	29	+0.5

M=missing data D=doubtful data

365

METEOROLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/18/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	200	14	29	+0.5
1-2	200	16	29	0
2-3	200	16	29	+2.0
3-4	200	14	29	+4.0
4-5	190	15	29	+3.5
5-6	190	14	29	+3.5
6-7	200	12	29	+3.5
7-8	210	13	30	+2.5
8-9	190	13	30	+1.5
9-10	200	14	30	+1.0
10-11	190	12	30	0
11-12	190	14	30	0
12-13	200	13	30	0
13-14	200	12	29	0
14-15	200	12	29	-0.5
15-16	200	10	28	+0.5
16-17	200	10	27	+0.5
17-18	210	12	28	+0.5
18-19	200	10	27	0
19-20	210	10	27	+0.5
20-21	210	10	28	+0.5
21-22	230	9	28	+0.5
22-23	240	6	27	+0.5
23-24	220	6	27	+0.5

DATE: 12/19/78

0-1	210	8	28	+0.5
1-2	200	9	27	+0.5
2-3	210	8	27	+0.5
3-4	220	6	26	+0.5
4-5	230	6	25	+1.5
5-6	240	8	25	+2.5
6-7	250	8	24	+2.5
7-8	260	6	24	+3.0
8-9	250	5	24	+3.0
9-10	250	5	22	+2.5
10-11	250	4	21	+2.0
11-12	80	4	20	+1.0
12-13	85	4	19	+1.5
13-14	95	4	18	+2.0
14-15	100	4	18	+2.0
15-16	100	4	18	+2.0
16-17	95	4	18	+1.5
17-18	90	4	17	+1.5
18-19	90	4	17	+1.5
19-20	90	4	16	+1.0
20-21	90	4	16	-0.5
21-22	90	4	16	-0.5
22-23	90	4	16	-1.0
23-24	90	4	15	0

Icing Over — Starting to ice over (Wind Speed Indicator is Broken)

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/20/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	90	4	14	+1.5
1-2	90	4	13	+1.5
2-3	90	4	12	+4.5
3-4	90	4	11	+5.0
4-5	90	4	10	+4.5
5-6	90	4	8	+3.0
6-7	90	4	6	+2.5
7-8	90	4	6	+2.0
8-9	90	4	9	+2.0
9-10	90	4	10	+1.0
10-11	90	4	12	0
11-12	90	4	14	-0.5
12-13	90	4	14	-0.5
13-14	90	4	12	-0.5
14-15	85	4	10	-0.5
15-16	80	4	10	0
16-17	80	4	10	0
17-18	80	4	10	0
18-19	80	4	10	-0.5
19-20	80	4	10	-0.5
20-21	85	5	10	-0.5
21-22	85	4	10	-1.0
22-23	85	4	10	-0.5
23-24	85	4	10	-0.5

DATE: 12-21/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	85	4	10	-0.5
1-2	85	4	10	+1.0
2-3	85	4	9	+2.5
3-4	85	4	8	+3.0
4-5	85	4	8	+3.5
5-6	85	4	8	+3.0
6-7	85	4	8	+3.5
7-8	85	4	9	+2.5
8-9	85	4	11	+2.0
9-10	85	4	12	+1.0
10-11	80	4	14	+1.0
11-12	80	4	14	+0.5
12-13	80	4	15	+0.5
13-14	80	4	14	-0.5
14-15	80	5	15	-1.5
15-16	80	5	14	-1.0
16-17	80	4	14	-1.0
17-18	80	4	14	-1.5
18-19	80	4	15	-1.5
19-20	80	4	16	+0.5
20-21	80	4	15	-0.5
21-22	80	4	14	+0.5
22-23	80	4	14	+0.5
23-24	80	5	14	+1.0

M=missing data D=doubtful data

365

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/22/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	80	5	14	-2.0
1-2	80	5	14	-3.5
2-3	80	5	14	-0.5
3-4	80	5	14	+0.5
4-5	80	5	14	-2.0
5-6	80	5	14	+3.0
6-7	80	4	14	+0.5
7-8	80	4	14	+1.0
8-9	80	4	14	+1.0
9-10	80	4	18	+0.5
10-11	80	5	19	-0.5
11-12	80	5	18	-2.0
12-13	80	5	18	-1.5
13-14	75	5	18	-1.5
14-15	70	5	18	-0.5
15-16	70	5	17	-1.0
16-17	70	5	16	-1.5
17-18	75	5	15	-1.5
18-19	75	4	14	-1.0
19-20	75	4	14	-1.0
20-21	80	4	14	-1.0
21-22	80	5	14	-1.5
22-23	80	5	14	-1.5
23-24	80	5	14	-1.0

DATE: 12/23/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	100	5	14	-1.0
1-2	100	5	14	0
2-3	100	5	14	+1.0
3-4	290	5	13	+1.5
4-5	290	5	14	clock stopped
5-6	290	5	14	
6-7	200	5	14	
7-8	180	4	14	
8-9	210	4	14	
9-10	220	5	16	
10-11	270	5	15	
11-12	260	5	16	
12-13	260	5	17	
13-14	250	5	16	
14-15	250	10	16	
15-16	250	8	14	
16-17	250	6	14	
17-18	250	4	14	
18-19	250	4	14	
19-20	250	4	14	
20-21	250	4	14	
21-22	250	5	15	
22-23	250	5	15	
23-24	250	5	15	

Weather Vane Broke

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/24/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	250	5	16	
1-2	250	5	15	
2-3	250	5	14	
3-4	250	5	14	
4-5	250	5	14	
5-6	250	5	14	
6-7	250	4	14	
7-8	250	4	16	
8-9	250	4	18	
9-10	250	10	22	
10-11	250	13	22	
11-12	250	14	19	
12-13	250	12	18	
13-14	250	14	19	
14-15	250	12	20	
15-16	250	12	20	
16-17	250	18	18	
17-18	250	20	18	
18-19	260	18	18	
19-20	260	20	18	
20-21	260	20	18	
21-22	260	20	18	
22-23	260	18	19	
23-24	260	16	19	

DATE: 12/25/78

0-1	260		14	18
1-2	260		14	18
2-3	260		14	19
3-4	260		14	18
4-5	260		14	18
5-6	260		12	19
6-7	260		12	19
7-8	260		10	20
8-9	260		10	22
9-10	260		5	24
10-11	260		5	24
11-12	260		5	24
12-13	260		5	24
13-14	260		5	23
14-15	260		5	22
15-16	260		5	22
16-17	260		5	20
17-18	260		5	20
18-19	260		5	20
19-20	260		5	20
20-21	260		5	18
21-22	260		5	18
22-23	260		5	17
23-24	260		5	16

Either Iced Up or Cup Broke

M=missing data D=doubtful data

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METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/26/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	260	5	16	
1-2	260	4	17	
2-3	260	4	16	
3-4	260	4	16	
4-5	260	5	17	
5-6	260	4	17	
6-7	260	4	16	
7-8	260	4	16	
8-9	260	5	14	
9-10	260	5	17	
10-11	260	5	18	
11-12	260	5	24	
12-13	260	5	22	
13-14	260	5	21	
14-15	260	5	20	
15-16	260	5	20	
16-17	260	5	18	
17-18	260	5	16	
18-19	260	5	16	
19-20	260	4	16	
20-21	260	5	15	
21-22	260	5	16	
22-23	260	5	17	
23-24	260	5	17	

DATE: 12/27/78

0-1	260	5	18	
1-2	260	5	18	
2-3	260	5	18	
3-4	260	5	18	
4-5	260	5	20	
5-6	260	5	20	
6-7	260	5	20	
7-8	260	5	22	
8-9	260	clock stopped	23	
9-10	260	changed chart	24	
10-11	260		changed chart	
11-12	changed chart			changed chart
12-13				
13-14				
14-15				
15-16				
16-17				
17-18				
18-19				
19-20				
20-21				
21-22				
22-23				
23-24				

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/27/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
6-7				
7-8				
8-9				
9-10				
10-11			started clocks	started clocks
11-12	broke down	broke down	23	+2.5
12-13	broke down	broke down	23	+2.0
13-14	" "	" "	24	+1.0
14-15	" "	" "	24	+1.5
15-16	" "	" "	23	+0.5
16-17	" "	" "	22	0
17-18	" "	" "	22	0
18-19	" "	" "	22	+0.5
19-20	" "	" "	22	+0.5
20-21	" "	" "	21	+0.5
21-22	" "	" "	20	+0.5
22-23	" "	" "	20	+0.5
23-24	" "	" "	20	+0.5

DATE: 12/28/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	broke down	broke down	19	+1.0
1-2	" "	" "	20	+0.5
2-3	" "	" "	19	+0.5
3-4	" "	" "	19	+0.5
4-5	" "	" "	18	+0.5
5-6	" "	" "	18	+0.5
6-7	" "	" "	18	+0.5
7-8	" "	" "	18	+0.5
8-9	" "	" "	18	+0.5
9-10	" "	" "	18	+1.0
10-11	" "	" "	18	+1.0
11-12	" "	" "	19	+1.0
12-13	" "	" "	20	+1.0
13-14	" "	" "	20	+1.0
14-15	" "	" "	20	+1.0
15-16	" "	" "	21	+1.0
16-17	" "	" "	20	+0.5
17-18	" "	" "	19	+0.5
18-19	" "	" "	19	+0.5
19-20	" "	" "	19	+0.5
20-21	" "	" "	19	0
21-22	" "	" "	18	0
22-23	" "	" "	19	0
23-24	" "	" "	20	+0.5

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/29/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	broke down	broke down	20	+0.5
1-2	" "	" "	18	0
2-3	" "	" "	18	0
3-4	" "	" "	18	+0.5
4-5	" "	" "	18	+0.5
5-6	" "	" "	18	+0.5
6-7	" "	" "	18	+0.5
7-8	" "	" "	18	+0.5
8-9	" "	" "	18	+0.5
9-10	" "	" "	20	+2.5
10-11	" "	" "	22	+3.0
11-12	" "	" "	22	+3.0
12-13	" "	" "	21	+1.5
13-14	" "	" "	21	+2.0
14-15	" "	" "	22	+2.5
15-16	" "	" "	22	+1.0
16-17	" "	" "	22	+0.5
17-18	" "	" "	22	+0.5
18-19	" "	" "	21	+0.5
19-20	" "	" "	20	+0.5
20-21	" "	" "	20	+0.5
21-22	" "	" "	19	+0.5
22-23	" "	" "	19	+0.5
23-24	" "	" "	19	+0.5

DATE: 12/30/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	broke down	broke down	19	-0.5
1-2	" "	" "	19	0
2-3	" "	" "	19	0
3-4	" "	" "	19	-0.5
4-5	" "	" "	18	0
5-6	" "	" "	18	-0.5
6-7	" "	" "	18	-1.0
7-8	" "	" "	18	-0.5
8-9	" "	" "	18	-1.5
9-10	" "	" "	18	clock stopped
10-11	" "	" "	20	" "
11-12	" "	" "	20	" "
12-13	" "	" "	19	" "
13-14	" "	" "	18	" "
14-15	" "	" "	19	" "
15-16	" "	" "	19	" "
16-17	" "	" "	18	" "
17-18	" "	" "	18	" "
18-19	" "	" "	17	" "
19-20	" "	" "	17	" "
20-21	" "	" "	16	" "
21-22	" "	" "	16	" "
22-23	" "	" "	15	" "
23-24	" "	" "	14	" "

M=missing data D=doubtful data

METEORLOGICAL DATA 1 HOUR AVERAGES

DATE: 12/31/78

HOUR	WIND DIR.(°)	WIND SPEED(mph)	TEMP.(°F)	ΔT(°F)
0-1	broke down	broke down	14	" "
1-2	" "	" "	13	" "
2-3	" "	" "	12	" "
3-4	" "	" "	10	" "
4-5	" "	" "	10	" "
5-6	" "	" "	9	" "
6-7	" "	" "	6	" "
7-8	" "	" "	2	" "
8-9	" "	" "	2	" "
9-10	" "	" "	4	" "
10-11	" "	" "	6	" "
11-12	" "	" "	7	" "
12-13	" "	" "	8	" "
13-14	" "	" "	7	" "
14-15	" "	" "	8	" "
15-16	" "	" "	7	" "
16-17	" "	" "	6	" "
17-18	" "	" "	6	" "
18-19	" "	" "	4	" "
19-20	" "	" "	2	" "
20-21	" "	" "	2	" "
21-22	" "	" "	-2	" "
22-23	" "	" "	-4	" "
23-24	" "	" "	-6	" "

DATE: 1/1/79

0-1	broke down	broke down	-6	" "
1-2	" "	" "	-7	" "
2-3	" "	" "	-9	" "
3-4	" "	" "	-10	" "
4-5	" "	" "	-10	" "
5-6	" "	" "	-12	" "
6-7	" "	" "	-13	" "
7-8	" "	" "	-13	" "
8-9	" "	" "	-12	" "
9-10	" "	" "	-11	" "
10-11	" "	" "	-10	" "
11-12	" "	" "	-10	" "
12-13	" "	" "	-10	" "
13-14	" "	" "	-9	" "
14-15	" "	" "	-9	" "
15-16	" "	" "	-10	" "
16-17	" "	" "	-10	" "
17-18	" "	" "	-10	" "
18-19	" "	" "	-10	" "
19-20	" "	" "	-10	" "
20-21	" "	" "	-9	" "
21-22	" "	" "	-10	" "
22-23	" "	" "	-10	" "
23-24	" "	" "	-8	" "

M=missing data D=doubtful data

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APPENDIX B8

MECHANICAL WEATHER STATION - HEATER TREATER SITE -
WIND FREQUENCY DATA - 10 METER LEVEL

FREQUENCY TABLE OF WIND SPEED BY DIRECTION

MRI WIND SPEED @ 10 METERS — LOGAN WASH OIL SHALE PROJECT

STATION LW01 PERIOD(10/01/78 TO 10/31/78)

WIND SPEED MAX METERS/SEC	WIND DIRECTION N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	CALM	TOTAL
	0	0	4	9	9	3	2	4	4	3	4	4	5	9	3	2	0	
GT 11. :	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 :	0
8. - 11. :	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0 :	3
5. - 8. :	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0 :	3
3. - 5. :	0	0	1	2	4	0	0	1	1	0	1	1	7	4	0	0	0 :	22
1. - 3. :	0	0	6	30	139	79	26	21	25	11	16	32	60	27	8	5	0 :	485
LT 1. :	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 :	0
TOTAL :	0	0	7	33	147	79	26	22	26	11	17	33	67	32	8	5	0	513
PERCENT	0.	0.	1.	6.	29.	15.	5.	4.	5.	2.	3.	6.	13.	6.	2.	0.	0.	99.

0 = NO OBSERVATIONS

FREQUENCY TABLE OF WIND SPEED BY DIRECTION

MPI WIND SPEED @ 10 METERS — LOGAN WASH OIL SHALE PROJECT

STATION LW01 PERIOD(11/01/78 TO 11/30/78)

WIND SPEED MAX METERS/SEC	WIND DIRECTION N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	CALM	TOTAL
	3	1	4	4	5	4	5	4	6	2	2	4	7	7	4	4	0	
GT 11.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8. - 11.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5. - 8.	0	0	0	0	0	0	0	0	1	0	0	0	4	2	0	0	0	7
3. - 5.	0	0	1	2	14	4	3	1	1	0	0	1	14	7	3	1	0	52
1. - 3.	1	2	6	8	87	127	62	29	24	15	13	17	111	47	17	2	0	568
LT 1.	0	0	0	1	5	0	1	1	2	1	0	0	1	0	1	1	0	14
TOTAL	1	2	7	11	106	131	66	31	28	16	13	18	130	56	21	4	0	641
PERCENT	0.	0.	1.	2.	17.	20.	10.	5.	4.	2.	2.	3.	20.	9.	3.	1.	0.	100.

0 = NO OBSERVATIONS

APPENDIX B9

MECHANICAL WEATHER STATION
HEATER TREATER SITE DATA - 10 METER LEVEL

DIURNAL VALUES OF WIND DIRECTION AT 10 METERS(DEG)
MRI STATION = LW01 PERIOD(10/01/78 TO 10/31/78)

DAY	HOUR 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MEAN
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																230	260	255	228	86	64	201	225	81	
11	211	155	80	157	77	57	90	72	92	133	229	250	247	259	248	252	268	263	228	81	135	93	120	142	158
12	116	121	70	63	79	97	91	97	112	111	210	243	253	268	246	252	258	284	180	78	117	82	69	63	117
13	100	90	85	85	90	150	100	85	260	180	270	260	240	200	90	200	180	150	89	85	100	100	90	150	127
14	70	65	70	60	90	90	90	90	160	90	160	250	270	280	230	270	270	260	100	90	90	100	85	80	98
15	90	85	85	90	90	90	90	90	90	90	180	250	240	220	260	270	270	250	75	90	90	80	83	80	103
16	90	80	85	90	90	90	90	105	90	150	270	270	270	265	270	270	270	150	90	90	90	85	85	80	99
17	90	75	90	90	90	90	90	90	90	90	180	270	260	270	260	253	270	270	188	180	75	90	260	75	122
18	273	90	85	90	90	305	91	90	90	185	340	180	265	180	90	90	270	195	105	93	78	117	83	90	105
19	64	134	87	87	83	87	101	83	88	101	134	242	251	253	263	262	252	249	143	96	88	77	68	60	106
20	60	62	82	88	87	92	96	115	89	257	280	311	289	276	262	241	262	85	189	267	194	123	78	81	108
21	341	189	103	35	120	117	221	146	81	190	97	269	263	246	233	73	55	56	70	94	99	78	85	119	106
22	140	221	180	209	150	176	191	165	286	83	304	299	297	297	292	311	45	50	61	149	189	325	101	328	226
23	327	316	79	158	125	161	94	83	79	102	136	225	249	250	234	262	271	169	79	78	162	134	92	103	136
24	98	97	93	135	119	336	103	89	62	261	254	266	287	284	267	286	260	254	216	168	183	195	182	276	214
25	281	149	178	267	286	135	145	137	123	117	154	175	178	164	198	180	174	237	292	226	119	100	99	163	169
26	125	117	114	105	87	121	114	118	105	121	222	242	268	283	278	287	289	267	102	111	114	116	109	60	126
27	87	96	97	110	108	109	116	127	119	128	125	282	295	269	288	295	275	321	92	80	85	91	91	105	100
28	105	108	102	114	107	109	102	121	105	122	120	224	265	270	273	274	277	244	108	102	108	111	98	95	123
29	95	91	110	103	115	125	117	108	35	191	236	291	291	278	284	285	282	282	237	113	122	153	108	120	142
30	124	56	110	129	135	125	107	121	108	318	296	270	280	284	283	282	266	95	97	112	117	93	91	99	110
31	116	117	148	105	115	116	108	135	116	120	127	244	265	281	286	286	294	213	97	75	81	97	94	98	122
MEAN	94	103	99	103	101	108	107	107	96	132	202	255	265	260	261	265	268	241	123	104	110	104	97	93	128

TOTAL NUMBER OF OBSERVATIONS = 513

DIURNAL VALUES OF WIND DIRECTION AT 10 METERS(DEG)
MRI STATION = LW01 PERIOD(11/01/78 TO 11/30/78)

	HOUR																							
DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MEAN
1	111	115	109	102	118	113	122	108	154	117	111	263	283	284	274	256	277	289	88	90	101	109	123	114	123
2	108	116	121	113	108	124	113	232	88	104	99	273	281	273	257	285	273	141	98	176	273	292	286	130	158
3	121	136	207	221	259	90	59	134	136	64	161	168	270	181	102	229	117	76	59	65	49	112	112	55	120
4	90	100	95	105	110	112	100	90	150	120	118	285	281	270	270	270	285	270	175	99	130	120	100	135	127
5	127	90	114	110	117	120	112	90	90	180	150	205	270	265	300	285	270	274	270	270	157	97	95	999	160
6	93	90	91	90	94	94	85	87	150	135	119	270	273	270	276	300	270	180	99	90	175	90	99	93	112
7	100	90	90	150	140	100	135	145	127	151	160	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	
8	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	
9	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	
10	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	270	270	270	270	312	315	270	303	90	127	
11	340	90	315	123	180	280	157	120	275	300	310	306	300	312	309	270	280	150	180	270	270	280	270	280	276
12	85	340	310	350	285	290	270	270	270	241	300	340	310	270	270	270	90	270	285	325	270	273	271	270	290
13	320	270	245	270	173	276	180	90	270	320	270	310	270	321	265	310	90	90	127	90	115	159	90	120	249
14	90	90	105	270	273	180	93	110	273	859	270	163	180	270	271	270	270	135	127	135	160	140	150	145	167
15	160	75	157	140	180	90	165	90	127	180	196	270	270	277	312	300	316	140	122	112	166	117	127	130	151
16	115	122	110	114	119	260	87	106	292	276	260	281	281	280	276	269	193	109	95	92	98	104	99	104	132
17	112	84	113	94	126	104	117	124	115	131	149	187	284	274	241	233	188	117	138	116	111	108	97	112	130
18	108	101	111	111	89	124	108	133	114	122	145	244	232	242	243	227	222	99	107	97	97	94	120	99	128
19	111	104	145	115	108	111	109	118	91	229	235	267	268	264	264	246	203	147	107	165	142	144	110	116	150
20	135	51	55	160	42	118	126	106	109	139	181	268	292	320	275	249	201	98	118	118	132	146	143	142	132
21	144	127	125	112	114	136	140	217	63	88	134	265	289	286	289	288	264	281	265	313	313	289	290	268	246
22	241	278	293	127	283	293	290	286	272	291	287	287	281	272	263	275	278	203	196	171	130	148	75	89	260
23	108	117	114	94	110	115	117	102	114	132	124	195	280	275	261	282	183	111	107	108	84	88	88	109	119
24	108	97	105	114	264	120	108	175	263	107	265	16	294	271	276	278	277	94	111	124	121	212	93	216	152
25	92	217	172	117	94	262	106	199	289	259	251	272	302	299	297	192	275	101	140	277	296	257	271	268	247
26	275	268	275	322	115	99	125	123	149	160	189	143	299	244	266	265	247	96	99	102	93	113	89	110	151
27	111	67	80	48	79	94	82	99	101	66	86	268	294	263	175	173	136	98	110	87	85	96	98	101	97
28	113	118	84	109	109	126	128	89	123	265	268	260	131	210	261	261	249	126	111	88	153	287	118	148	144
29	185	205	124	110	118	111	93	131	125	17	282	287	287	289	288	281	287	279	282	241	293	99	338	121	244
30	193	66	88	106	94	274	294	187	188	256	274	283	279	40	276	224	200	175	95	93	143	161	149	163	181
MEAN	117	102	113	113	121	122	116	126	141	152	199	264	279	275	271	264	245	139	121	110	134	131	107	129	143

TOTAL NUMBER OF OBSERVATIONS = 645

DIURNAL VALUES OF WIND SPEED AT 10 METERS(MPS)
MRI STATION = LW01 PERIOD(11/01/78 TO 11/30/78)

DAY	HOUR 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MEAN
1	2	2	1	1	1	1	1	1	1	1	1	1	2	2	2	1	1	2	2	2	2	2	1	1	2
2	1	1	1	1	1	1	1	1	1	1	1	2	3	2	2	2	1	2	3	6	4	2	1	1	2
3	1	2	2	2	3	5	4	4	5	4	3	3	3	3	2	2	2	2	2	3	3	3	3	4	3
4	3	2	2	1	2	2	2	2	2	1	1	2	2	3	3	3	2	1	2	2	2	1	1	2	2
5	2	2	2	2	2	2	2	2	2	1	1	1	2	3	2	4	5	4	2	3	3	4	4	5	3
6	4	4	4	4	4	4	3	3	2	0	1	1	2	3	3	3	1	1	2	2	4	4	1	1	3
7	2	2	2	2	1	1	1	1	1	1	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	
8	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	
9	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	
10	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	4	5	4	3	2	2	1	1	1	
11	1	2	3	1	2	2	3	4	3	3	3	4	4	3	1	4	2	2	3	3	3	4	3	4	3
12	2	3	4	3	4	4	4	2	0	1	3	4	4	1	2	3	2	1	3	2	3	3	3	3	3
13	2	1	1	2	0	1	0	2	1	1	1	2	2	2	1	0	1	1	1	0	1	1	1	1	1
14	1	0	1	1	1	1	1	1	1	1	1	0	1	2	1	1	1	1	2	1	1	1	1	1	1
15	1	1	1	1	1	1	1	2	2	2	2	1	1	2	3	1	1	1	1	1	1	1	1	1	1
16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1
17	2	2	1	1	1	1	1	1	1	1	1	1	2	2	1	1	1	1	2	2	2	2	2	2	2
18	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	3	2	2	2	2	2	2	2
19	2	2	2	2	2	2	2	2	2	2	2	3	4	4	3	3	2	1	1	1	2	1	1	1	2
20	1	1	1	1	1	1	2	2	2	2	2	3	3	3	2	2	2	2	2	2	2	2	2	2	2
21	2	2	2	2	1	1	1	1	1	1	2	3	4	4	3	3	2	2	2	2	3	3	1	4	2
22	4	3	3	3	3	3	3	3	4	5	7	7	7	6	6	6	2	1	1	1	1	1	1	1	3
23	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	1	1	1	2	2	2	2	2	2	2
24	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
25	1	1	1	1	1	1	1	1	1	1	2	2	3	3	3	2	1	1	1	1	1	1	1	2	1
26	2	2	2	2	4	4	4	4	3	2	3	3	3	3	2	2	3	2	2	3	3	3	4	4	3
27	3	3	4	3	3	4	3	2	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2
28	2	2	2	1	1	1	1	1	1	1	1	2	2	2	3	1	1	1	1	1	1	1	1	1	1
29	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	0	0	1	1
30	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4	1
MEAN	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

TOTAL NUMBER OF OBSERVATIONS = 643

DIURNAL VALUES OF WIND SPEED AT 10 METERS(MPS)
MRI STATION = LW01 PERIOD(10/01/78 TO 10/31/78)

DAY	HOUR 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MEAN
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																3	3	3	2	2	1	1	1	1	
11	1	2	1	2	2	2	2	2	2	1	2	2	2	2	3	3	3	2	1	1	1	1	1	2	2
12	2	2	2	2	2	2	2	1	1	2	2	2	3	3	3	3	2	2	2	2	2	9	4	9	3
13	7	6	6	5	3	4	3	3	2	3	2	2	3	3	2	2	2	1	1	2	2	2	2	1	3
14	2	2	1	1	2	2	2	2	2	1	2	2	3	2	2	3	2	4	1	2	2	3	3	4	2
15	2	2	2	2	2	2	2	2	1	1	1	2	3	2	3	2	3	1	2	3	3	2	3	2	2
16	2	2	2	2	2	2	1	1	1	1	1	2	3	3	4	4	4	3	1	2	2	2	2	2	2
17	2	3	2	2	2	2	2	1	1	1	1	2	3	3	4	3	2	1	1	1	1	1	1	1	2
18	2	3	2	2	3	1	1	1	1	2	1	1	2	1	1	1	1	1	2	2	2	2	1	2	2
19	2	2	2	2	2	2	2	2	1	1	1	2	2	3	3	4	4	2	2	2	2	2	2	2	2
20	2	2	2	2	2	2	2	1	1	1	1	3	3	3	2	2	1	1	1	1	1	1	1	1	2
21	1	1	1	1	1	1	1	1	1	1	1	2	2	3	3	2	3	4	4	4	4	3	3	3	2
22	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2
23	2	2	1	1	1	1	1	1	1	1	1	2	2	2	3	2	2	2	2	2	2	2	2	1	2
24	1	1	1	1	1	1	1	1	1	1	1	2	2	2	3	2	1	1	1	1	1	1	1	1	1
25	1	1	1	1	1	1	1	2	3	3	3	4	3	3	3	3	2	2	2	1	1	1	2	2	2
26	2	2	2	2	2	2	2	2	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2
27	2	2	2	2	2	2	2	2	1	1	1	2	2	2	2	2	2	2	2	3	2	2	2	2	2
28	2	2	2	2	2	2	2	2	2	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2
29	2	2	2	2	2	2	2	2	2	2	4	5	5	5	5	5	9	2	2	1	1	1	1	2	3
30	2	2	2	2	2	2	2	2	1	1	1	2	2	2	2	2	3	3	2	2	2	1	1	1	2
31	1	1	1	1	1	1	1	1	1	1	1	2	3	3	3	2	2	2	2	2	2	2	2	2	2
MEAN	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	2	2	2	2	2	2	2	2

TOTAL NUMBER OF OBSERVATIONS = 513

DIURNAL VALUES OF TEMPERATURE AT 10 METERS(DEG C)
MRI STATION = LW01 PERIOD(10/01/78 TO 10/31/78)

DAY	HOUR 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MEAN
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																21	19	19	17	12	12	12	13	12	
11	11	12	9	8	7	7	5	6	4	6	14	16	17	19	20	19	19	18	17	12	11	10	10	9	12
12	8	8	8	8	6	7	6	4	4	6	12	15	17	17	18	18	18	17	16	11	12	12	11	9	11
13	9	7	6	4	4	4	4	4	6	8	10	11	14	16	17	16	15	15	13	10	10	10	7	7	9
14	6	5	5	4	4	3	3	2	2	3	10	14	14	16	18	18	20	20	16	10	10	10	9	9	10
15	6	6	6	5	4	4	4	3	3	4	11	16	17	19	21	21	21	21	17	12	11	11	10	9	11
16	9	8	8	6	5	4	4	3	3	6	14	16	18	20	21	21	21	20	16	11	9	9	9	9	11
17	9	8	8	8	8	8	8	9	11	13	14	16	16	16	16	16	16	15	14	13	12	11	11	11	12
18	11	11	10	7	8	8	6	6	7	8	9	10	11	12	13	13	14	14	10	8	8	8	9	6	9
19	7	6	4	3	3	2	2	2	2	4	9	14	17	18	19	19	18	18	13	11	9	8	10	9	9
20	9	8	7	6	4	3	4	6	6	9	11	12	13	12	9	8	7	6	4	5	4	4	4	5	7
21	4	4	4	4	4	5	4	6	5	7	8	8	10	10	8	7	7	5	6	5	5	5	4	3	6
22	2	3	4	3	2	2	2	1	1	2	1	1	2	2	2	1	1	1	1	1	1	1	0	0	2
23	0	0	0	0	-3	-2	-4	-5	-5	-3	0	4	6	9	10	12	11	11	8	5	4	4	2	2	3
24	2	1	1	2	1	1	0	0	1	2	5	6	7	7	7	7	9	6	4	2	2	1	1	2	3
25	2	2	2	2	2	2	1	0	0	0	0	0	3	3	4	3	3	2	1	-1	-2	-3	-1	-1	1
26	-5	-5	-5	-3	-5	-5	-6	-6	-7	-6	-3	3	4	6	8	8	10	10	6	2	1	1	0	1	0
27	0	0	0	0	-2	-2	-2	-2	-3	-2	0	7	9	11	11	13	13	12	6	5	5	3	2	1	4
28	1	1	0	0	0	0	0	-2	-1	-1	1	11	10	11	13	13	13	13	7	5	3	3	3	2	4
29	2	1	1	1	2	1	1	1	5	4	7	11	12	13	13	14	14	13	10	6	6	6	5	5	6
30	6	6	5	5	5	4	4	3	4	6	7	8	9	9	9	10	6	6	6	4	4	3	2	2	6
31	1	1	0	1	0	0	-1	0	-1	0	2	10	11	11	11	13	13	12	7	7	7	6	6	5	5
MEAN	5	4	4	4	3	3	2	2	2	4	7	10	11	12	13	13	13	12	10	7	7	6	6	5	7

TOTAL NUMBER OF OBSERVATIONS = 513

DIURNAL VALUES OF TEMPERATURE AT 10 METERS(DEG C)
MRI STATION = LW01 PERIOD(11/01/78 TO 11/30/78)

DAY	HOUR 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MEAN
1	5	4	4	2	3	2	2	2	2	2	4	8	12	12	15	14	14	14	9	8	7	7	4	4	7
2	6	5	4	4	4	3	4	6	3	4	7	11	14	14	15	16	15	13	13	7	3	3	3	2	7
3	1	2	3	2	4	5	5	6	5	6	6	10	12	13	15	17	17	16	13	12	12	9	9	9	9
4	9	6	4	4	3	2	2	2	1	2	3	9	11	11	13	13	12	11	7	5	4	4	5	4	6
5	4	3	3	3	3	3	2	3	3	3	4	10	13	11	11	12	11	11	8	6	6	4	3	3	6
6	3	2	2	1	0	0	0	0	0	-1	0	4	7	8	8	9	9	7	3	2	2	4	3	3	3
7	2	2	2	0	0	0	-1	-1	-1	0	0	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	
8	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	
9	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	
10	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	RF	7	7	7	4	5	5	3	2	0	0	
11	3	3	3	4	2	2	1	2	2	3	5	4	6	6	6	6	6	6	7	7	4	4	0	0	4
12	0	0	0	0	0	0	0	-3	-3	-3	-1	-1	-3	-3	-6	-6	-5	-5	-5	-5	-5	-6	-6	-6	-2
13	-6	-6	-6	-6	-6	-6	-6	-6	-6	-5	-3	-6	-5	-5	-3	-5	-5	-6	-6	-6	-6	-7	-6	-6	-5
14	-6	-6	-6	-6	-7	-6	-6	-6	-6	-6	-5	0	2	0	0	-1	-2	-3	-6	-6	-6	-6	-6	-6	-3
15	-7	-6	-7	-8	-8	-8	-9	-10	-7	-6	-6	-6	-5	-1	-1	-1	-1	-3	-6	-8	-10	-11	-11	-11	-6
16	-10	-11	-11	-10	-8	-8	-8	-8	-8	-7	-6	-4	-3	-3	-1	-1	-5	-6	-7	-7	-7	-8	-8	-9	-6
17	-9	-9	-10	-9	-11	-11	-11	-11	-11	-10	-7	0	-2	-1	0	0	1	-3	-5	-6	-6	-7	-6	-7	-5
18	-8	-8	-8	-8	-8	-9	-10	-10	-10	-10	-7	0	0	1	1	2	0	-5	-5	-6	-6	-7	-7	-7	-5
19	-6	-7	-7	-7	-7	-7	-7	-6	-5	-2	-1	0	1	1	2	3	2	-1	-2	-3	-2	-2	-3	-3	-2
20	-2	-1	-2	-2	-1	-2	-2	-2	-3	-1	0	3	4	4	5	6	5	1	0	0	0	0	-1	-1	0
21	-1	-2	-2	-2	-2	-3	-2	-2	0	0	2	6	6	7	6	6	6	3	4	3	4	3	4	5	2
22	5	3	1	1	0	0	0	0	0	0	0	0	1	2	2	1	0	-1	-2	-3	-3	-3	-4	-5	0
23	-5	-5	-5	-4	-5	-5	-5	-6	-6	-5	-4	0	0	0	0	0	0	-2	-4	-4	-5	-4	-4	-5	-2
24	-4	-4	-7	-4	-3	-6	-6	-5	-2	-4	-3	-1	1	-1	0	0	0	-1	-1	-2	-3	-2	-2	-2	-2
25	-1	-1	-2	-3	-3	-3	-4	-3	-1	1	-1	1	0	-1	0	-2	-3	-4	-3	-2	-3	-3	-3	-4	-1
26	-5	-6	-6	-6	-6	-6	-6	-7	-6	-6	-6	-6	-4	-4	-4	-5	-6	-7	-7	-8	-8	-8	-8	-7	-5
27	-8	-8	-9	-9	-11	-11	-11	-12	-11	-10	-10	-8	-7	-5	-5	-6	-7	-11	-12	-12	-11	-12	-12	-13	-9
28	-12	-12	-12	-12	-12	-12	-11	-11	-9	-9	-6	-7	-3	-3	-5	-5	-5	-6	-7	-7	-7	-7	-7	-7	-7
29	-7	-7	-8	-8	-7	-7	-7	-7	-7	-6	-4	-3	-2	-2	-3	-4	-4	-5	-6	-6	-6	-6	-6	-6	-5
30	-6	-7	-7	-6	-6	-7	-6	-7	-6	-5	-4	-3	-1	-1	-1	-2	-2	-2	-4	-5	-3	-3	-4	-3	-3
MEAN	-1	-2	-2	-2	-2	-3	-3	-3	-2	-2	-1	1	2	2	3	3	2	1	0	-1	-1	-1	-2	-2	2

TOTAL NUMBER OF OBSERVATIONS = 645

APPENDIX B10

ACOUSTIC RADAR INVERSION HEIGHTS

Description of Data Symbols

Symbols used on the data sheets are:

CA	Calibration
MT	Maintenance (changing paper, tape, filters)
FO	Flame out (on the gas chromatographs)
IM	Instrument malfunction
PF	Power failure (generator failure, power outages)
RF	Recording system failure (chart jams, runs out, tape cassette fails, on-site computer goes down)
LI	Local interference (Car nearby, contamination by generator)
OS	Off scale (at top of chart data valve greater than range of instrument)
SE	Special experiment (instrument off-line for bag sample analysis or removed for special measurements in area.
VA	Variable wind direction
IN	Interference (CO_2 interference on sulfur data, SO_2 inteference in oxidant readings)
NV	Not visible (data not visible, within range of instrument/recorder; data presumed monitored)

INVERSION HEIGHT
METERS

Logan Wash
Station LW02
DEC 1978
OCCIDENTAL OIL SHALE INC.

HOUR (LOCAL STANDARD TIME)

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	AVE	PEAK
1	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
2	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
3	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
4	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
5	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
6	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
7	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
8	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	140	170	200	200	110	200	120	( )	200
9	180	160	110	160	240	200	220	240	17	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	120	130	160	200	100	110	120	100	151	240
10	140	130	130	190	120	200	160	120	90	100	200	220	(NV)	(NV)	320	260	200	210	220	200	280	160	120	140	178	320
11	100	140	100	120	120	120	130	140	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	200	240	130	140	240	160	100	120	140	140	143	240
12	580	520	400	300	300	300	240	280	300	260	200	190	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	323	580
13	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
14	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
15	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
16	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
17	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
18	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
19	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
20	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
21	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
22	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
23	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
24	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
25	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
26	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
27	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
28	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
29	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
30	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
31	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
AV	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	
PK	580	520	400	300	300	300	240	280	300	260	200	220	( )	( )	320	260	200	210	240	200	280	160	200	140		580

INVERSION HEIGHT
METERS

Logan Wash
Station LW02
NOV 1978
OCCIDENTAL OIL SHALE INC.

HOUR (LOCAL STANDARD TIME)

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	AVE	PEAK
1	270	310	260	260	300	340	340	400	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	200	210	170	120	120	310	200	254	400
2	220	310	270	220	240	240	220	240	200	220	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	130	640	540	400	340	300	260	294	640
3	450	520	680	600	660	490	460	280	510	580	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	280	210	220	240	290	431	680
4	180	200	280	200	190	200	240	200	200	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	130	180	160	160	130	120	130	181	280
5	100	160	140	190	140	180	180	180	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	120	180	180	300	171	300
6	220	220	240	230	220	190	190	230	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	120	140	180	160	100	140	140	200	183	240
7	90	210	340	320	200	300	280	200	200	300	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	120	180	160	180	150	180	213	340
8	160	140	160	180	230	220	200	200	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	150	140	180	120	150	160	171	230
9	210	230	190	200	270	190	200	200	160	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	270
10	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
11	140	190	200	160	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	200
12	460	500	500	340	380	450	360	230	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	500
13	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
14	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
15	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
16	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
17	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
18	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
19	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
20	40	40	60	50	50	40	80	50	90	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	80	120	120	100	80	100	100	75	120
21	110	120	100	100	100	140	130	160	140	130	140	930	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	192	930
22	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	50	100	130	120	140	200	( )	200
23	100	130	150	140	140	90	120	150	120	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	120	200	200	200	200	180	149	200
24	180	180	260	310	350	400	380	380	420	400	360	300	200	200	240	320	320	360	320	340	420	460	420	430	331	460
25	200	200	140	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	200
26	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
27	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
28	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
29	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
30	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
AV	196	229	248	233	248	248	241	221	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	192	191	204	219	220	
PK	460	520	680	600	660	490	460	400	510	580	360	930	200	200	240	320	320	360	640	540	420	460	420	430		930

INVERSION HEIGHT
METERS

Logan Wash
Station LW02
OCT 1978
OCCIDENTAL OIL SHALE INC.

HOUR (LOCAL STANDARD TIME)

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	AVE	PEAK
1	170	170	160	160	180	170	170	170	140	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	30	30	30	30	30	30	30	106	180
2	300	330	310	260	250	220	230	240	120	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	30	30	30	30	30	30	30	154	330
3	180	180	140	220	240	220	280	220	300	140	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	160	160	240	230	160	240	320	214	320
4	140	160	160	160	170	190	160	110	80	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	60	110	130	160	140	150	150	139	190
5	140	140	150	150	150	40	150	130	100	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	130	170	180	170	170	200	145	200
6	260	300	310	330	330	270	270	270	270	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	330
7	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
8	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
9	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
10	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	120	160	200	180	170	180	( )	200
11	160	140	160	230	190	360	310	300	260	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	100	110	110	80	110	110	100	177	360
12	120	180	160	160	180	180	140	140	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	90	140	170	200	200	210	180	163	210
13	350	370	240	140	160	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	100	120	140	180	180	180	160	193	370
14	180	180	180	200	180	170	120	100	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	110	140	160	160	160	160	150	160	157	200
15	180	200	160	160	160	200	160	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	120	150	180	160	110	180	163	200
16	200	180	200	160	140	140	120	200	200	100	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	80	120	120	160	160	160	160	153	200
17	160	180	200	200	220	200	200	200	220	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	140	140	120	140	140	176	220
18	180	140	160	240	130	110	180	80	140	90	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	80	120	220	220	240	340	380	179	380
19	280	380	400	360	380	360	340	340	260	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	60	160	180	180	200	240	220	271	400
20	280	280	280	300	300	240	220	220	240	220	160	(NV)	(NV)	(NV)	(NV)	(NV)	200	160	120	260	380	280	220	140	237	380
21	480	540	460	280	200	140	140	120	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	120	300	380	420	440	440	520	540	345	540
22	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	( )
23	30	120	200	340	340	400	460	(NV)	(NV)	(NV)	(NV)	(NV)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	( )	460
24	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(IM)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	60	140	140	80	40	30	30	( )	140
25	100	140	180	310	440	400	320	320	420	440	300	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	120	140	120	140	160	220	251	440
26	260	220	260	260	220	300	300	300	320	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	120	140	140	140	180	160	160	218	320
27	160	200	200	180	180	230	160	200	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	110	140	140	160	160	180	160	171	230
28	140	150	130	140	150	200	180	280	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	120	160	150	150	160	150	161	280
29	160	160	170	170	200	220	190	180	180	170	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	160	160	140	130	160	130	168	220
30	120	140	140	160	150	130	200	170	230	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	90	190	180	210	260	250	175	260
31	340	420	530	520	380	320	310	250	240	210	220	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	130	200	200	200	130	210	150	278	530
AV	203	224	226	232	225	225	221	206	219	( )	( )	( )	( )	( )	( )	( )	( )	106	135	164	173	166	180	181	191	
PK	480	540	530	520	440	400	460	340	420	440	300	( )	( )	( )	( )	( )	200	300	380	420	440	440	520	540		540

385

INVERSION HEIGHT
METERS

Logan Wash
Station LW02
SEPT 1978
OCCIDENTAL OIL SHALE INC.

HOUR (LOCAL STANDARD TIME)

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	AVE	PEAK
1	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
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4	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
5	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
6	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
7	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
8	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
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11	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
12	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
13	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
14	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
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20	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
21	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
22	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
23	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
24	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
25	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
26	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
27	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )
28	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	120	140	140	170	150	160	( )	170
29	140	230	180	170	180	200	130	170	140	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	120	180	190	180	180	180	171	230
30	180	220	250	200	240	270	300	140	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	(NV)	120	130	130	130	120	130	183	300
AV	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	
PK	180	230	250	200	240	270	300	170	140	( )	( )	( )	( )	( )	( )	( )	( )	( )	120	180	190	180	180	180		300

APPENDIX C

DEVELOPMENT GUIDE FOR RIFLE, COLORADO

DEVELOPMENT GUIDE

FOR

RIFLE, COLORADO

A WORKING DRAFT

October , 1978

Quality Development Associates, Inc.

SUITE 830 • 1700 BROADWAY • UNITED BANK CENTER • DENVER, COLORADO

PRESENTED TO THE CITY COUNCIL, CITY MANAGER
AND CITIZENS OF RIFLE, COLORADO

PREFACE

The efforts involoved in producing this draft Development Guide were funded by the C-b Shale Oil Venture. Since its formation in 1977, the management and staff of the C-b Shale Oil Venture have maintained a firm commitment to work closely and cooperatively with the local communities and their citizenry. This Draft Development Guide for the City of Rifle is but one sign of that ongoing commitment. The management staff that have been most directly involved in promoting and supporting this effort have been Robert A. Loucks, Vice President of Operations and David Courtney, Manager of Community Relations for the C-b Shale Oil Venture.

The work was performed by Community Development and Social Planners from Quality Development Associates, Inc. The effort was under the general directorship of Dr. Martin J. Redding and John W. Dempsey, AIP. The project was supervised and edited by Thomas W. Davis and Regina R.V. Roze-Benson,Community Development Specialist Project staff who were involved in data collection analysis and report drafting included: David Hallock, Land Use Analyst; Ron Moore, Economist; Marilyn Cross, Social Analyst; Donald Scrimgeour, Sociologist; Robert Melland, Architect; Regina Roze-Benson, Community Development Specialist; and Casey Shpall, Assistant Social Analyst.

ACKNOWLEDGEMENT

Any effort as large and detailed as this could not have been done without the cooperation and support of the people from Rifle. We could especially like to thank Daniel W. Deppe, City Manager; E.H. "Bud" Meisner, Mayor; and Lee Merkel, City Planner for their diligent support in providing our staff with their invaluable advice and guidance.

Numerous people were contacted formally and informally for information and opinions on Rifle's resources and needs. Others have offered us information indirectly through their participation in various local civic organizations. Some spent many hours commenting on and adding to our interpretations of Rifle's situation. To those people of Rifle listed below, a special thank you.

Kenneth Ash
Larry Allec
Dr. James Bascom
Stephen Carter
Flaven Cerise
Robert Choate
Dariel Clark
Bob Demos
John Fernandez
Harold Frieser
Frank Fuller
Bill Griffee
Ron Johnson
Richard Jolley
Emolin Kansgen
Allen Koeneke
Lee Martens
Kelley Meyer
Shirley Meyer
Dee Mobley
Harry Odgers
Dorothy Peercy
Sam Potter
Steve Schmitz
William Schumann
Leo Swartzendruber
Larry Velaquez
George Wear
Dr. Ronald Zastrow

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⁂ SUMMARY ⁂

SUMMARY

I. INTRODUCTION

The major intended purposes of this draft Development Guide are to provide the residents of Rifle with a thorough inventory and analysis of existing community characteristics; assessments of existing facility and program needs as disclosed by the application of accepted standards and community inputs; and projections of changes in community characteristics and needs as a consequence of natural growth conditions and rapid growth conditions. The baseline and projective data produced by this effort is intended to provide Rifle with a documented springboard from which its residents can design specific programs; seek funding; and generally better manage Rifle's impending growth.

A development guide document is but one step in a community's development planning process. It is hoped that the information presented in the twelve major sections of this document will assist Rifle in its planning efforts. The twelfth section of this draft Development Guide presents a description of a Comprehensive Plan Process that Rifle may wish to consider.

II. DATA COLLECTION AND PROJECTION METHODOLOGIES

Population trends and forecasts are the major basis on which the analysis and projections presented in almost all chapters of this Development Guide are based. Data on

population for Rifle and Garfield County have been provided by the U. S. Bureau of the Census for 1970, 1975, and 1977. All other figures relating to past population are estimates made by the Colorado Department of Planning and QDA staff.

Rifle's future population estimates have been divided into natural growth and impact growth components derived directly from the Colorado West Area Council of Governemnt's Growth Monitoring Information System. Natural growth trends represent the projected baseline population, assuming that Rifle and Garfield County grow as they have in the recent past and remain substantially unaffected by energy development projects. Impact growth trends refer to the population effects of the numerous energy development projects which have been judged highly likely to attract major growth to the area during the next decade or so. Of the two impact growth situations presented by COG's Growth Monitoring Information System, the high growth, or full-scale oil shale production scenario was used throughout. The impact projections are very dynamic, and may become subject to major revision as the industry development plans change and/or the mix of impacting development alters - something COG's Growth Monitoring Information System is designed to accommodate. For the purposes of this draft Development Guide, and in an effort to present a consistent analysis and planning basis for Rifle, these two scenario forecasts (natural growth and high growth) are utilized as the most complete and up-to-date projections currently available.

There were instances where special projection methodologies had to be developed. This occurs in the Health, Education, Transportation, Land Use, Population, and Economics sections, and in them, QDA explains the methodology used to project population within those service areas.

In addition to these secondary sources of historical and projective information used, much of the primary data collection was through field surveys. The major effort involved a by-parcel land use survey in the City of Rifle that was conducted during the summer of 1978. That effort involved considerable original mapping, as well as documentation of acreages in use. During that time period also, a major proportion of business operators were interviewed to generate information on past business practices and conditions and future outlooks. During the development of this guide, also, numerous searches and direct analysis of County, Town, School District, public agency and private agency records were made in an effort to document as much informaton as possible.

Much of the inventory data was provided by the needs assessment reports produced by Rifle Regional Development Impact Committee. Where information was not available from any of these sources, QDA staff generated it through additional field work in Rifle.

III. HIGHLIGHTS OF MAJOR FINDINGS

While the draft Development Guide is presented in twelve separate major sections, all the findings are very much interrelated. None of the projected needs can be separated from projections of population. For example, land use can not be projected adequately without a good understanding of both population and housing needs. Housing projections in turn can not be fully understood without an acceptance of projected capabilities by public services to provide the necessary sewer and water.

Throughout the draft Development Guide three consistent findings have been established: Rifle has some existing needs which have been generated by its past development; Rifle will have some specific continuing needs under natural growth conditions; and Rifle will be faced by greater needs under impact of full energy development conditions. Following is a short summary of major findings within eight of the twelve draft Development Guide Sections. The reader should refer to each section of interest within the body of the document for a much more detailed discussion.

POPULATION

Rifle's total population has fluctuated from 1960 to 1976 in a narrow range between 2,000 and 2,150. Between 1970 and 1975, Rifle lost population at the rate of one percent per year to 2,016--less than its 1960 population. By spring, 1978, Rifle had gained between 400 and 500 residents over the 1975 figure for an increase of 22 percent. Garfield County population trends are quite different, showing erratic growth from 12,000 in 1960 to over 20,000 in early 1978, for an average rate of four percent per year.

With natural growth conditions, populations in Rifle and in the County are projected to increase at a small but steady pace (four percent annual average) through 1985. In contrast, with energy impact growth conditions, population in Rifle could grow four to five times to the peak impact of 11,000 forecast for 1981-1982. A 25 percent drop is projected for 1983 as the energy-related work forces shift from construction to operations personnel, and as settlement patterns change. Beyond 1983 is forecast steady, operations-related growth of six percent per year. Rifle's population is expected to level off at 10,000 people by 1985.

Projections of Garfield County's impact population are smooth compared to the peaks and valleys evident in Rifle. Growth forecasts show increases averaging 19 percent per year in the 1978-1982 period - or from 20,000 to 35,000 total population. In 1983, population is projected to drop eight percent, followed by

recovery that places Garfield County's impact population at just over 36,000 by 1985.

The age distribution of Rifle's population traditionally has shown a larger number of senior citizens: 17.4 percent of Rifle's 1977 population was 65 years old compared to 10.1 percent for Garfield County. Without energy impact growth this trend should continue. With impact, however, only seven to nine percent of the projected 1985 population in Rifle and in the county is projected to be 65 and over. The age group picking up this share is 20 to 64 years--forecast to go from roughly 50 percent of the 1977 city and county populations to around 60 percent by 1985.

Major employment sectors in Rifle since 1970 include services, wholesale and retail trade, and government--each showing gains in employment from 25 to 60 percent by 1978. The agriculture and mining sectors in Rifle have lost employment since 1970, while construction and transportation, utilities, and communications have increased dramatically in employment during the same period.

With impact growth the services, trade, and government sectors are expected to keep growing, but not at the pace projected for the basic mining and construction sectors. As a result, the combined employment in services, trade, and government as a proportion of Rifle's total employment should decline from 63 percent in 1978 to 42 percent by 1985. During the same period, the share of Rifle's employment in

the mining and construction sectors is projected to triple, from 16 percent to 48 percent.

Rifle's per capita income has consistently surpassed that of Garfield County since 1970 by four to six percent, though it has trailed the statewide figure by around one percent since 1970. With impact growth, per capita income in Rifle should increase an average of 4.5 percent per year. Expressed in future dollars, Rifle's aggregate personal income is projected to increase from $13 million in 1977 to $77 million by 1985, or from $5,800 to $7,900 per capita.

COMMUNITY ECONOMICS

There are 201 business establishments located in Rifle covering a broad range of industrial, wholesale and retail activities. Trends in sales returns show that the number of businesses in Rifle is increasing on the order of 4.5 percent per year. During the 1972-1977 period, retail trade sales increased at an average annual rate of 20 percent in Rifle and 19 percent annually for Garfield County. Sales in the financial, insurance and real estate sector and the wholesale trade sector have increased the most.

In 1977, the business and economy committee of the Rifle Impact Mitigation Task Force conducted a survey of consumers and businesses in the area. This survey described the pros and cons of shopping in Rifle. Consumers shopped in Rifle for convenience and helpful clerks, yet a considerable number of shoppers went elsewhere. Merchants are aware of these problems and are willing to work together in improving the central business district.

Of the total 144,000 square feet of retail space in Rifle, the greatest dollar volume value is represented by food and food service outlets. On an average annual basis, one square foot of food and food service space provides almost twice as much dollar volume as a square foot of space in drugstores, hardware, and liquor stores and almost three times as much as the same space devoted to merchandise activity. On a total annual basis, all the existing retail space in Rifle

has the potential of reaching at least $ 8,445,000 total sales volume.

Assuming that the proportion of a community's retail demand is 50% of aggregate income, Rifle currently has no unmet consumer retail demands. Impact growth conditions are expected to create a consumer retail demand in Rifle of $11 million by 1978, and more than $37 million by 1982 and thereafter. These figures do not take into account the business Rifle attracts from tourist and surrounding communities. These projections show that during 1978 a total of 194,000 square feet of additional retail space needed to supply local retail demands--an increase of 35 % over the estimated 1977 retail space in use. By 1985 a total of 464,000 additional square feet will be needed, which is an increase of 222 % over 1977 figures. Though these projections are far from complete, they give Rifle merchants a idea of what future retail demands may be.

LAND USE

The city of Rifle's zoning ordinance depicts eight zoning districts and two special classifications. Over 50% of the land is zoned to allow commercial land uses and relative to the cumulative nature of the ordinance, residential land uses are allowed in 95% of Rifle's corporate limits. Only 10% of the land is zoned to allow multi-family uses. The existing land uses calculated from a land use survey indicate quite a different picture. Only 10% of the land is actually used for commercial activities while approximately 46% of the land is or will be in residential land uses - almost half of this created from newly annexed subdivisions. In general, there is a high mixture of land uses in each zoning district.

Almost ¼ of the land in Rifle is considered vacant, but over 75% of this land is subject to environmental hazards - flood plains or steep slopes. 41.83 acres of vacant land have been identified as being developable, most of this being zoned commercial.

Future land use and area needs were calculated. The principal inputs were the population and housing projections new subdivisions and densities of projected future development.

Under the natural growth projection, Rifle's population would increase to 3,084 persons by 1985 which would call for an additional 283 dwelling units. This need would be met

by the newly annexed subdivisions. Other land use needs could primarily be met by the existing vacant lands.

The impact growth conditions, indicate a population of 9,702 persons in 1985. To meet this projection, Rifle will need approximately 300 additional acres of land, a 50% increase from the existing size of the city. Half would be needed for residential land uses and half for commercial, public/quasi public and open space land uses.

There is a substantial amount of new subdivisions in process or conceptually discussed in Rifle. Their potential impact is illustrated by the fact that based on worker housing preferences and impact growth conditions, the approval and construction of these subdivisions would create over 600 single family and 300 multi-family units and a deficit of over 300 mobile homes and recreational vehicle sites. In addition, there is a possible 1,950 dwelling units from proposed County subdivisions in the immediate vicinity.

The citizens of Rifle will have to explore various land use management options. Rifle's locational advantage in terms of various modes of transportation may increase its ability to attract new industries that could stabilize the housing and land use demands. Flexibility in the design new subdivisions that allow for more non-permanent land uses and flexibility in the housing type preferences of the new population are important considerations. Under impact growth conditions, the central commercial area will need

expansion. Based on the limited amount of developable vacant land in Rifle, expansion can take place through conversion of residential units and/or the creation of new commercial areas in the outlying areas. These should be planned to not hinder the viability of the existing central commercial area.

TRAFFIC AND TRANSPORTATION

According to the Colorado Division of Highways there is a serious need for improvement of the roadways in Rifle based on current usage. This will become more pronounced with increased traffic from oil, coal, gas and oil shale development. The main problem Rifle is facing now is that the one main North-South corridor (S.H. 13) passes through Rifle. The traffic congestion along this route has increased at such a rate that the Highway Department has done a study recommending six alternative routes.

The most popular mode of travel in Rifle is the automobile. If vehicle ownership practices remain the same in Rifle, the approximate increase in vehicles registered will almost triple by 1985 under impact growth conditions. Presently there are about 667 parking sites in the Rifle downtown area, with the majority of parking sites being public on-street parking.

Rifle is currently served by two freight hauling lines, two bus lines and a county owned airport facility. There is a current plan to increase the capacity of the airport. Impact growth conditions may require increased development of systems to move large quantities of freight and people through and around Rifle, as well as allow increased accessibility to Rifle itself.

HOUSING

The 1970 and 1977 Census indicate that the total number of housing units in Rifle had risen from 803 to 862. The cities permit records indicate that 166 residential permits have been issued from 1970 to mid 1978, representing 230 new dwelling units. Of this, more than 80 percent have been issued since 1975. The 1970 census additionally indicated that 74.2 percent of the units in Rifle were single family residences and that over 40% of the county wide housing stock was build prior to 1939.

By 1985 under natural growth conditions, 314 added employees are projected for Rifle. This corresponds to an additional housing demand of 283 units of which almost 81 percent are expected to be single family.

Under impact growth conditions, it is estimated that by 1985 there will be an additional 1,968 employees which corresponds to 1,593 dwelling units. The proportion of preference for single family units far exceeds preference for any other type of housing unit by some 35 percent. This principally originates with the operating workers and the permanent population that will generate the additional need for single-family residences. There will also be a need for multi-family units, mobile homes and recreational vehicles generated by construction related employees during several peak periods of impact.

The projection for impact growth also indicates that the population, particularly for construction and service workers will peak in 1982, generating a demand for 1,746 dwelling units. Rifle will be faced with a common boom town concern, that of not permitting the over building of housing - especially permanent units - in anticipation of projected peak population levels. This problem demands flexibility in meeting housing needs be maximized, at the same time avoiding a housing surplus that could burden both the community and the individual homeowner in the years to come.

EDUCATION

The fall enrollment in Rifle has risen modestly in all but two of the last eight years, with an average increase of 21.3 students per year. Within the same year the school enrollment has fluctuated from a plus 3.8 percent to a minus 5.4 percent relative to beginning enrollment. Rifle High School has realized the greatest overall increase in student enrollment with Esma Lewis Elementary School second. Junior High School enrollment has decreased by 4.4 percent from 1973 to 1978.

Under natural growth conditions the RE2 school district school-age population is expected to increase by only 17.6 percent by 1985. Under impact growth conditions, however, Rifle's school-age population is predicted to grow by more than 85.8 percent by 1982; drop by 14.8 percent in 1983; and then rise to 74.4 percent of the original size by 1985.

The elementary schools in RE2 school district will be operating at over capacity both under natural and impact growth conditions. The junior high schools, in contrast, are not projected to even reach their capacity by 1985 under natural growth conditions; by 1985 with impact growth, RE-2 junior high schools are forecast to exceed capacity by 1,977. Rifle High School is over-utilized currently, and is projected to remain so with either natural or impact growth. By 1985 under natural growth, the high school is predicted to be over-capacity by 232 students; with impact growth this figure increases to 715.

HEALTH

The health service area used for this report is known as the Grand River Hospital District, encompassing roughly two-thirds of Garfield County, includes the incorporated areas of Grand Valley, Rifle and Silt. Rifle's health related needs are presently served by Clagett Memorial Hospital, licensed as a 32 bed hospital; E. Dene Moore Memorial Home, which has a capacity of 56 beds; three physicians; three dentists; two optometrists; three pharamacits; a county health nurse; and several support personnel.

A mini-survey was conducted of other Colorado communities that had experienced impact growth conditions. It revealed that most changes in health service needed are more in terms of diversification of hospital services and gearing up for quick-response, short-term care rather than an increase in the number of hospital beds. The hospital service departments which will probably show the greatest increase in use are x-ray, laboratory, respiratory and emergency. Work-related injury treatments and out-patient visits will also probably increase.

Under natural growth conditions, Clagett Memorial Hospital's beds will remain under-utilized through the year 1985. Under impact growth conditions, optimum bed utilization will be reached between the second and fifth years of impact. The E. Dene Moore Memorial Home, used primarily for the elderly, is presently reported at full

capacity. There are no recognized standards presently available to evaluate needs for nursing home beds, but the State of Colorado Health Department, Division of Regulation is presently developing formulas for determination of optimum bed number. The predominant school of thought is that more emphasis should be placed on minimal care facilities and relative social programs.

According to the guide line ratios issued by the American Medical Association and the Colorado State Department of Health, under natural growth conditions, the Grand River Hospital District presently needs three general practitioners, one internist and four dentists. By 1985 these needs will slightly increase in addition to various other types of specialists. Under impact growth conditions all present and future needs will increase considerable, including five general practitioners, five dentists and one internist for the current year and ten general practitioners eleven dentists and four internists by 1985. Again, other types of specialists will be required. Under natural and impact growth conditions the role of Public Health, primarily provided by the County Health Nurse, will need to be increased.

PARKS AND RECREATION

The existing park land areas and recreational facilities in Rifle were compared against future needs based on population projections and selected national standards. The population components were projections for the City of Rifle and proportions of projections for DeBeque, Grand Valley, Silt, New Castle and unincorporated areas that are likely to use Rifle's recreational areas.

The principal existing facilities in the city are Rifle Metro Park (a multiple use community park), Heinz Park, a baseball field that is part of Garfield County Fairgrounds and the various facilities of the public schools. They all are also located in a region that provides an abundance of fishing, hiking, picnicking and backpacking experiences.

From the natural and impact growth population projections for the city and surrounding areas it was calculated that Rifle will need additional land and facilities for parks and recreation. Under natural growth conditions, the largest current and future need for park land areas are for neighborhood and community parks. The city will additionally need new tennis, softball and basketball facilities.

For impact growth conditions, the needs considerably increase. Presently they all need additional playgrounds, neighborhood parks and community parks as well as new tennis courts, softball fields and basketball courts.

For the 1980's under impact growth conditions, the city will need approximately 12 acres of playground, 20 acres of neighborhood parks, 50 acres of community parks and numerous tennis, baseball, softball and basketball facilities. The swimming pool and golf course will be above capacity and may require expansion.

The city has various policy alteratives to follow in meeting the projected generated demands. These include use of vacant and/or city owned lands, dedicated land for new subdivisions, and the purchase and annexation of new recreation lands by the city. The use of the existing flood plain lands, part of which are vacant, could be a supply of passive and possible active recreational lands. The multiple-use character of many facilities should be explored for meeting needs and demand changes.

Finally, reciprocal coordination between Rifle and the surrounding cities and unincorporated areas should be provided. This will assist in locating new facilities where most needed and prevent unnecessary duplication.

PUBLIC SERVICES

Public services are provided in Rifle by the municipal government, with two exceptions. Fire protection is the responsibility of the Rifle Fire Protection District, and the water and sewer facilities serving South Rifle residents are those of the Rifle South Metropolitan District. The remaining public services - water, sewer, solid waste, police protection, and public works - are directly provided by the City of Rifle.

The present level of services provided to Rifle is adequately serving the current population. Because current population increases reflect the early phases of a prolonged growth period for Rifle, services that are nearing their capacities now will need to expand in the near future. In Rifle, several services that would require expansion due to rapid population growth are already budgeted and in process, such as water treatment, water storage, sewage treatment, solid waste land fill, and the highway bypass.

Water supply is adequate to meet projected demands under either natural or impact growth conditions, and exceeds peak-year impact needs by 17 percent. Upon completion of the new water treatment plant and water storage tank, Rifle will have capacity for an additional 12,000 to 13,000 residents. A new sewage treatment plant is also scheduled for completion in 1979, but if impact growth projections come to pass, the expanded capacity will be UNDER - capacity in the peak year by almost 50 percent. The county landfill used by the City of Rifle is almost at capacity

now, and a planned 10-acre expansion may be fully utilized by 1983 or before.

In other areas of municipal service, expansions will also be necessary. Under natural growth conditions, the current police force would be large enough to handle the population forecast for 1985, though an additional 500 square feet of space is already needed for police administration and dispatch. However, with impact growth, an additional 15 patrolmen and 2 dispatchers will be required to protect the peak population of more that 11,000. A possible re-location and enlargement of the Rifle Fire Protection District station is presently under consideration, and the District's fire fighting crew is to expand by forty percent in the next few months as growth continues.

The Public Works Department anticipates improvement projects for street paving, curbs, gutters, and sidewalks totalling almost $1.5 million between 1978 and 1983. Capital replacement costs are forecast to exceed $70,000 in the same period. In addition, the City's share of right-of-way acquisition and construction of the highway 13 bypass already amounts to almost $2¼ million in the period from mid-1978 to mid-1980. It is hoped that the Joint Budget Committee will continue to support the bypass project with appropriations from the Oil Shale Trust Fund.

I HISTORY

I. INTRODUCTION

A. Rifle History

Rifle, in western Colorado's Garfield County, is located just north of the Colorado River. This mountain town has a rich and colorful pioneer history beginning in the latter part of the 19th century. Today this area can be considered one of the most promising recreational and industrial regions in the state because of its proximity to the Rocky Mountains and important mineral deposits.

Rifle was initially part of Summit County. Summit County in 1883 was divided and the town became part of Garfield County. In 1889 a further division of Garfield County formed Rio Blanco County, but Rifle remained in Garfield County.

Most of the farmland in the Grand River Drainage Basin, where Rifle is located, was homesteaded or pre-empted between 1881 and 1890. During this period the United States Army began construction on a post road to connect White River with the Grand River Valley. The Grand River was officially renamed the Colorado River in 1907, but the valley name remained the same. Construction on Post Road, also known as Government Road, was slow, and by 1884 private enterprise had taken over and opened up a stage road to Grand Junction. This highway then enabled a stage line route to open between White River country and the Rifle Valley. The first post office was at

Parker's Ranch, located two miles north of the Town of Rifle. In 1885, the post office was moved to A.W. Maxfield's ranch, who also became postmaster.

Prior to 1879, Nelson Ward, an early pioneer, established a trading post north of the convergence of East and West Rifle Creeks. Here he purchased hides and skins from the Ute Indians. Two years after the 1879 Meeker Massacre, the Utes were placed on a reservation, and the United States Government began selling their land. Ward filed on the land, and his homestead became the center of a small settlement.

As the population along Rifle Creek grew, it became apparent that a trade center was needed. Maxfield gave up part of his farm and surveyed it into lots, blocks, and streets to meet this demand. In 1887 cattlemen united to form the Grand River Cattlemen's Association. Schools began springing up even before Garfield County School Districts were organized in 1889. Around this time Elmer Babcock donated some of his farmland on Graham Mesa for a cemetery.

During these years life in Rifle was a daily challenge. There were no utilities, and the streets of the town were without drainage. There were ever-increasing cases of diphtheria and typhoid. The townspeople became aware of the fact that something had to be done about the situation, and they banded together in a concerted effort to modernize their town. By 1910, after two years of hard work, the modernization of the Town of Rifle was well underway.

The railroad line was completed in 1890, and the Denver and Rio Grande No. 1 passenger train made its first run in November of that year. Rifle was incorporated in 1905, and George Howard served as the city's first mayor. Bonds were issued to purchase Beaver Creek water rights, construct a retaining reservoir on Taughenbaugh Mesa, and run a water main into Rifle. By 1915 Rifle was completely plumbed with both water and sewer systems.

In December of 1905 the Rifle Chamber of Commerce was formed. This organization lent its support to the formation of the Rifle Volunteer Fire Department and the Rifle Light, Heat, and Power Company. A hydroelectric plant was installed below Rifle Falls for the production of electricity, but in 1959 the property was sold to the Colorado Game and Fish Department, and the plant was closed. The Shoshone hydroplant, which is tied to the Colorado Public Service Company, now provides electric service to the Rifle area. The Colorado Public Service Company also supplies the town with natural gas service from Piceance wells.

II. COMMUNICATIONS

In 1900 a telephone service station was added to Glenwood Springs on a Grand Junction toll line. By 1902 there were forty subscribers interconnected in what was known as the Beach Village System. The Rifle Creek company established telephone service along the creek in order to handle all the farmers' lines. In 1925 the Bell Company

purchased the Rifle Creek Telephone Company and became responsible for all the phone service in the area.

The first newspaper, "The Sharpshooter," was organized in Rifle in 1889. That same year the "Rifle Reveille" was established as a weekly publication. "The Rifle Independent" was also published for a time, beginning in 1890. Other newspapers established were: "The Rifle Telegram" in 1903; the Telegram Publishing Company incorporated in 1905; and in 1913 the Reveille and the Telegram consolidated under the title of "The Rifle Telegram." Television came to Rifle in 1956, which originated from Grand Junction. In 1976 Rifle opened its own radio broadcasting station with a tower located on Graham Mesa.

III. SCHOOLS

In 1890 the old Rifle Creek School District No. 9 was divided into two districts, to meet the demand for a more centrally-located school. Rifle became part of School District No. 9, and a small school house was erected on Fourth Street. Shortly afterwards, the rapidly growing population base required the building of a new brick, two-story school.

Rifle Union High School, formed in 1908, was also housed in the Fourth Street school until 1911, when it was moved to the Methodist Church. A new high school was erected on Ninth Street in 1913. Rifle High School received its full accreditation from the universities and colleges of Colorado in that same year.

IV. CHURCHES

Land was donated by Abram Maxfield for the construction of the First Methodist Church, completed in 1890. In 1906 this church was replaced with a new brick building, and in 1965 the Methodist Church annex was erected on the site of the old Fourth Street school. The First Christian Church was built in 1906 on the corner of Third and White River Avenue. In that same year another sect, under the name Christian Church, built a church on Fourth and White River Avenue. This church later merged with the Congregational Church but dissolved in 1917, only to reorganize as the Presbyterian Church. The Presbyterian Church joined the Methodist Church for united services in 1969.

Many other churches began springing up in Rifle, representing a wide range of denominations. These included St. Mary's Catholic Church, 1912; Seventh-Day Adventist Church, 1942; Assembly of God Church, 1958; First Baptist, 1948 and 1960; Latter Day Saints Chapel, 1954; and the Rifle Emmanuel Lutheran Church, 1954.

In addition to these, other organized religious groups in the Rifle area include: Pentacostal, Nazarene, Jehovah's Witness, Church of Christ, and Southern Baptist.

V. RIFLE MOUNTAIN PARK

The community of Rifle showed great foresight in its early years by acquiring permanent title to Box Canyon.

In June of 1910 Rifle bought 320 acres of this land, known as Rifle Mountain Park, from the government at $1.25 per acre. Additional land purchases by private sources later increased the size of the park to 434.35 acres. In the early 1930's the Civilian Conservation Corps helped out by making some improvements in Rifle Mountain Park. They widened the road, built bridges, established campsites, built grills and picnic tables, put up sanitary facilities, and erected a community house.

VI COMMERCE

One of the first successful enterprises in Rifle was that of horse trading. Wild mustang ponies were rounded up from the Road Plateau in the fall and taken to market. In 1893, when the silver mines closed down, the demand for horses lessened. During the Spanish American War, horses were needed again for cavalry mounts, and during World Wars I and II they provided food for many. Demand increased for draft horses such as Percheron, Belgian, and Clydesdale, to do the heavy work. These horses were displaced by mechanized implements, about 25 years later.

In 1885 the old JQS Trail was constructed to the top of Book Cliffs, providing access to pastures on the Road Plateau for herds of cattle. The protected low valleys were excellent for winter grazing, but as more settlers came into the area, the amount of rangeland steadily decreased. Ranchers were forced to drive their cattle to higher and more distant

ranges to provide them with grazing land.

The railroad contributed greatly to a more efficient method of marketing farm produce, and many stockmen in the Rifle area turned to farming for their livelihood. In place of hay fields, these new farmers began to plant grain, potatoes, fruit and sugar beets.

Semi-bituminous coal beds were found in the Hog Back north of Rifle. Though the surface coal was of a poor quality, it was available to anyone who wanted to haul it away. Soon claims were staked, and coal mining became an industry. Most of the mines were individually-owned or run by family partnerships. In 1935 the Holmes Mine and the Nate Dutton Mine (later known as the Burgland Mine) were leased by the Haas family from the Federal Government. During World War II these mines shipped an average of fifty tons of coal per day to Denver for use in the war effort. In later years these two mines, in addition to the Black Raven Mine, supplied from 100 to 150 tons of coal per day to the U.S. Vanadium Mill east of Rifle. The Holmes and Burgland Mines were both closed down in the 1960's, due to fire and flood.

During the Depression, the U.S. Vanadium Company, no longer able to find a market for its product, was forced to close down. This mine still had the largest deposit of vanadium in the United States and was rebuilt and reactivated during World War II.

With the production of nuclear fission, uranium also became an element in high demand. The tailing ponds from the vanadium mines were rich in deposits of uranium. The mill was revised for uranium extraction, and the tailings were dug up and refined. The mill operated until 1958, when it was replaced by a new one west of Rifle which extracts and refines both uranium and vanadium. The present operation is known as the Union Carbide Corporation, Mining and Minerals Division.

In 1963 Rifle incorporated and changed its status from town to city. A new city hall was erected in 1952 which houses the city government, police and fire department, and the city library. Water rights were filed on Rifle Creek and the Colorado River and equipped with storage tanks and treatment plants. A sewage disposal plant was also installed west of town.

Today, Rifle is a growing, healthy community. The oil shale development in the Piceance Creek Basin has brought new people into the area, with many more expected. Rifle is in a good position now to plan its future and take positive steps towards ensuring an orderly expansion of the community.

II TAXING AND PLANNING JURISDICTIONS

I. INTRODUCTION

The City of Rifle lies within the legal boundaries of a number of jurisdictions which levy taxes and provide governmental services. In all, there exist nine units of government which collect property taxes in Rifle, including the City of Rifle, Garfield County, Garfield RE-2 School District, Colorado Mountain College, and five special-purpose districts. The State of Colorado collects sales taxes and income taxes in Rifle, and the Federal Government collects income taxes.

It is the purpose of this section to examine the function and taxing authority of each jurisdiction which encompasses Rifle. Figure 1 outlines the legal or service area boundaries of each jurisdiction included in this discussion.

II. TAXING DISTRICTS

A. General Government Jurisdictions

1. Town of Rifle

The Town of Rifle provides its citizens with a number of general governmental services, including police and fire protection, street maintenance, water and sewer service, sold waste collection, building inspection, planning, health and welfare services, and cemetery and park maintenance. The town's revenues derive mainly from locally-collected taxes, fees and service charges; with some revenues resulting from state and federal government sources.

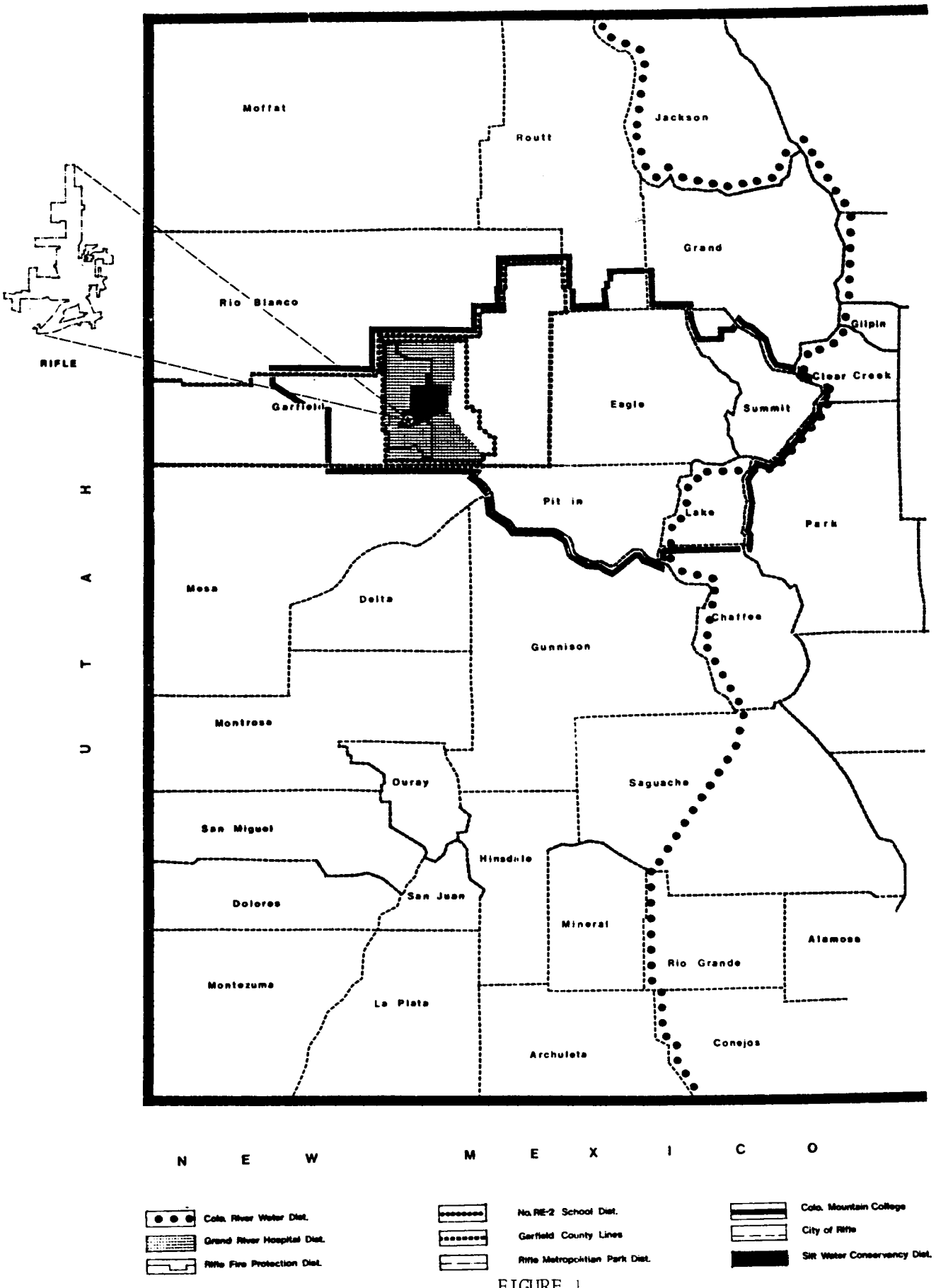


FIGURE 1

TAXING AND PLANNING DISTRICTS

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The primary source of tax revenues to the City is the sales and use tax. The sales tax was originally established in 1965 and was raised to two percent of all taxable sales in December, 1973. Rifle's status as a home rule city allows it to collect sales taxes directly, rather than rely on the State to collect the tax and return it to the City.

In recent years, total retail sales and sales tax receipts in Rifle have been steadily increasing (see Table 1). But the percentage of Rifle's total general fund revenues contributed through sales taxes has declined somewhat from nearly 55 percent in 1974 to an estimated 47 percent in 1978.

The other major source of tax revenue to the City of Rifle is the ad valorem property tax. The amount of revenue raised through property taxes is dependent upon two factors: the assessed valuation of all property in the City and the City mill levy, or property tax rate, established by the City Council. Assessed Valuation is determined by the county assessor, based upon guidelines established by the State Legislature. Assessed valuations are required to be 30 percent of actual value.

Assessed valuations in Rifle and Garfield County have risen steadily since 1907, with the exception of 1978 assessed valuations. This decrease was due to a mandate from the State Legislature to assess property using a 1973 base year rather than current value. Rifle property tax revenues were reduced by $19,000 in 1974 when the mill levy was lowered

TABLE 1

SALES TAX TRENDS IN THE CITY OF RIFLE

1970 - 1976

Year	Total Retail Sales	Amount of Revenue Received from Sales Tax	% Change	Per Capita	Amount of Sales Tax Revenue Paid to State of Colorado	Per Capita
1970	$13,502,600	$ 47,350		$22.00	$183,006	$ 85.10
1971	$15,452,422	$ 54,010	14.0	$25.50	$193,438	$ 91.50
1972	$ 9,482,181	$ 56,100	3.8	$27.00	$194,066	$ 93.30
1973	$11,058,081	$ 62,000	10.5	$30.30	$222,119	$108.60
1974*	$14,590,015	$183,100	195.3	$90.20	$298,020	$146.80
1975	$16,961,423	$195,800	6.9	$97.10	$335,992	$166.70
1976	$19,514,871	$205,336	4.9	$96.40	$372,099	$174.80

*The local sales tax rate was increased from 1% to 2%, effective 12/1/73.

Source: Department of Revenue, State of Colorado

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TABLE 2

PROPERTY TAX TRENDS IN THE CITY OF RIFLE

1970 - 1978

Year	Total Assessed Value	Mill Levy	Total Revenues
1970	$3,502,600	15.49	$54,255
1971	$3,432,740	15.49	$53,173
1972	$3,440,860	15.49	$53,299
1973	$3,669,520	15.49	$56,891
1974	$3,609,280	10.49	$37,861
1975	$4,078,920	10.49	$42,788
1976	$4,312,360	10.49	$45,237
1977	$5,220,410	9.87	$51,525
1978	$4,984,220	10.49	$52,284

Source: Annual Reports of the Colorado Division of Property Taxation, 1970-1977.

from 15.49 mills to 10.49 mills (see Table 2). Since that time, though, property tax revenues have been increasing as a result of increasing assessed valuation. Property tax revenues amount to about ten percent of total general fund revenues in the City of Rifle.

The City presently has outstanding debt totaling $614,000. The largest portion of that debt is a $400,000 loan from the Colorado Water Conservation Board, due to be repaid over thirty years beginning December 1, 1978. Other outstanding debt consists of general obligation bonds issued for water and sewer improvements, and general improvement revenue bonds (see Table 3). Because of their nature, none of these outstanding bond issues apply to the City's statutory debt limitation currently set at three percent of assessed valuation, or $149,520.

2. Garfield County

Residents of Rifle pay a portion of their total property tax bill to Garfield County to help finance county services. Property tax revenues represent about 35 percent of the total county budget. The 1977 levy of 21.19 mills was distributed among six county funds in the following manner:

County General Fund	12.04 mills
Contingent Fund	.57 mills
Road and Bridge Fund	5.84 mills
Public Welfare Fund	.95 mills

TABLE 3

OUTSTANDING FINANCIAL OBLIGATIONS IN THE CITY OF RIFLE

1978 - 1983

Year	General Obligation Bonded Debt	Revenue Bonded Debt	Colorado Water Conservation Board Loan	Total Outstanding
1978	110,000	104,000	400,000	614,000
1979	87,000	19,000	386,667	492,667
1980	64,000	13,000	373,334	450,334
1981	51,000	7,000	360,000	418,000
1982	38,000	0	346,667	384,667
1983	29,000	0	333,334	362,334

Source: Capital Improvement Program Plan, City of Rifle, 1978-1983

Library Fund	1.41 mills
Retirement Fund	.38 mills

County property tax revenues have more than doubled since 1971. And the county mill levy has increased by almost 50 percent, as indicated in Table 4. Total assessed valuation in Garfield County has increased by 40 percent since 1970. The City of Rifle represents 7.4 percent of the total county assessed valuation which is slightly more than the 7 percent of total county assessed valuation it represented in 1970.

Garfield County presently has no outstanding general obligation debt.

3. State of Colorado

The State of Colorado imposes a three percent sales tax on almost all retail transactions within the state. The amount of state sales tax collected in the City of Rifle has more than doubled in recent years from the $183,006 collected in 1970 to $372,099 collected in 1976. State sales taxes collected in Rifle represented about one-tenth of one percent (.1 percent) of the total state sales tax receipts in 1976. Table 1 listed Rifle's contributions to State sales taxes between 1970 and 1976.

Rifle and Garfield County residents are also subject to state income taxes which all Colorado residents must pay annually. Data on state income taxes paid by Rifle residents is not available, but data on Garfield County taxpayers as

TABLE 4

PROPERTY TAX TRENDS IN GARFIELD COUNTY

1970 - 1978

Year	Total County Assessed Value	Mill Levy*	Total Revenue
1970	$49,960,150	14.66	$ 732,416
1971	$42,826,580	14.79	$ 633,405
1972	$43,857,900	16.70	$ 732,426
1973	$46,558,650	15.80	$ 735,628
1974	$48,016,760	18.00	$ 864,302
1975	$52,972,800	18.50	$ 979,997
1976	$60,266,900	23.10	$1,392,165
1977	$70,255,900	21.19	$1,488,721
1978	$70,612,050	20.90	$1,475,791

*Includes - County General Fund, Road and Bridge Fund, Contingent Fund, Public Welfare Fund, Public Library Fund, Retirement Fund, Public Works Fund

Source: Annual Reports, Colorado Division of Property Taxation, 1970-1977.

TABLE 5

STATE INCOME TAX FILING TRENDS IN GARFIELD COUNTY

1970 - 1976

Year	Total Returns	Estimated Population	Total Taxes Paid	Average Taxes Paid Per Return	Estimated Per Capita Taxes Paid
1970	6,772	14,821	$ 761,000	$112.40	$ 51.40
1971	7,084	15,400	$ 954,000	$134.70	$ 61.90
1972	7,508	15,700	$1,106,000	$147.30	$ 70.50
1973	7,928	16,445	$1,372,000	$173.00	$ 83.40
1974	9,022	16,900	$1,685,000	$186.80	$ 99.70
1975*	7,351	17,906	$1,881,000	$255.90	$105.04
1976	7,857	18,900	$2,273,000	$289.30	$120.30

*Dual column filing instituted; two married persons could file on the same tax return.

Source: Division of Research and Statistics, Colorado Department of Revenue; U. S. Bureau of the Census

a whole shows a large increase in income tax payments between 1970 and 1976 (see Table 5). State income taxes paid by Garfield County residents more than tripled from $761,000 in 1970 to $2,273,000 in 1976. Population growth in the county only accounts for a portion of this increase, as income taxes paid per capita and per tax return have both increased about 150 percent.

B. School Districts

1. Garfield County RE-2 School District

Garfield County contains all or portions of five separate school districts. The City of Rifle lies within the Garfield RE-2 district, which also includes the communities of Silt and New Castle.

Total assessed valuation for District RE-2 has increased by $4,737,900 since 1970, or 33 percent (see Table 6). Even though school mill levies have fluctuated over the period, total property tax revenues have risen by a comparable 40 percent, from $754,734 in 1970 to $1,058,136 in 1978.

As is the case with all school districts in Colorado, the Garfield RE-2 District receives most of its operating revenue from a combination of local property taxes and State school equalization payments. School district property tax revenues are distributed among three separate school district functions, the general fund (operating expenses), the capital reserve fund and the bond redemption fund.

TABLE 6

PROPERTY TAX TRENDS
GARFIELD RE-2 SCHOOL DISTRICT
(1970-1978)

Year	Total Assessed Value	Mill Levy	Total Revenue
1970	$14,113,600.00	$53.40	$754,734.00
1971	13,876,970.00	63.49	881,049.00
1972	14,071,590.00	66.00	928,725.00
1973	14,875,320.00	61.88	920,485.00
1974	13,894,930.00	45.44	631,386.00
1975	14,517.530.00	45.06	654,160.00
1976	16,238,560.00	45.17	733,496.00
1977	18,554,630.00	56.41	1,046.666.00
1978	18,851,520.00	56.13	1,058,136.00

Source: Annual Reports - Colorado Division of Property Taxation (1970-1977).

In 1978 the property tax levies and total revenues for each fund were as follows:

School General Fund	40.97 mills	$ 772,247
Capital Reserve Fund	4.00 mills	75,406
Bond Redemption Fund	11.16 mills	210,383
Total Revenue		$1,058,136

General fund property tax revenues amounted to about 32 percent of the district's operating budget in 1978. In addition to property tax revenues, the district received $79,000. Other local revenues (primary specific ownership taxes), amounted to $1,516,337 in State payments and $52,000 from the Federal Government.

The significant rise in the district's mill levy in 1977 was due to the issuance of $1,980,000 of general obligation bonds for new junior high school construction. Revenues from the bond redemption fund levy are applied entirely toward retiring outstanding bonded debt. A State statutory limit of 20 percent of current assessed valuation is imposed upon all school district general obligation debt. The maximum amount of debt which District RE-2 could assume is $3,772,000 or about twice its present debt level.

2. Colorado Mountain Junior College District

The Colorado Mountain Junior College District (CMJCD) includes seven public school districts, in most of

Eagle, Garfield, Lake, Pitkin and Summit Counties. Total land area of the district is 5,700 square miles. The 1977 estimated population for the district was 55,898. The MJCD maintains two main campuses, in Leadville and Glenwood Springs and six other offices in and around the district.

Colorado Mountain College is classified as a local district college in the state community college system. CMJCD operates much like a special purpose district, with an elected five member governing board, one member from each of the five counties in the district.

CMJCD receives its financial support primarily from three sources, student fees, local property taxes and state equalization payments. Student fees amount to 23 percent of the districts total revenues. The state reimburses the district for costs according to the number of Full-Time Equivalent (FTE) students enrolled. The current rate is $700/per year for each FTE and an additional $475/per year for each FTE in occupational education.

Local Property tax revenues for the district are derived from a current levy of 5.24 mills. Garfield County's allocation (which includes all but the western most portion of the county) yielded $313,340 in 1977 (see Table 7). This amount represented about 21 percent of all local revenues collected by the district and 7 percent of all district revenues in 1977.

TABLE 7

COLORADO MOUNTAIN COLLEGE -
PROPERTY TAX TRENDS IN GARFIELD COUNTY
(1970 - 1978)

Year	Total Assessed Value	Mill Levy	Total Revenue
1970	$42,856,920.00	$3.95	$169,285.00
1971	39,887,830.00	3.95	157,557.00
1972	40,853,760.00	5.09	207,946.00
1973	43,984,240.00	5.09	223,880.00
1974	45,538,700.00	5.34	243,177.00
1975	50,303,690.00	5.56	279,689.00
1976	57,047,630.00	5.74	327,453.00
1977	65,552,470.00	4.78	313,340.00
1978	65,392,280.00	5.24	342,656.00

Source: Annual Reports - Division of Property Taxation (1970-1977).

B. Special Purpose Taxing Districts

Special purpose taxing districts, as opposed to units of general government, are created to serve a limited purpose. A special purpose district can be established by the State Legislature through petition to a district court, through issuance of a special district bond, or the passage of a resolution by the county commissioners or proper legislative authority. Special purpose districts' service areas are not necessarily limited by existing political boundaries, but are designated by the establishing entity. These districts are supported by taxation of those it serves, and mill levy rates are determined, in most cases, by the governing boards. Maximum mill levy rates have been set by the State Legislature for most special purpose districts, according to the function of the district. Special purpose district taxes are collected by the county treasurer as part of the annual assessment and dispersed to each appropriate service area.

Five special purpose taxing districts serve the City of Rifle. They include: (1) Colorado River Water Conservation District, (2) Grand River Hospital District, (3) Rifle Fire Protection District, (4) Rifle Metropolitan Park District, (5) Silt Water Conservancy District, and South Rifle Metropolitan District.

1. Colorado River Water Conservation District, (CRWC)

The CRWC District is the primary water policy agency for the 156,000 residents of the Colorado River Basin counties

in Colorado. Its main concern is with water conservation and assuring that the most beneficial use is made of the Colorado River Waters. The district was created in 1937 by the State Legislature and serves the entire 15-county western slope watershed area. The CRWC District's boundaries are outlined in Figure 1.

The district is governed by a Board of Directors which is appointed by the county commissioners of the various counties. CRWC is funded directly by its member counties. The amount of funding required for operation of the district is based on a determination of expenses by the board of directors which in turn sets the mill levy rate. Each county is assessed an equal share in revenues to be collected annually.

Table 8 presents the property tax levy and revenue trends for Garfield County's portions of the CRWC District between 1970 and 1978.

2. Grand River Hospital District

The Grand River Hospital District was established in 1958. The district under took the project of building and operating the Clagett Memorial Hospital and E. Dene Moore Memorial Home in Rifle. The hospital was opened in 1965. The district boundaries, as shown in Figure 1, incorporate a large portion of Garfield County, including the communities of Rifle, Silt, and Grand Valley. The district is governed by a seven-member board of directors who determine the district budget and set

TABLE 8

COLORADO RIVER WATER CONSERVANCY DISTRICT -

GARFIELD COUNTY PROPERTY TAX TRENDS

1970 - 1978

Year	Total Assessed Value	Mill Levy	Total Revenue
1970	$49,960,150	.40	$19,984
1971	$42,826,580	.40	$17,131
1972	$43,857,900	.40	$17,545
1973	$46,558,650	.40	$18,623
1974	$48,016,760	.40	$19,207
1975	$52,972,800	.55	$29,135
1976	$60,266,900	.50	$30,133
1977	$70,255,900	.39	$27,399
1978	$70,612,050	.34	$24,008

Source: Annual Reports, Colorado Division of Property Taxation, 1970-1977.

the district mill levy. The present property tax levy of 4.00 mills should generate $101,969 to meet both operating expenses and debt service requirements of the district. The amount of property tax revenues which can be used for operating purposes is limited by state statute to that generated by 2.00 mills. The district presently levies 1.84 mills for operating purposes, this limits the amount of additional operating revenues that could be generated from property taxes.

Table 9 shows that the total property tax revenues to the district have increased by over 2.5 times since 1970. Property tax revenues represent about four percent of total operating revenues for the hospital and nursing home. Property tax is also the sole source of revenue for debt retirement. Outstanding debt presently amounts to $443,000 in general obligation bonds.

3. Rifle Fire Protection District

The Rifle Fire Protection District was formed in 1976 to upgrade the fire protection and ambulance services in the Rifle area. The district encompasses the City of Rifle and a portion of the county north and south of the City (see Figure 1).

The district's operating expenses are financed primarily through ambulance fees and property tax revenues. The mill levy for the district is established by the district board. The district's assessed valuation is determined by the county

TABLE 9

GRAND RIVER HOSPITAL DISTRICT

PROPERTY TAX TRENDS

1970 - 1978

Year	Total Assessed Value	Mill Levy	Total Revenue
1970	$25,684,230	1.47	$ 37,756
1971	$18,540,340	2.00	$ 37,080
1972	$19,378,890	3.00	$ 58,137
1973	$18,595,620	3.00	$ 55,787
1974	$17,734,900	3.00	$ 53,205
1975	$18,274,720	3.00	$ 54,824
1976	$21,039,150	3.00	$ 63,117
1977	$24,742,080	2.95	$ 72,989
1978	$25,492,220	4.00	$101,969

Source: Annual Reports, Colorado Division of Property Taxation, 1970-1977.

assessor. Table 10 indicates that the district assessed valuation was $9,194,470 during its first year of operation. Assessed valuation decreased somewhat for 1978 because of state-imposed re-evaluation practices, which forced many districts to increase their mill levies in order to raise adequate revenues.

The Rifle Fire District, as with all fire districts in Colorado, is limited by state statute to a maximum levy of 7 mills for operating purposes. Additional mills could be imposed for purposes of debt retirement. The Fire District does not currently have any outstanding debt.

4. Rifle Metropolitan Park District

The Rifle Metropolitan Park District builds and manages park and recreation facilities in the City of Rifle. The district's facilities include a swimming pool, a lighted softball field, two tennis courts, and a picnic area. The district, if a pending grant application is approved, is planning the construction of a building for washroom and storage facilities and some improvements to existing park facilities.

The district obtains most of its operating revenues through pool admission fees, donations and property tax collections. Table 11 indicated that, despite a decrease in mill levy, the property tax revenues to the district have increased since 1970.

TABLE 10

RIFLE FIRE PROTECTION DISTRICT-

PROPERTY TAX TRENDS IN GARFIELD COUNTY

1970 - 1978

Year	Assessed Valuation	Mill Levy	Total Revenue
1977	$9,194,470	2.44	$22,435
1978	$8,317,900	2.77	$23,041

Source: Annual Reports, Colorado Division of Property Taxation, 1976-1977.

TABLE 11

RIFLE METROPOLITAN PARK DISTRICT-

PROPERTY TAX TRENDS

1970 - 1978

Year	Assessed Valuation	Mill Levy	Total Revenue
1970	$3,502,600	2.03	$7,110
1971	$3,432,740	2.03	$6,968
1972	$3,440,860	2.03	$6,985
1973	$3,498,830	2.03	$7,103
1974	$3,609,270	2.03	$7,327
1975	$4,078,920	1.90	$7,750
1976	$4,312,360	1.89	$8,150
1977	$5,217,820	1.73	$9,027
1978	$5,054,920	1.91	$9,655

Source: Annual Reports, Colorado Division of Property Taxation, 1970-1977.

District boundaries do not conform exactly to those of the City of Rifle, but they are very similar, so that total assessed valuation varies little between he two entities.

The Park District presently has $33,000 in outstanding bonded debt. This debt was incurred to finance construction of the swimming pool, and is due to be retired in 1988.

5. Silt Water Conservancy Districts

The Silt Water Conservancy District provides irrigation water to the Rifle and Silt area. None of the district's water is used for municipal purposes.

The primary source of revenues to the district are user fees. Property taxes are levied on all property within the district, including the entire City of Rifle, with the exception of the Union Carbide property. Property tax revenues amount to 10-15 percent of the district budget. As is shown in Table 12, property tax revenues have almost doubled since 1970. The district has no outstanding indebtedness.

6. South Rifle Metropolitan District

The South Rifle Metropolitan District (SRMP) serves a developing area south of the Colorado River and outside of Rifle. SRMD presently provides only water and sewer service to domestic customers. SRMD presently does not levy property taxes. It is supported solely from utility tap fees and service charges.

TABLE 12

SILT WATER CONSERVANCY DISTRICT

PROPERTY TAX TRENDS

1970 - 1978

Year	Assessed Valuation	Mill Levy	Total Revenue
1970	$ 6,624,660	1.00	$ 6,625
1971	$ 6,391,920	1.50	$ 9,587
1972	$ 6,517,700	1.50	$ 9,777
1973	$ 7,139,170	1.43	$10,209
1974	$ 7,547,300	1.42	$10,717
1975	$ 7,912,110	1.50	$11,868
1976	$ 8,723,550	1.40	$12,213
1977	$11,163,960	1.17	$13,061
1978	$10,911,880	1.20	$13,094

Source: Annual Reports, Colorado Division of Property Taxation, 1970-1977.

III. PLANNING DISTRICTS

Tax dollars collected from Rifle residents are used to finance various activities on the local, county, state, and Federal levels. One activity undertaken by specialized government agencies is planning. Rifle falls within the jurisdiction of three major planning districts and/or departments. Each district functions in a different manner, providing varying services to the town. The following section will identify these planning agencies and the functions they perform.

A. Colorado West Area Council of Governments

The most localized planning district concerned with the town is the Colorado West Area Council of Governments (COG) which includes Rio Blanco, Moffat, Garfield and Mesa Counties within its region. The Colorado West Area COG was formed in 1973 as an outgrowth of a three-county (Rio Blanco, Garfield, and Mesa) Oil Shale Regional Planning Commission which had been created by joint resolution in July 1971 in anticipation of the impact problems from oil shale development. The COG has continued the work of the Oil Shale Regional Planning Commission.

The boundaries of the COG are also the same as those of State Planning and Management Region #11 (See Figure 1) which is designated by executive order of the Governor. The COG was established to facilitate and coordinate regional

land use and economic development planning; to provide A-95 review and clearinghouse functions for federal funds; to develop regional policies on growth management; and facilitate water quality and wastewater management (208 programs). The COG is funded jointly by the four member counties and by various Federal programs or grants. Garfield County's yearly share of $10,000 comprises about 5 percent of the COG's total annual budget. Rifle's contribution is included within its payment of county property taxes.

B. Colorado Land Use Commission

The second planning agency to be considered is the Colorado Land Use Commission (LUC) which was established by the State Legislature in 1971. Designated under H.B. 1041, the LUC was designed to act primarily as a state review and recommendation mechanism to local governments. It has limited authority to see that local governments adequately consider matters of state interest.

House Bill 1041 divides this "interest" into two categories. The first addresses geographic areas of mineral resource deposits, natural hazards, wildlife, historical and archaeological concern, and areas around key state and federal facilities. The second category of LUC interest is concerned with site selection of new large airports, public utilities, arterial highways and new communities.

As a second primary authority, the LUC is granted temporary emergency powers by the Legislature if it determines that a particular land development activity constitutes a danger to the public. Local governments such as Meeker, (as well as counties and COGS) may request the LUC to intervene when they deem it necessary, or seek its advice on matters related to growth and development. The Land Use Commission is supported by funds collected by the State from sales tax and individual income tax and distributed to the LUC from the State's General Fund.

C. Area Oil Shale Supervisor's Office

The Area Oil Shale Supervisor's Office (AOSSO) is a Federally-funded area office of the Conservation Division of the United States Geological Survey (USGS). AOSSO was formed in June, 1974 to manage and administer the federal oil shale leases. AOSSO's function is to approve plans for the leases and accompanying development plans and monitor adherence to them. The agency's jurisdictional boundaries are community-based, i.e., its area of authority exists wherever Federally-owned oil shale is located. AOSSO has no formal working relationship with the towns and counties in oil shale areas.

III POPULATION

I. INTRODUCTION

Population forecasts provide the basis for many of the other projections presented in this Development Guide, including those concerning land use, housing, and education.

Future population estimates for Rifle have been developed by the Colorado West Area Council of Governments (COG), using the stable or historical growth assumption, and also the assumption of full-scale energy development. These two scenarios are used throughout this report, and are termed natural growth and impact growth. The impact projections are so dynamic that they require constant up-dating, something that COG's Growth Monitoring Information System is specifically designed to do. The natural and impact scenarios for the 1978-1985 period are presented here as the most complete projections currently available.

Most of the data on past population trends comes from the U.S. Bureau of the Census, and other estimates are provided by the QDA staff.

II. GENERAL POPULATION

Rifle's population has fluctuated modestly from 1960 to 1976 within a narrow range between 2100 and 2200. As shown in Table 1, Rifle's estimated minimal growth in the decade from 1960 to 1970 turned to decline between 1970 and 1975. Since 1975,

TABLE 1

POPULATION TRENDS IN THE CITY OF RIFLE

1960 - 1978

Year	Rifle Population	% Change
1960[1]	2135	--
1970[1]	2150	+0.7
1971[2]	2115	-1.6
1972[2]	2080	-1.7
1973[1]	2046	-1.6
1974[2]	2030	-0.8
1975[1]	2016	-0.7
1976[2]	2129	+5.6
1977[1]	2244	+5.4
1978[2] (June 1)	2450	+9.2

Source: [1]U. S. Department of Commerce, Bureau of the Census

[2]QDA estimates

population levels have begun to climb past the 1970 peak of 2150 to 2450 as of June, 1978. The percentage population change provide another comparison between these growth periods:

1960 to 1970	-- growth of	0.7%
1970 to 1975	-- loss of	6.2%
1975 to 1978	-- growth of	21.5%

The recent growth has been of such magnitude that the overall growth rate since 1970 is almost 14%, for an average annual increase of 1.7%.

Garfield County's population trends are much different, showing steady population growth from 1960 to the present, with one minor dip in 1977. As indicated by Table 2, the average annual rate of growth in the County between 1960 and 1970 (2.3% per year) has been surpassed every year since then, with the exception of 1972 and 1977. Overall from 1970 to 1978 the County's growth has amounted to 35.6%, or an average of 4.5% per year.

Comparison of Rifle's population as a percent of the County's since 1960 is shown below:

	1960	1970	1973	1975	1977	1978
Rifle Population as a Percent of Garfield County Population	17.8	14.5	12.4	11.3	11.9	12.2

Decline in Rifle's share of Garfield County's population has been steady since 1960, but Special Census figures indicate a reversal in 1977. This reversal is now becoming the

TABLE 2

POPULATION TRENDS IN GARFIELD COUNTY

1960 - 1978

Year	County Population	% Change
1960[1]	12,017	--
1970[1]	14,821	+23.3
1971[1]	15,400	+ 3.9
1972[1]	15,700	+ 1.9
1973[1]	16,445	+ 4.7
1974[1]	16,900	+ 2.8
1975[1]	17,906	+ 8.9
1976[1]	18,900	+ 5.6
1977[1]	18,800	- 0.5
1978[2] (June 1)	20,100	+ 6.9

Source: [1]U. S. Department of Commerce, Bureau of the Census

[2]QDA estimates

trend and growth in Garfield County will be increasingly influenced by development in the Rifle area.

Population projections for the City of Rifle from 1978 through 1985 are given in Table 3 and shown graphically in Figure 1. The total projected populations are presented in terms of natural and impact growth components.

Population figures under the natural growth scenario are projected to increase consistently throughout the years. As Table 3 and Figure 1 indicate, the 1985 natural growth population is expected to be about 30% higher than the estimated 1978 population for the city.

Under impact conditions, Table 3 and Figure 1 indicate a period of major growth for Rifle from 1978 through 1982; a drop in 1983; and a subsequent period of more moderate growth through 1985.

According to these estimates, the impact population is expected to grow from 67% of the natural growth component in 1978 to 307% of the natural population in 1982, and remain above 214% even in 1985. In other words, one out of every two-and-a-half Rifle residents will be impact-related in 1978; by 1982, three out of four will be impact-related; and by 1985, two out of three in the community are projected to be related to energy development.

For the entire period 1977-1985, Rifle's population under impact conditions is expected to grow 332%, an average of more

III. EXISTING AND PROJECTED AGE AND EDUCATION CHARACTERISTICS

The Census Bureau collects data as to the age distribution of Rifle residents, though it is not customarily published. The Special Census done in the spring of 1977 did release such information, however, and it is presented in Table 5. This data shows that around 1/3 of Rifle's 1977 population is under 20, and more than half are between 20 and 64 years of age. The relatively high proportion of people over 65 (17% of Rifle's population) raises the median age of the community to more than 34 years.

For comparison, the age distribution figures available for Garfield County from 1960 through 1977 are shown in Table 6. The data for 1977 indicates the County's population is generally younger, with larger portions both in the 0-19 and 20-64 age groups, and a much smaller percentage in the 65 and over category than in Rifle's age distribution. The County's median age of 28.4 years is considerably lower than Rifle's 34.1 median age in 1977.

Between 1960 and 1977 the County's age distribution shows slight decline in the 0-19 and 65 and over age groups, while the 20-64 group increased its relative share of the total County population. Age distribution in Garfield County remained virtually unchanged in the decade 1960-1970, meaning that the growth noted in the 20-64 age group, at the expense of the 0-19 and the 65 and over age categories, has taken place largely since 1970. Median age in the County has shown steady

TABLE 5

AGE DISTRIBUTION IN THE CITY OF RIFLE

1977

Age Category	Population	Percent
0-19	694	30.9
20-64	1,160	51.7
65+	390	17.4
Total	2,244	100.0

Median Age = 34.1

Source: U. S. Department of Commerce, Bureau of the Census

TABLE 6

AGE DISTRIBUTION IN GARFIELD COUNTY

1960, 1970 and 1977

Age Category	1960		1970		1977	
	Population	Percent	Population	Percent	Population	Percent
0-19	4,493	37.4	5,538	37.3	6,338	33.7
20-64	6,162	51.3	7,614	51.4	10,566	56.2
65+	1,362	11.3	1,669	11.3	1,896	10.1
Total	12,017	100.0	14,821	100.0	18,800	100.1
Median Age	32.9		30.0		28.4	

Source: U. S. Department of Commerce, Bureau of the Census

decline from 32.9 years in 1960 to 30.0 years in 1970, and down to 28.4 years as of 1977.

Age distribution patterns are expected to change considerably under energy development conditions. In Table 7 and Figure 2, 1977 age distribution figures for Rifle and Garfield County are compared with projected age group patterns at three points during the projection period. The years 1978, 1982, and 1985 were chosen to represent, respectively, the first year of impact, the initial peak year of impact, and the year during which impact is expected to level off.

Energy development will mean absolute increases in the size of each of the major age categories. However, the relative share in the 0-19 and 65 and over age groups are expected to decrease over the period 1977 to 1985 for both the City of Rifle and Garfield County. For Rifle, the 0-19 age group is projected to remain at approximately 30% of the total population, dipping to a low of 28.7% of the 1982 (peak-year) population. The proportion within the over 65 group is projected to show a general decline, starting from 12.1% of the total population in 1978, to 7.1% in 1982 and 9.0% in 1985. During the same period, the 20-64 age group in Rifle is predicted to grow from 57.5% of Rifle's 1978 population to a high of 64.2% in 1982, and to over 60.8% of Rifle's total population in 1985. These projected trends are also reflected at the County level for the period 1977-1985.

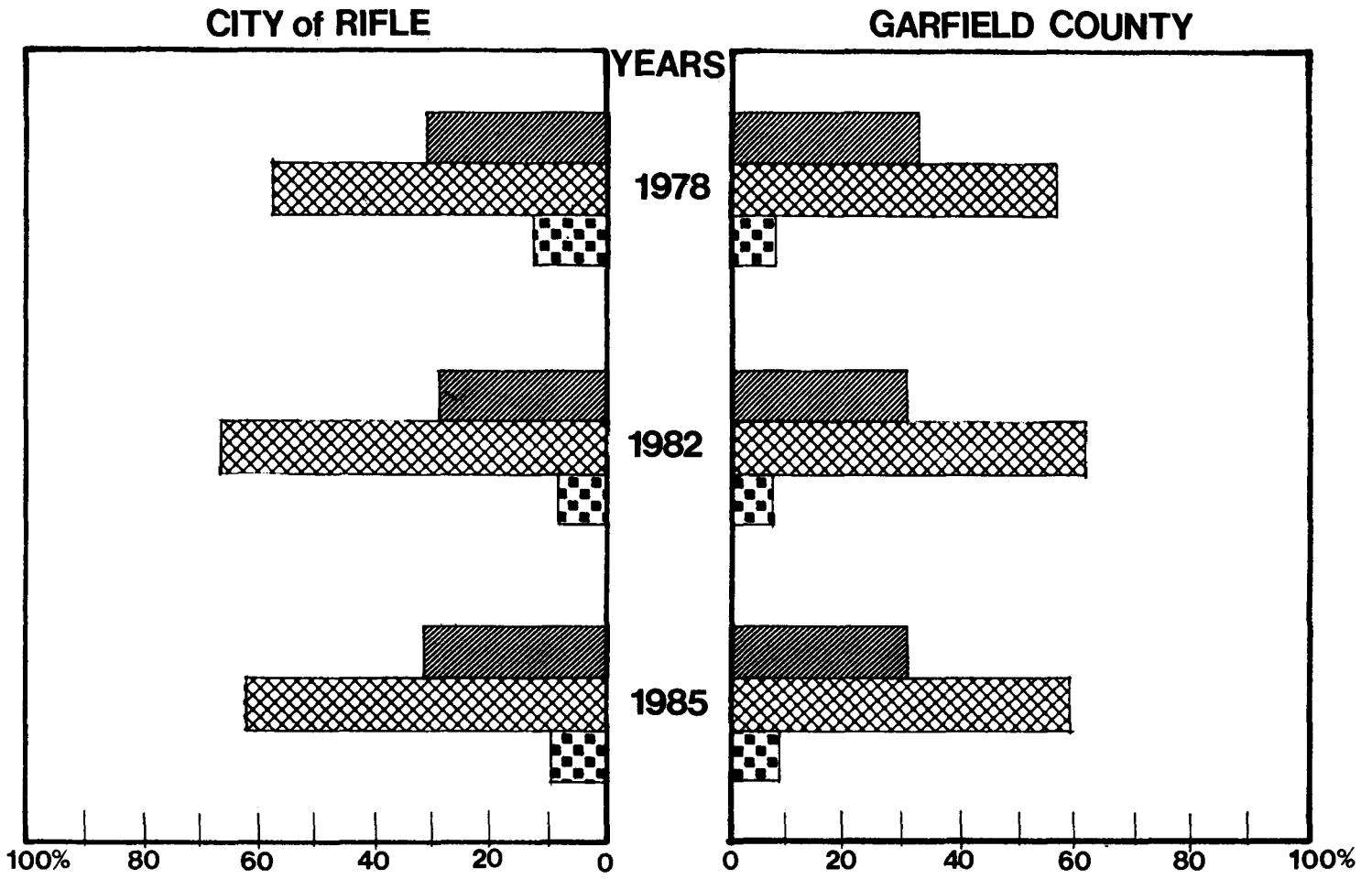
TABLE 7

ACTUAL AND PROJECTED AGE DISTRIBUTION TRENDS UNDER IMPACT GROWTH
IN THE CITY OF RIFLE AND GARFIELD COUNTY FOR
SELECTED YEARS, 1978, 1982 and 1985

Age Category	CITY OF RIFLE						GARFIELD COUNTY					
	1978		1982		1985		1978		1982		1985	
	#	%	#	%	#	%	#	%	#	%	#	%
0-19	1,162	30.4	3,200	28.7	2,931	30.2	7,432	33.1	11,010	31.1	11.494	31.9
20-64	2,196	57.5	7,171	64.2	5,903	60.8	12,986	57.7	21,774	61.5	21,506	59.7
65+	463	12.1	792	7.1	868	9.0	2,068	9.2	2,644	7.4	3,004	8.4
TOTAL	3,821	100.0	11,163	100.0	9,702	100.0	22,486	100.0	35,428	100.0	36,004	100.0

Source: QDA estimates based on COG's Growth Monitoring Information System

FIGURE 2



PROJECTED AGE DISTRIBUTIONS FOR RIFLE AND GARFIELD COUNTY

Regarding the educational levels of the residents of Rifle and Garfield County, not much recent data exists. The latest County-level figures are those in the 1970 Census. These indicate that at that time the median number of school years completed among all County residents, ages 25 and over, was 12.2 years--almost one quarter year beyond high school. While this is a respectable average figure, the 1970 Census also indicates that more than one-third (41.3%) of this same age group had not graduated high school. In addition, of the County's population between the ages of 3 and 34, more than half (54.7%) were enrolled in schools during the census period.

It is virtually impossible to project changes in educational level for the future populations of either Rifle or Garfield County. Certain logical assumptions can be examined, among them: incoming energy development-related employees are likely to be more skilled and educated than the average existing populations; and the secondary populations brought in by the direct employee forces, such as public servants, business persons, and social service providers, are normally educated more than the existing median education level would indicate. Thus, we could safely assume that the incoming impact population will not deteriorate the present educational level figures, and may well increase them.

IV. EXISTING AND PROJECTED EMPLOYMENT TRENDS

Data collected by the Colorado Division of Labor and Employment provides the basis for the following estimates of employment. Table 8 presents the trends in work force, employment, and unemployment for Rifle and Garfield County for 1970 into 1978.

A. Existing Employment Trends

The numbers in Rifle's work force increased steadily from 1970 to the present, with the exception of a slight decline in 1971. From 1970 to 1978, the work force grew by nearly 37%, for an average increase of 4.6% per year. Total numbers employed in the Rifle area have also increased, with declines noted in 1971 and 1975. Since 1970, employment in Rifle has grown about 29%, or an annual average of 3.6%. Because work force has grown at a faster rate than employment, Rifle's rate of unemployment has increased considerably, from 4.5% in 1970 to an estimated 9.9% in the first quarter of 1978. Unemployment reached its lowest point during the period in 1974 when it was 4.2%. Since then unemployment figures have fluctuated erratically, but have not been brought below 6%, and have in fact averaged better than 7.5% between 1975 and 1978.

The trends in Garfield County are very similar, showing increases in work force of 54% since 1970, increases in employment of 45% since 1970, and an escalating rate of unemployment up to an estimated 9.7% at present. The size of the work

TABLE 8

WORK FORCES, EMPLOYMENT, UNEMPLOYMENT, AND SECTOR ESTIMATES
FOR THE CITY OF RIFLE AND GARFIELD COUNTY, 1970-1978

City of Rifle								
Total Work Force	995	970	1,050	1,070	1,075	1,085	1,175	1,260	1,360
Total Employment	950	925	1,005	1,015	1,030	1,010	1,105	1,160	1,225
% Unemployed	4.5	4.6	4.3	5.1	4.2	6.9	6.0	7.9	9.9
1. Agriculture	150	135	135	125	115	100	100	90	80
2. Mining	100	95	95	90	85	80	80	80	75
3. Contract Construction	50	55	65	75	80	85	100	115	125
4. Manufacturing	25	25	30	30	30	35	40	40	45
5. Transportation, Utilities, Communications	50	50	55	60	65	65	70	75	85
6. Wholesale and Retail Trade	150	150	170	175	185	185	205	225	245
7. Finance, Insurance, and Real Estate	25	25	30	30	30	30	40	40	45
8. Services	300	290	320	325	330	325	355	375	400
9. Government	100	100	105	105	110	105	115	120	125

Garfield County	1970	1971	1972	1973	1974	1975	1976	1977	1978[1]
Total Work Force	6,815	7,070	7,905	8,665	8,955	9,610	10,415	10,525	10,465
Total Employment	6,525	6,750	7,575	8,225	8,575	8,975	9,800	9,700	9,450
% Unemployed	4.3	4.5	4.2	5.1	4.2	6.6	5.9	7.8	9.7
1. Agriculture	775	650	650	700	775	700	725	625	525
2. Mining	625	525	375	400	475	550	600	550	625
3. Contract Construction	225	300	500	700	625	650	850	725	650
4. Manufacturing	100	125	125	150	175	200	275	200	200
5. Transportation, Utilities, Communications	275	325	300	375	625	650	700	675	575
6. Wholesale and Retail Trade	1,075	1,350	1,675	1,700	1,625	1,700	2,025	2,025	1,925
7. Finance, Insurance, and Real Estate	75	125	200	250	225	275	275	300	250
8. Services	1,900	2,150	2,575	2,800	2,900	3,050	3,075	3,150	3,175
9. Government	1,475	1,200	1,175	1,150	1,150	1,200	1,275	1,450	1,525

[1]First Quarter estimates

Source: QDA estimates based on data provided by the Colorado Division of Labor and Employment

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force dipped only slightly in the first quarter of 1978, while employment has been slipping since its peak of 9,800 in 1976.

Employment sectors of major importance in Rifle include Services, Wholesale and Retail Trade, and Government. Mining and Contract Construction are other prominent sectors of employment. With the exception of Mining, each of these sectors has shown gains since 1970: employment in Services increased 33.3% from 300 to 400; Wholesale and Retail Trade employment of 150 in 1970 has increased 63.3% to 245 in 1978; and employment in Government has grown by 25% over its 1970 base of 100 employed persons. During the same period, Contract Construction has grown by 150% from 50 to 125, and Mining dropped 25% from 100 to 75. Only agriculture has declined since 1970 (from 150 to 80, a drop of 46.7 percent). Other categories showing increases were Manufacturing, Finance, Insurance and Real Estate; and Transportation, Utilities, and Communications.

Table 9 shows Services employing the greatest numbers in Rifle, with its share of total employment actually using from 31.6 percent in 1970 to 32.7 percent by the first quarter of 1978. Wholesale and Retail Trade climbed to second in employment in 1978 from third in 1970, and has also increased its share of total employment from 15.8 percent in 1970 to 20.0 percent in 1978. Government remains Rifle's fourth largest employer, still claiming around 10 percent of the

TABLE 9

TOP FIVE ECONOMIC SECTORS IN THE CITY OF RIFLE
RANKED IN TERMS OF EMPLOYMENT

1970 and 1978

1970		1978	
Sector	Percent of Total Employment	Sector	Percent of Total Employment
1. Services	31.6	1. Services	32.7
2. Agriculture	15.8	2. Wholesale and Retail Trade	20.0
3. Wholesale and Retail Trade	15.8	3. Contract Construction	10.2
4. Government	10.5	4. Government	10.2
5. Mining	10.5	5. Transportation, Utilities, and Communications	6.9

SOURCE: QDA estimates based on information provided by the Colorado Division of Labor and Employment.

community's total employment in 1978 as it did in 1970. By the first quarter of 1978, Construction and Transportation, Utilities, and Communications joined Services, Wholesale and Retail Trade, and Government to comprise Rifle's five largest sectors of employment. Since 1970, Agriculture and Mining have fallen from the top five sectors--Agriculture declined from 15.8 percent of Rifle's 1970 employment to only 6.5 percent in 1978, and Mining dropped from 10.5 percent to 6.1 percent by early 1978.

Overall, employment in Rifle seems to be spreading out somewhat since 1970. Whereas the top five sectors of employment in 1970 represented more than 84 percent of Rifle's total employment, the current top five constitute only 80 percent of total employment.

B. Projected Employment and Unemployment Trends

Forecasts of Rifle's employment are based on the number of service jobs attracted to the area and supported by the increasing basic employment engaged in energy development. Known as the basic-to-service employment multiplier, this relationship has been estimated to be 0.8 by the Region 11 Council of Government's Growth Monitoring Information System. That is, for every 10 jobs in the basic sectors, 8 would be generated in the service sectors. Generally, the value of this multiplier is expected to grow as the increased population becomes settled, and as Rifle becomes a more stable and economically self-sufficient community.

Projections of the total number of jobs that may result from energy impact in the Rifle area are presented in Table 10. Substantial increases over 1977 levels in employment are expected in Rifle, a 26% increase in 1978 over 1977 and a 59% increase in total employment in 1979 over 1978. Slight decreases in employment are projected for 1980 and 1983, with the overall peak in employment anticipated at 3,473 in 1982. This represents an annual average growth rate of 40 percent from 1977. By 1985, Rifle's total employment is expected to increase to 3,128, for an increase of 170 percent over 1977.

In addition, forecasts of total employment have been estimated by economic sector, also given in Table 10. These projections represent recent baseline trends and the added effects of energy impacts. Table 11 presents these figures in terms of the five largest employment sectors, ranked at three different points during the projection period.

These data indicate a significant effect of energy development on Rifle's employment outlook. The mining sector, representing less than 7 percent of Rifle's employment in 1977, is expected to approach 20 percent of total employment by 1982. By 1985, Mining is projected to be the largest single employer in Rifle, claiming nearly one in every three employees. Contract Construction, both energy-related and other private-market development, is predicted to nearly double its 1977 share of employment by 1978, from 10.2 percent in 1977 to 19.6% of total employment in 1978, becoming the second largest

TABLE 10

EMPLOYMENT PROJECTIONS FOR THE CITY OF RIFLE BY ECONOMIC SECTOR UNDER IMPACT GROWTH CONDITIONS

1978 - 1985

Economic Sector	1978	1979	1980	1981	1982	1983	1984	1985
Agriculture	85	79	73	66	59	51	44	37
Mining	122	284	392	608	668	800	919	1,027
Contract Construction	312	712	554	860	819	390	405	460
Manufacturing	48	67	64	81	88	67	70	72
Transportation, Utilities and Communications	92	125	119	149	162	125	128	132
Wholesale and Retail Trade	291	415	406	517	570	441	457	473
Finance, Insurance, and Real Estate	51	71	70	88	96	77	80	82
Services	447	588	576	700	758	608	622	638
Government	146	195	188	234	253	196	201	207
Total Employment	1,594	2,536	2,442	3,303	3,473	2,755	2,926	3,128

TABLE 11

THE PROJECTED TOP FIVE ECONOMIC SECTORS IN THE CITY OF RIFLE
RANKED IN TERMS OF EMPLOYMENT
1978, 1982 and 1985

	1978		1982		1985	
Rank	Sector	Percent of Total Employed	Sector	Percent of Total Employed	Sector	Percent of Total Employed
1	Services	28.0%	Contract Construction	23.6%	Mining	32.8%
2	Contract Construction	19.6%	Services	21.8%	Services	20.4%
3	Wholesale and Retail Trade	18.3%	Mining	19.2%	Wholesale and Retail Trade	15.1%
4	Government	9.2%	Wholesale and Retail Trade	16.4%	Contract Construction	14.7%
5	Mining	7.7%	Government	7.3%	Government	6.6%

Source: QDA estimates based on figures from COG's Growth Monitoring Information System and from the Colorado Division of Labor and Employment.

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employing industry in the Rifle area. By 1982, Contract Construction is projected to become the single largest employer. However, by 1985, Contract Construction is forecast to slip to fourth largest employment sector to around 15 percent of total employment. Together, Mining and Contract Construction are predicted to comprise between 40 and 50 percent of Rifle's projected employment from 1982 through 1985, or nearly as much as the employment in all the other sectors combined.

Wholesale and Retail Trade is forecast to drop slightly in its relative share of employment from 20 percent in 1977 to 15.1 percent by 1985, putting it slightly below even its level in 1970. It will still remain as third or fourth largest employer in Rifle throughout the 1978-1985 period.

The Services sector, the largest employment secto in Rifle since 1970 with more than 30 percent of total employment, is projected to remain an important part of the economy. Its relative share of local employment is predicted to decline to around 20 percent by 1985, still constituting the second major employer in the Rifle area.

The Government sector is also expected to remain a major employer in Rifle through 1985, though its relative portion by then will be reduced from 10.2 percent of total employment in 1977 to less than 7%.

Agriculture, Rifle's second leading employer in 1970 with 15.8 percent of total employment, is predicted to drop dramatically to around 5 percent by 1978. After that, it is projected that this sector will drop further to eventually comprise only one percent of Rifle's employment in 1985, ranking last of the nine economic sectors in employment (Table 10).

Overall, there is anticipated to be increased concentration of employment among the largest sectors between now and 1985. Whereas the top five sectors currently account for 80 percent of Rifle's total employment, by 1985 the influence of rapid growth will place almost 90 percent of Rifle's employment in five of the nine economic sectors.

Unemployment estimates are very complex, and have not been specifically forecast in this Development Guide. This is primarily due to the known unpredictability of labor force activity in past experience with rapidly growing energy developments, and the fact that such data under impact conditions are virtually impossible to collect on even a state or national basis, much less on a local level. On one hand, the sudden availability of many new job opportunities can be expected to lower employment rates locally, assuming that those unemployed and underemployed in the local labor pool have sufficient skills to take advantage of the new circumstances. On the other hand, however, the sheer size of the labor force requir-

ed to man the incoming industries is far greater than locally-available labor, and a tremendous influx of outside labor is required to meet industry's needs. Yet, the promise of employment opportunities in the area is likely to bring in more job hunters than there are jobs to fill. When this is the case, unemployment rates can rise, often dramatically, as the growth of the labor force outstrips the growth in employment.

A small-scale example of this latter situation can be found to the north of Rifle, in Craig and Moffat County. The "boom" in coal mining and generating plant construction has meant a 25 percent increase in employment since 1972, yet, the work force has increased by 32 percent in the same period. The result has been that only once since 1972 has unemployment matched the pre-boom level of 3.5 percent; it has not been below 7 percent since 1974, and through the first quarter of 1978 stands in excess of 11 percent.

If, for example, Rifle's labor force were to outgrow the number of jobs available by 1982, the initial peak year, by the same rate evidenced in Moffat County since 1972, its 1977 unemployment rate of 7.9 percent would increase to more than 15 percent in five years. Practically speaking, there probably exists a ceiling of unemployment above which new job seekers would be discouraged from migrating in hopes of employment. This is not to say that unemployment rates in energy boom towns will remain stable, but rather that initial

experiences in other situations indicate that they are likely to climb by 4 to 6 percent or more before reaching the limit that will turn off the flow of economic in-migration.

V. EXISTING AND PROJECTED INCOME LEVELS

Per capita income estimates for Rifle and Garfield County are based primarily on Bureau of Census figures for 1970, 1973, and 1975. Earnings by sector have been estimated on the basis of statistics published by the Colorado Division of Labor and Employment.

As indicated in Table 12, per capita income has grown very nearly at the rate evidenced by Garfield County and by the State as a whole. Since 1970, Rifle's per capita income has exceeded the County's income level by as much as 4 to 6 percent.

The poverty level is an index adjusted by factors, such as family size, number of children under 18, farm or non-farm residence and so on. In 1970, for an average non-farm family of four, the standard poverty threshold was $3,745. Census data for Garfield County in 1970 shows that 1,656 persons, or 11.3 percent of the County's population, had incomes below the poverty level. This is equivalent to 485 households, or 14.4 percent of all the households in the County in 1970.

Average earnings by economic sector are presented in Table 13. These figures indicate that the highest paying

TABLE 12

PER CAPITA INCOME TRENDS

1970 - 1977

Year	Rifle	Garfield County	State of Colorado
1970	$3,414	$3,214	$3,430
1971	$3,756	$3,547	$3,783
1972	$3,999	$3,788	$4,065
1973	$4,440	$4,214	$4,489
1974	$4,836	$4,599	$4,884
1975	$5,123	$4,883	$5,194
1976	$5,464	$5,214	$5,547
1977	$5,806	$5,548	$5,900
Total 1970-1977 Change	+70.06%	+72.62%	+72.01%
Compound Yearly Rate of Change	+ 7.88%	+ 8.11%	+ 8.06%

Source: QDA estimates based on figures from the U. S. Department of Commerce, Bureau of the Census.

TABLE 13

AVERAGE EARNINGS BY ECONOMIC SECTOR IN CURRENT DOLLARS

1970 and 1977

	1970	1977	Average % Change Per Year
Agriculture	$6,782	$ 9,919	6.6%/year
Mining	8,928	15,070	9.8%/year
Contract Construction	8,940	15,796	11.0%/year
Manufacturing	6,490	10,261	8.3%/year
Transportation, Utilities, and Communications	7,227	13,892	13.2%/year
Wholesale and Retail Trade	5,284	8,143	7.7%/year
Finance, Insurance, and Real Estate	5,271	8,061	7.6%/year
Services	6,268	7,649	3.1%/year
Government	6,098	9,191	7.2%/year

Source: QDA estimates based on information from the Colorado Division of Labor and Employment.

occupations are within the Construction, Mining, and Transportation, utilities, and Communications sectors, Finance, Insurance, and Real Estate, and Wholesale and Retail Trade are among the lowest-earning sectors. Average earnings in every sector have increased by better than 6 percent per year since 1970, with the exception of the services category. The greatest increases in average earnings have occurred in sectors which originally evidenced the highest average earnings in 1970: Transportation, Utilities, and Communications, Contract Construction, and Mining.

There exists no reliable price index specifically related to Garfield County or to Northwest Colorado, but even State and national rates of inflation would be less than the earning gains in all but the Agriculture and Services sectors. In the remaining categories since 1970, real earnings (or earnings adjusted for inflation) have risen 1 to 5 percent per year.

Per capita income projections are based on the employment forecasts by sector, presented in Section III, and average wage projections by sector. The wage forecasts, which are based on recent trends in each industry according to figures published by the Colorado Division of Labor and Employment, are adjusted upward to account for professional salaries and other income sources, such as rent and profits.

Table 14 shows projected per capita incomes for the City of Rifle for the years 1978, 1982, and 1985, for both natural and impact growth conditions.

TABLE 14

PER CAPITA INCOME PROJECTIONS FOR THE CITY OF RIFLE
Under Natural and Impact Conditions for Selected Years

	Natural Growth	Impact Growth
1978	# 6431	$ 5,951
1982	# 7559	$ 6,778
1985	# 9002	$ 7,896

Source: QDA estimates.

With natural growth, per capita incomes may be expected to show steady gains throughout the forcast period. Though total employment and population in Rifle are forecast to grow by only 3 to 4 percent per year with natural growth, average wages will be increasing by roughly 6 to 8 percent annually. Rifle's per capita income is therefore projected to surpass #9000 by 1985, for an average growth rate of 7 percent per year over the 1977 level.

Per capita income projections under impact growth show a slower rate of growth, averaging about 4.5 percent per year. This is the combined effect of two opposing pressures: considerable increases in average wages, and even greater proportional increases in population.

First, the wage scales associated with major energy development will be uncharacteristically high for the Rifle area. For example, average wages in the mining industry are expected to increase from $15,070, currently, to $27,131 by 1985, a jump of more than 80 percent. In the construction sector during the same period, the present average wage of $15,796 is predicted to grow by nearly 70 percent to $26,489. This combination of rapid increase in job opportunities and relatively high average incomes in these two dominate economic sectors which will see selected incomes rise dramatically.

However, a factor likely to reduce these inflated per capita income figures is the sudden increase in population that occurs during the energy development buildup. Though forecasts show total income in Rifle going up by nearly 500 percent between now and 1985, the local population is projected to increase by about 330 percent during the same period. Overall, then, per capita income in Rifle will show a gain of only 36 percent between 1977 and 1985, or an average increase of 4.5 percent per year.

While this represents a smaller average growth rate of Rifle's income levels than that experienced between 1970 and 1977, QDA feels that this is consistent with the extremely rapid population buildup associated with projected energy development.

IV COMMUNITY ECONOMICS

I. INTRODUCTION

A community's economic stability is primarily dependent on how much its members take home in wages and on how much of that they spend in the community. The Population Section of this Development Guide indicated that per capita income, under impact conditions, will rise from the existing level of $5,806 to $7,896 by 1985. Assuming that retail expenditures amount to 60% of the community's aggregate income, Rifle businesses can expect to have a substantially increased market. The primary subjects of this section are to inventory what business (retail, wholesale, etc.) establishments presently exist in Rifle; project their natural growth trends; review what consumer and business attitudes are toward the Rifle marketplace and its future; and project what increases in retail opportunity may accompany projected impact growth.

II. RIFLE'S ECONOMIC PROFILE

At present there are approximately 201 various business establishments in Rifle and the surrounding area. Their retail and wholesale activities range over 42 major sectors of the Standard Industrial Classification (SIC). Table 1 ranks the top nine SIC sectors by the proportion of Rifle businesses falling within them. Table 2 presents all Rifle businesses identified by QDA staff in each two-digit SIC category.

TABLE 1

PERCENT OF RIFLE BUSINESSES BY STANDARD INDUSTRIAL CATEGORY

Rank	Standard Industrial Category	Percent of Total Rifle Businesses
1	Miscellaneous Retail	9.5
2	Eating and Drinking Places	8.0
3	Automotive Dealers and Gasoline Service Stations	7.5
4	Health Services	6.0
5	Personal Services	5.5
6	Real Estate	4.5
6	Building Materials Hardware Garden Supply and Mobile Home Dealers	4.5
7	Construction-Special Trade Contractors	4.0
8	Miscellaneous Services	3.0
9	Food Stores	2.5

SOURCE: Estimates based on QDA field survey.

MAJOR GROUP 02 AGRICULTURAL PRODUCTION, LIVESTOCK

Colorado West Dairies	24341 U.S. 6 & 24
Hendricks Appaloosas	1025 Miller Lane
Jackson's Horse Center	0516 223 Road
Rifle Livestock Inc.	North of Rifle
Gentry Livestock Inc.	121 4th Street

MAJOR GROUP 07 AGRICULTURAL SERVICES

Rifle Veterinary Clinic	11832 320 Road
U Bar Seven	0409 265 Road
Centennial Gardens	11773 320 Road
B&B Tree Service	304 W. 9th

MAJOR GROUP 10 METAL MINING

Union Carbide Corporation, Metals Division	24230 U.S. 6 & 24

MAJOR GROUP 15 BUILDING CONSTRUCTION-GENERAL CONTRACTORS AND OPERATIVE BUILDERS

Boise Cascade Homes	1982 Hwy 13
Schumann Construction	Kensington Square

MAJOR GROUP 16 CONSTRUCTION OTHER THAN BUILDING CONSTRUCTION-GENERAL CONTRACTORS

White and Sons Construction	28485 U.S. 6 & 24
Johnson Lee Construction	1920 Hwy 13

MAJOR GROUP 17 CONSTRUCTION-SPECIAL TRADE CONTRACTORS

B&B Plumbing	328 E. 6th
Hutton Heating & Sheet Metal	120½ W. 4th
Colvin Plumbing	25653 U.S. 6 & 24
Carleton E. Hoffmeister (Painting Contractor)	0993 Miller Lane
Rifle Electric	1771 Railroad
H & H Drywall	1124 W. 2nd
Antlers Roofing Co.	30414 U.S. 6 & 24
Stoneman & Son Water Well Drilling	1550 293 Road

MAJOR GROUP 20 FOOD AND KINDRED PRODUCTS

Rifle Ice and Storage	128 West Ave.

MAJOR GROUP 27 PRINTING PUBLISHING AND ALLIED INDUSTRIES

Rifle Telegram	121 E. 3rd
The Weekly Newspaper	420 Railroad
Insta-Print of Colorado	123 E. 3rd
Lightning Quick Print Co.	121 4th Street

MAJOR GROUP 38

Antonelli Industries	515 W. 2nd
Copeland Concrete Inc.	28803 U.S. 6 & 24
Mountain Mobil-Mix	27346 U.S. 6 & 24

MAJOR GROUP 41 LOCAL AND SUBURBAN TRANSIT AND INTERURBAN HIGHWAY PASSENGER TRANSPORTATION

Trailways Bus System	111 E. 3rd
Ambulance Service	701 E. 5th

MAJOR GROUP 42 MOTOR FREIGHT TRANSPORTATION AND WARFHOUSING

A.J. Stampfel	1015 W. 2nd
Don Ward and Co.	121 W. 2nd
Hi-Way Food Lockers	128 West Ave.

MAJOR GROUP 45 TRANSPORTATION BY AIR

Morrison Aircraft Service	Garfield County Airport
Gordon Aviation	Garfield County Airport

MAJOR GROUP 47 TRANSPORTATION SERVICES

Target Travel and Tours	208 E. 3rd

MAJOR GROUP 48 COMMUNICATION

Mountain Bell	800 Main G. Jct.
KWSR Radio	436 East Ave.
Canyon Cable T.V. Service	Aspen Airport Business

MAJOR GROUP 49 ELECTRIC GAS AND SANITARY SERVICES

Public Service Company of Colorado	1995 Howard
Colorado-Ute Electric Association	South of Rifle
Mountain Fuel Resources Inc.	0613 264 Road
Western Slope Gas Co.	540 Prefountaine Road

MAJOR GROUP 51 WHOLESALE TRADE-NONDURABLE GOODS

Texaco Bulk Plant	120 S. Park
Phillips 66 Bulk Plant	0062 264 Road
Conoco Bulk Plant	West of Rifle
Mobil Oil co.	0484 294 Road

MAJOR GROUP 52 BUILDING MATERIALS, HARDWARE, GARDEN SUPPLY, AND MOBILE HOME DEALERS

Burkey Lumber co.	310 W. 3rd
Independent Lumber Co.	221 W. 2nd
Olympic Trussco	208 E. 3rd
Wylaco Supply Co.	426 Railroad
Inter-mountain Lumber Co.	1331 226 Road
The Home Place	121 4th Street
Rifle Hardware	132 E. 3rd
Garfield Mobile Homes	2178 Railroad
Loy Enterprises	328 E. Avenue

MAJOR GROUP 53 GENERAL MERCHANDISE STORES

Ben Franklin Store	120 E. 3rd
Gamble's	128 E. 3rd
Henry's Department Store	144 E. 3rd
Montgomery Ward and Co.	121 W. 3rd

MAJOR GROUP 54 FOOD STORE

Rifle's Food Market	133 E. Ave.
City Market	Railroad Ave.
7-11 Food	120 E. 1st
Go-Fer Foods	5th and Railroad
Porter-Villa Meats, Inc.	2140 White River Ave.

MAJOR GROUP 55 AUTOMOTIVE DEALERS AND GASOLINE SERVICE STATIONS

Kelley Chevrolet-Cadillac Inc.	139 W. 3rd
Rifle Auto Ford Agency	231 E. 3rd
Carriage Classics	North of Rifle
The Parts House	1000 Railroad
Rifle Auto Parts and Machine Inc.	225 W. 3rd
Rifle Radiator Shop	1902 Railroad
Carpenter's Parts House	1000 Railroad
Bob's 66 Service	134 W. 1st
Poor Boy Service Station	8th & Railroad
Rifle Mobil Service	501 Railroad
Rifle Chevron Service	100 Railroad
Texaco 6 & 13	100 W. 1st
Gil-Co Service	1248 Railroad
Rifle Recreational Sports Center	230 W. 3rd
Track-N-Trail Sales & Service	130 W. 2nd

MAJOR GROUP 56 APPAREL AND ACCESSORY STORES

Wilsons Toggery	118 E. 3rd
Cathy's Shoppe	313 Railroad
The Lady's Realm	110 W. 3rd
Clothes Review	1000 Railroad
Art and Bob's Shoe Store	121 W. 3rd

MAJOR GROUP 57 FURNITURE, HOME FURNISHINGS AND EQUIPMENT STORES

East Ave. Furniture Company	143 E. 2nd
Whelan Carpet Corner	201 Railroad
Western Slope Appliance	121 4th Street
D&M TV and Appliance	232 W. 3rd
Drapery Den	
Ace Sound & C.B. Center	Railroad Avenue

MAJOR GROUP 58 EATING AND DRINKING PLACES

Big Dipper Ice Cream Shoppe	3rd Street
Cozy Corner	Railroad
Dairy Kreme Drive-In	1248½ Railroad
Audrey's Bakery and Cafe	401 Railroad
Mc's Cafe	110 E. 3rd
Outwest Bar and Cafe	24081 U.S. 6 & 24
Rifle Fireside Inn	823 Hwy 325
The Other Place	1600 Railroad
Stockman's Cafe	North of Rifle
P.J.'s Deli	121 4th Street
The Alley	228 Railroad
Midland Lounge	111 E. 3rd
Texan Bar	129 E. 3rd
The Kegger	222 Railroad
Pizza Works	133 3rd
Lil Abner's	222 Railroad

MAJOR GROUP 59 MISCELLANEOUS RETAIL

Ben Rex Pharmacy (City Drug)	120 E. 3rd
Rifle Medical Center Pharmacy	220 E. Avenue
Rifle Walgreen Agency Pharmacy	100 E. 1st
It Liquors	401 W. 2nd
Rifle Liquor Store	201 Railroad
Two Twenty Liquors	234 Railroad
Casey's Auto Salvage	27925 U.S. 6 & 24
Frank's Welding & Salvage	0074 264 Road
Clara's Second Hand Store	339 W. 2nd
All Star Sports	101 E. 3rd
Bald Bob's Sports	309 Railroad
Georgette's Book Store	105 E. 3rd
Top Drawer Office Supply & Gifts	123 E. 3rd
F.M. Cross Jewelry	311 Railroad
Golden Thimble Fabrics	121 4th Street
Flowers by Micki	409 W. 3rd
Gilded Cage Pet Shop	139 E. 2nd
Amway Products	
Hospital Auxilary Gift shop	Hospital

MAJOR GROUP 60 BANKING

First National Bank in Rifle	100 E. 4nd

MAJOR GROUP 61 CREDIT AGENCIES OTHER THAN BANKS

Mesa Federal Savings	119 E. 3rd
Rifle Production Credit Assn.	101 W. 3rd

MAJOR GROUP 63 INSURANCE

Rifle Bank Agency Inc.	100 E. 4th
Rifle Gap Agency	100 W. 3rd
The Insurance Office	326 East
Transamerica Title Insurance Co.	229 W. Avenue

MAJOR GROUP 64 INSURANCE AGENTS, BROKERS AND SERVICE

Farm Bureau Insurance Services	413 Railroad
Farmer's Insurance Group	1430 Railroad
Farmer's Union Insurance	111 E. 3rd
Mutual of Omaha	517 Railroad

MAJOR GROUP 65 REAL ESTATE

Lamplighter Trailer Court	1831 Railroad
Six and Twenty-four Trailer Court	24341 U.S. 6 & 24
Sleepy Hollow Trailer Ranch	27653 U.S. 6 & 24
King's Crown	N of Rifle
Cottonwood Springs Park	U.S. 6 & 24
Rifle Realty	142 W. 3rd
Transmountain Title Co.	111 E. 3rd
Anderson Land Office	328 E. Avenue
Todd and Associates	233 Railroad

MAJOR GROUP 70 HOTELS, ROOMING HOUSES, CAMPS AND OTHER LODGINGS

Midland Hotel	111 E. 3rd
Shaler Motel	520 Railroad
La Donna Motel	101 Ray
Book Cliff Motel	1415 Railroad

MAJOR GROUP 72 PERSONAL SERVICES

Rifle Cleaners	422 Railroad
Alice's Beauty Shop	101 E. 12th
Sammy's Style Shop	232 W. 4th
Tillie's Beauty Shop	1631 Railroad
Vickie's Parlor of Beauty	305 Railroad
Dean's His & Hers Beauty/ Barber Shop	121 4th Street
Sowder Funeral Home	425 W. 3rd
Rifle Tax Service	317 Railroad
Midland Answering Service	111 E. 3rd
H&R Block	111 E. 3rd
Western Slope Uniform and Textile Rental	139 Railroad

MAJOR GROUP 73 BUSINESS SERVICES

Rifle Blueprinting Service	123 E. 3rd
Art Franklin Photo	123 E. 3rd
Mitchell Signs	515 W. 2nd

MAJOR GROUP 75 AUTOMOTIVE REPAIR, SERVICES AND GARAGES

H&K Frame and Body Shop	815 W. 2nd
Burris Garage	1902 Railroad
Swallow Car Wash & Service Station	9th & Railroad

MAJOR GROUP 76 MISCELLANEOUS REPAIR SERVICES

Fauna Taxidermy	2100 Railroad
Roto Rooter	111 E. 3rd
Scarrow Repair	24275 U.S. 6 & 24
Mountain Peak Septic Service	604 Jarrad
Bill's T.V. Service	

MAJOR GROUP 78 MOTION PICTURE THEATERS, EXCEPT DRIVE-INS

Ute Theater	332 E. 4th

MAJOR GROUP 79 AMUSEMENT RECREATION SERVICES EXCEPT MOTION PICTURE

Rifle Creek Golf Course	

MAJOR GROUP 80 HEALTH SERVICES

Dale Terrel, M.D.	220 East Ave.
U. Duane Smith M.D.	525 Aspen
Jerald Sisk M.D.	525 Aspen
Clark A. Rosenberry, D.O.	124 4th Street
George Christensen, D.D.S.	416 Railroad
Ronald Zastrow, D.D.S.	124 E. 4th
Gary P. Spoere (Chiropractor)	1400 Access Road
Paul E. McElvain (Optometrist)	127 W. 3rd
Ron E. McElvain (Optometrist)	127 W. 3rd
Moore E. Dene Memorial Home	701 E. 5th
Clagett Memorial Hospital	701 E. 5th
Sopris Mental Health Clinic	707 E. 5th

MAJOR GROUP 81 LEGAL SERVICES

Stephen Carter	227 Railroad
Martin Dumont	105 E. 3rd
Russell George	120 W. 3rd
Thomas Stuver	120 W. 3rd

MAJOR GROUP 82 EDUCATIONAL SERVICES

Rifle Library	337 E. Avenue

MAJOR GROUP 83 SOCIAL SERVICES

House at Pooh Preschool and Daycare	412 W. 3rd

MAJOR GROUP 86 MEMBERSHIP ORGANIZATIONS

Rifle Chamber of Commerce	intersection U.S. 6 & 24
Elks Lodge No. 2195 BPOE	501 W. 5th
Loyal Order of Moose	

MAJOR GROUP 89 MISCELLANEOUS SERVICES

Eldorado Engineering-McDowell	1984 Hwy 13
Scarrow and Walker Inc.	328 East
Cleveland-Cliffs Iron Co.	131 W. 3rd
Robert Choate (Accountant)	100 W. 3rd
Edwin Branson (Accountant)	829 Railroad
Dan M. Handy & Assoc. (Accountants)	[illegible] W. 3rd

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TABLE 2 CATEGORIZATION OF RIFLE BUSINESSES BY THE STANDARD INDUSTRIAL CLASSIFICATION SYSTEM

III. RECENT TRENDS IN COMMERCIAL ACTIVITY

Statistics indicate since 1972 the number of businesses in Rifle is increasing. Table 3 shows trends in the number of sales returns the Department of Revenue has received from Rifle for the years 1972, 1974, 1976 and 1977. The number of businesses in Rifle is increasing on the order of 4.5 percent a year.

During the 1972-1977 period, sales in Rifle's trade sector increased at an average annual rate of about 20 percent. Services increased at the rate of 34 percent per year and other industries at the rate of 81 percent per year (Table 4). During this same period, retail trade sales in Garfield County increased at a rate of 19 percent annually; sales in services increased 23 percent per year; and other industries increased their sales 30 percent annually (Table 5). These figures show Rifle sales growing at a faster rate than sales in the county.

The business sectors in Rifle which have increased the fastest have been financial, insurance, and real estate (166 percent annually) and wholesale trade (294 percent annually). These increases emphasize the economic growth that is occuring in Rifle. The only category which showed a decrease in sales during the five year period was manufacturing.

Table 6 indicates that the level of Rifle's retail sales activity fluctuates throughout the year. Tourist related businesses such as restaurants, gas-oil, and motels-hotels show the highest

TABLE 3

TRENDS IN NUMBER OF RIFLE SALES RETURNS 1972-1977

Type of Business	1972	1974	1976	1977	Average Yearly Change
Building Material	48	62	59	63	+6.3%
General Merchandise	24	21	19	22	-1.7%
Food Stores	38	28	26	36	-1.1%
Automotive	166	164	158	155	-1.3%
Apparel and Accessory	36	36	36	41	+2.8%
Furniture	37	28	26	21	-8.6%
Eating and Drinking	62	92	101	87	+8.1%
Miscellaneous	113	130	200	183	+12.4%
Fin., Ins., and Real Estate	04	13	28	29	+125%
Hotels and Lodging	60	48	40	40	-6.7%
Other Services	82	70	116	119	+9.0%
Wholesale Trade	26	40	50	54	+21.5%
Agriculture	N.A.	09	N.A.	N.A.	N.A.
Mining	N.A.	N.A.	N.A.	N.A.	N.A.
Contract Construction	34	46	37	32	-1.2%
Manufacturing	42	52	49	52	+4.8%
Tran., Comm. & P. Utilities	16	24	24	32	+20%
Government	N.A.	N.A.	N.A.	N.A.	N.A.
Non classifiable	N.A.	N.A.	05	N.A.	--
Total All Industries	788	863	974	966	4.5%

Source: Colorado State Revenue Department Research Statistics

N.A.: no activity reported

TABLE 4

RIFLE RETAIL SALES TRENDS
1972, 1974, 1976, 1977
(Thousands of Dollars)

Type of Business	1972	1974	1976	1977	Average Annual Increase
Building Material	$ 826	$ 1,209	$ 1,185	$ 1,805	23.7%
General Merchandise	267	350	340	379	8.4%
Food Stores	1,995	2,570	4,397	5,017	30.4%
Automotive	2,570	3,791	4,291	4,869	17.9%
Apparel and Accessory	283	319	302	340	4.0%
Furniture	170	194	217	261	10.7%
Eating and Drinking	490	832	935	1,076	24.0%
Miscellaneous	1,053	1,303	1,794	1,672	11.8%
TOTAL RETAIL TRADE	$7,654	$10,568	$13,461	$15,419	20.3%
Fin., Ins., and Real Estate	7	21	65	65	165.7%
Hotels and Lodging	186	280	262	314	13.8%
Other Services	894	1,090	2,044	2,576	37.6%
TOTAL SERVICES	$1,087	$1,391	$2,371	$2,955	34.4%
Wholesale Trade	141	1,288	1,801	2,214	294.0%
Agriculture	N.A.	0	N.A.	N.A.	N.A.
Mining	N.A.	N.A.	N.A.	N.A.	N.A.
Contract Construction	56	150	97	258	72.1%
Manufacturing	265	463	395	247	-1.3%
Tran., Comm. & P. Utilities	357	731	1,147	1,417	59.4%
Government	N.A.	N.A.	N.A.	N.A.	N.A.
Non classifiable	N.A.	N.A.	243	N.A.	--
TOTAL OTHER INDUSTRIES	$ 819	$2,632	$3,683	$4,136	81%
TOTAL ALL INDUSTRIES	$9,560	$14,591	$19,515	$22,510	27.1%
% of County	13.1%	12.5%	12.3%	14.8%	

Source: QDA estimates based on figures from Colorado Dept. of Revenue; University of Colorado Business Research Division

NA = no activity

TABLE 5

GARFIELD COUNTY RETAIL SALES TRENDS
1972-1977

Type of Business	Thousands of Dollars 1972	1977	Average Annual Increase
Building Material	$ 4,373	$ 8,728	19.9%
General Merchandise	1,963	4,981	30.7%
Food Stores	10,219	19,239	17.7%
Automotive	18,752	33,614	15.9%
Apparel and Accessory	1,506	3,298	23.8%
Furniture	1,978	2,761	7.9%
Eating and Drinking	3,637	9,310	31.5%
Miscellaneous	7,153	14,726	21.1%
Total Retail Trade	$49,581	$96,657	19.0%
Fin., Ins., & Real Estate	41	86	21.0%
Hotels and Lodging	3,364	5,850	14.8%
Other Services	3,685	9,188	29.9%
Total Services	$7,090	$15,124	22.7%
Wholesale Trade	2,399	6,884	37.4%
Agriculture	7,679	418	-18.9%
Mining	105	356	47.8%
Contract Construction	671	2,913	66.8%
Manufacturing	1,219	13,853	207.3%
Trans., Comm. & P. Utilities	4,385	15,884	52.4%
Government	00	--	--
Non classifiable	00	13	--
Total Other Industries	$16,458	$40,321	30.0%
Total All Industries	$73,129	$152,102	21.6%

Source: QDA estimates based on figures from Colorado Department of Revenue; University of Colorado Business Research Division

TABLE 6

QUARTERLY FLUCTUATIONS IN RETAIL SALES IN RIFLE 1977

Category	Jan-March	Apr.-June	July-Sept.	Oct.-Dec.
Food Stores	1,036,798	1,273,416	1,379,124	1,382,255
Department Stores	202,098	167,641	253,747	338,723
Lumber-Hardware	243,849	318,355	410,359	563,985
Pharmacy	166,874	195,610	201,545	253,359
Cafe-Bar	193,084	255,413	317,339	284,544
Liquor Stores	65,820	78,878	92,152	110,524
Car Sales Parts	1,302,849	1,298,163	1,347,736	1,409,659
Gas-Oil	603,327	760,449	962,100	866,853
Construction	79,417	101,887	164,816	153,769
Furniture/Appliance	50,046	72,984	86,790	85,281
Sports	42,447	61,222	53,723	95,577
Banks	12,787	6,203	6,559	4,883
Motel-Hotel	45,789	69,515	113,284	85,475
Office Supply	20,695	58,372	28,211	28,035
Beauty Shop	6,033	15,105	9,452	9,862
One of a kind	402,645	420,695	404,112	432,861

Source: Figures compiled from Rifle City Clerk monthly records

volume in the third quarter (summer months) as does construction. In most other businesses, the highest sales volume occurs during the fourth quarter.

IV. LOCAL CONSUMER PRACTICES

In 1977 the business and economy committee of the Rifle Impact Mitigation Task Force mailed 250 surveys to residents of Rifle, Grand Valley and Silt to get an idea of consumer attitudes to businesses in Rifle. Ninety-one surveys or roughly one third were returned.

Major reasons for shopping in Rifle were convenience and helpful clerks (see Table 7). Major problems shoppers cited included: a lack of variety of merchandise, unreasonable prices, shabby buildings, congested downtown streets, inadequate off street parking, crowded store interiors and poor condition of sidewalks (refer to Table 8). Different type stores, particularly department and variety stores and large discount stores were desired by the majority of the shoppers. The most frequently purchased items were groceries, medicine and drugs (see Table 9).

The survey has benefited the communities by illustrating the local spending habits and their relationship to the economic health of Rifle. Seven areas were identified that could augment the community merchant's capabilities to provide a more attractive atmosphere for Rifle residents where they are:

TABLE 7

MAJOR REASONS FOR SHOPPING IN RIFLE

Reason	Percent Responding
Convenience	71%
Helpful Clerks	33%
Plenty of Parking	12%
Special Sales Events	12%
Free Parking	11%
Attractive Shopping environment	11%
Wide Selection of Merchandise	9%
Wide Price Selection	8%

Source: Summary Report of Rifle Merchant and Shoppers' Survey

TABLE 8

SHOPPERS OPINIONS OF PROBLEMS IN DOWNTOWN RIFLE

Problem	Percent Responding
Lack of variety of merchandise	50%
Unreasonable prices	47%
Shabby buildings	29%
Congested downtown streets	36%
Inadequate off-street parking	39%
Crowded store interiors	25%
Poor Condition of Sidewalks	23%

Source: Summary Report of Rifle Merchant and Shoppers' Survey

TABLE 9

ITEMS OR SERVICES SHOPPERS PURCHASE IN RIFLE

Item or Service	Percent responding
Groceries	80%
Medicine and Drugs	70
Bank	64
Hardware	61
Dentist	53
Doctor	52
Insurance	52
Hospital or Clinic	43
Lawyer	42
Veterinarian	40
Restaurants	36
Automobiles	36
Clothing, Dress	35
Repair Shops	32
Clothing, Work	26
Furniture	23
Theatres	22
Farm Equipment	14

. more variety in stores

. lowering of prices/more competition

. improved parking/parking lots

. improved advertising/promotion

. improved customer/merchant relations

. improved traffic circulation

. improved shopping atmosphere/environment

V. LOCAL BUSINESS ATTITUDES AND PRACTICES

A similar survey of the Rifle business community was compiled by the business and economy committee of the Rifle Impact Mitigation Task Force. Forty-eight Rifle businesses were asked to participate and thirty-five responded. Results indicate that the business community was aware of the need to enhance downtown Rifle, also, several merchants are willing to help work together in downtown programs to improve the central business district.

The majority of merchants rated restaurants, movies and entertainment as poor; store hours, selection of goods and appearance of the buildings as fair; attention from salespeople and accessability to downtown were rated good. There was no characteristic that warrented an excellent or very good rating.

Most of the merchants felt that their trade area encompassed at least Rifle, Meeker, Silt, and Grand Valley.

VI. PROJECTED NEEDS IN RETAIL SPACE AND VALUE

The ability of Rifle to capture increasing amounts of consumer dollars is largely dependent on the local businesses' ability to anticipate and meet consumer demand.

It is possible to analyze a community's retail volume capacity, with the use of the Urban Land Institutes, The Dollars and Cents of Shopping Centers.

Certain assumptions are necessary, among them, that a fairly predictable relationship exists between retail categories and their average dollar volume capacity; and that an individual consumer's retail demand represents some constant proportion of his aggregate income. Although these assumptions are not 100 percent accurate, they can still offer reasonable predications. QDA has projected local retail supply and consumer demand on these assumptions. Table 10 presents the associated potential dollar volume capacity. The specific retail categories are defined as follows:

General Merchandise includes department, apparel, and variety stores;

Food and Food Service includes grocery stores, restaurants, and drive-ins;

Services includes beauty shops, barber shops, cleaners and dryers, service station, and repair services;

Other Retail includes drugstores, hardware, liquor and hobby stores, and miscellaneous.

TABLE 10

SQUARE FOOTAGE AND DOLLAR VOLUME CAPACITY
IN RETAIL TRADE - RIFLE, 1978

Retail Category	Square Feet	Average Annual Dollar Volume Per Square Foot[1]	Annual Dollar Volume Capacity[3]
General Merchandise	21,578	$ 35.99	$ 777,000
Food and Food Service	46,222	$100.82	$4,660,000
Services	42,314	$ 30.20	$1,278,000
Other Retail	33,977	$ 50.92	$1,730,000
Total	144,091	$ 58.61	$8,445,000

1. From Urban Land Institute, The Dollars and Cents of Shopping Centers; adjusted by type of outlet and regional factors; expressed in 1978 dollars.

2. This figure represents a weighted average dollar volume per square foot of the four retail categories combined.

3. The product of square feet and average dollar volume per square foot, rounded.

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The square footage figures were derived by QDA staff during September of 1978 through analysis of Garfield County Assessor's records.

These calculations represent average figures and certain retail outlets are exceptions to this indicator. For example, automotive dealers and suppliers and building materials and farm implement stores that use large open yard areas will have variable sales per square foot ratios.

There are 144,091 square feet of retail inventory space presently within Rifle. The greatest proportional dollar volume value exists within the Food and Food Service category. On an annual average basis, one square foot of Food and Food Service space provides almost twice as much dollar volume as the same space in drugstores, hardware and liquor stores and almost three times as much as a square foot in a general merchandise outlet. Rifle has the capability of achieving annually at least $ 8,445,000 total volume capacity in current retail space.

Earlier studies have revealed that total household expenditures (for housing, medical care, transportation, and retail goods and services, etc.) represent nearly 70 percent of gross annual income. 25 percent of gross income goes for federal and state income taxes, social security taxes, and contributions to insurance and other fringe benefits. Retail group expenditures represent about two-thirds of total expenditures, or about 50 percent of gross annual income.

Future retail demand under natural and impact growth conditions is projected through 1985 at 50 percent of personal incomes in Rifle, as shown in Tables 11 and 12. However, total retail demand in Rifle is much higher than the demand supported by Rifle incomes due to tourist trade and limited regional shopping in Rifle from nearby communities. Available data on the imported spending added to Rifle's economy is insufficient for analysis and projections. Therefore, the figures shown here reflect strictly Rifle's retail demand and retail space required. As tourism and regional shopping in Rifle increase in the 1978-1985 period, total retail demand and retail space required will be significantly higher than shown below.

Table 11 shows that current retail space in Rifle is adequate to serve the retail demand originating in Rifle. An addition of 24,000 square feet of retail space, or 17 percent, will be needed by 1985 under natural growth conditions for retail space to keep up with Rifle's projected retail demand, with impact growth.

Unmet retail demands will occur if major retail expansion is not accomplished (refer to Table 12). A dramatic increase in total population accompanied by substantial per capita income increases is projected to create a total consumer retail demand in Rifle of $11,369,386 in the first year of impact; $37,831,407 during the fifth year; and $38,303,496 in the eighth year. By 1985, the total retail demand in Rifle

TABLE 11

PROJECTED RETAIL DEMAND UNDER
NATURAL GROWTH CONDITIONS IN RIFLE

1978, 1982, and 1985

Year	Population [1]	Per Capita Income	Gross Income	Total Retail Demand	Total Retail Square Footage Required
1978	2,294	$6,431	$14,752,714	$7,376,357	126,000
1982	2,745	$7,559	$20,749,455	$10,374,728	146,000
1985	3,084	$9,002	$27,762,168	$13,881,084	168,000

1. From Table 3, Population Section

2. From Table 14, Population Section

3. 50% of Rifle's Gross Income
These figures represent only the retail demand of citizens in Rifle and do not reflect the purchasing power of tourists or of people in surrounding communities.

4. Derived by dividing the weighted average dollar volume per square foot value ($58.61/sq. ft. Table 9) into Total Retail Demand, and inflated at 5 per cent per year.

TABLE 12

PROJECTED RETAIL DEMAND UNDER IMPACT GROWTH CONDITIONS
IN RIFLE - 1978, 1982, and 1985

Year	Population[1]	Per Capita[2] Income	Gross Income	Total Retail[3] Demand	Total Retail[4] Square Footage Required
1978	3,821	$5,951	$ 22,738,771	$ 11,369,386	194,000
1982	11,163	$6,778	$75,662,814	$ 37,831,407	531,000
1985	9,702	$7,896	$76,606,992	$ 38,303,496	464,000

1. From Table 3, Population Section

2. From Table 14, Population Section

3. 50% of Rifle's Gross Income
These figures represent only the retail demand of citizens in Rifle and do not reflect the purchasing power of tourists or of people in surrounding communities.

4. Derived by dividing the weighted average dollar volume per square foot value ($58.61/sq. ft. Table 9) into Total Retail Demand, and inflated at 5 per cent per year.

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will have grown to over three times the inflated dollar volume capacity of Rifle's 1977 retail potential, (Tables 11 and 12). This rise in retail demand is projected to create a rise in the retail square footage required to meet demand. As table 12 indicates, a total of 194,000 square feet will be required to meet projected retail demand during the first year of impact--an increase of approximately 35 percent over the estimated retail square footage currently in use. By 1985, a total of 464,000 square feet will be needed to meet the corresponding retail demand in Rifle--an increase of approximately 222 percent over Rifle's 1977 retail square footage.

These projections are far from complete and do not take into account the additions planned at Remington Square and near City Market. Space will also be required by businesses for parking (see section on Transportation), administrative and storage facilities.

They also do not consider tourist and regional purchasing power in Rifle, or changes in the size or frequency of inventory turnover. The specific types of business activities needed are not differentiated. A service station's requirements and capacities are quite different from those of a drugstore. Also, these projections have not considered the amount of business that is absorbed by nearby cities such as Grand Junction and Glenwood Springs. In the future Rifle Businesses may be more competitive with nearby communities as present facilities expand.

VII. BUSINESS AND FINANCIAL RESOURCES

The boom period can be a period of opportunity. For the individual or business which seeks to meet the challenge there are a wide range of financial resources available including:

1. Banks and Savings and Loan Associations

   First National Bank in Rifle, 100 E. 4th

   Mesa Federal Savings, Rifle Branch, 119 E. 3rd

   Rifle Production Credit Association, 101 W. 3rd

2. Small Business Administration

   The Small Business Administration has programs available to assist community groups as well as individual businesses for such purposes as providing loans for purchases of machinery and equipment, construction, expansion and debt payment.

   The regional office address is: 721 19th Street
   Denver, Colorado 80202

3. Industrial Development Revenue Bonds

   Economic Development Revenue Bonds - Under the 1967 Colorado Economic Development Revenue Bond Act, cities, towns and counties may issue revenue bonds in order to acquire, own, improve and equip certain industrial projects for lease. These projects include "...any land, building, or other improvement and all real and personal properties excepting inventories, raw materials and other working capital in connection therewith, whether or not in existence, suitable for manufacturing, industrial or commercial enterprises,

including commercial enterprises to perform research, product-testing or other similar services."

Most cities, towns and counties are willing to issue revenue bonds if they feel the project will provide substantial employment and economic benefit for their community.

A copy of the Revenue Bond Act is available from the Division of Commerce and Development. 1313 Sherman

Denver, Colorado 80203

4. Rifle Chamber of Commerce

P.O. Box 809

Rifle, Colorado 81650

Type of Service: Information and location assistance.

5. Rifle Economic Development, Inc. (REDI)

REDI provides direction and capital for economic development in Rifle. REDI's efforts are to diversify Rifle's industrial base and to increase Rifle's tax base.

Earl Houlihan (President)

322 E. 1st

Rifle, Colorado

625-1332

VIII. PLANNING FOR FUTURE NEEDS

QDA has presented the projections in this section to give the Rifle business community an estimate of retail demands plus to augment planning in commercial development.

The oil shale development will create both positive and negative impacts to nearby communities. On the positive side, as workers and dollars locate in the area there will be an increased demand for goods and services. This will generate a greater business volume locally which will create new business opportunities and more jobs. But simultaneously, will be increases in the cost of living, (especially in housing); businesses will be forced to operate at a more sophisticated approach in advertising, merchandising and financial arrangements. If the citizenry of Rifle respond in a timely fashion, they can prevent many problems, conflicts, and costs in the future that might occur, and would be able to preserve the kind of quality community which Rifle is known today.

V. LAND USE

I. INTRODUCTION

The purpose of this section is to determine future land use and land area needs based upon the natural and impact growth conditions established in the previous sections of this Development Guide. In relation, the following will be examined: County and City land use regulations that affect present and future development; the existing land use situation in the City of Rifle; the relationship of approved and proposed new subdivisions to future needs; the capability of surrounding land to support new development.

This section does not present a land use plan to guide future development nor growth management proposals. It inventories present land uses and applicable regulations in Rifle and Garfield County, and calculates future use and area needs in light of the anticipated impacts from nearby energy resource development. The information can then be employed by the City of Rifle for the determination of planning and regulatory needs so as to insure that development proceeds at a timely rate and quality acceptable to the citizens of Rifle. Rifle's future character will be influenced through the careful management of the anticipated growth.

A general word needs to be stated about the data used in this section. The sources for housing, population and environmental hazards information are stated throughout

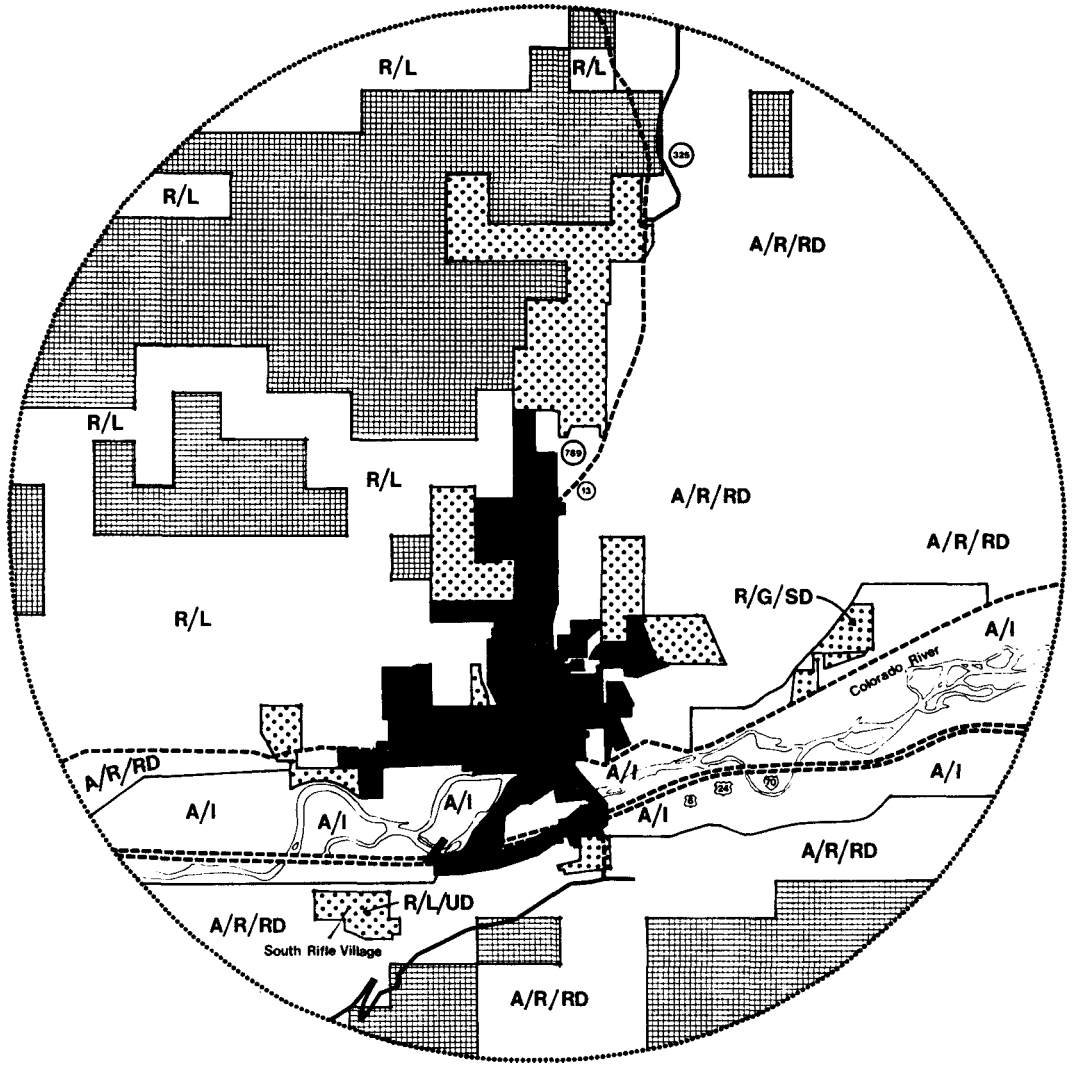
this and other appropriate sections. A by-parcel visual land use survey was performed by taking a 1" = 200' map of the City which showed parcels and structures, and identifying the predominant use of each parcel. A final survey update was performed during the first week in September, 1978, while most of the City was surveyed during the previous months. Calculations of parcel size were taken from the survey map and from approved final plats for subdivisions.

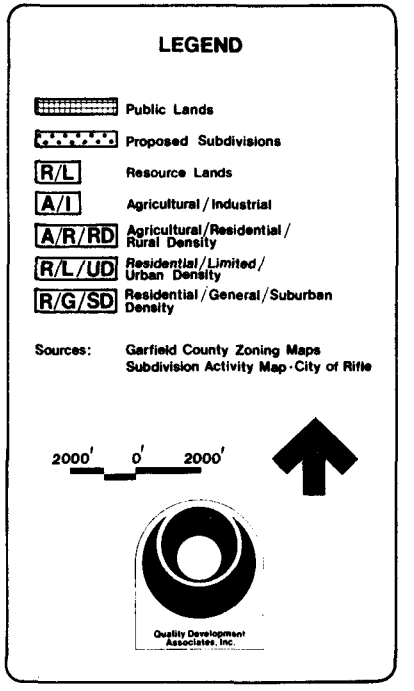
II. GARFIELD COUNTY - PLANNING & ZONING

In 1968, the "General Plan, Garfield County, Colorado", was published and presented to the citizens of the county. It profiled the existing conditions and made recommendations for such aspects of county planning as economic base, population, circulation, education, recreation and land use. The study also made planning proposals for the urban centers and such regulatory measures as air quality, solid waste disposal and land use control.

In light of the recommendations the County first adopted a zoning resolution in October of 1970 and subdivision regulations in September of 1972. Both have been updated to meet the diversity of situations that have surfaced in the County.

The Garfield County Zoning Resolution has 12 specific zoning districts which range from agricultural/industrial to planned unit development. Of these, five are found in the vicinity of Rifle. (See Figure 1.) Lands to the northeast and south are zoned agricultural-residential-rural density (A/R/RD) which allow for agricultural uses and single family dwellings with a 2 acre minimum lot size. Camper parks and mobile homes are allowed as special uses. The lands northwest of Rifle are resource lands (R/L) whose primary uses are agricultural and resource extraction. Minimum lot size for single family dwellings ranges from 2-35 acres, depending on the character of the land whether it is plateau, escarpment, talus slope or gentle slopes/lower





RIFLE AND GENERAL VICINITY

PUBLIC LANDS, COUNTY ZONING, PROPOSED SUBDIVISIONS

Fig. 1

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valley floor. Much of the land in this sector is owned by the Federal Government - it is estimated that 25% of all land within a 3 mile radius of the city is publicly owned. The Colorado River Valley is zoned agricultural/industrial(A/I), while such county subdivisions as South Rifle Village and Rifle Service Park have specific zonings related to the anticipated character of development. Such County subdivisions as these, Cottonwood Springs and Garfield County Airport-Industrial Park, will have a significant impact on the Rifle area housing market if fully developed. This will be discussed later in this section.

III. THE CITY OF RIFLE - REGULATIONS AND LAND USE

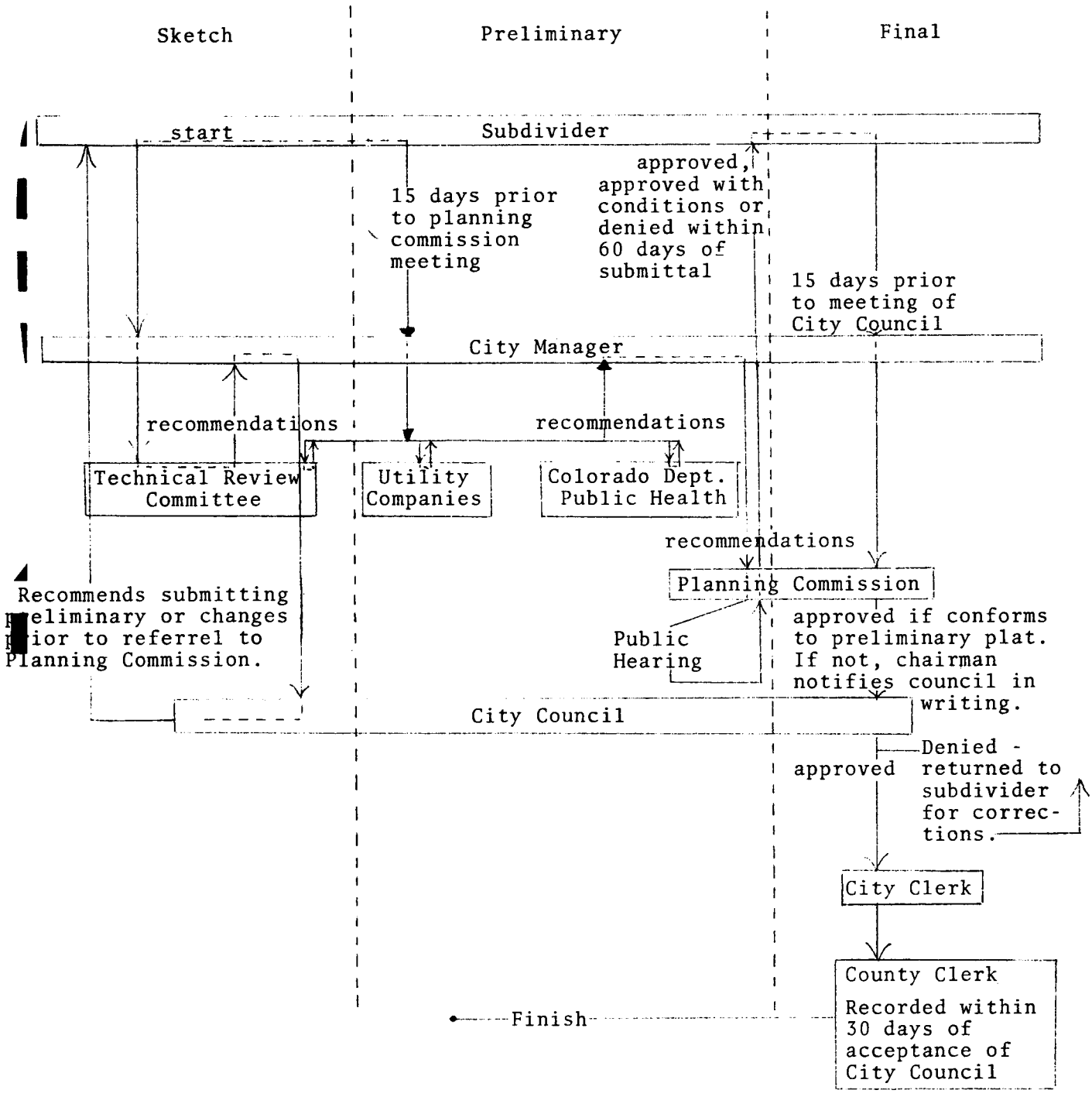
A. Regulations

The City of Rifle first adopted zoning regulations in 1951. Since then, the ordinance has been amended to deal with changing conditions. Subdivision and Annexation Regulations were last amended and adopted in June 1976. Together, these regulatory devices provide the most direct legal means for controlling land use, density and pace of development.

The effectiveness of planning in Rifle, then, is largely determined through the administration of the regulations controlling present and future land uses. Existing and proposed subdivisions should be planned and coordinated to meet the needs of the City. In this way, not only is a benefit provided to the City, but the developer/subdivider will possess a saleable product.

These values also hold true for such processes as zoning ordinance admendments, conditional uses, and variances. Each of these procedures were established for specific circumstances where special consideration is required. If these procedures are abused and used indiscriminately, the planning efforts of the City are jeopardized. Figures 2 and 3 diagram the subdivision application, amendments to zoning ordinance, and application for conditional use and various procedures.

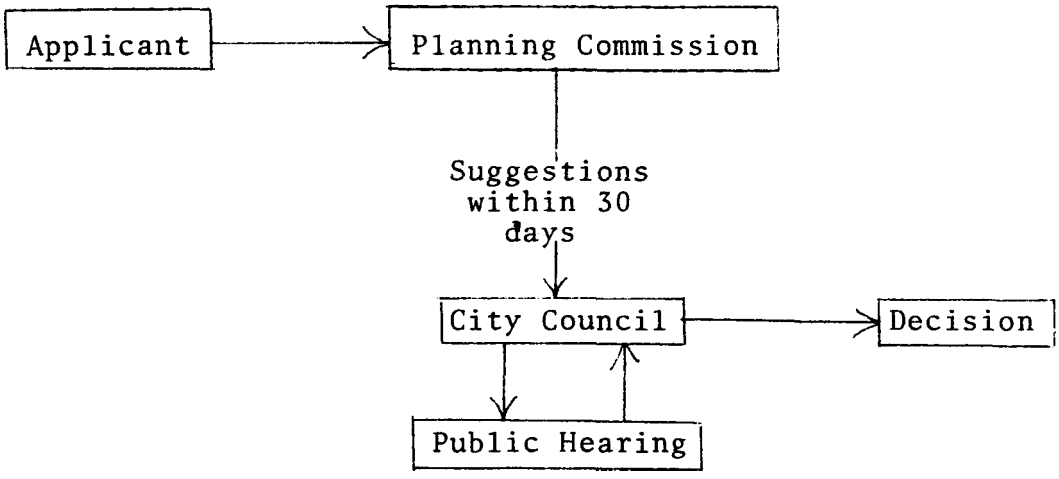
SUBDIVISION APPLICATION PROCEDURES CITY OF RIFLE



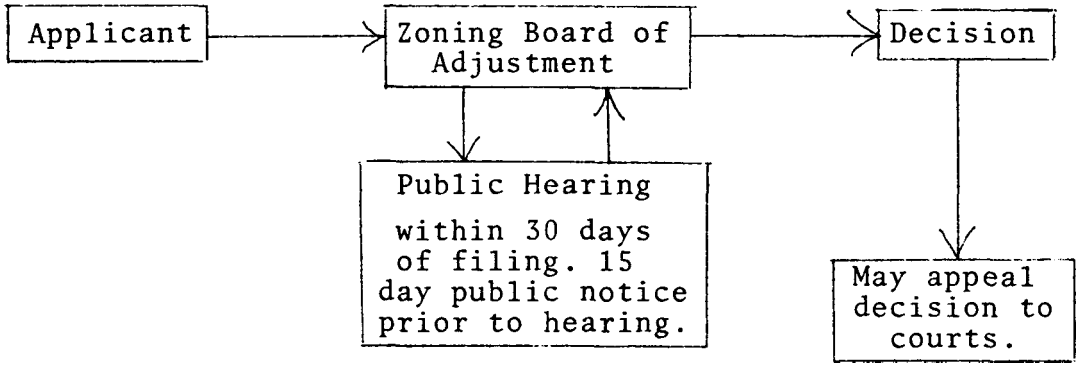
Source: Rifle Subdivision and Annexation Regulations, June 1976

Figure 2

AMENDMENT TO ZONING ORDINANCE - CITY OF RIFLE



CONDITIONAL USES AND VARIANCES - CITY OF RIFLE



Source: Rifle Subdivision and Annexation Regulations;
Rifle Zoning Ordinance.

Figure 3

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The Rifle Zoning Ordinance depicts eight zoning districts and two special classifications - flood plains and planned developments (see figure 5). The ordinance is primarily a "cumulative" regulation as every use permitted in the "higher use" district (single family residential) is permitted in the districts that are "lower" on the scale (commercial) (See Table 1). The exception in Rifle is the industrial district which excludes residential, institutional and many commercial uses. In general, commercial uses are not allowed in the residential districts while residential uses are allowed in the commercial districts. While this flexibility might allow for greater economic determinism in the location of the various residential and commercial land uses, it can also lead to incompatibility of adjacent land uses, or potential prime commercial sites being occupied by residential uses.

Table 2 shows the acreage of land within each zoning district. Over 50% of the land in Rifle is zoned for commercial land uses and due to the cumulative return of the zoning ordinance, also allows residential land uses. Therefore, approximately 95% of the land in Rifle is zoned to allow residential uses.

B. Existing Land Use

The land use survey performed by QDA examined the existing land uses within the corporate limits of Rifle as of September 1, 1978. There are six primary land use categories

Permitted and Conditional Uses C = Conditional

Office-Business-Professional	Restaurant, Accessory to Hotel, Motel, Lodge	Hospital, Medical and Dental Clinic	Art Gallery, Studio, Museum	Private Club	Assembly Hall	Public Building	Wholesale And Retail*	Personal Service	Recreation Service	General Service	Drive-in Restaurant and Bank	Auto Working Facility	Parking Lot or Garage	Outdoor Commercial & Recreation Site	Fabrication*	Aircraft Landing, Auto Salvage	Alfalfa Drying Feedmill, Slaughter of Animals	Extracting And Refining
P	P	P	P	C														
P	P	P	P		P	P	P*	P*	P*	P*	C	C	C					
P	P	P	P	P	P	P	P*	P*	P*	P*	C	C*	C					
P	P	P	P	P	P	P	P*	P*	P*	P*	C	C	C	C	C			
P	P	P	P	P	P	P	P*	P*	P*	P*	C	C	C	C	C			
P							P*	P*	P*	P*	P	P	P		P*	C	C	C

Planned Development* Allows for variation in lot size and block design through the use of such concepts as "average lot area" and "clustering".

Flood Plain New structures within areas of special flood hazard have specific construction standards (see ordinance B-163).

(a) FA = Front setback from arterial roadway; F = Front Setback; S = Side Setback; R = Rear Setback
(b) Rear Setback of 7.5' if there is no alley. If alley is present no rear setback.
* Zoning ordinance should be consulted for specific list of uses and/or special conditions.

Source: Rifle Zoning Ordinance, Flood Plain Ordinance, Mobile Home Ordinance.

Table 1

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ACRES AND PERCENTAGE OF LAND IN ZONING DISTRICTS

CITY OF RIFLE

Zoning District	Acres	% of Total
R-1-6	168.90	23.37
R-2	56.40	7.80
R-3	57.07	7.90
R-4	20.02	2.77
C-1	166.44	23.03
C-2	15.94	2.21
C-3	198.31	27.44
I	39.67	5.49
Totals	722.75	100.00

Source: QDA estimates from land use survey and zoning map for City of Rifle

with three special categories for new subdivisions within the City limits that are being constructed or committed to development.

Table 3 is a statistical breakdown of the existing land uses in Rifle while the map on Figure 6 shows the spatial distribution of each land use cateogry. It is esitmated that 24% of the land is for residential uses while another 22.5% will be residential when constructed. Only 10% of the land in Rifle is currently commerical, business or industrial, while over 50% of the land is zoned for such uses. Finally, nearly one quarter of Rifle is considered vacant land from the survey. The nature and quality of the vacant land will be discussed later in this section.

C. Relationship Between Zoning and Existing Land Uses

Due to the cumulative nature of the zoning ordinance, there is a high degree of mixture of land uses in each zoning district, particularly in the commercial districts (see Tables 4 and 5). The residentially zoned districts are either residential, public/quasi public or vacant, with the land presently residential or in a new subdivision. Only a small percentage of commercially zoned land is used for commercial purposes as most of the land is either vacent of in public/quasi public land uses. Presently, approximately 13% of commercially zoned land is used for residential purposes and if the new mobile home subdivision is completed this will increase to one quarter. Much of the multi-family zoned land(R-3 and R-4) is also occupied by single family residences.

EXISTING LAND USE - CITY OF RIFLE

Land Use	Acres	% of Total
1) Single-Family/Duplex Residential	153.45	21.23
2) Multi-Family Residential	3.50	.48
3) Mobile Home Residential	17.14	2.37
4) Public/Quasi - Public (a)	146.53	20.27
5) Business (b)	72.64	10.05
6. Vacant	164.70	22.79
7) New Subdivisions (1)	91.64	12.68
8) New Subdivisions (2)	27.17	3.76
9) New Subdivisions (3)	45.98	6.36
Totals	722.76	100.00

(a) Includes Government land/buildings, churches, schools, hospitals, medical centers, parks.

(b) Includes Business, Commercial, industrial, parking lots.

(1) Annexed land being developed as single-family residential subdivisions.

(2) Annexed land being developed as multi-family residential subdivisions.

(3) Annexed land being developed as mobile home residential subdivisions.

Source: QDA estimates from land use survey

TABLE 4

LAND USE AND ZONING DISTRICT ACREAGE DISTRIBUTIONS·

CITY OF RIFLE, SEPTEMBER, 1978 *

Zoning Districts	Land Use Categories: Single-Family Duplex Residential	Multi-Family Residential	Mobile Home	Public and Quasi Public	Business	Vacant
R-1-6	60.73	.89	0.0	4.92	0.0	12.99
R-2	34.85	.64	.69	14.76	0.0	3.19
R-3	16.70	0.0	0.0	0.0	0.0	13.20
R-4	11.20	1.07	0.0	6.61	.23	.91
C-1	5.74	0.0	1.51	21.32	18.04	73.85
C-2	6.85	.14	0.0	.93	7.68	.34
C-3	17.37	.76	14.94	58.32	46.69	60.23
I	0.0	0.0	0.0	39.67	0.0	0.0
Totals	153.45	3.50	17.14	146.53	72.64	164.70

*Exclusive of all streets and alleys

Source: QDA Land use Survey

Continued . . .

TABLE 4 (Continued)

LAND USE AND ZONING DISTRICT ACREAGE DISTRIBUTIONS

CITY OF RIFLE, SEPTEMBER 1978 *

Zoning Districts	Land Use Categories: Subdivision-Single-Family/Duplex	Subdivision-Multi-Family	Subdivisions-Mobile Home	Totals
R-1-6	89.37	0.0	0.0	168.90
R-2	2.27	0.0	0.0	56.40
R-3	0.0	27.17	0.0	57.07
R-4	0.0	0.0	0.0	20.01
C-1	0.0	0.0	45.98	166.44
C-2	0.0	0.0	0.0	15.94
C-3	0.0	0.0	0.0	198.31
I	0.0	0.0	0.0	39.67
Totals	91.64	27.17	45.98	722.76

* Exclusive of all streets and alleys

Source: QDA Land Use Survey

TABLE 5

LAND USE AND ZONING DISTRICT PERCENTAGE DISTRIBUTION

CITY OF RIFLE, SEPTEMBER, 1978*

Zoning District	Land Use Categories: Single-Family Duplex Residential	Multi-Family Residential	Mobile Home	Public and Quasi Public	Business	Vacant
R-1-6	35.95	.53	-	2.91	-	7.69
	39.58	25.43	-	3.36	-	7.89
R-2	61.79	1.14	1.22	26.17	-	5.65
	22.71	18.29	4.03	10.07	-	1.94
R-3	29.26	-	-	-	-	23.12
	10.88	-	-	-	-	8.01
R-4	55.95	5.33	-	33.03	1.15	4.53
	7.30	30.57	-	4.51	.32	.55
C-1	3.45	-	.91	12.81	10.84	44.37
	3.74	-	8.81	14.55	24.83	44.84
C-2	42.98	.86	-	5.83	48.16	2.16
	4.46	4.00	-	.63	10.57	.21
C-3	8.76	.38	7.53	29.41	23.54	30.37
	11.32	21.71	87.16	39.80	64.28	36.57
I	-	-	-	100.00	-	-
	-	-	-	27.07	-	-
Totals	21.23	.48	2.37	20.27	10.05	22.79
	100.00	100.00	100.00	100.00	100.00	100.00

* Exclusive of all streets and alleys

Source: QDA Land Use Survey

Continued . . .

TABLE 5 (Continued)

LAND USE AND ZONING DISTRICT PERCENTAGE DISTRIBUTION

CITY OF RIFLE, SEPTEMBER 1978*

Zoning District	Land Use Categories: Subdivision-Single Family/Duplex	Subdivision-Multi-Family	Subdivision-Mobile Home	Totals
R-1-6	52.91	-	-	100.00
	97.52	-	-	23.37
R-2	4.02	-	-	100.00
	2.48	-	-	7.80
R-3	-	47.61	-	100.00
	-	100.00	-	7.90
R-4	-	-	-	100.00
	-	-	-	2.77
C-1	-	-	27.62	100.00
	-	-	100.00	23.03
C-2	-	-	-	100.00
	-	-	-	2.21
C-3	-	-	-	100.00
	-	-	-	27.44
I	-	-	-	100.00
	-	-	-	5.49
Totals	12.68	3.76	6.36	100.00
	100.00	100.00	100.00	100.00

*Exclusive of all Streets and Alleys
Source: QDA Land Use Survey

In general, the zoning allows greater flexibility in the location of specific land uses. The overlay of the zoning districts upon the existing land uses illustrates this fact. In the more established sections of the City, the ordinance does little to threaten the continuance of past land use patterns. The newer subdivisions, because the land in most instances has been annexed into the City and was not zoned under the Rifle ordinance until such time, have virtually no mixture of commercial and residential land uses, though provide a range of residential types.

Relative to the existing land use and zoning situation in Rifle are the alternative proposals for the relocation of State Highway 13. It's eventual siting will influence the location of residential, commercial and industrial land uses and zoning districts. Several alternatives would follow Rifle Creek, utilizing vacant land and causing residential relocation. The relocation of the highway can influence the commercial center at Rifle by either relieving traffic congestion while providing easier shopping access or causing new commercial access to develop outside of the existing center. The compatibility of the highway to existing and new residential land uses should also be evaluated.

D. Vacant Lands in the City of Rifle

Since one of the prime objectives of this section is to determine the new land use and area needs based on projected population growth, the potential use of vacant lands within the City are important to analyze.

The determination of what is "vacant" requires specific judgements. A lot may appear to be vacant, but may be an integral part of the landscape surrounding a structure upon an adjacent lot. This kind of judgement was used in the land use survey. A total of 164.70 acres of land were determined to be vacant. This did not include vacant lands that are already committed to a subdivision. If any of these subdivisions are not completed nor constructed, these lands can be added into the vacant category.

To determine what lands had development potential, three criteria were used for evaluation. Vacant lands were considered to have development potential if they:

1) Were not subject to environmental hazards;
2) Were zoned appropriately;
3) Were within minimum lot size requirements.

While the latter two criteria are determined directly from the zoning ordinance and maps, the first - environmental hazards - is a judgemental evaluation tool. The two hazards that existed in Rifle were: 1) the 100 year flood plain or area of special hazard; and 2) slopes that equaled or exceeded 25%. This does not mean that development cannot take place on these lands. But with planning, environmental and economic considerations in mind, it would be to the benefit of the City to orient development away from these areas. As indicated from Table 6, most of the vacant lands are idle because of environmental hazards. If any of the vacant lands with hazards are developed, they can be put into the appropriate land use category. (See Figure 4 for map of Environmental Hazards.)

It is estimated, then, that 41.83 acres exist of developable vacant land. Their potential use is determined from the most appropriate use within the zoning districts they are located.

VACANT LAND - CITY OF RIFLE

SEPTEMBER, 1978

Existing Vacant Developable Land Within City Limits

Potential Use	Zoning Districts	# of Parcels	Parcel Size Range (Sq. Ft.)	Total Acreage
Single-Family	R1-6 & R-2	6	10,000-60,000	3.28
Multi-Family	R-3 & R-4	4	12,000-60,000	3.43
Commercial	C-1, C-2 & C-3	15	6,000-375,000	35.12
Totals		25	6,000-375,000	41.83

Existing Vacant Lands with Environmental Hazards

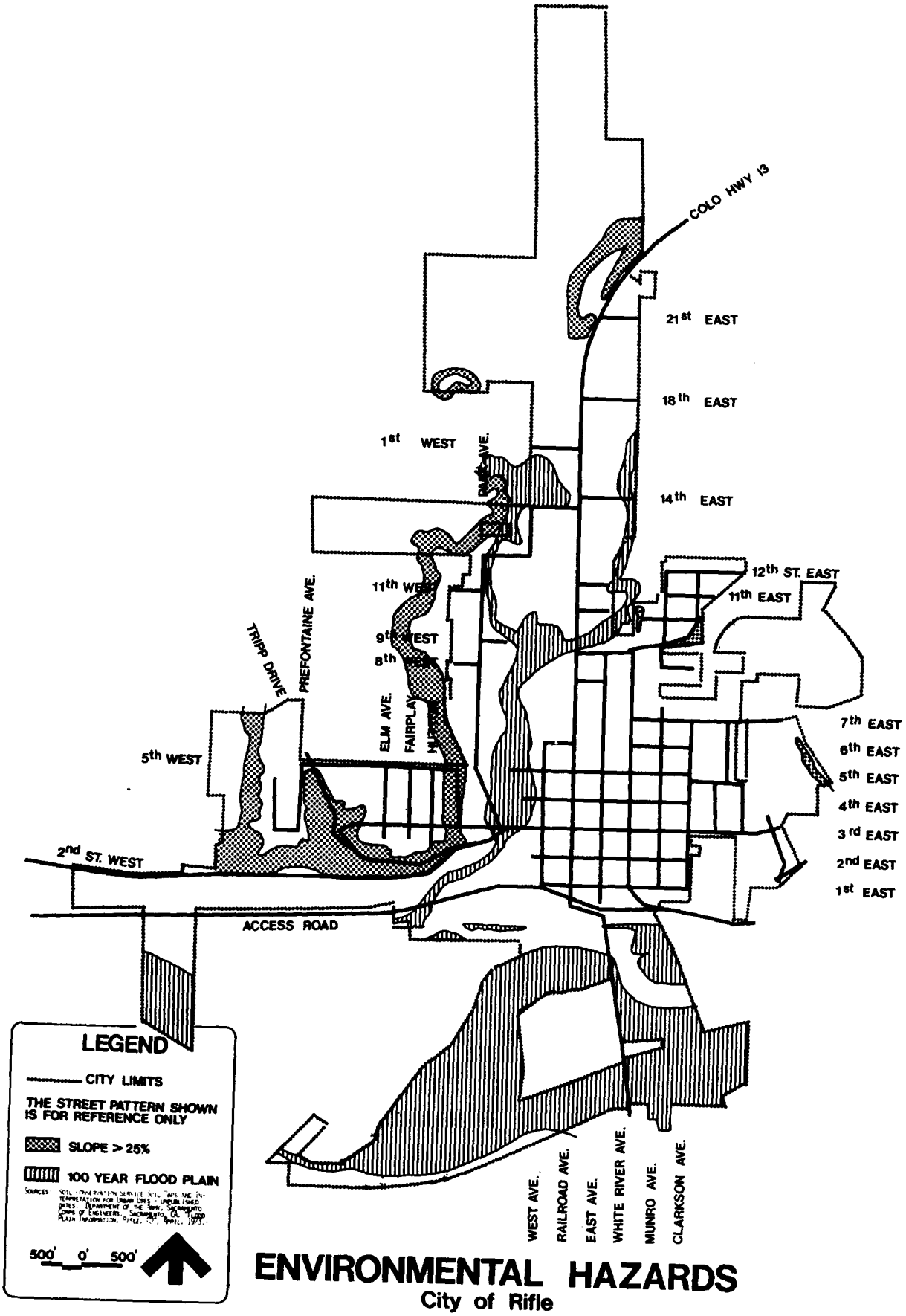
(Flood Plain, Slopes More Than 25%)

Hazard	# of Parcels	Parcel Size Range (Sq. Ft.)	Total Acreage
Flood Plain	17	20,400-1,729,800	89.07
Severe Slopes	3	22,400-482,000	33.80
Totals	20	20,400-1,729,800	122.87

Totals for All Existing Vacant Lands

	# of Parcels	Parcel Size Range	Total Acreage
Totals	45	6,000-1,729,800	164.70

Source: QDA Land Use Survey; Soil Conservation Scource-Soil Survey for Garfield County (unplublished data); Department of the Army, Sacramento District Corps of Engineers - "Flood Plain Information, Rifle, Colorado", April, 1973.

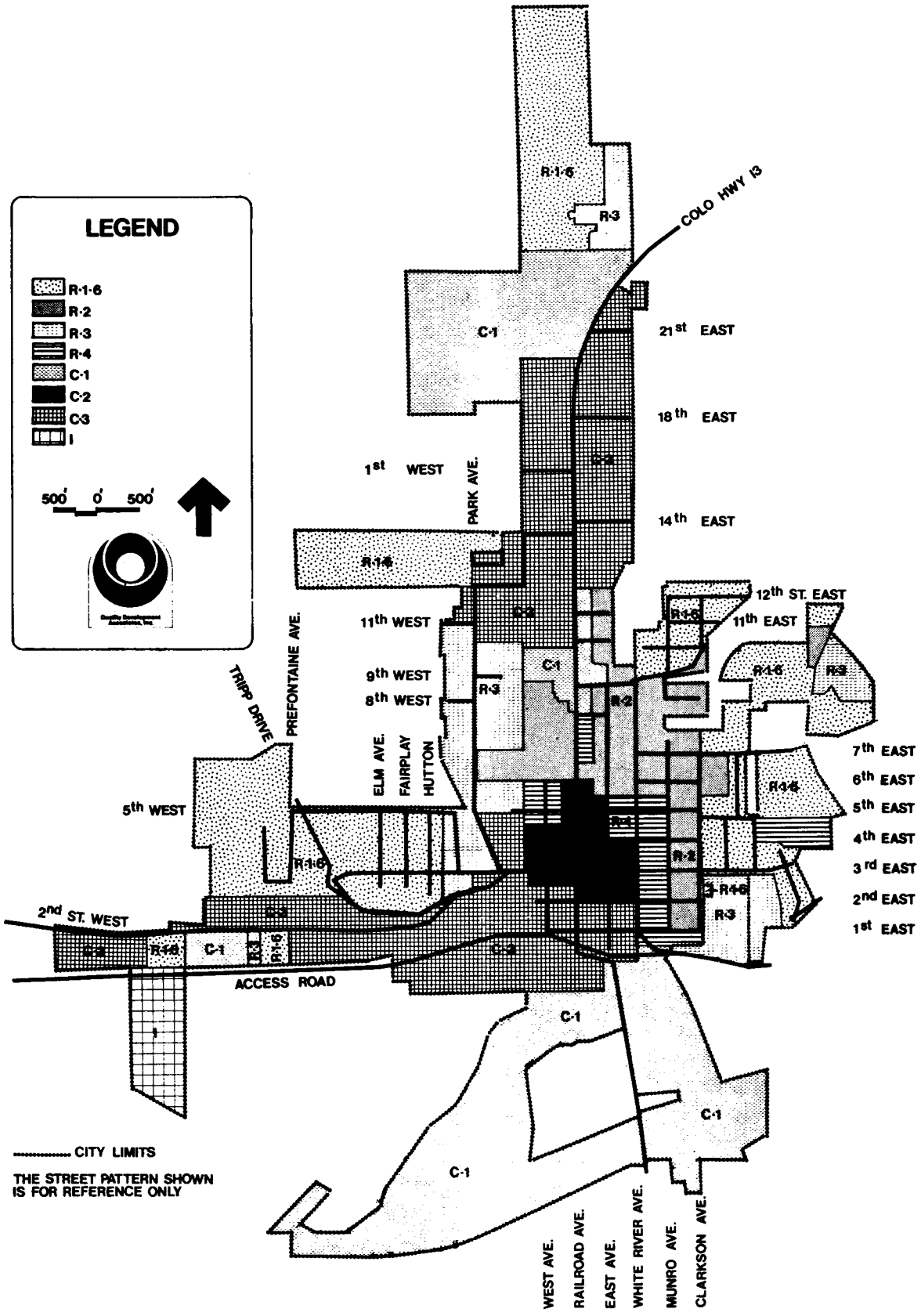


ENVIRONMENTAL HAZARDS

City of Rifle

FIG. 4

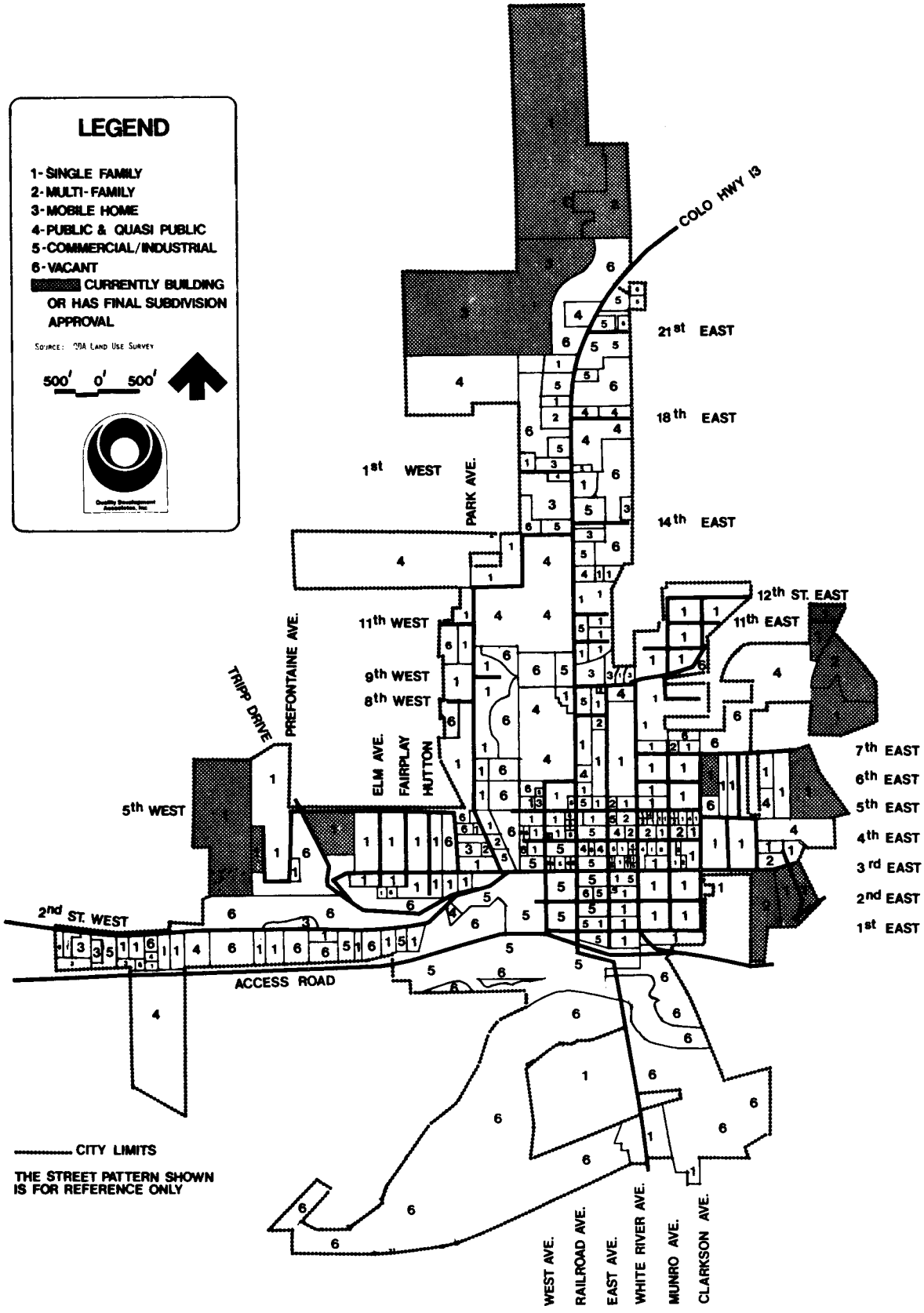
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ZONE DISTRICT MAP · CITY OF RIFLE

FIG. 5

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EXISTING LAND USE - CITY OF RIFLE

FIG. 6

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IV FUTURE LAND USE AND AREA NEEDS

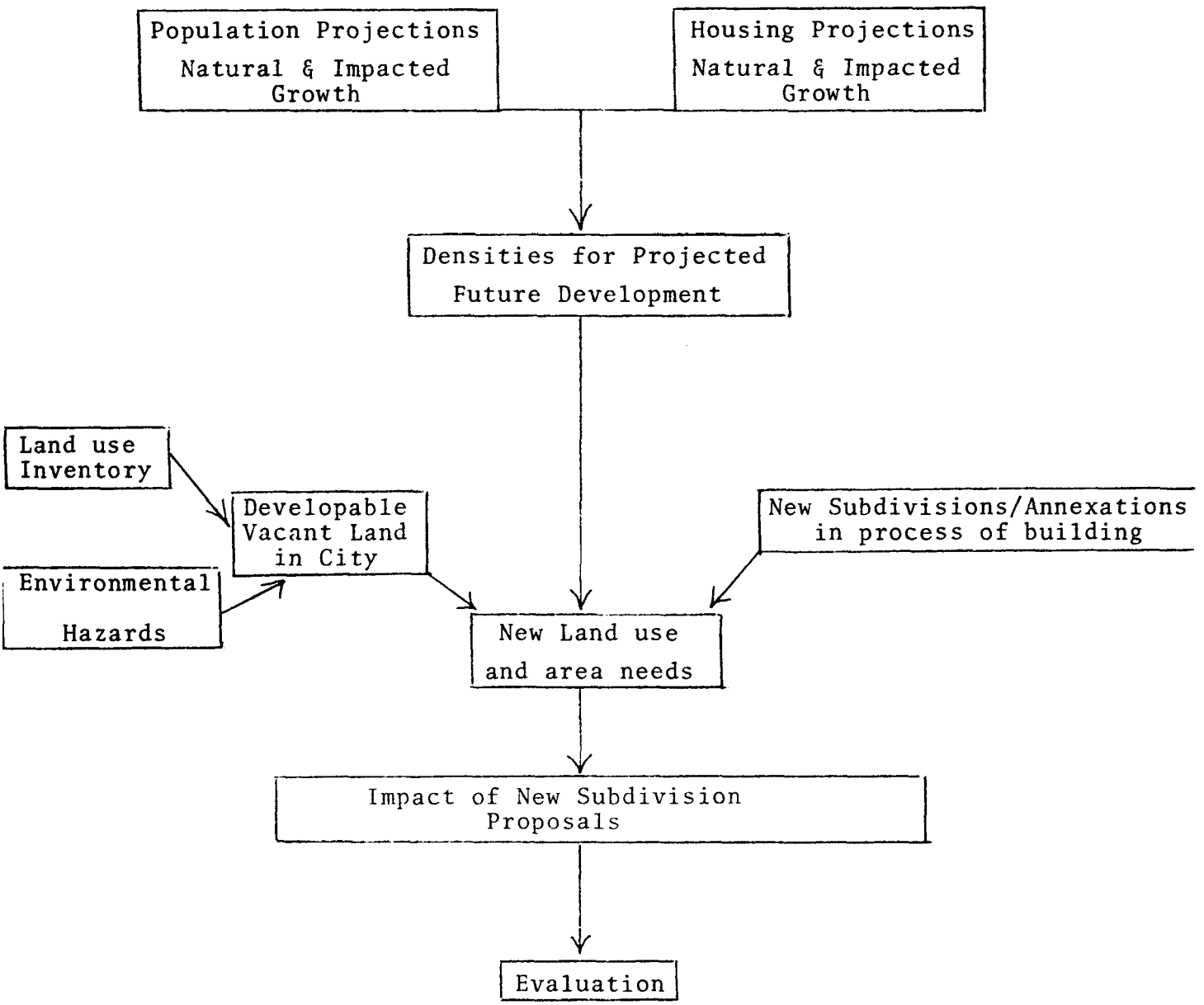
To calculate future land use and area needs, the model depicted in Figure 7 was employed. Of the inputs into the model, two have already been discussed in this section - new subdivisions within the city limits and developable vacant land. Two additional inputs are the population and having projections for natural and impact growth conditions. Tables 3 and 5 of the housing section and Table 3 of the population section provide the data for these projects.

The projections are then assessed in terms of densities for projected future development - a means of converting population and housing projections into acres of various land uses needed to support the projections. This input is combined with developable vacant land within the City and new subdivisions presently being constructed to determine how much new land will be required to meet projected needs. Finally, new subdivision proposals are evaluated for their ability to meet these needs.

The model, then, can be used as a dynamic evaluation process. As each new subdivision is proposed, it can be placed into the model to determine its effectiveness for meeting the growth conditions.

Figure 7

FUTURE LAND USE AND AREA NEEDS MODEL



The data indicates some special circumstances that must be handled for impacted growth. Under this scenario, the population and housing needs will peak in 1982 and then decrease the following year. If the projections for 1981 and 1982 were excluded, the projections to 1985 would follow a more normal progression. To deal with this statistically, two sets of data were used for the impacted growth scenario - one for the absolute change between the years 1978 - 1982 and the other for the absolute change between the years 1978 - 1985.

A. Densities for Projected Future Development

Under natural growth conditions Rifle would reach a population of 3,084 persons by 1985 which translates into 283 total new dwelling units. Under the impacted growth scenario, Rifle would reach a population of 11,103 persons by 1982 and after a decrease, gradually rise to a level of 9,702 persons by 1985. These equate into 1746 dwelling units and 1593 dwelling units respectively.

To convert these projections into land area needs, densities for projected future development have to be established. Data from appropriate literatures and several housing developers active in boom towns were consulted in an effort to construct ideal density ratios for various residential, commercial, public and open space uses. While there was a great variety of estimates, the consensus from these sources is that the best density standards are those that are acceptable with community goals and consistent with

zoning and subdivision regulations. Rifle's land development regulations and the densities of recent subdivision approvals and proposals were examined. From this research, the following were used as densities for the selected land use categories:

Single Family Residence	- 4.0 units/acre
Multi-Family Residence	- 15.0 units/acre
Mobile Homes (single wide)	- 8.0 units/acre
Recreational Vehicles	- 16.0 units/acre
Commercial Facilities (retail, wholesale, industrial)	- 15.0 acres/1000 population added
Public and Quasi - Public Facilities	- 5.0 acres/1000 population added
Open Space	- 9.0 acres/1000 population added

These figures should not be construed as ideal densities for the City of Rifle, but serve as guidelines. The citizens, themselves, must decide what is acceptable. In particular, the densities for commercial, public/quasi-public and open space lands are very general guidelines. Just by meeting an acreage standard does not imply that such land will meet the City's needs. Such factors as specific use, location and quality of land are just as important. These factors should be carefully examined to determine whether the needs of Rifle are being satisfied. If it is determined that development should occur at different densities than those used in this section, new assumptions can be introduced into the model and new acreage figures calculated.

B. Land Area Need Calculations

Tables 7 and 8 indicate the new land area needs for the City of Rifle based on projected population increases and housing preferences from 1978 to 1985.

Under the natural growth scenario, the housing needs of the City will be met if the new subdivisions within the City limits are completed. There is also adequate developable vacant land that would satisfy commercial land needs. Only 11.06 additional acres would be required to meet public/quasi-public and open space needs. Any new park and open space areas platted as part of the new subdivision should be evaluated for meeting these needs. Also, any vacant lands that are subject to environmental hazards, if obtained by the City as open space, should be taken into account.

The impact growth conditions indicate that a substantial amount of new land will be required to meet anticipated needs. The largest increases in land will be for new single family residences. Significant amounts of land will also be required for commercial, public/quasi-public and open space uses. Again, recreational open space areas that are platted as part of the new subdivisions may meet some of the needs.

It is also apparent that the new subdivisions, if fully constructed, will provide almost half of the anticipated housing unit needs. If any of these are not constructed, they will have to be taken out of the anticipated new unit category

TABLE 7

NEW LAND AREA NEEDS GENERATED BY PROJECTED HOUSING UNIT NEEDS UNDER NATURAL AND IMPACT GROWTH CONDITIONS BY 1985

HOUSING UNIT TYPE	1 HOUSING UNIT PROJECTIONS	2 ANTICIPATED NEW UNITS(a)	3 NEW HOUSING UNIT REQUIREMENTS(b)	4 NUMBER OF ACRES NEEDED(c)	5 ACRES OF VACANT DEVELOPABLE LAND	6 NUMBER OF ACTUAL ADDED ACRES NEEDED
NATURAL GROWTH 1978-1985						
Single Family/Duplex	229	356	0	0	3.28	0
Multi-Family	14	88	0	0	3.43	0
Mobile Home	40	292	0	0	-	0
Totals	283	736	0	0	6.71	0
IMPACTED GROWTH 1978-1982						
Single Family/Duplex	924	356	568	142.00	3.28	138.72
Multi-Family	220	88	132	8.80	3.43	5.96
Mobile Home	545	292	253	31.63	-	31.63
Recreational Vehicle	57	0	57	3.56	-	3.56
Totals	1746	736	1010	185.99	6.71	179.87
IMPACTED GROWTH 1978-1985						
Single Family/Duplex	915	356	559	139.75	3.28	136.47
Multi-Family	200	88	112	7.47	3.43	4.04
Mobile Home	448	292	156	19.50	-	19.50
Recreational Vehicle	30	0	30	1.87	-	1.87
Totals	1593	736	857	168.59	6.71	161.80

(a) Includes Annexed land from new subdivisions being constructed, with final approval or in subdivision process

(b) Subtraction of anticipated new units from Housing Unit projections if difference is positive.

(c) New Housing Unit Requirements divided by Densities of Projected Development for each land use category

SOURCES: QDA estimates based on Housing and Population Projections; Subdivision files and Final Subdivision Plats - City of Rife.

TABLE 8

NEW LAND AREA NEEDS IN SELECTED LAND USE CATEGORIES GENERATED BY PROJECTED POPULATION INCREASES UNDER NATURAL AND IMPACT GROWTH CONDITIONS BY 1985

LAND USE CATEGORY	NUMBER OF ACRES NEEDED(a)	ACRES OF DEVELOPABLE VACANT LAND	NUMBER OF ACTUAL ADDED ACRES NEEDED
NATURAL GROWTH 1978-1985 POPULATION INCREASE - 790			
Commercial	11.85	35.12	0
Public/Quasi-Public	3.95	-	3.95
Open Space	7.11	-	7.11
Totals	22.91	35.12	11.06
IMPACTED GROWTH 1978-1982 POPULATION INCREASE - 7342			
Commercial	110.13	35.12	75.01
Public/Quasi-Public	36.71	-	36.71
Open Space	66.08	-	66.08
Totals	212.92	35.12	177.80
IMPACTED GROWTH 1978-1985 POPULATION INCREASE - 5881			
Commercial	88.21	35.12	53.09
Public/Quasi-Public	29.41	-	29.41
Open Space	52.93	-	52.43
Totals	170.55	35.12	135.43

(a) Computed from using densities of projected development

SOURCES: QDA estimates based on Population projections

and put into the developable vacant land category. Since these lands are already annexed, this will not affect the number of actual added acres needed.

Under impact growth conditions, then, a total of 357.67 acres will be required to meet the anticipated needs for the 1978-1982 period, and 297.31 acres required for the 1978-1985 time period.

C. Impact of New Subdivision Proposals

Several new subdivisions have been submitted to the City of Rifle and are presently in the subdivision approval process. A few others have been conceptually discussed with City officials. Within the model, these can be evaluated for their ability to meet projected needs.

Table 9 indicates the type and number of dwelling units that would be added by the new subdivision proposals. It is apparent from the information that if all the subdivisions were approved and constructed, Rifle would exceed the anticipated needs for single and multi-family housing and have a deficit of mobile homes and recreational vehicle sites.

County developments around Rifle must be taken into account to meet the housing and land demand. Table 10 shows the number and types of dwelling units that could be provided. The development of South Rifle Village will provide 169 additional dwelling units when constructed. Cottonwood Springs

Mobile Home Park, if fully developed, could be a source of needed temporary housing. The Garfield County Air-Industrial Park, with a possible 1500 dwelling units, could also add to the housing supply.

TABLE 9

RELATION OF NEW SUBDIVISION PROPOSALS[a] TO NEW HOUSING UNIT REQUIREMENTS UNDER IMPACT GROWTH CONDITIONS BY 1985

HOUSING UNIT TYPE	NEW HOUSING UNIT REQUIREMENTS[b]	HOUSING UNITS-SUBDIVISIONS IN PROCESS	NEW HOUSING NEEDS[c]	HOUSING UNITS-SUBDIVISIONS IN CONCEPT[d]	NEW HOUSING NEEDS[e]
IMPACTED GROWTH 1978-1982					
Single Family/Duplex	568	607	-39[f]	609	-648
Multi-Family	132	213	-81	225	-306
Mobile Home	253	-	253	-	253
Recreational Vehicle	57	-	57	-	57
Totals	1010	820	310	834	310
IMPACTED GROWTH 1978-1985					
Single Family/Duplex	559	607	-48	609	-657
Multi-Family	112	213	-101	225	-326
Mobile Home	156	-	156	-	156
Recreational Vehicle	30	-	30	-	30
Totals	857	820	186	834	186

(a) Subdivisons of land presently outside City limits

(b) from Column 3, Figure 14

(c) Column 2 subtracted from column 1

(d) Subdivisions that have not yet been submitted, or whose submittal has lapsed, but have been discussed with City officials

(e) Column 4 subtracted from column 3

(f) Minus (-) sign by number indicates amount above anticipated need

SOURCES: Housing Projection; Subdivision files for City of Rifle

TABLE 10

COUNTY SUBDIVISIONS IN CLOSE PROXIMITY TO RIFLE-PROPOSED HOUSING UNITS

DWELLING UNIT TYPE	UNITS BUILT OR WITH FINAL APPROVAL	UNITS IN SUBDIVISION PROCESS	TOTALS
Single Family	7	838	845
Multi-Family	0	580	580
Mobile Home	30	495	525
Totals	37	1913	1950

County Subdivisions: Cottonwood Spring Mobile Home Park
South Rifle Village
Garfield County Air-Industrial Park

SOURCE: Garfield County Office of Planning

D. Evaluation

The projections indicate that Rifle's total land area will change little under the natural growth conditions and increase approximately 50% under impact growth conditions. The data also indicates that development, particularly from new subdivision proposals and from the projected impact growth population peaking in 1982 and declining the following year, may create a surplus of various types of land uses. This surplus would be with land uses that are more difficult to reverse or convert than by uses such as mobile homes and recreational vehicle lots. This would be an inefficient use of land.

It is evident from the data that flexibility will be very important - flexibility in terms of both worker preferences of housing types and housing type construction. It will be difficult for the City of Rifle to exactly meet the housing type expectations of the anticipated population, particularly in 1982, without causing problems in the following years. Using flexible land uses and housing types - mobile homes and recreational vehicle lots - may assist Rifle to succeed in meeting the anticipated demands and still allow the land to be converted to other uses as the needs and demands change.

A policy alternative would be for Rifle to actively draw new industries and workers that could increase stability for housing demand. Being close to several modes of transportation, Rifle appears to have a locational advantage. Presently, 13.6 acres of industrial land are proposed in new subdivisions.

The Garfield County Air-Industrial Park is proposing 530 acres of industrial land. There could have an impact on stabalizing the housing market.

The cost and financing of new homes will be important. If financing on mortgages is reasonable and easy to obtain, worker preferences for housing types could be altered. Employees may find it as easy and economical to purchase a single family or duplex home as it is to obtain a mobile home or recreational vehicle.

Projections for commercial land area indicate that under natural growth conditions there is adequate vacant land appropriately zoned to meet the need. Under impact growth conditions, however, the land required to meet anticipated needs exceeds the available vacant land in commercially zoned areas. This indicates that either existing residential land in commercially zoned districts must be converted, or new commercial areas outside the present city limits will have to be established through annexation. In order to maintain the viability of the present commercial center, new commercial areas should be developed to principally serve outlying sub-divisions with convenience services. The uses in the new centers should not directly compete with the central commercial district for service area but be compatible relation to provide services.

V. CAPABILITY OF LAND FOR DEVELOPMENT

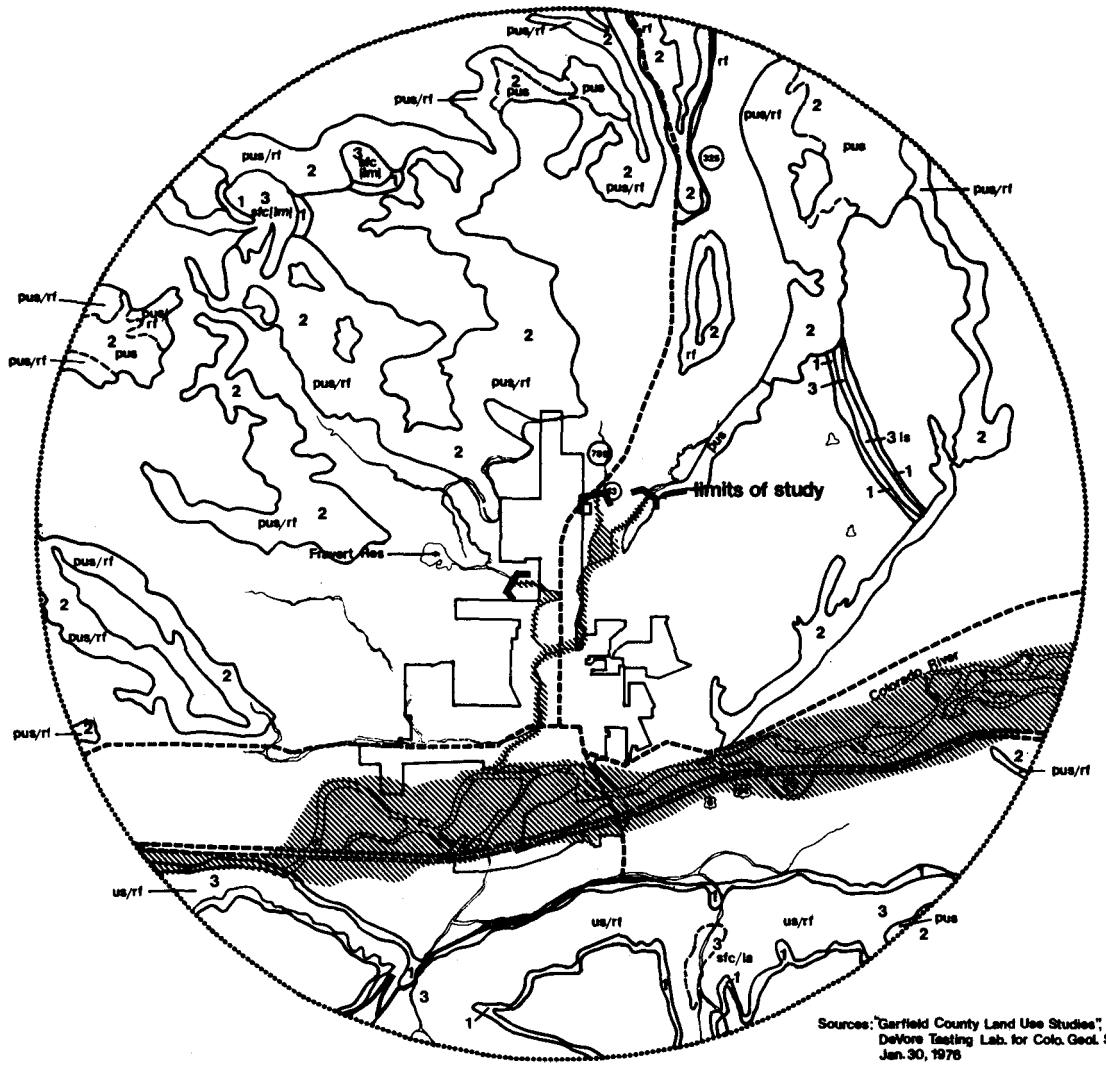
Two land capability maps have been prepared for approximately a 3 mile radius around the City. The maps are not recommendations to where development should occur, but illustrate areas where specific environmental hazards might be encountered. This information is useful not only to the City but also to developers/subdivisions as well.

Figure 8 shows possible geologic and flooding hazards. It delineates the 100 year flood plain and areas of potential or active slope hazards. The classification system for slope hazards was developed by the Colorado Geological Survey.

Figure 9 shows the soil capability for the surrounding areas. The Soil Conservation Service has evaluated the soils for urban land uses in terms of slight, moderate or severe limitations for dwellings with and without basements, shallow excavation, construction of roads and streets, and septic tank absorption. The factors used were: flood hazard; slope; shrink-swell potential; depth to rock; strength; and texture (composition). The following criteria were employed to make a composite evaluation:

Severe limitations: Subject to flooding; slopes $\geq$ 25%

Moderate limitations: Slopes $\geq$ 6%; moderate to severe structural problems - shrink-swell strength, depth to bedrock, texture.



LEGEND

- 100 year Flood Plain
- No Hazard
- 1 — Easily Mitigated Hazard
- 2 — Hazards of Significance
- 3 — Serious Hazard

pus — potentially unstable slope-2
rf — rockfall-2
pus/rf — 2
sfc/ls — active slope failure-3
sfc/lm — slope failure physiography-3
us/rf — unstable slope-3

2000′ 0′ 2000′

Quality Development Associates, Inc.

Sources: "Garfield County Land Use Studies", by Lincoln-DeVore Testing Lab. for Colo. Geol. Survey, Jan. 30, 1976

Dept. of the Army, Sacramento, CA April, 1973

Flood Plain Information, Rifle, CO

Garfield County Airport Environmental Impact Statement

GEOLOGIC HAZARDS AND 100 YEAR FLOOD PLAIN

Fig. 8

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LEGEND

SOIL LIMITATIONS TO DEVELOPMENT
1 Slight
2 Moderate
3 Severe

SOURCE: Soil Conservation Service
Soil Maps and Interpretation for Urban Uses – unpublished data

2000' 0' 2000'

Quality Development Associates, Inc.

SOIL HAZARDS TO DEVELOPMENT

Fig. 9

Slight limitations: < 6% slope; slight to moderate structural problems

Certain soil types had a wide range of characteristics. For instance, the soil that covers much of the eastern portion of Rifle is characterized by having a range of 6-45% slope. Overall, it must be given a severe limitation rating. It is evident that on-site inspection is required for all soils as these are just general maps. To find a specific soil type and characteristics, the Soil Conservation Service maps should be consulted.

VI TRAFFIC AND TRANSPORTATION

I. INTRODUCTION

Impact growth conditions in the City of Rifle would potentially affect the traffic and transportation systems in the community. According to the Colorado Division of Highways the existing system in the Rifle area has been adequate until recently, but the 1973 Sufficiency rating indicates that there is a serious need for improvement based on current usage. This will become more pronounced with increased traffic from oil, coal, gas and oil shale development. In addition even moderately accelerated growth would create more localized problems for Rifle in terms of downtown vehicle congestion and sufficient parking space. It is the intention of this section of the Development Guide to assess transportation and traffic systems in relation to present uses and future requirements under natural and impact growth conditions.

II. HIGHWAY ACCESS AND TRAFFIC VOLUMES

With increased activity in oil shale and local development, Rifle becomes a prime area for development to occur because it lies on two major intersecting highways. Rifle is located on Interstate 70, the major east-west route in the region and State Highway 13. The city draws some traffic from I-70 while other traffic comes from hunters in the fall and out of town residents using Rifle Mountain Park and Rifle Gap Reservoir.

Colorado Highway 13 (also designated Highway 789) is the major north-south access route through Rifle linking I-70 (serving west central Colorado) and U.S. Highway 40 (serving the northwestern sections of the state). Its potential usage will be primary access to energy resources to the north of Rifle at least as far as Rio Blanco County Highway (Piceance Creek Road). Highway 13 usage will include employee commuting, shipment of incoming goods, and product trucking to a rail terminal facility.

Interstate 70 is part of the nationwide Interstate system. I-70 crosses Colorado from the Utah State line to Kansas. The interstate was completed past Rifle and opened for traveling in November 1976. Completion of I-70 from Rifle to Grand Junction is expected by 1982.

U.S. 6 and 24 is also an east-west traffic artery serving the region. Originally it swung through the middle of town on Third Avenue but has been relocated to the southern end of Rifle.

Within the city limits, State Highway 13 is called Railroad Avenue. The traffic congestion along Railroad Avenue has been increasing at such a rate, that Rifle and Garfield county have requested that the highway department assist in determining a new route for S.H. 13 near Rifle. The Colorado Division of

of Highways had developed six alternatives for the improvement for S.H. 13. Each alternative connects with U.S. 6 in the city of Rifle and extends approximately 1.6 to 2.9 miles to the north.

According to the 1976 Colorado Traffic Volume Study prepared by the State Highway Department, annual Average Daily Traffic Volume (ADT) shows an average of 3550 movements on Railroad Avenue (S.H. 13) between U.S. 6 and the north city limits of Rifle. Just north of the city limits to S.H. 325 the Average Daily Traffic colume is 2000. Traffic volumes by vehicle types for the past ten years (the study is updated every two years) are shown in Table 1. This table indicates that there has been a steady increase in traffic approaching Rifle which could be attributed to increased energy development in the surrounding region, as well as increased travel by hunters and those taking advantage of recreational amenities in the area. Additionally, truck usage (pick-ups, single unit and combination vehicles) on the highway has increased while passenger car usage has decreased. By 1976, truck usage exceeded passenger usage. Table 1 indicates the traffic within the City of Rifle has increased to a greater degree than the traffic outside of Rifle.

Origin and destination surveys were conducted to determine basic travel characteristics of people living in the community in 1973 and 1977.

TABLE 1

AVERAGE DAILY TRAFFIC VOLUMES (ADT)
ON S.H. 13 BY VEHILCE TYPE
1968-1976

Between U. S. 6 and North City Limits Rifle

Year	Volume	Passenger Cars	Pick-ups	Single Unit Trucks	Combination Trucks	Total Trucks
1968	2950	1965	634	248	103	985
1970	2900	1694	822	307	77	1206
1972	3000	1772	950	199	79	1228
1974	4000	2130	1540	230	100	1870
1976	3550	1630	1540	290	90	1920
%Increase	20.3	(-17.0)	142.9	16.9	(-12.9)	94.9

Between North City Limits Rifle and S. H. 325

1968	1800	1191	364	142	103	609
1970	1550	911	409	153	77	639
1972	1750	1047	516	108	79	703
1974	2100	1060	730	210	100	1040
1976	2000	930	820	160	90	1070
% Increase	11.1	(-21.9)	125.3	12.7	(-12.6)	75.7

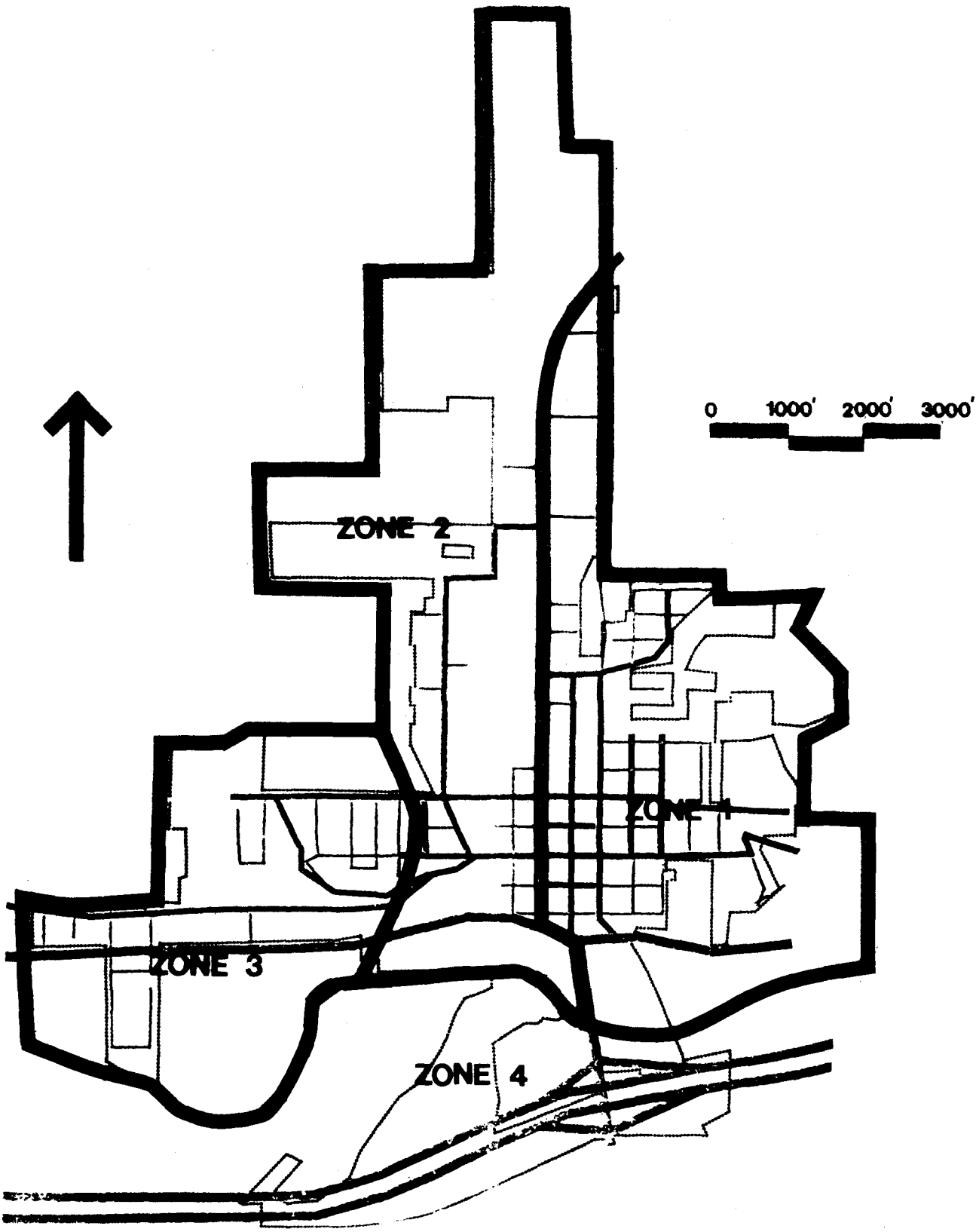
Source: Colorado Traffic Volume Study 1968, 1970, 1972, 1974, 1976
Colorado State Department of Highways

The 1973 origin and destination study revealed the area of major internal traffic congestion to be the intersection of Railroad Avenue and Third Street. The 1977 study was a house to house survey by the Oblinger-Smith Corporation. The City of Rifle was divided into 4 zones and a 20 percent sample was taken (See figure 1). Table 2 indicates the results of the survey.

A trip was defined as one-way movement from point of origin to point of destination by an individual over 5 years old. Next to home, the second most frequent trip was to work followed by social or recreation purposes. The automobile driver or auto passenger was the most common mode of travel.

Table 3 indicates the distributional patterns of the zone to zone person trips. Apart from trips in the Rifle area, the next area traveled was to Glenwood Springs.

Uncertainty exists in predicting traffic volumes. Based upon experience, extrapolating historical trends of traffic volumes has been one acceptable method. The Colorado Highway Department has developed a 20 year expansion multiplier to calculate probable future traffic volumes. Using a multiplier of 1.2, the 1985 and 1995 natural growth traffic volumes were determined (see table 4). This was compared to traffic volumes generated under impact conditions. These findings have revealed that 900 additional vehicles would travel daily on Railroad Avenue between U.S. 6 and 3rd Street by 1995.



ORIGIN-DESTINATION SURVEY ZONE MAP

City of Rifle

Fig. 1

TABLE 2

CITY OF RIFLE
Person Trip Summary[1]

	Zone				
	1	2	3	4	Total
Population	1,210	455	610	105	2,380
Number of Dwelling Units	455	205	235	40	935
Number of Vehicles owned	760	340	460	95	1,655
Total Number of Person Trips	3,375	1,250	2,140	230	6,995
Trips per Dwelling Unit	7.4	6.1	9.1	5.8	7.48
Percent Trips for Purpose of:					
Work	17.2	15.2	17.3	10.9	17.3
Personal Business	12.0	12.0	10.4	8.7	10.4
Medical-Dental	0.4	2.8	1.4	8.7	1.4
School	9.4	8.4	7.4	4.3	7.4
Social or Recreation	11.7	10.0	11.0	21.7	11.0
Change Mode	0.0	0.0	0.1	0.0	0.1
Dine Out	3.2	6.8	4.9	2.2	4.9
Shopping	6.1	2.4	7.5	8.7	7.5
Home	40.0	42.4	40.0	34.8	40.0
Mode of Travel (Percent)					
Auto	36.9	53.6	47.4	32.6	42.9
Auto Passenger	24.0	14.8	14.7	34.8	19.9
Pickup	14.7	6.8	28.3	21.7	17.6
Bike	1.3	0.0	0.5	0.0	0.8
Bus	0.4	1.2	4.2	0.0	1.7
Walk	21.2	23.6	4.7	10.9	16.3
Other	1.5	0.0	0.2	0.0	0.8

[1]Home interview travel survey conducted Spring, 1977.

Source: Garfield County Transportation Study
Oblinger-Smith Corporation

TABLE 3

CITY OF RIFLE
ORIGIN-DESTINATION SURVEY
ZONE TO ZONE PERSON TRIPS

To

From	CITY OF RIFLE				GARFIELD COUNTY PLANNING AREAS																	
	ZONE 1	ZONE 2	ZONE 3	ZONE 4	1-WEST END	2-ROAN CREEK	3-RULISON	4-GRAND VALLEY	5-SOUTH RIFLE	6-RIFLE SUBURBAN	7-SILT MESA	8-ELK CREEK	9-I-70 CORRIDOR	10-WEST DIVIDE	11-NAT'L. FOREST	12-GLENWOOD SPRINGS	13-SPRING VALLEY	14-FOUR MILE	15-CATTLE CREEK	16-CARBONDALE SUBURBAN	MESA COUNTY	OTHER	TOTAL
ZONE 1	1,595	645	465	20			5	10	5	265	75			10		60					35	35	3,225
ZONE 2	605	405	200	15	5			15	5	60	15					50					50	10	1,435
ZONE 3	455	180	220	5					15	100	30					55					30	30	1,120
ZONE 4	45	20	5	5												10		5					90
1-WEST END		5																					5
2-ROAN CREEK																							
3-RULISON	5																						5
4-GRAND VALLEY	10	15																					25
5-SOUTH RIFLE	5		20							15	5												45
6-RIFLE SUBURBAN	210	110	10	5				15		10													360
7-SILT MESA		15	20	5					5	5			20										70
8-ELK CREEK																							
9-I-70 CORRIDOR										10													10
10-WEST DIVIDE	10																						10
11-NAT'L. FOREST																							
12-GLENWOOD SPRINGS	65	50	15	20												15							165
13-SPRING VALLEY																							
14-FOUR MILE	5			5																			10
15-CATTLE CREEK																							
16-CARBONDALE SUBURBAN	5																						5
MESA COUNTY	15	55	25																				95
OTHER	60	5	15													10						10	100
TOTAL	3,090	1,505	995	80	5		5	40	30	465	125		20	10		200		5			115	85	6,775

Source: Home Interview Travel Survey
Oblinger-Smith Corporation

TABLE 4

PROJECTED AVERAGE DAILY TRAFFIC VOLUMES
1973 - 1995

Segment of Railroad Avenue	Natural Growth +				Impact Growth ++			
Segment	1973	1985	1995	Total Increase	1973	1985	1995	Total Increas
U.S. 6 - 3rd Street	4,300	4,800	5,200	900	4,300	11,100	12,300	8,200
3rd - 5th Street	5,000	5,600	6,100	1,100	5,000	12,900	13,900	8,900
5th - 8th Street	4,200	4,700	5,100	900	4,200	9,650	10,200	6,000
8th - 16th Street	3,500	3,900	4,300	800	3,500	8,700	9,150	5,650
16th - 21st Street	2,350	2,600	2,900	500	2,350	7,600	8,000	5,650
21st Street - White River Ave.	2,100	2,400	2,600	500	2,100	6,350	6,700	4,600
from North to White River Ave.	1,800	2,000	2,200	400	1,800	4,950	5,200	3,400

+ Projections based on a 20 year expansion factor of 1.2 for 1972 and 1974 determined by the Colorado Highway Department

++ Projections determined by Colorado Highway Department for Draft E. I. S. Through Rifle (p. k-17)

Source: Draft E. I. S. THROUGH RIFLE (p. k-17)

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Under impact conditions, the Colorado Division of Highways has projected figure volumes of traffic along Railroad Avenue without alternatives. These projections were of traffic volumes within the city, taking into account the origin and destination of the trips, speed and the capacity of the road. Table 4 also shows the projected increase in traffic along certain segments of Railroad Avenue under impact conditions.

By 1995, an average 3,400 additional vehicles daily will approach Rifle from the north on Highway 13 to White River Avenue (see Table 4). In the downtown area between 3rd and 5th Streets, an average of 8,900 additional vehicles can be expected to travel on Railroad Avenue. These figures may be low since they don't take into account local traffic.

The many local energy projects underway and in the planning stages would impact the use and condition of roads in and surrounding the city. The city planner is currently performing volume counts relating to traffic on Rifle Streets. This data will be helpful in updating the projections made by the Highway Division.

III. STREETS AND PARKING

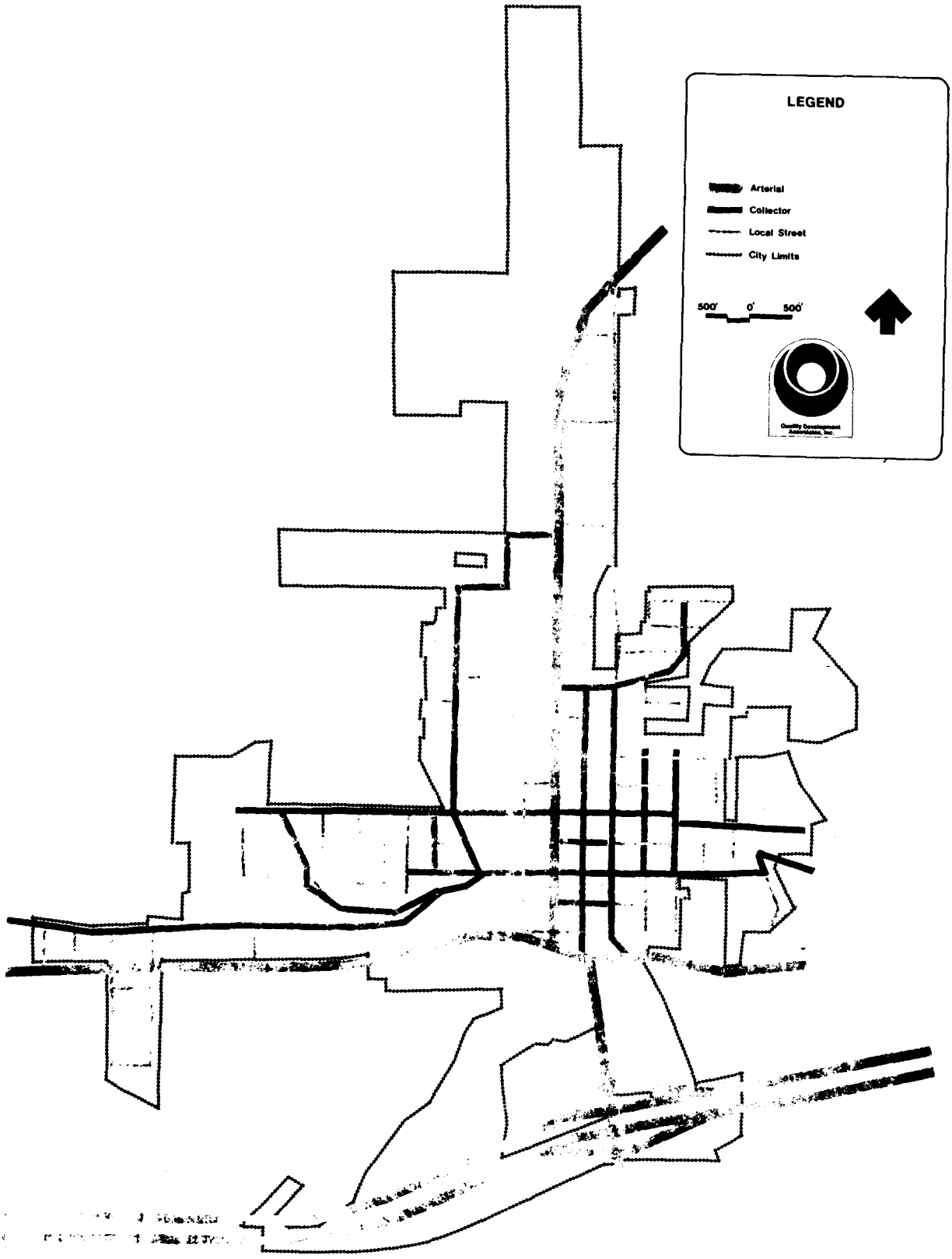
Local transportation and traffic impacts relating to expanded population must also be assessed by Rifle. Increases in the number of vehicles on town streets will present an additional need for street maintenance, traffic control and parking facilities. It is the intention of this section to assess the present street and parking conditions in Rifle and ascertain Rifle's future needs in meeting the demand for increased facilities.

A. Streets

There are approximately 13 miles of open, used and maintained streets in the City of Rifle: two miles of arterial streets (streets whose primary purpose is to facilitate traffic flow through the city rather than to or from the city) and eleven miles of local streets.

Three different type streets are presently being used in Rifle: arterial, collector, and local streets (Figure 2). Arterial streets are primarily utilized to accommodate traffic with an origin and destination beyond Garfield County or the State of Colorado. Collector streets are designed for high volume and circulation of traffic between major arterials and local streets. Local streets are designed to accommodate local traffic to residential areas.

Currently, Rifle has no major streets plan. Without a plan,new commercial and residential construction will locate near areas of good street access. In Rifle there is a need to



EXISTING TRANSPORTATION CORRIDORS

FIGURE 2

adopt a plan before a substantial amount of development occurs. Otherwise local streets will be unable to accommodate increases in traffic.

The existing street network is inadequate in many locations with dirt streets, and streets lacking curb and gutter and sidewalks. The existing street network will be unable to handle increases in traffic loads from a larger population on the order of 5,000 or greater. Designation of thorough-fares both North-South and East-West will improve the circulation of traffic between different areas of the city with a minimum of hindrance to traffic flow. The figure on page VI-6 shows the existing street network. There is one North-South corridor and no East-West thorough-fare

The "Regulations and Standards for Developers and Subdividers" gives regulations for platting and right-of-way dedication for streets. Subdivision requirements require private investors to pay for road construction and improvements in new commercial and residential areas. With the exception of a few existing residential areas still outside the city limits, all new roads added will only affect the city's maintenance department. Emphasis will be on street improvement and relieving bottlenecks.

Streets within Rifle are maintained by the City. Maintenance includes street sweeping, snow removal, patching and signing. There are two electronic signals in Rifle. All other traffic is controlled by stop signs. Center line stripping has been funded by State and Federal sources.

A larger percent of people interviewed in the Oblinger-Smith survey in 1977 used a vehicle as a mode of travel (refer to table 2). Private automobile is an accepted norm and will not likely change, given the rough topography of the immediate city area and the large traveling distances to other population and recreational centers such as Grand Junction, Denver, Vail, Rifle Mountain Park, etc.

Increased population will also mean more pedestrian and bicycle traffic. Pedestrian and bicycle safety will be a matter of concern especially in the downtown area, and in nearby schools, parks and public facilities. New highway improvements should consider the safety of pedestrian and bicycle traffic. The creation of buffer zones would reduce adverse impact.

Table 5 shows that 1,655 vehicles were owned in 1977 by citizens in Rifle. Using a figure of 1.9 vehicles per household and a QDA estimate of 862 households in Rifle, the approximate increase in vehicles registered to town residents under impact growth conditions will be on the order of 3,400 vehicles by 1982. If vehicle ownership practices remain the same, the number of vehicles owned by town residents will almost triple by 1985. This will increase traffic congestion, and affect Rifle's parking and the structural condition of streets and roads.

According to the Chief of Police 123 accidents occurred in 1977. By August 29, 1978, 112 accidents had already occurred, while in 1977 only 66 accidents were reported.

TABLE 5

PROJECTED INCREASE IN VEHICLE REGISTRATION
UNDER IMPACT GROWTH CONDITIONS
1977-1985

Year	Population	Family Size	No. of Households	Total Vehicles
1977*	2,244	2.60	862	1,655
1978	3,821	3.3	1,171	2,248
1979	7,563	4.0	1,874	3,598
1980	7,178	3.9	1,826	3,506
1981	10,546	4.2	2,482	4,765
1982	11,163	4.3	2,608	5,007
1983	8,302	3.9	2,135	4,099
1984	8,930	3.9	2,283	4,383
1985	9,702	3.9	2,455	4,713

* Actual figures are presented for 1977, all other figures are projected.

Source: Special Census, home interview surveys conducted, Springs 1977

by the same date. The greatest number of accidents were caused by improper backing from parking places in the downtown business district. Other types of accidents that occur frequently are: careless driving and improper left turns. It is likely that if the number of cars on the road increase dramatically, the accident rate will also increase.

B. Parking

Thomas Clarke, an architect and urban designer conducted a survey of existing parking sites in the central business district in May and June 1978. According to his survey there are approximately 667 parking sites in the Rifle downtown area. Existing parking could be divided into the following three categories:

public on street parking: 374 sites

public off street parking: 160 sites

restricted or private parking: 133 sites

Most of the parking is located between second and Fourth Street and West and East Avenue, although there is a fair amount of parking on side streets. Most of the parking in the central business area is at a 60^{o} angle to the curb, while most other parking is parallel. There are currently three off street parking lots located 1) in front of Remington Square 2) at the vacant lot on Second Street and 3) the lot provided by the bank.

The Urban Land Institute recommends that for planning purposes there should be a provision of 5.5 parking spaces per 1,000 square feet in areas where there is no walk-in trade nor public transit usage. Currently Rifle has about 150,000 square feet of retail and office space in the Central business district. Using the Urban Land Institute criteria for parking spaces, Rifle needs approximately 200 more parking spaces at this time in the downtown area. Under impact growth conditions Rifle will need to create the parking spaces necessary to handle increased retail demand.

IV. TRANSPORTATION MODES

Growth conditions will require increased development of systems to move large quantities of freight and people through and around Rifle, as well as to allow increased accessibility to Rifle itself. The Community is currently served by two freight hauling lines, two bus lines, a county-owned airport facility and the Denver and Rio Grande Railroad. The following section focuses on the existing transportation modes available for movement of goods and people to Rifle and the projected uses of these facilities as growth occurs.

A. Trucking

There are two freight hauling lines that serve Rifle: A.J. Stampfel Trucking Company and Don Ward and Company. The A. J. Stampfel Company began operations in

1937. Currently the company owns eight trucks which operate off and on depending on demand. Their trucks include dump trucks, trailers, tandem dumps and pumps. Primary loads have been uranium, vanadium, oil shale and gravel. The company hauls to oil shale tracts on demand, with approximately two to three trips made weekly. They have heavy equipment (graders, etc.) which have been used frequently. Seasonal slowdowns have been experienced in winter. Carol Gentry, the owner, anticipates more loads and hopes for expansion of the company. The company has the manpower to provide for increased services.

Don Ward and Company bought Estes Trucking Company in Rifle in 1970. Currently they operate heavy hauling equipment, bulk liquid trailers and have been hauling cement, heavy equipment and vanadium liquor. The Company maintains an office, a full-time shop and mechanic shop in Rifle. The company has a full seven day week operation making an average of three trips a day to the oil shale sites. The company can meet business demands by supplementing Rifle with trucks from other areas.

B. Bus Service

Two bus lines operate in Rifle covering different routes. Continental Trailways operates four buses daily East and West between Denver and Salt Lake City. During the summer of 1978, a majority of the buses have been running at capacity.

Wilderness Transit, Inc. maintains a daily round-trip bus from Craig to Grand Junction with a stop in Rifle. Wilderness passes through Rifle in the morning to Grand Junction and returns in the afternoon from Grand Junction. Approximately 75 percent of revenues generated by the bus line are from hauling freight.

Wilderness Transit was purchased by its current owner in 1969 when service consisted of an eleven passenger limousine. In 1971, the limousine was replaced by a twenty-five passenger bus and more recently, a forty-three passenger bus was acquired. However, increased bus size was needed for additional freight capacity rather than expanded ridership. Wilderness anticipates that an additional round trip from Craig - Rifle - Grand Junction may be added in the next 18 months to two years.

A local service, known as the Traveler Bus, is provided to the elderly and handicapped residents of the City of Rifle. This activity is sponsored by the Garfield County Council on Aging. There are three buses in circulation: one in Grand Junction, another in Rifle, and the third is wherever the demand is greatest. The Traveler Bus transports senior citizens to doctor's offices, the hospital, stores, etc., and provides trips to Glenwood Springs and Grand Junction. There is no charge for the service except a $1.00 per year user's fee for insurance purposes and a $3.00 charge for trips to Grand Junction. A money box is provided for those

who wish to donate. The communities of New Castle, Grand Valley, Glenwood Springs, Carbondale, Silt and Rifle have provided revenue for this activity. An information and referral service about the use of the bus is operated by R.S.V.P. volunteers. Currently the bus schedule is being revised, it is expected that more service would be provided to Grand Valley.

There is no public taxi service or internal transit system in Rifle. Taxi service may be needed within 3-4 years.

Presently the C-b Shale Oil Venture provides bus service for its employees to and from the mining area.

C. Railroads

Rifle has limited rail service by the Denver and Rio Grande Western Railroad (DRGW). The DRGW runs along Interstate 70 and the Colorado River. The line passes through Glenwood Springs, Rifle, Grand Valley and Grand Junction and provides both passenger and freight service. The most important function however, is hauling freight, and it is expected to follow this pattern in the future. There is a concern of possible tonnage restrictions through tunnels. These restrictions, if enforced, may call for unit trains to be only 50 to 55 cars.

The DRGW has the capacity to move 28 net million tons per year through the Moffat Tunnel. The DRGW ceiling will be reached in 1979 unless additional improvements are made, according to a report by the DRGW. The DRGW has planned capital expenditures, including siding extensions, power purchases and bail and

ballast programs, which will extend the railroad's capacity to 45 net million tons annually, maximum by 1983. Beyond 1983, the Moffat Tunnel will then become the limiting factor in additional capacity calculations. Using DRGW estimates of new energy business (which relied heavily on coal and less on shale oil), the absolute ceiling of 63 net million tons will be reached sometime in 1986. By 1986 if local projections hold out, alternatives either to Moffat Tunnel or to the use of the railroad itself, will need to be found.

D. Airport

Air Service is provided on an individual basis at the Garfield County Airport which is located 2.8 miles southeast of Rifle. The primary service area of the Garfield County Airport is approximately 2,400 square miles. The nearest major airport facilities to the Garfield County Airport site are as follows:

Walker Field, Grand Junction, Colorado - 1.5 hrs. driving time west

Stapleton Field, Denver, Colorado - 4 hrs. driving driving time east

Sardy Field, Aspen, Colorado - 1.5 hrs. southeast

Eagle County Airport, Eagle, Colorado - 1.2 hrs. east

There is a small municipal airport at Glenwood Springs. But according to Garfield County Airport Master Plan prepared by Mountain Affiliates, the airport is not considered usable for any major airport operations due to hazardous surrounding terrain and wind conditions.

The Garfield County airport consists of a single 50 foot wide paved runway with a length of 5,155 feet. This runway is in poor condition with evidence of extensive cracking and buckling. There is no commercial passenger service to the airport due to the inadequate size and deterioration of the existing facilities. Existing County financed improvements at the airport consist of two trailer-type units which serve as housing and office space for the airport manager, a 40 ft. X 50 ft. repair hangar, 3 tee hangars, parking apron area (Partially paved) and older hangar buildings belonging to Mile Hi Aviation. There is one navigational aid, a non-directional beacon, but it is inoperable. A low power commercial broadcasting station operates in Rifle during daylight hours.

In 1976 Mountain Affiliates prepared a Master Plan for the Garfield County Airport. Mountain Affiliates determined that the airport has experienced a substantial increase in activity from the years 1972 to 1975. During that three year period annual operations increased from approximately 7,000 to about 15,000 per year and the number of based aircraft increased from 12 to 26.

Mountain Affiliates reported that the Garfield County area has a ratio of 3.02 aircraft per 1000 population compared to 2.32 for the balance of the Western Mountain Region and 1.3 for the national average of non-metropolitan counties

under 100,000 population. It is anticipated that the high ratio of 3.02 in Garfield County may prevail for the immediate future and then decrease to be more in line with the balance of the Western Mountain Region.

Mountain Affiliates assumed that, for projecting the yearly general aviation operations at the airport, approximately 630 total operations per based aircraft will occur with about 30% of these being itinerant. Air carrier passenger enplanements projections suggest a significant portion of the initial population will be temporary construction type workers. It is assumed that the majority of airline passenger traffic will be generated from the related supportive population.

Table 6 presents a summary of present and projected future activities of various types that are forecast to occur at the County Airport over the next 5, 10 and 20 year periods. All figures come from the 1976 Master Plan except for data relating to 1977 which was obtained from the Federal Aviation Administration (F.A.A.).

An updated Master Plan was developed by Isbill Associates using the same projections, but making changes according to price increases and the area where the buildings will be placed. To date the runway has been staked out. The Convair 580 type will provide a major portion of the air carrier passenger and cargo service to the airport.

TABLE 6

PAST AND PROJECTED OPERATIONS AT GARFIELD COUNTY AIRPORT
1975-1995

	1975	1977**	1980		1985		1995	
			low	high	low	high	low	high
County Population	21,120	18,800	26,000	45,000	27,000	58,000	90,000	95,000
Based Aircraft	26	22	45	115	90	190	315	335
Annual Operations	±15,000	±14,000	28,000	64,000	56,000	99,000	155,000	164,000
*Enplaned Passengers (per year)	0	--	10,500	18,000	13,500	29,000	90,000	95,000

*Air carrier only

Source: Garfield County Airport Master Plan, 1977 Special Census

** figures given to QDA by Dave Epstein with F.A.A.

For the time period after 1985 and through 1995, it is projected that the Convair 580 type aircraft will gradually be replaced by a new 50 to 60 seat jet aircraft in the 60,000 pound class which will serve as the prevalent feeder line airplane.

Cargo Activity

Due to the projected substantial industrial and energy-related development that is to occur within the service area of the Garfield County Airport, cargo handling will become a major activity in the future. It is projected to increase from between 150 to 250 tons per year at the end of Phase 1 to a level of between 200 to 400 tons per year by the end of 1980. At the end of the twenty year period between 1,300 and 1,400 tons of cargo per year will be handled.

V. SOURCES OF FUNDING

The City, County, and State receive funds from The Highway Users' Tax, Special Vehicle Ownership taxes and the city and county share in the Road and Bridge mill levy. Other sources of funds include the general funds of the city and county, the Oil Shale Trust Fund, proceeds from Bond issues for the airport or special street improvement districts, Grants from federal off-systems road improvement programs and from aviation fuel taxes for the airport. Parking meters add small amounts of revenue that may help pay for striping,

parking lots, etc. The City traditionally uses Revenue sharing funds on streets. Traffic fines are added to the general fund.

To obtain funds from User's taxes, etc. the local governments need only comply with information and reporting requests. The same is true of revenue sharing monies. Special Improvement District require citizen initiative (not expected in most areas). Grants require formal applications, as do requests from the oil shale trust fund.

When all existing problems are taken care of (paving streets in poor neighborhoods, etc.), taxes should support regular maintenance activities. Bus systems and the vans for the elderly will require subsidies from local governments. With Federal grants forthcoming, the airport should be able to meet operation expenses and debt service out of operating revenues.

VII HOUSING

I. INTRODUCTION

Rifle's history is one of more or less steady growth based on agriculture and tourism, with occasional spurts and declines resulting from cycles of mining activity. Housing preferences in the past have been primarily single family in nature, while housing construction activity prior to 1970 has proceeded at a modest pace corresponding to the rate of population growth in the Rifle area.

The imminent boom in oil shale and coal, which is beginning to impact Rifle in 1978, will bring numerous changes to the area, one of the most important and visible of which being the rapidly changing housing picture. For example, the population generated solely by construction activity on major energy developments is expected to create a market in the area for temporary dwelling units that by 1981-1982 could match the total existing housing stock in Rifle as of 1977. For several years in advance of energy development, speculation has caused several up-and-down cycles in the local land market, and land prices currently are artificially high in comparison to rural areas not experiencing energy speculation. The cost of labor and materials is also higher in the Rifle area than in urban

areas of Colorado, thus adding to the costs of construction. Along with the inflation affecting housing prices across the country, these factors have contributed to a growing unmet demand for affordable housing in the Rifle area, even under natural growth conditions.

Planning, implementing, and monitoring new housing developments under both natural and impact growth conditions will require some changes in current policies and practices. Among the many housing-related issues which local decision-makers must resolve are:

- How adequate and realistic are projected housing needs?
- How much of that projected housing growth does Rifle actually want?
- Where should such growth be located?
- What should be the density and unit types of housing developments?
- Are the current zoning and subdivision regulations adequate to deal with either a natural or rapid growth situation?
- What control can the town exercise over shoddy developments or irresponsible developers?
- How can temporary unit construction, use, and removal be best controlled?

- Should the town subsidize directly or indirectly any housing development activity?
- What provisions should be made for low income and/or elderly housing?
- How can the visual qualities of the town be enhanced and preserved?
- What planned and implementable precautions are necessary to protect the town and individual housing investments in guarding against over development?

These difficult concerns and others will arise throughout the growth period. Some will have special meaning primarily because of problems generated by rapid growth, while others need to be addressed even under slow or natural growth conditions. Resolution of most of these issues will require practically and politically difficult choices.

Under impact growth, the magnitude and the rate of population growth in Rifle will be directly related to the progress in construction and operation of nearby energy development projects. When the projects are delayed or interrupted, or when their progress varies from proposed schedules, the supply and demand in housing will vary as well. Applications from developers and other private interests for subdivision plots, special use permits, and zoning variances and exemptions--which are already increasing in anticipation of rapid population build-up--may show greater uncertainty and more

erratic timing in the future, reflecting irregularities that might occur in project scheduling. During the course of major energy development, this will give rise to numerous policy and enforcement problems in managing growth in Rifle and in outlying areas of the County.

II. TRENDS IN HOUSING COMPOSITION

The most recent data on housing for Garfield County and the City of Rifle are given in the 1970 and 1977 Census reports. The general housing profile for Rifle and for Garfield County is given in Table 1. Between 1970 and 1977, Rifle gained nearly 60 housing units, for an increase in housing stock of 7.3 percent; during the same period the number of dwelling units in the entire County increased by around 1800, for a gain of 32.6 percent.

As of 1970 in both Rifle and the County, a very high percentage of total dwelling units were year-round units: in Rifle, 100 percent of the housing stock was year-round, with no seasonal units; in Garfield County, 98.3 percent were year-round units, with only a marginal supply of seasonal units.

In addition, the proportion of single family dwellings was greater in Rifle (74.2 percent) than in the County as a whole (70.3 percent) in 1970. Unfortunately, information collected for the 1977 Census did not include a classification of dwelling units by type, so updated trends in the

TABLE 1

HOUSING PROFILE FOR THE CITY OF RIFLE AND GARFIELD COUNTY - 1970 and 1977

	CITY OF RIFLE				GARFIELD COUNTY			
	1970		1977		1970		1977	
	#	%	#	%	#	%	#	%
Total Units [a]	803	100.0	862	100.0	5537	100.0	7340	100.0
Year-round	803	100.0	N/A	-	5445	98.3	N/A	-
Single family [b]	596	74.2	N/A	-	3894	70.3	N/A	-
Sub-standard [c]	17	2.1	N/A	-	287	5.2	N/A	-
Vacant	42 [d]	5.2	52 [e]	6.0	158 [d]	2.9	610 [e]	8.3
Occupied	739 [f]	92.0	810 [g]	94.0	4923 [f]	88.9	6730 [g]	91.7
Over-crowded [h]	57	7.1	N/A	-	416	7.5	N/A	-
Owner-occupied	503	62.6	N/A	-	3255	58.8	N/A	-
Renter-occupied	236	29.4	N/A	-	1668	30.1	N/A	-

[a] Total includes year-round, seasonal, single, multi-family and mobile home units.

[b] Single family units are year-round one-unit structures

[c] Sub-standard units are year-round housing units lacking some or all plumbing facilities.

[d] Vacant counts in the 1970 Census include only those year-round units that are for sale or for rent.

[e] Vacant counts in the 1977 Census include all uninhabited structures identified in the course of the census count.

[f] Occupation figures in the 1970 Census include only those year-round units which are inhabited by owners or renters at the time of the census count.

[g] Occupation figures in the 1977 Census include all inhabited structures identified in the course of the census count.

[h] Over-crowded units are occupied housing units with more than 1.01 persons per room.

Source: U.S. Department of Commerce, Bureau of the Census.

growth of single and multiple units are not available.

Although vacancy rates were recorded in both the 1970 and 1977 Census, the meanings attached to the term were very different. As is evident from Table 1, the "vacant" counts increased marginally in Rifle between 1970 and 1977 and rose sharply in the County. As is explained in the table notations, the 1970 vacant counts included only those uninhabited year-round structures which were for sale or rent, not all unoccupied structures. In other words, the 42 Rifle and 158 County units identified in the 1970 Census represent "effective vacancy" -- units which could accommodate incoming populations. However, QDA has determined from consultation with the Regional Bureau of the Census that the 1977 vacancy count included unoccupied as well as for sale and rent units both seasonal and year-round. The 1977 figures, then, of 52 units in Rifle and 610 in Garfield County do not represent "effective vacancy" and can not be represented as potential housing opportunities for incoming populations.

The same definitional confusion exists over the counts of occupied units. In the 1970 census, the occupied count included only those year-round structures which were occupied by owners or renters. The 1977 count of unoccupied units, on the other hand, included all seasonal and year-round units which were inhabited by anyone on the census date.

As the 1970 Census figures show, a majority of residents, both in Rifle and in the entire County, owned their homes rather than rented. In Rifle the percentage of ownership was 62.6; County-wide, it was 58.8.

Also provided in the 1970 Census is information regarding age, condition, and over-occupancy of the housing stock in Rifle and Garfield County. Such data was not updated, however, by the 1977 Census. As indicated in Table 1, only 2.1 percent of Rifle's total dwelling units, and 5.2 percent of the County's housing stock, was classified substandard in 1970 -- meaning that some or all necessary plumbing facilities were lacking. Also, 7.1 percent of Rifle's housing and 7.5 percent in the County was judged to be over-crowded--housing occupancy in excess of 1.01 persons per room. Concerning age of the housing stock, the 1970 figures show that most of the units in Garfield County were built prior to 1949. Age distribution as of 1970 for the County's housing is given below:

Age Category	% of Total Year-round Housing
1 mo.-10 yrs.	28.1
11 yrs.-20 yrs.	18.1
21 yrs.-30 yrs.	13.6
Over 31 years	40.2

This indicates that while more than one-quarter of the dwelling units in the County in 1970 were ten years old or less, nearly one-third were between 11 and 30 years old, with

the largest category being those homes that were at least 31 years old. No figures on housing age were collected in 1977, but the 32.6 percent increase in housing stock in Garfield County between 1970 and 1977 has probably increased the relative proportion of housing under 20 years of age by 1978.

Increasing residential construction activity has been occurring in Rifle since 1970, as evidenced by the residential building permits issued by the City.

Year	# Permits
1970	11
1971	3
1972	0
1973	4
1974	14
1975	25
1976	16
1977	47
1978 (midyear)	46

The City's permit records indicate that the 166 residential permits issued since 1970 represent 230 new dwelling units in Rifle as of mid-1978. These figures are exclusive of mobile home units (of which less than five have been added), but they do include nearly 60 units that were developed under C-b sponsorship during 1977. Of the total new residential permits issued since 1970, more than 80 percent

have been issued since 1975, representing about 87 percent of the total dwelling units permitted since 1970.

III. PROJECTED HOUSING NEEDS

Rifle, even under conditions of natural growth, has witnessed shortages of adequate or available housing. The entire western slope will be developing into a major growth center due to energy and tourism in the coming years and Rifle will attract its share of the spinoff growth in the area even under what could be termed natural growth conditions. Even without the impact of specific energy projects, housing units must be provided in increasing numbers to ensure that needed professionals and other newcomers will locate and establish themselves in Rifle for the long-term benefit of the quality of life in the community.

Under conditions of rapid energy development, Rifle will experience many boom town effects that will confront the community with many problems and opportunities in planning. Rifle will be faced with a common boomtown concern, that of not permitting the overbuilding of housing -- especially permanent units -- in anticipation of projected 'peak' population levels. This problem demands flexibility in meeting housing needs be maximized, at the same time avoiding a housing surplus that could burden both the community and the individual homeowner in the years to come.

Careful analysis of actual and projected growth patterns will allow Rifle to plan for sufficient temporary housing to meet the peak needs of the construction surge, and to create an adequate supply of permanent housing to accommodate a more stable population. In this section on Rifle's projected housing needs, QDA provides the data base with which the community can begin to make decisions on these issues.

A. Housing Needs Under Natural Growth Conditions

Rifle's total additional population under conditions of natural growth is not expected to exceed 800 persons by 1985. In order to project the housing preferences of this growing population, QDA has assumed that many of the newcomers under natural growth will be locating in Rifle as a consequence of generally increasing energy development activity throughout the area. In addition, the proporations and types of employment in construction, operations, and service categories are assumed to broadly reflect those under impact conditions, except at a much smaller scale. With these assumptions, housing coefficients derived from The Construction Worker Profile are applied to the natural growth scenario to project housing demand.

As shown in Table 2, each of the general employment categories shows steady growth throughout the forecasting period. By 1985 under natural growth conditions, 314 added

TABLE 2

ADDED EMPLOYMENT BY TYPE UNDER NATURAL GROWTH CONDITIONS IN THE CITY OF RIFLE 1978-1985

Year	Employment Type			Cumulative Totals
	Construction	Operations	Service	
1978	6	4	42	52
1979	17	11	59	87
1980	9	13	96	118
1981	13	19	133	165
1982	16	24	169	209
1983	18	27	189	234
1984	21	32	223	276
1985	25	35	254	314

Source: QDA estimates based on COG's Growth Monitoring Information System.

employees are projected for Rifle. This corresponds to an additional housing demand of 283 units, presented in Table 3. Of these new units, almost 81 percent are expected to be single family. Adding the total number of incremental units to Rifle's existing housing stock of 803 means that, by 1985 under conditions of natural growth and the assumptions discussed above, Rifle will need at least 1086 year-round inhabitable units to house its population.

These figures of added housing needs do not represent the exact number of new units that will be demanded. Even though some elderly homeowners will move into multi-units or senior housing alternatives, or possibly relocate to another community, this will not add as many homes to the available housing market as will be demanded by newcomers. Also, due to housing age, conditions, and accidents, some existing units will need to be replaced.

B. Housing Needs Under Impact Conditions

Under conditions of energy impact, population, employment, and housing demand are all projected to increase rapidly. As Table 3 and Figure 1 in the population section indicate, Rifle's 1977 population will grow 332 percent by 1985 under impact conditions - growth of nearly 400 percent is forecast for the initial peak in 1982; Rifle's 1977 employment is expected to jump 170 percent by

TABLE 3

ADDED HOUSING NEEDS GENERATED BY
NATURAL GROWTH CONDITIONS IN THE CITY OF RIFLE
1978-1985

Year	Single Family	Multi-Family	Mobile Homes	Total Housing Units
1978	38	2	7	47
1979	63	4	11	78
1980	86	5	15	106
1981	120	8	21	149
1982	152	10	26	188
1983	170	11	29	210
1984	201	13	35	249
1985	229	14	40	283

Source: QDA estimates based on applications of developed coefficients and COG Growth Monitoring Information System.

1985, showing an initial increase by around 200 percent in 1982. Though operations and service workers represent the majority of added employment over the years 1978-1985, Table 4 shows that there will also be a significant construction workforce, particularly in 1981-1982, residing in Rifle and demanding public services, housing, and so on. Projected fluctuations in the numbers and types of employment indicate the likelihood of similar fluctuations in the numbers and types of housing that will be demanded by the incoming population.

As given in Table 5, an additional 1593 dwelling units will be needed in Rifle by 1985 to accommodate the impact-generated population according to preference. As noted above, this is not to say that exactly 1593 new units will need to be constructed. Because of the need to replace some existing units, the total number of units demanded will probably exceed 1593. In addition to the existing base of 862 units in Rifle, at least 1593 more units will be needed by 1985, making a total housing stock at that time of 2455 minimum.

The proportion of preference for single family units far outstrips preference for any other type of housing unit by about 35 percent. The greatest need for single family units is expected to originate with the operations workers and their associated populations. By 1981-1982, the demand for single family units alone is projected to be as great as Rifle's entire 1977 housing stock.

TABLE 4

CUMULATIVE ADDED EMPLOYMENT BY TYPE UNDER IMPACT CONDITIONS IN THE CITY OF RIFLE 1978-1985

	Employment Type			
Year	Construction	Operations	Service	Total
1978	232	7	195	434
1979	632	169	575	1376
1980	474	277	531	1282
1981	780	493	870	2143
1982	739	553	1021	2313
1983	310	685	600	1595
1984	325	804	637	1766
1985	380	912	676	1968

Source: QDA estimates based on COG's Growth Monitoring Information System.

TABLE 5

ADDED HOUSING NEEDS GENERATED UNDER IMPACT GROWTH CONDITIONS
IN THE CITY OF RIFLE
1978-1985

Housing Type	Year								Employee Population Type
	1978	1979	1980	1981	1982	1983	1984	1985	
SINGLE FAMILY	60	163	122	201	191	80	84	98	
MULTI-FAMILY	19	52	39	64	61	25	27	31	
MOBILE HOME	81	221	165	272	258	108	113	133	Construction
REC. VEHICLE	15	42	31	51	49	20	21	25	
SUB-TOTAL	175	478	357	588	559	233	245	287	
SINGLE FAMILY	4	102	168	299	335	415	487	553	
MULTI-FAMILY	1	20	32	57	64	79	93	106	
MOBILE HOME	2	39	63	112	126	156	183	208	Operation
REC. VEHICLE	0	0	0	0	0	0	0	0	
SUB-TOTAL	7	161	263	468	525	650	763	867	
SINGLE FAMILY	76	224	207	339	398	234	248	264	
MULTI-FAMILY	18	53	49	81	95	56	59	63	
MOBILE HOME	31	91	84	137	161	95	101	107	Service
REC. VEHICLE	2	5	4	7	8	5	5	5	
SUB-TOTAL	127	373	344	564	662	390	413	439	
SINGLE FAMILY	140	489	497	839	924	729	819	915	
MULTI-FAMILY	38	125	120	202	220	160	179	200	
MOBILE HOME	114	351	312	521	545	359	397	448	All Types
REC. VEHICLE	17	47	35	58	57	25	26	30	
TOTAL	309	1012	964	1620	1746	1273	1421	1593	

Source: QDA estimates based on the application of preference coefficients to employment trend data.

The greatest demand for mobile homes and recreational vehicles results from the preferences of the construction workers.

Shown in Table 6 and in Figure 1, projections of the type of workforce and the type of housing demanded move more or less together. These projections indicate that the 1978-1985 forecasting period is actually broken up into two smaller time frames: 1978-1980 and 1981-1985. In the 1978-1980 period, there is a greater percentage of permanent housing than permanent employment, and temporary housing is relatively scarce compared to temporary employment. In order to balance this situation, it means that some temporary workers will settle in permanent dwellings. In contrast, from 1981 to 1985, the percentage of permanent housing is deficient with respect to the percentage of permanent workforce, while there are proportionately more temporary housing units than there are temporary workers. This indicates that some portion of permanent workers will live in temporary quarters.

If Rifle residents agree with the premises underlying these projections, accept the likelihood of projected energy development, pace, and schedules, and accept COG's allocation of settlement, then some important issues are raised by these fluctuations in housing-need. The projections indicate that in 1983 Rifle can expect a sudden 25.6 percent drop in total population (Table 3 Population Section);

TABLE 6

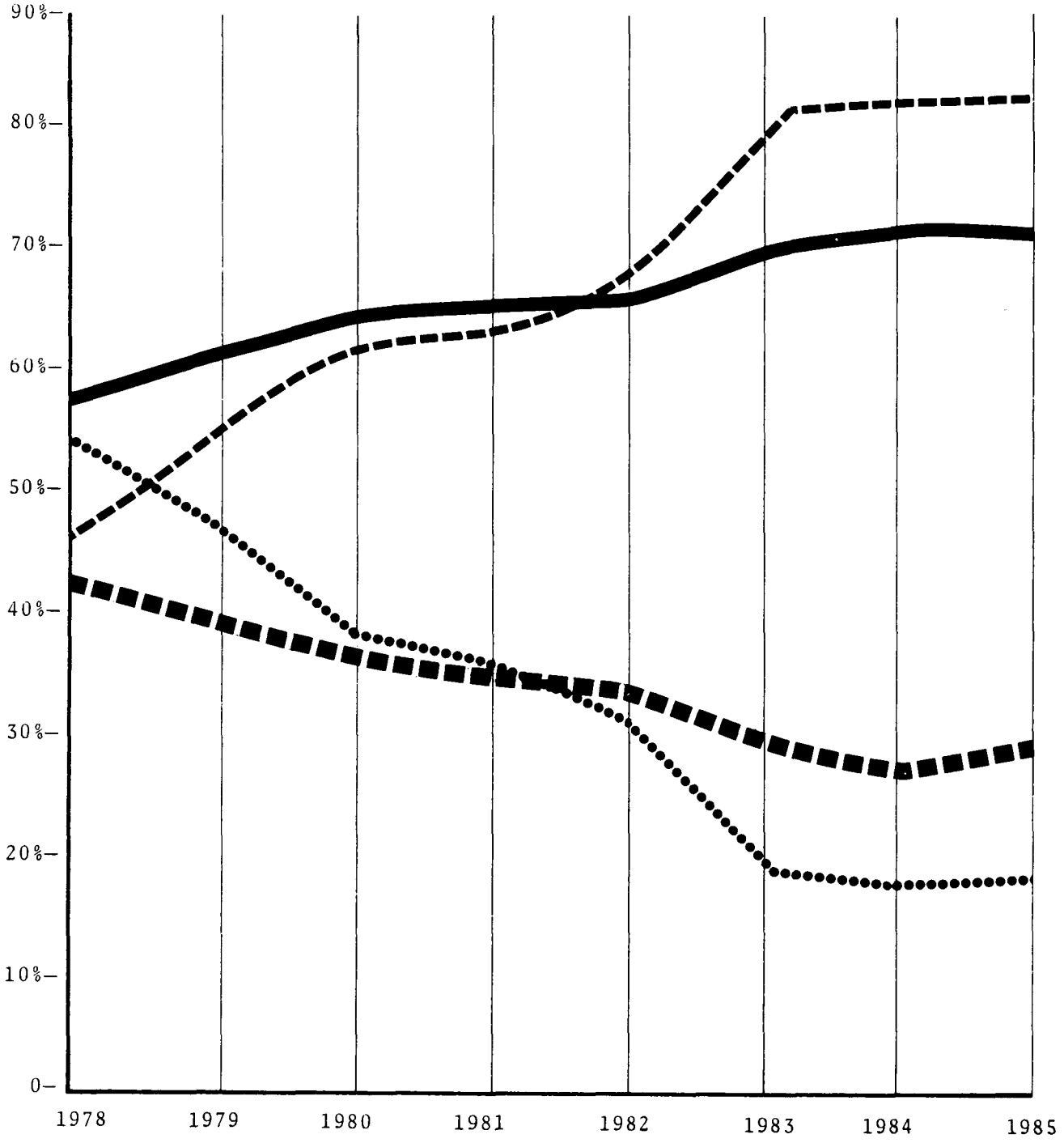
PROJECTED PERCENT DISTRIBUTION OF TEMPORARY AND PERMANENT IMPACT GENERATED WORK FORCE AND HOUSING UNIT PREFERENCES 1978-1985

	1978	1979	1980	1981	1982	1983	1984	1985
WORK FORCE[a]								
Temporary	53.5	45.9	37.0	36.4	31.9	19.4	18.4	19.3
Permanent	46.5	54.1	63.0	63.6	68.1	80.6	81.6	80.7
HOUSING UNIT[b]								
Temporary	42.4	39.3	36.0	35.7	34.5	30.2	29.8	30.0
Permanent	57.6	60.7	64.0	64.3	65.5	69.8	70.2	70.0

[a] Temporary Workers = Construction
Permanent Workers = Operations + Service

[b] Temporary Housing = Mobile Homes + Recreational Vehicles
Permanent Housing = Single Family + Multi-Family

Source: QDA estimates



COMPARISON OF TEMPORARY AND PERMANENT HOUSING NEEDS WITH PROJECTED TEMPORARY AND PERMANENT WORKER POPULATIONS

FIGURE 1

a 31.0 percent drop in added employment (Table 4, this section); a 20.7 percent decline in total employment (Table 10, Population Section); and a 27.1 percent decrease in total housing unit needs (Table 5, this section). In each instance, recovery to 1982 levels is not projected to occur for several years. An important question prompted by these findings, and one which Rifle will have to answer for itself, is to what threshold of housing units Rifle will develop.

VIII EDUCATION

I. INTRODUCTION

Analysis of educational resources and projections of needs are primarily dependent on assessments of past school activity participation, facilities, and programs. Projections of future needs extrapolate upon such trends and add on varying assumptions of population and age changes associated with the expected work force populations. Under both natural and impact conditions, both quantitative and qualitative changes in the educational needs of the population will occur. As an example, QDA has attempted to project additional square footages required to service the educational needs of both a natural and an impact growth population. Obviously, the kinds of classes, such as remedial reading and special education, will also change, but such change is in the level of service rather than in absolute service. In another instance, storage and security facilities may well become necessary because of behavioral differences in the impact population. In this section QDA primarily analyzes the physical and budgetary resources and needs associated with primary and secondary educational systems in Rifle and attention is drawn to qualitative service change needs when such appears to be warranted.

The reader may want to refer to the section on jurisdictions for an outline of the RE-2 School District boundaries (Figure-1) and the districts revenues and levy trends (Table 6). An additional profile matrix

has been prepared and presented in Figure 1, this section, to provide a thumbnail review of primary and secondary school facilities in the District.

II. EXISTING AND PROJECTED SCHOOL AGE POPULATION AND ENROLLMENTS

The best measure of past school participation is an analysis of past enrollment and attendance. As Table 1 indicates, the Fall Membership has risen modestly in all but two of the last eight years with an average increase of 21.3 students per year. The overall student increase from 1970 to 1977 was 12.2% with an average annual increase of 1.5%. The same situation exists with the Closing Day Membership. We find an average annual increase of 30.1 students and an overall increase of 17.5%. By comparing Fall Membership to Closing Day Membership in any given year, we find that student enrollment has consistently decreased by anywhere from 0.9% to 5.4%. The only exception to this occurred during the 1977-78 school year at which time the enrollment increased 3.8%. This seems to indicate that even before the onset of impact growth not everyone in School District RE-2 remained in school throughout the year, nor did the same number of pupils necessarily finish the school year that had started out.

When total fall enrollments are broken out by school type, certain trends become apparent, as can be seen in Table 2. Rifle High School has realized the greatest overall increase in student enrollment over the recent year with Esma Lewis Elementary coming in second.

PROFILE OF RIFLE SCHOOL DISTRICT RE-2 FACILITIES

NAME OF SCHOOL	TYPE	LOCATION	SQUARE FOOTAGE	YEAR OPENED	NUMBER OF TEACHERS	NUMBER OF ADMINISTRATIVE* PERSONNEL	STUDENT CAPACITY
Esma Lewis	Elementary	Rifle	34,595	1959	24	2	422
Silt	Elementary	Silt	15,430	1971	10	2	183
Riverside	Elementary & Junior High	New Castle	34,713	1978	15	2	400
Rifle	Junior High	Rifle	44,690	1977	13	2	300
Rifle	Senior High	Rifle	46,116	1948	33	4	443

* Including secretarial

SOURCE: Superintendent's office - Garfield School District RE-2

Figure 1

TABLE 1

PUPIL MEMBERSHIP TRENDS FOR GARFIELD

SCHOOL DISTRICT RE-2

1970-71 TO 1977-78

SCHOOL YEAR	FALL MEMBERSHIP	CLOSING DAY MEMBERSHIP	PERCENT CHANGE	AVERAGE DAILY MEMBERSHIP
1970-71	1393	1381	-0.9	1387.9
1971-72	1429	1383	-3.2	1396.1
1972-73	1385	1310	-5.4	1328.8
1973-74	1421	1385	-2.5	1397.5
1974-75	1513	1483	-2.0	1484.5
1975-76	1583	1555	-1.8	1549.5
1976-77	1605	1545	-3.7	1526.8
1977-78	1563	1622	+3.8	*

* This figure is no longer reported by the state education department.

SOURCE: Colorado Department of Education

TABLE 2

PAST ENROLLMENT BY SCHOOL TYPE
FOR GARFIELD SCHOOL DISTRICT RE-2
1973-74 TO 1977-78*

SCHOOL YEAR	ELEMENTARY ESMA LEWIS	ELEMENTARY NEW CASTLE	ELEMENTARY SILT	JUNIOR HIGH RIVER-SIDE	JUNIOR HIGH RIFLE	HIGH RIFLE	RE-2 TOTALS
1973-74	397	174	188	70	200	356	1385
PERCENT	28.7	12.6	13.6	5.1	14.4	25.7	100
1974-75	435	214	184	68	200	403	1504
PERCENT	28.9	14.2	12.2	4.5	13.3	26.8	100
1975-76	454	203	189	69	203	454	1572
PERCENT	28.9	12.9	12.0	4.4	12.9	28.9	100
1976-77	435	209	181	73	213	474	1585
PERCENT	27.4	13.2	11.4	4.6	13.4	29.9	100
1977-78	500	197	190	62	196	477	1622
PERCENT	30.8	12.2	11.7	3.8	12.1	19.4	100
% CHANGE	+25.9	+13.2	+1.1	(11.4)	(2.0)	+34.0	+17.1

* All enrollment figures are tabulated from Closing Day Membership counts.

SOURCE: Superintendent's office, Garfield School District RE-2

The total enrollment increase for all three elementary schools combined amounts to 16.9% over the last five year period. Junior High School enrollment, however, has decreased over the same time at both of the schools. From 1973 to 1977 the total junior high school membership dropped 4.4%. Rifle Senior High School has shown 34.0 percent growth in enrollment during this period.

It should be noted, however, that the general decrease in Junior High School enrollment is due largely to the immediate drop in the 1977-78 school year enrollment. If the previous year only had been used to calculate the percentage change over time, the enrollments would have shown an increase of 5.9%.

Three towns, Rifle, Silt, and New Castle, plus other unincorporated areas in Garfield County, constitute School District RE-2. To determine future school enrollments under natural and impact conditions, QDA has estimated (based on COG projections) the number of school age children within the three incorporated towns and Garfield County and then extrapolated the likely enrollment within the District itself.

As indicated by Table 3, under natural growth conditions, Garfield County's school age population is expected to increase by 33.0% while the school district's population will increase by only 17.6%. However, under impact conditions, Garfield County's school age population is predicted to grow by more than 48.2% as soon as 1982; drop by 2.8% in 1983, and then rise again to 54.7% of the original size in 1985. In School

TABLE 3

SCHOOL AGE POPULATION PROJECTIONS FOR
GARFIELD COUNTY AND GARFIELD SCHOOL DISTRICT RE-2
UNDER NATURAL GROWTH AND IMPACT CONDITIONS
1978-1985

	GARFIELD COUNTY		SCHOOL DISTRICT RE-2	
YEAR	NATURAL GROWTH	IMPACT GROWTH	NATURAL GROWTH	IMPACT GROWTH
1978	4944	5397	1777	2094
1979	5184	6609	1824	3004
1980	5415	6761	1871	2965
1981	5647	7729	1911	3753
1982	5880	7996	1903	3890
1983	6112	7776	1996	3345
1984	6343	8032	2043	3482
1985	6576	8347	2090	3652
% INCREASE OVER 1978	33.0	54.7	17.6	74.4

SOURCE: QDA estimates based on COG's Growth Monitoring Information System

District RE-2 impact growth is projected to create a 85.8% increase in the school age population by 1982; drop by 14.8% in 1983; and then rise to 74.4% of the original size by 1985.

In projecting the likely enrollment changes for School District RE-2, QDA has noted that because the unincorporated areas of the district currently contribute more than 3000 people in addition to those residing within the towns, and because the projected impact growth has been allocated by COG's Growth Monitoring Information System to existing towns rather than to rural areas elsewhere in the county, total population within the RE-2 District derived from COG forecasts will probably run higher than COG's projection of incorporated areas' total population by some constant number. QDA has chosen to use the figure of 3200 as the constant contribution to the District's total population from the unincorporated areas. After calculating the total population within the District, the school age population was then determined using ratios extracted from COG's Growth Monitoring Information System.

Under both natural and impact growth conditions, the District's school age populations are further observed to maintain a ratio of school level distribution as follows:

	Natural	Impact
Elementary	52.0	52.5
Junior High	15.7	15.8
Senior High	32.3	31.7

TABLE 4

PROJECTED ENROLLMENT BY SCHOOL TYPE FOR GARFIELD SCHOOL DISTRICT RE-2

1978-1985

YEAR	ELEMENTARY		JUNIOR HIGH		SENIOR HIGH		TOTALS	
	Natural Growth	Impact Growth	Natural Growth	Impact Growth	Natural Growth	Impact Growth	Natural Growth	Impact Growth
1978	924	1099	279	331	574	664	1777	2094
1979	949	1577	286	475	589	952	1824	3004
1980	973	155	294	468	604	940	1871	2965
1981	994	1970	300	593	617	1190	1911	3753
1982	990	2042	298	615	615	1233	1903	3890
1983	1038	1756	313	529	645	1060	1996	3345
1984	1062	1828	321	550	660	1104	2043	3482
1985	1087	1917	328	577	675	1158	2090	3652

SOURCE: QDA estimates based on COG's Growth Monitoring Information System and previously cited ratios.

These ratios are also based on COG data and are derived from population projections for Garfield County. Table 4 presents the projected enrollments by school type for both natural and impact growth conditions under these various assumptions.

Under natural growth conditions small incremental increases are anticipated amounting to less than 18% over 1978 by 1985 for all school types. Under impact growth conditions enrollment in all school types is expected to increase in 1979; lag slightly in 1980; and reach peak membership by 1982. In 1983 the enrollment drops by 14% of the previous year's figure in all school types and does not reach the 1982 peak membership by the year 1985. But in 1985 the enrollment in all school types is expected to reach a 74% increase over 1975.

III. PUPIL/TEACHING STAFF RATIOS

Consistently, over the last eight years, the Garfield School District RE-2 has enjoyed a lower pupil/teaching staff ratio than the State of Colorado as a whole. As Table 5 indicates, the local district ratio has fluctuated little over the years and has remained consistently below State averages. A state ratio is generally higher than a rural district's primarily because State figures include ratios derived from urbanized areas such as Denver and Colorado Springs, which usually have much higher ratios than less populated areas. In terms of ratio adequacy, there is no absolute measure or ideal pupil/teaching staff ratio. However, the National Teacher's Association and the Colorado

TABLE 5

PUPIL/TEACHING STAFF RATIOS* FOR GARFIELD SCHOOL DISTRICT RE-2 AND THE STATE OF COLORADO**

1970-71 TO 1977-78

YEAR	GARFIELD SCHOOL DISTRICT RE-2	STATE OF COLORADO
1970-71	19.0	23.0
1971-72	19.8	23.6
1972-73	19.3	23.1
1973-74	20.6	22.3
1974-75	19.9	21.3
1975-76	18.4	20.2
1976-77	18.5	19.6
1977-78	18.6	19.6

* Ratio includes librarians, special education teachers, counselors, and special therapists.

** Counts were done at the beginning of the school year.

SOURCE: Colorado Department of Education

Department of Education cite the ratio of anything over 25.0 pupils per staff member as detrimentally influencing educational effectiveness. Neither the local average ratio nor the State average ratio seem to come close to that level.

How many teaching staff members will be needed under future growth conditions is difficult to predict primarily because special teaching needs of the incoming population are unknown. However, using the previous enrollment projections as a guide, and assuming that the local district will not want to exceed a comfortable ratio of 20.0, gross estimates of the number of staff needed can be made. Table 6 presents such estimates.

Presently there are approximately 95 teachers and teaching staff within the RE-2 school district system. Under natural growth conditions the current number of teachers and staff will suffice through 1982 and only an estimated ten additional classroom staff members will be needed by 1985. However, under impact growth conditions the size of the teaching staff needed by 1985 is expected to increase. Taking natural growth requirements into account, the energy development impact itself is estimated to necessitate 100 additional teachers and staff by 1982 (in addition to the 95 teachers needed for natural growth enrollment). This is the maximum number of teaching staff expected to be needed through 1985. The following year the impact generated staff needs drops to 67 and rises again to 78 by 1985. These estimates do not take into account at which schools these teachers will be needed or what fields

TABLE 6

TOTAL TEACHING STAFF NEEDED UNDER VARYING GROWTH CONDITIONS

IN GARFIELD SCHOOL DISTRICT RE-2

1978-1985

YEAR	NATURAL GROWTH	IMPACT GROWTH
1978	89	105
1979	91	150
1980	94	148
1981	96	188
1982	95	195
1983	100	167
1984	102	174
1985	105	183

SOURCE: QDA estimates based on enrollment projections and information from the Colorado Department of Education.

the teachers should represent. Additionally, they assume a rather idealistic ratio throughout the impact period, when obviously, such fast growth conditions will make it difficult to maintain ideal standards. In the event that the ideal ratio is substantially increased by rapid population growth, learning conditions for RE-2 school children may be expected to decline to a less-than-desirable level.

If the ratio of 25 pupils per teaching staff member is used under impact growth conditions, especially for the peak impact years, then a total of 156 teachers and staff will be needed by 1982, 80 of which would be necessitated solely by the projected energy development impacts.

IV. FACILITY AND SPACE NEEDS

As originally seen in Figure 1, the High School is the largest single education facility in the RE-2 district, with a 46,116 sq. ft. floor space and a student capacity potential of 443. Since we are evaluating needs by school type it will be necessary to combine the square footage and student capacity figures of the three elementary schools and the figures of the two junior high schools. As Riverside Junior High and New Castle Elementary are housed in the same building, it is necessary to determine what percentage of floor space each of these use. With the aid of past enrollment figures and general standards of total square footage needed per pupil it was determined that the junior high students make up about 25% of the student body at the school but use approximately 30% of the floor space. The reason for this is the standard for

elementary school students is 120 sq. ft. per pupil, while for junior high students it is 135 sq. ft. per pupil. Hence the junior high students use approximately 10,000 sq. ft. and the elementary students 24,713 sq. ft. These figures will be used in determining future space needs by school type. The standard space requirements for senior high school planning used here is 150 sq. ft. per pupil.

As can readily be seen by a comparison of the student capacity figures for the individual schools (Figure 1) and past enrollment figures (Table 2) there are schools in RE-2 which have been operating at over-capacity for some time. These include Esma Lewis Elementary and Rifle High School. Silt Elementary is currently operating at full capacity. It is obvious that both natural and impact growth conditions would only aggravate the situation. On the other hand, the junior high schools are presently operating at under-capacity.

In an attempt to pinpoint specific space requirements through 1985, QDA has prepared Table 7 which presents the estimated number of students over capacity and the associated space needed under both natural and impact growth conditions.

As can be seen by referring to Table 7, the elementary schools will be operating at over capacity both under natural and impact growth conditions. The junior high schools, in contrast, are not projected to even reach their capacity by 1985 under natural growth conditions; with impact growth, RE-2 junior high schools are forecast to exceed capacity by

177 pupils. Rifle High School is over-utilized currently, and is projected to remain so with either natural or impact growth. By 1985 under natural growth, the high school is predicted to be over-capacity by 232 students; with impact growth this figure increases to 715.

System-wide by 1985, natural growth conditions will add 342 students in excess of capacity, while impact projections show that more than 1900 pupils will exceed current capacity by 1985. Added square feet of school space required by the growth through 1985 is estimated at 57,000 with natural growth, and 253,000 with impact growth.

According to the supintendent of School District RE-2, no new facilities are in the plannning at this time. The old junior high school, now being used by Colorado Mountain College to house their continuing education program, is one possible alternative for accommodating a relatively small number of the influx of new studetns under natural growth conditions. (Only three rooms have been reserved for possible use by RE-2 under the 30-year leasing agreement between the school district and the Colorado Mountain College). But under impact growth conditions, the increases in enrollment would be so large that other solutions, such as new facilities, will have to be considered.

Standards for school design and site requirements used below are taken from J. DeCheara and L. Koppelman, Urban Planning and Design Criteria.

TABLE 7

NUMBER OF STUDENTS OVER CAPACITY AND ADDITIONAL SQUARE FOOTAGE NEEDED FOR GARFIELD SCHOOL DISTRICT RE-2 1978-1985

YEAR	ELEMENTARY SCHOOLS				JUNIOR HIGH SCHOOLS				HIGH SCHOOL			
	No. of Students Over Capacity*		Additional Sq. Footage Needed**		No. of Students Over (Under) Capacity*		Additional Sq. Footage Needed**		No. of Students Over Capacity*		Additional Sq. Footage Needed*	
	Natural Growth	Impact Growth	Natural Growth	Impact Growth	Natural Growth	Impact Growth	Natural Growth	Impact Growth	Natural Growth	Impact Growth	Natural Growth	Impact Growth
1978	19	194	2,280	23,280	(121)	(69)	-0-	-0-	131	221	19,650	33,150
1979	44	672	5,280	80,640	(114)	75	-0-	10,125	146	509	21,900	76,350
1980	68	652	8,160	78,120	(106)	68	-0-	9,180	161	497	24,150	74,550
1981	89	1,065	10,680	127,800	(100)	193	-0-	26,055	174	747	26,100	112,050
1982	85	1,137	10,200	136,440	(102)	215	-0-	29,025	172	790	25,800	118,500
1983	133	851	15,960	102,120	(87)	129	-0-	17,415	202	617	30,300	92,550
1984	157	923	18,840	110,760	(79)	150	-0-	20,250	217	661	32,550	99,150
1985	182	1,012	21,840	121,440	(72)	177	-0-	23,895	232	715	34,800	107,250

*Current Student Capacity	
Elementary	905
Junior High	400
Senior High	443

**Square Footage Needed Per Pupil
120
135
150

SOURCE: QDA estimates based on information from School District RE-2 Supintendent's Office and Real Estate Research Corporation, 1974, Cost of Sprawl, pp 36-146.

Projections of elementary school enrollment in RE-2 indicate that perhaps no new elementary school is required under natural growth conditions by 1985, and as many as three new schools could be in demand under impact growth by that time. Using the planning guideline of 4 to 6 acres elementary school site requirement plus one acre per hundred pupils, with a school size of 450 pupils, impact growth conditions through 1985 could call for 26 to 32 acres for new elementary school facilities.

No new junior high school would be needed under natural growth conditions, but should impact growth materialize to the extent projected, only one additional junior high at most would be required by 1985. Using the guideline of 10 to 16 acres plus one acre per hundred pupils with school capacity at 350 students, roughly 13 to 20 acres would be needed by 1985 to accommodate, with some excess capacity, the junior high enrollment projected for school district RE-2.

RE-2 high school enrollment will require perhaps one additional school by 1985 with natural growth, and as many as two new schools with impact growth (with some excess capacity built-in either way). Applying the guideline of 22 to 24 acres plus one acre per hundred pupils for high schools of 450 student capacity, this means that 26 to 28 acres may be needed for high school sites by 1985 with natural growth, and that 53 to 57 acres could be required under impact growth by 1985.

A useful range, then, for predicting new site requirements by 1985 for School District RE-2 would be roughly 30 acres under natural growth, to around 100 acres under impact growth.

V. DISTRICT EXPENSES AND PER STUDENT EXPENDITURES

Total expenses for the school district have increased almost 63% between 1970 and 1975. As Table 8 indicates, of those total expenses, instructional costs (mostly salaries) have consistently comprised over 60% of total expenses. On a line item increase basis, administrative costs within the district have gone up the most, showing an increase of 161% in 1975 over 1970.

Salaries have risen the least, representing only a 25.7% increase in 1975 over 1970.

Table 9 gives the per student expenditures over time for Garfield School District RE-2 and for the State of Colorado. In both instances the per student expenditures have gone up substantially over the years while the Average Daily Attendance Entitlement has grown modestly. Garfield School District RE-2 total expenses have increased almost 82% from 1970 to 1976, which is on par with the total expense increase for the state as a whole. The Average Daily Attendance Entitlement in RE-2 has increased by only half as much as the state, which is common for smaller communities.

TABLE 8

GARFIELD SCHOOL DISTRICT RE-2 EXPENSES BY LINE ITEM
1970-71 TO 1975-76

YEAR	SALARIES	TOTAL INSTRUCTIONAL	PLANT/EQUIPMENT OPERATIONS/MAIN.	ADMINISTRATION	PUPIL TRANSPORTATION	FIXED CHARGES	OTHER	TOTAL CURRENT EXPENSES (CE)
1970-71	813,295	848,683	98,671	41,937	64,506	99,379	15,334	1,168,510
% of CE	69.6	72.6	8.4	3.6	5.5	8.5	1.3	100
1971-72	843,727	886,263	108,376	45,435	64,284	104,723	6,124	1,215,204
% of CE	69.4	72.9	8.4	3.7	5.3	8.6	1.3	100
1972-73	703,104	928,632	112,848	53,992	51,691	116,952	13,523	1,277,568
% of CE	55.0	72.7	8.8	4.2	4.0	9.2	1.0	100
1973-74	720,603	1,003,440	132,495	66,090	91,137	130,289	19,971	1,443,422
% of CE	49.9	69.5	9.2	4.6	6.3	9.0	1.4	100
1974-75	873,125	1,232,572	159,271	84,500	105,113	157,161	15,992	1,764,609
% of CE	49.5	69.8	9.0	4.8	6.0	9.5	0.9	100
1975-76	1,022,491	1,212,287	179,939	109,464	102,852	N.A.	20,356	1,894,715
% of CE	53.9	63.9	9.4	5.7	5.4		1.0	100
% of INCREASE Over 70-71	25.7	42.8	82.4	161.0	59.5	68.1	32.8	62.2

1. Salaries are included in total instructional figures, and by themselves represent only teachers and teaching staff salaries.
2. Fixed charges include teachers retirement and insurance
3. Administration expenditures include salaries for administration, secretarial, and central office personnel.

SOURCE: Colorado Department of Education

TABLE 9

COMPARITIVE STUDENT EXPENDITURES FOR GARFIELD SCHOOL DISTRICT RE-2

AND THE STATE OF COLORADO 1970-71 TO 1976-77

SCHOOL YEAR	TOTAL EXPENDITURES DISTRICT RE-2	TOTAL EXPENDITURES COLORADO	ADAE* DISTRICT RE-2	ADAE* COLORADO	PER STUDENT EXPENDITURE DISTRICT RE-2	PER STUDENT EXPENDITURE COLORADO
1970-71	$1,273,108	$523,830,008	1,292.1	513,310.6**	$ 985.3	$1,020.5
1971-72	1,551,270	532,552,990	1,312,3	526,221.3	1,182.1	1,012.0
1972-73	1,482,365	590,538,190	1,268.4	533,899.1	1,168.7	1,106.1
1973-74	1,550,770	660,377,479	1,313.0	532,248.3	1,181.1	1,240.7
1974-75	1,857,908	770,453,582	1,398.7	529,539.6	1,328.3	1,455.0
1975-76	1,948,829	914,371,948	1,488.1	527,434.2	2,309.6	1,733.6
1976-77	2,314,643	939,462,094	1,466.5	526,904.6	1,578.4	1,783.0
% OF INCREASE OVER 1970-71	81.8	79.4	13.5	26.5	60.2	74.7

*ADAE- Average Daily Attendance Entitlement - is defined as the sum of the daily attendance for a period of time divided by the actual number of days of school taught during that period of time, or ninety-six percent (96%) of the average daily membership during a four-week period ending with the fourth Friday in October.

** Gilpin County not included.

SOURCE: Colorado Department of Education

VI. VOCATIONAL TECHNICAL PROGRAMS

Garfield School District RE-2 offers a variety of vocational courses, mainly at the high school level, which may be taken for credit during the regular school day. These courses are partially funded by the Colorado State Board for Community Colleges and Occupational Education.

Specific courses offered include instruction in business and office occupations, vocational agriculture, distributive education, auto mechanics, construction trades, and welding. Table 10 shows the number of students enrolled in particular vocational classes during the 1977-78 school year. The business and office education classes have by far the largest enrollment. About half as many students are enrolled in the vocational agriculture class.

VII. SPECIAL EDUCATION

Garfield School District RE-2 also provides a special education program for the educationally and mentally handicapped. There are seven teachers, working full and part-time, within the district in this capacity. There are approximately 88 school children participating in this program. There is also one speech therapist assigned to the district.

TABLE 10

VOCATIONAL EDUCATION PROGRAM ENROLLMENT

FOR GARFIELD SCHOOL DISTRICT RE-2

1977-78

	STUDENT ENROLLMENT
Business & Office Education	116
Vocational Agriculture	51
Distributive Education	32
Auto Mechanics	28
Construction Trades	17
Welding	10
TOTAL:	254

SOURCE: Garfield School District Re-2 Superintendent's Office

IX HEALTH

I. INTRODUCTION

Analysis of health care services and needs are primarily dependent upon past health care resources, facilities, and guidelines adopted by governmental entities to ensure adequate health care. Projections of future health care needs extrapolate upon such trends and add on varying assumptions of population and medical care changes associated with the expected work force population.

In this section existing medical services and future medical service needs will be discussed, but the direction medical services actually take must be determined by the people of the area themselves.

Data presented in this section takes into account expected changes under both natural and impact growth conditions. The health service area boundaries encompass roughly two-thirds of Garfield County, including the incorporated areas of Grand Valley, Rifle and Silt. This health service area is known as the Grand River Hospital District. The reader may want to refer to the section on Taxing and Planning (Figure 1) for exact boundary locations.

Rifle's health related needs are presently served primarily by Clagett Memorial Hospital, the only licensed hospital facility in the District; E. Dene Moore Memorial

Home; three physicians; three dentists; two optometrists; three pharmacists; a county health nurse; and several support personnel. Clagett Memorial Hospital is currently licensed as a thirty-two bed hospital, while the nursing home has a capacity of fifty-six.

II. EXISTING AND PROJECTED POPULATION WITHIN THE HEALTH SERVICE AREA

In order to determine the extent of need likely to be experienced in the future in terms of hospital space, manpower requirements, and auxiliary health care services, QDA has estimated the population growth within the health service area under both natural and impact growth conditions.

To determine the total population growth within the health service area QDA has had to determine the population growth of that portion of the health service area which is outside the incorporated areas (for which no COG projections are available) and then add it into the COG projections of incorporated growth.

It was determined that growth in the unincorporated areas of Grand River Hospital District would be comparable to growth in unincorporated areas throughout Garfield County. Henceforth the same ratios were used to determine unincorporated growth within the hospital district, as were projected by COG's Growth Monitoring System for the county as a whole. Additionally, QDA assumed that no major settlements would

occur outside the incorporated areas which would outstrip the growth occurring within these areas. The consequent projections of population growth within the Health Service Area are presented in Table 1.

As Table 1 indicates, while the population within the Health Service Area is greater than the total population of Rifle, Silt, and Grand Valley combined, because of constant growth assumptions, the unincorporated areas are expected to grow at a somewhat lesser rate than the incorporated areas. Under natural growth conditions the unincorporated areas make up about 48 percent of the Health Service Area while under impact growth conditions, these areas make up an average of only 40 percent of the District.

Under natural growth conditions the Health Service Area population is expected to increase less than 35 percent between 1978 and 1985, while under impact conditions this population will increase by 114 percent over the same time period.

The population projections presented here form the basis on which existing health resources are evaluated, and future health needs are projected.

III. HOSPITAL FACILITIES

In attempting to generate a more precise overview of what kinds of changes, relative to hospital needs, occur in a boom

TABLE 1

PROJECTED POPULATION WITHIN GRAND RIVER HOSPITAL DISTRICT 1978-1985

Year	Garfield County		Grand River Hospital District		Rifle	
	Natural	Impact	Natural	Impact	Natural	Impact
1978	19,278	22,486	6,873	9,608	2,294	3,821
1979	20,226	28,548	7,210	15,469	2,407	7,563
1980	21,174	28,800	7,548	15,745	2,520	7,178
1981	22,122	33,834	7,848	20,870	2,633	10,546
1982	23,678	35,428	8,440	21,985	2,745	11,163
1983	24,018	32,619	8,561	18,072	2,858	8,302
1984	24,965	34,220	8,898	19,224	2,971	8,930
1985	25,914	36,004	9,238	20,591	3,084	9,702
% Increase over 1978	34.4	60.1	34.4	114.3	34.4	153.9

Source: QDA estimates based on COG's Growth Monitoring Information System

town, QDA conducted an informal mini-survey of impacted communities. Two cities in particular were selected: Craig, Colorado, because of its proximity to Rifle and because it represents a newly-booming community; and Rock Springs, Wyoming, because it represents a boom town situation of considerable variety and duration. In some ways, information generated by these interviews challenges a commonly-held notion that hospital facility needs increase during a rapid growth situation. Rather than increase in absolute number of beds and personnel, the changes come by diversifying hospital services and gearing up for quick-response, short-term care.

In both towns, interviews with hospital administrators indicated that actual bed utilization is not increasing dramatically, but rather at a normal rate in comparison to the population growth. The hospital service departments showing the greatest increases are x-ray, laboratory, respiratory, and emergency. Work-related injury treatments and outpatient visits generally are increasing dramatically. Some of this has already been experienced in the Rifle area, where according to employees of Clagett Memorial Hospital, the hospital utilization has remained at a fairly low figure of (thirty-six) 36 percent for the end of 1977, whereas the general emergency room treatments have gone up slightly in the last year.

Interviewed hospital administrators further noted that with rapid population growth in the hospital's service area, the ratio of inpatient days to population may actually decline. For the Grand River Hospital District this annual use rate, as it is called, was calculated at .63 inpatient days per capita for the end of 1977. In attempting to determine anticipated inpatient days per year, average daily patient loads, and bed use rates it is first necessary to determine the anticipated annual use rate. In the Meeker area, for example, the use rate is predicted to drop by almost one-third with the influx of impact population. As this has been the case with most other impact communities, QDA has decided to present two different assumptions. The first (I) goes on the assumption that the annual use rate will remain the same through 1985 while the second (II) assumes a one-third drop in use rate. Using the growth projections shown in Table 1, QDA has made some estimates concerning future hospital usage (Table 2 and 3) through 1985. Assumption I carries a use rate of .63 while assumption II has a rate of .42 inpatient days per capita.

As Tables 2 and 3 indicate, under natural growth conditions (Assumptions I and II), Clagett Memorial Hospital's beds will remain under-utilized through the year 1985. Under Assumption I less than 50 percent of the beds will be utilized by 1985, while under Assumption II only 33 percent will be in use by 1985.

TABLE 2

USE PROJECTIONS FOR CLAGETT MEMORIAL HOSPITAL
UNDER NATURAL AND IMPACT GROWTH CONDITIONS
ASSUMPTION I*
1978-1985

Year	In-Patient Days		Average Daily Census		% Bed Use Rate	
	Natural	Impact	Natural	Impact	Natural	Impact
1978	4,330.0	6,053.0	11.9	16.6	37.2	51.9
1979	4,542.3	9,745.5	12.4	26.7	38.8	83.4
1980	4,755.2	9,919.4	13.0	27.2	40.6	85.0
1981	4,944.2	13,148.1	13.6	36.0	42.5	112.5
1982	5,317.2	13,850.6	14.6	37.9	45.6	118.4
1983	5,393.4	11.385.4	14.8	31.2	46.2	97.5
1984	5,605.7	12,111.1	15.4	33.2	48.1	103.8
1985	5,819.9	12,972.3	15.9	35.5	49.7	110.9

* Assumption I: Annual use rate equals .63 inpatient days per capita

Source: QDA estimates based on information from Clagett Memorial Hospital data and the COG Growth Monitoring Information System.

TABLE 3

USE PROJECTIONS FOR CLAGETT MEMORIAL HOSPITAL
UNDER NATURAL AND IMPACT GROWTH CONDITIONS
ASSUMPTION II*
1978-1985

Year	In-Patient Days		Average Daily Census		% Bed Use Rate	
	Natural	Impact	Natural	Impact	Natural	Impact
1978	2,886.7	4,035.4	7.9	11.1	24.7	34.7
1979	3,028.2	6,497.0	8.3	17.8	25.9	55.6
1980	3,170.2	6,612.9	8.7	18.1	27.2	56.6
1981	3,296.2	8,765.4	9.0	24.0	28.1	75.0
1982	3,544.8	9,233.7	9.7	25.3	30.3	79.1
1983	3,595.6	7,590.2	9.9	20.8	30.9	65.0
1984	3,737.2	8,074.1	10.2	22.1	31.9	69.1
1985	3,880.0	8,648.2	10.6	23.7	33.1	74.1

* Assumption II: Annual use rate equals .42 inpatient days per capita

Source: QDA estimates based on information from Clagett Memorial Hospital data and the COG Growth Monitoring Information System.

Optimum hospital bed utilization is set at a rate of 80 percent. The September 23, 1977 Federal Register suggests this capacity rate because in the event of a disaster in the community, emergency treatment could be provided efficiently and adequately. The application of the 80 percent capacity figure to Clagett Memorial Hospital, would leave open approximately 6 to 7 beds.

Under impact conditions, assumption I, optimum bed utilization will be reached by the second year of impact while under assumption II this will not occur until the fifth year of impact. Such projections can be used as one indication of when it would be necessary to add more hospital beds or expand hospital facilities.

It is very difficult to determine how much Clagett Memorial Hospital will need to expand in the event of rapid growth. The current situation seems to indicate that changes in the type of service will be necessary. The State of Colorado utilizes a set formula in order to determine bed needs for the Grand River Hospital District. Here the projected average daily census was divided by an occupancy factor of 85 percent. An additional 10 beds was then added to this figure to give the total number of beds required in any given year. Table 4 indicates bed requirements, as presently determined by the state, through 1985.

Under natural growth conditions, assumptions I and II,

TABLE 4

PROJECTED HOSPITAL BED NEEDS FOR CLAGETT MEMORIAL HOSPITAL UNDER NATURAL AND IMPACT GROWTH CONDITIONS*: 1978-1985

Year	Assumption I**		Assumption II**	
	Natural	Impact	Natural	Impact
1978	24.0	29.5	19.3	23.1
1979	24.6	41.4	19.8	30.9
1980	25.3	42.0	20.2	31.3
1981	26.0	52.4	20.6	38.2
1982	27.2	54.6	21.4	39.8
1983	27.4	46.7	21.7	34.5
1984	28.1	49.1	22.0	36.0
1985	28.7	51.8	22.5	37.9

* Current Hospital Capacity equals 32 beds

** Assumption I: Annual use rate equals .63 inpatient days per capita

Assumption II: Annual use rate equals .42 inpatient days per capita

Source: QDA estimates based on determination of bed requirements calculated by the State using the U.S. Public Health Service Formula.

it would appear that the existing bed capacity will be adequate through 1985. However, under impact growth conditions, assumption I, nine additional beds will be required by the second year of impact. Under this assumption 23 additional beds will be required in the peak year, 1982, but will drop down to 20 beds by 1985. Under impact conditions, assumption II, no additional beds will be required until 1981, at which time six beds will be needed. The following peak year 2 more additional beds will be required, but this will drop down to six again by 1985. If these projections are related to the Government's suggestion of limiting bed capacity at 80 percent and with previous utilization rate projections (Tables 2 and 3), then it becomes clear that some caution should be exercized in directly projecting Clagett Memorial Hospital needs. Growth communities may well present some special needs not reflected in these standards. The Western Colorado Health Systems Agency, Inc. has reportedly developed a revised formula for bed ratios specifically for Western Slope towns, which is not yet available, but will address these problems.

The E. Dene Moore Memorial Home, is a fifty-six bed extended care facility, primarily for the elderly, which is usually included with Clagett Memorial Hospital in discussions of local medical care needs. Reportedly, the facility is presently at full occupancy. There are no recognized standards presently available that would indicate the present

adequacy or future needs for nursing home beds. The State of Colorado Health Department, Division of Regulations is in the process of developing a new formula to determine optimum bed numbers for nursing homes in diverse geographic locations. The new formula, while not yet available, will reportedly consider criteria such as location accessability, population age, and rural as opposed to urban environments.

The predominant school of thought among those who deal with elderly persons is that other alternatives for care of the elderly need to be developed. Nursing homes are only appropriate for those who physically cannot care for themselves. Emphasis is being placed by recent state and federal programs on the development of minimal care facilities, elderly housing developments and social programs to help the elderly remain active community members. It is attitudinal changes like this, changes in the patterns of physician recommendations, and the fact that the population itself, especially under impact conditions, will not necessarily increase in the proportions of elderly persons in need of care that will affect the future use and need for nursing home facilities.

IV. AMBULANCE SERVICES

The Rifle Ambulance Service is operated in conjunction with the Rifle Fire Department under the Rifle Volunteer Fire Protection District (RVFPD). The District, which is

the principal founder, was formed in 1976 and began operations on January 1, 1977. The RVFP District covers approximately 175 sq. miles. The reader should refer to the section on Taxing and Planning (Figure 1) for exact boundary locations of this District. Before the District was formed, operating funds were received from the City of Rifle, Rifle Rural Association and fund drives.

The fire station is located on the first floor of the Rifle City Hall building and provides storage space for three fire trucks and two ambulances. The ambulance service currently has at its disposal two vehicles; a 1973 Ford modular ambulance and a 1961 Cadillac ambulance.

The quality of the ambulance service is reported to be good considering the equipment available and the present population. Because of limited funds in the past, capital improvements and equipment upgrading has been kept to a minimum. A transfer ambulance is required to bring the service up to the necessary strength for immediate standards. In turn the purchase of more vehicles will require additional garage space.

The same personnel operate the Fire Department as well as the Ambulance Service. There are currently 27 members in the Volunteer Fire Department with 2 additional members solely involved with the Ambulance service. A total of 30 volunteers are anticipated for 1978 with the addition of

another five the following year. The Department is anticipated to remain volunteer through 1979. The increase for ambulance service should be greater the first two years of impact than for the fire department. Silt and Grand Valley Ambulance services are operated in the same manner. Silt has one ambulance and Grand Valley has two.

Two industrial variables may diminish or add to the demand for ambulance capability in the Clagett Memorial Hospital service area for the next five to eight years. The first depends on industry's plans for shuttling the work force from the towns to the job sites. If mass transportation is used for this purpose, the traffic situation on State Highway 13 and County Road 5 (Piceance Creek Road) will be much improved over the alternative, which would be the congestion of these highways with hundreds of private vehicles. As a consequence, the frequency of traffic accidents and the need for a greater ambulance fleet hinges on industry policies concerning the transportation of their work forces. A second item affecting the area's future ambulance capability is to what extent industry plans to maintain their own ambulance fleet and paramedical staffs to meet their own particular requirements. The C-b Oil Shale Venture is planning to provide full medical coverage in its project tract -- including a fully-equipped ambulance and necessary paramedical staff.

Current indications regarding both these issues are favorable; industry is reported to be planning both mass

transportation of the work force and private ambulance capability for their own needs. If this turns out to be the case, the minimal expansion of Grand River Hospital District's ambulance service will prove more than adequate to meet projected needs through 1985.

V. ESTIMATED MEDICAL MANPOWER REQUIREMENTS

Using the projected population figures within the Health Service Area, the number of doctors and medical support personnel needed to provide good medical care are estimated as shown in Tables 5 and 6. It should be noted that certain population sizes are necessary to support individual doctors. The American Medical Association and the Colorado State Department of Health have developed the following guideline doctor/population ratios:

General Practitioner	1:2,000
Internist	1:5,000
Pediatrician	1:10,000
Ob & Gyn	1:11,000
General Surgeon	1:10,000
Opthalmologist	1:20,000
Radiologist	1:15,000
Dentist	1:1,800

Rifle presently has three physicians; a general practitioner, a surgeon (who is also involved in family practice), and an internist. As can be seen in Table 5, under natural growth

TABLE 5

PROJECTED PROFESSIONAL NEEDS UNDER NATURAL AND IMPACT GROWTH CONDITIONS FOR GRAND RIVER HOSPITAL DISTRICT 1978-1985

Occupation	Year* 1978 N	1978 I	1979 N	1979 I	1980 N	1980 I	1981 N	1981 I	1982 N	1982 I	1983 N	1983 I	1984 N	1984 I	1985 N	1985 I
General Practitioner	3	5	3	7	4	8	4	10	4	11	4	9	4	10	4	10
Internist	1	2	1	3	1	3	1	4	2	4	2	4	2	4	2	4
Pediatrician	0	1	0	1	1	1	1	2	1	2	1	2	1	2	1	2
Ob & Gyn	0	1	0	1	0	1	0	2	1	2	1	2	1	2	1	2
General Surgeon	0	1	0	1	1	1	1	2	1	2	1	2	1	2	1	2
Opthalmologist	0	0	0	1	0	1	0	1	0	1	0	1	0	1	0	1
Radiologist	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
Dentist	4	5	4	8	4	9	4	11	4	12	5	10	5	10	5	11

* N = Natural Growth; I = Impact Growth

Source: QDA estimates based on previously cited ratios and projected population within the Health Service Area

conditions another general practitioner (GP) could be used immediately. The addition of another two GP's would take care of the District's needs through 1985. One internist will be adequate to serve the district through 1981 under natural growth conditions. The addition of another internist the following year will be sufficient to serve the needs of the people of the area through 1985. In 1980, under natural growth conditions, the service area will require a pediatrician and a general surgeon. In 1982 the addition of an Ob and Gyn doctor will be necessary. Under natural growth conditions only one physician in each of these three fields of medicine will be required to serve the area through 1985. The addition of a dentist in 1978 and again in 1983 will take care of the areas dentistry needs under natural growth conditions through 1985.

Under impact growth conditions the requirements for physicians are much greater. Five general practitioners would be required immediately; two more in 1979; one more in 1980; and two additional GP's the following year. This would make a total of 10 GP's by 1981. The peak impact year, 1982, would require the addition of one more GP but the requirement would drop back to a total of ten GP's by 1985. Under impact conditions two internists are needed in 1978; one more the following year; and another by 1981. This would make a total of four internists, which would adequately serve the area through 1985.

In 1981, under impact conditions, other types of specialists would be required. These include a pediatrician, an ob and gyn physician, a general surgeon, and a radiologist. An additional pediatrician, ob and gyn physician, and general surgeon would be required by 1981. Two physicians in each of these fields would be adequate to serve the area through 1985. In 1979 the service area would need an opthalmologist, which along with one radiologist would meet the health service areas requirements through 1985. Under impact conditions the addition of two dentists in 1978 would bring the total number to the five dentists required to meet area needs. Three more dentists would be required the following year; one more in 1980; and two more in 1981. A total of twelve dentists are necessary to meet impact health demands in 1982 but this requirement would drop to eleven by 1985. Under impact conditions the addition of three general practitioners and two dentists will fill the most immediate needs of the Grand River Hospital District.

Table 6 presents projected needs in medical support personnel primarily involved in hospital or clinic practices. In terms of absolute need, under natural growth conditions, approximately 14 support personnel are needed in 1978 and 1979. In 1980 ten to eleven additional workers will be required. By 1982 a total of 32 support personnel will be needed, which will adequately serve the population of the health service area through 1985.

TABLE 6

PROJECTED HOSPITAL AND MEDICAL SUPPORT PERSONNEL NEEDS UNDER NATURAL AND IMPACT GROWTH CONDITIONS
1978-1985

Year	MO Aides RN, LPN		Ancillary Personnel		Medical Records		Housekeeping Maintenance		Administrative Personnel		Other		Totals*	
	Natural	Impact	Natural	Impact	Natural	Impact	Natural	Impact	Natural	Impact	Natural	Impact	Natural	Impact
1978	5.3	14.6	2	5.5	1.9	5.2	0.4	1.1	4.4	12.1	0.2	0.7	14.2	39.2
1979	5.3	20.0	2	7.5	1.9	7.1	0.4	1.5	4.4	16.5	0.2	0.9	14.2	53.5
1980	9.3	21.3	3.5	8.0	3.3	7.5	0.7	1.6	7.7	17.6	0.4	1.0	24.9	57.0
1981	9.3	29.3	3.5	11.0	3.3	10.3	0.7	2.2	7.7	24.2	0.4	1.3	24.9	78.3
1982	12.0	30.6	4.5	11.5	4.2	10.8	0.9	2.3	9.9	25.3	0.5	1.4	32.0	81.9
1983	12.0	27.9	4.5	10.5	4.2	9.9	0.9	2.1	9.9	23.1	0.5	1.3	32.0	74.8
1984	12.0	29.3	4.5	11.0	4.2	10.3	0.9	2.2	9.9	24.2	0.5	1.3	32.0	78.3
1985	12.0	29.3	4.5	11.0	4.2	10.3	0.9	2.2	9.9	24.2	0.5	1.3	32.0	78.3

* Support personnel for Dentists are not included

Source: QDA estimates based on standards from the management Group Medical Association and the projected population within the Health Service Area

Under impact conditions 40 medical support personnel will be needed immediately. By 1981 twice that many will be required to sufficiently meet the demands on the medical profession by the health service area population through 1985. Half of the support personnel needed under both natural and impact conditions will be in the areas of administration, maintenance, and record keeping. None of these figures take into account the need for specialized technicians with privately practicing physicians and dentist support personnel.

VI. PUBLIC HEALTH

Public Health in Rifle is represented primarily by the county health nurse. The objectives of the county health nurse position are primarily:

- To provide home health care and conserve health resources, thus expanding the overall capacity of the health care system
- To meet the requests of physicians, to administer medication; and check the general well-being of patients who need frequent observation, particularly those who have just been released from the hospital, with respiratory and coronary problems, on certain medications, and with other serious illnesses
- To help and educate people on how to care for themselves more adequately
- To help identify when patients and others need different or more complete care and to communicate this need to the families involved and other professionals
- To help reduce medical care costs

- To cooperate with the schools, mental health services, Council on Aging, Extension Service, Department of Social Services, churches, local clubs and organizations, hospitals and clinics, and other professional agencies in initiating and coordinating other health-related programs
- To further educational efforts in the area of health and safety
- To make it possible to utilize hospital beds more efficiently as a result of patients being discharged sooner, yet still receiving health care through a county nurse
- To provide some specialized services such as physical and/or occupational therapy when needed
- To assist the County in getting full benefit from State Health Department programs

Presently Garfield County provides for the equivalent services of one county health nurse. As with facilities, programs, and personnel, there are ideal ratios of county health nurses to given population sizes. For a "straight county" nurse -- one who performs only traditional county health activities -- the ideal ratio is one nurse to every 2,500 people. For a "Home Health Agency" nurse -- one who provides Federal medicare-covered services--the ratio is one nurse to every 2,000 people. In the case of Garfield County the "Home Health Agency" nurse ratio will be applied. These ratios include school nurses, one of which is assigned to Garfield School District RE-2.

According to the projected needs in Table 7, even under natural growth conditions, these nurses are currently operating with a larger population than is considered "ideal".

TABLE 7

PROJECTED COUNTY HEALTH NURSE NEEDS
GRAND RIVER HOSPITAL DISTRICT
UNDER NATURAL AND IMPACT GROWTH CONDITIONS
1978-1985

Year	Natural	Impact
1978	3.4	4.8
1979	3.6	7.7
1980	3.8	7.9
1981	3.9	10.4
1982	4.2	11.0
1983	4.3	9.0
1984	4.5	9.6
1985	4.6	10.3

Source: QDA estimates based on information from the State Health Department - Nursing Division.

Using the ratio of one nurse to every 2,000 people, an additional two to three nurses will need to be added to the county health nurse roster during the later part of the 1970's and early 1980's under natural growth conditions. By 1985 a total of 4 to 5 nurses will be needed in the Health Service Area in order to provide for the area's needs.

Under impact growth conditions a total of five nurses would be required immediately. Three more county health nurses would be needed by 1979 and by 1982 a total of 11 nurses would be required to meet the needs of the health service area. This would drop down to 9 nurses the following year and 10 nurses by 1985.

Presently the county health nurse is operating a well-baby clinic testing children for gross and fine motor movement, hearing, and vision. An immunization program is also part of the county health nurse's duties. This program is funded by the State of Colorado. The county health nurse program is centered on the family and includes such varied activities as: home health visits for the elderly as well as a monthly well-oldsters clinic, family health counseling, and aid to new mothers. The county health nurse also visits patients in their homes who have been recently released from the hospital, in addition to providing office visits for able patients. All of these services are offered to area residents at no cost to themselves.

Plans for the future of increased county health care will depend largely on what county citizens want; what resources are available to the county, and; what the feelings of existing medical professionals are toward increased county health responsibilities.

VII. MENTAL HEALTH SERVICES

Rifle's mental health needs are primarily being met on an outpatient basis through a branch Sopris Mental Health Clinic. The Clinic is an affiliate of Colorado West Regional Mental Health Center located in Glenwood Springs. There is currently one psychologist located in Rifle who is available for counseling five days a week from 9:00 am to 5:00 pm. In case of emergencies Sopris Mental Heatlh Clinic in Glenwood Springs can be contacted after office hours. There is also a toll free crisis line out of Grand Junction.

The services offered by the clinic include family and individual counseling, recreational therapy, and counseling to students and teachers. A program was recently offered to junior high school students which focused on the socialization process and communication skills.

The program is partially funded by the county. The cost to the public is based on a sliding scale in order that all residents who are in need of these services will find them accessible.

Perhaps one of the greatest voiced concerns in the arena of mental health is that of alcoholism. In order to see what ramifications rapid growth impact may have on Rifle's problems of alcoholism, QDA conducted interviews with staff at Craig's A.A. center. Within the tradition of "boom town" thought, there have been frequently-expressed concerns that a rapidly growing population, inflated by temporary workers, would show an increased incidence of general anti-social behavior, particularly alcoholism. It has also been felt that loneliness and increased isolation among workers' wives have contributed to a higher incidence of alcoholism. While the interview conducted by QDA can hardly be considered a scientific study disputing these thoughts, the interviews did raise several questions about the direction and validity of the whole issue of boom town growth and its causal link with alcoholism. In Craig the incidence of alcoholism has risen, but the staff felt that this was not necessarily because of growth impacts, but rather a combination of generally increasing numbers and increased acceptance of such programs which would tend to inflate the "known" alcoholic figures. It was stated that Craig had an "alcoholism problem" long before impact conditions were realized.

The Craig A.A. staff did not feel that "impact generated" people exhibited alcoholic tendenicies to any greater extent than Craig's long-time residents. Obviously, there is much

confusion over the definition, occurrence, causes, and recovery from alcoholism. It is probably safe to say at this point that alcoholism in Rifle will not suddently become a new problem upon impact growth. As the population grows, the number of alcoholics may also increase. But the experience in Craig indicates that there is no reason to expect a disproportionate problem with alcoholism in Rifle.

Currently the problem of alcoholism in Rifle is being handled through the Mountain Rivers Substances Abuse Task Force, Inc. in New Castle. Here is located a seven-bed detoxification center and halfway house where problems of alcoholism and drug abuse are dealt.

The center if funded by state, county, and local governments and the fee to the public is based on a sliding scale according to individual income. The Detox Center has a counselor on call twenty-four hours a day to deal with any problems or questions which may arise.

X PARKS AND RECREATION

I. INTRODUCTION

The objectives of this section are to evaluate the present park land and recreational facilities in and around the City of Rifle and project use and area needs based on the natural and impact growth conditions. A selected set of standards are used for comparison with the existing conditions to determine the adequacy of parks and facilities. The same set of standards are combined with population projections to determine additional acres of park land and number of facilities required for the future.

This is not a park and recreation plan but an overview of present conditions and projection of future needs. The information can be used by the citizens and officials of Rifle for policy and program decision making relative to meeting these needs.

II. REGION XI PROFILE

For the purpose of conducting studies and coordinating planning activities, Colorado has been divided into thirteen State Planning Regions. Rifle is included in State Planning Region XI which consists of Moffat, Rio Blanco, Garfield, and Mesa Counties. Most of the recreational information gathered by state agencies is reported in terms of State Planning Regions. Since State Planning Region XI covers such a large area, the information gathered is perhaps less pertinent in terms of Rifle itself.

Nonetheless, the regional recreational profile presented in Table 1 gives some idea of the type and extent of recreational activities the area people participated in during 1974.

As can be seen from Table 1, the most popular activities in Region XI are bicycling, pleasure driving, fishing, hiking, camping, swimming, picnicking, and game-playing. Table 1 also indicates that the people who reside in Region XI are not the only recreationist who use the available facilities. Seventy-five percent of the horseback riders in the region come from other parts of the state. This is probably due to the numerous area resorts and dude ranches. Other activities bringing large numbers of Coloradoans to Region XI are four-wheeling, camping, fishing, hunting, and snowmobiling. Activities which are attracting large numbers of out-of-state residents to the region include camping, picnicking, skiing, and snowshoeing. Pleasure driving, itself, attracts many more out-of-state people than Colorado residents.

There are several specific facilities in close proximity to Rifle. The facilities and provided activities are:

1. Rifle Mountain Park - Located 15 miles north of the City, it is owned and administered by the city. On the 440 acres are nine footpaths and two vehicular access trails and 18 campsites. Picnic sites can accomodate 150 persons per day.

TABLE 1

RECREATION USE IN REGION XI - 1974*

Recreational Activities	Residents of Region XI	Residents of Other Colo. Regions	Non-Residents	Total Users
Hiking	2,234,427	367,007	528,540	3,129,974
%	71.0	12.0	17.0	100.0
Horseback Riding	205,092	626,071	-	831,163
%	25.0	75.0	-	100.0
Bicycling	4,047,874	75,560	42,947	4,166,381
%	97.0	2.0	1.0	100.0
Motorcycling	593,688	118,737	34,357	764,782
%	78.0	16.0	5.0	100.00
Driving for fun	939,107	248,269	2,474,398	3,661,774
%	26.0	7.0	67.0	100.0
Four Wheeling	237,475	345,418	94,483	677,376
%	35.0	51.0	14.0	100.0
Swimming	1,133,405	291,447	307,217	1,732,069
%	65.0	17.0	18.0	100.0
Picnicking	593,688	237,475	687,740	1,518,903
%	39.0	16.0	45.0	100.0
Camping	302,241	658,454	849,828	1,810,523
%	17.0	13.0	47.0	100.0
Boating	356,213	64,767	73,009	493,989
%	72.0	13.0	15.0	100.0
Game Playing	1,349,292	43,177	64,420	1,456,889
%	93.0	3.0	4.0	100.0
Tennis	194,298	-	8,589	202,887
%	96.0	-	4.0	100.0
Golf	356,213	43,177	17,179	416,569
%	86.0	10.0	4.0	100.0
Fishing	1,727,096	1,176,582	473,305	3,376,983
%	51.0	35.0	14.0	100.0
Shooting/Hunting	431,774	194,298	142,615	768,687
%	56.0	25.0	19.0	100.0
Skiing/Snowshoeing	248,270	21,588	182,158	452,016
%	55.0	5.0	40.0	100.0
Snowmobiling	151,121	43,177	-	194,298
%	78.0	22.0	-	100.0
Sledding/Tobog-ganning/Tubing	356,213	-	-	356,213
%	100.00			100.00
Ice Skating	53,972	-	-	53,972
%	100.00	-	-	100.00
Other	442,568	21,589	373,635	837,792
%	53.0	2.0	45.0	100.0
Total	15,954,027	4,576,793	6,354,420	26,903,240
%of Total users	59.0	17.0	24.0	100.00

*Expressed in Activity Days.

Source: U.S. Departmant of the Interior: Environmental Statement

Other permitted uses include: fishing and horseback riding.

2. Rifle Gap Recreation Area - Located approximately 6½ miles north of the City, Rifle Gap Dam and Reservoir were created as part of the 1968 Silt Project and resulted in a 350 acre impoundment. There are 68 campsites and such permitted activities as fishing, boating, swimming, hiking, horseback riding and picnicking.

3. Rifle Creek Golf Course - Located five miles north of the City and dedicated in 1962, the nine hole course is situated upon 80 acres with additional land available for expansion.

In addition there are over 900 acres of National Forest land in Garfield County for hiking, camping, and back-country recreation.

When compared to national standards for these activities, the listed facilities provide an adequate amount of land and facilities for existing and projected population under both natural and impact growth conditions (the only exception could be the expansion of the Rifle Creek Golf Course to 18 holes under the impact growth condition). However, due to the distance these facilities are from the City, they are not easily accessible for daily use.

III. EXISTING PARK AND RECREATION SITUATION

Table 2 shows the existing park and recreational facilities and activities available in the City of Rifle. The principal community park is Rifle Metro Park located at Railroad Avenue and 16th Street. It is a multiple use park as indicated by its numerous facilities. The park is owned and operated by Rifle Metropolitan Park District which was established as a separate taxing district in 1971 in order to raise funds to pay off the bond indebtedness created by the construction of the swimming pool.

The taxing district consists of most of the City of Rifle, although some areas annexed after the creation of the district are not included. An ordinance has been passed stating that new areas annexed between the creation of the District and the ordinance are not included. The service area, however, is much larger than the District, as many people from Silt, New Castle, Grand Valley, DeBeque and the unincorporated areas of use Rifle's parks and facilities.

Other principal parks in the City are: Heinze Park which has picnic and limited playground facilities; a playground located on the Rifle Public Schools Complex; and a baseball field located on the Garfield County Fairgrounds.

TABLE 2

EXISTING PARK LAND AND RECREATIONAL FACILITIES AND ACTIVITIES - CITY OF RIFLE

NAME	TYPE OF FACILITY	SIZE
1) Heinze Park	picnic and limited playground	.69 acres
2) Rifle Metro Park	multiple use - one 25 meter swimming pool, wading pool, softball field, 2 tennis courts, 2 basketball courts, playground	5.86 acres
3) Fairgrounds - Baseball field	baseball	2 acres
4) School Playground	playground	2 acres
5) Schools - Rifle Public Schools Complex, New Jr. High School	2 outdoor multi-purpose courts, 3 basketball courts, soccer field, football field, running track	

CLUBS/TEAMS (and financing)

Boys baseball teams	public
Four boys baseball teams	private
Two girls softball teams	private
Valley Softball League	private
Rifle Marlin Swim Team	private
Colorado River Valley Wrestling Club	private

OTHER

Colorado Mountain College-Continuing Education Program	classes in ceramics, macrame, jewelry making, modern dance, tennis, yoga, drama, hiking, camping, business

Sources: Visual survey and conversations with City Officials.

The remainder of the facilities are part of the school system in Rifle including basketball/multiple-use courts, soccer and football fields. Also, listed are the various teams/clubs that participate in Rifle. All but several boys baseball teams are privately financed. Finally, the Colorado Mountain College offers courses as part of their continuing education program located in the old junior high school.

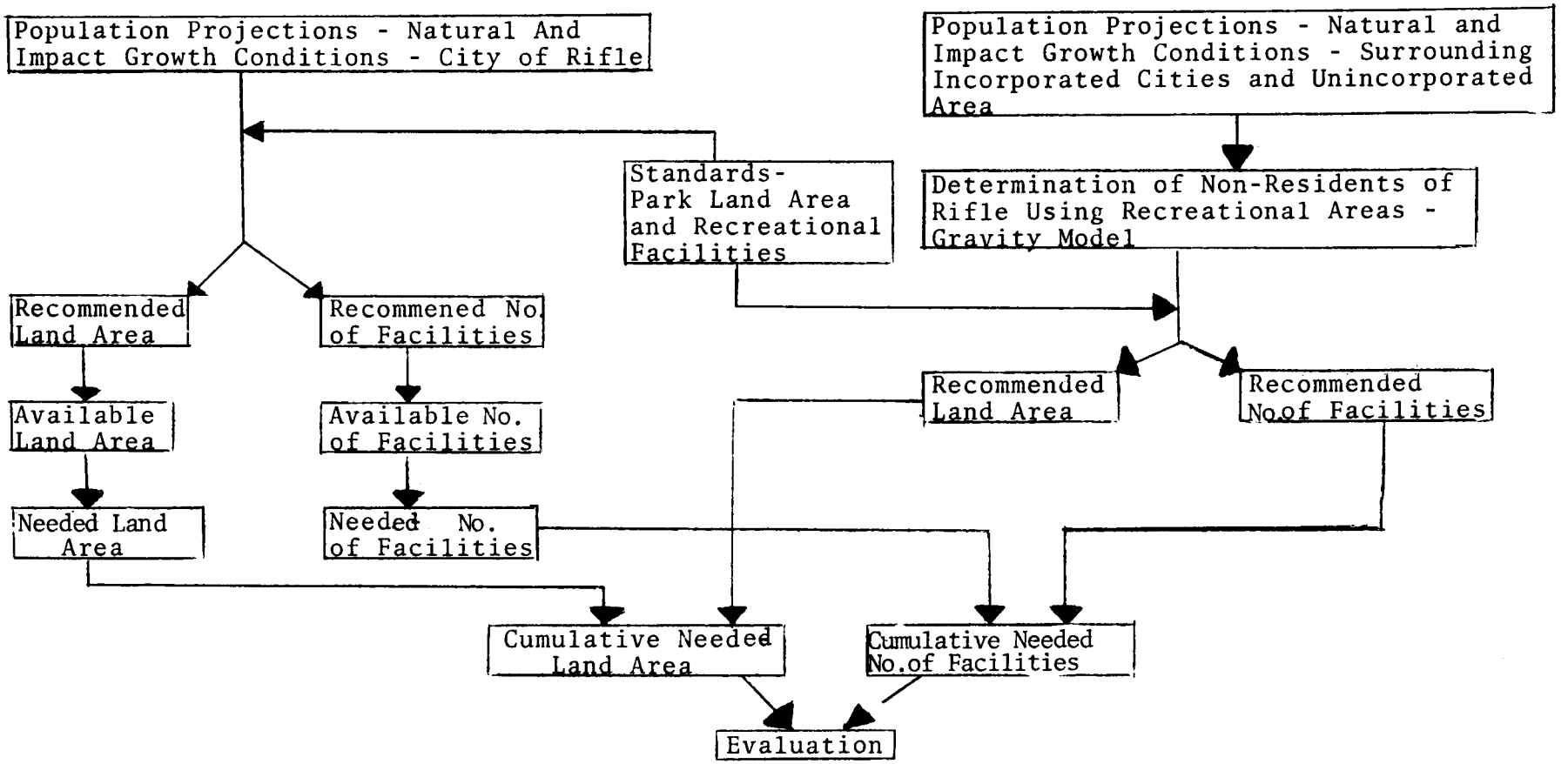
IV. FUTURE PARK LAND AREA AND RECREATIONAL FACILITY NEEDS

A. Methodology

Figure 1 is a model used to project future recreational needs in the City of Rifle. There are two population components and two types of assessed needs. The population components are: 1) the population projections for the City of Rifle; and 2) the population projections for nearby cities and unincorporated areas. For the latter component a determination was made as to the population that used Rifle for recreational needs. Then using a set of selected standards, the population projections were converted into two types of needs: 1) land area in acres; and 2) number of specific facilities. The needs are compared to the available facilities in Rifle to calculate additional acres of land and number of facilities that Rifle will need to meet projected future conditions.

Figure 1

FUTURE PARK LAND AND RECREATIONAL
FACILITY NEEDS MODEL



B. Selected Standards for Land Area and Number of Facilities

Standards were established for the two types of described needs by which to make comparisons and projections. The first set of standards are land requirements, for specific types of parks. These standards were derived from the following sources: Urban Planning and Design Criteria (DeChiara and Koppleman, 1975); (Apprehensive Planning - A Manual for Colorado Planners and Land Use Administrators (Colorado Division of Planning, Department of Local Affairs, January, 1977); and various publications from the National Recreation and Parks Association and the Colorado Division of Parks and Outdoor Recreation.

The following are definitions for park types:

1) Community Parks - These parks provide city wide activities having a general service radius of two miles. Their minimum size should be 15 acres with an ideal size of 30-40 acres. Activities include outdoor fields for organized sports, indoor space for activities, special facilities and horticultural development designed to provide a variety of active and passive recreational service for all age groups.

2) Neighborhood Parks - These parks provide neighborhood activities and have a general service radius of one-fourth to one-half miles. Their minimum size should be four acres with an ideal size of ten acres. Activities include passive recreational opportunities created through the design of horticultural features and park furniture.

3) Playgrounds - These parks provide active recreational opportunities on a neighborhood scale principally for children aged 12 and under but may also provide activities for older children and adults. They have a general service area of one-fourth to one-half miles and should have a minimum area of two acres with an ideal size of four acres.

The selected standards for the three park types are shown in Table 3. They indicate the land requirements per 1,000 population. Also, facility standards required per unit of population. Facilities considered were: basketball, tennis, baseball, softball, swimming and golf.

The existing parks and facilities in Rifle have already been presented in Part III of this section (see Table 2). For the three park land area categories (community, neighborhood and playground) the existing facilities were categorized as follows:

1) Community Parks - 7.86 acres exist. Includes Metro Park (5.86 acres) and baseball field at the county fairgrounds (2 acres).

2) Neighborhood Parks - .61 acres exist. Includes Heinz Park (excluding playground area).

3) Playgrounds - 3.47 acres exist. Includes elementary school playground (2 acres), playground at Metro Park (1.4 acres) and playground at Heinz Park (.07) acres).

TABLE 3

STANDARDS FOR PARK LAND AREA AND NUMBER OF FACILITIES

Type	Standard
Parks	
Community Park	3.5 acres/1000 population
Neighborhood Park	2.0 acres/1000 population
Playground	1.5 acres/1000 population
Facilities	
Basket Court	1/500 population
Tennis Court	1/2000 population
Baseball Field	1/6000 population
Softball Field	1/3000 population
Swimming	1-25 meter pool/10,000 population
Golf Course	1-9 hole course/5,000 population
	1-18 hole course/20,000 population

Sources: Urban Planning and Design Criteria, Delhiara and Koppelman, 1975; Comprehensive Planning- A Manual for Colorado Planners and Land Use Administrators, Colorado Division of Planning, Department of Local Affairs, January 1977; National Recreation and Parks Administration; Colorado Division of Parks and Outdoor Recreation

C. Future Park Land Area and Recreational Facility Needs for the City of Rifle - 1978-1985

Using published population projections of Rifle future needs for land area and number of facilities were calculated. These needs are for both the natural and impact growth conditions from 1978 to 1985.
Under both natural and impact growth conditions, the most immediate need is for neighborhood parks (see Table 4). For playgrounds and community parks, the present natural growth needs are being met and both will require over 30 percent increase in land area for the 1985 natural growth projections. Under impact growth conditions, considerable increases are required for the current year and for the 1980's.

Playground and neighborhood park locations are just as important as total acreage. For both types, the ideal service area is on one-fourth mile. Figure 2 shows the location of present parks with a one-third mile radius circle drawn to indicate an average service area. It can be seen that except for central Rifle, there is a considerable need for neighborhood parks in terms of location. This need will increase with the new subdivision activity cited in the land use section. While the service area for playgrounds cover a larger portion of the City, there is still a need in the western, eastern and northern sections of the City.

TABLE 4
PROJECTED PARKLAND AREA NEEDS GENERATED BY CITY OF RIFLE POPULATION PROJECTIONS - 1978-1985

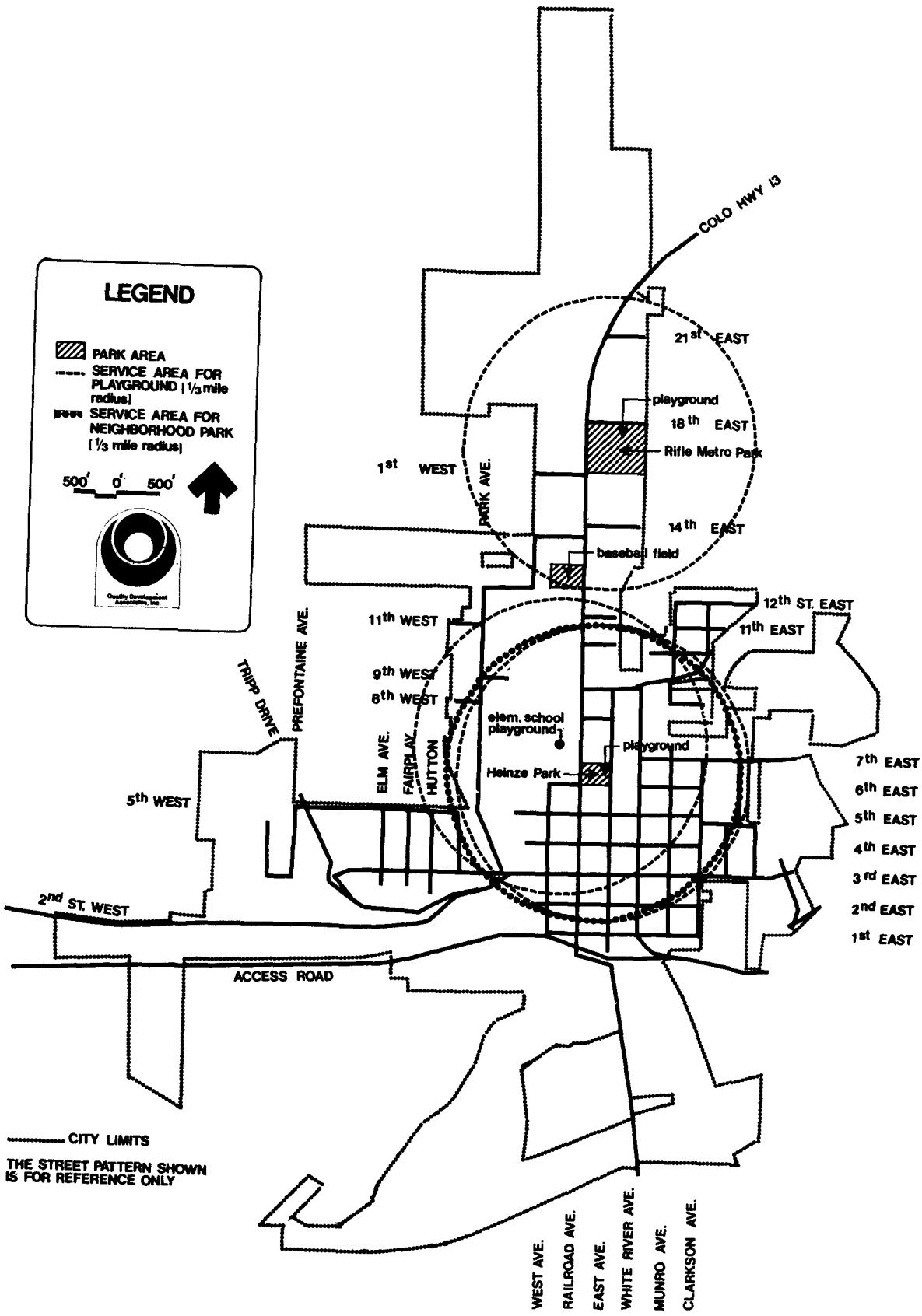
Year	Projected Population[a]	Recommended Area (Acres)	Available Area (Acres)	Need (Acres)	Percent Increase
Playground 1.5 Acres/1000 Population					
Natural Growth 1978	2,294	3.44	3.47	0	0
Natural Growth 1985	3,084	4.63	3.47	1.16	33
Impact Growth 1978	3,821	5.73	3.47	2.26	65
Impact Growth 1982	11,163	16.74	3.47	13.27	382
Impact Growth 1985	9,702	14.55	3.47	11.08	319
Neighborhood Parks 2.0 Acres/1000 Population					
Natural Growth 1978	2,294	4.59	.61	3.98	652
Natural Growth 1985	3,084	6.17	.61	5.56	911
Impact Growth 1978	3,821	7.64	.61	7.03	1,152
Impact Growth 1982	11,163	22.33	.61	21.72	3,561
Impact Growth 1985	9,702	19.40	.61	18.79	3,080

TABLE 4 (Continued)
PROJECTED PARKLAND AREA NEEDS GENERATED BY CITY OF RIFLE POPULATION PROJECTIONS - 1978-1985

Year	Projected Population[a]	Recommended Area (Acres)	Available Area (Acres)	Need (Acres)	Percent Increase
		Community Parks 3.5 Acres/1000 Population			
Natural Growth 1978	2,294	8.03	7.86	.17	2
Natural Growth 1985	3,084	10.79	7.86	2.93	37
Impact Growth 1978	3,821	13.38	7.86	5.51	70
Impact Growth 1982	11,163	39.07	7.86	31.21	397
Impact Growth 1985	9,702	33.96	7.86	26.10	332

(a) Population projections for City of Rifle

Sources: Sources cited in Figure 4; Growth Monitoring Information System, Colorado West Area Coural of Governments, December 1977.



EXISTING COMMUNITY PARKS, NEIGHBORHOOD PARKS AND PLAYGROUNDS · CITY OF RIFLE

FIG. 2

For the specific recreational facilities, the calculations in Table 5 indicate that there is no projected additional need under the natural growth conditions. Under the impact growth conditions, there is a possible need for one softball field. In the 1980's, there will be a need for approximately three tennis courts, a new baseball field, two to three new softball fields and over a dozen basketball courts. In addition under the impact conditions, the swimming pool and golf course will be above capacity.

D. Future Park Land Area and Recreational Needs for the Surrounding Incorporated Cities and unincorporated Area, 1978-1985

It was apparent from conversations with officials and citizens of the City of Rifle that facilities were used by non-residents from nearby cities of DeBeque, Grand Valley, Silt and New Castle, and from the unincorporated areas. In conversations with officials from these four cities, it was found that they had few recreational facilities and had to rely on Rifle, Grand Junction or Glenwood Springs for recreational activities.

A gravity model was developed to determine the number of residents from these outlying districts that may use Rifle recreational facilities as opposed to Grand Junction or Glenwood Springs. This gravity model is based on the size of two cities and the distance between them. The interaction is directly proportional to the size of the cities and inversely related to the distance. For example, people in Grand Valley

TABLE 5

PROJECTED RECREATIONAL FACILITY NEEDS GENERATED BY CITY OF RIFLE POPULATION PROJECTIONS - 1978-1985

Year	Projected Population	Recommended No. of Facilities	Existing No. of Facilities	Needed No. of Facilities
		Tennis 1/2000		
Natural Growth 1978	2,294	1-2	2	0
Natural Growth 1985	3,084	1-2	2	0
Impact Growth 1978	3,821	2	2	0
Impact Growth 1982	11,163	5-6	2	3-4
Impact Growth 1985	9,702	4-5	2	2-3
		Baseball 1/6000		
Natural Growth 1978	2,294	1	1	0
Natural Growth 1985	3,084	1	1	0
Impact Growth 1978	3,821	1	1	0
Impact Growth 1982	11,163	2	1	1
Impact Growth 1985	9,702	1-2	1	0-1

TABLE 5 (Continued)

PROJECTED RECREATIONAL FACILITY NEEDS GENERATED BY CITY OF RIFLE POPULATION PROJECTIONS - 1978-1985

Year	Projected Population	Recommended No. of Facilities	Existing No. of Facilities	Needed No. of Facilities
		Softball 1/3000		
Natural Growth 1978	2,294	1	1	0
Natural Growth 1985	3,084	1	1	0
Impact Growth 1978	3,821	1-2	1	0-1
Impact Growth 1982	11,163	3-4	1	2-3
Impact Growth 1985	9,702	3-4	1	2-3
		Basketball 1/500		
Natural Growth 1978	2,294	4-5	7	0
Natural Growth 1985	3,084	6-7	7	0
Impact Growth 1978	3,821	7-8	7	1
Impact Growth 1982	11,163	22-23	7	15-16
Impact Growth 1985	9,702	19-20	7	12-13

TABLE 5 (Continued)

PROJECTED RECREATIONAL FACILITY NEEDS GENERATED BY CITY OF RIFLE POPULATION PROJECTIONS - 1978-1985

Year	Projected Population	Recommended No. of Facilities	Existing No. of Facilities	Needed No. of Facilities
		Swimming 1.25 Meter Pool/10,000 Population		
Natural Growth 1978	2,294	1	1	0
Natural Growth 1985	3,084	1	1	0
Impact Growth 1978	3,821	1	1	0
Impact Growth 1982	4,163	1-2	1	0-1
Impact Growth 1985	9,702	1	1	0
		Golf Course 9 Hole/5,000 Population - 18 Hole/25,000 Population		
Natural Growth 1978	2,294	1	1	0
Natural Growth 1985	3,084	1	1	0
Impact Growth 1978	3,821	1	1	0
Impact Growth 1982	11,163	2	1	1
Impact Growth 1985	9,702	1-2	1	0-1

SOURCE: Sources cited in Figure 4; Growth Monitoring Information System, Colorado West area Council of Governments, December 1977.

will generally use either Grand Junction or Rifle for many recreational activities. The gravity model determines the percentage of residents in Grand Valley that may journey to Grand Junction versus to Rifle for recreational activities. This procedure was also applied to the cities of DeBeque, Silt, and New Castle. Refer to the appendix for a more detailed description of the gravity model.

In order to provide a basis for estimates of population projections for the unincorporated population, the four Census County Divisions, (CCD) in Garfield County (Glenwood Springs, CCD, New Castle CCD, Rifle CCD and Grand Valley CCD) were applied. It was assumed that persons from the Rifle CCD and Glenwood Springs CCD would most likely travel to their respective city. In assignments for the New Castle and Grand Valley CCDs, the gravity model discussed earier was used to ascertain the percentage of persons likely to travel to Rifle for recreational activity.

A final set of assumptions were made concerning what parks and facilities are most impacted by these additional demands. It is assumed that the neighborhood parks and playgrounds are used principally by Rifle residents. The community park and all other facilities (softball field, tennis courts, swimming pool, etc.) are used both by Rifle residents and people from the outlying districts.

Table 6 illustrates the possible additional demands placed on Rifle's parks and facilities from non-residents.

TABLE 6

PROJECTED PARK LAND AREA AND RECREATIONAL FACILITY NEEDS ON RIFLE BY SURROUNDING INCORPORATED CITIES AND UNINCORPORATED AREA POPULATION PROJECTIONS - 1978-1985

Year	Projected Population[a]	Recommended Area (Acres) or Number of Facilities
	Baseball 1 Field/6000 Population-Continued	
Impact Growth 1978	3,468	0-1
Impact Growth 1982	6,128	1
Impact Growth 1985	6,059	1
	Softball 1 Field/3000 Population	
Natural Growth 1978	2,729	1
Natural Growth 1985	3,664	1-2
Impact Growth 1978	3,468	1-2
Impact Growth 1982	6,128	2-3
Impact Growth 1985	6,059	2
	Basketball 1 Court/500 Population	
Natural Growth 1978	2,729	5-6
Natural Growth 1985	3,664	7-8
Impact Growth 1978	3,468	7
Impact Growth 1982	6,128	12-13
Impact Growth 1985	6,059	12

TABLE 6 (Continued)

PROJECTED PARK LAND AREA AND RECREATIONAL FACILITY NEEDS ON RIFLE BY SURROUNDING INCORPORATED CITIES AND UNINCORPORATED AREA POPULATION PROJECTIONS - 1978-1985

Year	Projected Population[a]	Recommended Area (Acres) or Number of Facilities
	Community Park 3.5 Acres/1000 Population	
Natural Growth 1978	2,729	9.55
Natural Growth 1985	3,664	12.82
Impact Growth 1978	3,468	12.13
Impact Growth 1982	6,128	21.45
Impact Growth 1985	6,059	21.21
	Tennis 1 Court/2000 Population	
Natural Growth 1978	2,729	1-2
Natural Growth 1985	3,664	1-2
Impact Growth 1978	3,468	1-2
Impact Growth 1982	6,128	3-4
Impact Growth 1985	6,059	3
	Baseball 1 Field/6000 Population	
Natural Growth 1978	2,729	0-1
Natural Growth 1985	3,664	0-1

TABLE 6 (Continued)

PROJECTED PARK LAND AREA AND RECREATIONAL FACILITY NEEDS ON RIFLE BY SURROUNDING INCORPORATED CITIES AND UNINCORPORATED AREA POPULATION PROJECTIONS - 1978-1985

Year	Projected Population[a]	Recommended Area (Acres) or Number of Facilities
Swimming 1-25 Meter Pool/10,000 Population		
Natural Growth 1978	2,729	0-1
Natural Growth 1985	3,664	0-1
Impact Growth 1978	3,468	0-1
Impact Growth 1982	6,128	1
Impact Growth 1985	6,059	1
Golf 9-Hole Course/5000 Population		
Natural Growth 1978	2,729	0-1
Natural Growth 1985	3,664	0-1
Impact Growth 1978	3,468	0-1
Impact Growth 1982	6,128	1
Impact Growth 1985	6,059	1

(a) Population projections based on gravity model calculating likelihood of persons from DeBeque, Grand Valley, Silt, New Castle and unincorporated areas using Rifle for recreational needs. See statistical appendix at end of this section for detailed information.

Sources: Sources cited in Figure 4; Growth Monitoring Information System, Colorado West Area Council of Governments; QDA calculations of generated demand (see statistical appendix of this section)

E. Cumulative Park Land Area and Recreational Facility Needs for City of Rifle - 1978-1985

This section discusses the expected demand on Rifle's recreational facilities from both the City of Rifle and environs. It is expected the greatest demand will be in neighborhood and community park land (refer to table 7). The existing playgrounds meet the 1978 natural growth needs but fall considerably short of the 1978 impact growth condition needs. The locational difficiencies for the neighborhood parks and playgrounds have already been discussed (see part IV C, Table 6 of this section).

Natural and impact growth projections suggest significant expansion of all three types of park land is necessary. Under the impact growth condition over 10 acres of playground land are required while approximately 20 acres of neighborhood parks and 50 acres of community park land will be needed.by 1982.

Under natural growth conditions, Rifle's cumulative recreational facility demands are for an additional tennis court, a new softball field and three basketball courts in 1978. By 1985, additional demands are for six basketball courts, two new tennis courts and a new softball field. (Table 8)

The impact growth projection shows a high demand for recreational facilities (Table 8). It is estimated that for 1978 an additional seven to eight basketball courts, one to two tennis courts, one to two softball fields and possibly a new baseball field will be needed. The projection for the 1980's indicate that on the order of twenty-five basketball courts.

TABLE 7
CUMULATIVE PARK LAND AREA NEEDS FOR
CITY OF RIFLE - 1978-1985

Year	Projected Population[a]	Recommended Area (Acres)	Available Area (Acres)	Need (Acres)	Percent Increase
		Playground 1.5 Acres/1000 Population			
Natural Growth 1978	2,294	3.44	3.47	0	0
Natural Growth 1985	3,084	4.63	3.47	1.16	33
Impact Growth 1978	3,821	5.73	3.47	2.26	65
Impact Growth 1982	11,163	16.74	3.47	13.27	382
Impact Growth 1985	9,702	14.55	3.47	11.08	319
		Neighborhood Parks 2.0 Acres/1000 Population			
Natural Growth 1978	2,294	4.59	.61	3.98	652
Natural Growth 1985	3,084	6.17	.61	5.56	911
Impact Growth 1978	3,821	7.64	.61	7.03	1152
Impact Growth 1982	11,163	22.33	.61	21.72	3561
Impact Growth 1985	9,702	19.40	.61	18.79	3080

TABLE 7 (Continued)

CUMULATIVE RECREATIONAL FACILITY NEEDS
FOR RIFLE - 1978-1985

Year	Projected Population[a]	Recommended # of Facilities	Existing # of Facilities	Needed # of Facilities
		Tennis 1 Court/2000 Population		
Natural Growth 1978	5,023	2-3	2	0-1
Natural Growth 1985	6,748	3-4	2	1-2
Impact Growth 1978	7,289	3-4	2	1-2
Impact Growth 1982	17,291	8-9	2	6-7
Impact Growth 1985	15,761	7-8	2	5-6
		Baseball 1 Field/6000 Population		
Natural Growth 1978	5,023	1	1	0
Natural Growth 1985	6,748	1	1	0
Impact Growth 1978	7,289	1-2	1	0-1
Impact Growth 1982	17,291	2-3	1	1-2
Impact Growth 1985	15,761	2-3	1	1-2

TABLE 7 (Continued)
CUMULATIVE PARK LAND AREA NEEDS FOR
CITY OF RIFLE - 1978-1985

Year	Projected Population[a]	Recommended Area (Acres)	Available Area (Acres)	Need (Acres)	Percent Increase
		Community Parks 3.5 Acres/1000 Population			
Natural Growth 1978	5,023	17.58	7.86	9.72	124
Natural Growth 1985	6,748	23.62	7.86	15.76	201
Impact Growth 1978	7,289	25.51	7.86	17.65	225
Impact Growth 1982	17,291	60.52	7.86	52.66	670
Impact Growth 1985	15,761	55.16	7.86	47.30	602

(a) Population projections for playgrounds and neighborhood park land for City of Rifle. Population projections for community parks based on City of Rifle and percentage of DeBeque, Grand Valley, Silt, New Castle and unincorporated areas. (see statistical appendix).

Soures: Sources cited in Figure 4; Growth Monitoring Information System, Colorado West Area Council of Governments; QDA calculations of generated demand (see statistical appendix at end of this section).

TABLE 8

CUMULATIVE RECREATIONAL FACILITY NEEDS
FOR RIFLE - 1978-1985

Year	Projected Population[a]	Recommended # of Facilities	Existing # of Facilities	Needed # of Facilities
		Softball 1 field/3000 Population		
Natural Growth 1978	5,023	1-2	1	0-1
Natural Growth 1985	6,748	2	1	1
Impact Growth 1978	7,289	2-3	1	1-2
Impact Growth 1982	17,291	5-6	1	4-5
Impact Growth 1985	15,761	5	1	4
		Basketball 1 Court/500 Population		
Natural Growth 1978	5,023	10	7	3
Natural Growth 1985	6,748	13	7	6
Impact Growth 1978	7,289	14-15	7	7-8
Impact Growth 1982	17,291	34-35	7	27-28
Impact Growth 1985	15,761	31-32	7	24-25

TABLE 8 (Continued)
CUMULATIVE RECREATIONAL FACILITY NEEDS
FOR RIFLE - 1978-1985

Year	Projected Population[a]	Recommended # of Facilities	Existing # of Facilities	Needed # of Facilities
	Swimming 1-25 Meter Pool/10,000 Population			
Natural Growth 1978	5,023	1	1	0
Natural Growth 1985	6,748	1	1	0
Impact Growth 1978	7,289	1	1	0
Impact Growth 1982	17,291	1-2	1	1
Impact Growth 1985	15,761	1-2	1	1
	Golf 1-9 Hole Course/5000 Population; 1-18 Hole Course/25,000 Population			
Natural Growth 1978	5,023	1	1	0
Natural Growth 1985	6,748	1	1	0
Impact Growth 1978	7,289	1-2	1	0-1
Impact Growth 1982	17,291	2	1	1
Impact Growth 1985	15,761	2	1	1

TABLE 8 (Continued)

CUMULATIVE RECREATIONAL FACILITY NEEDS
FOR RIFLE - 1978-1985

(a) Population projections for all facilities based on City of Rifle and percentage of DeBeque, Grand Valley, Silt, New CAstle and unincorporated areas (see statistical appendix)

Sources: Sources cited in Figure 4; Growth Monitoring Information System, Colorado West Area Council of Governments; QDA calculation of generated demand (see statistical appendix at the end of this section).

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six tennis courts, four softball fields, one to two baseball fields, a new swimming pool and nine more holes of golf will be needed.

V. EVALUATION

Rapid changes in an area's employment pattern result in concurrent and equally rapid changes in recreational facility demand patterns. An analysis of existing recreational facility patterns and characteristics in Rifle and estimates of probable recreational facility demand, indicate that additional park land and recreational facilities are required as a result of the C-b project. It will be an important aspect in terms of creating community feeling within the city. This will especially be important under the impact growth conditions and the many related temporary residents. Creating a feeling of community with a large number of transients is difficult to accomplish. Providing an extensive park and recreation system is one method to provide an environment to satisfy recreation needs of the public. Creating an adequate recreation system may also be a way to offset many of the health related problems that often appear in growth towns.

Several policy alternatives should be evaluated for meeting the projected demands in Rifle. To meet the area's requirements for community parks, neighborhood parks and playgrounds, there is the possible use of existing vacant land in the city. Much of this land is flood plain and may be usable for passive recreational purposes. Much of the land along Rifle Creek is

vacant and could be developed into a lineal neighborhood park. The use of the land south of the Colorado River (which is presently owned by the City) can be evaluated for both passive and active recreational purposes. Again this is dependent on flood danger. This land could also be used to meet temporary demands created at the peak of construction activity in 1982.

Another source of park land is the 5 percent dedication of land for public use by new subdivisions. While this land must be shown on the final plat, there is no guarantee that it will be developed into recreational land. It is imperative in new subdivisions that this land be at a quality location to be accessible to all residents.

Based on research of other recreational/open space land dedication requirements in subdivision regulations of other communities, it appears that Rifle could increase their amount of land dedication. Relating the requirement on the number of possible users (dwelling units) rather than a flat percentage will help provide more land, particularly in multifamily subdivisions. To help insure that the land is eventually developed with recreational facilities, a fee may also have to be assessed. Some combination of land and money per dwelling unit could insure adequate developed recreational land based on actual need of the subdivision. The land in these subdivisions would probably be most suited for neighborhood parks and playgrounds.

A third source for obtaining land for parks is for the City to purchase and annex land. This would be the most expensive alternative but may give the City better control over location of such land.

It is important to realize the possible multplicity of uses for many recreational lands and facilities. Such activities as basketball and tennis can share the same area. Similarly, baseball fields can be used for football and soccer. This multiple use feature should be kept in mind when planning new facilities. In addition, recreational land is more easily converted to other land uses than residential, commercial or industrial land. If the future supply of such land exceeds the demand, it would be possible to convert this land if so desired (except in the case of a swimming pool or recreational building).

There should be some form of regional coordination for park and recreational facilities. Presently, Rifle serves as a regional center for many of the residents in DeBeque, Grand Valley, Silt, New Castle and unincorporated areas. In the planning of new facilities, the needs of the entire region should be considered to insure the adequacy of such facilities and to eliminate any unnecessary duplication. For certain facilities it may be best to place them in the other incorporated cities. For instance, it is estimated that there will be a need for 25 basketball courts in 1985 under impact growth conditions. This appears to be a large number just for the

City of Rifle and it could be possible to develop these courts in the other communities. Other facilities such as a swimming pool, these communities would not have the necessary population base and must continue to rely on Rifle, Grand Junction and Glenwood Springs.

The facilities evaluated in this study should not be considered a final list for meeting future needs. The standards used in this report should not be a substitute for surveying the actual needs of the citizens but only used as a guideline. If possible many other types of facilities (handball courts, indoor multipurpose facilities) could be supported in Rifle. As recreational interests and trends change, so will the demand for specific facilities.
Rifle's recreational needs should be constantly monitored through public participation and public meetings and surveys.

VI. STATISTICAL APPENDIX

GRAVITY MODEL

A gravity model was employed to calculate the demand for recreational activities from citizens who live outside Rifle. The theory of the gravity model is that two places interact with each other in proportion to the product of their masses (population) and inversely according to some function of the distance between them. Stated in an equation, the gravity model used in this section is:

$$I = \frac{P_1 P_2}{D}$$

Where: I = Interaction

P_1 = Population of City 1

P_2 = Population of City 2

D = Distance between P_1 and P_2

Tables 9 and 10 show the population and distance figures used in the model. For the unincorporated areas, estimates were made based on projections for all unincorporated areas in Growth Monitoring Information Systems and percentage distribution in the County Census Districts (CCD's) relative to their present population. The distances were based on estimates of the population center of the area.

Table 11 is an example of the calculating procedure for the gravity model. It is assumed that the people of New Castle either go to Glenwood Springs or Rifle for recreational activities not found in their own city. Based on the population and the distance, interaction is calculated between New Castle and both Rifle and Glenwood Springs. These figures are added to illustrate the total interaction. The interaction with Rifle is shown as a percent of the total, so 27.3 percent of all people in New Castle are likely to use Rifle as opposed to Glenwood Springs.

This procedure was used for all four communities and the unincorporated population of the County Census District Areas. Table 12 shows the percentages of the populations for each city or area that is likely to use Rifle. An assumption was

TABLE 9
POPULATION PROJECTIONS USED IN GRAVITY MODEL

City	Natural Growth 1978	Natural Growth 1985	Impact Growth 1978	Impact Growth 1982	Impact Growth 1985
Rifle	2,294	3,084	3,821	11,163	9,702
Glenwood Springs	4,203	5,649	4,450	5,464	6,039
De Beque	269	378	284	346	394
Grand Valley	386	518	546	882	890
Silt	887	1,192	1,044	1,654	1,672
New Castle	559	752	660	1,198	1,168
Grand Junction	26,168	36,855	28,044	35,482	40,967
Unincorporated Grand Valley CCD (a)	501	681	530	653	714
Unincorporated New Castle CCD (a)	1,923	2,587	2,037	2,522	2,770
Unincorporated Rifle CCD (a)	1,347	1,815	1,427	1,764	1,935

(a) QDA estimates for County Census Districts (CCD's) based on West Area Council of Governments, Growth Monitoring Information System.

Sources: Growth Monitoring Information System, Colorado West Area Council of Governments; QDA estimates.

TABLE 10
DISTANCES BETWEEN CITIES USED IN
GRAVITY MODEL

City	Rifle	(Miles) Grand Junction	Glenwood Springs
Rifle	-	62	27
DeBeque	29	33	-
Grand Valley	16	46	-
Silt	8	-	19
New Castle	16	-	11
Unincorporated Grand Valley CCD [a]	16	46	-
Unincorporated New Castle CCD [a]	16	-	11

(a) Distances for CCD's based on estimate of population center.

Source: Colorado State Highway Map

TABLE 11
EXAMPLE OF GRAVITY MODEL -
1978 NATURAL GROWTH FOR NEW CASTLE

Inputs:

Population New Castle - 559

Population Rifle - 2,294

Population Glenwood Springs - 4,203

Distance - New Castle to Rifle - 16 miles

Distance - New Castle to Glenwood Springs - 11 miles

Interaction With Rifle

$$\frac{559 \times 2,294}{16} = 80,147$$

Interaction With Glenwood Springs

$$\frac{559 \times 4,203}{11} = 213,589$$

Total Interaction = 293,736

Interaction with Rifle is 27.3 percent of total

$$\frac{80,147}{213,589} = 27.3 \text{ percent}$$

So 27.3 percent of population of New Castle is likely to use Rifle's recreational areas.

TABLE 12
PERCENTAGE OF NEARBY CITY/UNINCORPORATED AREA THAT USES RIFLE'S RECREATIONAL AREAS BASED ON GRAVITY MODEL

City	Natural Growth 1978	Natural Growth 1985	Impact Growth 1978	Impact Growth 1982	Impact Growth 1985
DeBeque	9.1	8.7	13.4	26.4	21.2
Grand Valley	20.1	19.4	28.1	47.5	40.5
Silt	56.5	56.5	67.1	82.9	79.2
New Castle	27.3	27.3	37.1	58.4	52.5
Unincorporated Rifle CCD	100.0	100.0	100.0	100.0	100.0
Unincorporated Grand Valley CCD	27.3	27.3	37.1	58.4	52.5
Unincorporated New Castle CCD	20.1	19.4	28.1	47.5	40.5

Source: QDA estimates based on gravity model.

TABLE 13

POPULATION OF NEARBY CITY/UNINCORPORATED AREA THAT USES RIFLES RECREATIONAL AREAS BASED ON GRAVITY MODEL

City	Natural Growth 1978	Natural Growth 1985	Impact Growth 1978	Impact Growth 1982	Impact Growth 1985
DeBeque	24	33	38	91	84
Grand Valley	78	100	153	419	360
Silt	501	673	700	1,371	1,324
New Castle	153	205	245	700	613
Unincorporated Rifle CCD	1,347	1,815	1,427	1,764	1,935
Unincorporated Grand Valley CCD	101	132	149	310	289
Unincorporated New Castle CCD	525	706	756	1,473	1,454
Sub Total	2,729	3,664	3,468	6,128	6,059
Projections City of Rifle	2,294	3,084	3,821	11,163	9,702
Total	5,023	6,748	7,289	17,291	15,761

Sources: QDA estimates based on gravity model; Growth Monitoring Information System, West Area Council of Governments

made that all persons living in the unincorporated areas of the Rifle CCD used Rifle. It was also assumed that all persons living in the Glenwood Springs CCD used Glenwood Springs.

It can be seen that as Rifle's population increases under the impact growth conditions, its proportion relative to Grand Junction or Glenwood Springs increases, so Rifle will attract more users from the other cities and unincorporated areas.

Table 13 shows the actual projected population that will likely use Rifle's recreational areas calculated from the gravity model. Also, shown is the addition of population projections for the City of Rifle which indicate the cumulative demand on Rifle's park land area and recreational facilities.

XI. PUBLIC SERVICES

I. INTRODUCTION

Public services such as water and sewer, solid waste disposal, police protection, and public works are provided to Rifle directly by the municipality from local general fund revenues. Fire protection is currently the only public service provided to Rifle residents by a special purpose district, namely the Rifle Fire Protection District. This service is supported by taxes assessed annually by the district.

The present level of municipal services provided to Rifle is adequate to meet the demands of the current population. In order to maintain this level of services while absorbing an increasing population, these public services will need to expand. This expansion is not limited to just facilities, but will include increases in manpower, equipment, and operating space as well. In this chapter, Rifle's public services are examined to determine their expansion requirements under both natural growth and energy impact assumption.

II. WATER

A. Supply and Demand

Rifle derives its water supply from the Colorado River and from Beaver Creek, which together provide rights for 6.14 million gallons per day (MGD). Rifle has an additional 1.03 MGD in water rights from Rifle Creek, but this is used strictly as raw water to irrigate Rifle Cemetery. At the present time, residential demand for water in Rifle is 0.33 MGD; adding in commercial, industrial, and all other users brings total demand for treated water to 0.42 MGD. On a peak-day basis, Rifle's total water demand in 1977 is figured at 1.05 MGD.

Table 1 indicates that, using rates for both average daily consumption and peak-day consumption, Rifle's natural population growth between 1978 and 1985 will not seriously deplete available raw water supplies. Similar data are presented in Table 2 for conditions of impact growth, and even using peak-day rates during 1982 (the project peak-year), demand of 5.25 MGD leaves 0.89 MGD excess supplies of raw water. Both these estimates indicate that Rifle's 6.14 MGD raw water supply is sufficient to meet increased demand under either natural or impact growth conditions, even at peak-day consumption rates.

TABLE 1

ESTIMATED ANNUAL WATER CONSUMPTION FOR THE CITY OF RIFLE, UNDER CONDITIONS OF NATURAL GROWTH, 1978 TO 1985

	Millions of Gallons Per Day (MGD)		
Year	Average Daily Consumption	Peak Day Consumption	Raw Water Supply (1978)
1978	0.43	1.08	6.14
1979	0.45	1.13	6.14
1980	0.47	1.18	6.14
1981	0.50	1.24	6.14
1982	0.52	1.29	6.14
1983	0.54	1.34	6.14
1984	0.56	1.40	6.14
1985	0.58	1.45	6.14

Notes: Water consumption based on the following gallons per capita per day:

	Average Day	Peak Day
Residential	145	363
All Other	43	107
Total	188	470

SOURCE: Estimates based on consumption data provided by Nelson, Haley, Patterson, and Quirk, Inc. and on population data provided by COG's Growth Monitoring Information System.

TABLE 2

ESTIMATED ANNUAL WATER CONSUMPTION
FOR THE CITY OF RIFLE, UNDER CONDITIONS
OF IMPACT GROWTH, 1978 TO 1985

Millions of Gallons Per Day (MGD)

Year	Average Daily Consumption	Peak Day Consumption	Raw Water Supply (1978)
1978	0.72	1.80	6.14
1979	1.42	3.55	6.14
1980	1.35	3.37	6.14
1981	1.98	4.96	6.14
1982	2.10	5.25	6.14
1983	1.56	3.90	6.14
1984	1.68	4.20	6.14
1985	1.82	4.56	6.14

Notes: Water consumption based on the following gallons per capita per day:

	Average Day	Peak Day
Residential	145	363
All Other	43	107
Total	188	470

SOURCE: Estimates based on consumption data provided by Nelson, Haley, Patterson, and Quirk, Inc. and on population data provided by COG's Growth Monitoring Information System.

B. Treatment Capacity

Of Rifle's 6.14 MGD raw water rights, 5.49 MGD is claimed from the Colorado River. Roughly 2.16 MGD is processed at the Graham Mesa treatment plant, now operating at capacity. This water, at the rate of 1500 gallons per minute (GPM), is pumped more than half-a-mile from the river through a steel transmission line to the plant. The treated water is then pumped to an adjacent 250,000 gallon storage tank. From here it is gravity fed to the water distribution system.

Depending on the availability of water during dry years, or peak seasons of the year, Beaver Creek provides up to 0.65 MGD at a rate of 450 GPM. This water is treated at the Beaver Creek plant, and stored in a 600,000 gallon tank adjacent to the site, from which it also is gravity fed to the distribution system.

Due to the limited availability of water from Beaver Creek, Rifle's water treatment capacity is essentially the capacity of the Graham Mesa plant, or 2.16 MGD. With current peak day water consumption in the range of 1.05 1.15 MGD (including outlying customers on city water), this leaves Rifle with a surplus in treatment capacity of 1.01 to 1.11 MGD.

Since future demand for treatment capacity is commonly calculated on a peak-day basis, Rifle's current 2.16 MGD capacity for water treatment should be examined in light of

the projected peak-day demands given earlier in Tables 1 and 2. This is done in Table 3. Under the assumption of continued natural growth between 1978 and 1985, Rifle's 2.16 MGD water treatment capacity will only be 67 percent utilized (calculated on peak-day consumption rates) by the end of this period. However, in the impact scenario this capacity is predicted to be exceeded by 64 percent as early as 1979 using the peak-day rates. By 1982, when population and water demand are expected to peak, there is predicted to be a shortage of 3.09 MGD in water treatment capacity given present facilities. Even at the end of the forcasting period (1985), unmet demand for treated water is expected to be 2.4 MGD.

The City of Rifle has included as part of its capital improvements plan the addition of a 4.0 MGD treatment plant at a cost of around $1.7 million. In July, 1978, the Joint Budget Committee appropriated $2.1 million for this project, and for more than 10,000 feet of transmission lines. The new plant will increase total capacity to 6.16 MGD, and afford an excess capacity of 0.91 MGD, or 15 percent over predicted peak year rates of water consumption. The greater total capacity should prove adequate for many years, or until Rifle surpasses roughly 13,000 population.

C. Water Storage

Total storage capacity of the Rifle water system is currently 1.35 million gallons (MG). This includes 0.25 MG at Graham Mesa, 0.60 MG at Beaver Creek, and 0.50 MG at

TABLE 3

ESTIMATED REQUIREMENT FOR
TREATED WATER UNDER CONDITIONS
OF NATURAL AND IMPACT GROWTH FOR THE
CITY OF RIFLE 1978 to 1985

Millions of Gallons per Day (MGD)

Year	Natural Growth	Impact Growth	Water Treatment Capacity
1978	1.08	1.80	2.16
1979	1.13	3.55	6.16
1980	1.18	3.57	6.16
1981	1.24	4.96	6.16
1982	1.29	5.25	6.16
1983	1.34	3.90	6.16
1984	1.40	4.20	6.16
1985	1.45	4.56	6.16

Source: Tables 1 and 2: Peak day water consumption.

the cemetery. Currently under construction is a 3.0 MG storage tank in east Rifle which will increase Rifle's total storage capacity to 4.35 MG upon its completion in 1979.

Using 1977 population figures and data from Rifle's engineering consultants, estimated water storage requirements for fire, emergency, and other purposes in 1977 amounted to 1.22 MG. As of last year, Rifle had only 0.13 MG (130,000 gallons) in excess storage capacity, or a 37 percent margin, pending completion of the new tank.

As Table 4 indicates, the current capacity of 1.35 MG would likely be exceeded even under natural growth conditions by as early as 1981. Without the new tank, natural growth would require an additional 0.13 MG by 1985. Under impact conditions, an estimated 2.2 MG to 2.6 MG of added storage would be needed by 1982 and beyond - if the new tank is not considered.

With the addition of the 3.0 MG tank, water storage needs for Rifle will be met under either natural or impact growth. By 1985, the total 4.35 MG capacity would be 66 percent unused with natural growth conditions, and about 10 to 20 percent unused with impact growth. The total 4.35 MG water storage capacity available to Rifle by 1979 would provide enough storage for approximately 12,000 to 13,000 residents.

TABLE 4

ESTIMATED WATER STORAGE REQUIREMENTS
UNDER CONDITIONS OF NATURAL AND IMPACT GROWTH
FOR THE CITY OF RIFLE
1978 to 1985

Year	Natural Growth	Impact Growth	Water Storage Capacity
1978	1.24	1.71	1.35
1979	1.27	2.85	4.35
1980	1.31	2.73	4.35
1981	1.35	3.76	4.35
1982	1.38	3.95	4.35
1983	1.42	3.08	4.35
1984	1.45	3.27	4.35
1985	1.48	3.50	4.35

Storage determined by the formula: 0.54MG + Average Daily Consumption+25% Peak Day Consumption.

SOURCES: Nelson, Haley, Patterson and Quirk, Inc. and COG's Growth Monitoring Information System.

D. Distribution System

The present water distribution system in Rifle consists of lines ranging from four to fourteen inches in diameter. Many of these lines are cast iron or steel, with the rest being transite or asbestos cement. Much of the system is now over 40 years old. Due to the elevation extremes in and around Rifle, the distribution system itself experiences variations in water pressure ranging from 150 pounds per square inch in downtown Rifle and south of the river, to less than 50 pounds per square inch in the west and northeast sections of the city (where the elevation may exceed that of downtown by 170 feet or more). This high water pressure in the lower, older lines has caused increased leakage and breakage in the system. The capital cost of replacing and extending the distribution lines where needed and of installing valves and hydrants that would decrease pressure in the lower system to under 120 pounds per square inch is estimated at around $350,000. Approximately $900,000 in additional funds would be required to place some 24,000 lineal feet of new transmission lines to expand and upgrade the network.

At the beginning of 1978 there were 1022 in-service water taps in and around Rifle, including 821 residential taps and 96 commercial taps. Overall, approximately 12 percent of the in-service taps were located outside city limits, including about 13 percent of the total residential taps and 5 percent of the total commercial taps. The minimum

residential tap fee is currently $325, and quarterly billing rates for in-city customers start at $12 for the first 10,000 gallons and go to $0.60 per thousand gallons in excess of 50,000 gallons. The charge for out-of-town water is three times higher in each user-category. In addition, Rifle charges a system improvement fee based on a point system. The minimum water system improvement fee is $660.

III. SANITATION

A. Treatment

Sewage treatment and disposal within city limits is another responsibility of Rifle's general government. Revenues for sanitation services are generated primarily from sewer tap fees and system improvement fees. Currently, minimum charges are $150 for tap fees, and $275 for system improvement fees. User charges are set at 60% of water charges.

The design capacity of Rifle's aereated lagoon sewer treatment facility built in 1965, is 0.33 million gallons per day (MGD). Presently the system is operating at 0.297 MGD, or 90 percent of capacity. Using Rifle's current average of 130 gallons of treated sewage per person per day, Table 5 shows projected sewage treatment requirements for the city of Rifle through 1985 for both natural and impact growth. These figures indicate that even with natural growth, current

TABLE 5

ESTIMATED GALLONS PER DAY SEWAGE TREATMENT NEEDS*
UNDER CONDITIONA OF NATURAL AND IMPACT GROWTH
FOR THE CITY OF RIFLE
1978 to 1985

Year	Gallons Per Day Treatment		
	Natural Growth	Impact Growth	Sewage Treatment Capacity
1978	298,220	496,730	330,000
1979	312,910	983,190	1,000,000
1980	327,600	933,140	1,000,000
1981	342,290	1,370,980	1,000,000
1982	356,850	1,451,190	1,000,000
1983	371,540	1,079,260	1,000,000
1984	386,230	1,160,900	1,000,000
1985	400,920	1,261,260	1,000,000

*Assumes treatment required at the rate of 130 gallons per person per day.

SOURCE: QDA estimates based on COG's Growth Monitoring Information System.

sewer capacity will exceed during 1981. With impact growth, Rifle's 0.33 MGD capacity will be deficient by year-end 1978. To meet peak requirements from 1982 to 1985, an additional 0.93 MGD to 1.12 MGD of sewage treatment capability will be needed.

Expansion of the treatment plant is currently being undertaken as part of Rifle's capital improvement plan. Work should be completed by late 1979 in expanding the existing lagoon system from 0.33 MGD capacity to 1.00 MGD capacity. The projected cost of these improvements is $438,750, a sum that has already been appropriated from the state's oil shale trust fund.

The expanded treatment capacity would appear to be adequate until 1981 under impact growth, after which time an additional 0.3 MGD to 0.4 MGD would be needed to accommodate the impact population. A later phase of Rifle's sewer expansion project calls for a new lift station at the treatment plant and 9,000 feet of 18" and 24" interceptor sewer lines running from the plant to the city and proceeding up Rifle Creek. The cost for this second phase is around $325,000.

B. Collection

The sewer collection system consists of 162,820 linear feet of primarily 4", 6", and 8" pipe. The older pipe (installed prior to the mid-1950's) is made of vitrified clay, with some made of corrugated metal. In the last

twenty years, sewer lines have been made of concrete, clay, asbestos concrete, and plastic. The condition of Rifle's sewage collection system is generally poor. Due to the system's age and condition, and the high water tables locally, and estimated 127,000 gallons of water enter Rifle's sewer lines daily due to infiltration and inflow.

Some of these problems are dealt with in the sewer treatment expansion - such as rebuilding alleys and disconnecting storm water drains, and designing extra capacity to treat infiltration. Other improvements, such as replacing and upgrading sewer lines, are scheduled as part of Rifle's capital improvements program on a pay-as-you-go basis. Between 1978 and 1985, between $10,000 and $120,000 will be spent on these related system improvements.

IV. SOLID WASTE

The city of Rifle collects and disposes of solid waste in and around city limits. The waste is transported by city-owned dumpster to the County-operated landfill site, just south of the airport. Residential customers are charged a monthly fee of $3, and commercial users must pay between $5 and $20 per month depending on frequency of collection.

The current county landfill site south of the airport is nearing its solid waste capacity, and without land expansion it will exceed capacity by mid-1979. Two recent developments will ease this situation. The first is a

bridge improvement project proposed in Garfield County's 1979 capital facilities plan allowing access to the county's other landfill, the South Canyon site west of Glenwood Springs. With the improved bridge, solid waste from Glenwood Springs can be hauled to the South Canyon landfill, and not diverted to the Rifle site as it has been for the past several months. A second factor is the county's planned purchase from the Bureau of Land Managment of ten acres suited for landfill and adjoining the airport site. If this is done by early 1979, there will be no immediate danger of exceeding solid waste capacity in Garfield County.

Using an EPA standard of 0.21 acres of landfill site per 1000 residents per year, Rifle would need 4.5 acres of landfill between 1978 and 1985 under natural growth conditions and more than 14 acres with impact growth in the same period. This projection shows that the capacity of the proposed ten acre addition would be exceeded by 1983-1984 under impact growth in Rifle. Utilization of this expanded Rifle site may be somewhat greater than anticipated in light of the recent closures of city landfills in Newcastle and Silt due to code violations. If residents of these communities and of unincorporated parts of the county also use the Rifle site for disposal of solid waste, it is likely that its capacity could be exceeded as early as 1980 - 1981.

V. POLICE PROTECTION

Police protection in the city of Rifle is provided by the Chief of Police, a sergeant and five patrolmen. Since police functions are directly related to population and criminal activity there will be an increased demand on the police department as population and crime levels increase.

Currently the seven officers do meet the needs for the population projections for 1978 (see Table 6). Federal Bureau of Investigation manpower requirements suggest a ratio of 1.8 sworn officers per 1000 population for a force consisting of less than 20. Under natural growth conditions, the existing force would be more than sufficient, but projected impact growth conditions indicate that 14 officers will be needed by the end of 1979. Current plans to increase the staff include the addition of a juvenile officer at the schools and an investigator.

At present there are five dispatchers, (four full time and one part-time) that provide clerical assistance to the officers. The dispatchers also handle communications for the fire and ambulance department and for Silt and Grand Valley. According to the Chief of Police, the five dispatchers do meet the current needs. The dispatching staff under normal growth conditions is sufficient. Estimates of needs under impact growth conditions were made by assuming an additional dispatcher would be needed for every five officers added to the force. The

TABLE 6

ESTIMATED POLICE MANPOWER AND VEHICLE REQUIREMENTS
FOR THE CITY OF RIFLE UNDER
CONDITIONS OF NATURAL AND IMPACT GROWTH
1978 to 1985

Year	Natural Growth Population	Total Number of Officers Needed(a)	Dispatch & Clerical Employees Needed(b)	Vehicles Needed(c)	Impact Growth Population	Total Number of Officers Needed(a)	Dispatch & Clerical Employees Needed(b)	Vehicle Needed(c)
1978	2,294	5	5	2	3,821	7	5	3
1979	2,407	5	5	2	7,563	14	6	5
1980	2,520	5	5	2	7,178	13	6	5
1981	2,633	5	5	2	10,546	19	7	7
1982	3,745	5	5	2	11,163	21	7	7
1983	2,858	6	5	2	8,302	15	6	5
1984	2,971	6	5	2	8,930	17	6	6
1985	3,084	6	5	2	9,702	18	7	6

(a) Using F.B.I. standard of 1.8 officers per 1000 population

(b) Using present base of 5, one additional dispatcher was added for each five additional officers.

(c) Assumes the standard of 1 vehicle per 3 officers.

SOURCE: Estimates based on F.B.I. standards and COG's Growth Monitoring Information System

police department has a 4-channel base radio, which has been adequate as long as calls are limited to Rifle. The current radio does not allow contact between Rifle and others outside Rifle (Glenwood Springs, State Patrol, etc.) at the same time, the police department sees a need for a 6-channel base radio, 1 jerk and run, 5 pagers and 1 encoder.

Presently, the department uses an instamatic camera purchased by the officers themselves for documentation. With an increase in criminal activity better photographic equipment and investigative tools are needed in order to procure evidence needed for the courts.

Rifle has two patrol cars - a 1976 and 1977 Plymouth. There are plans each year to replace the oldest car which usually has about 60,000 miles after two years' use. The department has submitted a grant application for a third car. Under natural growth the present system is adequate, but with impact growth a third vehicle will be needed by the end of 1978 and as many as six vehicles by 1985 will be needed (Table 6).

As Rifle's population expands, the department will have to increase funding. Sources of funding could be the city budget, Law Enforcement Assistance Administration (LEAA) and the Oil Shale Trust Fund.

TABLE 7

INCREASED FACILITIES REQUIREMENTS FOR POLICE FUNCTION
UNDER CONDITIONS OF NATURAL AND IMPACT GROWTH
IN THE CITY OF RIFLE
1978 to 1985

	Natural Growth		Impact Growth	
Year	Total Employees[a]	Total Sq. Feet	Total Employees	Total Sq. Feet
1978	10	1700	11	1870
1979	10	1700	20	3400
1980	10	1700	19	3230
1981	10	1700	26	4420
1982	10	1700	28	4760
1983	11	1870	21	3570
1984	11	1870	23	3910
1985	11	1870	25	4250

(a) Total of police officers and clerical staff.

SOURCE: Estimates based upon FBI's standards of a ratio of 170 square feet per employee.

The police headquarters operates in an 1128 square foot office in city hall with four rooms: the Chief's office, a dispatch office, an interrogation room, squad room and one holding cell. The holding cell is adequate in cases of only one arrest or as long as the prisoners do not become violent. Table 7 indicates that based on a ratio of 170 square feet per employee, natural growth conditions would require more than 700 square feet of additional space. Impact growth conditions show that a substantial increase in office space will be needed of 3000 to 3500 square feet.

The figures presented in this section are rough estimates. The Rifle police department must periodically evaluate its needs based on population and work load. The department needs careful planning to prepare for the increased demands resulting from the rapid growth situation in Rifle.

VI. FIRE PROTECTION

The Rifle Fire Department is operated in conjunction with the Rifle Ambulance service under the Rifle Volunteer Fire Protection District. The District was formed in 1976 and began operations on January 1, 1977. The district covers approximately 175 square miles. It borders the Grand Valley Fire District on the west at Anvil Points, the Silt Fire District on the east at Miller Lane and the National Forest on the north and south.

The fire station is located on the first floor of the Rifle City Hall building and consists of 2400 square feet of space. It provides storage space for three fire trucks and two ambulances. One ambulance stall provides area for regular monthly meetings. The city's present fire protection equipment consists of four trucks. Two of the trucks can be used on the hydrant system - a 1064 Ford 750 gpm pumper and a 1000 gpm pumper. The other two trucks are a 1966 Ford pickup with an independent 300 gallon tank and a U.S. Forest Service truck with a 500 gallon tank.

Currently there are 25 volunteer firemen plus 28 rescue or other emergency service volunteers. The District is planning to add 10 personnel to its force at the present time.

As of 1962, Rifle's fire protection was rated a Class 7 protection level inside city limits and a class 10 outside the city by the Insurance Services office. Fire protection is rated in order (good to poor) from Class 1 to Class 10 on a point system basis. As determined by periodic I50 inspections. Results are then used to establish fire insurance rates in and around the city.

As rapid population growth is felt within the city limits and in the fire protection district, the volunteer fire department will be faced with an expansion of its crew and of its operating space. Issues such as whether to create a projessional firefighting force, perhaps supplemented with volunteers, and where best to

locate a satellite fire station in relation to future patterns of population settlement will need to be addressed by the District as growth continues.

VII. PUBLIC WORKS

Rifle's Department of Public Works has responsibility in the areas of parks, weed and pest control, cemetery, sanitation, streets, and limited social work. Because most of these are discussed elsewhere in this Development Guide. this section deals with the department's single largest operation, the construction and maintenance of streets, curbs and gutters, and sidewalks. The extent of improvements in these public works activities is determined in general by the amount of revenues generated from property tax assessments and by political priorities. Anticipated impact growth conditions will dictate how much and what type of public improvements actually occur.

The major public works project to be undertaken by Rifle is the proposed bypass of State Highway 13 away from the central business district. Though six alternative routes have been suggested and studied, a final choice has yet to be made. In November, 1978, the city's voters will go to the polls to select their preference for the bypass route. In addition, to the road's exact configuration, other matters remain uncertain at this time, such as the timing of actual construction on the bypass, and the extent of participation by the State Highway Department in building

it. It presently appears that public opinion favors a plan for phasing the construction of two routes, alternative three and alternative six. By mid-1980, the City expects to have completed $700,000 worth of grading and drainage work on alternative six and to have committed some $1.7 million on right-of-way acquisitions for both alternatives three and six. In addition, the Joint Budget Committee appropriated $500,000 on July 1, 1978 to the City of Rifle for preliminary studies and right-of-way acquisition for the bypass project. Rifle is also currently planning the extension and re-engineering of nearly 10,000 linear feet of existing roadways, at an estimated cost of $49,000 as part of its capital improvements program. Construction costs for widening pavement and curb and gutter to standard on these improvement projects amount to $980,000. In the 1978 to 1983 period, additional public works projects are scheduled for street paving ($619,000), curbs and gutters (481,000), and sidewalks ($354,000) totalling almost $1.5 million. Most paving, as well as curbs, gutters, and sidewalks will be the responsibility of developers in new sub-divisions. Therefore, no additional expense for paving is immediately anticipated except for the amount presently planned to complete current paving and pavement preservation efforts.

Recurring capital expenditures, such as for tools, equipment , and vehicles have been included in Rifle's capital improvement program. Current forecasts by city

officials show $15,000 to $20,000 in needed expenditures annually between 1978 and 1985. Adding major equipment and facilities to accommodate the impact growth will not be required in the near future, but should be planned and budgeted for by the early 1980's.

The present public works maintenance crew of six will need to be expanded as Rifle's population grows. Utilizing a ratio of two maintenance personnel per 1000 population, Rifle will need roughly 20 employees on its public works staff from 1981 through 1985 under conditions of impact growth. This is shown in Table 8.

TABLE 8

ESTIMATED MANPOWER REQUIREMENTS FOR PUBLIC WORKS
UNDER CONDITIONS OF NATURAL AND IMPACT GROWTH
FOR THE CITY OF RIFLE
1978-1985

Year	Natural Growth Total Employees	Impact Growth Total Employees
1978	5	8
1979	5	15
1980	5	14
1981	5	21
1982	5	22
1983	6	17
1984	6	18
1985	6	19

Assumes a need for 2 employees per 1000 population.

SOURCE: Estimates based on COG's Growth Monitoring Information System.

XII COMPREHENSIVE PLAN PROCESS

I. INTRODUCTION

A comprehensive plan is an official public document adopted by a local government which sets forth major long-range policies concerning desirable future physical and social development. The document itself is variously known as a master plan, general plan, concept plan and development plan. Whatever it is called, it seeks to delineate and guide the growth of the community in a manner which would achieve the conceptualized goals that community members have set for it. In a rapid growth situation, an over-all plan or set of goals is even more essential. Without it, Rifle will not be able to take full advantage of the potentials presented by growth. Without a set of explicit goals and programs, decisions will be made haphazardly, and the community will certainly reflect that.

For any community to establish development goals, it must first have a thorough understanding of what it already has and what kinds of needs will be presented in the future. This document attempts to fill that need.

The major intended purposes of this Development Guide are to provide the residents of Rifle with a thorough inventory and analysis of existing community

characteristics; assessments of existing facility and program needs as disclosed by the application of accepted standards and community inputs; and projections of changes in community characteristics and needs as a consequence of natural growth and rapid growth conditions. The baseline and projective data produced by this effort are intended to provide Rifle with a documented springboard from which its residents can design specific programs; seek funding; and generally better manage Rifle's impending growth.

A development guide document is but one step in a community's development planning process. Figure 1 illustrates the document's role in a comprehensive development planning process. Without such a process this document and the potentials for growth management that it presents will end up being ineffectual. While it is the intent of this document to provide a description as to the likelihood Rifle is expected to grow and develop, it has not dealt with specific policies, in which to coordinate the expected impacts. Consequently, it is felt that in the next step of the development process, a number of concepts could be explored to help facilitate a policy growth plan. These concepts presented at the end of the chapter could be used as tools to assist Rifle in the development a growth management program. These concepts would address such growth and development issues such as City services, land uses, etc. It should be mentioned that these concepts are merely ideas, and do not necessarily indicate established policy. They do provide

THE DEVELOPMENT GUIDE WITHIN A COMMUNITY DEVELOPMENT PLANNING PROCESS

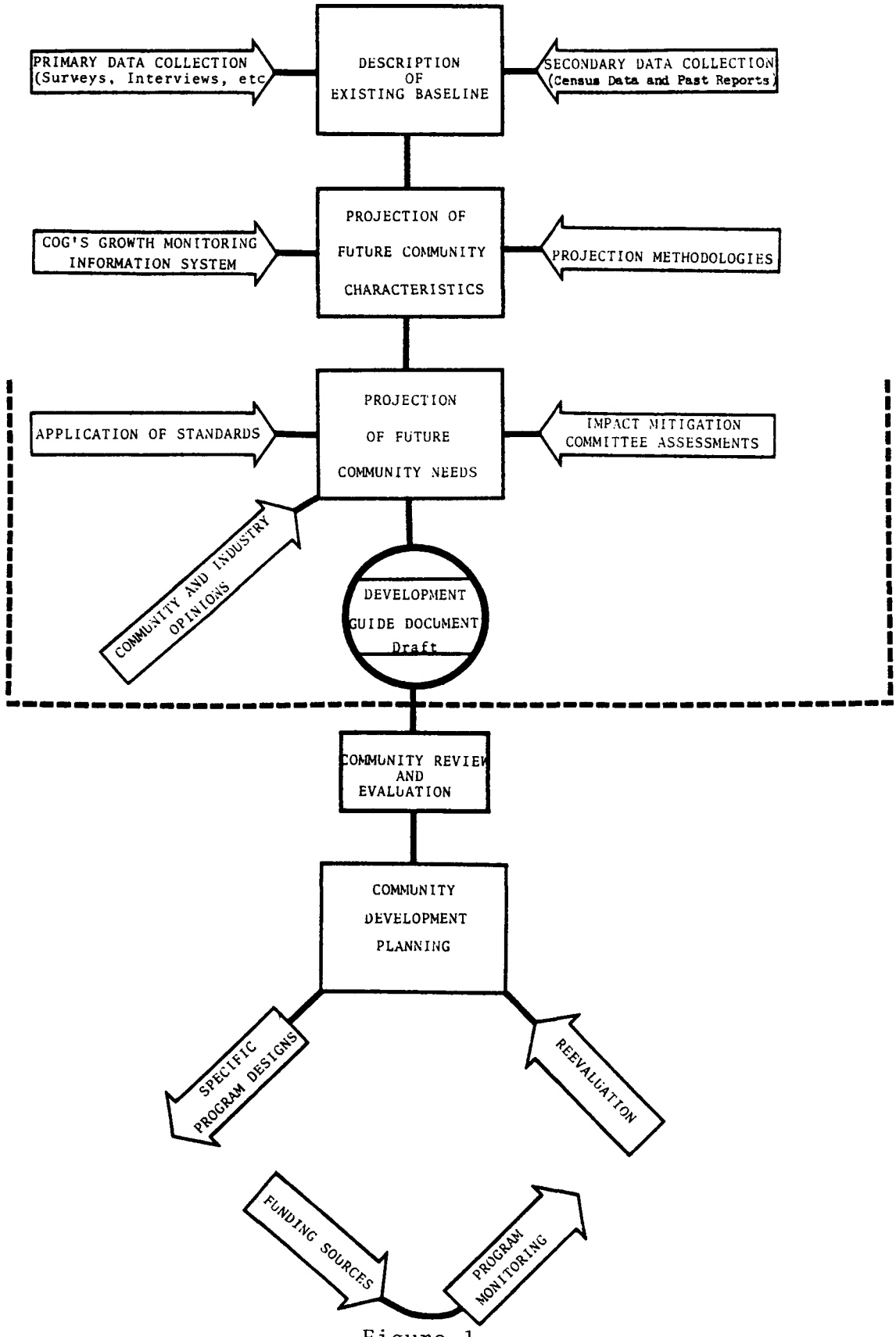


Figure 1
XII-3

a level in which thoughts can be oriented to generate the framework in establishing a policy growth plan. Also, this list is not intented to be complete, since that is beyond the scope of this document.

II. THE PLANNING PROCESS

A planning process usually has four distinct stages: an overt or implied statement of goals and objectives; the basic research and analysis work; the documentation of baseline and projective data; and the implementation of desired programs. The single connecting thread throughout these efforts is provided by public information, education and participation.

A comprehensive plan is a guide to orderly town development in promoting the health, safety, welfare, and convenience of the people of a community. It also provides an important vehicle by which a community can capitalize on benefits that growth presents and minimize any undesirable impacts that too rapid a growth may present. The process of preparing a plan offers many opportunities for citizens to express their views and to contribute to the formulation of the community's implementation policies. Effective citizen participation includes the involvement of elected officials, planning commission members, representatives of clubs and organizations, special interest groups, business firms, property owners, and the general public. Rifle

already has a wealth of organized group and individual citizenry involvement on which such a participatory process could be built. Citizen input helps to assure elected officials that their decisions are meeting the expressed needs of the people; it provides planning commissions with suggestions as to which of the many alternatives for future physical development should be pursued; and it affords local citizens the opportunity to express their opinions about the accountability they expect to see in future land use determinations. It is now an age-old planning axiom that for political and practical reasons citizens must be involved in all phases of the comprehensive planning process.

The techniques for encouraging and channeling citizen input are many, ranging from formal, permanent advisory commissions to impromptu group rap sessions. What specific techniques will work when and how is best determined by the community itself at the initiation of those individuals who are committed to expending a lot of energy seeking public input and participation.

Some of the ways of promoting citizen participation in a planning process which are suggested by the Colorado Division of Planning, Department of Local Affairs are:

- Forming citizen advisory groups
- Utilizing existing and community neighborhood associations.

- Distribution of questionnaires and conducting opinion surveys.
- Holding structured public hearings and workshops
- Developing slide presentations and other media items
- Publishing newspaper articles and entire community newsletters

The public educational value of any plan is greatest during the period of deliberation over the preliminary plan. It is felt that a public review of this Development Guide draft would present such an opportunity. The communication and education process will provide a test of public acceptance of the draft and would provide a direction for public officials in its use.

In most cases any comprehensive plan effort would begin with a go-ahead from the legislative body. In the case of Rifle, this would be the city council. Usually the city planning staff would prepare a preliminary version of the baseline, growth projections and future needs, assisted by the planning commission. In the case of Rifle, it is hoped that the material presented in the Development Guide will make that task considerably easier. What the citizens of Rifle need to add to this Development Guide, through the suggested participatory process, are expressions of consensus on major goals and objectives and priority implementation strategies. A list of development policies is provided at the end of this chapter.

A comprehensive community development plan is not considered formal legislation and is therefore usually adopted by public resolution. The resolution usually addresses the general procedures that will be used to implement the plan and to keep it current.

The success of a comprehensive plan depends on the way in which it is implemented. While each project may be implemented separately or in conjunction with others, implementation planning is usually a separate task for each project. Each project will have its own requirements for administration, work programming, budgeting and source funding. Even the scale of implementation may require separate development schemes or administrative frameworks for different project elements. Regardless of the project diversity or administrative overlaps, each implementation project should be open to public participation; coordinated with as many supportive agencies and individuals that express an interest; and evaluated, monitored and re-evaluated as to its compliance with expressed over-all goals of the adopted comprehensive plan.

III. THE PLANNING DOCUMENT

While there are no ideal or legislated formats for a comprehensive plan, there is general professional agreement on the types of data that are required for a comprehensive plan. The State of Colorado (Division of Planning, Department of Local Affairs) has prepared a valuable planning

manual intended to provide a step-by-step suggested procedure and format for a community's comprehensive planning efforts: Comprehensive Planning - A Manual for Colorado Planners and Land-Use Administrators, January, 1977. An attempt has been made from the onset of initial data collection that efforts in developing the Guide would meet those suggestions. In most instances, the level of data detail far exceeds the suggested levels and should be more than sufficient to comply with the suggested inventory, projection and needs assessment efforts. This document does make suggestions as to what goals and objectives Rifle should have in forging their future. This element of a comprehensive plan, along with the planning process itself, will need to be added by the local citizenry.

The following goals and objectives, taken primarily from the manual, Comprehensive Planning, are defined in terms of seven planning elements. A goal is defined as a statement of general values desired by a community's citizenry for its area, while an objective is defined as a realistic and achievable statement of intention for which specific implementation programs can be designed.

Each element should state its own specific goals and objectives, though many of the elements are inter-related. The seven elements of a model comprehensive plan include: (1) land use, (2) transportation, (3) housing, (4) public

facilities and services, (5) parks, recreation and open space, (6) environmental resources and hazards, and (7) appearance and design. Following is a description of what ideal goals and objectives should encompass within each of the seven elements.

A. LAND USE

The land use planning goal should provide guidance as to the type and distribution of land use desired in Rifle . Objectives should be set out by categories which consider local and regional development and residential, business, industry, agricultural, and forest land uses.

Local and Regional Development

Objectives should consider:

a. Types and extent of growth to be encouraged and discouraged.

b. Cooperative processes to be employed in assuring that future development is compatible with local and regional scales of planning.

c. Ways in which local and regional decision-making is to be strengthened and self-determination maintained in development decisions.

d. Basic principles to be employed to provide an orderly transition from rural to urban land use.

Residential

Objectives should consider:

a. Guidance for the location of new residential areas.

b. Relationships of residential land use to other types of land use and development.

c. Housing types to be encouraged.

d. Types and extent of innovations and experimentation to be encouraged in the design of residential areas.

e. Uses and placement of residential densities.

f. Relationship of residential areas to public services and transportation systems.

g. Development potential for various locations of vacant land.

h. Needs and locational factors related to energy consumption.

Business and Industry

Objectives should consider:

a. Basis for distributing and locating the areas of business and industrial land use.

b. Types, extent, and classifications of business and industrial concentrations to be encouraged or discouraged.

c. Relationship of business and industry to population settlement patterns and growth management.

d. Design, appearance, and improvement of these areas as they have developed or are intended to develop.

e. Special servicing requirements needed to assist in the development of business and industrial land use areas.

f. Positions relating to unusual or external development pressures, such as for tourism, large-scale recreational areas, or energy development.

g. Energy conservation relating to business and industry.

Agricultural and Forest

Objectives should include:

a. Land conservation and development practices related to agriculture and forest areas.

b. Relationships of these areas to more urbanized types of land use.

c. Design and management of access and other rural service and facility requirements.

d. Financial or other incentive and regulations to assist in maintaining the use and character of these lands where appropriate.

B. TRANSPORTATION

The transportation goal should consider the needs for mobility of all residents in Rifle, regardless of age, handicap, or income level. The objectives should consider:

a. Cooperation and coordination of local, regional, and state transportation systems.

b. Effects and relationships between transportation and land use patterns.

c. Transportation requirements of inaccessible portions.

d. Transportation requirements to supply and reinforce development patterns.

e. Use of public transportation in urban and rural areas.

f. Special transportation needs related to the shipment and delivery of products.

g. Uses and needs for transportation alternatives including railroads, airports, and bikeways.

h. Transportation improvements needed to provide greater convenience, accessibility, and reduced travel time.

i. Social and economic costs and benefits of transportation.

j. Reconciling needs between transportation, energy consumption, and the environment.

C. HOUSING

This goal should express the concerns and assurances for housing opportunities in Rifle . The objectives must consider the various housing problems, issues, and needs and should include the following as a minimum:

a. Provisions for the elimination of any discrimination in housing.

b. Relationships and coordination of housing plans among the various agencies having an involvement with housing .

c. Strategies in meeting housing needs and assuring an adequate supply of housing.

d. Maintenance and rehabilitation of existing housing.

e. Development and coordination of dispersed housing for low-income families having a housing need.

f. Incentives to reverse trends or otherwise alter housing patterns and market conditions that are inefficient from the standpoint of land absorption.

g. Financial and site design review incentives to promote housing production.

h. Energy conservation practices relating to housing.

D. PUBLIC FACILITIES AND SERVICES

This goal should deal with providing efficient public facilities and services to meet the needs of Rifle residents. These facilities and services include government buildings; educational institutions; utilities (water, sewer, gas, electricity, telephone); solid waste disposal; and police and fire protection services.

Objectives should consider the following:

a. Consolidation and combination of services as appropriate to local or area-wide needs.

b. Use and timing of public facilities and services as a form determinant for growth and land use development.

c. Reducing the costs of providing facilities and services and encouraging private participation in meeting public service needs.

d. Monitoring progress in achieving plans and programs through the use of public facilities and services.

e. Programming public improvements and services.

f. Needs and provision for education and cultural achievement.

E. PARKS, RECREATION, AND OPEN SPACE

The park, recreation, and open space goal should set out the basic purposes for which the system is intended. Objectives should consider:

a. Categories and distribution of park, open space, and recreation areas.

b. Utilization of areas unsuitable for other types of development.

c. Application of the open space system as a form determinant for growth and land use development.

d. Types and extent of acquisition and preservation controls to be exercised in the open space and recreation system.

e. General recreational activities to be encouraged.

f. Unusual or extensive recreational activities to be encouraged.

g. Relationship to federal and state open space and recreation lands.

F. ENVIRONMENTAL RESOURCES AND HAZARDS

This goal should characterize the public's concern for the preservation and conservation of the local natural and man-made environment. Objectives should take into consideration:

a. Areas and activities having present and potential environmental consequences.

b. Preservation of environmental features such as historic or archeological sites, water bodies, etc.

c. Multiple-use management of compatible features such as drainageways and streams within the open space system.

d. Public awareness and understanding of environmental issues and concerns.

e. Environmental assessment and damage control techniques.

f. Protection and control of major latent environmental dangers, including flood, geologic hazards, and air and water pollution.

g. Coordination and cooperation among local, state, federal, and private agencies in reducing or minimizing environmental damages.

G. APPEARANCE AND DESIGN

This goal should address the aesthetic quality of Rifle. Its objectives should consider the following:

a. Qualities and characteristics to be preserved or enhanced.

b. Scale of land use appropriate to Rifle.

In general, the purpose of goals and objectives is to clearly state the long-range desires for physical development in Rifle , while helping to assure consistency and continuity of public interests when changes occur in population mix, administrative personnel and elected officials.

IV. RECOMMENDED GROWTH PLAN POLICIES

In keeping with the general guidelines detailed in the comprehensive planning process. A list of suggested policy statements is presented. This list can be the first step in preparing the format within which development policies can be made. These development policies can serve as an element to give more specified definition and direction to the future growth and development of Rifle. These policies are:

1) The pace of development and mix of housing types should insure that the supply meets the demand relative to worker preferences.
   - Encourage flexible housing types (non-permanent housing types- to meet peak year and temporary worker demands
   - Encourage new industrial development to draw more workers. Should be timed to affect anticipated worker decrease after 1982.

2) Development should be designed and proceed at a pace that insures fiscal capability of city and adequate provision of public services.
   - Encourage new growth in areas where public services can be provided at the least cost
   - Encourage use of growth management to control pace of development
   - Encourage use of fiscal impact analysis to reveal public costs of new developments

3) Development should provide a variety of housing types which meet all income ranges.
   - Encourage planned unit developments
   - Encourage provisions for low/moderate income housing.

4) Development should be planned to reduce consumption of land and impacts on the natural environment.
   - Encourage cluster design and offer similar techniques

- Discourage new development on flood plains, steep slopes and other natural hazards.

5) The viability of the existing central business district should be enhanced.
   - Encourage expansion of existing area by use of vacant parcels and/or conversion of other land uses.
   - Discourage sprawl and strip highway commercial development.
   - Encourage compatible and discourage noncompatible land uses in commercial areas.
   - Discourage new large-scale commercial development in outlying areas that would compete with the existing area.
   - Encourage new convenience service commercial in outlying areas to serve new subdivisions.

6) Transportation should enhance viability of the existing central business district and provide adequate access within, to and from Rifle.
   - Encourage increased accessibility to the central business district.
   - Encourage "through traffic" to bypass central business district and help alleviate congestion.
   - Encourage development of additional parking.
   - Encourage alternative means of transportation throughout the city (pedestrian, bicycle, etc.)
   - Encourage development of street plan for city to insure that function of streets (local, collector, arterial) are compatible with adjacent land uses.

- Encourage location and function of new streets to be compatible with street plan and allow for future development.

7) Adequate park land and recreational facilities should be provided for current and future needs.
   - Encourage potential recreational development of existing city owned land, flood plains and other vacant parcels.
   - Encourage adequate recreational areas and proper development of facilities in new subdivisions.
   - Encourage playgrounds and neighborhood parks to be located to provide adequate accessibility for all parts of the city.
   - Encourage regional coordination and planning for locating new recreational facilities.

APPENDIX D

SHALE OIL REFINING ANALYSES REPORT

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SHALE OIL REFINING ANALYSIS

Prepared For

Occidental Oil Shale, Inc.

For PACE

W. J. Mears

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T. J. Manning

November, 1978

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A

INTRODUCTION

The Pace Company Consultants & Engineers, Inc. was retained by Occidental Oil Shale, Inc. to assist in identifying key technical and economic parameters which affect the refining value of Occidental's shale oil. The study has been exploratory in nature and has relied in part on available literature estimates for certain investment and refinery process parameters. The results are intended for screening purposes in establishing the scope of future detailed pilot plant and engineering studies.

In this study, Pace examined the refining value of Occidental's shale oil in a refinery of intermediate complexity typical of those located in the Petroleum Administration for Defense District (PADD) 4. Pace has worked closely with Occidental personnel to develop estimates of key shale oil-related parameters which will impact refinery operations. These parameters were incorporated into Pace's Refinery/Petrochemical Linear Programming (LP) Model to simulate refinery operations with shale oil.

B

MANAGEMENT SUMMARY

GENERAL

This section summarizes Pace's conclusions on the refining of Occidental's shale oil in a typical PADD 4 refinery. It also presents recommendations for future pilot plant testing and engineering analysis needed for better definition of the key economic and technical parameters which affect shale oil's refining value.

The quantitive results of Pace's analysis should be considered tentative since they are based, in part, on available literature estimates of certain investment and process unit parameters. Future pilot plant and engineering studies are required to establish accurate data for a reliable economic analysis. Since the main objective of the study was to define those areas where the economic results are particularly sensitive to the quality of the cost or yield estimates, the actual processing requirements and value of Occidental's shale oil relative to conventional crude oils may differ from the results developed by Pace in this study. Moreover, Pace believes that the additional refining costs for shale oil processing indicated in the report are conservative and should be reduced in the future.

The base refinery selected for analysis was assumed to have a crude oil processing capacity of 32.6 thousand barrels per stream day. The major processing units incorporated in the refinery included atmospheric and vacuum crude oil distillation, naphtha hydrotreating and reforming, fluid catalytic cracking (FCC), and alkylation. The base feedstock slate to the refinery was assumed to consist of a 75/25 mix of low/high sulfur crude oils typical of those produced in PADD 4.

Shale oil processing in this refinery was analyzed within a framework of alternative cases to examine the requirements for:

1. Expanding the base refinery's processing capacity, with North Slope crude oil as the incremental feedstock.

2. Expanding the base refinery's processing capacity, with Occidental's shale oil as the incremental feedstock.

3. Substituting high sulfur asphaltic PADD 4 crude oil in place of low sulfur crude oil.

4. Substituting Occidental's shale oil in place of low sulfur crude oil.

In each case, the expansion or substitution volume was fixed at 30 percent of the base refinery's processing capacity. Simulations of the refinery operations were developed using Pace's Refinery/Petrochemical Linear Programming (LP) Model. The product slates in each pair of alternate cases were maintained substantially identical so that the differences between the refining values of shale oil and each crude oil could be determined on the basis of the different processing requirements.

In each shale oil case, a primary hydrotreater was included in the refinery process configuration for treating the whole shale oil feedstock. Operating severity (expressed in terms of percent denitrogenation) was limited to a range of 87.0 to 97.5 percent. The shale oil fractions were then directed to downstream processing units, including secondary hydrotreating, as required to meet the requirements for product volumes and quality specifications.

CONCLUSIONS

Following are the major conclusions derived from Pace's study.

- The optimum shale oil hydrotreating severity for the processing configuration which has been analyzed is lower than 87 percent. Further studies will be required to establish the economic and process yield interactions between shale oil hydrotreating severity and conventional refinery processes.

- The refining value of Occidental's shale oil in the refinery selected for this analysis is estimated to be $2.02 per barrel less than the value of Alaskan North Slope crude oil. This is based on the differences in variable operating costs, modest changes in product slate, and capital charges approximating a 10 percent DCF rate of return on the incremental investment requirements.

  On the same basis, the refining value of Occidental's shale oil is estimated to be $1.31 per barrel less than the selected PADD 4 high sulfur asphaltic crude oil.

- Refining cost differentials between shale oil and conventional crude are most sensitive to incremental capital, particularly for the shale oil hydrotreater. For that unit, estimates ranging between $1,500 and $3,000 per barrel of capacity were found in the literature and a value of $2,730 per barrel was used in the study. In view of the relatively lower contaminant levels and residual content of Occidental's shale oil compared to other shale oils, the cost could be expected to trend toward the lower end of the range. However, due to the uncertainty in applying a complex process to an untested feedstock, Pace chose a conservative capital case.

Also, in all cases examined, a large component of the incremental capital cost covered expansion of the FCC unit. This capital cost was arrived at based upon throughput volume only. This approach could possibly penalize the shale oil case since the incremental feedstock will have been severely hydrotreated which may allow for a lower cost cracking expansion.

- Shale oil contains less light, low boiling point material and less heavy residual material than an average petroleum crude oil. The boiling range for shale oil is typically 375°F to 1,030°F. As refinery product demands shift to more fuels products (kerosene, No. 2 fuel oil, No. 6 fuel oil, etc.) and less motor gasolines, the refining value of shale oil should increase.

RECOMMENDATIONS

Pace offers the following recommendations to assist in defining the scope of future shale oil processing evaluation efforts.

- Future analyses should evaluate whole shale oil hydrotreating severities below the 87 percent nitrogen removal level. It will be necessary to determine the impact of the resulting higher nitrogen content of shale oil fractions on downstream conventional refinery processing units. The impact of shale oil nitrogen content on FCC operations and yields should be determined. Actual requirements for secondary treating of shale oil fractions should be assessed based upon possible alternative dispositions in the refined product slate or refinery process units.

- Due to the extreme economic sensitivity to capital and operating cost of the shale oil hydrotreater, a cost estimate should be acquired for specific processing equipment to accomplish this step.

- The quantity of shale oil (as a percent of refinery feed or total volume processed) should be varied in future studies. By varying the shale oil quantity, the economic impact of process unit economies of scale will be indicated. The effects of different refined product and feedstock slates should also be analyzed.

- A shale oil processing option that should be evaluated is hydrocracking. Hydrocracking might be more desirable than the hydrotreating/FCC combination in certain grass roots refinery applications, or in plants whose product slates are weighted more heavily towards jet fuel and other middle distillate fuels products.

- Consideration should be given to assessing whole or treated shale oil as coker feedstock. This option was not included in the scope of this study.

C

BASES

This section defines the bases used in determining the requirements for refining Occidental's shale oil. Included is a discussion of the following:

- Definition of the cases studied
- Raw materials availability
- Product slate and specifications
- Investments
- Refinery operating costs
- Utility consumption rates for the processing units
- Shale oil hydrotreating material balance
- Crude oil assays

CASES STUDIED

The requirements for processing Occidental's shale oil were evaluated for a "typical" PADD 4 refinery of intermediate complexity with a light, low sulfur crude oil feedstock. A forecasted 1980 product demand pattern for PADD 4 was utilized.

The cases studied are identified below:

Reference Case

This case evaluates the typical PADD 4 refinery with feedstock, processing units, and product slate at expected 1980 levels. Figure C–1 shows a block flow diagram of the refinery in this case.

Refinery Expansion Analyses

These cases considered increasing the refinery capacity by 30 percent from 32.6 to 42.38 thousand barrels per stream day. Installation of new processing units and expansion of existing processing units were allowed. The incremental products were targeted to be approximately 30 percent gasoline and 50 percent distillates.

Alternate Case 1

The incremental feedstock was assumed to be Alaskan North Slope crude oil.

Alternate Case 2

The incremental feedstock was assumed to be Occidental's shale oil.

Feedstock Substitution Analyses

These cases maintained the same primary feedstock capacity as in the Reference Case. Each alternate feedstock replaced 9,780 barrels per stream day of the light, low sulfur feedstock. Installation of new processing units and expansion of existing processing units were allowed. The product volumes were maintained at substantially the same rates as in the Reference Case.

Alternate Case 3

The alternate feedstock was assumed to be a PADD 4 high sulfur asphaltic crude oil.

Alternate Case 4

The alternate feedstock was assumed to be Occidental's shale oil.

In each of the Alternate Cases, new processing requirements were economically selected by Pace's Refinery/Petrochemical LP Model. Within the constraints applied, the Model optimized the disposition of streams to the various refinery process units and product pools.

RAW MATERIALS AVAILABILITY

The raw materials available to the refinery are summarized in Table C–1. The crude oils were fixed at the rates shown in the table. Utilization of the purchased streams was allowed without limitations on volume. Excess refinery fuel gas was allowed to be sold at $2.30 per million BTU's.

PRODUCT SLATE AND QUALITY SPECIFICATIONS

For the Reference Case, motor gasolines, commercial Jet A, No. 2 fuel oil, and No. 6 fuel oil volumes were limited with minimum and maximum constraints to represent expected 1980 product slate requirements.

For the Expansion Cases (Alternate Cases 1 and 2), the incremental volume of motor gasoline was restricted to approximately 3.0 thousand barrels per day above the Reference case. Commercial Jet A volume was limited between 5.5 and 6.1 thousand barrels per stream day; No. 2 fuel oil volume was limited between 5.3 and 5.9 thousand barrels per stream day. No. 6 fuel oil volume was not limited.

For the Substitution Cases (Alternate Cases 3 and 4), motor gasoline volumes were limited to a maximum of 5 percent above the Reference Case volumes. Commercial Jet A and No. 2 fuel oil volumes were limited to a ±5 percent variation from the Reference Case volumes. No. 6 fuel oil volume was not limited.

Table C-2 defines the product quality specifications imposed.

INVESTMENTS

Process unit investment requirements were developed using Pace's estimates of 1978 investment rates. Offsite facility investment estimates for steam generation, electric power distribution, cooling water, and tankage were similarly developed based on the specific requirements for each case. Unspecified "Other Offsites" investment was taken as 10 percent of total onsite investments and was not intended to include allowance for facilities such as new laboratories, roads, administration buildings, shops, and warehouses.

The estimated investments for shale oil hydrotreating facilities which are presented in the literature vary over a considerable range. Estimates between $1,500 and $3,500 per barrel of feed capacity have been cited (see below).

It was recognized that the difference between the investment requirements for the two shale oil hydrotreating severities (i.e. 87 and 97.5 percent nitrogen removal) would be a key parameter. However, development of a complete process design basis and detailed cost estimate for the shale oil hydrotreating facilities was beyond the scope of this study. Therefore, Pace elected to utilize available investment estimates for low and high severity hydrocracking process units as a basis for the two shale oil hydrotreaters which have been considered. The resulting estimated investments used in this study are as follows:

Percent Nitrogen Removal	Investment $MM	Investment $/Bbl
87.0	26.7	2,730
97.5	33.6	3,440

References:

1. "Refining And Upgrading of Synfuels From Coal And Oil Shales By Advanced Catalytic Processes", R.F. Sullivan, et al, Chevron Research Company, First Interim Report/Processing of Paraho Shale Oil, prepared for U.S. Department of Energy, July, 1978.

2. "Economic Screening Evaluation of Upgrading Coal Liquids To Turbine Fuels", M.J. Dabkowski, et al, Mobil Research and Development Corporation, prepared for Electric Power Research Institute, March, 1978.

Pace recognizes that these investments are in the upper range of those quoted elsewhere. As such, the additional refinery costs for processing shale oil relative to conventional crude oil could be lower than indicated by the results of this study.

REFINERY OPERATING COSTS

The costs for direct operating manpower, utilities, and maintenance costs are specified in Table D–5. The costs indicated in Table D–5 for supervision and technical manpower are taken as 60 percent of direct operating salaries and wages. Plant administration is calculated as 50 percent of the sum of direct operating and supervision and technical manpower costs. Taxes and insurance are estimated to be 2 percent of the total plant investment.

SHALE OIL PROCESSING

The major consideration in shale oil processing is removal of nitrogen from the oil stream. This can be achieved by either hydrotreating the whole raw shale oil or hydrotreating the fractions individually, or a combination of both. Pretreatment of the shale oil to remove arsenic and particulates is required.

Pretreatment of Whole Shale Oil

Conventional hot water desalting used to treat crude oil can be used for particulate removal and to dewater shale oil. The particulate matter in the whole shale oil could also be removed by passing the stream through small pore filters. Such filters are currently in use to remove particulates from crude oil atmospheric residuum prior to hydrodesulfurization. It might prove optimal to filter prior to desalting in order to improve performance of the desalting equipment.

A guard bed in front of the reactor train of the shale oil hydrotreating unit for removal of arsenic and iron should be installed. Alumina catalyst with a moderate surface area is indicated to be effective in this service. Research has also indicated that arsenic and iron may be removed by non-catalytic thermal treatment at 750° to 850°F in the presence of hydrogen at 500 to 1,500 psig.

Shale Oil Hydrotreating

Hydrotreating shale oil is similar to conventional petroleum hydrotreating normally employed to reduce the sulfur content of refinery streams. A shale oil hydrotreating unit must operate at a higher severity than a conventional unit to successfully remove nitrogen from the oil stream. The requirement for higher operating pressures results in greater capital investment due to thicker walled vessels and lines, high pressure flanges, valves, and higher head pumps and compressors.

The formulations of catalysts used for shale oil hydrotreating are considered proprietary, but are likely to be advanced cobalt-nickel-molybdenum types commonly employed in hydrocracking applications.

Reaction conditions can vary over a wide range. Upper limits on reactor temperatures are likely to be in a range of 760° to 780°F, similar to conventional petroleum processing limits. Operating pressures and hydrogen consumption could vary over an extremely wide range, depending upon actual severity requirements.

The overall processing concept most often suggested is to denitrogenate whole shale oil to a level such that the gas oil fraction (boiling between approximately 525°F and 1,000°F) for catalytic cracking has a sufficiently low nitrogen content to prevent undue deactivation of FCC catalyst. Under such conditions, further hydrotreating of the shale oil naphtha fraction would be required to lower its nitrogen content for use as catalytic reformer feed. (A commonly used maximum for reformer feed nitrogen content is 0.5 ppm.) Additional hydrotreating might also be required on the middle distillate fractions blended in kerosene, diesel, or jet fuel products to meet specifications on gum level and product stability.

Precise definition of operating parameters for both the whole shale oil and downstream processing units will require pilot plant testing on the specific shale oil being processed, complete data on any crude oil to be processed with the shale oil, and the exact product specifications.

Other Processing Options

An alternate to the general approach of hydrotreating the whole shale oil has been suggested by some researchers. It involves distilling the whole shale oil into the appropriate boiling range fractions and individually hydrotreating each of them. The individual hydrotreaters would operate at somewhat more severe conditions than if the whole oil had been treated prior to distillation. This scheme provides greater control over the specifications of each fraction.

Whole shale oil has also been considered for use as feed to delayed coking which produces coke and coker distillate products. The distillates must be hydrotreated for use in refinery processing and product blending. The disposition, quality, and value of the coke product must be evaluated in addition to the other processing alternatives if shale oil coking is considered.

Basis For Pace's Study

To evaluate Occidental's shale oil as feedstock, Pace only considered the scheme which employs primary hydrotreating of the entire shale oil stream followed by secondary hydrotreating of the shale oil naphtha and middle distillate fractions. Particulate removal was assumed to be accomplished via double desalting. Arsenic removal was assumed to be accomplished by catalytic hydrotreating at a pressure of 500 psig.

The operating conditions for the whole shale oil hydrotreater were estimated to be similar to low and high severity hydrocracking. The material balances and utility consumptions utilized for the two shale oil hydrotreater severities are given in Table C-3.

CRUDE OIL ASSAYS

The four crude oil types considered in this study are:

Crude Oil Type	°API	Wt.% Sulfur
Low Sulfur	39.0	0.182
High Sulfur	26.2	2.250
Alaskan North Slope	27.5	0.960
Asphaltic	23.0	2.700

The high and low sulfur and asphaltic crude oils are typical of PADD 4 indigenous crude supplies. Tables C-4, C-5, C-6, and C-7 present the assay data for these four crude oils.

TABLE C-1

REFINERY INPUT SUMMARY
(Barrels Per Stream Day)

	Reference Case	Alternate Case 1 North Slope	Alternate Case 2 Shale Oil	Alternate Case 3 Asphaltic	Alternate Case 4 Shale Oil	
Crudes						
Low Sulfur	24,000	24,000	24,000	14,220	14,220	
High Sulfur	8,600	8,600	8,600	8,600	8,600	
Alaskan North Slope	0	9,780	0	0	0	
Asphaltic	0	0	0	9,780	0	
Shale Oil	0	0	9,780	0	9,780	
Total Crudes	32,600	42,380	42,380	32,600	32,600	
Purchased Streams						Purchase Price $/Bbl
Fuel Gas (FOE)	0	0	0	0	0	15.75
Isobutane	218	0	0	0	0	13.86
Normal Butane	685	895	363	650	580	13.44
Total Barrels In	33,503	43,275	42,743	33,250	33,180	

TABLE C-2

PRODUCT SPECIFICATIONS

Premium Gasoline		
Research Octane	Minimum	99.0
Motor Octane	Minimum	92.0
Lead Concentration, cc/gallon	Maximum	2.0
RVP, psi	Maximum	10.0
Percent Evaporated @ 212°F	Minimum	43.0
Regular Gasoline		
Resarch Octane	Minimum	93.5
Motor Octane	Minimum	86.5
Lead Concentration, cc/gallon	Maximum	2.0
RVP, psi	Maximum	10.0
Percent Evaporated @ 212°F	Minimum	43.0
Lead Free Gasoline		
Research Octane	Minimum	92.0
Motor Octane	Minimum	84.0
RVP, psi	Maximum	10.0
Percent Evaporated @ 212°F	Minimum	43.0
Commercial Jet A		
Sulfur Content, Weight Percent	Maximum	0.2
Pour Point, °F	Maximum	-50.0
Smoke Point, mm	Minimum	20.0
Volume Percent 285/350°F	Maximum	20.0
Volume Percent over @ 400°F	Minimum	10.0
No. 2 Fuel Oil		
Sulfur Content, Weight Percent	Maximum	0.3
Pour Point, °F	Maximum	0.0
Diesel Index	Minimum	46.0
Motor Diesel		
Sulfur Content, Weight Percent	Maximum	0.3
Pour Point, °F	Maximum	10.0
Diesel Index	Minimum	46.0
No. 6 Fuel Oil		
Sulfur Content, Weight Percent	Maximum	1.0
Pour Point, °R	Maximum	625.0
Asphalt Stock and Other		
Sulfur Content, Weight Percent	Maximum	3.0
Plant Fuel Oil		
Sulfur Content, Weight Percent	Maximum	0.75

TABLE C-3

SHALE OIL HYDROTREATER
MATERIAL BALANCE

	87 Percent Denitrified	97.5 Percent Denitrified
Products (Barrels Per Barrel Feed)		
Fuel Gas (FOE)	0.00036	0.00039
Propane	0.00114	0.00151
Normal Butane	0.00614	0.00851
Isobutane	0.00212	0.00280
C_5/160°F	0.00996	0.01444
160/220°F	0.03284	0.04741
220/285°F	0.05826	0.05927
285/350°F	0.06886	0.07543
350/400°F	0.05826	0.08621
400/525°F	0.04237	0.02155
430/525°F	0.11112	0.15086
525/650°F	0.21758	0.21616
650+°F	0.44989	0.39267
Total Products	1.05890	1.07721
Utility Consumptions		
Fuel (MBTU)	78.07	80.17
Power (KWH)	6.56	9.68
Cooling Water (MGal)	0.077	0.107
Steam (MLbs)	0.052	0.058
Catalysts/Chemicals ($)	0.103	0.177
Hydrogen (SCF)	1,447	1,913

TABLE C-4

LOW SULFUR CRUDE

DENSITY,LB/BBL = 290.35 WT PCT SULFUR = 0.182 C1 & LTR =0.004 LB/BBL C2'S =0.019 LB/BBL C3'S =0.993 LB/BBL
DENSITY,DEG API = 39.0 POUR POINT,DEG F = 6.6 IC4'S =0.481 LV PCT NC4'S =1.943 LV PCT

ASTM BOILING RANGE,DEG F CUT NAME	C5/160 C5	160/220 LN	220/285 HN	285/350 NK	350/400 LK	400/430 MK	430/525 HK	525/650 LG	650/1000 HG	1000+ VB	650+ AR
VOLUME PCT CRUDE	2.68	8.62	9.50	6.98	6.20	2.11	11.88	10.92	24.31	13.79	38.11
DENSITY,LB/BBL	227.66	242.26	257.86	267.68	275.76	279.95	287.07	298.08	315.78	346.70	326.97
WT PCT SULFUR	0.00	0.01	0.01	0.01	0.03	0.04	0.06	0.11	0.22	0.62	0.37
VOLUME FRACTION IC5	0.257										
VOLUME FRACTION NC5	0.350										
VOLUME FRACTION IC6	0.236										
VOLUME FRACTION NC6	0.157										
VOLUME FRACTION PARAFFINS		0.479	0.509	0.536	0.497						
VOLUME FRACTION AROMATICS		0.050	0.067	0.101	0.137	0.160	0.203				
VOLUME FRACTION MCP		0.060									
VOLUME FRACTION CH		0.066									
VOLUME FRACTION BENZENE		0.009									
VOLUME FRACTION C7N		0.306									
VOLUME FRACTION TOLUENE		0.040									
VOLUME FRACTION C8N			0.330								
VOLUME FRACTION C8A			0.067								
RON, CLEAR	70.3	66.1	58.2	51.3							
RON, +0.5 CC/GAL	78.0	71.4	65.8	59.4							
RON, +1.0 CC/GAL	81.8	74.6	69.5	63.4							
RON, +2.0 CC/GAL	85.9	79.9	74.3	68.8							
RON, +3.0 CC/GAL	88.3	82.7	77.9	73.3							
MON, CLEAR	73.0	65.8	0.0	0.0							
MON, +0.5 CC/GAL	78.6	71.4	0.0	0.0							
MON, +1.0 CC/GAL	81.5	74.1	0.0	0.0							
MON, +2.0 CC/GAL	85.5	78.9	0.0	0.0							
MON, +3.0 CC/GAL	87.9	82.7	0.0	0.0							
REID VAPOR PRESSURE,PSIA	12.63	3.61	2.03	1.27	0.88	0.77	0.58				
PCT EVAP AT 212 DEG F	110.0	83.1									
POUR POINT,DEG F				-103.9	-84.4	-66.6	-34.1	21.0	90.2	115.2	99.6
POUR POINT INDEX				0.5	0.6	0.8	2.1	13.0			
DIESEL INDEX				17.0	61.4	60.8	59.6	57.8			
ASTM SMOKE POINT				32.8	30.0	27.7	24.4	19.0			
VIS BLNDS NO AT 122 DEG F				81.6	74.4	58.3	54.2	47.7	29.9	11.6	23.2
UOPK	13.716	12.432	11.907	11.746	11.705	11.698	11.702	11.816	12.025	12.443	12.186
WT PCT NITROGEN								0.01	0.10		
WT PCT ASPHALTENES										9.9	3.8
METALS,PPM								0.0	0.0	35.6	13.7
HEAT OF COMBUSTION, MMBTU/LB	0.0	0.0	0.0	0.02010	0.01997	0.01989	0.01976	0.01955	0.01913	0.01834	0.01884

NOTE: PERCENT EVAPORATED,REID VAPOR PRESSURE,AND OCTANE VALUES ARE GASOLINE POOL BLENDING VALUES.

THE ABOVE ASSAY IS THE ASSAY THAT CORRESPONDS TO THE PUNCHED REVISE DECK.

TABLE C-5

HIGH SULFUR CRUDE

DENSITY,LB/BBL = 313.78 WT PCT SULFUR = 2.250 C1 & LTR =0.0 LB/BBL C2'S =0.0 LB/BBL C3'S =0.355 LB/BBL
DENSITY,DEG API = 26.2 POUR POINT,DEG F = 0.0 IC4'S =0.330 LV PCT NC4'S =0.770 LV PCT

ASTM BOILING RANGE,DEG F	C5/160	160/220	220/285	285/350	350/400	400/430	430/525	525/650	650/1000	1000+	650+
CUT NAME	C5	LN	HN	NK	LK	MK	HK	LG	HG	VB	AR
VOLUME PCT CRUDE	0.52	2.81	3.91	3.76	4.18	1.71	11.89	21.92	31.68	16.32	48.00
DENSITY,LB/BBL	227.50	246.90	261.10	270.50	277.80	282.80	291.30	305.00	330.00	369.00	343.26
WT PCT SULFUR	0.01	0.05	0.10	0.15	0.23	0.40	0.90	1.80	2.87	4.10	3.32
VOLUME FRACTION IC5	0.250										
VOLUME FRACTION NC5	0.250										
VOLUME FRACTION IC6	0.300										
VOLUME FRACTION NC6	0.200										
VOLUME FRACTION PARAFFINS		0.650	0.570	0.510	0.460						
VOLUME FRACTION AROMATICS		0.055	0.083	0.130	0.157	0.170	0.195				
VOLUME FRACTION MCP		0.045									
VOLUME FRACTION CH		0.040									
VOLUME FRACTION BENZENE		0.011									
VOLUME FRACTION C7N		0.170									
VOLUME FRACTION TOLUENE		0.044									
VOLUME FRACTION C8N			0.247								
VOLUME FRACTION C8A			0.083								
RON, CLEAR	76.0	70.0	61.0	52.0							
RON, +0.5 CC/GAL	81.9	76.2	66.8	56.6							
RON, +1.0 CC/GAL	84.9	79.4	69.9	59.0							
RON, +2.0 CC/GAL	88.1	82.9	73.0	61.8							
RON, +3.0 CC/GAL	90.0	85.0	75.0	63.5							
MON, CLEAR	68.0	62.0	0.0	0.0							
MON, +0.5 CC/GAL	76.3	71.0	0.0	0.0							
MON, +1.0 CC/GAL	80.4	75.4	0.0	0.0							
MON, +2.0 CC/GAL	84.8	80.2	0.0	0.0							
MON, +3.0 CC/GAL	87.5	83.0	0.0	0.0							
REID VAPOR PRESSURE,PSIA	10.60	4.50	2.20	1.25	1.00	0.85	0.60				
PCT EVAP AT 212 DEG F	110.0	80.0									
POUR POINT,DEG F				-92.0	-76.0	-58.0	-40.0	10.0	86.0	110.0	95.6
POUR POINT INDEX				0.6	0.8	1.2	1.7	3.5			
DIESEL INDEX				65.0	61.5	59.0	53.5	41.2			
ASTM SMOKE POINT				29.0	26.0	24.0	19.0	11.4			
VIS BLNDG NO AT 122 DEG F				75.0	70.5	64.0	60.0	48.0	28.0	9.0	21.5
UOPK	13.723	12.298	12.036	11.979	11.923	11.878	11.796	11.697	11.460	11.232	11.369
WT PCT NITROGEN								0.0	0.02		
WT PCT ASPHALTENES										35.0	12.8
METALS,PPM								0.0	0.0	0.0	0.0
HEAT OF COMBUSTION, MMBTU/LB	0.0	0.0	0.0	0.02006	0.01993	0.01984	0.01969	0.01941	0.01876	0.01793	0.01843

NOTE: PERCENT EVAPORATED,REID VAPOR PRESSURE,AND OCTANE VALUES ARE GASOLINE POOL BLENDING VALUES.

TABLE C-6

ALASKAN NORTH SLOPE

DENSITY,LB/BBL = 311.20	WT PCT SULFUR = 0.960			CI & LTR =0.031 LB/BBL		C2'S =0.124 LB/BBL			C3'S =0.498 LB/BBL		
DENSITY,DEG API = 27.5	POUR POINT,DEG F = 30.0			IC4'S =0.127 LV PCT		NC4'S =0.488 LV PCT					
ASTM BOILING RANGE,DEG F	C5/160	160/220	220/285	285/350	350/400	400/430	430/525	525/650	650/1000	1000+	650+
CUT NAME	C5	LN	HN	NK	LK	MK	HK	LG	HG	VR	AR
VOLUME PCT CRUDE	3.53	3.85	4.56	4.03	4.14	1.61	11.88	12.37	28.63	24.38	53.01
DENSITY,LB/BBL	228.40	258.00	270.50	278.70	284.90	288.80	296.80	309.50	324.10	348.50	335.32
WT PCT SULFUR	0.00	0.00	0.01	0.02	0.04	0.08	0.20	0.50	1.07	2.03	1.53
VOLUME FRACTION IC5	0.109										
VOLUME FRACTION NC5	0.192										
VOLUME FRACTION IC6	0.419										
VOLUME FRACTION NC6	0.280										
VOLUME FRACTION PARAFFINS		0.327	0.380	0.320	0.295						
VOLUME FRACTION AROMATICS		0.245	0.240	0.285	0.290	0.300	0.300				
VOLUME FRACTION MCP		0.063									
VOLUME FRACTION CH		0.126									
VOLUME FRACTION BENZENE		0.073									
VOLUME FRACTION C7N		0.199									
VOLUME FRACTION TOLUENE		0.172									
VOLUME FRACTION C8N			0.280								
VOLUME FRACTION C8A			0.240								
RON, CLEAR	75.5	66.0	54.5	44.5							
RON, +0.5 CC/GAL	81.1	72.3	61.7	53.5							
RON, +1.0 CC/GAL	84.0	75.0	65.2	57.5							
RON, +2.0 CC/GAL	87.1	79.4	69.6	61.5							
RON, +3.0 CC/GAL	89.0	81.5	72.0	64.0							
MON, CLEAR	73.6	64.1	0.0	0.0							
MON, +0.5 CC/GAL	79.6	71.0	0.0	0.0							
MON, +1.0 CC/GAL	82.8	74.4	0.0	0.0							
MON, +2.0 CC/GAL	86.1	78.3	0.0	0.0							
MON, +3.0 CC/GAL	88.1	80.6	0.0	0.0							
REID VAPOR PRESSURE,PSIA	8.68	4.20	2.40	1.30	0.65	0.35	0.25				
PCT EVAP AT 212 DEG F	110.0	90.0									
POUR POINT,DEG F				-102.0	-81.0	-64.0	-38.0	7.0	86.0	120.0	100.0
POUR POINT INDEX				0.5	0.7	0.9	1.8	7.2			
DIESEL INDEX				55.2	53.5	52.0	49.5	45.5			
ASTM SMOKE POINT				23.5	21.0	19.0	16.0	10.5			
VIS BLNDG NO AT 122 DEG F				70.0	67.5	64.0	58.5	50.0	29.0	12.5	21.4
UOPK	12.640	11.760	11.620	11.620	11.630	11.630	11.580	11.510	11.680	11.890	11.780
WT PCT NITROGEN								0.01	0.13		
WT PCT ASPHALTENES										1.0	0.5
METALS,PPM								0.0	0.0	38.6	18.4
HEAT OF COMBUSTION, MMBTU/LB	0.02085	0.02027	0.02002	0.01991	0.01980	0.01974	0.01958	0.01929	0.01891	0.01830	0.01862

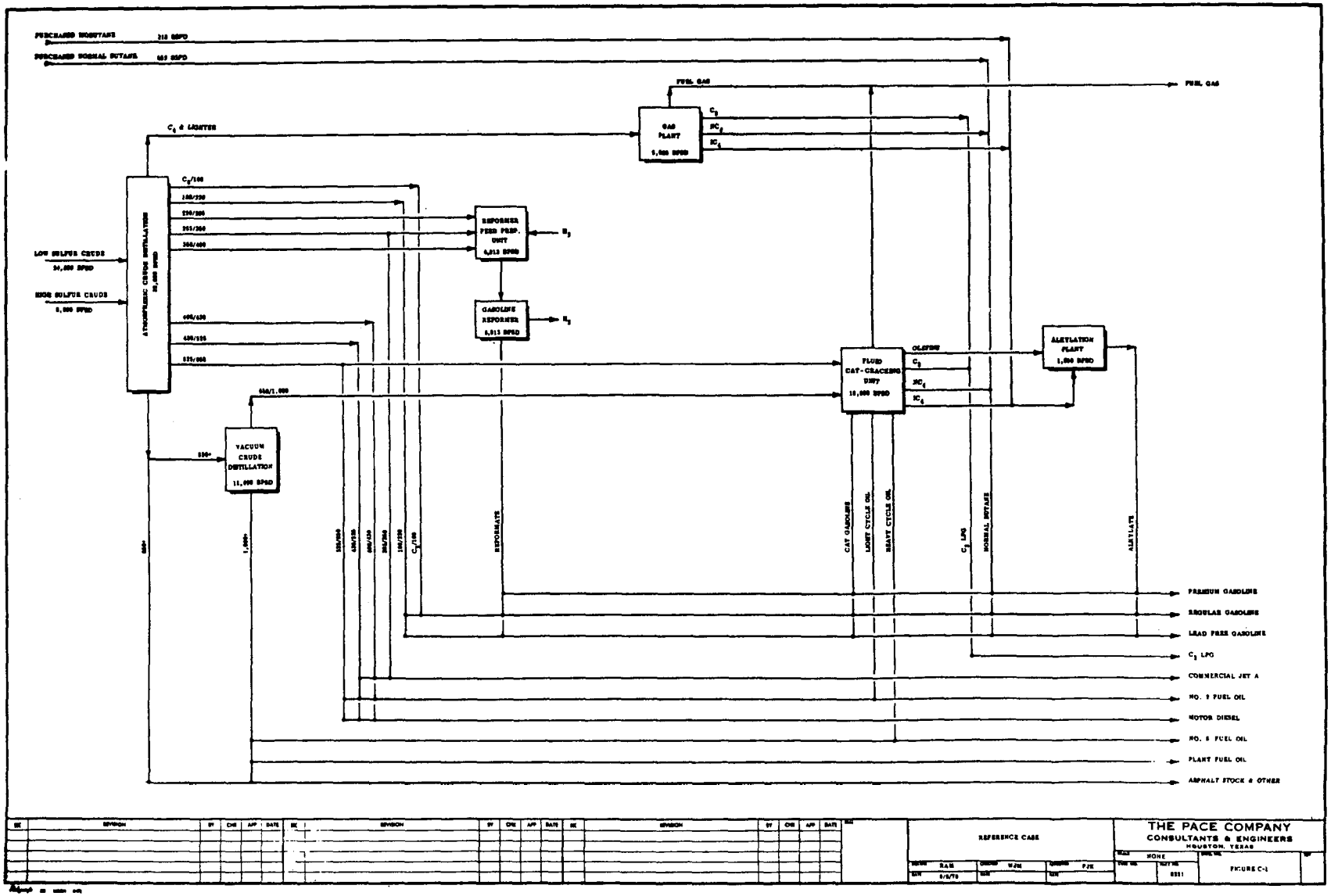
NOTE: PERCENT EVAPORATED,REID VAPOR PRESSURE,AND OCTANE VALUES ARE GASOLINE POOL BLENDING VALUES.

TABLE C-7

HIGH SULFUR ASPHALTIC CRUDE

DENSITY,LB/BBL = 320.40	WT PCT SULFUR = 2.700	C1'S LTR =0.0	LB/BBL	C2'S =0.0	LB/BBL	C3'S =0.355 LB/BBL					
DENSITY,DEG API = 23.0	POUR POINT,DEG F = 0.0	IC4'S =0.330 LV PCT		NC4'S =0.770 LV PCT							
ASTM BOILING RANGE,DEG F	C5/160	160/220	220/285	285/350	350/400	400/430	430/525	525/650	650/1000	1000+	650+
CUT NAME	C5	LN	HN	NK	LK	MK	HK	LG	HG	VB	AR
VOLUME PCT CRUDE	1.42	1.91	3.51	3.76	4.18	1.71	7.69	13.28	22.44	38.80	61.24
DENSITY,LB/BBL	227.50	246.90	261.10	270.50	277.80	282.80	291.30	305.00	325.00	355.30	344.00
WT PCT SULFUR	0.01	0.05	0.10	0.15	0.23	0.40	0.90	1.80	2.87	3.80	3.72
VOLUME FRACTION IC5	0.250										
VOLUME FRACTION NC5	0.250										
VOLUME FRACTION IC6	0.300										
VOLUME FRACTION NC6	0.200										
VOLUME FRACTION PARAFFINS		0.650	0.570	0.510	0.460						
VOLUME FRACTION AROMATICS		0.055	0.083	0.130	0.157	0.170	0.195				
VOLUME FRACTION MCP		0.045									
VOLUME FRACTION CH		0.040									
VOLUME FRACTION BENZENE		0.011									
VOLUME FRACTION C7N		0.170									
VOLUME FRACTION TOLUENE		0.044									
VOLUME FRACTION C8N			0.247								
VOLUME FRACTION C8A			0.083								
RON, CLEAR	76.0	70.0	61.0	52.0							
RON, +0.5 CC/GAL	81.9	76.2	66.8	56.6							
RON, +1.0 CC/GAL	84.9	79.4	69.9	59.0							
RON, +2.0 CC/GAL	88.1	82.9	73.0	61.8							
RON, +3.0 CC/GAL	90.0	85.0	75.0	63.5							
MON, CLEAR	68.0	62.0	0.0	0.0							
MON, +0.5 CC/GAL	76.3	71.0	0.0	0.0							
MON, +1.0 CC/GAL	80.4	75.4	0.0	0.0							
MON, +2.0 CC/GAL	84.8	80.2	0.0	0.0							
MON, +3.0 CC/GAL	87.5	83.0	0.0	0.0							
REID VAPOR PRESSURE,PSIA	10.60	4.50	2.20	1.25	1.00	0.85	0.60				
PCT EVAP AT 212 DEG F	110.0	80.0									
POUR POINT,DEG F				-92.0	-76.0	-58.0	-40.0	10.0	80.0	110.0	96.0
POUR POINT INDEX				0.6	0.8	1.2	1.7	3.5			
DIESEL INDEX				65.0	61.5	59.0	53.5	41.2			
ASTM SMOKE POINT				29.0	26.0	24.0	19.0	11.4			
VIS BLNDG NO AT 122 DEG F				75.0	70.5	64.0	60.0	46.0	28.0	9.0	20.9
UOPK	13.723	12.298	12.036	11.979	11.923	11.878	11.796	11.697	11.460	11.232	11.369
WT PCT NITROGEN								0.00	0.02		
WT PCT ASPHALTENES										35.0	14.0
METALS,PPM								0.0	0.0	0.0	0.0
HEAT OF COMBUSTION, MMBTU/LB	0.0	0.0	0.0	0.02006	0.01993	0.01984	0.01969	0.01941	0.01876	0.01793	0.01843

NOTE: PERCENT EVAPORATED,REID VAPOR PRESSURE,AND OCTANE VALUES ARE GASOLINE POOL BLENDING VALUES.



NO	REVISION	BY	CHK	APP	DATE

REFERENCE CASE

THE PACE COMPANY
CONSULTANTS & ENGINEERS
HOUSTON, TEXAS

FIGURE C-1

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D

RESULTS

RESULTS OF SIMULATION CASES

Tables D–1 and D–2 summarize the refinery product slate and processing unit utilization rates for the Reference Case and each of the Alternate Cases which have been analyzed. Table D–1 also shows the sales prices assumed for the refined products.

Table D–3 summarizes the utility consumption rates for each process unit incorporated in the refinery. Investment requirements, manufacturing costs, and product revenues in each case are shown on Tables D–4, D–5, and D–6, respectively.

ECONOMIC EVALUATION

Based on the results of the cases studied, Pace developed a comparison of the relative economics of shale oil processing as compared to conventional crude oil processing. These economic comparisons were based on the differences in investment requirements, raw materials and refinery manufacturing costs, and product revenues between the two alternate expansion and two alternate substitution cases. An operating factor of 350 stream days per year was used in these economic calculations. A capital recovery factor of 20 percent is charged in each of the cases to approximate annual investment related charges for a project earning a 10 percent DCF rate of return.

The results of these comparisons are shown in Tables D–7 and D–8. As shown in Table D–7, the difference between the refining values of Alaskan North Slope crude oil and Occidental's shale oil is $2.02 per barrel. The difference between the refining values of high sulfur asphaltic PADD 4 crude oil and Occidental's shale oil are $1.31 per barrel, as shown in Table D–8.

ECONOMIC SENSITIVITIES

Throughout the report, the point has been made that the base case is conservative with respect to shale oil value largely because of the lack of data specific to the application. In Table D–9, Pace has quantified the potential effect of some of this conservatism. The magnitude of the sensitivities shown in the table also provide guidance in aligning future studies to those areas which have substantial economic impact.

The first sensitivity is the hydrotreater cost. If the unit can be installed for a price toward the lower end of the estimates which have been examined, a substantial portion of the refining value difference will be eliminated. The table shows that a reduction of $1,000 per barrel in onsite capital investment will result in $0.78 additional value to the shale oil.

In the second item, sensitivity to hydrogen consumption is shown. While the higher quality of the Occidental shale oil was taken into account when adjusting published yield data on other oils, lower consumption may be achieveable. The magnitude of the cost of hydrogen consumption is particularly important in assessing the total benefits which might be achieved by lowering the severity of the hydrotreating. As stated in the Recommendations, Pace feels that there is potential for reducing the difference in refining cost between shale oil and crude oil through a closer examination of lower severity hydrotreating cases.

The third sensitivity shows the impact on shale oil refining value to a refiner who effectively has open FCC capacity for a severely hydrotreated feedstock. In this case, no additional capital would be needed to handle incremental feed. This could be the case for a number of PADD 4 refiners who are experiencing the general U.S. trend toward heavier crude oil feedstocks. Inherent with the heavier crude oil, traditional FCC feedstocks are becoming poorer in quality both from the standpoint of contaminant level and coke precursors.

It is generally recognized that in the case where a refiner must hydrotreat the cracking feedstock for sulfur removal, one of the offsetting benefits is usually increased cracking capacity. The shale oil hydrotreating severity carried out in these cases is far in excess of that normally employed for sulfur removal and some benefits in the cracking unit should be expected. A refiner that can increase his cracking capacity at no cost on a severely hydrotreated feedstock will value shale oil $0.50–$0.75/Bbl higher than one who would have to invest heavily.

For the processing configuration used in this evaluation, Pace suggests that this consideration may be the most relevant in determining how much shale oil can be economically processed in an existing refinery. The amount that can be hydrotreated and processed through existing catalytic cracking facilities with only nominal investment may well represent a sharply defined economic plateau.

TABLE D-1

REFINERY PRODUCT SUMMARY
(Barrels Per Stream Day)

	Reference Case	Alternate Case 1 North Slope	Alternate Case 2 Shale Oil	Alternate Case 3 Asphaltic	Alternate Case 4 Shale Oil	Sales Price $/Bbl
Product to Sales						
Fuel Gas (FOE)	767	877	455	992	433	12.60
C_3 LPG	1,937	2,473	2,798	2,453	2,496	9.66
Premium Gasoline	877	1,069	1,085	881	933	17.26
Regular Gasoline	7,979	9,619	9,765	7,931	8,393	16.13
Lead Free Gasoline	8,866	10,688	10,850	8,812	9,325	17.18
Commercial Jet A	3,346	6,000	5,676	3,200	3,200	15.12
No. 2 Fuel Oil	3,167	5,500	5,900	3,000	3,350	14.70
Motor Diesel	2,400	2,400	2,400	2,400	2,400	14.28
No. 6 Fuel Oil	1,849	2,203	1,360	928	240	10.92
Asphalt Stock & Other	2,450	2,450	2,450	2,450	2,450	13.02
Sulfur (Tons)	0	13	17	27	18	20.00
Petroleum Coke (Tons)	0	93	0	205	0	12.00
Ammonia (Tons)	0	0	20	0	20	100.00

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TABLE D-2

PROCESSING UNIT UTILIZATION SUMMARY
(Barrels Per Stream Day)

	Reference Case	Alternate Case 1 North Slope	Alternate Case 2 Shale Oil	Alternate Case 3 Asphaltic	Alternate Case 4 Shale Oil
Atmospheric Crude Distillation	32,600	42,380	32,600	32,600	22,820
Vacuum Crude Distillation	11,699	17,472	11,623	14,952	8,297
Shale Oil Hydrotreater:					
97.5% Denitrogenation	0	0	0	0	0
87% Denitrogenation	0	0	9,780	0	9,780
Gas Plant (C_3 & C_4 Feed)	5,028	6,199	7,078	5,959	6,310
Catalytic Reformer	6,013	5,140	6,450	3,731	5,266
Alkylation Plant	1,850	1,945	1,850	1,850	1,850
Fluid Catalytic Cracker	10,800	17,441	20,211	14,767	16,513
Delayed Coker	0	1,873	0	3,318	0
Merox Treating	11,913	12,000	10,495	10,473	8,063
Thermal Naphtha/Distillate Hydrotreater	0	5,244	5,676	1,177	3,200
Gas Oil Hydrotreater	0	0	0	2,867	0
Shale Oil Naphtha Hydrotreater	0	0	570	0	602
Hydrogen Plant (MSCFD Prod.)	0	0	11,793	0	12,176
Sulfur Recovery (Tons/D)	0	13	17	27	18

TABLE D-3

UTILITY CONSUMPTION RATES
(Per Barrel of Feedstock)

	Atmospheric Crude Distillation	Vacuum Crude Distillation	Gas Plant	Gasoline Reformer	Alkylation Plant (Olefins Per Barrel Feed)	Fluid Catalytic Cracker	Delayed Coker	Sulfur Recovery Facilities
Fuel (MBTU)	87.6	56.0	0.0	342.4	757.0	68.9	213.0	0.049
Steam (MLbs)	0.023	0.024	0.267	(0.0675)	0.082	(0.9494)	(0.0625)	0.0008
Cooling Water (MGal)	0.480	0.115	1.082	0.540	3.44	0.43	1.19	0.0461
Power (KWH)	0.24	0.234	1.420	4.563	4.50	7.22	3.36	0.0116
Catalysts/Chemicals ($)	0.0	0.0	0.0171	0.0211	0.110	0.096	0.0	0.0004
Hydrogen (SCF)	0	0	0	(1,055)		0	0.0	0
Initial Inventory, Catalysts/Chemicals ($)	0.0	0.0	0.507	59.2	0.973	4.22	0.0	0.1425

Note: Numbers in parentheses are credits

TABLE D-3
(Continued)

	Shale Oil Hydrotreater 87% Denitro.	Shale Oil Hydrotreater 97.5% Denitro.	Reformer Feed Hydrotreater	Shale Oil Naphtha Hydro-treater	Distillate Hydrotreater	Vacuum Gas Oil Hydrotreater	Hydrogen Generation (Per 1,000 SCF Hydrogen)
Fuel (MBTU)	78.07	80.17	89.9	179.8	119.9	23.78	182.9
Steam (MLbs)	0.052	0.058	0.0	0.0	0.0036	0.0	0.0142
Cooling Water (MGal)	0.077	0.107	0.203	0.406	0.301	0.284	0.467
Power (KWH)	6.56	9.68	0.887	1.77	1.26	2.297	2.16
Catalysts/Chemicals($)	0.103	0.177	0.004	0.008	0.007	0.032	0.005
Hydrogen (SCF)	1,447	1,913	50	100	250	350	-
Initial Inventory Catalysts/Chemicals($)			4.93	3.63	5.75	22.22	22.88

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TABLE D-4

PLANT INVESTMENTS
(Million Dollars)

	Alternate Case 1 North Slope	Alternate Case 2 Shale Oil	Alternate Case 3 Asphaltic	Alternate Case 4 Shale Oil
Onsite Investments				
Shale Oil Hydrotreater	0	26.70	0	26.70
Atmospheric Crude Distillation	3.43	0	0	0
Vacuum Crude Distillation	2.10	0	1.44	0
Gas Recovery Facilities	1.27	1.84	1.06	1.35
Fluid Catalytic Cracker	6.12	8.67	3.36	5.60
Alkylation Plant	0.08	0	0	0
Delayed Coker	5.86	0	8.97	0
Shale Oil Naphtha Hydrotreater	0	0.58	0	0.58
Distillate Hydrotreater	2.97	3.12	1.13	2.16
Gas Oil Hydrotreater	0	0	2.64	0
Hydrogen Plant	0	6.08	0	6.20
Sulfur Recovery Plant	1.57	1.91	2.42	1.97
Total Onsite Investments	23.40	48.90	21.02	44.56
Offsite Investments				
Steam Generation	0.08	0.58	0	0.28
Power Distribution	0.36	0.76	0.34	0.62
Cooling Water Facilities	0.42	0.50	0.18	0.21
Tankage	3.00	3.00	0.50	2.00
Other Offsites	2.34	4.89	2.10	4.46
Total Offsite Investments	6.20	9.73	3.12	7.57
TOTAL PLANT INVESTMENTS	29.60	58.63	24.14	52.13

TABLE D-5

MANUFACTURING COSTS
(Thousand Dollars Per Year)

	Reference Case	Alternate Case 1 North Slope	Alternate Case 2 Shale Oil	Alternate Case 3 Asphaltic	Alternate Case 4 Shale Oil
1. **Salaries and Wages**					
Direct Operating @ $9.75/hour	2,306	2,989	2,819	3,075	2,819
Supervision and Technical	1,384	1,794	1,691	1,845	1,691
Plant Administration	1,845	2,391	2,255	2,460	2,255
Total Salaries & Wages	5,535	7,174	6,765	7,380	6,765
2. **Utilities**					
Power @ $0.023/KWH	1,617	2,189	2,973	2,033	2,697
Make-up Water @ $0.15/MGal	75	103	109	90	90
Total Utilities	1,692	2,292	3,082	2,124	2,787
3. **Maintenance**					
Base Plant Maintenance	2,687	2,687	2,687	2,687	2,687
Incremental Maintenance					
Onsite @ 4 Percent	0	936	1,956	841	1,782
Offsite @ 2 Percent	0	124	195	62	151
Total Maintenance	2,687	3,747	4,838	3,590	4,620
4. **Plant Supplies** (8% Maintenance)	215	300	387	287	370
5. **Catalysts/Chemicals**	1,917	2,263	2,383	1,946	2,074
6. **Taxes and Insurance**	1,010	1,602	2,183	1,493	2,053
7. **Total Manufacturing Costs**	13,056	17,378	19,638	16,820	18,669

TABLE D-6

REVENUES SUMMARY
(Thousand Dollars Per Year)

	Reference Case	Alternate Case 1 North Slope	Alternate Case 2 Shale Oil	Alternate Case 3 Asphaltic	Alternate Case 4 Shale Oil
Revenues					
Fuel Gas	3,383	3,868	2,007	4,375	1,910
C_3 LPG	6,549	8,361	9,460	8,294	8,439
Premium Gasoline	5,359	6,459	6,555	5,323	5,637
Regular Gasoline	45,040	54,297	55,122	44,774	47,377
Lead Free Gasoline	53,305	64,259	65,233	52,987	56,065
Commercial/Jet A	17,707	31,752	30,037	16,934	16,934
No. 2 Fuel Oil	16,294	28,298	30,356	15,435	17,236
Motor Diesel	11,995	11,995	11,995	11,995	11,995
No. 6 Fuel Oil	7,067	8,420	5,198	3,547	917
Asphalt Stock & Other	11,165	11,165	11,165	11,165	11,165
Sulfur	0	91	122	189	128
Petroleum Coke	0	391	0	861	0
Ammonia	0	0	700	0	700
Total Revenues	177,864	229,356	227,950	175,879	178,503

TABLE D-7

EXPANSION SCENARIO: ECONOMIC COMPARISON
(Million Dollars Per Year)

	Alternate Case 1 Alaskan North Slope	Alternate Case 2 Occidental's Shale Oil	Difference Case 2 Less Case 1
Revenues	229.4	228.0	(1.4)
Incremental Costs			
Secondary Feedstock Costs	4.2	1.7	
Manufacturing Costs	17.4	19.6	
Marketing Expenses	2.3	2.3	
Capital Recovery (20 Percent)	5.9	11.7	
Total Incremental Costs	29.8	35.3	5.5
Difference in Refining Value			
Million Dollars Per Year			6.9
Dollars Per Barrel			2.02

TABLE D-8

SUBSTITUTION SCENARIO: ECONOMIC COMPARISON
(Million Dollars Per Year)

	Alternate Case 3 High Sulfur Crude	Alternate Case 4 Occidental's Shale Oil	Difference Case 4 Less Case 3
Revenues	175.9	178.5	2.6
Incremental Costs			
Secondary Feedstock Costs	3.1	2.7	
Manufacturing Costs	16.8	18.7	
Marketing Expenses	1.8	1.8	
Capital Recovery (20 Percent)	4.8	10.4	
Total Incremental Costs	26.5	33.6	7.1
	Difference in Refining Value		
	Million Dollars Per Year		4.5
	Dollars Per Barrel		1.31

TABLE D-9

KEY SENSITIVITIES TO ECONOMIC COMPARISON
(Dollars Per Barrel of Shale Oil)

	Incremental Scenario Case 2 vs. Case 1	Substitution Scenario Case 4 vs Case 3
Base Difference in Refining Value, $/Bbl	2.02	1.31
Lower Capital Cost for Shale Oil Hydrotreater $1,730 vs $2,730/Barrel	(0.78)	(0.78)
Lower H_2 Consumption for Shale Oil 1250 vs 1450 SCF/Bbl	(0.28)	(0.28)
No Additional FCC Investment Needed for Shale Oil Cases due to Severe Hydrotreating	(0.73)	(0.47)
Cumulative Effect of Sensitivities	(1.79)	(1.53)

* U.S. GOVERNMENT PRINTING OFFICE: 1980-640-258/157

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