SFUND RECORDS CTR
161388

EPA FIELD INVESTIGATION TEAM

Ecology & Environment, Inc.
120 Howard St., Suite 640
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POTENTIAL HAZARDOUS WASTE SITE

SITE INSPECTION REPORT

OFFSITE RECONNASSIANCE AND TENTATIVE DISPOSITION

TDD # F-9-8009-11

INDUSTRY

Mohave Generating Station, Southern California Edison
P.O. Box 505
Laughlin, Nevada 89046

DATE OF RECONNASSIANCE

10 September 1980; 1400-1600

SITE INVESTIGATORS

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INDUSTRIAL CONTACTS

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INTRODUCTION

Mohave Generating Station was identified by the Nevada Surface Impoundment Assessment (SIA) as a potential hazardous waste site. This report consists of a review of information provided by Southern California Edison (SCE) and the U.S. Department of the Interior as well as an off-site reconnaissance

report (10 September 1980). The detailed industry-supplied information was submitted in lieu of an on-site visit which could not be conveniently scheduled by SCE due to inflexible manpower dedication.

SITE DESCRIPTION

Mohave Generating Station is located in southeastern Nevada on the west side of the Colorado River approximately three miles south of Davis Dam (Figure 1). The site is reached by taking Route 95 south from Las Vegas to to Route 77 east, at the California-Nevada border. This route drops from a 1400 feet elevation to 600 feet at the Colorado River. Mohave is located south of Laughlin, Nevada. Bullhead, Arizona is across the Colorado River to the east.

The area is arid (approx. 4-8 inches of precipitation/year) with alluvium deposits at the site consisting of nearly horizontal interbedded strata of gravel, sand, and clay (J.D. Nowlin, "A Groundwater Monitoring Program for Nevada," 1977, USGS, Carson City, NV). The area on the eastern edge of the Mojave Desert is earthquake prone.

Mohave Generating Station is operated by Southern California Edison Company (SCE) of Rosemead, California. Mohave is owned jointly by SCE, Los Angeles Department of Water and Power, San Diego Gas and Electric, Salt River Project, and the Nevada Power Company. The facility has been operating since 1970.

INDUSTRIAL PROCESS DESCRIPTION

SCE's Mohave Generating Station has two coal-fired units with a total rated capacity of 1580 megawatts. Coal is stored on-site as a slurry after its transport from the Black Mesa Mine (Kayenta, Arizona) in a 275 miles long pipeline. A chemical analysis of the Black Mesa coal was done by the Arizona Bureau of Mines and is included in the Appendix. The slurry is about a 50-50 mixture of crushed coal and water. Centrifuges remove about 75% of the water before the dewatered coal is pulverized and pneumatically transported to the boiler for combustion.

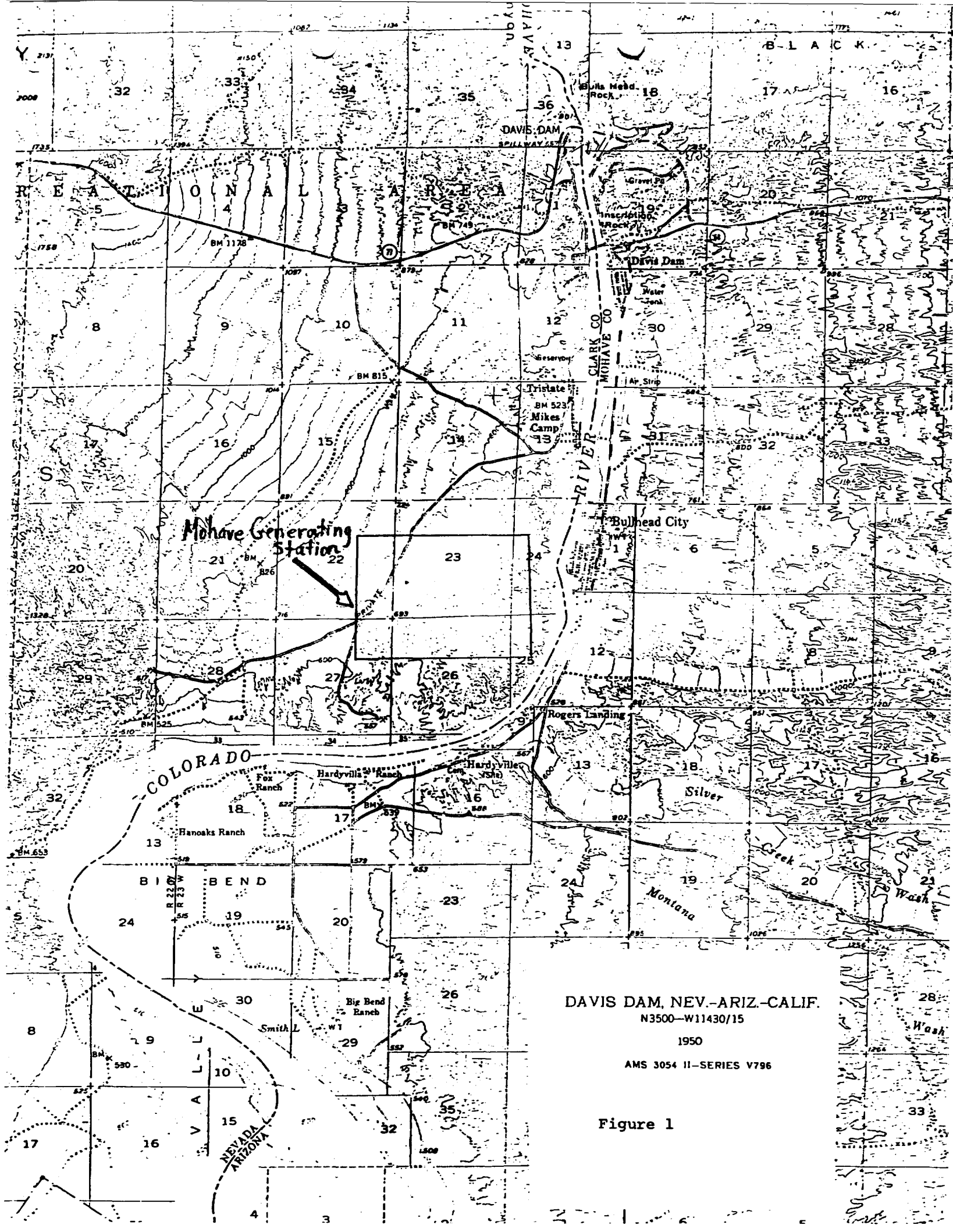

DAVIS DAM, NEV.-ARIZ.-CALIF.
N3500—W11430/15
1950
AMS 3054 II—SERIES V796
Mohave Generating Station
DAVIS DAM
Davis Dam
Bulls Head Rock
Inscription Rock
Tristate
Mikes Camp
Bullhead City
Rogers Landing
Hardyville
Hardyville Ranch
Fox Ranch
Hanoaks Ranch
Big Bend Ranch
Silver Creek
Montana Wash
Smith L
COLORADO RIVER
CLARK CO
MOHAVE CO
NEVADA
ARIZONA
BIG BEND
R 22 W
R 23 W
BM 1128
BM 749
BM 815
BM 523
BM 525
BM 653
BM 839
BM 530
Reservoir
Air Strip
Water Tank
Gravel Pit

Figure 1

The average quality of coal burned in 1976 (based on dry weights) yielded 9.36-10.96% ash, 0.41% sulphur, and 12,200 BTU/lb. Less than 4% of the total fuel consumed in 1976 was natural gas. At full capacity, 15,000 tons of coal are burned per day. This produces 600-800 tons of fly ash and 400-500 tons of bottom ash. Two-thirds of the fly ash is sold to recycling companies and one-third into a natural canyon - Ash Canyon. All of the bottom ash is buried in Ash Canyon.

The general processes are summarized in Figure 2. Figures 3 and 4 are aerials of the site.

WASTE HANDLING SYSTEM

There are eight lined ponds and five smaller impoundments on the Mojave site which receive process waters of various types. Table 1 gives a description of the impoundments, as provided by SCE (design and permeability data for the asphalt concrete liner is described in the Appendix). The eight lined ponds have a total capacity of 886 million gallons with a maximum storage volume of approximately 660 million gallons in 1975. Coal fines are removed regularly from Pond #5 and sold.

The following is the usage status of the surface impoundments.

Impoundment	Usage
Pond #1	Filled with coal fines; currently receives no waste water; formerly received intermittent underflow when clariflocculator was malfunctioning.
Pond #2	Receives peripheral pond water; decant is reused at station.
Ponds #3 #4 #5 #6A #6B #6C	Cooling tower blowdown; some softener unit treatment waste.
Pond #5	Receives intermittent underflow.

Figure 2

PROCESS SUMMARY

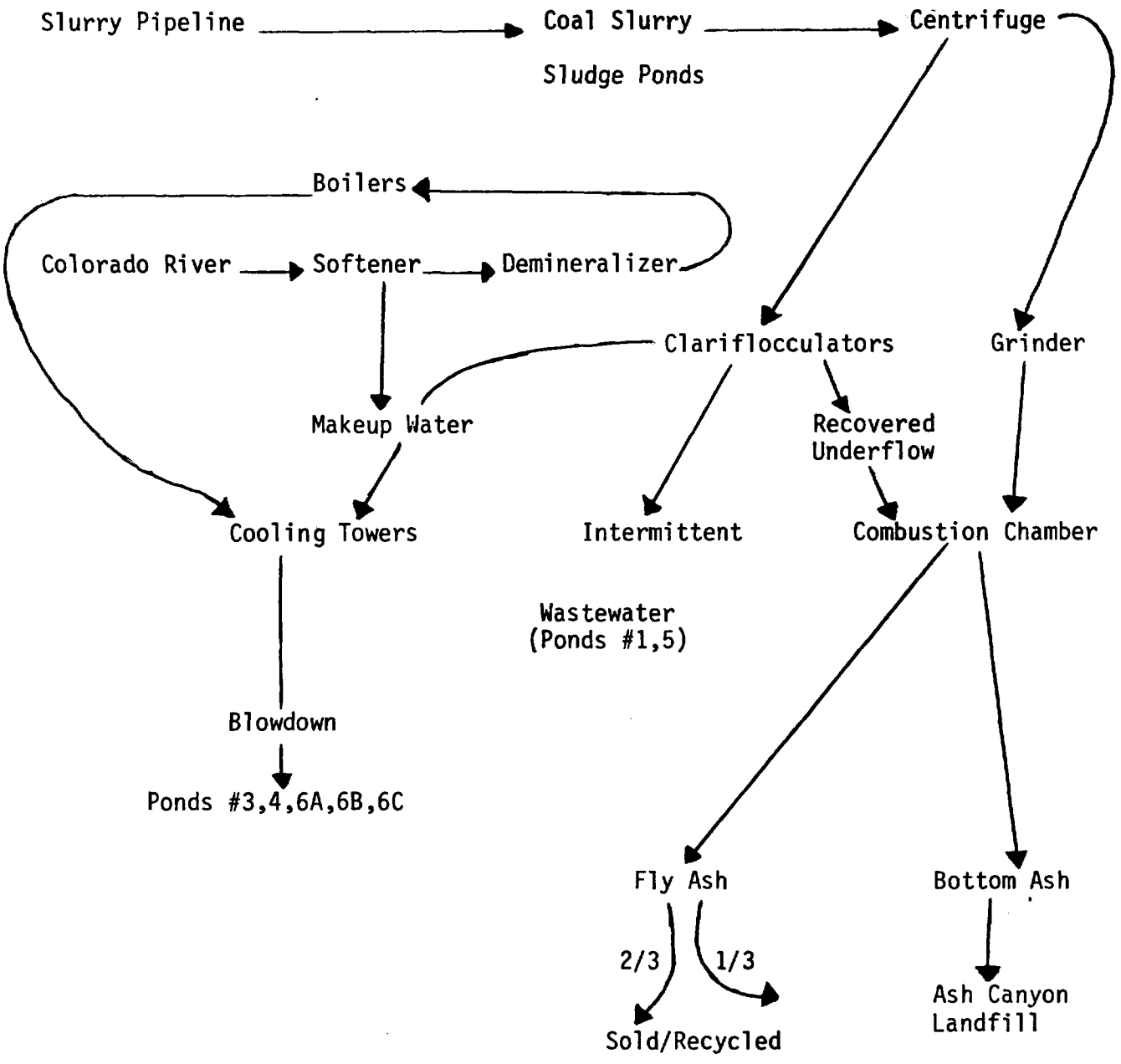


Figure 3

Aerial Photo of Mohave Generating Station

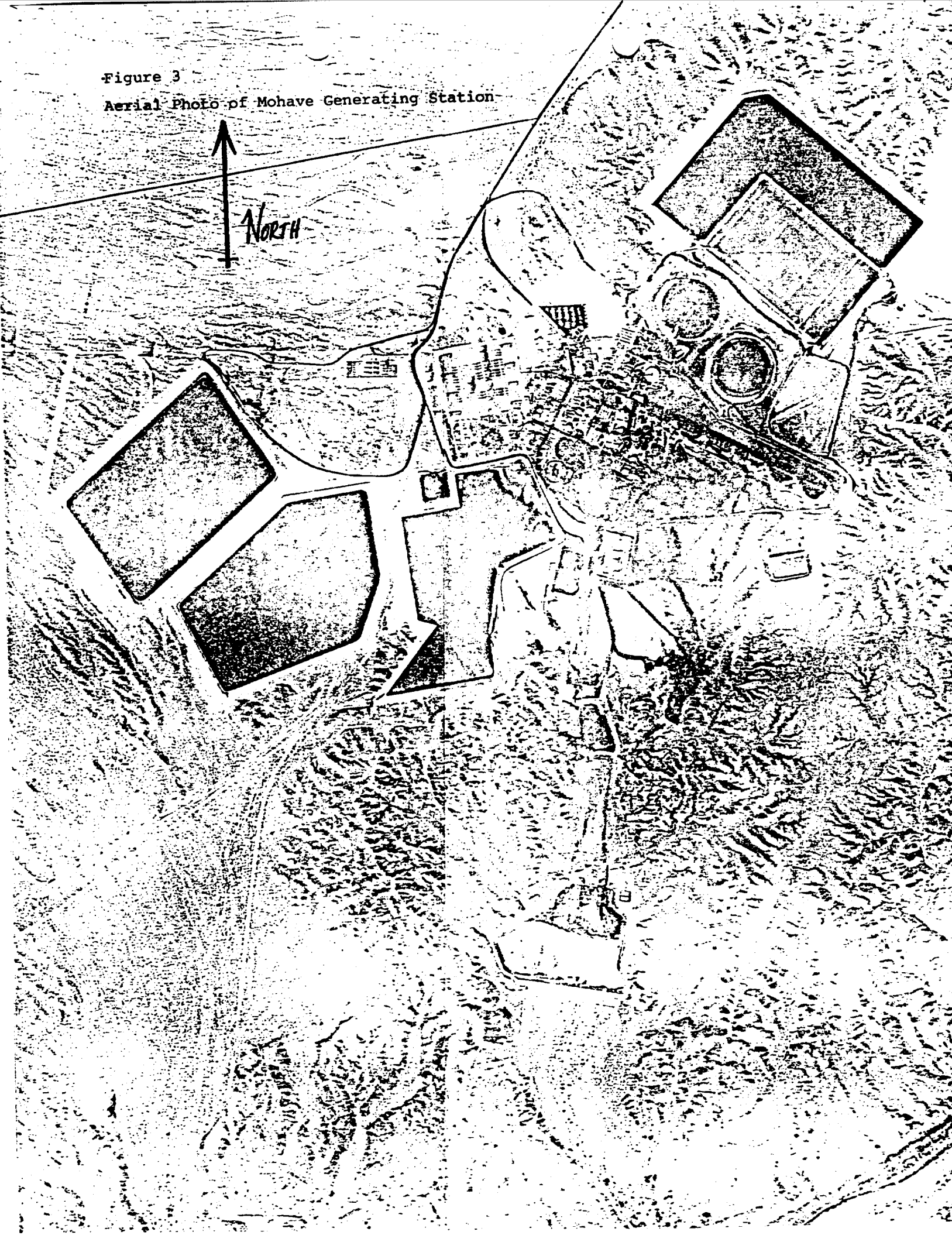


TABLE 1
DESCRIPTION OF IMPOUNDMENTS

Impoundment	Size (surface area, depth)	Year of Construction	Liner Type	Existing Liner Installed	Remarks
Pond No. 1	35 acres, 7.8'	1970	6 mil PVC liner + 1 ft of soil	1970	
Pond No. 2	19 acres, 10'	1971	Hydraulic Asphaltic Cement	1975	Previously lined with soil cement.
Pond No. 3	36 acres, 10'	1971	Hydraulic Asphaltic Cement	1976	Previously lined with soil cement.
Pond No. 4	55 acres, 15'	1973	Hydraulic Asphaltic Cement	1979	Previously lined with soil cement.
Pond No. 5	48 acres, 15'	1974	Hydraulic Asphaltic Cement	1974	
Pond No. 6A	20 acres, 12'	1976	Hydraulic Asphaltic Cement	1976	
Pond No. 6B	20 acres, 12'	1976	Hydraulic Asphaltic Cement	1979	Previously lined with hydraulic asphaltic ceme
Pond No. 6C	20 acres, 12'	1976	Hydraulic Asphaltic Cement	1976	
No. Peripheral Pond	1 acre, 10'	1974	Hydraulic Asphaltic Cement	1978	Previously lined with soil cement.
No. Peripheral Pond	1 acre, 10'	1974	Hydraulic Asphaltic Cement	1978	Previously lined with soil cement.
No. Sludge Curing	.5 acres, 10'	1974			
So. Sludge Curing	1 acre, 10'	1974			
Coal Dump Pond	3 acres, 10'	1971	Hydraulic Asphaltic Cement	1975	

Impoundment	Usage
North & South Peripheral Ponds	Surge tanks for recyclable water, decant reused at station. Receives demineralizer regenerates, floor drain wastes, centrate when centrifuges malfunctioning.
North & South Sludge Curing Ponds	Inactive - softener and demineralizer wastes.
Coal Dump Pond	Coal

Excess coal slurry is stored in two circular ponds adjacent to the plant (see Figure 2). Fly ash is buried on-site in Ash Canyon which is blocked at the lower end by a retention dam.

An impoundment water analysis for December 1979 is given in Table 2. The The location of the impoundments is shown in Figures 5 and 6.

GROUNDWATER MONITORING SYSTEM

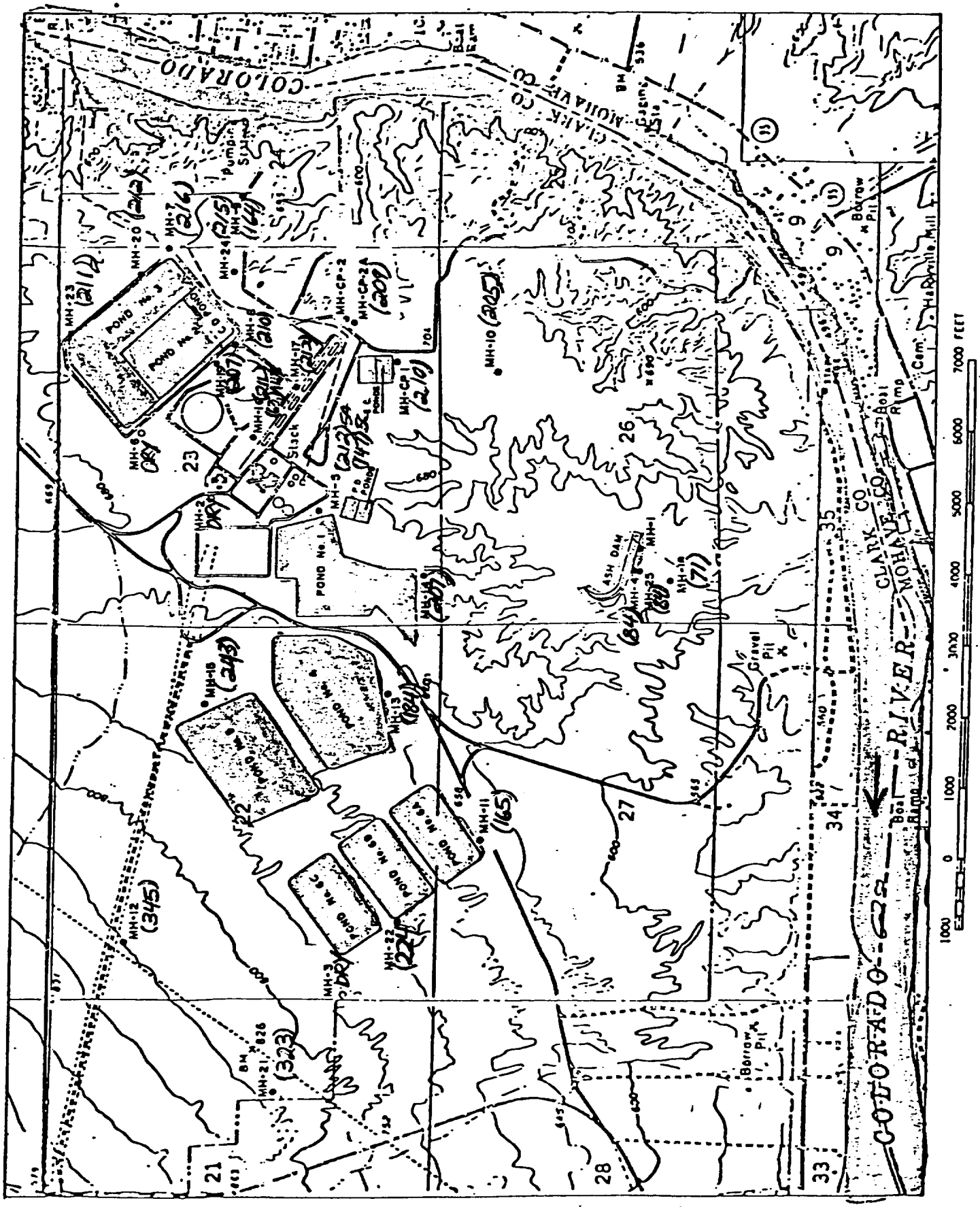
Mohave Generating Station has established a groundwater monitoring program in conjunction with Leroy, Crandall and Associates, consultants, and the Lower Colorado Regional Office of the U.S. Water and Power Resource Service. This includes a network of 27 monitoring and/or pumping wells (see Figure 5 for locations and depth to water in the wells, December 1979) which allows for drawdown and pumping of groundwater from select wells when contaminated water is detected. The conta minated water is returned to the impoundments.

SCE is required by a water user contract with the Division of Colorado River Resources to operate the facility in a manner to prevent any significant and measurable pollution of the Colorado River. The review of water user contract compliance is performed by the USGS on a consultant basis to the U.S. Department of the Interior, Water and Power Resources Service in Boulder City, Nevada. Quarterly reports of the monitoring program are submitted to the Division of Colorado River Resources. Data is collected on a monthly basis on the monitoring wells for electroconductivity, TDS, pH, and mineral constituents (Ca, Mg, Na, K, CO_3, HCO_3, SO_4, Cl, NO_3, F, and B). There is no monitoring for metal constituents.

TABLE 2
IMPOUNDMENT WATER ANALYSIS
SUMMARY
DECEMBER 1979

Impoundment	Conductivity ($x\ 10^6$)	pH	Ca^{++} (mg/l)	Mg^{++} (mg/l)	Na^{+} (mg/l)	K^{+} (mg/l)	$CO_3^{=}$ (mg/l)	HCO_3^{-} (mg/l)	$SO_4^{=}$ (mg/l)	Cl^{-} (mg/l)	NO_3^{-} (mg/l)	B (mg/l)
Pond No. 2	2,100	3.1	113	31	360	6	0	—	1,020	132	18	0.52
Pond No. 3	28,000	8.4	375	825	7,500	140	9	187	14,400	3,700	4	5.6
Pond No. 4	11,000	8.5	350	275	1,900	40	3	133	4,470	1,320	44	1.7
Pond No. 5	26,000	6.2	350	788	6,000	10	0	32	12,600	3,775	13	4.0
Pond No. 6A	38,000	7.7	1,153	1,175	11,000	130	0	347	21,375	6,500	4	8.4
Pond No. 6B	13,000	8.2	663	300	3,400	66	0	128	7,800	1,680	4	1.6
Pond No. 6C	28,000	8.0	472	825	7,900	160	0	208	15,900	4,025	9	5.8
Coal Dump Pond	2,250	3.9	100	32	370	6	0	182	855	136	13	0.55
So. Sludge Curing Pond	15,000	8.0	890	488	4,300	88	0	922	10,620	1,250	9	5.2
No. Peripheral Drain Pond	2,500	3.3										
So. Peripheral Drain Pond	1,700	7.1	63		450	6	0	182	882	90	22	0.4

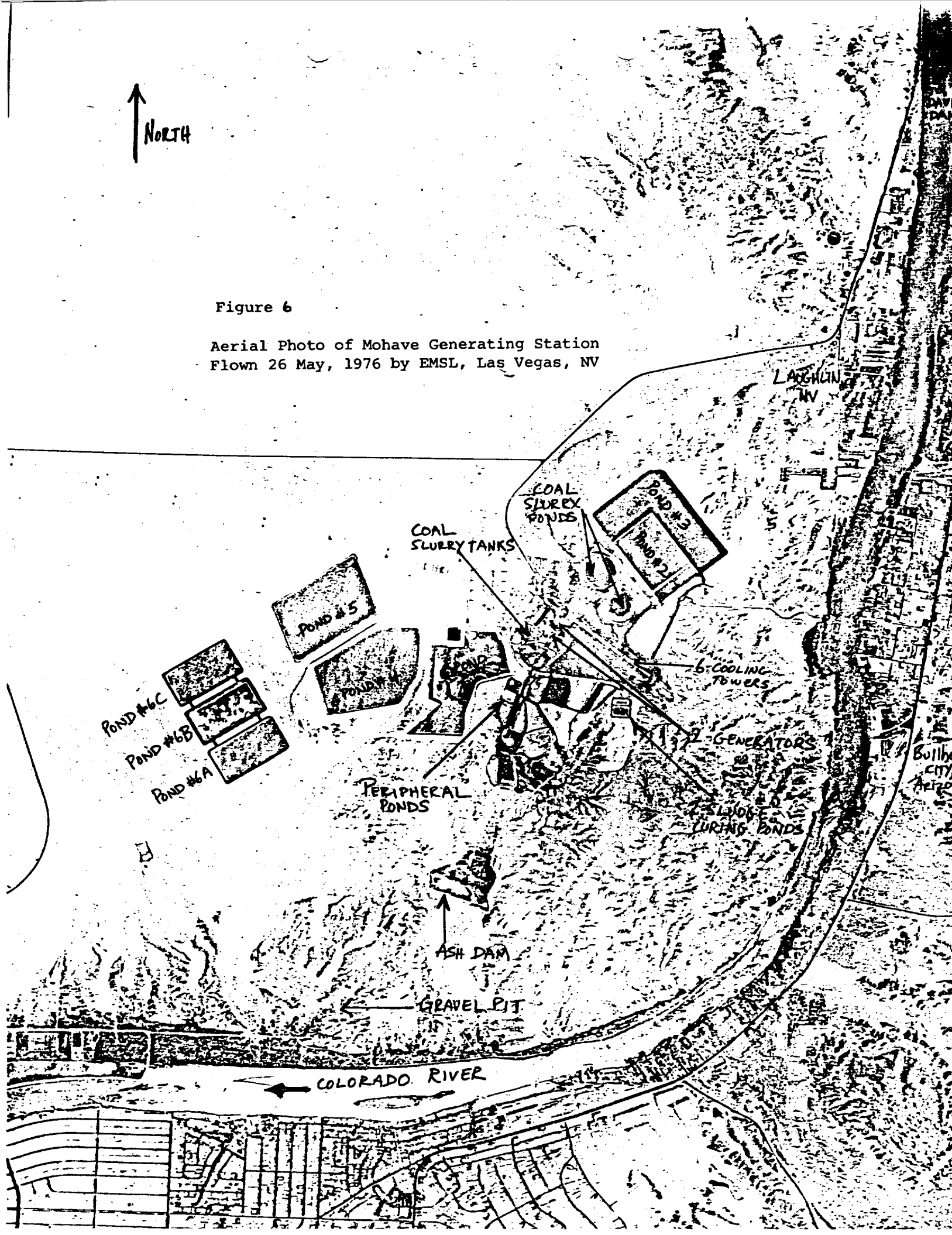
FIGURE 5
LOCATION OF IMPOUNDMENTS
AND MONITORING WELLS*



*( )Depth to water in December, 1979

Figure 6

Aerial Photo of Mohave Generating Station
Flown 26 May, 1976 by EMSL, Las Vegas, NV



A description of the monitoring wells was provided by SCE (Table 3). The depth to water at each well is indicated in Figure 5. Pre-operational water levels (August 1970) were at about 214 feet below the land surface (J.O. Nowlin, 1977).

The Nowlin report prepared for the Nevada Department of Environmental Protection cited four sources of potential groundwater contamination at Mohave:

1) leakage from evaporation ponds
2) leakage from coal slurry ponds
3) percolation of leachate from ash disposal areas
4) accidental spills from operational problems

The ash disposal area leachate percolation was also considered by Nowlin to constitute a potential groundwater contamination source. In this regard, it is significant that Mohave's monitoring program does not include an analysis for metals (e.g., Cu, Cr, Pb, Cd, As). Bottom ash and fly ash are the inorganic portion of coal and are composed largely of complex silicates, oxides, and carbonates. A list of trace elements found in coal is given in Table 4. A portion of a preliminary publication of work done on coal fly ash by Frederick, et al, is included in the Appendix and includes a description of chemical constituents of fly ashes. As illustrated in this article, the actual disposal problem of fly ash may be reduced as practical methods are found to recover titanium and aluminum from the material. It is understood that Mohave is currently investigating a suitable process for recovery of aluminas from fly ash in conjunction with the State of Nevada Desert Research Institute.

TABLE 3

DESCRIPTION OF MONITORING WELLS

Well Number	Year Constructed	Well Depth (Feet)	Depth to Water (December 1979)
* MH-CP-1	1973	260	210.33
MH-CP-2	1973	300.5	
* MH-CP-2A	1973	260	209.40
MH-CP-2B	1973	109	Dry
* MH-1	1970	100	
MH-2	1970	189	Dry
MH-3	1970	270	Dry
* MH-4	1970	100	84.23
* MH-5A	1970	220	211.70
MH-5B	1970	60	
* MH-5C	1970	165	147.07
MH-6	1971	75	Dry
* MH-7	1971	252	216.13
* MH-8A	1971	257	210.41
MH-8B	1971	77	Dry
* MH-9	1972	200	163.42
* MH-10	1972	280	205.45
* MH-11	1972	220	164.83
* MH-12	1972	384	345.02
* MH-13A	1973	241.7	184.31
MH-13B	1973	71.6	Dry
* MH-14A	1973	247.6	207.17
MH-14B	1973	167.5	Dry
MH-14C	1973	101.4	Dry
* MH-15A	1974	306	243.16
MH-15B	1974	74	Dry
* MH-16A	1974	262	210.62
* MH-16B	1974	73	62.50
* MH-17A	1974	262	212.47
MH-17B	1974	79	Dry
MH-17C	1974	22	Dry
* MH-18	1974	202	71.25
* MH-19	1974	300	207.12
* MH-20	1974	320.4	211.68
MH-21	1976	420	323.87
MH-22A	1976	300	223.52
MH-22B	1976	126	Dry
MH-23	1977	340	210.75
MH-24	1976	340	215.09
MH-25	1977	226	83.98

* WPRS historic profile available (see appendix)

Table 4

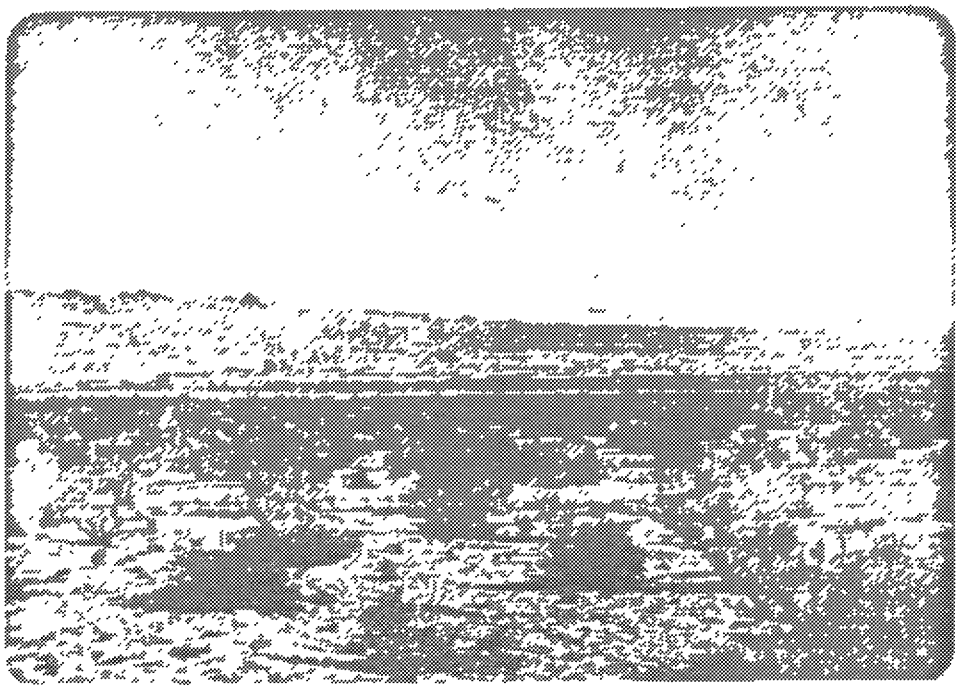
MEAN ANALYTICAL VALUES FOR 44 TRACE ELEMENTS IN 28 WHOLE COAL SAMPLES FROM THE WESTERN UNITED STATES

Element	Mean	Standard Deviation	Range
Antimony, ppm	0.58	0.61	0.18 - 3.5
Arsenic, ppm	2.3	2.6	0.34 - 9.8
Barium, ppm	500	320	160 - 1600
Beryllium, ppm	0.46	0.34	0.10 - 1.4
Boron, ppm	56	32	16 - 140
Bromine, ppm	4.7	7.3	0.50 - 25
Cadmium, ppm	0.18	0.13	0.10 - 0.60
Cerium, ppm	11	8.0	2.8 - 30
Cesium, ppm	0.42	0.82	0.02 - 3.8
Chromium, ppm	9.0	4.2	2.4 - 20
Cobalt, ppm	1.8	1.5	0.60 - 7.0
Copper, ppm	10	5.9	3.1 - 23
Dysprosium, ppm	0.63	0.32	0.22 - 1.4
Europium, ppm	0.20	0.17	0.07 - 0.80
Fluorine, ppm	62	28	19 - 140
Gallium, ppm	2.5	1.4	0.80 - 6.5
Germanium, ppm	0.91	0.92	0.10 - 3.0
Hafnium, ppm	0.78	0.33	0.26 - 1.3
Indium, ppm	0.10	0.07	0.01 - 0.25
Iodine, ppm	0.52	0.25	0.20 - 1.0
Lanthanum, ppm	5.2	3.0	1.8 - 13
Lead, ppm	3.4	2.3	0.70 - 9.0
Lutetium, ppm	0.07	0.09	0.01 - 0.43
Manganese, ppm	49	49	1.4 - 220
Mercury, ppm	0.09	0.11	0.02 - 0.63
Molybdenum, ppm	2.1	5.6	0.10 - 30
Nickel, ppm	5.0	3.2	1.5 - 18
Phosphorus, ppm	130	130	10 - 510
Rubidium, ppm	4.6	6.6	0.30 - 29
Samarium, ppm	0.61	0.29	0.22 - 1.4
Scandium, ppm	1.8	1.1	0.50 - 4.5
Selenium, ppm	1.4	0.59	0.40 - 2.7
Silver, ppm	0.03	0.02	0.01 - 0.07
Strontium, ppm	260	140	93 - 500
Tantalum, ppm	0.15	0.08	0.04 - 0.33
Terbium, ppm	0.21	0.15	0.06 - 0.58
Thorium, ppm	2.3	1.5	0.62 - 5.7
Tin, ppm	1.9	3.8	0.10 - 15
Tungsten, ppm	0.75	0.65	0.13 - 3.3
Uranium, ppm	1.2	0.65	0.30 - 2.5
Vanadium, ppm	14	10	4.8 - 43
Ytterbium, ppm	0.38	0.17	0.13 - 0.78
Zinc, ppm	7.0	4.9	0.30 - 17
Zirconium, ppm	33	31	12 - 170

Source: Adapted from Gluskoter et al. 1977

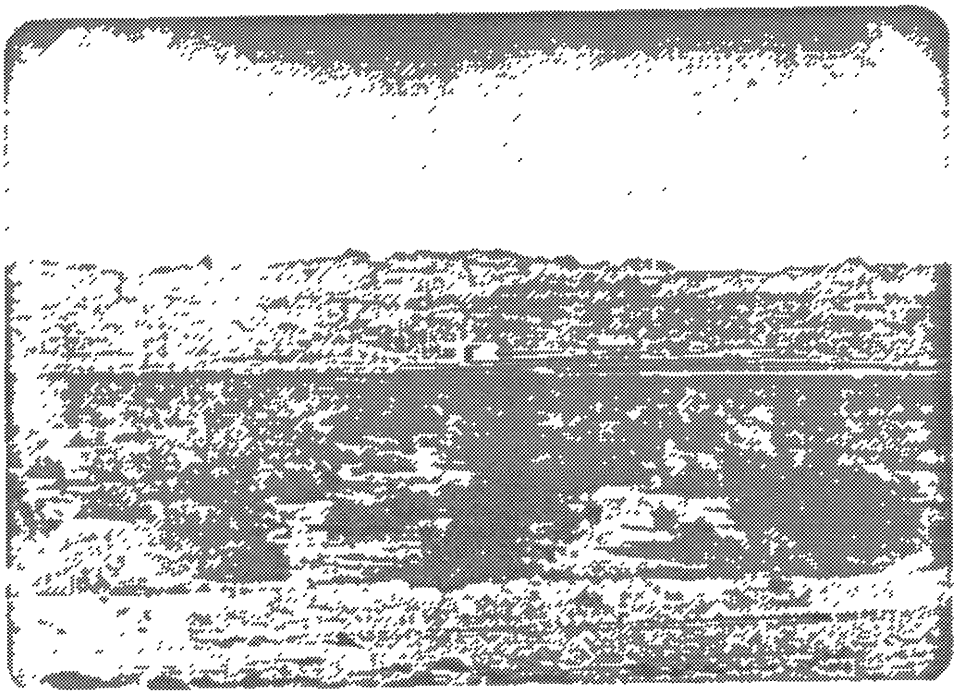
Photographic Documentation

Photographer:	D. A. Buecker, Ecology & Environment, Inc.
Date:	10 September 1980
Camera:	Canon AE-1

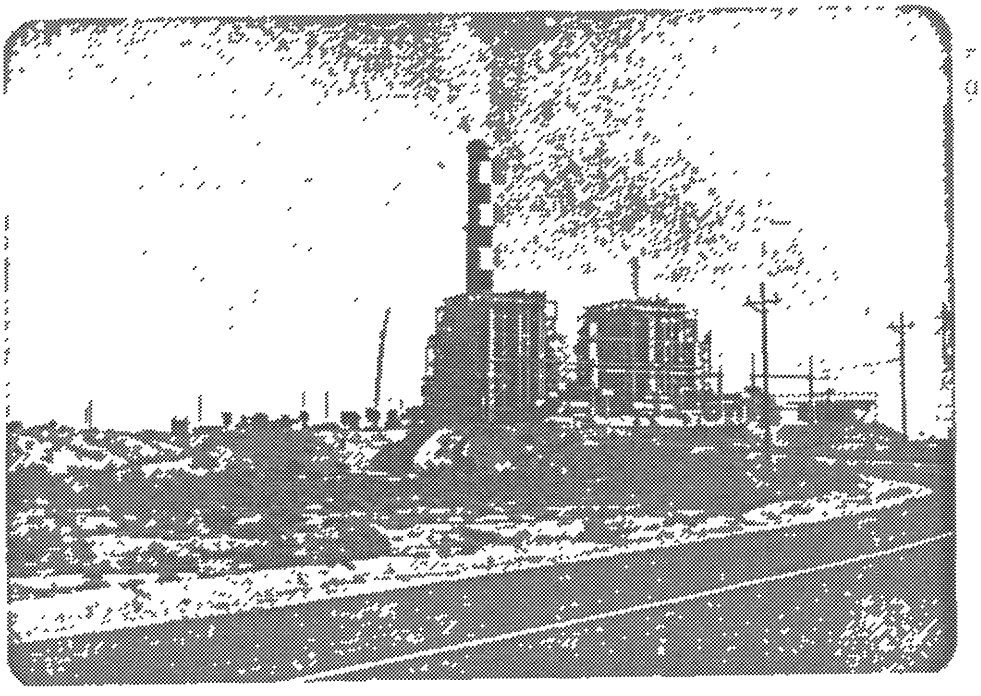


#1 View from Route 66 to the southeast showing Navajo Generating Station and Bullhead City, Arizona

#2 Navajo Generating Station, view from Route 66, as Photo #1



#3 Mohave Generating Station, surface impoundments visible at left and right of facility. The two generators are in front of the stack and coal slurry tanks are at its right.



#4 Access road to Mohave, 2 generators in foreground.

EPA FIELD INVESTIGATION TEAM

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120 HOWARD ST., SUITE 640
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ANALYSIS AND RECOMMENDATIONS
MOHAVE GENERATING STATION
TDD # F-9-8009-11

The well monitoring data presented in the Appendix of the Inspection Report and summarized in Table 5 reveal unexplained increases in chemical parameters at several well locations. The data allude to migration to wells MH-4, MH-5A, MH-5C, MH-7, MH-8A, MH-11, MH-15A, MH-16A, and MH-17A. Depths to water for these wells range from 84 - 243 feet. Figures 7-9 illustrate trends for selected parameters over the last 8-9 years. Sinodal fluctuations are evident at several wells, possibly indicating successful pumping and decontamination of impaired groundwater. The monitoring results at other wells indicate steadily increasing concentrations. Correlating well locations with neighboring impoundments reveals probable past and/or present migration from the cooling tower canal, ash dam, and ponds 1, 2, and 3. Ponds 5 and 6A may also be leaching.

The information obtained to date is not conclusive to assess hazard potential; the presence of toxic metals such as Cu, Pb, Ag, Cr, Cd, and As in hazardous quantities is not confirmed from the sampling program, nor is migration beyond the groundwater pumping stations verified. The apparent increases in constituent levels may stem from either failure of the impoundment liners, failure of the pumping system, leaching from unknown natural sources, or contamination of groundwater prior to line r installation.

SCE has not indicated that liner modification or pumping activities have been performed at the request of the Lower Colorado Office of the Water and Power Resource Service (WPRS) nor has SCE or WPRS indicated that to their knowledge there has been any off-site migration or failure in the pumping strategy. However, the intra-agency relationships and communication mechanisms have been difficult to decipher and quantitative criteria for determining at what levels conta mination requires activation

of the pumping system have not been developed. Quarterly consultant reports submitted to WPRS describing the monitoring program and interpretative results have been requested from both WPRS and SCE, but appear to be published in limited quantity or are nonexistent.

Several options are available to EPA for further investigation:

1. Be placed on mailing list via WPRS to receive quarterly monitoring reports and maintain a vigilance on trends of certain constituents, and/or

2. Sample selected wells and analyze for metals (additional well drilling might be necessary to confirm extent of migration), and/or

3. Review and verify consultants (Leroy, Crandall and Associates) monitoring and reporting practices.

Recommended priority for exercise of these options is low to medium considering the current oversight by WPRS, the existing monitoring and pumping program, and unpopulated land use.

Table 5

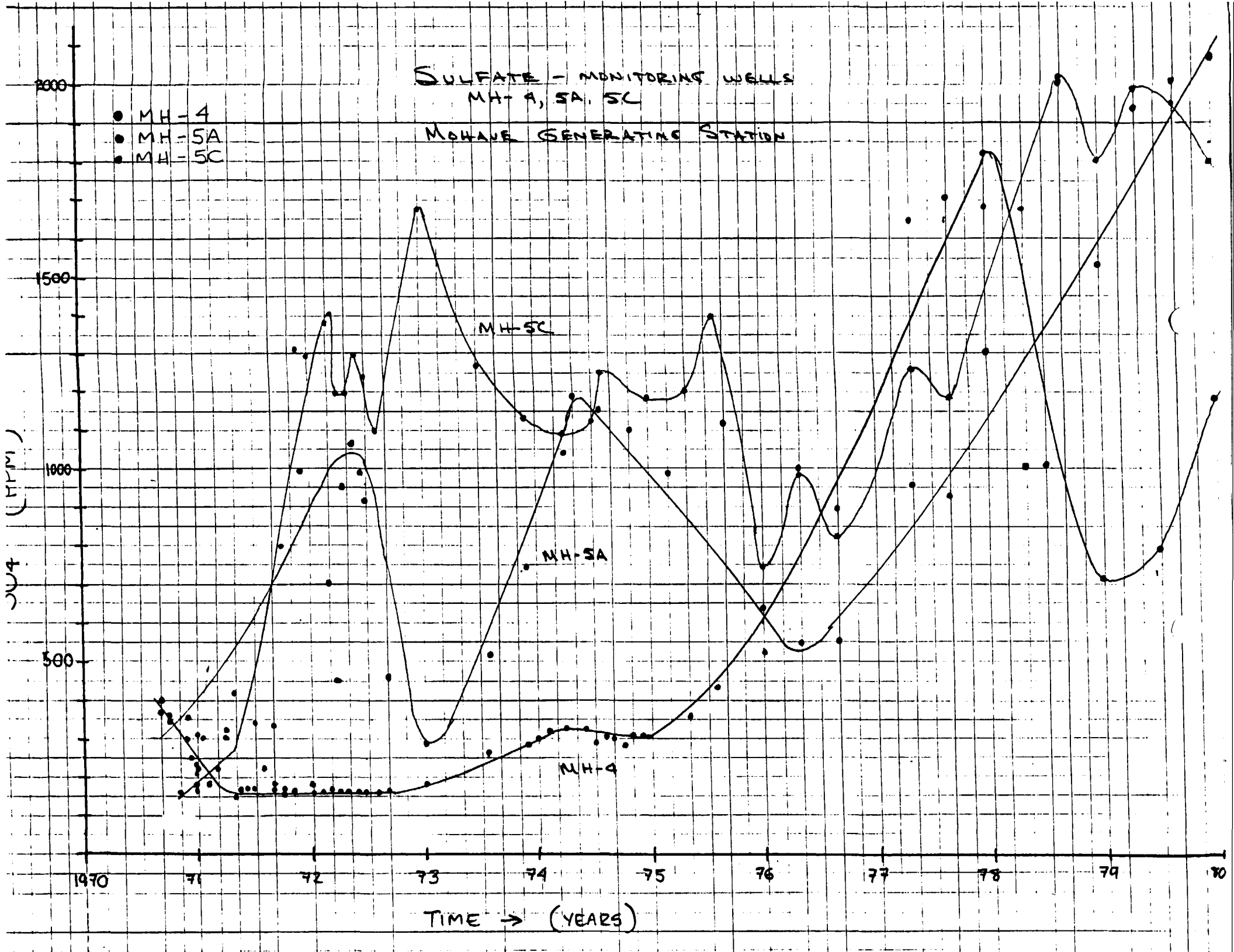
Summary Analysis of Water Samples and Groundwater Quality

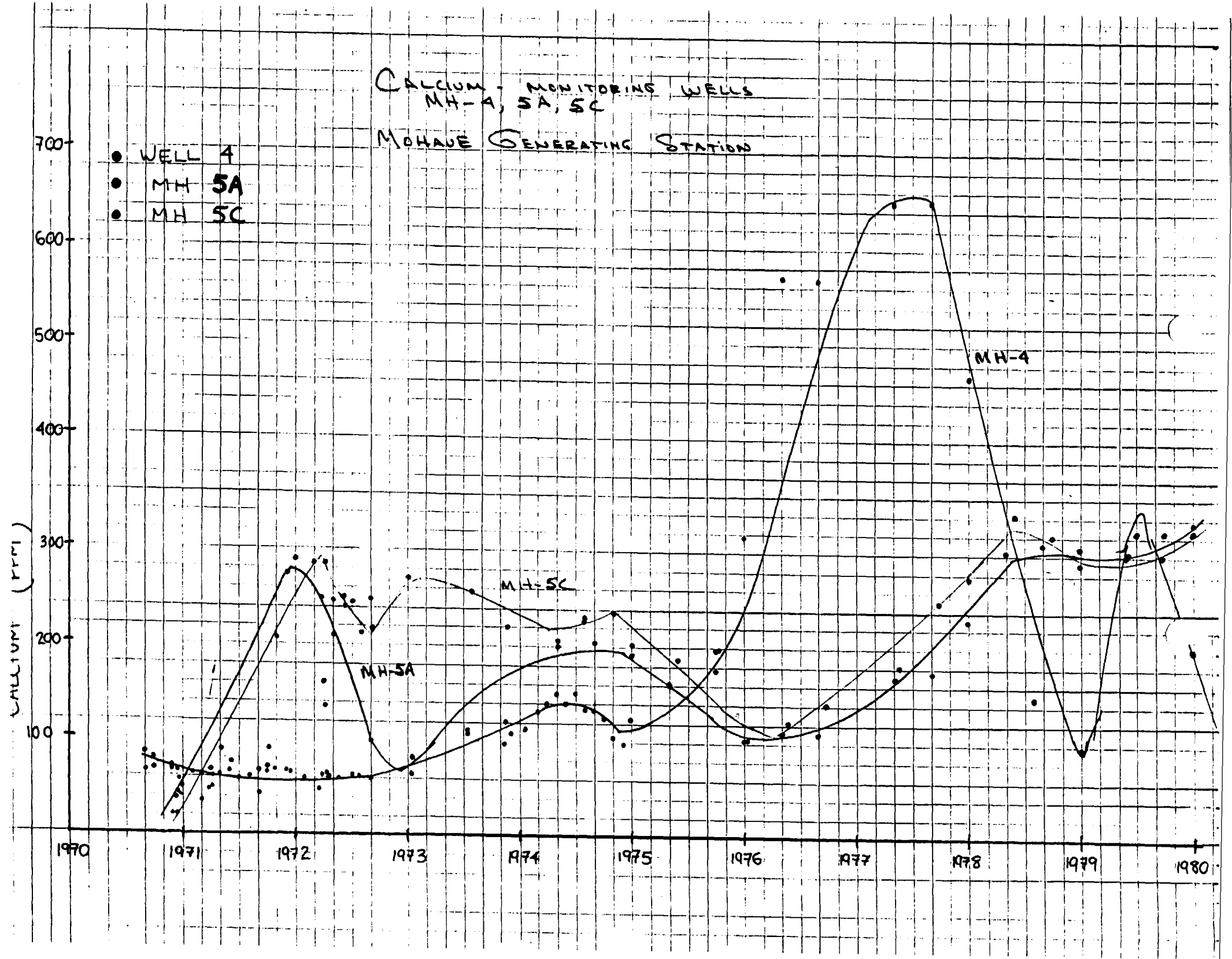
Well Number	Apparent Gradient Location	Trends*
MH-CP-1	downgradient sludge curing ponds	1/74-12/79 no trends discernible; 1/6/76 high readings appear erroneous
MH-CP-2A	downgradient cooling tower blowdown canal; SE end	1/74-12/79 slight increase in EC; increase in NO_3 and SO_4
MH-1	down gradient ash dam	6/70-8/77 no discernible trends
MH-4	downgradient ash dam	8/70-12/79 sinodal variations in EC, HCO_3; increases in TDS, Ca, Mg, Na, SO_4, Cl
MH-5A	adjacent pond #1; East	8/70-12/79 increases in Ca, Mg, Na, SO_4, Cl, NO_3, B
MH-5C	adjacent pond #1; East	11/70-12/79 significant increase in EC, TDS, Ca, Mg, Na, HCO_3, SO_4, Cl, NO_3, B
MH-7	downgradient pond #3; East corner	12/71-12/79 significant increase in EC, TDS, Ca, Mg, Na, K, SO_4, Cl, NO_3; decrease in F
MH-8A	adjacent to SE corner pond #2 and coal dump pond	10/71-12/79 sinodal variation in EC, TDS, Ca, Mg, Na, K, SO_4, Cl, F; increase in NO_3
MH-9	downgradient approx. 1000' from pond #3; SE	12/72-12/79 slight decrease in EC, TDS, Cl
MH-10	approx. 1500' south downgradient sludge curing pond	12/72-12/79 slight decrease in EC, TDS, Ca, Mg, K, HCO_3, SO_4; slight increase in NO_3 since 1979
MH-11	downgradient pond #6A; southeastern corner	12/72-12/79 sinodal variations in EC, TDS, increase in Ca, Mg, K, SO_4, Cl, NO_3
MH-12	upgradient 2500' from cooling tower blowdown ponds	12/72-12/79 decrease in EC, TDS, SO_4, Cl
MH-13A	adjacent (south) pond #4	3/73-12/79 no discernible trends
MH-14A	adjacent (south) pond #1	3/73-12/79 no discernible trends
MH-15A	adjacent to pond #5; northeast edge	4/74-12/79 increase in EC, TDS, Ca, Mg, SO_4, Cl, NO_3
MH-16A	btw. cooling tower canal and coal slurry ponds	4/74-12/79 increase in EC, TDS, Ca, Mg, Na, K, SO_4, Cl, NO_3

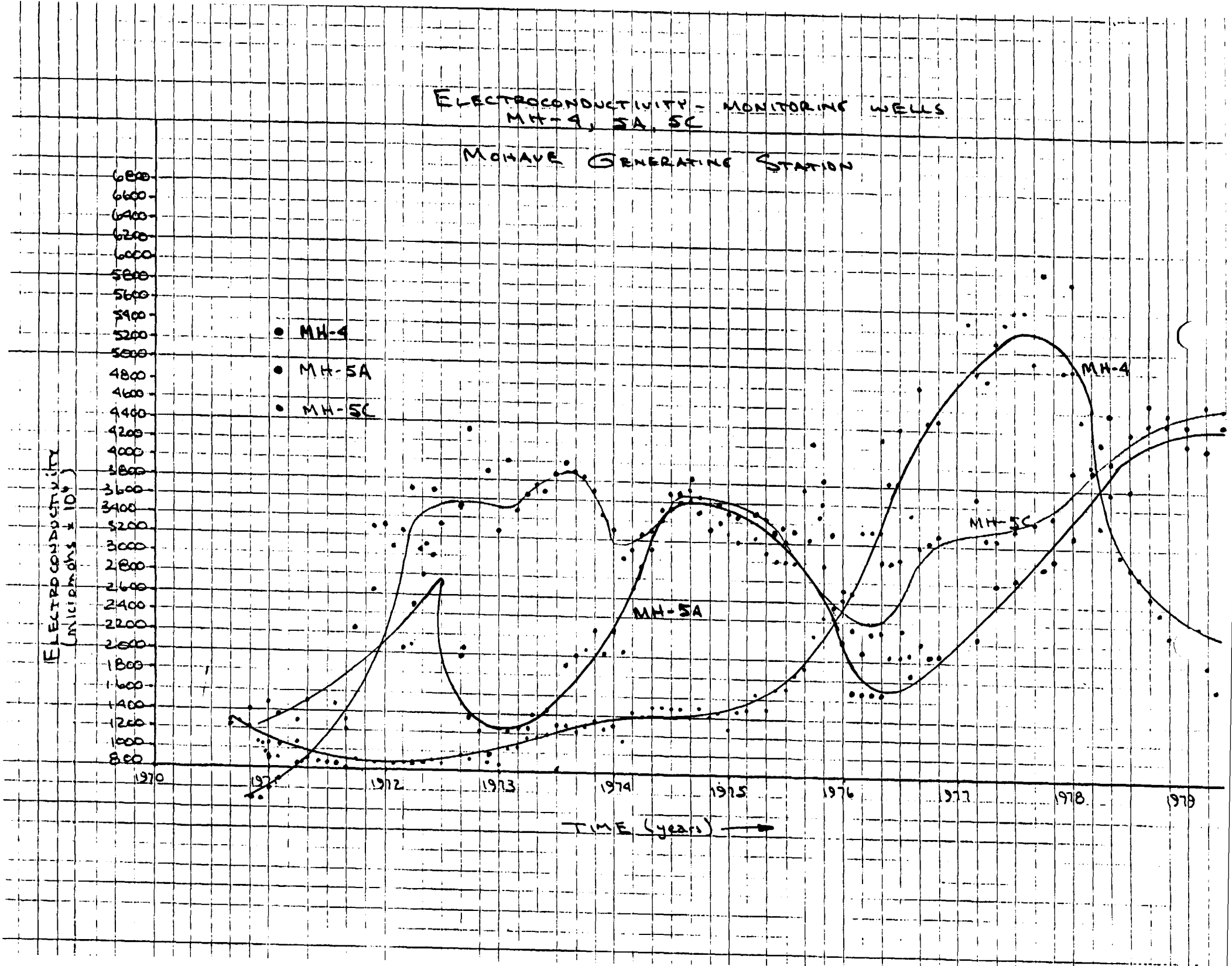
*observed by visually scanning data; no statistical tests of significance applied

Well Number	Apparent Gradient Location	Trends*
MH-16B	unknown	4/74-6/77 high TDS; no discernible increase trends
MH-17A	adjacent to cooling tower canal	4/74-12/79 increase in EC, Ca, Mg, Na, SO_4, Cl; significant increase in NO_3 since 1978
MH-18	500' downgradient ash dam; south	4/74-12/79 slight increase in EC; Ca, Mg, SO_4, Cl, NO_3 gradual increase
MH-19	btw. pond #2 and coal slurry ponds	11/74-12/79 no discernible trends
MH-20	northeast edge of pond #3	11/74-12/79 no discernible trends

*observed by visually scanning data; no statistical tests of significance applied

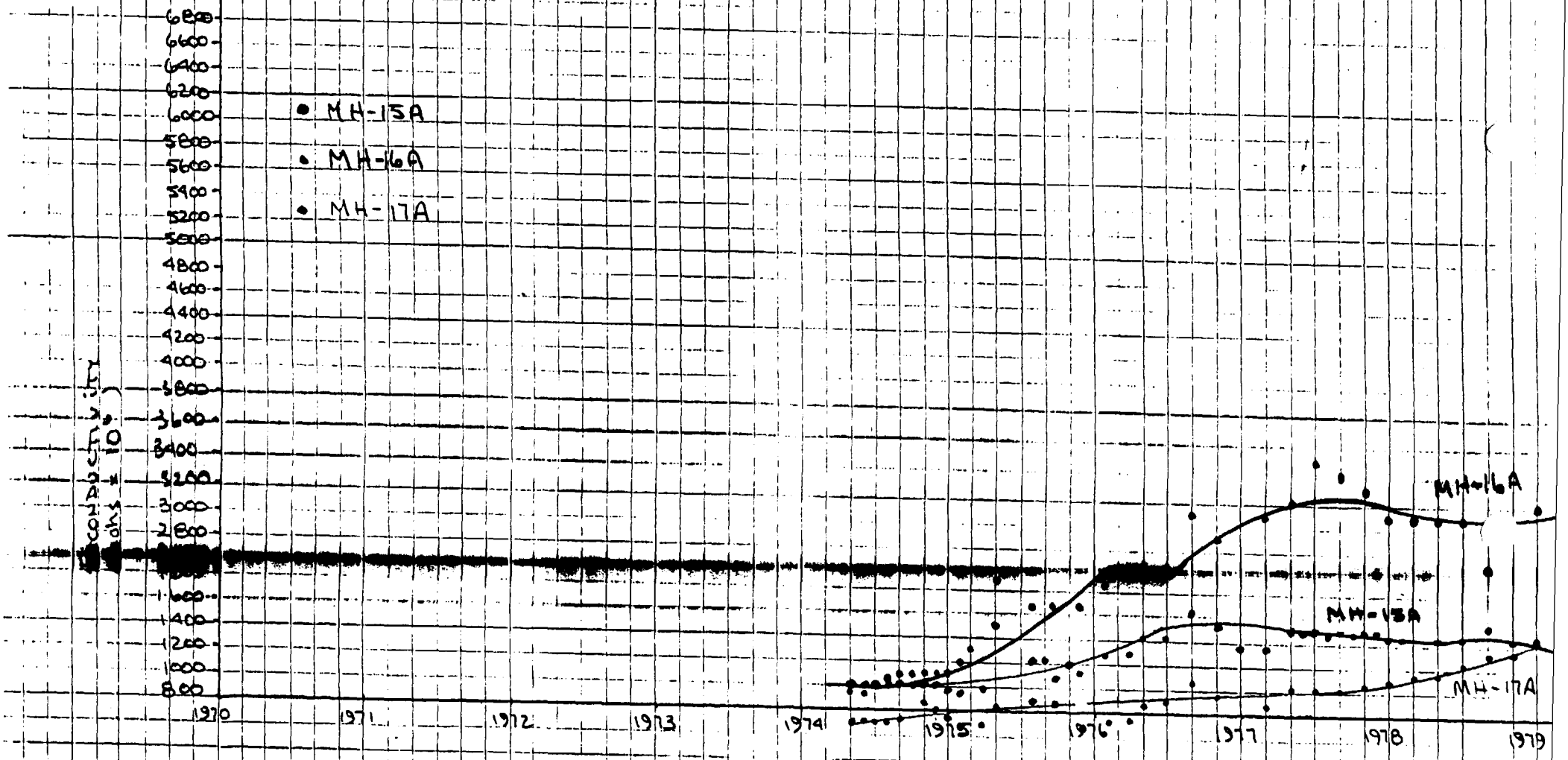

SULFATE - MONITORING WELLS
MH-4, 5A, 5C
MOHAVE GENERATING STATION
MH-4
MH-5A
MH-5C
MH-5C
MH-5A
MH-4
2000
1500
1000
500
SO4 (PPM)
1970
71
72
73
74
75
76
77
78
79
80
TIME → (YEARS)

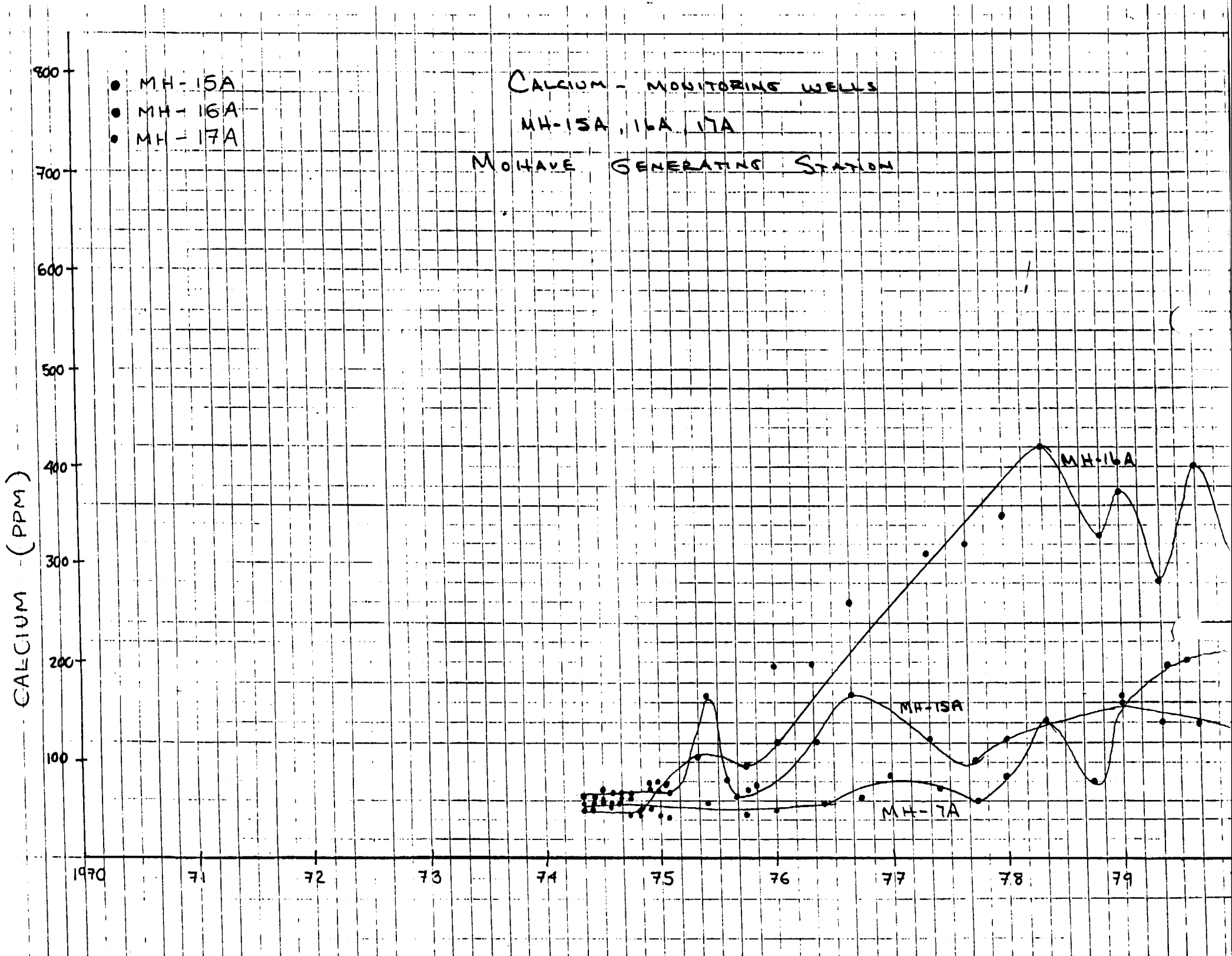

CALCIUM - MONITORING WELLS
MH-4, 5A, 5C
MOHAVE GENERATING STATION
WELL 4
MH 5A
MH 5C
MH-4
MH-5C
MH-5A
CALCIUM (PPM)
700
600
500
400
300
200
100
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980

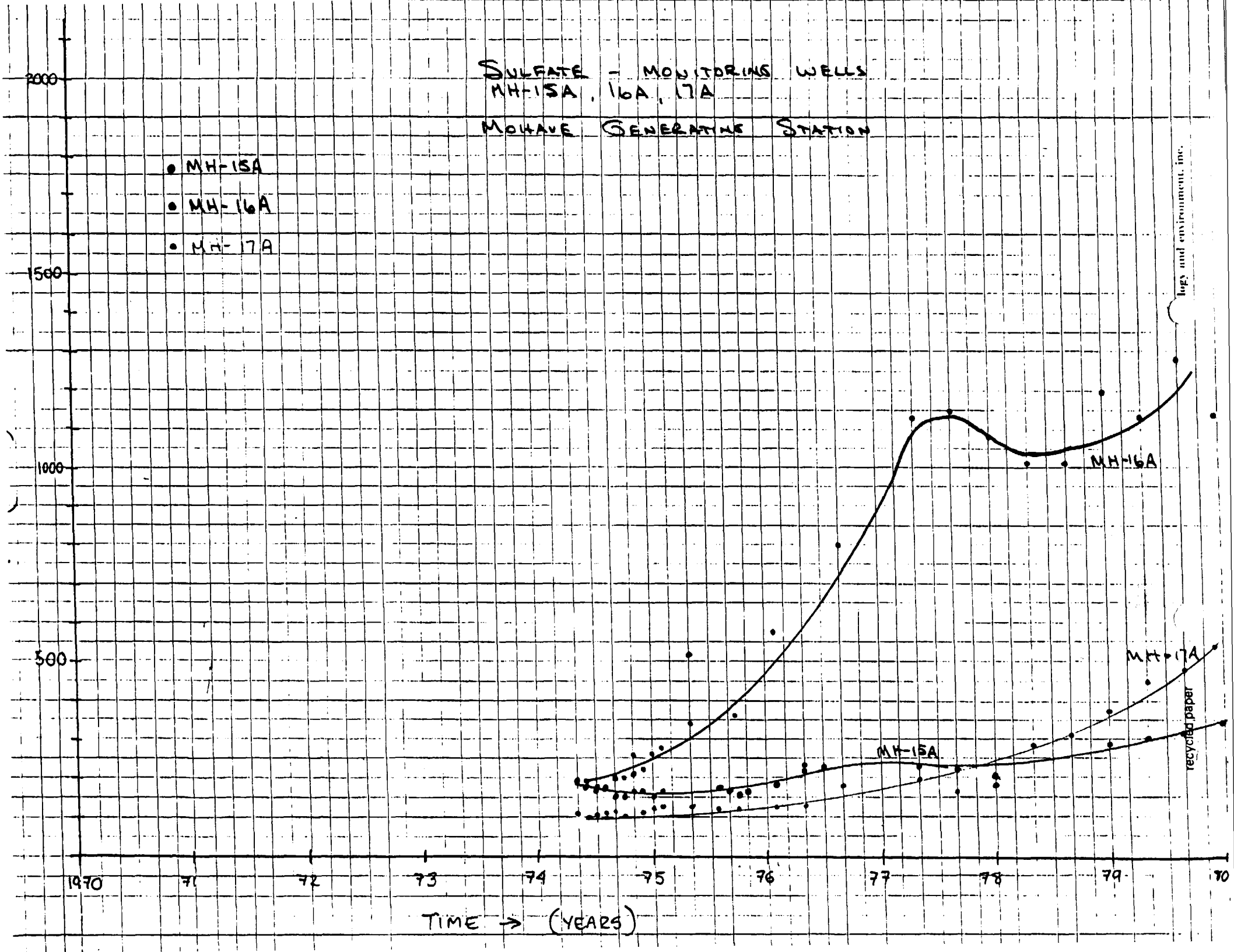

ELECTROCONDUCTIVITY - MONITORING WELLS
MH-4, 5A, 5C
MOHAVE GENERATING STATION
MH-4
MH-5A
MH-5C
ELECTROCONDUCTIVITY (micromhos x 10³)
6800
6600
6400
6200
6000
5800
5600
5400
5200
5000
4800
4600
4400
4200
4000
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
TIME (years)

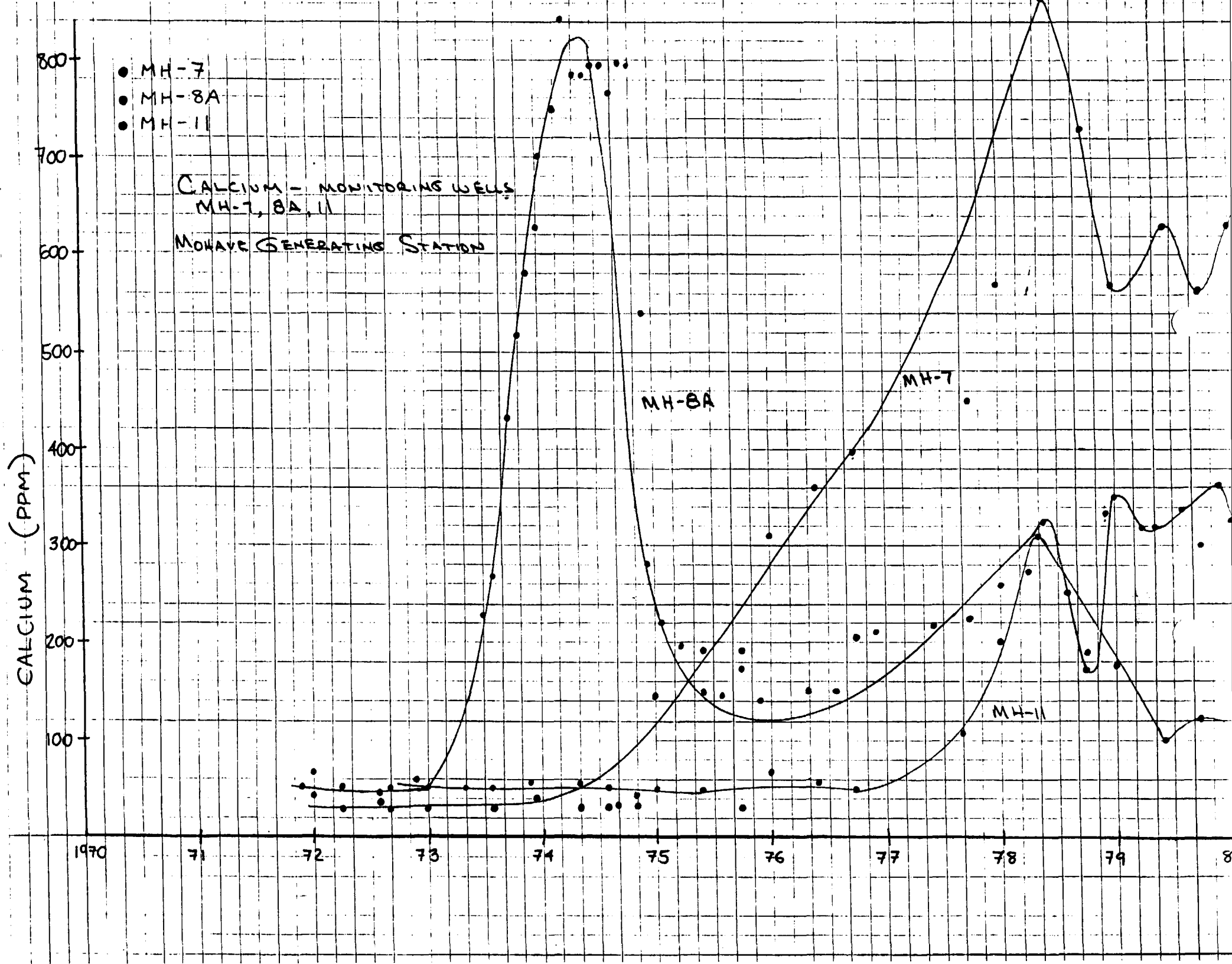
ELECTROCONDUCTIVITY - MONITORING WELLS
MH-15A, 16A, 17A

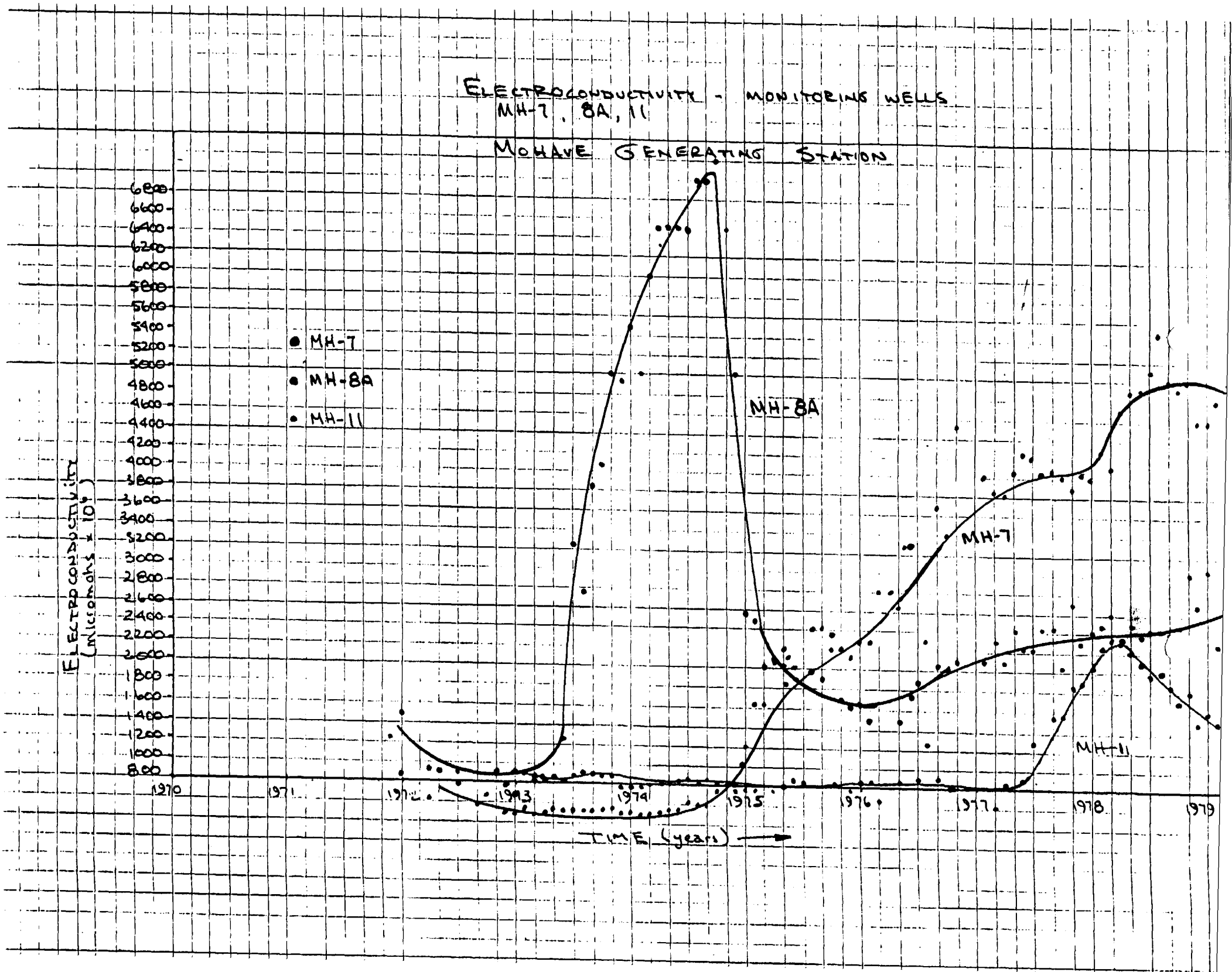
MOHAVE GENERATING STATION




CALCIUM - MONITORING WELLS
MH-15A, 16A, 17A
MOHAVE GENERATING STATION
MH-15A
MH-16A
MH-17A
CALCIUM (PPM)
800
700
600
500
400
300
200
100
1970
71
72
73
74
75
76
77
78
79
MH-16A
MH-15A
MH-17A


SULFATE - MONITORING WELLS
MH-15A, 16A, 17A
MOHAVE GENERATING STATION
• MH-15A
• MH-16A
• MH-17A
2000
1500
1000
500
MH-16A
MH-17A
MH-15A
1970
71
72
73
74
75
76
77
78
79
80
TIME → (YEARS)


● MH-7
● MH-8A
● MH-11
CALCIUM - MONITORING WELLS
MH-7, 8A, 11
MOHAVE GENERATING STATION
CALCIUM (PPM)
800
700
600
500
400
300
200
100
1970
71
72
73
74
75
76
77
78
79
8
MH-8A
MH-7
MH-11


ELECTROCONDUCTIVITY - MONITORING WELLS
MH-7, 8A, 11
MOHAVE GENERATING STATION
MH-7
MH-8A
MH-11
ELECTROCONDUCTIVITY (micromohs x 10⁶)
6800
6600
6400
6200
6000
5800
5600
5400
5200
5000
4800
4600
4400
4200
4000
3800
3600
3400
3200
3000
2800
2600
2400
2200
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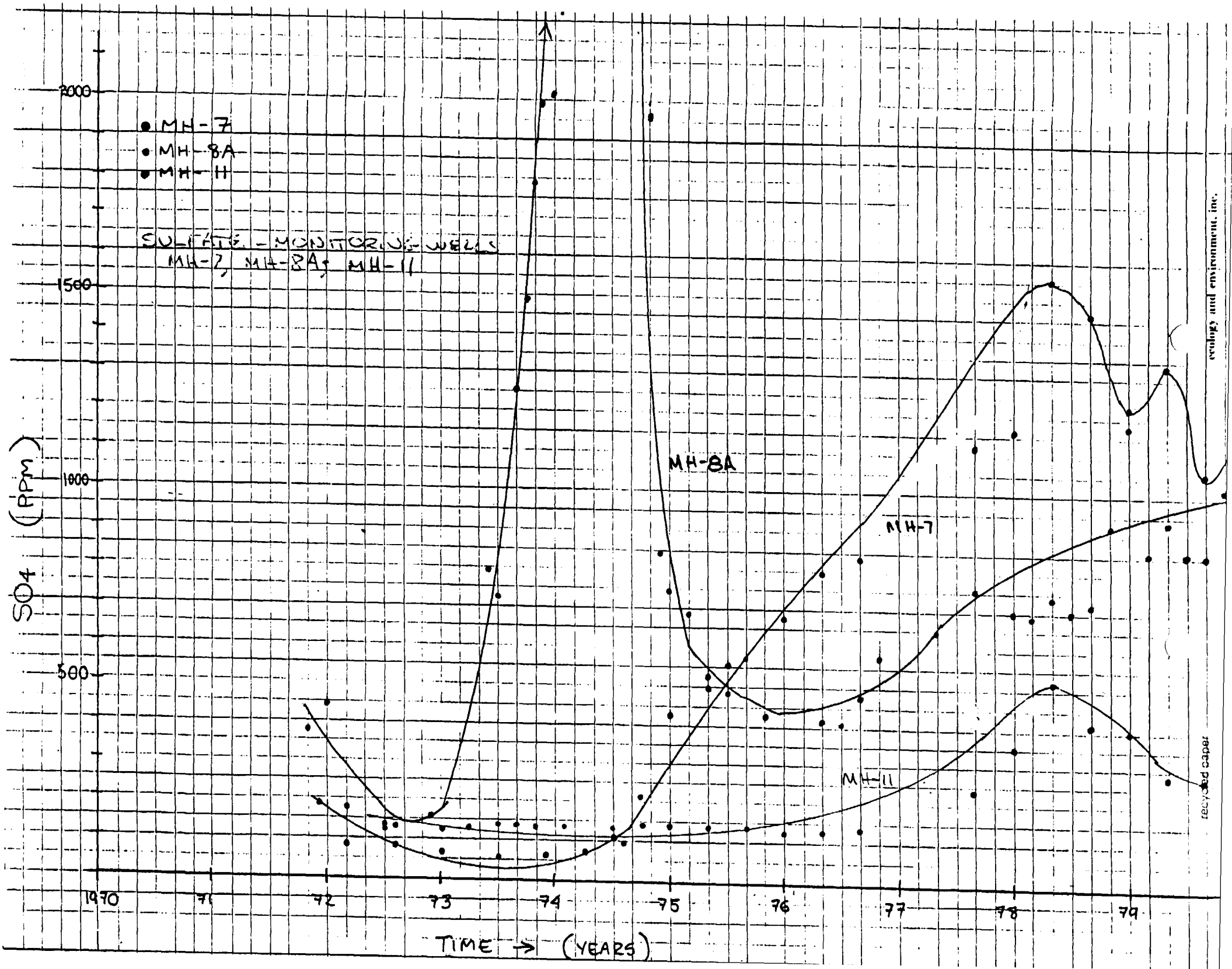
800
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
TIME (years)



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for partially scanned image(s).

For complete version of oversize document(s),
see paper copy.

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APPENDIX

I. Impermeable Asphalt Concrete Pond Liner

II. Coal Fly Ash

III. Chemical Analysis of Water Samples from Monitoring Wells

IV. Chemical Analysis of Coal Samples from the Black Mesa Field, AZ.

Impermeable asphalt concrete pond liner

There are many kinds of water storage facilities that require reliable, impermeable linings. Recently, an impermeable asphalt concrete (AC) liner was developed for a 50-acre (4,046m²) evaporation pond constructed by the Southern California Edison Company at its Mohave Generating Station. The project showed that high density (97% of Marshall density) AC can be placed using standard construction and paving equipment. Potential application is projected for any liquid storage facility not subject to rapid drawdown.

R. DALE HINKLE, A.M. ASCE
Geotechnical Engineer
Southern California Edison Company
Rosemead, California

THE PLANT, LOCATED in the Mojave Desert near the southern tip of Clark County, Nevada, is a coal-fired, 1500 megawatt steam generation station. It is owned jointly by Southern California Edison Company (SCE), Los Angeles Department of Water and Power, San Diego Gas and Electric, Salt River Project and Nevada Power. The coal is supplied by slurry pipeline from Kayenta in the Black Mesa region of northeast Arizona.

The generating station disposes of large volumes of wastewater by pumping it to evaporation ponds. The waste, generally consisting of cooling tower blowdown, contains high concentrations of soluble salts. Other waste water and acids from the plant are also directed into the ponds for evaporation.

Many acres of ponds are required for evaporation of large quantities of waste water. Because of the size of the ponds, economy of liner design and construction is an important consideration. The most important criterion, however, is liner impermeability, since waste water must be prevented from reaching and polluting the Colorado River.

Resistance to wave action is another major criterion. Winds of 30 mph (48 kmph), with occasional gusts up to 60 mph, (96 kmph) are common in this area. Further, the pond lining must be flexible enough to withstand the potential seismic hazards of the Southern California-Nevada region.

The strong winds and blowing dust dictated development of a lining that could be easily and quickly installed by use of standard construction equipment. With air temperatures of 110°-120°F (43-48°C) in summer and freezing in winter, the lining had to be resistant to extremes of heat and cold. It was also important that the lining material not react chemically with any agents contained in the stored water.

Design procedure

It was decided that the most economical paving mix was one made up of available on-site material combined with an AR4000 grade asphalt. Material in the site area consists of a well-graded silty gravelly sand containing 10-25% silty fines. It was found to provide a dense asphalt mix. The design mix, showing adequate Marshall stability, could serve as a liner as well as a driving surface in case it became necessary to run vehicles on it to clean the pond. Charts showing the graduation of the mix compared to an Asphalt Institute recommended gradation are attached (See Fig. 1)

The aggregate required sifting through a ¾-inch (19mm) screen to remove oversized material and a small percentage of the silty fines. The on-site aggregate mix was investigated to determine the optimum asphalt content, compaction effort and stability for the lining. Figs. 2, 3 and 4, prepared by Testing Engineers Inc., show the results of these studies. Aggregate mixes could be developed using many different materials such as flyash or mineral fines with concrete sand.

The most important factor considered was the permeability of the asphalt concrete after compaction. Because it was necessary to measure very low permeabilities, a pressurized apparatus was developed to deliver a high hydraulic head (See photos A, B, and C). The apparatus consisted of a constant head permeameter fitted with a pressure cap which could withstand pressures up to 200 psi (138kN/m²).

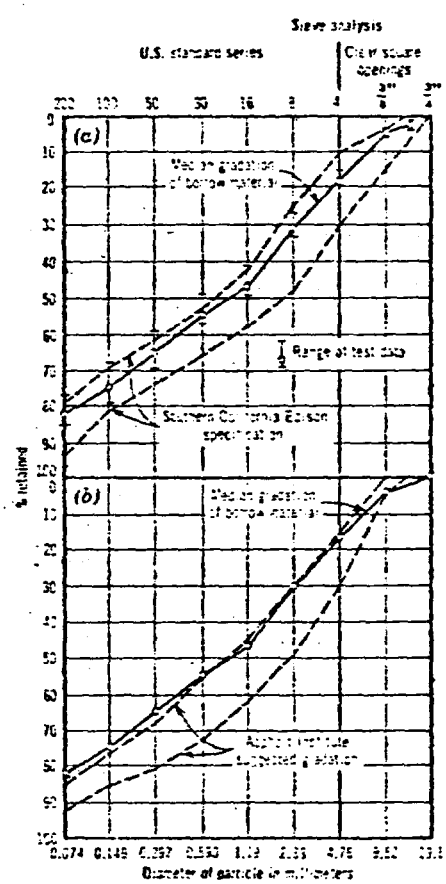


Fig. 1a. Comparison of gradation data to ¾ in. maximum. Southern California Edison (SCE) aggregate specification.

Fig. 1b. Comparison of measured median gradation to ¾ in. maximum. Asphalt Institute suggested gradation.

The asphalt sample was prepared in the laboratory and compacted into the 4 in. (101.6mm) mold (1-2 in. (25-50mm) thick) using a standard Marshall hammer. Water was then introduced at the top of the sample and the cap fitted and pressurized. The edges of the sample were sealed using liquid asphalt to prevent blowouts. The inside of the mold was machined to provide a continuous seal. It was found that maximum working pressure was 30 psi (207kN/m2) (70 ft (21.3m) of head); higher pressures ruptured the seal at the interface between the asphalt and the mold.

At high void contents (3-10%), measurable permeabilities were encountered, but at void contents of less than 2½%, permeabilities became less than .001 ft/yr (See Fig. 4). Void contents are varied by percent compaction and asphalt content. Some samples using our design mix (8½% asphalt at 97% compaction) were left in the apparatus more than two months with no observable flow through the sample.

Our conclusion is that all asphalt samples prepared according to our specification have a coefficient of permeability of less than .01 ft/yr and approaching .001 ft/yr (See Table 1). We feel that the reliability of tests providing such low permeability values is questionable, but enough samples yielded similar results so that our skepticism was satisfied. A theoretical permeability constant of .001 ft/yr was assumed using our construction method.

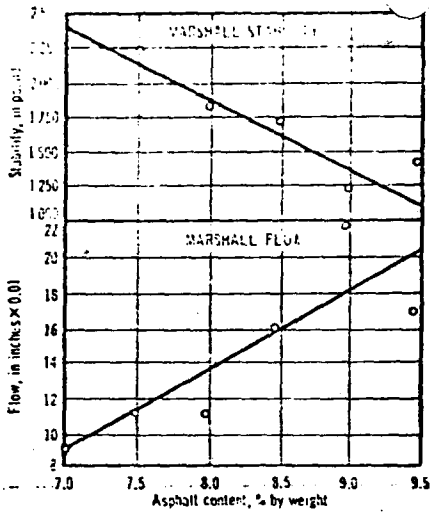


Fig. 2. Material in the site area consists of a wellgraded silty gravelly sand containing 10-25% silty fines which was found to provide a dense asphalt mix. The design mix, showing adequate Marshall stability, could serve as a liner as well as a driving surface.

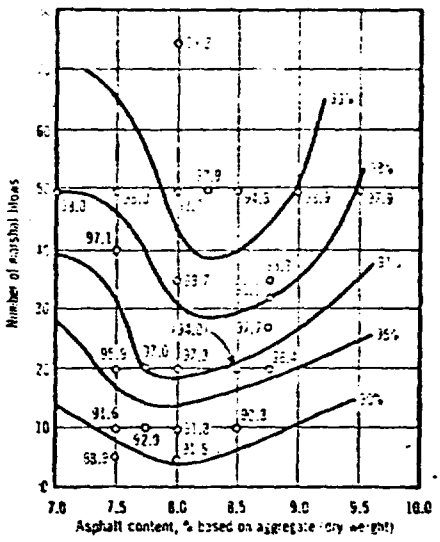


Fig. 3. Relationship of per cent compaction, compactive effort and asphalt content.

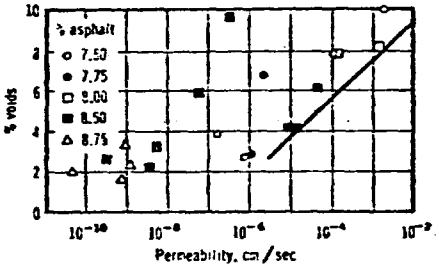


Fig. 4. Permeability of asphalt concrete vs. per cent voids.

The thickness design for the lining is as follows:

1. Assume zero leakage over the 25-year life of the pond lining is required.
2. If zero is used as the allowable leakage, the solution to the equation will approach infinity so a more reasonable figure must be assumed. It is then assumed that the 1 cf/yr/ft (.028m³/yr/.093m²) of area will be undetectable over

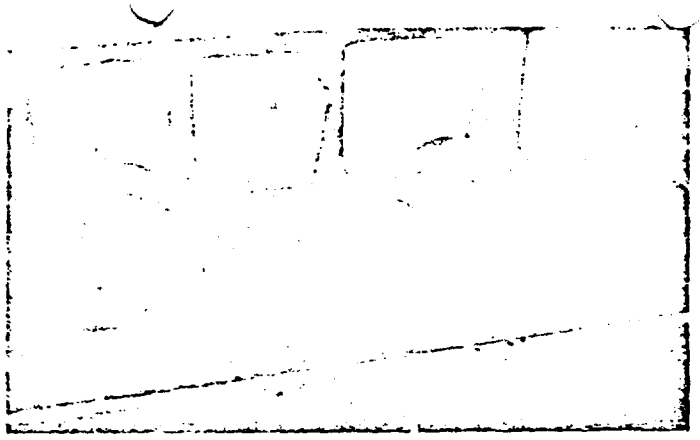
TABLE 1. Permeability Data

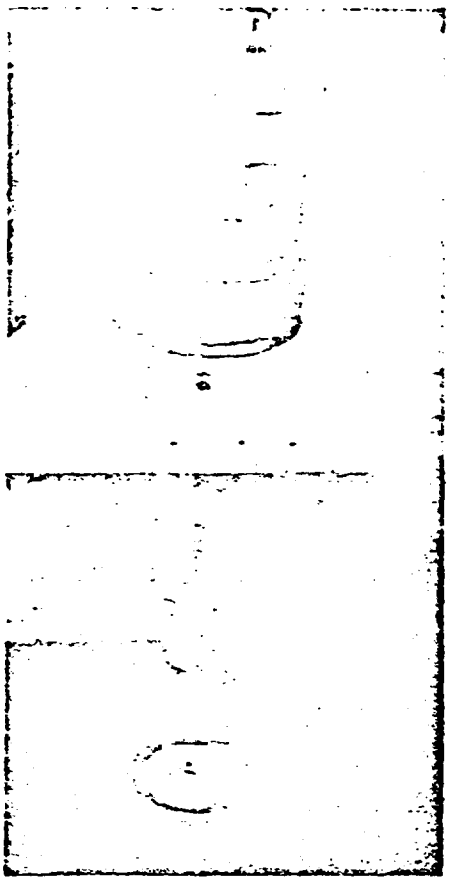
% Asphalt	% Compaction*	% Voids	Specific Gravity	Unit Weight	Maximum Specific Gravity	Permeability Constant Millidarcys	Coefficient of Permeability cm/sec	ft/year
7.5	99.2	2.8	2.248	140.3	2.313	7.6×10^{-7}	7.9×10^{-7}	0.82
7.5	98.0	3.9	2.223	138.7	2.313	1.6×10^{-7}	1.7×10^{-7}	0.18
7.5	93.8	8.0	2.128	132.8	2.313	1.05×10^{-4}	1.09×10^{-4}	112
7.5	91.4	10.4	2.072	129.1	2.313	1.53×10^{-3}	1.58×10^{-3}	1630
7.75	96.0	6.9	2.147	134.0	2.306	1.97×10^{-6}	2.04×10^{-6}	2.1
7.75	99.0	2.9	2.240	139.8	2.306	9.7×10^{-7}	1.0×10^{-6}	1.0
8.0	93.2	8.0	2.115	132.0	2.299	1.3×10^{-4}	1.31×10^{-4}	136
8.0	93.0	8.4	2.107	131.5	2.299	1.3×10^{-3}	1.3×10^{-3}	1340
8.0	98.7	2.6	2.240	139.8	2.299	$<1.9 \times 10^{-9}$	$<2 \times 10^{-9}$	<0.002
8.5	90.6	9.5	2.067	129.0	2.285	3.0×10^{-7}	3.1×10^{-7}	0.32
8.5	94.4	6.0	2.147	134.0	2.285	5.2×10^{-6}	5.4×10^{-6}	0.056
8.5	94.0	6.2	2.144	133.8	2.285	4.3×10^{-5}	4.4×10^{-5}	46
8.5	96.0	4.2	2.189	136.6	2.285	1.3×10^{-5}	1.4×10^{-5}	14
8.5	95.0	4.2	2.189	136.6	2.285	8.2×10^{-4}	8.48×10^{-4}	8.8
8.5	97.0	3.2	2.313	138.0	2.285	$<4.8 \times 10^{-9}$	$<5 \times 10^{-9}$	<0.005
8.5	98.0	2.1	2.236	139.5	2.285	$<3.8 \times 10^{-9}$	$<4 \times 10^{-9}$	<0.004
8.5	98.0	2.6	2.224	138.8	2.285	$<5.5 \times 10^{-10}$	$<5.7 \times 10^{-10}$	<0.0005 **
8.75	99.0	2.3	2.226	138.9	2.279	$<1.6 \times 10^{-9}$	$<1.68 \times 10^{-9}$	<0.0016 **
8.75	99.8	1.7	2.240	139.8	2.279	$<9.6 \times 10^{-10}$	$<9.28 \times 10^{-10}$	<0.0009 **
8.75	99.5	2.0	2.232	139.3	2.279	$<8.0 \times 10^{-10}$	$<7.79 \times 10^{-10}$	<0.0007 **
8.75	98.0	3.6	2.197	137.1	2.279	$<1.2 \times 10^{-9}$	$<1.21 \times 10^{-9}$	<0.001 **

* Based upon 35 blows Marshall = 100%

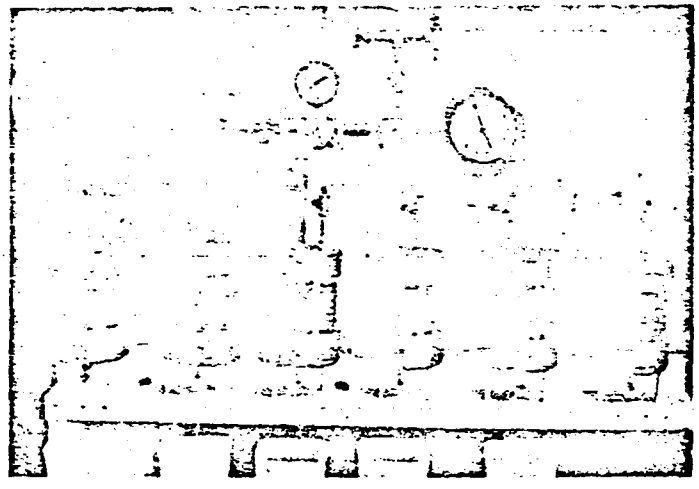
** Samples still on permeability apparatus as of this writing.

Permeability apparatus broken down to show component parts.





Permeability apparatus with six samples being tested.



Method of taking permeability readings after establishing steady state flow.

25 years. It is likely that the soil moisture deficiency in the desert area would allow between 5-100 cu ft (.14-2.8m³) of water per square foot (.093m²) of area without a noticeable effect in 25 years.

We chose to use an allowable flow of 1 cu ft per square foot (.028m³/.093m²) in 25 years. The depth to groundwater, soil moisture, geologic conditions, economics, and danger to the environment influence decisions as to permissible leakage. The allowable leakage for other projects must be evaluated on an individual basis.

Darcy's Law for one-dimensional flow across a membrane is:

$$Q = KIAT$$

Where Q = Allowable Water Passage
= 1 cu ft per square foot (0.28m³/.093m²) of area
K = Permeability Constant
= .001 ft/yr
I = Hydraulic Gradient
= head/lining thickness
A = Area = 1 sq ft
T = 15 years

$$1 = .001 \frac{(13)}{(T)} (1)\ 25$$

Solve for T (Thickness)

$$T = .001\ (13)\ (25) = .33'$$

This theoretical thickness is very close to what experience has shown to be an optimum thickness for traffic, workability and wave erosion protection, so it was acceptable for final design.

A double two-inch (51mm) layer system with overlapping joints was chosen as optimum.

Construction procedure

The entire lining was installed with standard construction equipment. The subgrade was finish-graded to ± .1 in. in 10 ft (.03m in 3.05m) using Cat. 12a motor graders.

The aggregate handling operation consisted of a Cat. 988 loader, a ¾-in. (19mm) vibrating screen for scalping and a 30 ft (9.15m) long conveyor belt with a loading hopper. Material from the pond excavation was supplied by Cat. 633 self-loading scrapers to the processing area.

All paving was performed by means of a 12 ft (3.66m) wide, self-propelled track-mounted paving machine similar to a Barber-Greene or Blow-Knox paver with an adjustable spreader bar. A light, rubber-tired compactor was used for both breakdown and final compaction. Usually four or more passes were required to achieve the 97% Marshall Density.

Taking erosion, wave action and equipment operation into account, engineers chose to make the slopes 5 horizontal to 1 vertical. It was possible to place asphalt lifts transversely on these 5:1 slopes without damage to the subgrade or asphalt pavement. No deadmen or equipment anchors were required on the slopes. The subgrade had to be very dense and well compacted to provide an adequate surface for equipment operation.

The asphalt was placed in two 2 in. (51mm) lifts for a total depth of 4 inches ± ¼ in. (101.6mm ± 6.35mm). Joints were overlapped by at least 2 ft (.6m) in all cases so that no joint extended through the entire pavement depth. It was attempted to leave as few cold joints as possible to minimize the possibility of leakage at joints.

SCE, LeRoy Crandall and Associates, Testing Engineers, Inc., and Robert E. Dunning (Chemical and Asphalt Consultant) participated jointly in development of the lining procedure. Inspection of construction was carried out by the staff of each organization.

It was necessary to test the compacted density without puncturing or coring the lining. It was felt that coring would cause localized weakness and possible future leakage. Compaction control was performed by us-

ing a nuclear density gauge. Campbell Pacific Portaprobe, with a setting especially for asphalt pavements, was utilized successfully. In the backscatter mode of operation, the majority (95%) of pentration is in the upper 2 in. (51mm), so the machine was ideal for asphalt concrete density measurements. The moisture measuring mode of the probe records the presence of hydrogen ions and since an asphalt molecule has the same number of ions as water the device was useful in determining the field asphalt content. The asphalt content could be measured relatively quickly and accurately in this manner as confirmed by extraction tests. The test results often correlate to within .5% measured asphalt content.

Monitoring the performance of the pond has been difficult. Evaporation stations are located nearby so that accurate evaporation comparison data are available, but pond rates are extremely variable. Such substances as oil slicks on the pond, coal dust and slugs of waste chemicals severely affect the evaporation rate. The pond levels and inlets are metered to obtain as much information as possible.

In addition to metering, a system of deep monitoring wells 200-300 ft (61-91.5m) deep installed in the vicinity are used to measure static ground water level and obtain samples for chemical analysis.

Cost

The original pond installation in 1974 was approximately $.65/ft ($.65/.093m²). This cost is comprised of $.45 for lining installation with the remaining costs in earthwork and engineering. (The relining of a soil cement pond with A.C. in 1975 costs approximately $.55/sq ft ($.55/.093m²).

Smaller operations will have a significantly higher cost if an asphalt batch plant has to be moved in. If a batch plant is available locally the cost can probably be significantly reduced.

Conclusion

A dense asphalt concrete was developed which can be used as a reliable lining for evaporation ponds or reservoirs. The material consists of a well-graded silty gravelly sand mixed with 8½-8¾% (of dry aggregate weight) of AR4000 asphalt compacted to at least 97% of the standard Marshall Density (35 blows).

The pond has performed well in its first six months of service and shows no evidence of cracking or distress. The high asphalt content tends to make the lining semiflexible and able to withstand the heat extremes.

The material can be placed, inspected and tested using standard procedures if performed on relatively flat (5:1) slopes. If necessary, the lining can be patched without damaging its uniformity.

Since the installation of this pond, the lining design mix has been used in relining a 20 and 30 acre (80.940 and 121.410 m²) soil cement evaporation pond and a 3 acre (12.141 m²) sweetwater and coal overflow pond. A 3 in., (76mm) 2-layer overlay system of the same material was used. The existing 3:1 slopes were overlaid with a 4 in. (101.6mm) (2-layer) thickness to protect against wave action and to prevent damage from equipment operation during cleanout. The intention is to pave the 3:1 slopes perpendicular to the dikes. It was found very difficult to operate a paving machine and a compactor transversely on 3:1 slopes.

Another 60 acre (242.820 m²) evaporation pond and 20 acres (80.940 m²) of coal storage ponds were constructed in 1976 of this material.

Other uses

The techniques developed during this operation could be applied in other water storage projects requiring near-zero leakage. This type of asphalt lining should be suitable for sewage lagoon or industrial installations requiring large-scale tanks. Any liquid storage facility not subject to rapid drawdown could be built with a lining like this.

Acknowledgements

Special recognition is given to Karl A. Blaufuss, of Testing Engineers, and Robert L. Dunning, independent consultant, for their work in developing the test mixes and apparatus. All graphs and plates are taken from their original reports. The project was a joint effort participated in equally by myself and these parties. Further assistance was supplied by R. L. Chieruzzi and A. Sekas of LeRoy Crandall and Associates and L. J. Totten of SCE. Much original work done by Jewell Benson for SCE in 1965-1966 was incorporated into the specification for this project. The prime contractor for the project was Union Engineering Company of Ventura, California with paving subcontracted to Fresno Paving Company.

R. Dale Hinkle spent the first 1½ yrs. of his working career analyzing and repairing damage to power facilities caused by the Feb. 1971 earthquake. His significant contributions since then include the development of AC and clay impermeable lining systems for evaporation ponds.

Do You Know That

. . . the U.S. has received one of the poorest energy conservation ratings among major nations? Among the 18 members of the International Energy Agency, the U.S. shared the bottom of the list with Canada and Switzerland. Rated number one for its comprehensive energy conservation program was England; also cited was Germany for having cut oil use by 10% last year. The agency reports said that the U.S. has "no standards, incentives, almost no taxes to force down energy consumption." Meanwhile the Federal Energy Administration reported that the practice of U.S. service station attendants of "topping off" fuel tanks results in the loss of between 10 and 40 million gal (38,000 to 151,000 m³) of gasoline per year.

. . . a system has been developed that would convert New York City's solid waste into clean fuel gas and reusable materials? A research team at Columbia University's engineering school says that the cost of converting the garbage into a fuel and a useful residue is less than the cost of present waste disposal methods. Team head Dr. Helmut W. Schulz, senior research associate and adjunct professor of the University's chemical engineering and applied chemistry department, said "it (the system) would produce energy equivalent to 8 million barrels of fuel oil a year, worth $100 million." The design, which utilizes a pyrolysis process, consumes the garbage at very high temperatures, and could convert the refuse New York generates each day into enough fuel to satisfy "15% of the base-load electric power requirements for the metropolitan area." (The oxygen-fed pyrolysis process is currently in operation—on a scale of 200 tpd—at a demonstration plant built by Union Carbide in Charleston, W. Va.) Although the design would require a total investment of $535 million over a 10-year implementation period, the new system would, in the long run, "pay for itself," according to Dr. Schulz. Once fully operational, it would cost $1.10 per ton of municipal waste as compared to the current cost of more than $7 per ton for landfill disposal and about $13 per ton for incineration.

COAL FLY ASH A POTENTIAL RESOURCE FOR ALUMINUM AND TITANIUM

by

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Presentation given at the Second Chemical Congress of the North American Continent, August 26, 1980 in the ACS Geochemistry Symposium on Chemical and Geochemical Aspects of Fossil Energy Extraction at Las Vegas, Nevada.

Introduction

There is a trend toward the substitution of coal for petroleum or nuclear fuels to produce current and future electric power. Combining this with the need to maintain clean air means that there is going to be a large disposal problem for the inorganic portion of coal which is collected as boiler slag, bottom ash, or fly ash. As more stringent requirements are placed on the disposal sites, coupled with the possibility that fly ash may be classified as a hazardous material under the Resources Conservation and Recovery Act, the cost for disposal is going to increase. These factors make it essential that schemes be developed to use the ash.

Figure 1 depicts the levels of present and projected coal use and resulting ash production by U.S. electric utility power generation plants (1). The estimated steam coal production value for 1985 (2) is depicted by the plotted point in Figure 1. This value supports the projected increased use of coal but suggests that enough coal may not be available in time to meet the coal consumption levels required by the National Energy Act of 1978.

Figure 2 contains the data for the amount and types of coal ashes collected and utilized by the electric utilities in 1978 (1). While some ash materials are being used as fill material, cement admixtures, aggregate, and ice anti-skid materials, it is evident that ways to use large amounts of ash need to be developed. At the Ames Laboratory, two processes are being developed to utilize fly ash as a source of metals and by-products from the residues. This paper summarizes past work, presents some new data, and indicates some areas that will be investigated in the future.

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[1] Operated for the U.S. Department of Energy by Iowa State University under contract No. W-7405-Eng.-82. This research was supported by the Assistant Secretary for Fossil Energy, Office of Advanced Research and Technology, WPAS-AA-15-05-00.

The Nature of Fly Ash

Coal fly ash, the portion of the inorganics entrained in the combustion gases and removed before the flue gas exits to the atmosphere, represents about 80 weight percent of the ash generated. While the amount of ash in coal varies over a wide range, depending upon location of the mine and the seam the coal comes from within the mine, the composition of the ash is much less variable. The chemical analyses for the fly ash from power stations burning pulverized coal, shown in Figure 3 (3), are reported as oxides to permit ready comparison. Actually the elements are present as complex silicates, oxides, carbonates, and sulfates, and a large portion of the ash is noncrystalline vitreous glass. The fly ashes of the three major types of coal shown in Figure 3 contain the equivalent of 1 to 2, 20, and 50 weight percent of titanium, aluminum, and silicon oxides, respectively. The major ash composition differences are the low iron and high calcium contents of subbituminous and lignite coal fly ashes.

A bituminous fly ash (coded C-1) of representative composition given in Table 1 has been used to develop the Ames Laboratory processes. Bituminous coal fly ashes of high iron content contain a magnetically separable iron fraction. Magnetic separation was achieved on a laboratory scale with a moving field low intensity electromagnet(3). The dense, finely divided, spheroidal, magnetic ash particles are comparable to commercial ground magnetite for use as a heavy medium material in coal beneficiation (4). The feasibility of beneficiating the magnetic fly ash fraction for use as an iron ore is also being investigated (5).

Processing Fly Ash

The non-magnetic fraction of fly ashes with high iron content and the total fly ashes of low iron content are the raw materials for processing to obtain alumina and titania. The recovery of these metal oxides from the coal fly ashes could provide for a significant replacement of the U.S. imports of these metals. From Table 2, processing of all of the waste fly ash at an 80 percent recovery rate in 1978 would have replaced the equivalent of 90, 100, and 10 percent, respectively, of the aluminum, titanium, and iron imported that year (6).

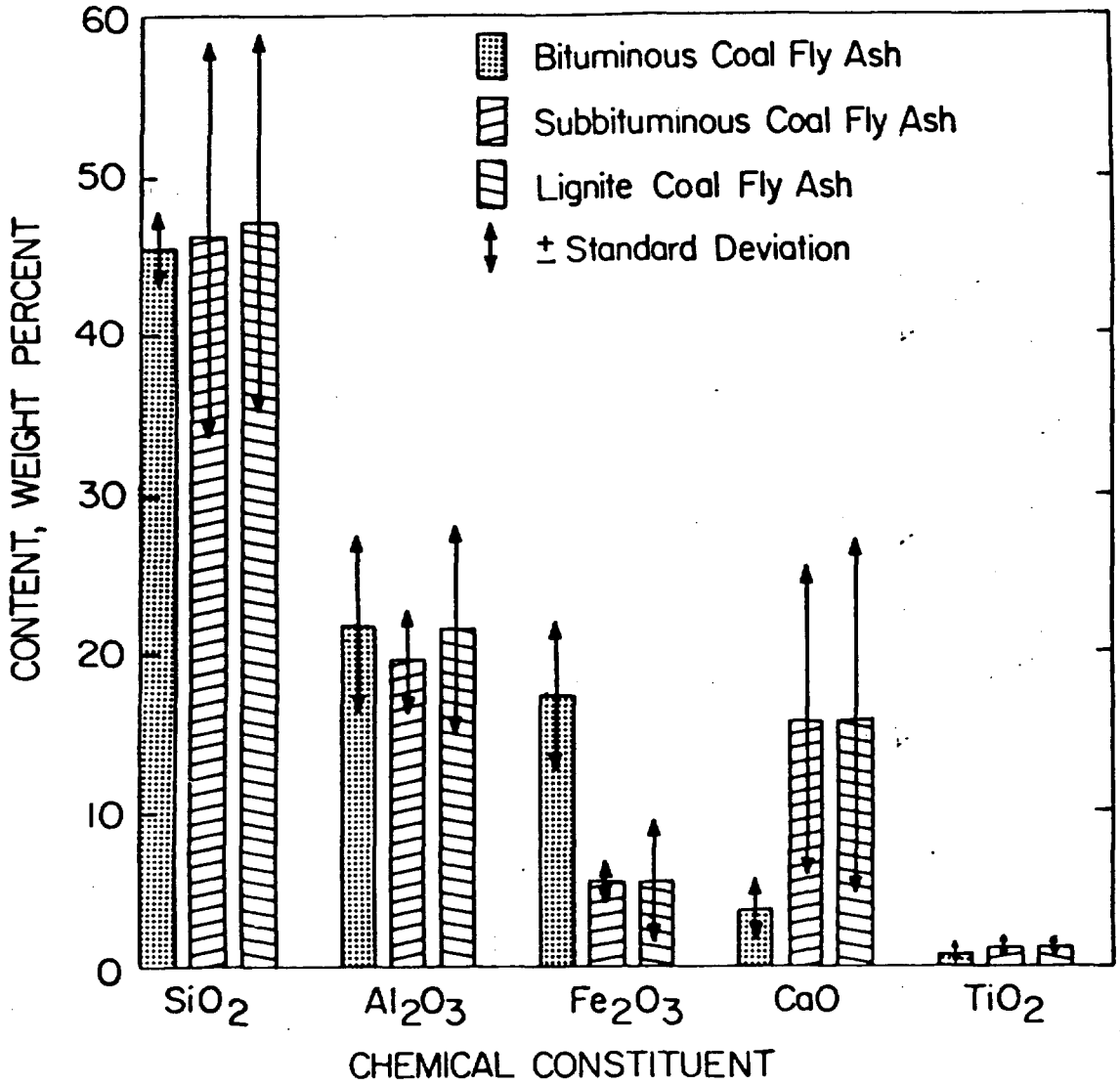


Figure 3. Chemical Compositions of U.S. Power Station Fly Ashes (4).

Table 1. Composition of C-1 Fly Ash and Fractions Obtained by Magnetic Separation.[a(4)]

	Chemical Composition, Wt. Percent		
Constituent	Whole Fly Ash	Magnetics[b]	Non-magnetics[b]
SiO_2	39.1	14.4	46.9
Al_2O_3	17.8	7.5	21.0
Fe_2O_3	17.8	71.5	5.6
CaO	4.5	1.5	5.4
MgO	0.7	0.4	0.8
Na_2O	0.4	0.2	0.4
K_2O	1.7	0.8	1.8
SO_3	1.9	1.1	1.9
LOD[c]	0.5	0.1	0.5
LOI[d]	10.6	0.6	13.0

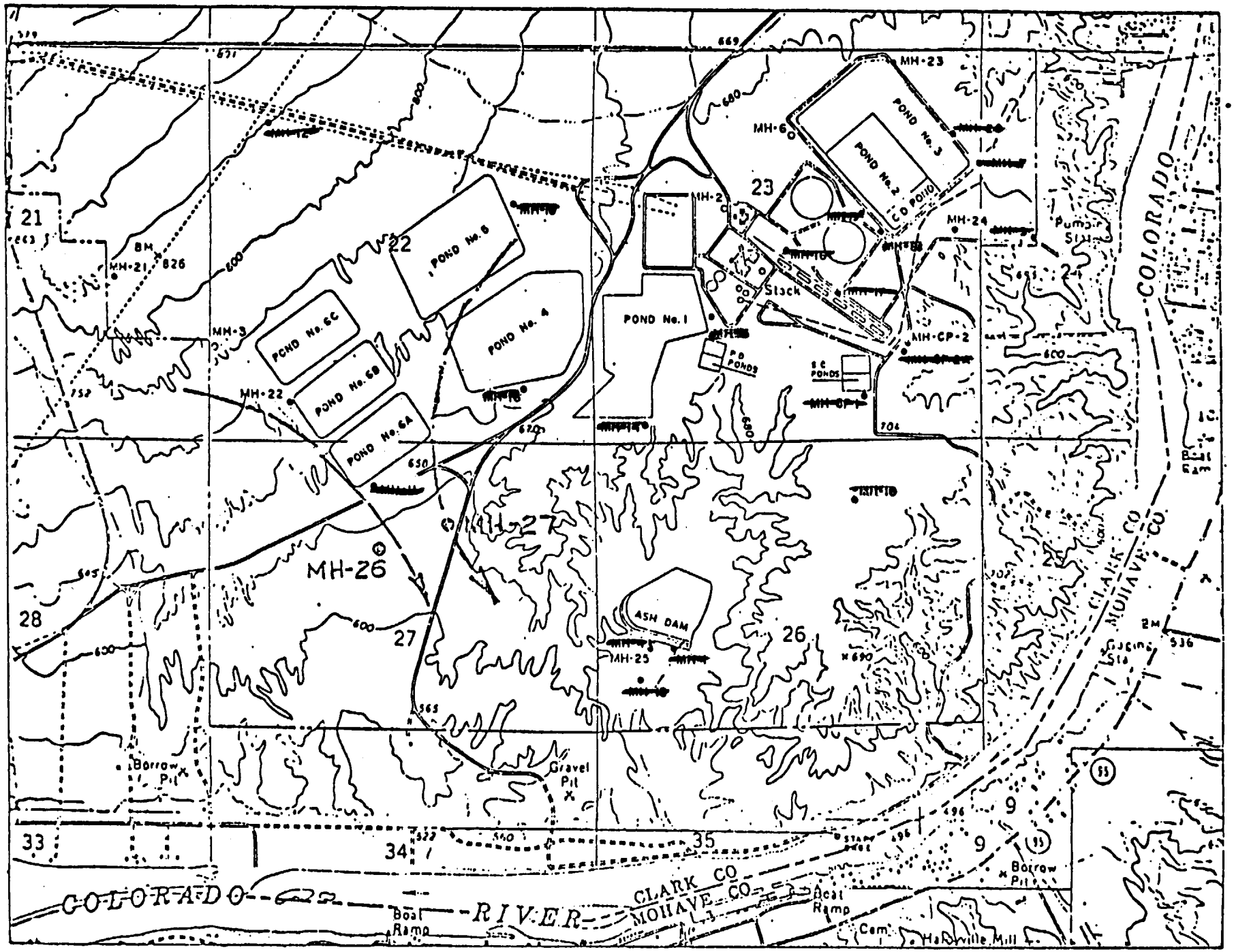
[a]C-1 fly ash was collected by mechanically precipitators from a dry bottom type boiler using coal from western Kentucky and Southern Illinois. This sample was received from the Lakeside Power Plant, Milwaukee, Wisconsin.

[b]Whole fly ash separated as 24 wt. percent magnetics and 76 wt. percent non-magnetics

[c]LOD is loss on drying at 110°C

[d]LOI is loss on ignition from 110-800°C

The recovery of the purified metal constituent from coal fly ash is difficult because of the vitreous, refractory nature of the fly ash particles. Unlike primary ores such as bauxite or rutile, the metals are contained in a glass-like matrix (7). Secondarily, if all the components are reactive, the separation and recovery of the products becomes complicated.



EXPLANATION

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-1

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-1	6- 4-70	1194	7.7	53	13	209		0	215	274	120	3.1			886
	8- 5-70	946	7.5	57	18	114		0	172	191	84	11.1			684
	9-10-70	891	7.9	56	20	113	5	0	171	168	95	12.5		0.25	640
	11-18-70	935	7.6	56	16	122	5.5	0	177	175	92	12.1	0.8	0.14	656
	11-20-70	875	7.8	61	20	102	6.0	0	173	165	92	14.7	0.9	0.25	633
	11-24-70	867	7.5	58	24	98	3.5	0	162	160	90	12.3	1.1	0.10	607
	12- 4-70	852	6.7	60	20	96	5.0	0	170	161	94	11.6	1.0	0.21	618
	12-18-70	927	7.8	62 / 58	19 / 19	117 / 121	7.0 / 5.3	0	197 / 190	189 / 185	87 / 94	4.3	0.9	0.36	682 / 676
	2-10-71	853	7.5	65	20	84	4.5	0	153	162	88	12.4	1.2	0.19	589
	3-26-71	844	7.7	58	23	80	5.5	0	159	161	86	13.1	0.9	0.36	586
	4- -71	936	7.4	63	23	94	4.5	0	183	160	101	1.2	1.5		619
	5- -71	863	6.9	67	22	85	5.0	0	186	155	98	2.6	1.2		629
	6-24-71	860	7.5	64	20	82	5.0	0	183	170	73	3.8	0.8	0.19	602
	7-27-71	906	7.3	75	18	90	5.0	0	213	164	84	1.6	0.6	0.27	650
	8-30-71	800	7.7	64	25	54	4.0	0	134	160	72	11.3	0.8	0	526
	9-28-71		7.5	72	16	94	6.0	0	183	166	95	4.2	1.0	0.8	636
	11-29-71	903	8.2	66 / 66	14 / 20	98 / 85	6.5 / 5.1	0	174 / 174	181 / 164	82 / 87	7.1	1.1	0.25	630 / 607
	2-29-72	923	7.9	64	24	79	3.5	0	172	156	90	16	1.05		638
	3-28-72	871	7.9	64	22	86	5.0	0	189	159	84	4.7	0.88	0.75	615
	4-24-72	880	7.4	50	37	80	3.5	0	198	156	90	5.3	0.96	0.02	622
	5-25-72	946	7.3	62	31	90	6.0	0	221	158	93	7.7	1.27	0.41	670
	6-29-72	861	7.4	66 / 61	22 / 27	86 / 84	5.5 / 4.7	0	180 / 192	161 / 158	90 / 87	7.3	0.74	0.15	618 / 633

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-1 (cont'd.)

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-1 (cont'd)	9-29-72	916	7.8						201		95				
	11-15-72	800	7.7						195		98				
	12- 6-72	720	7.8						198		92				
	1- 3-73	880	7.7	63	23	75	3.1		192	143	85	8.5	1.5	0.2	619
	2- 8-73	800	7.8						168		95				
	3- 6-73	830	7.8						172		143				
	3-27-73	870	7.8						208		85				
	5-7-73	820	8.0						177		88				
	6-7-73	850	7.9						177		88				
	8-5-73	850	7.6	62	16	91	3.5		162	154	90	15	1.33	ND	608
	9-7-73	850	7.8	62.5	19.5	83	3.3		159	148.5	90				455
	10-8-73	850	7.7						93		159				
	11-14-73	810	7.7						177		90				
	12-5-73	820	7.7	62	22	92	3.9		162	155	95	13	1.00	N.D.	589
	1-3-74	790	7.4						177		83				
	2-8-74	820	7.5						183		90				
	3-5-74	820	7.4						168		90				
	4-3-74	850	7.8	66	22	94	3.9		171	161	93	11	0.96	ND	609
	5-1-74	900	7.6						177		103				
	6-5-74	900	7.8						177		95				
	7-2-74	900	7.9	68	19	83	3.9		171	163	95	16	0.37	ND	625
	7-29-74	900	7.8						174		90				
	9-5-74	900	7.5						125		33				
	10-1-74	850	7.7	65	49	99	3.9		171	181	100	14	0.90	ND	639
	11-5-74	850	7.6						161		98				
	12-2-74	820	7.6						146		94				
	1-8-75	840	7.4	65	24	81	3.9		146	178	98	14	0.87	ND	599
	3-6-75	820													
	4-30-75	850	7.4	67	22	90	3.7		162	159	98	15.7	0.90	ND	605
	7-2-75	950													
	9-5-75	990	7.8	51	34	86	4.4		164	165	100	15.8	0.89	ND	657

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-1 (Cont'd)

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-1 (Cont'd)	11-4-75	850													
	1-6-76	810	7.95	69	22	78	3.5		160	170	94	0.3	0.90	0.24	580.
	3-1-76	880													
	4-28-76	940	7.8	67	24	91	14.9		180	173	102	13.2	0.88	ND	660
	6-29-76	1,000													
	1-6-76	810	7.95	69	22	78	3.5		160	170	94	0.3	0.90	0.24	580
	3-1-76	880													
	4-8-76	940	7.8	67	24	91	14.9		180	173	102	13.2	0.88	ND	660
	6-29-76	1000													
	8-25-76	1010	8.0	76	24	92	3.5		207	173	98	11.4	0.9	ND	696
	10-22-76	900													
	2-23-77	900													
	4-28-77	970	7.85												
	6-28-77	975													
	8-31-77	975													

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-CP-1

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-CP-1															
	1-4-74	700	7.4	57	14	97	3.9		153	116	115	8.0	1.20	ND	527
	2-8-74	800	7.8	55	15	95	3.5		122	120	115	6.8	1.22	ND	546
	3-7-74	800	7.8	64	10	101	3.5		159	152	110	7.4	1.18	ND	584
	4-1-74	800	7.7	56	12	97	3.1		149	115	115	8.1	1.25	0.31	558
	4-30-74	780	8.1	51	14	96	3.1		131	114	120	12	1.27	0.24	544
	6-5-74	720	8.2	56	12	96	3.1		137	122	115	9.9	1.30	ND	528
	7-2-74	800	8.0	55	11	105	3.5		134	117	115	12	0.56	ND	557
	7-30-74	800	8.0	70	1	133	5.5		198	119	162	11.4	1.22	ND	630
	9-4-74	800	8.1	45	16	98	3.5		131	109	118	11.0	1.25	ND	546
	10-1-74	850	8.0	55	17	108	3.9		140	178	108	11.2	1.35	ND	608
	11-5-74	750	8.1	53	12	95	3.1		134	115	114	11	1.23	ND	531
	12-3-74	730	7.8	34	18	100	3.1		134	118	110	14.1	1.27	0.31	520
	1-7-75	700	8.1	40	18	94	3.1		128	113	114	9.9	1.3	ND	505
	3-5-75	780													
	4-29-75	800	7.7	46	16	93	3.1		134	118	112	12.2	1.2	ND	550
	7-2-75	860													
	9-4-75	290	8.1	48	13	95	3.5		120	109	113	10.3	1.22	0.29	568
	11-4-75	770													
	1-6-76	2780	7.7	354	81	216	7.5		90	743	630	6.4	0.48	0.17	2037
	3-2-76	780													
	4-29-76	840	7.9	55	14	94	3.1		153	99	120	8.5	1.23	ND	565
	6-29-76	840													
	8-26-76	900	8.0	76	6	99	4.3		163	110	125	8.2	1.2	0.2	611
	10-21-76	800													
	2-24-77	750													
	4-28-77	810	7.9	48	17	105	2.8		159	117	117	10.2	1.3	0.62	595
	6-28-77	825													
	8-30-77	825	7.9	38	21.8	98	4.0		146	105	117	13.3	0.5	0.6	575
	10-27-77	850													
	12-21-77	800	8.0	53	15.0	93	2.9		137	105	112	14.2	1.0		492
	2-26-78	800													

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH- CP-1

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
CP-1 Cont'd	4-25-78	800	8.3	91	15	83	5.5		175	157	107	2.13	1.55		
	6-28-78	750													
	8-29-78	800	8.3	53	18	97	3	3	119	120	118	9		0.26	
	10-27-78	800													
	12-29-78	750	8.1	75	16	90	3		141	150	118	15		0.43	
	2-24-79	775													
	4-27-79	800	8.1	45	15	98	4		150	99	114	18		0.30	
	6-28-79	800	7.8												
	8-31-79	750	7.9	48	16	125	2		136	126	119	35		0.34	
	10-30-79	720													
	12-27-79	720	7.5	48	16	106	4		152	143	122	-		0.39	

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-CP-2A

Well Number	Date Sampled	$EC \times 10^6$ at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-CP-2A															
	1-4-74	680	8.0	37	7.3	109	3.9		82	138	113	3.1	1.10	ND	485
	2-8-74	800	7.8	50	12	110	3.9		140	138	115	8.1	1.12	ND	564
	3-7-74	820	8.2	55	9.1	116	3.9		143	138	115	8.1	1.10	ND	581
	4-2-74	820	7.7	51	15	110	3.9		143	130	115	8.7	1.10	0.58	571
	4-30-74	800	8.2	51	12	108	3.9	9.0	122	132	113	11	1.12	ND	551
	6-5-74	850	8.2	53	12	108	3.5	6.0	137	125	113	9.9	1.40	ND	581
	7-3-74	850	8.2	51	12	115	3.9		146	138	113	11	1.12	ND	593
	7-30-74	820	8.1	54	10	110	5.1		153	136	110	11.4	1.15	ND	582
	9-4-74	800	8.1	47	14	110	3.9		146	119	108	11	1.10	0.24	560
	10-1-74	850	7.8	55	10	132	4.3		140	196	105	10.7	1.25	0.55	625
	11-5-74	800	8.0	50	10	112	4.3		140	141	115	9.3	1.17	ND	571
	12-3-74	820	7.3	28	25	114	3.9		190	129	100	11.1	1.17	ND	585
	1-7-75	750	7.9	29	18	115	4.3		145	129	105	10	1.2	ND	540
	2-6-75	680													
	3-5-75	780													
	4-29-75	850	7.7	46	14	90	1.9		98	127	104	13.3	1.1	ND	545
	7-2-75	900													
	7-31-75	940													
	9-3-75	880	7.9	42	16	114	4.5		132	127	119	10.3	1.25	ND	590
	10-2-75	880													
	11-4-75	850													
	12-3-75	900													
	1-6-76	900	7.8	80	15	118	7		186	151	134	9.0	1.19	0.48	665
	2-4-76	910													
	3-2-76	920													
	4-2-76	890													
	4-29-76	1000	8.0	67	23	120	4.7		146	197	75	11.4	1.17	0.36	672
	5-7-76	1000													
	6-29-76	1080													

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH- CP-2A

Well Number	Date Sampled	ECx10⁶ at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-CP-2A (Cont'd)	7-28-76	950													
	8-26-76	1110	8.1	68	27	122	4.3		152	180	155	9.6	1.0	0.1	747
	9-28-76	1020													
	10-21-76	1000													
	1-28-77	950													
	2-24-77	950													
	3-30-77	980													
	4-28-77	1020	8.1	65	17.6	140	5.2	3.0	137	80	147	12	1.37	0.32	620
	5-26-77	1005													
	6-28-77	1050													
	7-28-77	1000													
	8-20-77	1030	7.9	53	22	128	4.2		146	162	142	16.0	0.5	0.55	685
	9-23-77	975													
	10-27-77	950													
	11-30-77	975													
	12-21-77	975	8.1	58	15.3	115	3.8		134	145	137	17.7	1.0		582
	1-31-78	975													
	2-26-78	1000													
	3-30-78	950													
	4-25-78	925	8.3	59	12	114	6.2		127	158	133	2.53	1.04		
	5-25-78	900													
	6-28-78	925													
	7-31-78	1000													
	8-29-78	970	8.3	63	18	117	4	3	107	158	127	18		0.25	
	9-26-78	925													
	10-27-78	975													
	11-30-78	950													
	12-29-78	950													
	1-31-79	1150													
	2-24-79	975													
	4-27-79	1050	8.0	65	19	132	5		145	164	180	27		0.31	

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-CP-2A

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-CP-2A (Cont'd)	6-01-79	1100													
	7-28-79	1150													
	7-31-79	1100													
	8-31-79	1100	7.7	70	22	163	3		120	189	235	44		0.38	
	9-24-79	1100													
	10-30-79	1050													
	11-29-79	1150													
	12-27-79	1100	7.2	86	25	178	4		115	209	218	40		0.39	

FROM MONITORING WELL MH-4

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-4	8-5-70	1310	7.4	84	12	188		0	166	400	85	0.3			935
	9-10-70	1300	7.5	79	24	165	10.6	0	209	343	101	0.8		0.35	932
	10-28-70	1215	7.5	69	21	160	10.0	0	206	296	100	1.0	0.6	0.31	863
	11-20-70	1106	7.6	69	18	148	9.5	0	209	258	95	0.6	0.9	0.28	808
	11-24-70	1032	7.7	58	28	138	7.0	0	206	237	92	0.2	0.80	0.19	766
	12- 4-70	1007	7.5	48	26	129	8.0	0	192	219	93	0.9	0.9	0.10	716
	12-18-70	920	7.8	40 64	32 23	94 146	5.0 8.4	0	164 193	161 275	92 94	16.2	0.9	0.38	603 803
	1-27-71	881	7.8	64	26	94	6.5	0	192	180	88	9.4	1.4	0.11	659
	3-15-71	1108	6.8	48	66	102	7.0	0	145	342	94	11.0	1.0	0.10	815
	3-26-71	832	7.8	61	12	96	6.0	0	176	146	82	7.7	1.0	0.54	587
	4- -71	918	7.5	63	21	94	5.5	0	175	160	94	9.2	1.5	0.48	622
	5- -71	866	7.5	67	20	94	5.5	0	183	172	90	11.6	0.9	0.17	643
	6-24-71	850	7.5	59	22	82	5.0	0	177	169	72	10.1	0.9	0.19	597
	7-27-71	851	7.5	62	16	88	5.0	0	152	163	83	11.0	0.7	0.33	581
	8-30-71	797	7.4	67	22	55	4.0	0	135	157	73	12.0	0.9	0.02	521
	9-28-71	906	7.6	68	20	92	5.0	0	175	157	101	8.5	0.8	0.8	626
	11-29-71	874	8.0	69	23	85	5.5	0	170	174	93	8.7	1.0	0.13	629
	12- -71		7.8	64 63	20 24	90 88	5.0 5.5	0	165 168	155 180	88 87	12.4	0.9	0.11	600 625
	1-24-72	818	7.7	60	23	86	5.0	0	166	161	87	12.4	0.8	0.32	602
	2-22-72	844	7.3	47	30	88	5.0	0	165	167	89	5.0	0.8	0.34	596
	2-28-72	932	8.0	64	19	90	3.5	0	165	161	91	15	1.05		643
	3-28-72	867	7.7	61	24	90	5.5	0	165	164	102	5.9	0.67	0.22	619
	4-24-72	859	7.6	64	20	80	5.0	0	154	165	89	15.3	0.90	0.07	592
	5-25-72	940	7.4	63	24	90	5.5	0	173	164	92	16.2	1.4	0.06	628

FROM MONITORING WELL MH-4 (cont'd.)

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-4 (Cont'd)	6-29-72	843	7.7	61	21	80	5.0	0	159	158	84	9.9	0.72	0.10	578
	8- 5-72	973	7.8	60/60	21/23	92/87	3.3/4.7		153/163	169/164	95/91	15.1	1.19	0.2	645/613
	9-29-72	912	7.9						195		98				
	11-16-72	900	7.7						156		123				
	12- 6-72	840	7.6						159		126				
	1- 3-73	1060	7.6	82	27	89	3.5		159	187	135	10	1.2		730
	2- 8-73	1080	7.4						143		167				
	3- 6-73	1170	7.6						145		170				
	3-27-73	1180	7.7						123		161				
	5- 7-73	1200	7.9						137		175				
	6-7-73	800	7.7						137		186				
	7-5-73	1340	7.9	113	37	113	4.3		134	261	195	4.8	0.71	ND	913
	8-5-73	1250	7.6						143		180				
	9-7-73	1300	7.7						140		200				
	10-9-73	1380	7.9						210		140				
	11-7-73	1230	7.6	121/105	30/31	112/105	4.7/4.2		171/155	285/244	175/168	11	0.73	ND	880/841
	12-5-73	1310	7.6	110	30	113	4.7		180	277	150	11	0.70	N.D.	896
	1-3-74	1160	7.3	114	49	117	4.7		143	301	225	7.4	0.70	N.D.	887
	2-6-74	1450	7.6	132	49	118	6.3		140	318	240	8.1	0.71	N.D	1013
	3-5-74	1400	7.9	140	44	159	5.1		140	324	230	6.2	0.65	ND	1014
	4-3-74	1500	7.7	136	46	114	5.1		146	323	225	8.1	0.72	ND	1027
	5-1-74	1500	7.5	140	44	118	5.5		134	318	230	11.0	0.67	0.14	1026
	6-5-74	1500	7.8	148	27	113	3.1		137	273	250	7.4	0.75	ND	1005
	7-2-74	1500	7.8	133	40	123	5.5		146	312	240	11	0.27	ND	1031
	7-29-74	1400	7.9	133	38	129	7.0		146	300	240	6.6	0.68	ND	990
	9-5-74	1450	7.6	125	42	30	4.7		138	285	225	0.1	0.54	ND	934
	10-1-74	1400	7.6	105	59	109	5.5		139	311	225	11	0.74	ND	973
	11-5-74	1430	7.6	97	52	136	5.1		135	314	246	11	0.68	ND	999
	12-2-74	1320	7.3	125	45	120	5.5		121	314	237	9.2	0.68	0.58	950

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-4 (Cont'd)

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-4 (Cont'd)	1-8-75	1500													
	2-6-75	1550													
	3-6-75	1650	7.4												
	4-4-75	1500													
	4-30-75	1700	7.3	161	50	132	5.6		129	363	299	3.7	0.72	ND	1165
	5-29-75	1720													
	7-2-75	1840	7.8												
	8-1-75	1930													
	9-5-75	2260	7.7	198	52	161	4.9		122	435	388	9.5	0.58	ND	1477
	10-2-75	2,430													
	11-4-75	2410	7.7												
	12-3-75	2620													
	1-7-76	2700	7.65	318	108	184	7.5		103	644	638	5.3	0.60	ND	1,949
	2-4-76	3340													
	3-1-76	3350													
	3-29-76	3350													
	4-28-76	4340	7.6	571	130	228	9.8		104	1006	975	7.7	0.50	0.50	3035
	5-27-76	3810													
	6-29-76	4400	7.5												
	7-28-76	3490													
	8-25-76	4820	7.7	565	150	248	9.0		94	893	1050	4.8	0.5	ND	3194
	9-29-76	4580													
	10-22-76	4500													
	1-26-77	5500													
	2-23-77	4950	7.4												
	3-30-77	4960													
	4-28-77	5300	7.4	630	202	470	17.2		146	1654	1122	9.6	1.8	0.82	
	5-26-77	5500													
	6-28-77	5600													
	7-28-77	5600													
	8-31-77	5100	7.5	650	273	420	11.5		98	1704	1290	11.1	2.15	0.6	4484
	9-23-77	6000													
	10-27-77	11950													

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-4 (Cont'd)

Well Number	Date Sampled	ECx10⁶ at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-4 (Cont'd)	11-30-77	5900													
	12-21-77	5000	7.4	472	165	710	12.5		138	1821	957	12.8	0.6		4247
	1-31-78	4550													
	2-26-78	4050													
	3-30-78	3400													
	4-25-78	3725													
	5-25-78	3150													
	6-29-78	3000	7.9	150	47	520	9		165	1020	382	18		0.35	
	7-31-78	2900													
	8-29-78	2700													
	9-26-78	2500													
	10-27-78	2550													
	11-29-78	2300													
	12-28-78	2250	7.7	97	32	460	1		161	720	320	9		0.4	
	2-24-79	2600													
	3-28-79	2000													
	4-26-79	1750													
	5-31-79	2150													
	6-28-79	2100	7.7	325	34	206	5		171	786	290	18		0.37	
	7-31-79	2450													
	8-30-79	2550													
	9-24-79	2700													
	10-30-79	2400													
	11-29-79	2800													
	12-27-79	2900	7.2	198	60	590	6		168	1170	425	35		0.4	

FROM MONITORING WELL MH-5A

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-5A	8-14-70	1227	8.5	63	12	184	21.1	25	31	372	123	0.6		0.3	832
	9-10-70		7.8	64	16	194	16.5	0	134	361	135	0.7		0.54	923
	10-28-70	1405	7.8	66	20	226	13.5	0	189	366	142	1.1	0.9	0.53	1022
	11-20-70	940	8.1	37	10	160	9.5	0	142	235	84	0.2	1.7	0.15	678
	11-24-70	1048	7.9	43	15	165	9.0	0	152	254	99	0	1.5	0.13	738
	12- 4-70	1120	6.6	47	18	170	11.0	0	172	272	110	0.4	1.5	0.08	800
	12-18-70	1469	7.8	55	36	194	14.0	0	148	326	195	2.8	1.8	0.98	971
	1-27-71	1380	7.8	61	32	189	12.5	0	151	304	190	1.0	1.6	0.12	940
	3-15-71	1304	7.6	66	18	192	13.5	0	177	315	136	1.3	1.3	0.14	917
	3-26-71	1500	7.9	89	43	193	12.0	0	139	433	191	2.3	1.1	0.49	1103
	6-24-71		7.6	74	37	175	11.0	0	157	340	177	1.3	1.1	0.44	973
	7-26-71	1472	7.5	67	18	192	12.8	0	176	333	129	1.0	1.0	0.50	929
	8-30-71	1312	7.6	72	23	162	7.5	0	234	144	209	0.6	1.1	0.20	852
	11-29-71	2615	7.9	276	55	257	20.5	0	73	972	278	8.1	0.8	0.42	1941
	2-22-72	2059	7.8	160	59	230	14.5	0	115	688	258	2.6	1.0	0.35	1527
	2-29-72	2101	7.9	132	46	209	6.3	0	116	440	298	9.3	0.97		1372
	3-28-72	2524	7.6	213	72	257	17.0	0	110	941	235	18.0	0.84	0.97	1865
	4-24-72	2804	7.5	251	85	276	17.5	0	115	1063	276	14.0	1.20	0.42	2099
	5-25-72	3042	7.5	224	100	286	18.8	0	171	990	317	20.3	1.34	0.96	2129
	6-29-72	2730	7.6	213	72	291	17.0	0	91	919	307	22	0.82	0.87	1933
	8- 4-72	1953	7.5	96	43	202	7.4	0	146	460	170	1.1	1.43	0.4	1265
	8- 5-72	2045	7.6	112	44	205	6.7	0	110	460	252	1.3	1.1	0.3	1321
	9-29-72	1369	7.8						149		145				

FROM MONITORING WELL MH-5A (cont'd.)

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-5A (Cont'd)	11-16-72	1210	7.6						133		124				
	12- 6-72	950	7.7						140		108				
	1- 4-73	1210	7.8	66	23	153	3.5		125	291	130	16	2.9	0.4	840
	2- 8-73	1230	7.8						113		143				
	3- 6-73	1230	7.8						123		95				
	3-27-73	1400	7.8						140		153				
	5-8-73	1450	7.8						116		167				
	6-7-73	1300	7.7						116		170				
	7-6-73	1900	8.0	110	47	244	4.7		122	517	225	19	0.95	ND	1321
	8-5-73	2000	7.7						122		260				
	9-7-73	2070	7.8						122		285				
	10-9-73	2250	7.9						313		125				
	11-10-73	2020	7.8						270		137				
	12-5-73	2250	7.8	96	88	324	5.9		199	740	280	32	1.08	0.96	1645
	1-4-74	2050	7.7						146		270				
	2-8-74	2700	7.9						146		330				
	3-5-74	2950	7.3						153		400				
	4-2-74	3150	7.7	200	105	431	7.4		165	1066	435	27	1.04	0.58	2321
	5-1-74	3400	7.9						162		530				
	6-4-74	3550	7.8						146		500				
	7-2-74	3600	7.9	228	83	524	9.3		149	1183	520	59	0.44	0.60	2638
	7-30-74	3620	7.9						168		500				
	9-4-74	3650	7.9						207		500				
	10-1-74	3350	7.6	204	108	529	9.4		159	1149	495	44	1.25	ND	2521
	11-6-74	3400	7.8						146		516				
	12-3-74	3300	7.8						154		480				
	1-7-75	3200	7.6	188	94	455	7.8		146	1105	440	45	1.40	1.44	2360
	2-5-75	3270													
	3-6-75	3120													
	4-4-75	3000													

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-5A (Cont'd)

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-5A (Cont'd)	4-28-75	3000	7.7	160	78	432	7.2		145	991	378	35.0	1.5	1.1	2165
	5-29-75	2980													
	7-2-75	3240													
	7-31-75	3490													
	9-4-75	3620	7.85	176	88	529	8.6		130	1134	402	51.3	2.06	0.96	2527
	10-2-75	2,880													
	11-4-75	2580													
	12-3-75	2180													
	1-7-76	1730	8.05	102	47	278	5.1		136	527	262	0.3	1.82	0.48	1285
	2-4-76	1720													
	3-3-76	1720													
	3-30-76	1720													
	4-30-76	2030	7.7	114	52	271	5.9		140	549	280	21.4	1.05	NO	1425
	5-27-76	2030													
	6-30-76	2320													
	7-28-76	1900													
	8-26-76	2190	8.0	112	50	274	5.8		119	556	275	48.0	1.1	0.2	1486
	9-30-76	2120													
	10-22-76	2080													
	2-23-77	2250													
	4-29-77	2800	7.8	172	70	444	8.2		149	953	342	68.7	2.5	1.0	2318
	6-29-77	2825													
	8-31-77	2975	7.5	176	94.5	410	6.0		146	927	425	57	2.35	1.02	2128
	10-27-77	3050													
	12-21-77	3300	7.5	231	122	500	8.5		155	1311	434	74.9	1.1		2779
	2-26-78	4075													
	4-25-78	4100	7.8	302	15	478	14.5		133	1010	514	2.48	1.82		
	6-29-78	4400													
	8-30-78	4500	8.3	313	178	690	9	8	119	2050	564	84		1.57	
	10-27-78	4500													
	12-28-78	4300	7.8	287	160	605	6		158	1530	580	80		1.5	
	2-24-79	4250													
	4-27-79	4500	7.7	304	215	620	10		155	1900	580	75		1.6	

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH- 5A- (Cont'd)

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-5A(Cont'd)	6-25-79	4800	7.3												
	8-31-79	4500	7.6	325	160	770	10		173	2040	550	89		1.6	
	10-31-79	4250													
	12-28-79	4200	7.3	325	175	925	8		155	2076	870	97		1.75	

FROM MONITORING WELL MH-5C

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-5C	11-20-70	569	8.1	24	1	104	8.0	0	81	165	37	0.8	1.3	0.24	421
	11-24-70	573	8.0	26	6	102	9.5	0	82	160	43	0.2	6.0	0.28	436
	12- 4-70	595	8.3	28	7	100	9.0	5.4	84	154	65	0.8	1.6	0.11	452
	1-27-71	698	8.0	38	16	90	5.5	0	118	180	56	1.2	1.0	0.11	505
	3-15-71	825	7.5	55	17	102	6.5	0	140	228	59	0.4	1.2	0.20	609
	7-27-71	848	7.8	41	25	96	5.8		118	228	68	1.0	1.3	0.30	583
	8-30-71	1208	7.6	89	38	106	5.0		248	167	169	2.2	1.1	0.0	824
	9-28-71	2223	7.6	207	79	175	12.5	0	122	787	225	7.0	1.2	0.9	1615
	11-29-71	3335	7.8	289	142	286	15.0	0	122	1307	339	13.0	1.39	0.25	2516
	12- -71	3369	7.8	273	151	291	14.0	0	116	1314	324	20.4	1.0	0.65	2504
	1-24-72	3167	7.6	285	131	286	14.0	0	119	1290	317	9.3	0.94	0.90	2452
	2-22-72	3296	7.8	252	150	315	14.0	0	117	1372	290	21.3	1.06	0.97	2534
	3- 1-72	3749	7.9	285	151	315	8.2	0	140	1413	335	13	1.33	0.76	2649
	3-28-72	3052	7.6	244	139	276	13.0	0	137	1176	317	16.6	0.75	0.48	2320
	4-24-72	3068	7.6	240	118	296	13.0	0	128	1177	302	24.8	1.28	0.72	2299
	5-25-72	3703	7.4	246	151	346	14.5	0	140	1279	379	30.6	1.20	0.83	2588
	6-29-72	3320	7.4	242	119	361	14.0	0	147	1242	330	24.4	0.73	0.93	2481
	8- 4-72	3588	7.5	216	120	327	7.4	0	159	1094	386	2.3	1.50	0.7	2424
	8- 5-72	3584	7.5	215	114	315	7.8	0	146	1068	380	1.9	1.52	0.8	2338
	9-29-72	4351	7.5						153		248				
	11-15-72	3920	7.2						171		437				
	12- 6-72	3260	7.7						177		390				
	1- 4-73	4000	7.7	273	150	460	7.8		156	1675	358	22	1.7	0.9	2963
	2- 8-73	3500	7.8						142		355				
	3- 6-73	3650	7.7						151		400				

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-5C (Cont)

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-5C (Cont'd)	3-27-73	3750	7.8						159		413				
	5-8-73	3700	7.8						146		480				
	6-7-73	3850	7.8						143		510				
	7-6-73	4000	7.9	256	140	495	8.6		150	1267	550	59	0.91	1.2	2876
	8-5-73	3900	7.7						150		606				
	9-7-73	3850	7.7						146		620				
	10-9-73	3700	7.8						600		143				
	11-10-73	3450	7.7						505		162				
	12-5-73	3300	7.8	220	100	474	7.0		165	1137	435	30	1.05	0.84	2439
	1-4-74	3000	7.6						162		420				
	2-8-74	3120	7.7						168		180				
	3-5-74	3250	7.3						156		440				
	4-2-74	3300	7.9	206	109	449	7.8		183	1097	470	30	1.02	ND	2431
	5-1-74	3550	7.8						153		520				
	6-4-74	3680	8.0						153		540				
	7-2-74	3700	7.9	228	97	497	9.4		156	1129	528	59	0.44	0.96	2647
	7-30-74	3790	7.8						156		500				
	9-4-74	3850	7.7						156		520				
	10-1-74	3550	7.7	238	130	557	10.2		162	1257	555	59	1.30	ND	2725
	11-6-74	3600	7.8						162		530				
	12-3-74	3500	7.5						148		499				
	1-7-75	3450	7.6	202	98	520	7.8		164	1181	434	51	1.55	1.20	2561
	2-5-75	3490													
	3-6-75	3420													
	4-4-75	3300													
	4-28-75	3450	7.7	183	92	515	7.4		157	1210	420	37.3	1.9	1.7	2520
	5-29-75	3400													
	7-2-75	3740													
	7-31-75	3970													
	9-4-75	4220	7.9	199	100	593	75.1		158	1400	454	53.5	2.40	1.13	2994

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-5C (Cont'd)

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-5C (Cont'd)	10-2-75	3,870													
	11-4-75	3350													
	12-3-75	2710													
	1-7-76	2350	8.0	100	50	350	5.0		146	694	250	29.5	3.21	12	1635
	2-4-76	2140													
	3-3-76	2310													
	3-30-76	2320													
	4-30-76	3010	7.9	124	97	454	7.0		159	972	330	46	1.38	1.0	2150
	5-27-76	3200													
	6-30-76	3050													
	7-28-76	2100													
	8-26-76	3190	8.0	139	81	451	6.2		223	835	335	170	1.4	ND	2237
	9-30-76	3280													
	10-22-76	3300													
	2-23-77	3700													
	4-29-77	3250	8.0	182	107	546	8.2		149	1266	387	73.5	2.0	1.49	2720
	6-29-77	3375													
	8-31-77	3450	7.5	248	141	440	9.0		140	1192	581	41	1.5	0.28	2752
	10-27-77	3500													
	12-21-77	4000	7.8	277	153	600	11.0		157	1685	509	88.6	1.2		3425
	2-26-78	4300													
	4-25-78	4600	8.1	342	22.	752	11.3		132	1667	539	2.48	1.92		
	6-29-78	3800													
	8-30-78	4700	8.3	321	183	665	9	4	157	2011	578	93		1.70	
	10-27-78	4600													
	12-28-78	4500	7.7	312	182	625	6		167	1800	580	84		1.6	
	2-24-79	4700													
	4-27-79	4650	7.7	304	220	610	13		158	1944	580	80		1.7	
	6-28-79	4700													
	8-31-79	4500	7.6	300	178	770	10		186	1950	565	93		1.7	
	10-31-79	4300													
	12-28-79	4400	7.2	337	195	450	8		166	1800	500	111		1.74	

FROM MONITORING WELL MH-7

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-7	12-30-71	836	8.00	42	8.0	129	8.0	0.0	161	180	77	1.0	1.2	0.10	607
	3- 1-72	650	8.2	30	7.9	86	3.9	--	171	79	50	6.7	1.38	0.00	456
	6-29-72	789	7.65	38	18	108	7.2	0.00	181	134	87	3.5	0.78	0.48	577
	8- 4-72	587	8.0	30	9	85	3.8	--	162	83	60	7.3	1.72	0.0	426
	9-28-72	679	7.8						195		60				
	11-15-72	530	7.9						189		47				
	12- 6-72	500	8.0						186		48				
	1- 3-73	570	7.7	30	6.7	73	3.1	--	183	59	43	6.2	2.1	0.00	415
	2- 7-73	495	7.9						168		43				
	3- 5-73	498	7.8						171		45				
	3-27-73	560	8.1						177		43				
	5-7-73	530	8.1						171		45				
	6-6-73	550	8.1						168		48				
	7-5-73	540	8.2	30	6.3	78	3.1		168/75	56/53	45/44	5.5	1.35	ND	396/406
	8-6-73	540	8.0						168		45				
	9-7-73	550	7.9						171		46				
	10-8-73	570	8.0						53		168				
	11-14-73	520	8.0						214		50				
	12-4-73	530	8.0	39	9	81	3.52		174	68	45	8.1	1.36	0.36	411
	1-4-74	500	7.8						171		48				
	2-7-74	500	8.5						156		50				
	3-7-74	530	7.8						165		50				
	4-2-74	550	8.1	30	8.5	87	3.5		168	73	53	5.6	1.35	ND	407
	5-1-74	550	8.2						174		48				
	6-5-74	620	8.4						128		70				
	7-3-74	600	8.2	31	7.9	92	4.3		156	105	58	8.7	1.32	ND	389

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-7 (Cont'd)

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-7 (Cont'd)	7-30-74	600	8.0	35	5	101	5.1		149	94	67	11.3	1.22	ND	445
	9-5-74	780	7.8						146		85				
	10-1-74	800	8.0	36	22	99	4.3		140	135	105	14	1.15	ND	558
	11-6-74	1040	8.0						120		155				
	12-4-74	1200	7.8						177		184				
	1-8-75	1650	7.7	145	31	182	6.6		103	424	264	29	0.82	ND	1176
	2-5-75	1650													
	3-5-75	2050	7.9												
	4-4-75	2200													
	4-29-75	2100	7.7	191	39	224	7.2		98	546	336	24.7	0.9	ND	1468
	5-28-75	2000													
	7-2-75	2420	7.85												
	8-1-75	2410													
	9-3-75	2210	7.7	192	50	238	6.8		88	558	259	19.2	0.78	ND	1480
	10-2-75	2,220													
	11-4-75	2150	7.85												
	12-3-75	2480													
	1-6-76	2480	7.6	312	37	258	8.6		87	676	506	0.4	0.68	0.24	1810
	2-4-76	2800													
	3-2-76	2800													
	4-1-76	2650													
	4-28-76	3300	7.70	359	87	304	10.6		82	779	690	9.8	0.61	0.4	2315
	7-28-76	2300													
	8-26-76	3670	7.7	396	86	306	8.6		140	834	692	10.8	0.61	ND	2520
	9-29-76	3400													
	10-21-76	4550													
	1-28-77	4000													
	2-24-77	3850													
	3-30-77	3830													
	4-29-77	4095	7.5												
	5-26-77	4240													
	6-28-77	4200													
	7-28-77	4050													

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH- 7 (Cont'd)

Well Number	Date Sampled	ECx10⁶ at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-7 (Cont'd)	8-30-77	4150	7.5	448	126	400	11.5		98	1121	879	25	1.1	0.36	3370
	9-23-77	4025													
	10-27-77	3950													
	11-30-77	4075													
	12-21-77	4025	7.5	571	133	350	12.5		132	1160	996	51.8	0.6		3359
	1-31-78	4306													
	2-27-78	4100													
	3-30-78	4500													
	4-25-78	4900	7.8	873	18	395	13.7		64	1550	1049	2.39	0.91		
	5-25-78	4950													
	6-29-78	5150													
	7-31-78	5300													
	8-29-78	5000	8.3	728	158	435	13	4	90	1470	1117	58		0.38	
	9-26-78	4950													
	10-27-78	5000													
	11-30-78	4600													
	12-29-78	4600	7.8	575	140	380	10		84	1224	1090	49		0.31	
	1-31-79	4800													
	2-27-79	5000													
	3-28-79	4700													
	4-27-79	4900	7.7	625	195	360	13		68	1338	1190	53		0.25	
	5-31-79	4950													
	6-28-79	5200	7.7												
	7-31-79	4900													
	8-31-79	4550	7.4	565	148	400	13		133	1065	1120	66		0.27	
	9-25-79	4500													
	10-30-79	4500	7.9												
	11-29-79	4550													
	12-27-79	4500	7.0	630	158	346	10		85	1230	1160	71		0.40	

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-8A

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-8A	10-31-71	1217	7.7	54	14	244	11.0		176	378	137	1.5	1.05	0.38	1014
	12-30-71	1509	7.7	66	18	239	12.0		161	440	133	0.5	1.1	0.03	1072
	3- 2-72	956	8.1	49	17	121	5.5		148	173	115	10.6	1.19	0.5	666
	6-29-72	894	7.5	44	21	106	6.8		159	138	115	0.0	0.70	0.64	591
	8- 3-72	897	7.8	55	10	122	4.5		140	136	140	10.2	1.14		623
	9-29-72	908	7.6						143		123				
	11-15-72	780	7.9						146		107				
	12- 6-72	700	7.9						156		108				
	1- 3-73	876	7.6	57	13	94	3.5		153	127	108	10	1.35	0.2	600
	2- 7-73	800	7.8						172		103				
	3- 5-73	821	7.7						148		105				
	3-27-73	840	7.9						143		103				
	5-7-73	1450	8.0						125		239				
	6-6-73	3220	7.8	233	63	329	9.4		92	786	440	13	1.6		2122
	7-5-73	2900	7.6	273	66	294	8.2		104	725	500	12	0.63	ND	2017
	8-6-73	3850	7.6						89		690				
	9-7-73	4150	7.4	433	112	442	11		85	1267	75	18	0.50	ND	3023
	10-8-73	5000	7.6	517	131	497	13		70	1472	900	2.6	0.42	ND	3562
	11-5-73	4880	7.4	580	144	543	13		70	1774	1000	16	0.42		3770
	12-4-73	5500	7.2	631	164	616	15		64	1991	1005	16	0.39	N.D.	4176
	1-4-74	5000	6.9	700	146	604	15		70	2064	1050	15	0.42	ND	4082
	2-8-74	6000	7.4	752	164	672	20		70	2399	1050	15	0.42	0.5	4671
	3-7-74	6500	7.7	842	158	692	16		107	2553	1175	12	0.38	ND	5003
	4-2-74	6500	7.4	782	182	696	16		122	2501	1150	16	0.44	ND	5008
	4-30-74	6500	7.4	782	188	768	19		67	2604	1200	30	0.41	ND	5104
	6-4-74	7000	7.6	792	188	725	16		183	2620	1150	14	0.46	0.6	5294
	7-5-74	7000	7.6	792	195	817	20		76	2321	1350	45	0.16	0.48	5258
	7-30-74	7200	7.6	761	207	897	23.5		132	2684	1165	7.1	0.42	ND	5458
	9-5-74	7000	7.8	795	192	828	16.8		73	2640	1215	2.5	0.45	ND	4785

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH- 8A (Cont'd)

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-8A (Cont'd)	10-1-74	6500	7.7	776	180	817	17.2		92	2693	1175	12	0.44	ND	5156
	11-5-74	5000	7.8	539	136	626	14		95	1951	872	15	0.57	0.24	3874
	12-3-74	2580	7.4	280	85	368	9.4		366	842	445	28.4	0.16	0.96	2115
	1-9-75	2500	7.8	221	59	297	7.4		107	739	408	20	0.78	0.17	1804
	2-5-75	2050													
	3-5-75	2250	7.6	194	58	271	7.4		106	684	380	24	0.85	0.31	1650(
	4-4-75	2050													
	4-29-75	1850	7.8	149	36	213	6.4		112	499	274	23.8	0.86	ND	1305
	5-28-75	1900													
	7-2-75	1980	7.6	144	45	216	5.9		95	483	274	23.2		ND	1336
	8-1-75	1900													
	9-3-75	2380	8.0	177	50	235	4.9		79	624	316	19.2	0.72	0.24	1586
	10-2-75	1710													
	11-6-75	1610	7.85	140	37	182	6.0		108	429	242	39.5	0.71	0.31	1156
	12-3-75	1670													
	4-1-76	1500													
	4-28-76	3300	7.7	153	39	182	6.3		116	424	262	29.5	0.74	ND	1230
	5-27-76	1730													
	6-29-76	1840	7.6	156	42	171	5.1		122	412	462	26.5	0.8	ND	1181(
	7-28-76	1240													
	8-26-76	2060	7.8	204	24	186	5.5		122	480	275	28.0	0.7	ND	1383
	9-28-76	2030													
	10-21-76	2190	7.4	212	56	239	63?		159	639	345	25.1	0.8	0.4	1607
	1-28-77	2170													
	2-24-77	2350	7.8												
	3-30-77	2160													
	4-28-77	2420	7.3	215	73	224	7.4		122	650	376	49	1.3	0.48	2010
	5-26-77	2220													
	6-28-77	2300													
	7-28-77	2425													
	8-30-78	2450	7.7	224	85	252	7.5		98	754	425	42	0.95	0.46	1912
	9-23-77	2175													
	10-27-77	2725													

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH- 8A (cont'd)

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-8A (cont'd)	11-30-77	2225													
	12-21-77	2400	7.5	258	65	234	8.0		139	700	394	62.9	0.6		1811
	1-31-78	2475													
	2-27-78	2600	8.0	275	61	213	7.5		122	676	393	62.0	0.7		1775
	3-30-78	2350													
	4-25-78	2500	8.0	324	13	195	579 ?		81	742	376	1.95	0.91		
	5-25-78	2375													
	6-29-78	2450	7.7	250	68	219	7		97	705	382	80		0.13	
	7-31-78	2450													
	8-29-78	2400	8.0	175	73	200	8		95	720	411	71		0.24	
	9-26-78	2500													
	10-27-78	3050	7.7	335	80	275	9.3		89	924	485	69.5	0.6		2256
	11-30-78	2700													
	12-29-78	3250	7.8	350	95	335	8		94	1182	600	53		0.36	
	1-31-79	2300													
	2-24-79	2650	7.9	317	78	238	7.5		97	867	466	68	0.6		2115
	3-28-79	3100													
	4-27-79	2900	7.8	317	89	260	10		95	930	520	66		.26	
	6-01-79	2850													
	6-28-79	3000	7.8	338	98	238	8		100	858	545	66		0.27	
	7-31-79	2900													
	8-31-79	2850	7.7	300	95	291	9		104	855	525	71		0.25	
	9-25-79	2600													
	10-30-79	2700	7.9	363	105	290	10		104	1026	520	71		0.63	
	11-29-79	3000													
	12-27-79	2600	7.2	325	95	271	8		102	918	510	84		0.35	

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-9

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-9	12-15-72	900	8.0	41	12	127	3.9		162	129	119	7.4	1.38		628
	2- 7-73	900	7.7						180		118				
	3- 5-73	880	7.6						167		123				
	3-28-73	930	8.0	47	13	119	3.9		165	130	120	4.1	1.25		637
	5-7-73	890	8.0						165		123				
	6-6-73	950	7.9	47	12	136	4.3		162	132	125	4.8	1.55		656
	7-5-73	930	8.1	48	11	139	4.3		162	137	126	5.7	1.07		654
	8-5-73	950	7.8						159		129				
	9-7-73	900	7.9	48	10	137	4.3		162	137	125	6.1	1.07	N.D.	642
	10-8-73	930	8.0						133		159				
	11-6-73	850	7.9	49/48	10/11	138/134	3.9/4.1		165/163	139/135	123/124	6.2	0.94		610/640
	12-4-73	850	7.8	51	9.1	135	3.5		165	145	130	6.2	1.07	N.D.	620
	1-4-74	850	7.7						165		125				
	2-7-74	850	8.1						146		125				
	3-7-74	900	7.6						146		135				
	4-2-74	900	7.9	50	7.9	133	3.5		159	152	125	5.5	1.15	ND	633
	4-30-74	900	8.0						153		135				
	6-4-74	950	8.1						146		135				
	7-3-74	950	8.0	49	13	136	4.3		162	157	135	8.7	1.35	ND	665
	7-30-74	970	7.9						153		133				
	9-5-74	980	7.8						153		135				
	10-1-74	900	7.8	45	16	136	3.9		149	205	110	7.7	1.10	ND	650
	11-6-74	850	8.0						150		131				
	12-3-74	850	8.0						159		126				
	1-9-75	800	7.9	43	11	125	3.9		154	138	120	6.2	1.12	1.80	581
	2-5-75	820													
	3-5-75	800													
	4-4-75	800													
	4-29-75	850	8.0	43	10	121	3.6		150	136	116	6.5	1.1	0.2	590
	5-28-75	800													
	7-2-75	900													

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-9 (Cont'd)

Well Number	Date Sampled	ECx10⁶ at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-9 (Cont'd)	7-31-75	900													
	9-3-75	820	7.9	33	11	116	3.8		137	105	102	5.6	1.23	ND	545
	10-2-75	800													
	11-4-75	760													
	12-3-75	800													
	1-6-76	760	7.9	37	9	117	6.8		153	113	95	4.5	1.21	0.29	53
	2-4-76	760													
	3-2-76	780													
	4-1-76	710													
	4-29-76	790	7.9	39	9	114	18.3		183	104	94	3.7	1.19	ND	560
	5-27-76	770													
	6-29-76	810													
	7-28-76	780													
	8-26-76	830	8.2	46	12	110	3.4		186	106	90	6.2	1.18	ND	570
	9-28-76	790													
	10-21-76	780													
	1-28-77	730													
	2-24-77	750													
	3-30-77	780													
	4-28-77	780	8.0	59	1.8	125	4.5		171	115	110	7.6	1.3	0.7	550
	5-26-77	735	8.2	38	10	113	3.3		149	105	99	10.6	1.3	—	520
	6-28-77	825													
	7-28-77	810													
	8-30-78	840	7.9	34	18.2	118	4.0		159	109	128	9.7	0.80	0.10	602
	9-23-77	825													
	10-27-77	800													
	11-30-77	800													
	12-21-77	775	7.9	39	10	112	3.2		157	91	96	21.3	1.1		471
	1-31-78	775													
	2-27-78	850													
	3-30-78	800													
	4-25-78	775	8.0	60	10	92	4.8		161	137	93	2.75	1.89		
	5-25-78	750													

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-9 (Cont'd)

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-9 (Cont'd)	7-31-78	850													
	8-29-78	910	8.3	50	16	133	4	4	125	128	172	18		0.24	
	9-26-78	775													
	10-27-78	825													
	11-30-78	750													
	12-29-78	750	8.2	53	11	118	3		146	138	102	14		0.35	
	1-31-79	825													
	2-24-79	850													
	3-28-79	750													
	4-27-79	850	8.1	45	13	100	4		143	120	110	22		0.31	
	6-01-79	800													
	6-28-79	925	7.9												
	7-31-79	760													
	8-31-79	780	7.5	33	11	129	4		162	128	110	22		0.31	
	9-25-79	760													
	10-30-79	750													
	11-29-79	780													
	12-27-79	710	7.4	37	11	141	2		187	126	115	40		0.41	

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-10

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-10	12-19-72	780	7.8	63	21	64	2.7		165	159	70	1.5	0.77		559
	2-8-73	700	7.9						161		67				
	3-6-73	720	7.5						153		73				
	3-29-73	720	8.1	54	17	62	2.7		171	125	43	0.9	1.03		501
	5-7-73	690	8.0						159		68				
	6-7-73	730	8.0						159		70				
	7-6-73	720	8.0	55	18	71	2.7		165	132	70	1.3	0.84		521
	8-5-73	700	7.8						162		68				
	9-7-73	640	7.9	43	14	75	3.1		165	105	66	N.D.	1.12	N.D.	470
	10-8-73	630	8.0						70		156				
	11-6-73	680	7.8	55/52	20/17	70/70	3.1/2.9		156/164	141/126	75/64	N.D.	0.67		500/498
	12-5-73	680	7.9	51	19	71	3.1		149	138	75	N.D.	0.61	N.D.	491
	1-3-74	600	7.8						153		68				
	2-8-74	650	8.0						149		70				
	3-7-74	600	7.6						153		70				
	4-1-74	650	7.9	44	16	72	2.7		159	103	65	1.2	1.15	ND	459
	4-30-74	650	8.1						153		70				
	6-4-74	600	8.2						168		53				
	7-2-74	600	8.1	39	12	77	2.7		159	86	68	1.2	1.20	ND	433
	7-30-74	640	8.0						156		65				
	9-4-74	600	7.9						149		65				
	10-1-74	600	8.1	35	14	86	3.1		140	145	55	1.3	1.32	0.12	450
	11-5-74	530	8.1						151		70				
	12-3-74	550	8.1						150		65				
	1-7-75	550	7.9	36	12	74	2.3		160	77	65	0.6	1.38	ND	406
	3-5-75	550													
	4-29-75	550	7.85	36	12	74	2.3		145	78	68	0.4	1.4	ND	400
	7-2-75	660													
	9-4-75	620	7.8	33	15	73	2.4		146	78	117	0.6	1.32	ND	450

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-10

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-10 (Cont'd)	11-4-75	580													
	1-6-76	530	7.75	36	12	75	2.3		150	74	65	0.01	1.40	ND	390
	3-2-76	600													
	4-29-76	650	8.1	37	13	74	2.3		166	83	70	.9	1.3	ND	450
	6-29-76	640													
	8-26-76	680	8.0	58	5	68	2.3		168	72	68	0.6	1.4	ND	459
	10-21-76	610													
	2-24-77	600													
	4-28-77	595	8.0	40	9.1	83	2.2		156	81	71	2.2	1.6	0.1	550
	6-28-77	625													
	8-30-77	650	7.9	33	18.9	75	3.0		165	70	78	1.8	1.25	0.3	430
	12-21-77	600	7.9	34	12.3	69	2.5		149	71	66	0.1	1.2		345
	2-27-78	600													
	8-29-78	570	8.3	33	13	70	2	4	122	93	83	4		0.19	
	10-29-78	560													
	12-28-78	550	7.7	45	12	77	2		124	99	71	1		0.22	
	2-24-79	575													
	4-27-79	850	8.4	25	13	77	2		145	85	62	4		0.15	
	6-28-79	625													
	8-29-79	550	7.7	33	13	72	5		154	76	70	22		0.05	
	12-28-79	560	7.4	35	19	60	2		115	129	74	9		0.26	

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-11

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-11	12-11-72	910	8.1	59	18	100	3.9		183	166	86	17	1.5		651
	2- 8-73	810	7.8						187		75				
	3- 6-73	800	7.7						192		75				
	3-27-73	850	8.0	54	13	94	3.5		195	130	75	15	2.10		602
	5-7-73	800	7.9						189		78				
	6-7-73	850	7.7						186		78				
	7-5-73	890	7.9	57	15	105	4.3		198	141	80	15	2.30	N.D.	635
	8-5-73	850	7.7						195		78				
	9-7-73	830	7.9	54	16	104	3.9		192	138	80	16	2.32	N.D.	608
	10-8-73	850	7.9						83		189				
	11-6-73	790	7.8	57/56	15/15	102/101	4.3/4.0		189/186	134/136	83/80	17	2.10		570/604
	12-5-73	780	7.8	57	15	97	3.5		192	137	80	17	2.3	N.D.	572
	1-4-74	780	7.4						195		75				
	2-7-74	790	8.2						189		80				
	3-7-74	800	7.7						192		85				
	4-2-74	800	7.9	57	14	105	3.9		207	140	80	12	2.3	ND	590
	5-1-74	820	8.0						186		80				
	6-5-74	850	8.1						195		78				
	7-3-74	820	8.2	55	15	104	3.9	9.0	177	135	80	17	2.40	ND	585
	7-30-74	850	7.6						195		75				
	9-5-74	820	7.9						192		78				
	9-30-74	800	8.1	42	21	114	3.5		171	211	70	16.6	2.40	ND	605
	11-6-74	750	8.2						181		82				
	12-3-74	760	8.1						181		76				
	1-7-75	750	7.9	50	14	100	3.9		183	139	79	16	2.40	ND	555
	3-6-75	750	8.3												
	4-29-75	800	7.85	52	14	101	3.6		175	136	83	16.6	2.3	0.6	570
	7-2-75	860													
	9-3-75	820	7.8	30	27	102	3.9		167	129	129	16.6	2.70	ND	590

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-11

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-11 (Cont'd)	11-4-75	780	8.05												
	1-7-76	850	8.0	69	6	110	3.99		233	123	81	14.4	2.49	0.48	620
	3-2-76	680													
	4-29-76	850	8.1	57	13	104	4.3		192	127	77	15.9	2.45	ND	590
	6-29-76	870													
	8-26-76	900	8.1	48	17	94	3.9		177	139	80	14.6	2.4	ND	602
	10-21-76	800													
	2-24-77	600													
	3-30-77	820													
	5-26-77	905													
	7-28-77	1300													
	8-30-77	1550	7.8	108	43.6	142	6.0		140	235	241	76	1.7	0.4	1005
	9-23-77	1550													
	10-27-77	1850													
	11-30-77	1950													
	12-21-77	2025	7.9	201	61.0	168	5.6		153	355	362	140	1.6		1339
	1-31-78	2275													
	2-27-78	2375													
	3-30-78	2350													
	4-25-78	2200	8.0	312	12	152	9.2		105	513	394	0.49	2.29		
	5-25-78	2100													
	6-29-78	1950													
	7-31-78	2000													
	8-29-78	1875	8.1	186	57	159	6		127	420	314	106		0.36	
	9-26-78	1700													
	10-27-78	1800													
	11-30-78	1550													
	12-29-78	1600	8.0	172	46	147	2		152	401	250	89		0.28	
	1-31-79	1550													
	2-24-79	1500													
	3-28-79	1400													
	4-27-79	1400	8.4	100	43	131	5		115	282	225	71		0.30	

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH- 11

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-11 (Cont'd)	6-1-79	1350													
	6-28-79	1400	8.0												
	7-31-79	1250													
	8-31-79	1300	7.7	126	36	131	6		165	275	200	62		0.27	
	9-25-79	1300													
	10-30-79	1250													
	11-29-79	1300													
	12-29-79	1250	7.5	119	35	114	4		176	252	184	71		0.32	

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-12

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-12	12-20-72	820	7.9	44	13	105	4.3		174	136	75	23	0.95		583
	2- 7-73	1270	7.3						217		111				
	3- 5-73	1150	7.2						204		100				
	3-28-73	1010	7.2	63	16	131	5.1		177	248	88		1.55		724
	5-7-73	880	7.4						107		85				
	6-6-73	830	7.2						89		85				
	7-5-73	800	7.5	49	8.9	104	4.7		98	172	85	N.D.	1.26	N.D.	547
	8-6-73	710	7.1						101		78				
	9-7-73	620	7.4	39	6.7	82	3.9		85	121	78	N.D.	1.33	N.D.	430
	10-8-73	590	7.4						75		95				
	11-6-73	500	7.4	38/47	6/9.4	71/97	3.5/4.3		92/113	85/157	83/84	N.D.	1.13		364/516
	12-5-73	500	7.2	40	4.9	60	3.1		104	63	78	N.D.	1.42	N.D.	352
	1-4-74	475	7.6						125		73				
	2-7-74	440	7.9						113		65				
	3-7-74	480	7.5						128		65				
	4-2-74	600	7.5	47	7.9	74	3.9		183	79	50	1.2	1.25	ND	433
	4-30-74	470	7.9						116		68				
	6-5-74	500	8.1						159		65				
	7-3-74	430	8.1	24	3.6	63	3.5		128	18	63	ND	1.20	ND	302
	7-30-74	420	7.8						128		65				
	9-7-74	410	8.2						125		65				
	9-30-74	405	8.0	29	16	48	2.7		127	48	70	0.6	1.45	ND	310
	11-6-74	360	8.1						105		76				
	12-3-74	440	7.9						133		71				
	1-7-75	485	7.6	38	6.9	61	3.1		149	48	68	2.5	1.70	ND	358
	3-6-75	370													
	4-29-75	385	7.85	31	3	51	2.5		120	7	72	0.7	1.4	0.2	280
	10-2-75	483	7.6	38	8	54	2.9		141	27	79	0.8	1.38	ND	345

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in. ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-12 (Cont'd)	1-6-76	418	7.8	44	3	47	2.4		134	16	75	0.4	1.25	ND	307
	3-2-76	420													
	4-29-76	460	8.0	39	7	48	2.3		153	15	70	0.7	1.24	0.4	330
	8-26-76	379	8.2	25	3	45	2.0		107	1	60	–	1.2	ND	254
	10-21-76	375													
	2-24-77	380													
	4-28-77	383	8.2	32	2.4	60	2.2		122	29	64	1.1	1.2	0.22	204
	6-28-77	425													
	8-30-77	450	7.8	88	12.7	52	3.0		159	16.0	74	1.3	0.95	0.2	375
	10-27-77	400													
	12-21-77	425	7.9	42	5.8	44	2.2		135	23	64	0.1	1.0		257
	2-27-78	400													
	4-25-78	325	8.3	35	6	43	2.6		111	37	51	1.59	1.56		
	6-29-78	390													
	8-29-79	495	8.4	50	8	48	3	3	122	13	83	4		0.25	
	10-28-78	370													
	12-29-78	360	8.1	50	4	44	2		134	30	59	1		0.23	
	2-24-79	350													
	4-27-79	350	8.0	20	4	45	2		120	16	50			0.16	
	6-28-79	400													
	8-31-79	460	7.6	48	9	49	4		178	34	73	4		0.17	
	10-30-79	370													
	12-27-79	350	7.3	35	6	46	2		123	15	72	9		0.26	

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-13A

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-13A	3-28-73	950	8.1	60	18	108	3.1		147	180	113	6.6	1.58		664
	5-7-73	940	7.9						153		113				
	6-7-73	950	7.8						143		118				
	7-5-73	980	8.0	50	15	131	4.3		153	168	118	7.4	1.42	N.D	679
	8-6-73	950	7.7						153		139				
	9-7-73	900	7.8	52	15	121	4.3		143	156	117	9.2	1.46	N.D.	637
	10-8-73	880	7.9						123		137				
	11-6-73	800	7.7	57/55	16/16	104/116	3.9/3.9		134/144	141/161	125/118	11	1.30		570/638
	12-5-73	820	7.6	57	15	106	3.5		134	133	125	9.3	1.47	N.D.	580
	1-4-74	800	7.7						131		120				
	2-7-74	820	8.2						140		125				
	3-7-74	850	7.6						146		125				
	4-2-74	880	7.9	56	16	110	3.5		146	161	120	8.7	1.45	ND	619
	5-1-74	900	8.2						144		120				
	7-2-74	900	7.9	54	19	115	3.9		140	169	115	11	1.48	ND	629
	7-30-74	960	7.9						137		123				
	9-6-74	950	7.9						149		115				
	9-30-74	900	8.2	41	28	127	3.9		134	238	108	12.2	1.45	0.12	661
	11-6-74	870	8.1						143		121				
	12-3-74	880	8.2						144		115				
	1-7-75	850	8.1	58	16	107	3.5		142	177	112	11	1.42	0.60	611
	3-6-75	850													
	7-2-75	990													
	9-3-75	920	7.8	38	29	108	3.7		129	168	116	10.1	1.47	ND	625
	11-4-75	890													
	1-6-76	860	7.9	61	16	109	3.5		144	174	117	10.0	1.4	ND	619
	3-2-76	880													
	4-29-76	980	8.1	64	15	124	3.9		147	170	126	11.1	1.49	ND	675
	6-29-76	1000													

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-13A (Cont'd)

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-13A (Cont'd)	8-26-76	1010	8.0	56	16	109	3.9		128	175	118	10.0	1.3	ND	661
	10-21-76	900													
	2-24-77	900													
	4-28-77	905	8.0	50	23	122	5.3		159	183	121	0.89	1.4	0.62	615
	6-28-77	950													
	8-30-77	975	7.9	52	23	100	2.6		134	169	117	12.4	1.2	0.4	625
	10-27-77	1025													
	12-21-77	875	7.8	59	18.8	106	3.5		175	140	113	3.1	1.2		565
	2-27-78	1,025													
	4-25-78	875	8.4	75	16	82	4.2		137	153	109	1.59	1.89		
	6-29-78	850													
	8-29-78	900	8.2	56	20	113	4		122	206	118	18		0.27	
	10-27-78	900													
	12-29-78	850	8.5	67	17	104	3	2	126	147	117	13		0.28	
	2-24-79	775													
	4-27-79	870	8.5	45	19	110	3		112	156	110	10		0.26	
	6-28-79	900													
	8-31-79	870	7.8	100	20	113	4		186	203	120	31		0.13	
	10-30-79	810													
	12-27-79	780	7.4	50	20	95	2		155	105	128	35		0.37	

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-14A

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-14A	3-29-73	920	8.0	36	13	132	4.3		150	192	90	5.5	1.65		644
	5-7-73	820	8.0						153		91				
	6-7-73	820	8.0						143		94				
	7-5-73	840	8.1	35	12	127	3.5		153	140	95	6.7	1.50	ND	592
	8-6-73	820	7.9						153		93				
	9-7-73	800	7.9	35	12	127	3.5		153	134	95	8.1	1.51	N.D.	576
	10-8-73	800	5.0						98		153				
	11-6-73	730	7.9	37/36	12/12	120/127	3.5/3.7		154/153	132/150	95/94	8.1	1.32	N.D.	532/596
	12-5-73	750	7.9	37	4.9	123	2.7		153	131	95	5.6	1.5	N.D.	539
	1-4-74	740	7.7						153		93				
	2-8-74	750	8.2						159		90				
	3-7-74	750	7.9						156		98				
	4-2-74	800	8.0	36	13	122	3.1		165	140	100	5.6	1.62	ND	573
	5-1-74	820	8.2						162		95				
	6-5-74	850	8.3						140		100				
	7-2-74	800	8.2	34	12	122	3.1		153	138	95	8.1	0.71	ND	563
	7-29-74	860	8.0						156		100				
	9-4-74	820	8.0						189		90				
	10-1-74	800	8.1	33	15	130	3.5		140	208	80	9.2	1.55	ND	590
	11-6-74	750	8.1						149		94				
	12-2-74	750	8.2						155		90				
	1-7-75	750	7.9	35	11	115	3.1		98	150	92	8.7	1.7	ND	519
	3-6-75	750													
	4-29-75	780	8.0	35	12	117	3.0		144	131	94	8.2	1.5	0.41	545
	7-2-75	860													
	9-4-75	920	8.1	33	15	120	3.4		149	143	95	8.0	1.53	ND	605
	11-4-75	790													
	1-7-76	810	7.9	36	14	119	3.1		161	132	93	7.4	1.56	0.26	565
	3-2-76	800													
	4-29-76	880	8.3	38	12	123	3.1	18	126	133	103	6.6	1.5	0.10	590
	6-29-76	880													

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-14A (Cont'd)

Well Number	Date Sampled	ECx10⁶ at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-14A (Cont'd)	8-26-76	910	8.2	38	10	121	1.6		156	135	100	7.2	1.6	ND	603
	10-21-76	800													
	2-24-77	800													
	4-28-77	805	7.7	33	13.9	122	3.8		171	85	95	2.26	1.7	0.42	595
	6-28-77	825													
	8-30-77	850	8.0	67	21.8	120	2.6		183	118	99	11.8	1.2	0.4	595
	10-27-77	800													
	12-21-77	800	7.9	39	13.5	117	2.5		152	147	89	2.5	1.4		526
	2-27-78	850													
	4-25-78	800	8.4	41	11	113	3.8		143	139	94	2.3	1.95		
	6-29-78	775													
	8-29-78	810	8.3	40	15	117	3		146	135	118	17		0.24	
	10-27-78	810													
	12-29-78	780	8.5	70	14	113	2	2	149	208	93	13		0.35	
	2-24-79	750													
	4-27-79	770	8.5	45	13	115	2		100	166	95	17		0.21	
	6-28-79	850													
	8-31-79	770	7.3	35	16	119	3		160	126	95	31		0.09	
	10-30-79	740													
	12-27-79	720	7.5	33	12	122	2		158	137	102			0.29	

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-15A

Well Number	Date Sampled	ECx10⁶ at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-15A	4-3-74	1000	8.0	65	18	131	4.7		137	191	145	6.2	1.05	0.84	699
	4-30-74	1000	8.0	64	19	130	5.1		137	180	150	3.7	0.95	0.38	697
	6-5-74	1000	8.1	70	18	114	4.3		137	170	150	8.1	1.05	0.4	686
	7-2-74	1000	8.1	66	20	122	5.1		125	176	155	9.3	1.20	ND	689
	7-30-74	1000	8.1	68	17	124	4.7		131	150	160	9.0	1.05	ND	680
	9-4-74	1000	8.0	68	20	108	3.9		115	150	159	6.8	0.96	ND	66[illegible]
	10-1-74	1000	8.0	56	29	120	3.9		122	213	150	9.2	1.05	ND	695
	11-6-74	1000	8.0	73	20	117	3.9		125	167	173	7.4	1.00	ND	693
	12-3-74	930	7.9	69	19	108	3.9		134	150	164	6.1	1.06	0.12	650
	1-8-75	950	7.9	68	21	110	4.3		116	159	171	7.4	1.1	ND	661
	3-6-75	980													
	4-29-75	1930	7.8	1.66	79	166	5.7		101	521	310	10.5	0.92	0.3	1355
	7-1-75	1200	7.9	84	30	115	3.6		128	175	201	21.3	1.15	ND	799
	7-31-75	1220	7.7	62	36	127	4.5		118	162	211	5.8	0.87	0.72	791
	9-3-75	1170	7.6	74	29	116	4.4		104	152	221	7.7	1.15	ND	765
	10-2-75	1200	7.8	76	32	125	4.1		107	169	238	8.5	0.96	ND	800
	11-4-75	1150													
	1-6-76	1280	7.25	119	29	122	6		125	181	268	10.7	1.00	0.31	880
	3-2-76	1300													
	4-29-76	1470	7.85	117	36	127	5.1		110	223	148	8.1	1.07	0.60	902
	6-29-76	1480													
	8-26-76	1660	8.0	172	12	130	8.9		131	239	304	8.5	1.0	ND	1081
	10-21-76	1480													
	2-24-77	1350													
	4-28-77	1505	8.3	126	38	135	7.6		122	238	295	3.6	2.5	0.32	1080
	5-26-77	1480													
	6-28-77	1525													
	7-28-77	1475													
	8-30-77	1510	7.8	100	48.5	142	5.2		146	221	294	12.8	2.4	0.5	995
	9-23-77	1450													
	10-27-77	1525													
	11-30-77	1525													
	12-21-77	1475	7.9	123	36.0	130	4.3		107	202	294	18.6	1.4		886

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-15A (Cont'd)

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-15A Cont'd	2-27-78	1450													
	4-25-78	1425													
	6-29-78	1450													
	8-29-78	1850													
	10-27-78	1450													
	12-29-78	1450	7.6	159	43	132	4		114	280	322	18		0.33	
	2-24-79	1375													
	4-27-79	1450	8.3	140	40	127	4		105	257	300	22		0.30	
	6-28-79	1550	7.4												
	8-31-79	1400	7.6	139	39	165	5		112	272	310	40		0.34	
	10-30-79	1400													
	12-27-79	1350	7.3	132	37	137	2		115	227	330	35		0.34	

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH- 16A

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-16A	4-2-74	980	7.9	53	15	161	4.3		149	192	145	6.2	1.35	ND	706
	4-30-74	980	8.2	52	16	147	4.8	9.0	116	194	143	11	1.37	0.24	689
	6-4-74	1000	8.2	59	15	133	3.9		125	181	145	11	1.35	ND	687
	7-3-74	1020	8.1	58	15	141	4.7		137	198	143	9.9	1.40	ND	711
	7-30-74	1110	7.9	57	19	179	6.3		159	224	160	10.4	1.28	ND	795
	9-5-74	1100	7.9	64	20	140	3.9		137	201	154	9.9	1.35	0.24	750
	10-1-74	1100	8.0	51	28	153	3.9		132	258	150	10.7	1.3	ND	7
	11-5-74	1100	8.0	77	15	141	3.9		121	223	173	9.9	1.22	ND	767
	12-3-74	1100	7.8	79	20	159	4.3		149	259	178	12.9	1.22	0.62	815
	1-8-75	1200	8.0	74	27	167	4.3		111	275	195	11	1.20	ND	852
	3-5-75	1300	8.0						98		205				
	4-29-75	1510	7.85	104	32	178	4.7		106	341	237	10.1	1.09	0.2	1040
	7-2-75	1680	8.1						104		245				
	9-3-75	1670	7.8	95	41	167	3.9		104	363	228	12.4	1.10	ND	1092
	11-3-75	1700	7.8												
	1-6-76	1860	7.5	192	41	221	5.5		92	586	313	0.3	0.94	0.24	1375
	3-2-76	2120													
	4-29-76	2400	7.7	198	22	232	5.9		101	239	356	21.4	0.86	ND	1430
	6-29-76	2690													
	8-26-76	3100	8.0	256	68	315	6.2		92	853	430	30.6	0.9	ND	2.0
	10-21-76	2870													
	2-24-77	3100													
	4-28-77	3200	8.1	312	99	352	8.2		95	1136	510	16	1.6	0.52	2504
	6-28-77	3525													
	8-30-77	3400	7.3	320	138	330	7.0		92	1147	567	25	1.7	0.7	2640
	10-27-77	3325													
	12-21-77	3100	7.7	351	113	308	6.3		96	1086	516	46.5	0.7		2496
	2-27-78	3100													
	4-25-78	3100	8.1	421	24	286	10.6		70	1010	481	2.7	0.98		
	6-29-78	3100													
	8-29-78	2700	7.8	330	115	300	8		87	1020	490	5.8		0.37	
	10-27-78	3100													

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH- 16A

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-16A (Cont'd)	12-29-78	3200	7.7	375	118	300	4		83	1200	530	57		0.43	
	2-24-78	3000													
	4-27-78	3200	7.5	283	125	270	10		97	1140	520	62		0.30	
	6-28-78	3300													
	8-31-78	3250	7.6	403	118	300	7		96	1284	550	62		0.40	
	10-30-79	3200													
	12-27-79	3100	7.2	300	123	280	6		123	1140	380	80		0.40	

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-16 B

Well Number	Date Sampled	ECx10⁶ at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-16 B	4-2-74	9500	7.3	481	280	2098	27		366	4551	1200	20	1.48	ND	7837
	7-3-74	11,500	7.6	681	304	2162	31		427	5337	1901	26	1.42	ND	9460
	7-30-74	11,000	7.8	551	419	2208	39.1		308	5507	1300	15.5	1.27	0.7	9,024
	9-5-74	11,000	8.2	527	417	2070	31.3		272	5198	1230	18.0	1.45	2.16	8,732
	10-1-74	11,000	7.8	501	404	1978	34		281	5323	1225	14.0	1.4	1.8	8,730
	11-5-74	10,000	7.7	533	434	1932	3.4		273	5023	1320	21.	1.48	1.8	8,2[illegible]
	12-3-74	9,200	7.5	465	413	1794	32.8		268	4529	1260	40.6		3.4	7,8[illegible]
	1-8-75	9,000	7.8	483	343	1668	31		244	4225	1180	19	1.50	ND	7,247
	3-5-75	9,500	7.9						254		1200				
	9-3-75	10,600	7.8	260	608	1877	31.3		220	4851	1242	20.1	1.45	ND	8255
	10-2-75	10,200													
	11-3-75	11,000	7.7												
	1-6-76	11,400	7.6	531	424	1921	25.81		256	4311	1790	28.6	1.31	3.17	8.635
	3-3-76	10,800													
	4-28-76	10900	7.9	986	105	1932	21.9		262	4537	1525	9.2	1.18	2.3	8505
	6-29-76	10,700													
	8-25-76	10,800	7.9	513	364	1426	2.0		250	3599	1450	12.2	1.1	ND	7588
	10-22-76	11,000													
	2-24-77	10,000													
	4-29-77	10,200	7.9	466	300	1930	25		244	4014	1582	1.3	3.0	3.5	-(
	6-28-77	9,000													

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH- 17A

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-17A	4-2-74	700	7.8	49	12	104	5.1		146	114	105	6.2	1.25	ND	516
	4-30-74	700	8.1	46	12	97	3.9		131	109	95	9.3	1.27	0.31	497
	6-4-74	700	8.0	50	10	92	3.9		134	108	100	8.7	1.25	0.52	499
	7-3-74	750	8.1	45	12	94	3.9		134	116	100	11	1.35	ND	521
	7-30-74	750	7.9	60	6	108	5.1		168	119	100	10.3	1.22	ND	550
	9-5-74	700	8.1	43	15	89	3.5		130	109	95	9.3	1.25	ND	492
	10-1-74	850	8.1	44	15	105	3.5		128	166	93	8.9	1.3	ND	579
	11-5-74	800	7.9	50	12	95	3.5		127	119	99	8.7	1.25	0.5	537
	12-2-74	730	7.8	45	22	69	3.9		166	122	97	13.3	1.25	ND	525
	1-8-75	700	8.0	43	16	92	3.5		127	127	104	9.9	1.3	0.2	443
	3-5-75	700	8.2						262		97				
	4-28-75	820	8.1	57	10	95	3.3		121	128	114	8.9	1.25	0.3	555
	7-2-75	900	7.8						126		123				
	9-4-75	910	7.9	45	19	92	3.4		118	127	115	9.2	1.17	0.21	583
	11-3-75	740	8.0												
	1-6-76	780	7.75	54	14	93	4		131	129	113	6.8	1.28	0.12	545
	3-2-76	780													
	4-29-76	850	7.7	59	14	98	3.6		140	133	117	7.7	1.2	ND	585
	6-29-76	900													
	8-26-76	1100	8.0	65	18	130	4.3		125	187	138	28.5	1.3	0.6	737
	10-21-76	950													
	2-24-77	850													
	4-28-77	1010	7.8	73	12.7	128	4.8		125	197	142	10.7	1.65	0.42	594
	6-28-77	1025													
	8-30-77	1010	7.9	60	25.5	100	4.5		122	157	149	9.7	0.5	0.7	655
	10-27-77	1150													
	12-21-77	1100	7.9	85	21.8	113	4.3		117	186	170	17.7	1.0		665
	2-27-78	1150													
	4-25-78	1150	8.3	124	22	115	6.7		116	287	181	2.75	1.3		
	6-29-78	1250													
	8-29-78	1350	7.5	80	32	142	5		108	306	196	27		0.40	
	10-27-78	1375													

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-17A

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-17A (Cont'd)	12-29-78	1450	7.8	165	30	134	5		104	356	260	20		0.35	
	2-24-79	1400													
	4-27-79	1550	7.9	193	46	140	10		107	450	270	27		0.26	
	6-28-79	1700	7.7												
	8-31-79	1700	7.7	205	43	137	6		101	468	300	40		0.37	
	10-30-79	1600													
	12-27-79	1700	7.2	210	53	190	4		128	540	330	49		0.36	

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH- 18

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-18	4-3-74	780	7.7	55	18	89	3.5		153	152	80	8.7	0.74	ND	553
	5-1-74	750	7.8	50	12	98	3.9		137	157	85	1.9	0.71	0.29	535
	6-5-74	700	7.9	46	15	97	4.7		134	149	80	1.9	0.70	ND	509
	7-2-74	750	7.8	45	15	87	3.9		128	147	83	1.9	0.27	0.36	518
	7-29-74	700	7.8	45	16	86	4.3		140	146	75	ND	0.68	0.6	500
	9-5-74	700	7.9	45	18	90	3.5		136	146	80	1.9	0.64	ND	505
	10-1-74	750	7.9	46	19	83	3.5		137	187	60	1.5	0.70	ND	530
	11-5-74	700	8.0	48	18	86	3.5		139	149	79	1.9	0.67	ND	507
	12-2-74	680	8.1	40	22	81	3.5		134	150	74	2.7	0.65	0.19	490
	1-8-75	700	7.9	43	20	83	3.1		134	152	79	1.2	0.72	ND	503
	2-6-75	700													
	3-6-75	700													
	4-4-75	700													
	4-30-75	730	7.86	48	15	82	3.3		131	142	80	1.5	0.76	ND	505
	5-29-75	730													
	7-2-75	810													
	8-1-75	840													
	9-5-75	840	8.0	49	15	81	2.9		131	150	81	1.0	0.62	ND	550
	10-2-75	770													
	11-4-75	740													
	12-3-75	780													
	1-7-76	700	8.1	51	18	82	3.0		134	147	82	1.0	0.70	0.19	504
	2-4-76	720													
	3-2-76	700													
	3-31-76	630													
	4-28-76	710	7.9	27	17	78	2.3		122	138	76	2.0	0.73	0.48	480
	5-27-76	690													
	6-29-76	760													
	7-28-76	710													
	8-26-76	790	8.2	37	18	79	2.3		113	144	75	0.6	0.7	ND	511
	9-29-76	770													
	10-21-76	720													

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH- 18

Well Number	Date Sampled	ECx10⁶ at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-18 (Cont'd)	1-28-77	920													
	2-24-77	800													
	3-30-77	810													
	4-28-77	790	7.6	50	18.2	92	3.2		134	161	89	2.4	1.25	0.22	468
	5-26-77	900													
	6-28-77	810													
	7-28-77	790													
	8-30-77	1010	7.2	59	35	90	4.0		140	198	117	6.6	0.35	0.6	675
	9-23-77	1125													
	10-27-77	1025													
	11-30-77	925													
	12-20-77	1000	7.6	76	23	92	4.0		138	179	117	19.0	0.8		600
	1-31-78	975													
	2-27-78	1075													
	3-30-78	950													
	4-25-78	975	7.6	80	21	90	4.8		129	199	127	2.66	1.10		690
	5-25-78	1000													
	6-29-78	1000													
	7-31-78	1075													
	8-29-78	1050	8.3	76	33	100	4	4	106	252	127	18		0.45	
	9-26-78	1000													
	10-27-78	1000													
	11-29-78	1000													
	12-28-78	1125	7.8	113	36	100	5		139	247	175	18		0.32	
	1-31-79	975													
	2-24-79	975													
	3-28-79	850													
	4-26-79	1100	8.1	127	42	90	10		129	247	174	18		0.26	
	5-31-79	1100													
	6-28-79	1050													
	7-31-79	1050													
	8-30-79	950	7.8	87	28	101	5		144	272	135	22		0.33	

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH- 18

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-18 (Cont'd)	9-24-79	935													
	10-30-79	930													
	11-29-79	1080													
	12-27-79	1050	7.2	93	36	130	4		136	261	200	31		0.29	

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH- 19

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-19	11-20-74	2089	7.3	256	54	240	10.1		104	697	430	11.2	1.1		1765
	2-5-75	2000	7.9	192	32	230	9.8		97	492	335	29	0.81	ND	1453
	3-6-75	2080	7.2	198	46	212	8.2		76	506	396	30	0.72	ND	1464
	4-5-75	1900	7.7	157	50	188	6.7		90	431	343	29.5	0.66	ND	1310
	4-29-75	2010	7.45	162	40	214	7.0		92	378	395	24.0	0.84	ND	1320
	5-28-75	1820	7.40	162	39	209	7.0		94	369	390	22.2	0.87	ND	1285
	7-1-75	1980	7.5	156	43	196	5.9		87	377	350	9.3	0.94	ND	1305
	7-31-75	2170	7.3	136	57	223	7.7		89	369	404	24.4	0.81	0.24	1386
	9-4-75	2430	8.0	178	47	223	7.8		82	381	454	23.3	0.86	ND	1549
	10-2-75	2220	7.5	171	48	244	7.6		77	375	491	17.9	0.91	ND	1493
	11-3-75	2290	7.6	187	59	251	7.8		68	416	521	17.9	0.79	ND	1566
	12-3-75	2300	7.55	183	54	236	7.5		76	396	526	19.7	0.85	ND	1554
	1-6-76	2000	7.5	171	46	223	7.0		76	332	496	14.3	0.94	0.29	1383
	2-4-76	2150													
	3-3-76	2100	7.4	165	44	238	6.8		112	321	475	25	0.93	0.24	1430
	3-30-76	2000													
	4-28-76	2190	7.65	173	48	219	7.4		79	344	251	21	1.05	0.60	1338
	5-27-76	2070													
	6-29-76	2290	7.1	166	49	228	6.6		94	307	475	17.3	0.9	ND	1473
	7-28-76	1800													
	9-29-76	2270													
	10-22-76	2100	7.4	160	45	225	8.2		70	328	485	23.6	0.9	0.2	1408
	1-27-77	2110													
	2-23-77	2050	7.4												
	3-30-77	1980													
	4-29-77	2130	7.2	171	60	214	7.4		98	332	470	39	1.25	0.62	—
	5-26-77	2320													
	6-29-77	2200													
	7-27-77	2160													
	8-30-77	2600	7.35	216	89	252	8.0		122	535	539	20	1.2	0.7	1820
	9-23-77	2050													
	10-27-77	2200													

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-19 (Cont'd)

Well Number	Date Sampled	ECx10⁶ at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-19 Cont'd	11-30-77	2000													
	12-21-77	2050	7.7	164	43	219	6.8		73	343	466	41.2	0.9		1333
	1-31-78	2125													
	2-26-78	2275													
	3-30-78	2175													
	4-25-78	2075	7.9	211	9	219	10.3		69	339	465	3.54	1.18		1329
	5-25-78	2250													
	6-29-78	2150													
	7-31-78	2275													
	8-27-78	2300	7.4	215	47	229	8		65	540	470	35		0.35	
	9-26-78	2000													
	10-27-78	2150													
	11-30-78	1975													
	12-29-78	2050	7.7	191	49	216	7		73	290	520	36		0.34	
	1-31-79	2100													
	2-25-79	2200													
	3-28-79	1900													
	4-26-79	1950	7.9	194	50	210	10		67	301	520	27		0.29	
	6-01-79	2100													
	6-28-79	2100													
	7-30-79	2000													
	8-31-79	1950	7.5	178	40	220	8		80	311	470	40		0.33	
	9-24-79	2000													
	10-30-79	2000													
	11-29-79	2000													
	12-27-79	1850	7.1	159	36	218	8		72	105	580	–		0.27	

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MH-20

Well Number	Date Sampled	ECx10^6 at 25°C	pH	Mineral constituents in parts per million											TDS in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	
MH-20	11-26-74	3,954	7.4	436	90	250	9.9		66	719	836	13	0.4		2453
	12-3-74	887	7.6	85	19	95	3.9		154	160	130	3.9	0.8		612
	12-4-74	1,353	7.5	159	38	142	14		74	317	331	6.6	0.5		1,077
	2-6-75	-2,400	7.5	224	43	193	8.6		79	466	459	11	0.50	ND	1,582
	3-5-75	2,450	6.8	259	59	207	8.6		33	563	552	1.2	0.42	ND	1,699
	4-4-75	2,750	7.4	281	80	225	8.6		38	641	632	3.5	0.39	ND	1,915
	4-30-75	4,090	7.65	493	131	292	9.0		75	1,053	920	5.6	0.33	ND	2,920
	5-29-75	2,100	7.42	234	49	180	6.1		107	479	432	14.8	0.56	ND	1,485
	7-1-75	1,400	7.6	118	29	117	4.3		128	252	217	13.0		ND	929
	8-1-75	1,720	7.7	115	57	131	5.3		126	328	274	11.4	0.57	0.26	1,126
	8-1-75	1,200	7.7	82	30	108	4.1		146	204	166	8.2	0.68	ND	864
	9-4-75	1,200	7.8	93	18	103	3.9		147	194	160	9.7	0.76	0.31	785
	10-2-75	2,620	7.6	297	75	200	6.7		99	630	522	13.8	0.48	ND	1839
	11-4-75	2650	7.6	307	81	207	7.5		93	651	546	17.6	0.48	0.31	1883
	12-4-75	2520	7.6	282	70	195	6.6		92	605	532	14.4	0.5	ND	1781
	1-6-76	2780	7.7	354	81	216	7.5		90	743	630	6.4	0.48	0.17	2027
	2-4-76	2400	7.45	278	55	184	6.4		65	563	478	13.7	0.50	0.24	1662
	3-3-76	2280	7.7	257	59	193	7.0		101	528	480	14.4	0.59	ND	1620
	4-1-76	2700	7.6	317	58	205	6.5		70	658	550	15.9	0.58	ND	1890
	4-29-76	1230													
	4-28-76	2720	8.0	337	88	214	7.0		104	335	145	12.6	0.57	0.24	1574
	5-27-76	3390	7.6	413	82	235	7.8		98	808	720	ND	0.47	0.5	2369
	6-29-76	2240	7.6	223	59	146	4.3		119	466	400	9.8	0.6	ND	1,498
	1/7-28-76	3000	7.55	337	80	221	7.8		88	684	154	15	0.46	0.24	1844
	2/7-28-76	2170													
	1/8-26-76	2010	7.4	184	47	140	4.7		110	389	332	25.5	0.6	ND	1320
	1/9-30-76	2100	7.3	204	49	158	7.8		104	441	355	18.5	0.55	0.8	1369
	2/10-22-76	1210	7.7	110	26	113	3.3		140	233	190	9.8	0.7	0.5	836
	1-28-77	1850													
	2-23-77	1700	7.8												
	3-30-77	2200	7.3	214	45	190	8.2		92	424	425	25	1.0	0.25	1514

1/ Pump on 5 min.
2/ Pump on 50 min

CHEMICAL ANALYSES OF WATER SAMPLES
FROM MONITORING WELL MW- 20

Well Number	Date Sampled	EC x 10⁶ at 25°C	pH	Mineral constituents in parts per million											TDS, in ppm
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	S	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	6-29-77	1950													
	7-28-77	1950													
	10-27-77	2125	7.9	215	50	173	8.0		105	412	401	35.4	0.6		1340
	11-30-77	1800													
	12-21-77	1650													
	1-30-78	1950													
	3-30-78	2000													
	4-25-78	2000	8.3	234	9	164	8.5		99	335	339	3.32	0.75		1210
	5-25-78	2050													
	6-28-78	1950	8.1	162	45	150	6		116	228	352	35		0.14	
	7-31-78	2800													
	8-30-78	2000	7.7	210	50	164	6		111	414	392	31		0.27	
	9-26-78	2000													
	10-27-78	2000	7.7	210	47	75	7.5		112	363	417	38.7	0.6		1346
	11-30-78	1925													
	12-29-78	2050	7.5	226	55	168	6		104	410	440	28		0.33	
	1-31-79	2350													
	2-25-79	2700	7.3	308	72	195	7.5		84	500	613	38.7			1814
	3-28-79	2150													
	4-26-79	2000	8.1	278	57	150	10		115	423	480	35		0.25	
	5-31-79	2050													
	6-28-79	2050	7.5	224	57	155	6		150	414	440	31		0.27	
	7-30-79	2000													
	8-30-79	1900	7.5	217	50	180	5		117	285	480	49		0.34	
	9-24-79	2100													
	10-30-79	1850	7.7	211	58	166	6		107	421	420	49		0.50	
	11-28-79	1900													
	12-26-79	2200	6.9	250	63	184	8		102	384	545	49		0.31	

1/ Beginning of pumping cycle.
[illegible] of pumping cycle.

CHEMICAL ANALYSES OF COAL SAMPLES FROM THE BLACK MESA FIELD, ARIZONA

Sample study initiated and coordinated by Richard T. Moore, Principal Geologist, Arizona Bureau of Mines, Tucson, Ariz.; and Vernon E. Swanson, Geologist, U.S. Geological Survey, Denver, Colo.

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CHEMICAL ANALYSES OF COAL SAMPLES FROM THE BLACK MESA FIELD, ARIZONA

INTRODUCTION

by
Richard T. Moore

Coal mining on a major scale in Arizona began in the early 1970s when Peabody Coal Company started full-scale mining on their Black Mesa leases. These leases cover some 64,800 acres of Navajo and Hopi lands on Black Mesa in northeastern Arizona (see Fig. 1).

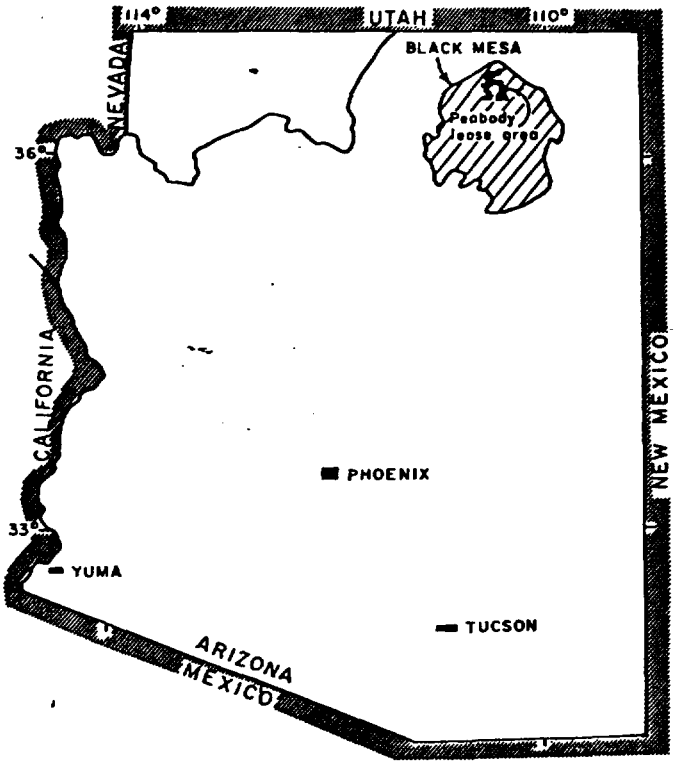


Figure 1. Map showing location of Black Mesa coal field in Arizona.

Currently, Peabody is operating two mines, Black Mesa No. 1 and Black Mesa No. 2 (formerly designated the Kayenta Mine), which supply, respectively, coal to the Mohave electrical generating station in Nevada, near Davis Dam, and the Navajo generating station near Page, Arizona.

The coal being mined comes from three seams, designated the Green, Blue, and Red seams, occurring in the Wepo Formation of Upper Cretaceous age. The following description of the Wepo Formation is abstracted with slight modification from Peirce et al. (1970).

According to available data the Wepo Formation contains not only the highest rank and highest quality coal on Black Mesa but the largest minable reserves as well. The coal seams are thicker, more numerous, more widespread, and more accessible for strip mining. Coal occurs in an alternating sequence of dark olive-gray to brown siltstones and mudstones and yellowish gray sandstones. The Wepo Formation crops out on the northern portion of Black Mesa (Fig. 1). On the extreme northeast it is capped by the massive yellowish gray Yale Point Sandstone. About 1,270 square miles of the Wepo Formation is exposed at the surface of Black Mesa.

The Wepo is 743 feet thick east of Cow Springs and over 600 feet thick in the central part of the mesa. To the north it thins to 318 feet at Rough Rock. Because the top of Black Mesa is an erosion surface the remaining Wepo thickness in a particular area depends upon its structural position and the extent of downcutting by streams. Greater thicknesses of Wepo strata and, therefore, potentially more coal, are preserved in synclines, or downwarps. The Maloney and the Black Mesa synclines are examples of such protective structures. The relatively sharp depositional thinning of Wepo strata to the northeast away from the Maloney synclinal area suggests that a downwarp existed during Wepo deposition. This downwarp and the later movement constituting the Maloney syncline, might well be closely related events. The principal coal reserves that are to be mined by the Peabody Coal Company are, in part at least, associated with the Maloney syncline (Fig. 2).

Because the thickest and most continuous coal beds studied thus far are in the upper half of the Wepo Formation, the best coal prospects appear to be in the northern part of Black Mesa where the upper half of the formation

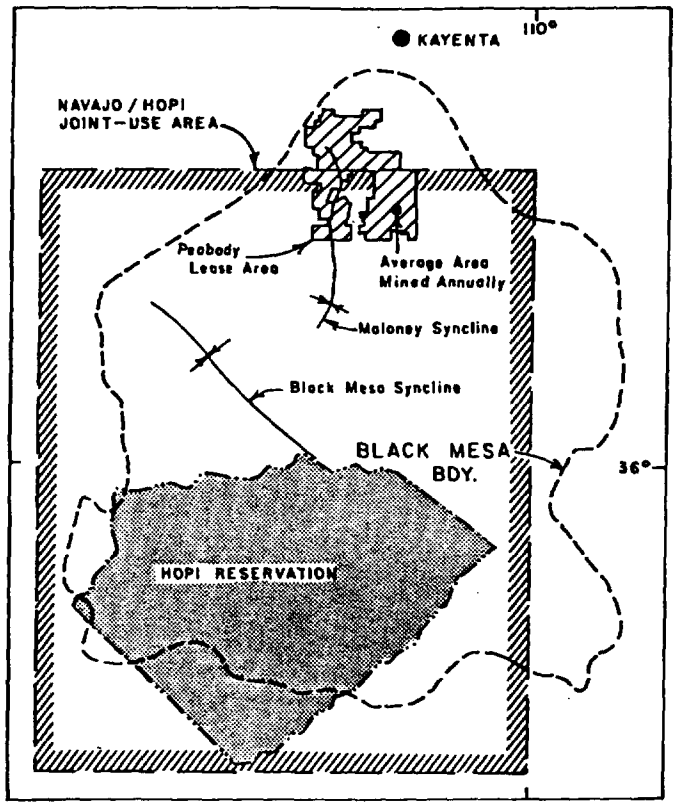


Figure 2. Map showing location of the Peabody Coal Company Black Mesa leases and the Black Mesa and Maloney synclines.

has not been completely eroded away. The Wepo contains at least ten coal beds thicker than three feet in the area examined by Williams (1951, p. 214–5) along the northwest rim. Most of the coal beds occur in the siltstone units below sandstone beds (Repenning and Page, 1956, p. 278). Individual coal seams persist for hundreds of thousands of feet but invariably thin laterally to seams a few inches to a foot thick. However, another seam usually begins within a few feet, vertically. The coal seams average four to eight feet thick although individual seams may be from twelve to twenty feet thick (Kiersch, 1955, p. 51). Because some of the coal near the surface has either been burned out, cut out locally by erosion, or covered, only a detailed drilling program can indicate the presence, thickness, and depth of coal and provide fresh samples for testing. Using such a drilling program, Peabody Coal Company has found sufficient reserves of coal to justify entrance into long-term contractual arrangements as a coal supplier, the first such in Arizona.

Although the two Peabody mines on Black Mesa are managed as separate operations, the mining methods which have been outlined in "Mining Coal on Black Mesa" (Peabody Coal Co., 1970), are essentially the same.

Coal on Black Mesa is close enough to the surface to be removed through surface or strip mining methods, which permit 100 percent recovery of the mineral. At some points the coal seams reach the surface, but in most areas they are covered by shale and rock up to 120 feet deep.

The underground coal seams vary from 4 feet to 30 feet thick. To reach them, the overlying rock and shale, known as overburden, is stripped away by dragline equipment.

In mid-1976 three draglines, one each of 14-yard, 30-yard, and 36-yard capacity, were being used at the Black Mesa No. 1 mine. A single 85-yard unit was in operation at the Black Mesa No. 2 mine. Also, two 90-cubic-yard draglines were under construction, one for each mine.

The coal is then mined and loaded by power shovels into off-highway trucks which can haul up to 120 tons at a time. Fifteen such haulers carry coal from the open mine to the processing centers.

The processing centers consist of truck receiving hoppers, systems of conveyors, and rotary breakers which reduce the coal to two-inch size and remove rock and other extraneous material. The systems also include sampling and weighing facilities. Water spray systems have been installed to avoid coal dust problems where trucks are unloaded and at the stockpile sites.

Power lines have been built to bring in electricity for the processing centers and the mining operations, where the power shovels and draglines are electrically powered. Small plots have been leveled to accommodate transformers, switch houses and oil circuit breakers. This equipment will be moved as mining progresses.

The company has identified 42 separate coal deposits, and mining operations will move to a new deposit as each active deposit is finally depleted.

These deposits lie under a total of nearly 14,000 acres within the 64,858-acre lease area. The coal areas, scattered throughout the lease territory, are the only sections where the surface will be affected. This means that an average of about 400 acres will be mined in any one year.

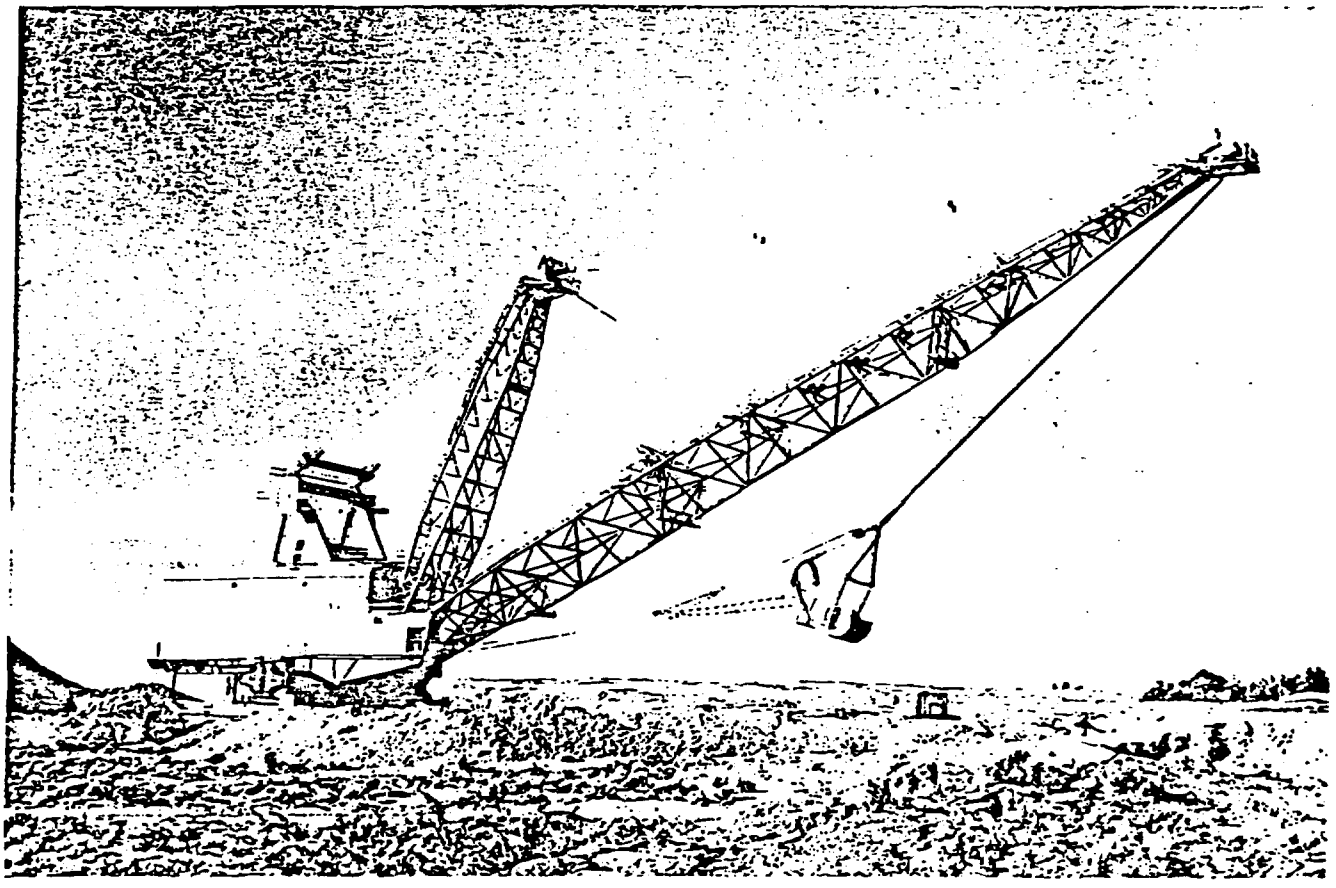
Although current annual production (1976), all of which is shipped to the two generating stations, is estimated to be about 9.8 million tons per year, scheduled production is designed to be at a rate of between 12 and 13 million tons per year. Over the 35-year expected lifespan of the operations, approximately 415 million tons of coal will be produced and converted into electrical energy. The total design generating capacity of the two plants is 3,760 megawatts, of which approximately 1,122 megawatts, or 30 percent, is available to serve customers in Arizona.

To perhaps put this into proper perspective, the combined generating capacity of the two plants is sufficient to meet the normal needs of a city of 3,750,000 people, or more than enough to supply the 2,295,000 people living in Arizona in 1976. Extrapolating from data in the Arizona Statistical Review (1976), the average demand in August, the peak month of 1976, amounted to some 3,600

megawatts and the peak demand probably exceeded 6,000 megawatts.

Arizona's population increased by approximately 29 percent between 1970 and 1976, and if this trend continues at anything like the same rate, it is readily apparent that Arizona's energy requirements will also grow rapidly. In such an event, there is little doubt that Black Mesa coal will become very important to Arizona as a source of this energy.

During field seasons in 1975 and 1976, the Arizona Bureau of Mines, through the support of a grant from the U.S. Geological Survey (Contract #14-08-0001-G-216), collected representative samples of these important coal deposits being mined on Black Mesa and submitted them to the U.S. Geological Survey for analysis. The specific sample locations are recorded in Table 1. Tables 2 through 5 give the results of the analyses.



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TABLES OF ANALYSES

by
U.S. Geological Survey
Denver, Colorado 80225

TABLE 1

Sample No. Lab. No.	Field No.	Seam	Location (Protracted) ¼, ¼, ¼, Sec.; Twnshp.; Range*	Sample Interval
D176225	KMA1	Green	NW, NW, SW, 9, 36N, 18E	Full Seam (5′)
D176226	KMA2	Green	NE, SW, NW, 9, 36N, 18E	Full Seam (5′)
D176227	KMB1	Blue	SW, SE, SE, 8, 36N, 18E	Upper 5′
D176228	KMB2	Blue	SW, SE, SE, 8, 36N, 18E	Lower 5′
D176229	KMB3	Blue	NW, SE, SE, 8, 36N, 18E	Upper 5′
D176230	KMB4	Blue	NW, SE, SE, 8, 36N, 18E	Lower 5′
D176231	BMM1	Red	NE, NW, NW, 4, 35N, 18E	Upper 5′
D176232	BMM2	Red	NE, NW, NW, 4, 35N, 18E	Upper Middle 5′
D176233	BMM3	Red	NE, NW, NW, 4, 35N, 18E	Lower Middle 5′
D176234	BMM4	Red	NW, NW, NW, 4, 35N, 18E	Lower 5′
D176235	BMM5	Red	SW, SW, SW, 27, 36N, 18E	Upper 5′
D176236	BMM6	Red	SW, SW, SW, 27, 36N, 18E	Upper Middle 5′
D176237	BMM7	Red	SW, SW, SW, 27, 36N, 18E	Lower Middle 5′
D176238	BMM8	Red	SW, SW, SW, 27, 36N, 18E	Lower 5′
D176239	Page Composite (Grab sample of Navajo Generating Station feed on June 9, 1975)			
D176240	Page Fly Ash (No Analyses)			
[redacted]	[redacted]			

*Gila and Salt River Base and Meridian

TABLE 2

Proximate, ultimate, Btu, and forms of sulfur analyses of seven samples from Arizona

[All analyses except Btu are in percent. Original moisture content may be slightly more than shown because samples were collected and transported in plastic bags to avoid metal contamination. Form of analyses: 1, as received; 2, moisture free; 3, moisture and ash free. All analyses by Coal Analysis Section, U.S. Bureau of Mines, Pittsburgh, Pa. Sample D176227* is a composite of samples D176227, D176228, D176229, and D176230; D176231* is a composite of samples D176231, D176232, D176233, and D176234; D176235* is a composite of samples D176235, D176236, D176237, and D176238]

		PROXIMATE ANALYSIS				ULTIMATE ANALYSIS							FORMS OF SULFUR		
Sample	Form of Analysis	Moisture	Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Btu	A. D. Loss	Sulfate	Pyritic	Organic
D176225	1	10.6	38.3	42.0	9.1	5.6	61.5	1.2	22.1	0.5	10770	2.3	0.01	0.04	0.49
	2	—	42.9	46.9	10.2	4.9	68.8	1.4	14.1	.6	12050	—	.01	.04	.55
	3	—	47.8	52.2	—	5.5	76.7	1.5	15.6	.7	13430	—	.01	.05	.61
D176226	1	9.3	40.8	41.4	8.5	5.7	63.5	1.1	20.7	.5	11100	1.8	.02	.07	.41
	2	—	44.9	45.8	9.3	5.1	70.0	1.2	13.8	.6	12240	—	.02	.08	.45
	3	—	49.6	50.4	—	5.6	77.2	1.4	15.2	.6	13500	—	.02	.08	.50
D176227*	1	9.3	40.1	45.3	5.3	5.7	66.1	1.2	21.3	.4	11560	1.7	.01	.01	.36
	2	—	44.2	50.0	5.8	5.1	72.9	1.3	15.4	.4	12750	—	.01	.01	.40
	3	—	47.0	53.0	—	5.4	77.4	1.4	15.3	.4	13530	—	.01	.01	.43
D176231*	1	10.2	41.2	43.9	4.7	5.9	65.6	1.1	22.4	.3	11470	2.5	.02	.02	.30
	2	—	45.8	49.0	5.2	5.3	73.0	1.2	14.9	.4	12760	—	.02	.02	.34
	3	—	48.4	51.6	—	5.6	77.0	1.3	15.7	.4	13470	—	.02	.02	.35
D176235*	1	8.6	40.0	42.3	9.1	5.4	63.2	1.1	20.7	.5	10910	1.7	.03	.05	.37
	2	—	43.8	46.3	9.9	4.9	69.2	1.2	14.3	.5	11940	—	.03	.05	.41
	3	—	48.6	51.4	—	5.4	76.8	1.3	16.0	.5	13250	—	.04	.06	.45
D176239	1	10.9	37.5	44.5	7.1	5.7	63.1	1.1	22.6	.4	10930	2.5	.02	.02	.39
	2	—	42.0	50.0	8.0	5.0	70.9	1.3	14.3	.5	12270	—	.02	.02	.44
	3	—	45.7	54.3	—	5.4	77.0	1.4	15.7	.5	13330	—	.02	.02	.47
D176241	1	21.9	31.4	39.6	7.1	6.3	54.5	.9	30.9	.3	9490	15.7	.10	.02	.17
	2	—	40.2	50.6	9.2	4.9	69.8	1.2	14.5	.4	12160	—	.13	.02	.21
	3	—	44.2	55.8	—	5.4	76.8	1.3	16.1	.4	13380	—	.14	.02	.23

TABLE 3

Major and minor oxide and trace-element composition of the laboratory ash of 16 coal samples from Black Mesa Field, Ariz.

[Values are in either percent or parts per million. The coals were ashed at 525°C. L after a value means less than the value shown, N means not detected, and B means not determined. S after the element title means that the values listed were determined by semiquantitative spectrographic analysis. The spectrographic results are to be identified with geometric brackets whose boundaries are 1.2, 0,83, 0.56, 0.38, 0.26, 0.18, 0.12, etc., but are reported arbitrarily as mid-points of those brackets, 1.0, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1, etc. The precision of the spectrographic data is approximately one bracket at 68-percent, or two brackets at 95-percent confidence]

Sample	Ash %	SiO_2 %	Al_2O_3 %	CaO %	MgO %	Na_2O %	K_2O %	Fe_2O_3 %	MnO %	TiO_2 %
D176225	12.5	55.	22.	4.0	1.29	1.46	1.3	5.6	0.015	1.0
D176226	10.8	45.	16.	12.	2.21	.70	.92	5.6	.016	.84
D176227	6.0	43.	17.	10.	1.73	3.37	.47	5.9	.017	1.2
D176228	3.5	24.	16.	14.	2.16	4.79	.32	10.	.018	1.0
D176229	9.3	47.	19.	8.8	1.34	2.40	.50	4.0	.012	1.3
D176230	4.4	28.	17.	14.	2.37	4.09	.36	8.8	.015	1.2
D176231	4.9	31.	13.	19.	4.17	.86	.60	8.0	.035	.93
D176232	5.9	23.	8.5	27.	2.89	1.19	.20	6.7	.028	.81
D176233	5.0	29.	13.	16.	3.47	1.89	.27	9.8	.028	.86
D176234	5.5	24.	10.	25.	2.52	2.23	.28	6.4	.017	.78
D176235	12.3	49.	15.	13.	1.33	:45	.86	4.5	.008	.98
D176236	7.4	27.	9.3	25.	3.07	.80	.28	5.7	.010	.85
D176237	10.0	59.	12.	7.7	2.29	.39	.98	4.6	.009	1.1
D176238	7.5	37.	16.	15.	2.54	.45	.52	5.6	.014	.97
D176239	7.9	46.	18.	9.0	1.98	2.12	.80	6.0	.015	.98
D176241	9.2	45.	13.	13.	2.16	1.19	.76	5.7	.023	.97

Sample	P_2O_5 %	SO_3 %	Cl %	Cd PPM	Cu PPM	Li PPM	Pb PPM	Zn PPM	Ag PPM-S	B PPM-S
D176225	1.0 L	6.0	0.20 L	1.0 L	58.	67.	25. L	69.	N	300
D176226	1.0 L	8.5	.20 L	1.0 L	62.	37.	25. L	40.	N	300
D176227	1.0 L	14.	.20 L	1.0 L	127.	50.	25.	23.	N	1000
D176228	1.0 L	23.	.20 L	1.0 L	89.	50.	30.	32.	N	1500
D176229	1.0 L	8.9	.20 L	1.0 L	90.	51.	40.	23.	N	300
D176230	1.0 L	19.	.20 L	1.0 L	87.	46.	40.	25.	N	1000
D176231	1.0 L	16.	.20 L	1.0 L	71.	29.	30.	136.	N	300
D176232	1.0 L	12.	.20 L	1.0 L	57.	20.	30.	60.	N	300
D176233	1.0 L	16.	.20 L	1.0 L	88.	38.	45.	107.	N	300
D176234	1.0 L	15.	.20 L	1.0 L	61.	28.	25.	118.	N	500
D176235	1.0 L	7.3	.20 L	1.0 L	60.	45.	25.	66.	N	200
D176236	1.0 L	11.	.20 L	1.0 L	60.	42.	40.	48.	N	300
D176237	1.0 L	8.4	.20 L	1.5	65.	39.	20.	150.	N	300
D176238	1.0 L	14.	.20 L	1.0 L	68.	72.	75.	42.	N	300
D176239	1.0 L	13.	.20 L	1.0 L	68.	44.	30.	81.	1	500
D176241	1.0 L	11.	.20 L	1.0 L	69.	36.	20.	102.	N	300

TABLE 3 (Continued)

Major and minor oxide and trace-element composition of the laboratory ash of 16 coal samples from Black Mesa Field, Ariz.

Sample	Ba PPM-S	Be PPM-S	Ce PPM-S	Co PPM-S	Cr PPM-S	Ga PPM-S	La PPM-S	Mo PPM-S	Nb PPM-S	Nd PPM-S
D176225	3000	7	500 L	15	70	30	100 L	15	20	150 L
D176226	3000	3	500 L	10	30	30	100 L	10	20 L	N
D176227	5000	7	500 L	15	30	30	100 L	15	20	N
D176228	5000	5	500 L	15	70	30	100 L	10	20	N
D176229	3000	7	500 L	15	30	50	100	15	20	150 L
D176230	10000	10	500 L	15	50	30	100 L	30	30	N
D176231	5000	N	500 L	15	50	30	100 L	7	20	N
D176232	5000	N	N	10	30	30	N	N	20	B
D176233	5000	7	500 L	20	30	30	150	30	20	150 L
D176234	7000	3	N	15	50	30	100 L	15	20	N
D176235	2000	3	N	15	30	30	100 L	10	20	N
D176236	7000	N	500 L	10 L	30	20	100 L	7	20	N
D176237	5000	15	500 L	30	70	30	100	7	30	150 L
D176238	3000	7	500 L	10	50	30	100 L	20	20	N
D176239	5000	7	500 L	15	50	30	100 L	7	20	N
D176241	3000	5	N	15	50	30	N	7	20	B

Sample	Ni PPM-S	Sc PPM-S	Sn PPM-S	Sr PPM-S	V PPM-S	Y PPM-S	Yb PPM-S	Zr PPM-S
D176225	30	20	N	2000	150	30	3	200
D176226	30	15	N	700	70	50	3	200
D176227	30	15	70	2000	70	50	5	300
D176228	50	15	70	3000	100	50	5	200
D176229	20	20	N	1000	150	50	5	300
D176230	30	20	N	2000	100	70	7	150
D176231	30	15	N	1000	100	50	3	200
D176232	30	15	N	2000	70	20	2	150
D176233	70	20	N	1500	150	70	7	150
D176234	50	15	N	3000	100	30	3	150
D176235	50	15	N	700	70	50	3	300
D176236	30	15	N	2000	70	30	3	200
D176237	50	20	N	1000	70	100	10	300
D176238	30	15	N	700	100	50	3	150
D176239	30	15	N	700	100	50	5	200
D176241	50	15	N	700	150	50	5	200

TABLE 4

Major, minor, and trace-element composition of 16 coal samples from Black Mesa Field, Ariz., reported on whole-coal basis

[Values are in either percent or parts per million. Si, Al, Ca, Mg, Na, K, Fe, Mn, Ti, P, Cl, Cd, Cu, Li, Pb, and Zn values were calculated from analysis of ash. As, F, Hg, Sb, Se, Th, and U values are from direct determinations on air-dried (32°C) coal. The remaining analyses were calculated from spectrographic determinations on ash. L after a value means less than the value shown, N means not detected, and B means not determined]

Sample	Si %	Al %	Ca %	Mg %	Na %	K %	Fe %	Mn PPM	Ti %	P PPM
D176225	3.2	1.4	0.36	0.098	0.135	0.13	0.49	15.	0.078	550. L
D176226	2.3	.94	.93	.144	.056	.082	.43	13.	.055	470. L
D176227	1.2	.54	.43	.062	.150	.023	.25	8.1	.043	260. L
D176228	.39	.29	.35	.046	.124	.009	.25	4.9	.021	150. L
D176229	2.1	.94	.58	.075	.166	.039	.26	8.8	.072	410. L
D176230	.58	.39	.44	.063	.133	.013	.27	5.1	.032	190. L
D176231	.70	.34	.66	.123	.031	.024	.27	13.	.027	210. L
D176232	.62	.27	1.1	.103	.052	.010	.28	13.	.029	260. L
D176233	.69	.34	.57	.105	.070	.011	.34	11.	.026	220. L
D176234	.61	.29	.98	.084	.091	.013	.25	7.2	.026	240. L
D176235	2.8	.99	1.1	.098	.041	.089	.38	7.4	.072	540. L
D176236	.92	.36	1.3	.137	.044	.017	.30	5.9	.038	320. L
D176237	2.8	.65	.55	.138	.029	.081	.32	7.0	.066	440. L
D176238	1.3	.64	.80	.115	.025	.033	.29	7.9	.044	330. L
D176239	1.7	.76	.51	.094	.124	.052	.33	9.1	.046	340. L
D176241	1.9	.61	.85	.120	.081	.058	.37	17.	.053	400. L

Sample	Cl %	As PPM	Cd PPM	Cu PPM	F PPM	Hg PPM	Li PPM	Pb PPM	Sb PPM	Se PPM
D176225	0.025 L	10.	0.1 L	7.3	50.	0.05	8.4	3.1 L	0.4	1.2
D176226	.022 L	1.	.1 L	6.7	35.	.05	4.0	2.7 L	.4	1.3
D176227	.012 L	1.	.1 L	7.6	50.	.03	3.0	1.5	.5	1.9
D176228	.007 L	1. L	.04 L	3.1	30.	.03	1.8	1.1	.2	1.4
D176229	.019 L	2.	.1 L	8.4	50.	.02	4.7	3.7	.3	2.1
D176230	.009 L	1.	.04 L	3.8	20. L	.02	2.0	1.8	.2	1.6
D176231	.010 L	1.	.05 L	3.5	20. L	.03	1.4	1.5	.1	1.5
D176232	.012 L	1. L	.1 L	3.4	25.	.02	1.2	1.8	.2	1.1
D176233	.010 L	1.	.05 L	4.4	20. L	.02	1.9	2.3	.4	2.1
D176234	.011 L	1.	.1 L	3.4	25.	.02	1.5	1.4	.2	1.6
D176235	.025 L	3.	.1 L	7.4	35.	.07	5.5	3.1	.6	1.9
D176236	.015 L	2.	.1 L	4.4	30.	.02	3.1	3.0	.1	1.4
D176237	.020 L	2.	.2	6.5	75.	.03	3.9	2.0	.1	1.8
D176238	.015 L	1.	.1 L	5.1	30.	.03	5.4	5.6	.4	1.5
D176239	.016 L	2.	.1 L	5.4	40.	.03	3.5	2.4	.2	1.5
D176241	.018 L	1.	.1 L	6.3	25.	.03	3.3	1.8	.3	1.5

TABLE 4 (Continued)

Major, minor, and trace-element composition of 16 coal samples from Black Mesa Field, Ariz., reported on whole-coal basis

Sample	Th PPM	U PPM	Zn PPM	Ag PPM-S	B PPM-S	Ba PPM-S	Be PPM-S	Ce PPM-S	Co PPM-S	Cr PPM-S
D176225	3.0 L	1.1	8.6	N	30	300	1	70 L	2	10
D176226	3.7	.6	4.3	N	30	300	.3	50 L	1	3
D176227	3.0 L	.2 L	1.4	N	70	300	.5	30 L	1	1.5
D176228	3.0 L	.2 L	1.1	N	50	150	.15	15 L	.5	2
D176229	3.0 L	1.0	2.1	N	30	300	.7	50 L	1.5	3
D176230	3.0 L	.2 L	1.1	N	50	500	.5	20 L	.7	2
D176231	3.0 L	.2 L	6.7	N	15	200	N	20 L	.7	2
D176232	3.0 L	.2 L	3.5	N	15	300	N	N	.7	1.5
D176233	3.0 L	.2 L	5.3	N	15	200	.3	20 L	1	1.5
D176234	3.0 L	.2 L	6.5	N	30	500	.15	N	.7	3
D176235	3.0 L	.9	8.1	N	20	200	.3	N	2	3
D176236	3.0 L	.5	3.6	N	20	500	N	30 L	.7 L	2
D176237	3.0 L	1.1	15.0	N	30	500	1.5	50 L	3	7
D176238	3.0 L	.6	3.2	N	20	200	.5	30 L	.7	3
D176239	3.0 L	.8	6.4	.07	50	500	.5	50 L	1	5
D176241	3.0 L	.5	9.4	N	30	300	.5	N	1.5	5

Sample	Ga PPM-S	La PPM-S	Mo PPM-S	Nb PPM-S	Nd PPM-S	Ni PPM-S	Sc PPM-S	Sn PPM-S	Sr PPM-S	V PPM-S
D176225	3	15 L	2	2	20 L	3	2	N	200	20
D176226	3	10 L	1	2 L	N	3	1.5	N	70	7
D176227	1.5	7 L	1	1	N	1.5	1	5	100	5
D176228	1	3 L	.3	.7	N	1.5	.5	2	100	3
D176229	5	10	1.5	2	15 L	2	2	N	100	15
D176230	1.5	5 L	1.5	1.5	N	1.5	1	N	100	5
D176231	1.5	5 L	.3	1	N	1.5	.7	N	50	5
D176232	1.5	N	N	1	B	1.5	1	N	100	5
D176233	1.5	7	1.5	1	7 L	3	1	N	70	7
D176234	1.5	5 L	.7	1	N	3	.7	N	150	5
D176235	3	15 L	1.5	2	N	7	2	N	100	10
D176236	1.5	7 L	.5	1.5	N	2	1	N	150	5
D176237	3	10	.7	3	15 L	5	2	N	100	7
D176238	2	7 L	1.5	1.5	N	2	1	N	50	7
D176239	2	7 L	.5	1.5	N	2	1	N	50	7
D176241	3	N	.7	2	B	5	1.5	N	70	15

Sample	Y PPM-S	Yb PPM-S	Zr PPM-S
D176225	3	0.3	20
D176226	5	.3	20
D176227	3	.3	15
D176228	1.5	.15	7
D176229	5	.5	30
D176230	3	.3	7
D176231	2	.15	10
D176232	1	.1	10
D176233	3	.3	7
D176234	1.5	.15	7
D176235	7	.3	30
D176236	2	.2	15
D176237	10	1	30
D176238	3	.2	10
D176239	5	.5	15
D176241	5	.5	20

TABLE 5

Content of seven trace elements in 16 coal samples from Black Mesa Field, Ariz.

[Analyses on air-dried (32°C) coal. All values are in parts per million. L after a value means less than the value shown]

Sample	As PPM	F PPM	Hg PPM	Sb PPM	Se PPM	Th PPM	U PPM
D176225	10.	50.	0.05	0.4	1.2	3.0 L	1.1
D176226	1.	35.	.05	.4	1.3	3.7	.6
D176227	1.	50.	.03	.5	1.9	3.0 L	.2 L
D176228	1. L	30.	.03	.2	1.4	3.0 L	.2 L
D176229	2.	50.	.02	.3	2.1	3.0 L	1.0
D176230	1.	20. L	.02	.2	1.6	3.0 L	.2 L
D176231	1.	20. L	.03	.1	1.5	3.0 L	.2 L
D176232	1. L	25.	.02	.2	1.1	3.0 L	.2 L
D176233	1.	20. L	.02	.4	2.1	3.0 L	.2 L
D176234	1.	25.	.02	.2	1.6	3.0 L	.2 L
D176235	3.	35.	.07	.6	1.9	3.0 L	.9
D176236	2.	30.	.02	.1	1.4	3.0 L	.5
D176237	2.	75.	.03	.1	1.8	3.0 L	1.1
D176238	1.	30.	.03	.4	1.5	3.0 L	.6
D176239	2.	40.	.03	.2	1.5	3.0 L	.8
D176241	1.	25.	.03	.3	1.5	3.0 L	.5

Tables 6 and 7 show comparative data on the content of various elements and oxides for Black Mesa and Rocky Mountain province coals. In these tables the geometric mean (GM) is used as the estimate of the most probable concentration (mode); the geometric mean is the antilog of the logarithms of concentrations. The measure of scatter about the mode used here is the geometric deviation (GD) which is the antilog of the standard deviation of the logarithms of concentration. These statistics are used because of the common tendency for the amounts of trace elements in natural materials to exhibit positively skewed frequency distributions; these distributions are normalized by analyzing and summarizing trace element data on a logarithmic basis.

If the frequency distributions are, in fact, log-normal, the geometric mean is the best estimate of the mode, and the estimated range of the central two-thirds of the observed distribution has a lower limit equal to GM/GD and an upper limit equal to GM·GD. The estimated range of the central 95 percent of the observed distribution has a lower limit equal to $GM/(GD)^2$ and an upper limit equal to $GM\cdot(GD)^2$ (Connor and others, 1976).

Although the geometric mean is, in general, an adequate estimate of the most common concentration, it is, nevertheless, a biased estimate of the arithmetic mean. In the summary tables of data, the estimates of the arithmetic means are Sichel's *t* statistic (Miesch, 1967). In this report the terms arithmetic mean, average value, and abundance are used synonymously.

A common problem in statistical summaries of trace element data arises when the element concentration in one or more of the samples lies below the limit of analytical detection, resulting in a censored distribution. Procedures developed by Cohen (1959) were used here to compute unbiased estimates of the geometric mean, geometric deviation, and arithmetic mean where the concentration data are censored.

TABLE 6a

Arithmetic mean, observed range, geometric mean, and geometric deviation of 15 major and minor oxides and trace elements in the ash of 26 Black Mesa field coal samples

[All samples were ashed at 525°C; L after a value means less than the value shown]

Oxide or element	Arithmetic mean (abundance)	Observed range Minimum	Observed range Maximum	Geometric mean (expected value)	Geometric deviation
Ash %	8.0	3.2	13.6	7.4	1.5
SiO_2 %	38	19	59	36	1.4
Al_2O_3 %	15	5.9	28	15	1.4
CaO %	15	3.4	27	13	1.7
MgO %	2.42	.75	6.11	2.20	1.5
Na_2O %	1.9	.39	4.79	1.45	2.1
K_2O %	.49	.1 L	1.3	.38	2.1
Fe_2O %	6.1	2.1	10	6.2	1.3
MnO %	.018	.008	.035	.016	1.5
TiO_2 %	1.0	.78	1.3	.98	1.2
SO_3 %	13	6.0	23	12	1.4
Cd ppm	1 L	1 L	2.0	1 L	3.0
Cu ppm	70	54	127	69	1.2
Li ppm	47	20	89	44	1.4
Pb ppm	31	20 L	75	29	1.5
Zn ppm	67	20	275	54	1.9

TABLE 6b

Arithmetic mean, observed range, geometric mean, and geometric deviation of 15 major and minor oxides and trace elements in the ash of 295 Rocky Mountain province coal samples

[All samples were ashed at 525°C; L after a value means less than the value shown]

Oxide or element	Arithmetic mean (abundance)	Observed range Minimum	Observed range Maximum	Geometric mean (expected value)	Geometric deviation
Ash %	13.3	1.76	88.2	10.9	1.9
SiO_2 %	46	15	79	44	1.4
Al_2O_3 %	21	4.3	35	19	1.4
CaO %	8.9	.21	35	6.2	2.4
MgO %	1.63	.22	7.10	1.4	1.8
Na_2O %	1.39	.08	8.56	.68	3.3
K_2O %	.65	.05	3.0	.45	2.3
Fe_2O_3 %	7.6	1.1	26	4.5	2.8
MnO %	.049	.004	.55	.029	2.8
TiO_2 %	.89	.02 L	1.8	.81	1.6
SO_3 %	8.4	.10 L	29	5.1	2.7
Cd ppm	.7	.5 L	4.0	.6	1.9
Cu ppm	87	22	1,260	77	1.6
Li ppm	88	10 L	328	73	1.9
Pb ppm	45	20 L	195	41	1.5
Zn ppm	77	13	1,820	62	1.9

TABLE 7b

Arithmetic mean, observed range, geometric mean, and geometric deviation of 36 elements in 295 Rocky Mountain province coal samples (whole-coal basis). For comparison, average shale values are listed (Turekian and Wedepohl, 1961)

[As, F, Hg, Sb, Se, Th, and U values used to calculate the statistics were determined directly on whole coal. All other values used were calculated from determinations made on coal ash. L means less than the value shown]

Element	Arithmetic mean (abundance)	Observed range Minimum	Observed range Maximum	Geometric mean (expected value)	Geometric deviation	Average shale
Si %	3.2	0.9	23	2.3	2.3	7.3
Al %	1.6	.14	13	1.1	2.3	8.0
Ca %	.61	.05	3.7	.48	2.0	2.21
Mg %	.107	.015	.76	.089	1.8	1.55
Na %	.155	.002	.76	.055	4.2	.96
K %	.092	.003	1.7	.041	3.6	2.66
Fe %	.64	.10	4.2	.34	3.1	4.72
Mn ppm	33	2.7	492	20	2.6	850
Ti %	.062	.001 L	.54	.047	2.1	.46
As ppm	2	1 L	50	2	2.5	13
Cd ppm	.08	.021	.50	.05	2.7	.3
Cu ppm	10.8	1.3	100	8.4	2.0	45
F ppm	95	20 L	920	69	2.2	740
Hg ppm	.08	.01	1.48	.05	2.4	.4
Li ppm	13	.44 L	82.9	8.0	2.7	66
Pb ppm	6.5	.95	62	4.7	2.2	20
Sb ppm	.4	.05 L	5.2	.3	2.2	1.5
Se ppm	1.6	.10 L	5.7	1.2	2.1	.6
Th ppm	4.2	1.7	34.8	2.9	2.5	12
U ppm	1.9	.1	23.8	1.1	2.8	3.7
Zn ppm	10.7	1.0	380	6.8	2.6	95
B ppm	70	7	300	70	2.2	100
Ba ppm	300	3	1,500	150	2.6	580
Be ppm	.7	.05	3	.5	2.3	3
Co ppm	2	.3	10	1.5	2.0	19
Cr ppm	5	.5	70	5	2.2	90
Ga ppm	5	.3	30	3	2.3	19
Mo ppm	2	.2	15	1.5	2.3	2.6
Nb ppm	1	.3	30	.5	2.6	11
Ni ppm	3	.7	20	2	2.1	68
Sc ppm	2	.3	15	1.5	2.0	13
Sr ppm	100	5	700	100	2.1	300
V ppm	15	1.5	100	100	2.1	130
Y ppm	7	.5	30	5	2.1	26
Yb ppm	.7	.03	3	.5	2.2	2.6
Zr ppm	30	3	100	20	2.3	160

TABLE 7a

Arithmetic mean, observed range, geometric mean, and geometric deviation of 36 elements in 26 Black Mesa coal samples (whole-coal basis). For comparison, average shale values are listed (Turekian and Wedepohl, 1961)

[As, F, Hg, Sb, Se, Th, and U values used to calculate the statistics were determined directly on whole coal. All other values used were calculated from determinations made on coal ash. L means less than the value shown]

Element	Arithmetic mean (abundance)	Observed range Minimum	Observed range Maximum	Geometric mean (expected value)	Geometric deviation	Average shale
Si %	1.6	0.28	3.3	1.2	2.0	7.3
Al %	.69	.21	1.8	.57	1.8	8.0
Ca %	.78	.28	1.3	.70	1.6	2.21
Mg %	.104	.046	.245	.098	1.4	1.55
Na %	.093	.025	.166	.079	1.8	.96
K %	.037	.004	.13	.024	2.5	2.66
Fe %	.31	.18	.53	.31	1.2	4.72
Mn ppm	9.7	4.9	16	9.0	1.5	850
Ti %	.046	.021	.078	.042	1.5	.46
As ppm	2	1 L	10	1	1.9	13
Cd ppm	.1 L	.03L	.23	1 L	1.4	.3
Cu ppm	5.5	2.3	11.7	5.1	1.5	45
F ppm	51	20 L	100	41	1.9	740
Hg ppm	.04	.02	.08	.03	1.6	.4
Li ppm	3.9	1.2	10.5	3.2	1.8	66
Pb ppm	2.7	1.0	5.6	2.4	1.7	20
Sb ppm	.3	.1	.6	.2	1.7	1.5
Se ppm	1.6	.7	3.1	1.5	1.4	.6
Th ppm	2.2	2.1	4.6	2.0	1.6	12
U ppm	.6	.2 L	1.1	.4	2.7	3.7
Zn ppm	5.6	1.1	32.5	4.0	2.3	95
B ppm	20	15	70	20	1.6	100
Ba ppm	300	150	500	300	1.5	580
Be ppm	.5	.15L	1.5	.3	2.5	3
Co ppm	1.5	.5	7	1	1.9	19
Cr ppm	3	1	10	3	1.7	90
Ga ppm	2	.7	7	2	1.8	19
Mo ppm	1	.3 L	2	.7	1.8	2.6
Nb ppm	1.5	.7	3	1	2.0	11
Ni ppm	2	.7	10	2	1.9	68
Sc ppm	1.5	.5	2	1	1.5	13
Sr ppm	150	30	500	100	1.9	300
V ppm	7	3	20	7	1.6	130
Y ppm	3	1	10	3	1.8	26
Yb ppm	.3	.1	1	.3	1.7	2.6
Zr ppm	15	3	70	15	1.9	160