150
5-29-84 JS (1)

DR# 0044-2

DOE/OR/03054-85
(DE84010110)

Energy

F
O
S
S
I
L

AQUIFER CHARACTERIZATION PROPOSED SRC-I FACILITY
NEWMAN, KENTUCKY

By
Dames & Moore

January 1984

Work Performed Under Contract No. AC05-78OR03054

International Coal Refining Company
Allentown, Pennsylvania

Technical Information Center
Office of Scientific and Technical Information
United States Department of Energy

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

This report has been reproduced directly from the best available copy.

Available from the National Technical Information Service, U. S. Department of Commerce, Springfield, Virginia 22161.

Price: Printed Copy A05
Microfiche A01

Codes are used for pricing all publications. The code is determined by the number of pages in the publication. Information pertaining to the pricing codes can be found in the current issues of the following publications, which are generally available in most libraries: *Energy Research Abstracts (ERA)*; *Government Reports Announcements and Index (GRA and I)*; *Scientific and Technical Abstract Reports (STAR)*; and publication NTIS-PR-360 available from NTIS at the above address.

AQUIFER CHARACTERIZATION
PROPOSED SRC-I FACILITY
NEWMAN, KENTUCKY

Prepared by
Dames & Moore

for the

UNITED STATES DEPARTMENT OF ENERGY
Office of Solvent-Refined Coal Products
under Contract DE-AC05-78-OR-03054

Printed in the United States of America

Available from •

National Technical Information Service

5285 Port Royal Road

Springfield, VA 22161

NTIS price codes

Printed copy: A05

Microfiche copy: A01

ABSTRACT

Dames & Moore conducted a two-phase groundwater supply and aquifer characterization study on a portion of the proposed Solvent-Refined Coal (SRC-I) Demonstration Plant site at Newman, Kentucky. The objectives were to assess the transmissivity, hydraulic conductivity, and storability of the aquifer in the vicinity of the test well, and to determine the aquifer characteristics beneath the proposed facility.

TABLE OF CONTENTS

	<u>Page</u>
INTRODUCTION	1
HYDROGEOLOGICAL SITE ASSESSMENT	3
Test Borings	3
Site Hydrogeological Conditions	5
THE PRODUCTION TEST WELL	5
Test Well Location and Observation Well Layout	5
Production Well Installation	9
Aquifer Pumping Test	14
AQUIFER PUMPING TEST RESULTS	16
Pumping Well Performance Evaluation	16
Aquifer Performance Evaluation	16
Groundwater Quality	19
Quality Assurance	20
RECOMMENDATIONS	20
CONCLUSIONS	23
LITERATURE CITED	24
APPENDIX A	BORING LOG - L-10
APPENDIX B	GRADATION CURVES
APPENDIX C	TIME DRAWDOWN PLOTS
APPENDIX D	PUMP TEST DATA
APPENDIX E	STANDARD METHODS
APPENDIX F	LABORATORY RESULTS
APPENDIX G	QUALITY ASSURANCE AUDITS

INTRODUCTION

This report presents the results of a groundwater supply and aquifer characterization investigation performed on a portion of the proposed Solvent-Refined Coal (SRC-I) Demonstration Plant site at Newman, Kentucky. The overall objective of this investigation was to provide an assessment of the transmissivity, hydraulic conductivity, and storability of the aquifer in the vicinity of a test well, and, if possible, to determine the aquifer characteristics beneath the proposed facility. This information was then used to determine if the aquifer underlying the proposed SRC-I facility was capable of supplying water to it that was of sufficient quantity and quality to satisfy the potable water requirements. A sustained yield of 300 gal/min (gpm) from a single production well was required to meet this objective.

As originally proposed, the study was to be conducted in two phases. The first phase was to investigate a proposed well site in the southeast corner of the plant site (Figure 1) and determine its suitability for aquifer development. Three exploratory borings were to be drilled to supplement the stratigraphic information for this area. On February 17, 1982, International Coal Refining Company (ICRC) changed this proposed well location to the final site of the production well (Figure 1), where more stratigraphic information was available from previous reports (ATEC, 1979; Dames & Moore, 1981) and from ongoing Dames & Moore investigations.

The new location on the eastern edge of the proposed facility was chosen to 1) take advantage of induced infiltration from the Green River, 2) remove the water supply well from the proximity of the proposed hazardous waste disposal area, and 3) move the well away from a possible impermeable boundary resulting from a clay body between the site and the Green River. After completion of a boring program to delineate the areal extent of the clay body, Dames & Moore determined that the limited extent of the body would have little impact on the water supply capability and the extent of the cone of depression. The well site was then relocated to its final position near the proposed water distribution and handling system.

Boring L-10 was drilled within 10 ft of the proposed production test well to characterize the planned well site. In addition, six observation wells were installed at the end of Phase 1 to provide water level observation points for the aquifer pumping test.

The second phase included the design, installation, testing, and evaluation of the test well. The well was designed and installed as a permanent structure, and will serve as the potable water supply for the SRC-I facility.

HYDROGEOLOGICAL SITE ASSESSMENT

Test Borings

The initial hydrogeological investigation consisted of reviewing the geologic data resulting from the previous 27 borings, the installation of 16 observation wells at the SRC-I site (Dames & Moore, 1982), and boring data from a earlier geotechnical report (ATEC, 1979). A review of the boring logs and the geohydrologic information from these investigations indicated that the aquifer was fairly uniform in this area, and that the clay unit bordering the river was not as extensive as preliminary estimates had indicated.

Boring L-10 was then drilled to evaluate the thickness and character of the aquifer at this site and to provide soil samples for sieve analysis. Boring L-10 was drilled with a truck-mounted rotary auger rig using 6-in. hollow stem augers. The boring was sampled at 5-ft intervals using a split spoon sampler driven by a 140-lb weight dropped 30 in. as per ASTM D-1586 specifications. Boring samples were logged in the field and visually classified using the Unified Soil Classification System (Wagner, 1957) (Figure 2) and the Munsell Soil Color Charts (Kollmorgan Corp., 1975). Representative samples were collected in clean jars with the boring depth and sample number clearly labeled. The field classifications were supplemented in the laboratory by sieve analysis and visual classification (Appendix A). The resulting sand gradation analyses were used to design the production well screen and gravel pack. The boring was then equipped as an observation well for the aquifer test.

BY _____ DATE _____
 CHECKED BY _____

 REVISIONS
 BY _____ DATE _____

FILE _____

MAJOR DIVISIONS			GRAPH SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
			GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM
	GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SAND AND SANDY SOILS		CLEAN SAND (LITTLE OR NO FINES)		SW
		SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND-SILT MIXTURES
	SC	CLAYEY SANDS, SAND-CLAY MIXTURES	
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS.

SOIL CLASSIFICATION CHART

 INTERNATIONAL COAL
 REFINING COMPANY
 Newman, Ky.

Figure 2. Unified Soil Classification Chart

Dames & Moore

PLATE

Site Hydrogeological Conditions

Subsurface conditions at the SRC-I site were shown to be favorable for groundwater development. The ground surface elevation is nearly uniform at 389 ft mean sea level (MSL) for the entire test well site.

The test well site is underlain by a yellowish brown silty clay to 10.5 ft, which overlies the sand and gravel of the aquifer. The aquifer is unconfined and consists of a poorly sorted yellowish brown fine to medium sand, which grades to a poorly sorted grayish brown fine to medium sand with a trace of coarse sand and gravel below 51.5 ft. The aquifer becomes coarser with more gravel to its interface with Pennsylvania shale at 125.0 ft.

The aquifer is 114.5 ft thick and, at the time of the test, it had a saturated thickness of 96.5 ft. The top of the bedrock lies at an elevation of 264 ft mean sea level, 75 ft below normal pool in the Green River. A generalized geologic log of the aquifer at the test site is shown in Figure 3.

THE PRODUCTION TEST WELL

Test Well Location and Observation Well Layout

The test well location was chosen by International Coal Refining Company based on the preferred location recommended by the Rust Engineering Company. This was done after a boring program by Dames & Moore indicated that the actual extent of a clay unit previously identified along the Green River was of limited importance to the preferred well site (Figure 4).

Once the location was defined, Boring L-10 was drilled to determine the subsurface conditions near the coordinates provided by International Coal Refining Company (N 544,806 and E 1,547,807, Kentucky Plan Coordinate System). A pattern of six additional observation wells was drilled to monitor the aquifer response to the pumping of the test well (Figure 5). These wells were installed in two rows, one perpendicular and the other parallel to the river. The line of wells parallel to the river was designated the "parallel" row and consisted of observation wells P-10, P-50, and P-100, located approximately 10, 50, and 100 ft west of the pumping well, respectively. The "river" row consisted of

GEOLOGIC LOG

CONSTRUCTION RECORD

Depth Below Ground Surface (Feet)

Elevation in Feet Above Sea Level

Depth in Feet

PRODUCTION WELL
Elevation of Ground Surface - 388.82 MSL

Kentucky Plane Coordinates

N- 544,806
E- 1,547,807

INTERNATIONAL COAL
REFINING COMPANY
Newman, Ky.
Figure 3. Composite Boring Log &
Well Construction Details
for Production Well
Dames & Moore

BY _____ DATE _____
 CHECKED BY _____ FILE _____
 REVISIONS BY _____ DATE _____

BY _____ DATE _____
 CHECKED BY _____

FILE _____

REVISIONS
 BY _____ DATE _____

wells R-10, R-50, and R-100, located approximately 10, 50, and 100 ft, respectively, south of the pumping well and perpendicular to the Green River. Boring L-10 was also completed as an observation well and is located 10 ft north of the pumping well. All of these observation wells were screened within the screened interval of the production well at a depth of 113-118 ft except L-10, which was screened at 119-124 ft. The variation in the screened interval is insignificant since the production well fully penetrates the aquifer, and flow lines are essentially perpendicular to the screen.

In addition to these seven wells, observation wells PVC-1 and 315, installed during earlier investigations, were utilized as observation wells during the aquifer test. Boring 315, however, was vandalized 1 day after the aquifer pumping test had begun and could no longer be used as a monitoring location.

The observation well drilling procedure was identical to that employed in the test boring except that the observation wells were sampled only within the screened interval. Each observation well is constructed of a 5-ft section of PVC screen and cased with PVC pipe to the surface. Well elevations were tied into the U.S. Geological Survey "Hensley" Benchmark located approximately 2 mi north of the site. Specifications for the observation wells are shown in Table 1 and a typical observation well design is shown in Figure 6.

Groundwater levels were measured in wells PVC-1, P-50, and 315 before the test to determine trends in water levels within the test site. Antecedent water levels for the 3 days before the test are shown in Table 2.

Production Well Installation

Samples of the aquifer material were delivered by Dames & Moore personnel to Milton M. Greenbaum Associates, Inc. of Louisville, Kentucky, for grain size analysis. Results from these tests were used in designing the well screen and selecting the gravel pack gradation. A clean silica sand (Parry No. 5) was selected as the gravel pack. Grain size distribution of the gravel pack material and gradation curves for typical samples of the aquifer are shown in Figure 7. (See also Appendix B.) A screen slot size opening was selected that would exclude

TABLE 1
SPECIFICATIONS FOR OBSERVATION WELLS

Observation Well Number	Distance From Test Well (ft)	Elevation of Reference (ft) ^a	Static Water level on 4/14/82 (ft below reference) ^b	Slotted Interval (ft below ground surface) ^c
Test Well	0.0	389.58	28.28	105-125
L-10	9.7	389.70	28.78	119-124
P-10	11.3	389.95	29.12	113-118
P-50	51.6	389.92	28.55	113-118
P-100	101.3	389.94	28.67	113-118
R-10	10.5	389.99	28.64	113-118
R-50	51.4	389.75	28.46	113-118
R-100	100.8	389.86	28.75	113-118
PVC-1	1337.6	391.44	29.40	31- 51
315	697.8	369.28	10.15	66- 70

^a Mean Sea level (top of casing)

^b Static Water levels taken immediately prior to start of 48-hour aquifer pumping test

^c Typical observation well design is illustrated on Figure 6

BY _____ DATE _____
 CHECKED BY _____

FILE _____

REVISIONS
 BY _____ DATE _____

INTERNATIONAL COAL
 REFINING COMPANY
 Newman, Ky.

Figure 6.

Typical Observation Well
 Dames & Moore

TABLE 2
ANTECEDENT WATER LEVEL TRENDS

<u>Observation Well Number</u>	<u>Ground Water Elevation</u>		
	<u>4/12/82</u>	<u>4/13/82</u>	<u>4/14/82</u>
PVC-1	362.09	362.05	362.04
315	359.72	359.35	359.13
R-50	361.27	361.29	361.17
Green River	353.9	353.1	352.6

REVISIONS
 BY _____ DATE _____
 BY _____ DATE _____
 FILE _____
 BY _____ DATE _____
 CHECKED BY _____

INTERNATIONAL COAL
 REFINING COMPANY
 Newman, Ky.
 Figure-7. Typical Gradation Curves
 for
 Aquifer Strata & Gravel Pack
 Dames & Moore

90% of the gravel pack material, which for the Parry No. 5 gravel was a slot size of 40 thousandths of an inch (40 slot). The 12-in.-diam, stainless steel, pipe-size screen fabricated for this well is 20 ft in length and provides 99 in.² of open area per lineal foot of screen. It is manufactured by the Johnson Division, UOP Inc., of St. Paul, Minnesota.

The production well was drilled to a total depth of 126 ft below ground surface on April 9, 1982. The drilling was performed by Reynolds Supply of Louisville, Kentucky with a reverse circulation rotary rig utilizing a 24-in roller bit. The screen and casing were installed to a total depth of 125 ft. The annular space between the casing and the outside of the drill hole was packed with clean silica sand. A geologic log and construction diagram of the well are shown in Figure 3.

The well was developed by using both mechanical and air surging on April 12-13, 1982. A liquefied solution of sodium tripolyphosphate and "HTH" was injected into the well before development to sterilize the screen and gravel pack. Development continued until the water produced from the well was clear and free of sand. At the conclusion of development, a solution of "HTH" with 70% available chlorine was applied to further sterilize the well. After completion of the sterilization process, the well was pumped clean and the chlorine/water solution was discharged to the Green River.

Aquifer Pumping Test

A step drawdown test was conducted on April 14, 1982. The well was pumped at 225, 346, and 513 gpm, and each rate was held constant until drawdown stabilized. These discharge rates were chosen to bracket the proposed 300-gpm discharge rate. The static water level before the start of pumping was 28.28 ft below the top of the casing. At the end of the test, after 15 min of pumping at 513 gpm, the dynamic pumping level was 36.91 ft, or a drawdown of 8.63 ft. The aquifer was allowed to recover in preparation for the constant rate pumping test. An analysis of the step test data indicated that a discharge at the proposed 300-gpm rate would create a shallow cone of depression near the well, and Dames & Moore decided to pump the well at 513 gpm (the maximum

capability of the temporary test pump) to allow greater drawdown (hydraulic stress) on the aquifer for the duration of the 48-hr pumping test. The step test also indicated that the hydraulic response was adequate in the observation wells, which were checked intermittently during the test. Only three discharge rates were used instead of the 4 to 5 indicated in the Technical Program Plan due to the data obtained and the limited size of the pump discharge after the high-pumping-rate, long-term test.

Discharge for the test was controlled by a gate valve on the pump discharge line, which consisted of a 6-in.-diam hose that carried the discharge water to the Green River, thus ensuring that the discharge would not recharge the aquifer and influence the test. A 6-in.-diam pipe with a 4-in. orifice equipped with a manometer tube was installed at the end of the discharge hose to measure the pumping rate. Discharge rates were determined utilizing tables developed at the Engineering School of Purdue University (1949) with an accuracy of $\pm 2\%$ obtained using this orifice and manometer setup (UOP, 1980). The 48-hr aquifer pumping test began at 2:00 PM on April 14, 1982. Groundwater levels were measured in all the observation wells and in the pumping well immediately before pumping. The pumping rate was held as closely as possible to 513 gpm throughout the 2-day test and was monitored frequently. Wells L-10, P-10, P-50, P-100, R-10, R-50, and R-100 were also monitored frequently for water level changes. In addition, pumping well PVC-1 and Boring 315 were monitored during the test, although less frequently than the others.

The pump was shut down at 2:20 PM on April 16, 1982, after the 48-hr test was completed. Groundwater recovery was then monitored in L-10, P-10, R-10, R-50, and the pumping well. (All aquifer test measurements and time-drawdown plots are included in Appendices C and D.)

Groundwater samples were obtained from the discharge pipe after the start of pumping, and were delivered daily to McCoy & McCoy Laboratories of Madisonville, Kentucky for analysis.

AQUIFER PUMPING TEST RESULTS

Pumping Well Performance Evaluation

Specific capacity data from the step test and 48-hr pumping test are presented in Table 3, and are included for determination of historical well performance at some future time. Well efficiency was 73%, as determined by the calculated values of specific yield and transmissivity in the Theis equation (Lohman, 1974). This value indicates that the well is properly designed and developed.

At the end of the 2-day pumping test, the specific capacity of the test well was 55 gpm per foot of drawdown. A stable value was not obtained due to the short time of the pumping test.

Aquifer Performance Evaluation

Results of the pumping test were analyzed using the semilogarithmic Neuman method for anisotropic unconfined aquifers considering a delayed gravity response (a modified Jacob method of analysis) (Neuman, 1965). This method was used with Neuman's curve-matching procedure (Neuman, 1965) and Stallman's curve-matching method (Lohman, 1974) to obtain values of transmissivity, hydraulic conductivity, and specific yield. In addition, the Neuman methods allow for the determination of both the vertical and horizontal hydraulic conductivity.

The semilogarithmic method entailed plotting the drawdown versus time on semilog paper; the other methods involved matching a full logarithmic plot of drawdown versus time to type curves. Calculated values of transmissivity are listed in Table 4; an average value of 104,142 gal/day/foot (gpd/ft) was selected to represent the aquifer at the well site. Calculation of transmissivity from the wells situated 100 ft from the pumping well was not possible because the effects of delayed gravity drainage had not dissipated in these wells at the conclusion of the 48-hr aquifer pumping test.

An average saturated thickness of 96.5 ft for the aquifer provides an average horizontal hydraulic conductivity of 1,079 gpd/ft² (0.10 ft/min). An average value for the vertical hydraulic conductivity as obtained from an analysis of the data is 86 gpd/ft² (0.008 ft/min), and an average specific yield of 0.30 is indicated for the aquifer. In

TABLE 3
SPECIFIC CAPACITY DATA
PRODUCTION WELL

<u>Date</u>	<u>Pumping Period (minutes)</u>	<u>Pumping Rate (gpm)</u>	<u>Maximum Drawdown (ft)</u>	<u>Specific Capacity (gpm/ft)</u>
April 14, 1982	28	225	3.33	67.6
April 14, 1982	23.5	346	5.40	64.1
April 14, 1982	12.5	513	8.63	59.4
April 14, 1982	230	517	8.78	58.9
April 14, 1982	341	513	8.81	58.2
April 15, 1982	1077	517	8.94	57.8
April 15, 1982	1920	517	9.25	55.9
April 16, 1982	2085	518	9.07	57.1
April 16, 1982	2715	513	9.32	55.0

Note: Specific Capacity = $\frac{\text{Pumping rate (gpm)}}{\text{drawdown (ft)}}$

TABLE 4
VALUES OF TRANSMISSIVITY FROM 48-HOUR
PUMPING TEST DATA

<u>Observation Point</u>	<u>Method of Analysis</u>	<u>Apparent Transmissivity (gpd/ft)</u>
Pumping Well	(a)	100,280
P-10	(a)	117,622
P-10	(b)	114,713
P-10	(c)	106,312
R-10	(c)	105,019
R-10	(a)	103,401
R-10	(b)	101,896
L-10	(c)	106,635
L-10	(b)	99,849
P-50	(c)	90,478
P-50	(a)	101,034
P-50	(b)	102,650
R-50	(c)	101,034
R-50	(b)	<u>107,065</u>
Average		104,142

(a) Neuman, 1965 - curve matching method

(b) Neuman, 1965 - semi-log method (modified Jacob)

(c) Stallman, 1965 - curve matching method (In Lohman, 1974)

coarse-grained material, particle shape and orientation and the sedimentation process usually result in a larger horizontal than vertical hydraulic conductivity.

Groundwater Quality

Groundwater quality was determined by obtaining samples through the manometer tube at the pump discharge orifice. Samples were collected after 24, 30, 36, 42, and 48 hr of pumping, and at 6 and 12 hr after the well was pumped for an additional 12 hr following the recovery test.

The samples were collected in clean glass and plastic containers as supplied by McCoy & McCoy Laboratories and returned to the laboratory within 24 hr of sampling. The samples were not filtered or preserved in the field. Temperature, pH, dissolved oxygen, conductivity, and free CO₂ measurements were performed in the field utilizing a properly calibrated hydrolab for all of the above except the free CO₂, which was measured by the Bausch and Lomb CO₂ spectrokit filtration method. Samples were labeled and stored on ice until they were delivered to the laboratory by Dames & Moore personnel. Methods used by McCoy & McCoy Laboratories in analyzing the water samples are listed in Appendix E. The following additional parameters were to be analyzed by McCoy & McCoy as stipulated in Dames & Moore's Purchase Order:

Total organic carbon	2,4-D
Endrin	2,4,5-TP
Lindane	Radium
Methoxychlor	Gross alpha
Toxaphene	Gross beta
Methyl orange alkalinity	Phenolphthalein alkalinity

However, because of a misunderstanding with McCoy & McCoy, these analyses were not performed. Dames & Moore did not discover the problem until after the storage time for the above parameters had been exceeded and analysis was useless.

The analyses that were performed showed that the groundwater is generally within the U.S. EPA Interim Primary (June 24, 1977) and Secondary (January 19, 1981) Drinking Water Standards promulgated pur-

suant to the Safe Drinking Water Act. The only exceptions were iron and manganese, which were above recommended Secondary Drinking Water Standards; however, these primarily affect the aesthetic qualities of the water, and are not health hazards (Gallagher and Price, 1966) (Table 5). One occurrence of chromium was also slightly above the Primary Drinking Water Standards, but, on the average, chromium was within the standards. High levels of iron are common in wells in the area and usually range from 0.5 to 10 mg/L. Laboratory reports are presented in Appendix F.

Quality Assurance

Quality Assurance (QA) of all work was performed by the Dames & Moore QA section. This included field QA through review of the work scope by senior personnel and ongoing communications during the design, procedure, and actual performance of the aquifer test. All equipment was calibrated in either the field or office before commencement of field activities.

Laboratory QA was ensured by an initial prequalification audit of McCoy & McCoy Laboratories performed by project level Dames & Moore chemists and QA personnel. The results of this audit are included in Appendix G.

Laboratory in-house QA by McCoy & McCoy consisted of running standards and EPA spikes on every seventh sample for which confidence limits of 95% are required. Duplicate analyses were also performed on every seventh sample and for a determination of the concentration where required by testing procedures. Standard testing methods for the parameters of concern, EPA performance standards, and duplicate test results are listed in Appendix E.

RECOMMENDATIONS

On the basis of the aquifer pumping test and well design, a pumping rate of 300 gpm is recommended for the production well. Although the well is capable of producing considerably more, the long-term safe yield

Table 5
CHEMICAL ANALYSIS OF GROUND WATER FROM THE PRODUCTION WELL

Parameter (mg/l) ^a	Sampling Time (from Beginning of Pumping)					Sampling Time (Start Up)		Average	U.S. EPA Drinking Water Standards
	24 Hours	30 Hours	36 Hours	42 Hours	48 Hours	6 Hours	12 Hours		
Temperature (°C) ^d	14.9	16.2	14.7	14.8	15.3	15.0	14.5	15.0	--
Dissolved Oxygen ^d	1.6	0.9	1.3	1.5	1.2	1.6	1.1	1.3	--
Conductivity $\mu\text{gms/cm}^d$	598	576	595	601	582	597	575	589	--
pH (pH units) ^d	6.9	6.9	6.7	6.7	6.9	6.9	6.7	6.9	6.5-8.5
Free Carbon Dioxide ^d	14	24	36	26	14	24	26	23	--
Sodium	11.5	11.8	11.6	11.6	11.5	11.6	11.6	11.6	--
Calcium	86.8	83.4	83.0	81.6	82.4	81.7	85.5	83.5	--
Silica	17.0	15.8	19.7	17.0	17.0	18.5	18.5	17.6	--
Cyanide (total)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	--
Nitrate (as N)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	10.0
Hydrogen Sulfide	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	--
Carbonate	0	0	0	0	0	0	0	0	--
Surfactants	<0.10	<0.10	0.10	0.17	0.16	0.20	0.19	0.15 ^b	0.5
Chloride	10.0	11.0	13.5	11.0	12.0	9.0	11.0	11.1	250.0
Fluoride	0.23	0.22	0.22	0.19	0.21	0.22	0.22	0.22	2.0 ^c
Total Dissolved Solids	404.0	404.0	414.0	408.0	410.0	404.0	404.0	406.7	500.0
Turbidity (NTU)	31	32	32	30	30	29	30	30.1	--
Color (color units)	45.0	51.0	55.0	37.0	28.0	28.0	35.0	39.9	15.0
Acidity	-17.2	-17.4	-18.0	-17.2	-14.6	-19.6	-19.2	-18.3	--
Suspended Solids	6.0	8.0	8.0	10.0	11.0	13.0	11.0	9.6	--
Hardness (total as CaCO ₃)	299.0	303.0	317.0	303.0	325.0	305.0	317.0	309.0	--
Sulfate	108.0	108.0	105.0	110.0	108.0	108.0	108.0	107.9	250.0

TABLE 5 Continued

Parameter (mg/l) ^a	Sampling Time (from Beginning of Pumping)					Sampling Time (Start Up)			U.S. EPA Drinking Water Standards
	24 Hours	30 Hours	36 Hours	42 Hours	48 Hours	6 Hours	12 Hours	Average	
Odor (odor units)	1	1	1	1	1	1	1	1	3.0
Arsenic	0.019	0.018	0.018	0.018	0.018	0.017	0.018	0.018	0.05
Barium	0.20	0.20	0.20	0.19	0.18	0.19	0.20	0.19	1.0
Cadmium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01
Chromium	0.001	0.014	0.005	0.001	0.001	0.056	0.002	0.011	0.05
Copper	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	1.0
Iron	3.70	3.52	3.83	3.40	3.23	2.93	2.99	3.37	0.3
Lead	0.001	0.001	0.001	0.001	0.001	<0.001	0.001	0.001 ^b	0.05
Manganese	0.11	0.12	0.12	0.12	0.11	0.10	0.09	0.11	0.05
Mercury (ppb)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	2.0
Selenium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01
Silver	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05
Zinc	<0.03	<0.03	<0.03	0.05	<0.03	<0.03	<0.03	0.03 ^b	5.0
Corrosivity (Langlier units)	0.63	0.74	0.76	0.74	0.78	0.75	0.79	0.74	Non Corrosive
Appearance	clear	clear	clear	clear	clear	clear	clear	clear	--

^aUnless other wise noted.^bAbsolute value is less than mean value shown.^cWater temperature of 14.7-17.6°C.^dField determinations.

should be 300 gpm. The well screen and gravel pack were designed for the required 300 gpm and should provide a long-term yield at this rate. This pumping rate should also aid in preventing a large amount of fine material from being pulled from the aquifer into the gravel pack with resultant clogging of the pack, which is normally irreversible and should be prevented if possible.

Short-term pumping rates may exceed 300 gpm. However, it is recommended that if increased supplies are needed, additional wells should be installed rather than increasing the pumping rate. Should additional wells be required, well spacing is recommended to be 200 ft, oriented in a westerly direction away from the existing well. This will limit interference and excessive drawdown near the wells.

CONCLUSIONS

The production well site is an excellent source of groundwater for the anticipated 300-gpm rate required by the SRC-I Demonstration Plant. Aquifer hydraulic parameters are somewhat higher than the conservative values anticipated in the earlier reports, in which values were estimated from the literature and from in situ point permeability tests (Dames & Moore, 1981). Values given in the earlier reports estimated horizontal hydraulic conductivity as 430.5 gpd/ft^2 (0.04 ft/min), whereas the results of the aquifer test indicate values of $1,076 \text{ gpd/ft}^2$ (0.10 ft/min). Transmissivity values are three times larger, $104,142 \text{ gpd/ft}$ vs. $32,301 \text{ gpd/ft}$ ($9.7 \text{ ft}^2/\text{min}$ vs. $3.0 \text{ ft}^2/\text{min}$); however, some of this is attributed to the higher groundwater levels at the site at the time of this investigation.

Discharge samples indicate that the groundwater quality is well within the EPA Primary Drinking Water Standards. Iron, manganese, and color are above the Secondary Drinking Water Standards; however, these are primarily aesthetic limits that mainly affect taste and staining.

Visual classification of samples obtained in the Monitoring Well Program (Dames & Moore, 1982) indicate that, with minor exception, the aquifer material within the depths drilled is a fairly constant, poorly sorted fine to medium sand with some gravel, which is consistent with the material in which the aquifer test was performed. Therefore, the

values obtained by the aquifer test should be appropriate for the proposed SRC-I site.

LITERATURE CITED

- ATEC Associates, Inc. 1979. Geotechnical engineering study prepared for The Rust Engineering Company, 6,000 tpd SRC plant, Newman, Kentucky.
- American Society for Testing and Materials. Annual standards, part 19, method D-1586.
- Dames & Moore. 1981. 1980 geohydraulic investigation, proposed SRC-I facility, Newman, Kentucky.
- _____. 1982. Well installation and boring report, proposed SRC-I facility, Newman, Kentucky.
- Gallagher, J. T., and W. E. Price. 1966. Hydrology of the alluvial deposits in the Ohio River Valley in Kentucky. Geological Survey Water-Supply Paper 1818.
- UOP Inc. 1980. Groundwater and wells. Johnson Division, UOP Inc., St. Paul, Minnesota.
- Lohman, S. W. 1974. Groundwater hydraulics. Geological Survey Professional Paper 708.
- Kollmorgen Corporation. 1975. Munsell soil color charts. MacBeth Division, Kollmorgen Corp., Baltimore, MD.
- Neuman, S. P. 1965. Analysis of pumping test data from anisotropic unconfined aquifers considering delayed gravity response. Water Resources Research 11(2) 329-342.
- Purdue University. 1949. Measurement of water flow through pipe orifice with free discharge. Purdue University, Lafayette, IN.
- Southern Company Services, Inc. and Air Products/Wheelabrator-Frey Joint Venture. 1980. Environmental report, SRC-I solvent refined coal demonstration facility, Daviess County, Kentucky. Prepared for U.S. Department of Energy.
- Wagner, A. A. 1957. The use of the unified soil classification system by the Bureau of Reclamation. Proceedings of the 4th International Conference on Soil Mechanics Foundation Engineering (London). Vol. 1, p. 125.

APPENDIX A
BORING LOG
(L-10)

BORING L 10

SURFACE ELEVATION (FT.): 388.7

COORDINATES: N544,815
E1,547,811

DEPTH (FT.)	SYMBOLS	SAMPLE NO.	BLOWS/FOOT	DESCRIPTION
	CL	1	9	Mottled yellowish brown and gray silty CLAY, with concretions
	ML	2	9	Dark yellowish brown clayey SILT 5.6
10		3	8	10.6
		4	5	Yellowish brown fine SAND with trace silt, with dark yellowish brown seams
20	SM SP	5	11	
		6	17	
30		7	14	30.0
		8	20	Brown fine to medium SAND with trace coarse sand and gravel
40	SP	9	12	
		10	18	
50		11	14	51.5
		12	35	Grayish brown fine to medium SAND with trace coarse sand and gravel with occasional gravelly layers
60	SP	13	38	
		14	60	
70				

BORING L 10

SURFACE ELEVATION (FT.): 388.7

COORDINATES: N544,815
E1,547,811

DEPTH (FT.)	SYMBOLS	SAMPLE NO.	BLOWS/FOOT	DESCRIPTION
70		15	64	See previous log sheet
	SP	16	25	
80		17	57	
	SP	18	60	Brown medium SAND with trace coarse sand 82.0
		19	79	Grayish brown fine to medium SAND with trace coarse sand and gravel with occasional gravelly layers 87.0
90	SP	20	53	
		21	84	Grayish brown fine to coarse SAND with gravel and occasional gravelly layers 99.0
100		22	100	
			5	
110	SW	23	32	
		24	19	
120		25		
		26	19	
	Sh		5	Grayish brown SHALE 125.0

APPENDIX B
GRADATION CURVES

International Coal & Refining Company
Owensboro, Kentucky
P.N. 82007

Form 1227 Rev.

Client: Dames & Moore
Date: March 23, 1982

GRAIN SIZE DISTRIBUTION CURVE

Location: L-10 @ 86'

Milton M. Greenbaum Associates, Inc.
994 Longfield Avenue
Louisville, Kentucky 40215

International Coal & Refining Company
Owensboro, Kentucky
P.N. 82007

Form 1227 Rev.

Client: Dames & Moore
Date: March 23, 1982

Location: L-10 @ 91'

GRAIN SIZE DISTRIBUTION CURVE

Milton M. Greenbaum Associates, Inc.
994 Longfield Avenue
Louisville, Kentucky 40215

International Coal & Refining Company
Owensboro, Kentucky
P.N. 82007

Form 1227 Rev.

Client: Dames & Moore
Date: March 23, 1982

GRAIN SIZE DISTRIBUTION CURVE

Location: L-10 @ 96'

Milton M. Greenbaum Associates, Inc.
994 Longfield Avenue
Louisville, Kentucky 40215

International Coal & Refining Company
Owensboro, Kentucky
P.N. 82007

Form 1227 Rev.

Client: Dames & Moore
Date: March 23, 1982

GRAIN SIZE DISTRIBUTION CURVE

Location: L-10 @ 101'

Milton M. Greenbaum Associates, Inc.
994 Longfield Avenue
Louisville, Kentucky 40215

International Coal & Refining Company
Owensboro, Kentucky
P.N. 82007

Form 1227 Rev.

Client: Dames & Moore
Date: March 23, 1982

GRAIN SIZE DISTRIBUTION CURVE

Location: L-10 @ 105'

Milton M. Greenbaum Associates, Inc.
994 Longfield Avenue
Louisville, Kentucky 40215

International Coal & Refining Company
Owensboro, Kentucky
P.N. 82007

Form 1227 Rev.

Client: Dames & Moore
Date: March 23, 1982

GRAIN SIZE DISTRIBUTION CURVE

Location: L-10 @ 111'

Milton M. Greenbaum Associates, Inc.
994 Longfield Avenue
Louisville, Kentucky 40215

International Coal & Refining Company
Owensboro, Kentucky
P.N. 82007

Form 1227 Rev.

Client: Dames & Moore
Date: March 23, 1982

GRAIN SIZE DISTRIBUTION CURVE

Location: L-10 @ 116'

Milton M. Greenbaum Associates, Inc.
994 Longfield Avenue
Louisville, Kentucky 40215

International Coal & Refining Company
Owensboro, Kentucky
P.N. 82007

Form 1227 Rev.

Client: Dames & Moore
Date: March 23, 1982

GRAIN SIZE DISTRIBUTION CURVE

Location: L-10 @ 120'

Milton M. Greenbaum Associates, Inc.
994 Longfield Avenue
Louisville, Kentucky 40215

International Coal & Refining Company
Owensboro, Kentucky
P.N. 82007

Form 1227 Rev.

Client: Dames & Moore
Date: March 23, 1982

Location: L-10 @ 125'

GRAIN SIZE DISTRIBUTION CURVE

Milton M. Greenbaum Associates, Inc.
994 Longfield Avenue
Louisville, Kentucky 40215

APPENDIX C
TIME DRAWDOWN PLOTS

Time Drawdown Plot of Pumping Well

Time Drawdown Plot of Observation Well L-10

Time Drawdown Plot of Observation Well R-10

Time Drawdown Plot of Observation Well P-10

Time Drawdown Plot of Observation Well P-50

Time Drawdown Plot of Observation Well P-100

Time Drawdown Plot of Observation Well R-50

Time Drawdown Plot of Observation Well R-100

Time Drawdown Plot of Observation Well PVC-1

Time Drawdown Plot of Observation Well 315

APPENDIX D
PUMP TEST DATA

TABLE D-1

PUMP TEST DATA

Pumping Well: New Production WellObservation Well: Well No. L-10

<u>t</u> Elapsed Time (minutes)	<u>s</u> Unadjusted Drawdown (feet)	<u>t</u> Elapsed Time (minutes)	<u>s</u> Unadjusted Drawdown (feet)
0 Pump on 2:00 pm, 5/14/82			
1.0	3.23	478	3.64
1.5	3.39	538	3.67
2.0	3.45	604	3.69
2.5	3.46	660	3.75
3.0	3.47	719	3.76
3.5	3.47	790	3.80
4.0	3.48	845	3.81
5.0	3.49	903	3.83
6.0	3.49	965	3.85
7.0	3.49	1020	3.87
9.0	3.48	1079	3.87
10.0	3.48	1139	3.88
12	3.48	1201	3.90
14	3.48	1265	3.90
16	3.47	1322	3.92
18	3.48	1380	3.92
20	3.48	1425	3.96
22	3.48	1512	3.97
27	3.48	1631	3.98
32	3.48	1741	4.05
37	3.47	1857	4.07
42	3.47	1985	4.11
52	3.49	2105	4.12
61	3.49	2226	4.13
70	3.49	2343	4.20
80	3.50	2458	4.21
90	3.50	2595	4.24
100	3.50	2713	4.23
110	3.51	2824	4.30
120	3.52	2900	4.26
150	3.53		
180	3.56		
210	3.59	<u>Recovery</u> 0.08	3.07
241	3.58	0.17	2.12
270	3.60	0.33	1.08
335	3.56	0.67	1.02
387	3.61	1.00	0.97
432	3.65	1.33	0.92

Pump off 2:20 pm

TABLE D-1 (con't.)

PUMP TEST DATA

Pumping Well: New Production Well Observation Well: Well No. L-10

(recovery con't.)	
t Elapsed Time (minutes)	s Unadjusted Drawdown (feet)
1.67	0.90
2.00	0.89
2.17	0.88
2.33	0.86
2.50	0.86
3.00	0.85
3.50	0.85
4.00	0.85
5.00	0.85
5.50	0.85
6.00	0.85
10	0.85
14	0.85
16	0.83
20	0.83
25	0.83
30	0.81
35	0.81
40	0.79
45	0.78

TABLE D-2

PUMP TEST DATA

Pumping Well: New Production WellObservation Well: Well No. R-10

<u>t</u> Elapsed Time (minutes)	<u>s</u> Unadjusted Drawdown (feet)	<u>t</u> Elapsed Time (minutes)	<u>s</u> Unadjusted Drawdown (feet)	
0 Pump on 2:00 pm, 4/14/82				
0.75	2.71	729	3.69	
1.25	3.11	797	3.71	
1.75	3.13	852	3.74	
2.08	3.23	910	3.68	
2.67	3.25	972	3.78	
3.13	3.26	1027	3.79	
3.58	3.25	1083	3.79	
4.80	3.26	1145	3.75	
5.92	3.27	1205	3.83	
7.03	3.27	1270	3.79	
11	3.27	1327	3.85	
12	3.29	1384	3.86	
14	3.26	1430	3.81	
16	3.31	1518	3.80	
18	3.28	1635	3.87	
20	3.30	1748	3.96	
25	3.26	1864	3.93	
30	3.28	1995	4.05	
35	3.27	2115	4.07	
40	3.30	2235	4.12	
50	3.33	2351	4.06	
60	3.32	2523	4.14	
70	3.36	2592	4.17	
80	3.34	2708	4.20	
90	3.33	2830	4.19	
100	3.35	2900	4.24	Pump off 2:20 pm
110	3.35			
120	3.36			
158	3.38	<u>Recovery</u> 0.25	2.49	
184	3.38	0.67	1.75	
215	3.42	1.00	1.35	
246	3.47	1.50	1.17	
278	3.50	1.83	1.14	
351	3.50	1.42	1.12	
393	3.49	2.92	1.09	
441	3.58	3.33	1.03	
486	3.54	3.75	1.06	
545	3.55	4.00	1.03	
610	3.64	4.33	1.03	
668	3.69	4.75	1.03	

TABLE D-2 (con't.)

PUMP TEST DATA

Pumping Well: New Production Well Observation Well: Well No. R-10

(recovery con't.)

^t Elapsed Time (minutes)	^s Unadjusted Drawdown (feet)
5.00	1.02
5.50	1.02
6.00	1.01
6.50	1.03
7.00	1.00
7.50	1.03
8.00	1.01
10	1.01
15	0.98
20	0.97
25	0.97
30	0.96
35	0.96
40	0.95
49	0.95
85	0.91

TABLE D-3

PUMP TEST DATA

Pumping Well: New Production WellObservation Well: Well No. R-50

<u>t</u> Elapsed Time (minutes)	<u>s</u> Unadjusted Drawdown (feet)	<u>t</u> Elapsed Time (minutes)	<u>s</u> Unadjusted Drawdown (feet)
0 Pump on 2:00 pm, 4/14/82			
0.5	1.20	547	1.83
1.0	1.48	613	1.87
1.5	1.55	674	1.88
2.0	1.59	733	1.90
2.5	1.64	798	1.93
3	1.63	856	1.96
4	1.66	912	1.96
5	1.63	975	1.99
6	1.62	1028	2.01
7	1.63	1086	2.02
8	1.64	1146	2.03
9	1.63	1208	2.04
10	1.61	1271	2.06
12	1.61	1330	2.08
14	1.60	1385	2.09
16	1.63	1415	2.11
18	1.62	1520	2.13
20	1.61	1641	2.18
25	1.61	1750	2.19
30	1.62	1868	2.23
35	1.61	1997	2.27
40	1.62	2119	2.29
50	1.61	2237	2.32
60	1.66	2354	2.36
70	1.63	2468	2.38
80	1.66	2594	2.40
90	1.66	2711	2.41
100	1.65	2832	2.47
110	1.66	2900	Pump off 2:20 pm 4/16/82
120	1.68		
155	1.66		
185	1.69		
218	1.70		
248	1.73		
280	1.76		
353	1.79		
397	1.80		
443	1.79		
490	1.81		

TABLE D-4

PUMP TEST DATA

Pumping Well: New Production WellObservation Well: Well No. R-100

<u>t</u> Elapsed Time (minutes)	<u>s</u> Unadjusted Drawdown (feet)	<u>t</u> Elapsed Time (minutes)	<u>s</u> Unadjusted Drawdown (feet)
O Pump on 2:00 pm, 4/14/82			
10.5	0.90	1430	1.36
12.5	0.90	1522	1.39
20.5	0.89	1638	1.41
25.5	0.94	1752	1.47
30.5	0.90	1866	1.50
35.5	0.90	1999	1.55
40.5	0.91	2121	1.57
50.5	0.90	2241	1.58
60.5	0.89	2357	1.62
70.5	0.91	2525	1.65
80.5	0.92	2593	1.68
90.5	0.94	2710	1.70
100.5	0.93	2834	1.74
110.5	0.97		
120	1.0		
156	0.99		
189	0.95		
220	0.97		
250	1.0		
282	1.02		
355	1.04		
395	1.05		
445	1.08		
498	1.04		
549	1.10		
615	1.12		
676	1.15		
731	1.17		
801	1.20		
854	1.21		
913	1.23		
974	1.25		
1030	1.27		
1085	1.27		
1147	1.29		
1207	1.30		
1275	1.32		
1333	1.32		
1387	1.35		

PUMP TEST DATA

Observation Well: Well No. P-10

Pump off 2:20 pm

TABLE D-5 (con't.)

PUMP TEST DATA

Pumping Well: New Production Well Observation Well: Well No. P-10

<u>t</u> Elapsed Time (minutes)	<u>s</u> Unadjusted Drawdown (feet)
2901.83	0.95
2902	0.98
2902.17	0.92
2902.50	0.92
2902.83	0.91
2903.5	0.90
2904	0.90
2904.5	0.89
2905	0.89
2905.5	0.89
2906	0.89
2906.5	0.89
2907	0.89
2908	0.89
2910	0.88
2911	0.88

TABLE D-6

PUMP TEST DATA

Pumping Well: New Production WellObservation Well: Well No. P-50

<u>t</u> Elapsed Time (minutes)	<u>s</u> Unadjusted Drawdown (feet)	<u>t</u> Elapsed Time (minutes)	<u>s</u> Unadjusted Drawdown (feet)
0 Pump on 2:00 pm, 4/14/82			
1.0	0.18	848	2.04
2.0	0.18	906	2.06
3.0	0.15	968	2.09
4.5	0.15	1024	2.11
5.5	0.15	1081	2.11
6.5	0.15	1144	2.13
7.5	1.45	1203	2.15
8.5	1.58	1267	2.15
9.5	1.62	1325	2.15
11.5	1.68	1382	2.18
13.5	1.65	1427	2.17
15.5	1.65	1516	2.22
18.5	1.65	1633	2.27
20.0	1.65	1745	2.32
25.0	1.66	1860	2.34
30.0	1.67	1990	2.37
35.0	1.70	2100	2.39
40.0	1.70	2230	2.43
50.0	1.70	2348	2.44
60.0	1.73	2461	2.47
70.0	1.73	2590	2.51
80.0	1.74	2703	2.50
90.0	1.74	2823	2.55
100.0	1.74	2900	2.53
110.0	1.74	4/16/82	
120.0	1.76		
152.0	1.77		
182.0	1.80		
213.0	1.80		
244.0	1.81		
275.0	1.82		
337.0	1.85		
389.0	1.86		
438.0	1.89		
481.0	1.89		
541.0	1.94		
606.0	1.97		
664.0	1.98		
723.0	2.00		
794.0	2.03		
		Recovery	
		0.17	2.13
		0.33	1.54
		0.50	1.67
		0.67	1.73
		0.83	1.78
		1.17	1.35
		2.00	1.85
		2.33	1.91
		2.50	1.91
		3.00	1.90
		3.50	1.90
		4.00	1.90
		4.50	0.95

Pump off 2:20 pm

TABLE D-6 (con't.)

PUMP TEST DATA

Pumping Well: New Production Well No. Observation Well: Well No. P-50

(recovery con't.)	
^t	^s
Elapsed	Unadjusted
Time	Drawdown
<u>(minutes)</u>	<u>(feet)</u>
5.00	1.92
5.50	1.92
6.00	1.94
6.50	1.94
7.00	1.94
7.50	0.95
8.00	0.95
8.50	0.93
9.00	0.92
9.50	0.92
10.00	0.91
10.50	0.89
11.00	0.89
11.50	0.87
12.00	0.85
12.50	0.84
13.00	0.83
13.50	0.81
14.00	0.78
14.50	0.78
15.00	0.75
16.00	0.75
17.00	0.70
18.00	0.70
19.00	0.70

TABLE D-7

PUMP TEST DATA

Pumping Well: New Production WellObservation Well: Well No. P-100

<u>t</u>	<u>s</u>	<u>t</u>	<u>s</u>
<u>Elapsed</u>	<u>Unadjusted</u>	<u>Elapsed</u>	<u>Unadjusted</u>
<u>Time</u>	<u>Drawdown</u>	<u>Time</u>	<u>Drawdown</u>
<u>(minutes)</u>	<u>(feet)</u>	<u>(minutes)</u>	<u>(feet)</u>
0	Pump on 2:00 pm, 4/14/82		
11	0.48	1204	1.06
14	0.46	1268	1.07
18	0.55	1326	1.09
20	0.59	1383	1.09
25	0.65	1428	1.12
27	0.66	1517	1.14
33	0.67	1634	1.14
36	0.70	1746	1.14
41	0.69	1862	1.16
50	0.72	1992	1.18
60	0.74	2113	1.17
70	0.75	2232	1.16
81	0.78	2349	1.18
91	0.78	2461	1.20
100	0.79	2589	1.20
110	0.80	2701	1.26
121	0.81	2820	1.31
153	0.84	2900	Pump off 2:20 pm, 4/16/82
183	0.83		
214	0.86		
245	0.86		
276	0.90		
338	0.91		
391	0.93		
439	0.93		
483	0.95		
543	0.90		
608	0.91		
667	0.93		
725	0.94		
795	0.95		
850	0.97		
908	0.97		
970	0.98		
1025	0.99		
1082	1.01		
1143	1.04		

TABLE D-8

PUMP TEST DATA

Pumping Well: New Production WellObservation Well: Well No. 315

<u>t</u> Elapsed Time (minutes)	<u>s</u> Unadjusted Drawdown (feet)
--	--

0 Pump on 2:48 pm,
4/14/82

48	0.02
306	0.11
562	0.18
756	0.23
921	0.26
1092	0.31
1288	0.35

Well vandalized at 2:00 pm,
4/15/82

TABLE D-9

PUMP TEST DATA

Pumping Well: New Production WellObservation Well: Well No. PVC-1

<u>t</u> Elapsed Time (minutes)	<u>s</u> Unadjusted Drawdown (feet)
0	Pump on 3:04 pm, 4/14/82
64	0.11
327	0.10
599	0.02
779	0.10
944	0.10
1114	0.10
1314	0.10
1493	0.11
1734	0.10
1902	0.08
2075	0.09
2267	0.06
2479	0.06
2643	0.06
2868	0.13
	Pump off 2:20 pm, 4/16/82
	<u>Recovery</u>
2956	0.14

TABLE D-10

PUMP TEST DATA

Pumping Well: New Production WellObservation Well: Production Well

<u>t</u> Elapsed Time (minutes)	<u>s</u> Unadjusted Drawdown (feet)
--	--

0 Pump on 2:00 pm,
4/14/82

9.42	8.66
16	8.72
28	8.66
73	8.75
113	8.78
230	8.78
341	8.81
398	8.78
553	8.87
734	8.78
915	8.84
1077	8.94
1332	8.98
1639	9.11
1920	9.25
2085	9.07
2282	9.10
2362	9.17
2471	9.33
2715	9.32
2836	9.46
2900	9.47

Pump off 2:20 pm

4/16/82

Recovery

0.50	0.96
1.00	0.63
1.75	0.58
2.50	0.52
3.00	0.49
4.50	0.50
5.75	0.50
10	0.80
11	0.47
15	0.47

TABLE D-11
PUMP TEST DATA
MANOMETER LOG
(6 inch pipe, 4 inch orifice)

<u>Elapsed Time (minutes)</u>	<u>Manometer Height (inches)</u>	<u>Discharge Rate (gpm)</u>
0	Pump on at 2:00 pm 4/14/82	
36	66	513
225	67	517
308	66	513
1089	67	517
1800	67	517
2055	67.5	518
2278	66.5	515
2460	67	517
2595	66	513
2900	Pump off 2:20 pm 4/ 6/82	

APPENDIX E
STANDARD METHODS

Office and Laboratories:
Lexington, Kentucky
Madisonville, Kentucky
Paducah, Kentucky
Pikeville, Kentucky

McCOY & McCOY, INC.

Environmental Consultants

P. O. Box 238 • 85 East Noel Avenue • Madisonville, Kentucky • Phone 502-821-7375

<u>TEST DESCRIPTION</u>	<u>METHOD USED</u>
MBAS	EPA 425.1
Odor	EPA 140.1
Turbidity	EPA 180.1
Color	EPA 110.2
Chloride	EPA 325.3
Arsenic	EPA 206.3
Fluoride	EPA 340.2
Barium	EPA 208.1
Total Dissolved Solids	EPA 160.3
Corrosivity	Langelier Index
Acidity	EPA 305.1
Cadmium	EPA 213.2
Total Suspended Solids	EPA 160.2
Chromium	EPA 218.2
Copper	EPA 220.1
Iron	EPA 236.1
Hardness	EPA 130.2
Mercury	EPA 245.1
Sulfate	EPA 375.4
Manganese	EPA 243.1
pH	EPA 150.1
Sodium	EPA 273.1
Calcium	EPA 215.1
Lead	EPA 239.2
Silica	EPA 370.1
Cyanide	EPA 335.2
Selenium	EPA 270.3
Nitrate	EPA 353.3
Hydrogen Sulfide	EPA 376.2
Carbonate	SM 406C
Zinc	EPA 289.1
Silver	EPA 272.2

Standard Methods for the Examination of Water and Wastewater, 15th Edition
1980.

EPA Methods for Chemical Analysis of Water & Waste, #60014-79-020.

Office and Laboratories:
 Lexington, Kentucky
 Madisonville, Kentucky
 Paducah, Kentucky
 Pikeville, Kentucky

McCOY
 & McCOY, INC.

Environmental Consultants

P. O. Box 238 • 85 East Noel Avenue • Madisonville, Kentucky • Phone 502-821-7375

EPA PERFORMANCE STANDARDS

<u>Test Description</u>	<u>Units</u>	<u>Known Concentration</u>	<u>Test Concentration</u>
Hardness	ppm	27.0 109.0	28.0 112.0
Chlorides	ppm	20.5 70.2	24.0 73.0
Nitrate	ppm	1.32 0.36	1.40 0.39
T. Suspended Solids	ppm	236 ± 28	242.0
pH	STD	7.4 8.6	7.37 8.45
Sulfate	ppm	12.0 75.0	13.0 76.0
T. Dissolved Solids	ppm	66.0 277.0	76.0 292.0
Fluoride	ppm	1.12 0.63	1.17 0.625
Cadmium	ppm	0.0015	0.001
Lead	ppm	0.018	0.018
Arsenic	ppm	0.018	0.0182 0.0184

Office and Laboratories:
Lexington, Kentucky
Madisonville, Kentucky
Paducah, Kentucky
Pikeville, Kentucky

**McCOY
& McCOY, INC.**

Environmental Consultants

P. O. Box 238 • 85 East Noel Avenue • Madisonville, Kentucky • Phone 502-821-7375

EPA PERFORMANCE STANDARDS

<u>Test Description</u>	<u>Units</u>	<u>Known Concentration</u>	<u>Test Concentration</u>
Barium	ppm	0.5	0.46
Silver	ppm	0.024	0.027
Chromium	ppm	0.011	0.013
Copper	ppm	0.034	0.033
Zinc	ppm	0.042	0.040
Iron	ppm	0.80	0.80
Manganese	ppm	0.35	0.33
Mercury	ppb	1.3	1.5
Selenium	ppm	0.0054	0.0056
Calcium	ppm	32.0	32.2
Sodium	ppm	40.0	40.2

Office and Laboratories:
 Lexington, Kentucky
 Madisonville, Kentucky
 Paducah, Kentucky
 Pikeville, Kentucky

McCOY
 & McCOY, INC.

Environmental Consultants

P. O. Box 238 • 85 East Noel Avenue • Madisonville, Kentucky • Phone 502-821-7375

<u>Test Description</u>	<u>Units</u>	<u>Sample Number</u>	<u>Test Concentration</u>
Hardness	ppm	4	315.0
			303.0
Chlorides	ppm	1	11.0
			9.0
		2	11.0
			11.0
		3	14.0
			13.0
		4	12.0
			10.0
		5	12.0
			12.0
		6	9.0
			9.0
		7	11.0
			11.0
Cadmium	ppm	1	<0.001
			<0.001
		2	<0.001
			<0.001
		3	<0.001
			<0.001
		4	<0.001
			<0.001
		5	<0.001
			<0.001
		6	<0.001
			<0.001
		7	<0.001
			<0.001
Lead	ppm	1	0.001
			0.001
		2	0.001
			0.001
		3	0.001
			0.001

Office and Laboratories:
 Lexington, Kentucky
 Madisonville, Kentucky
 Paducah, Kentucky
 Pikeville, Kentucky

McCOY
 & McCOY, INC.

Environmental Consultants

P. O. Box 238 • 85 East Noel Avenue • Madisonville, Kentucky • Phone 502-821-7375

<u>Test Description</u>	<u>Units</u>	<u>Sample Number</u>	<u>Test Concentration</u>
Lead (cont'd)	ppm	4	0.001
			0.001
		5	0.001
			0.001
		6	< 0.001
			< 0.001
		7	0.001
			0.001
Barium	ppm	4	0.19
			0.19
Chromium	ppm	2	0.014
			0.014
		6	0.054
			0.059
Silver	ppm	2	0.001
			0.001
		6	0.001
			0.001
Copper	ppm	4	< 0.03
			< 0.03
Zinc	ppm	4	0.05
			0.05
Iron	ppm	7	2.99
			2.99
Manganese	ppm	7	0.09
			0.09

APPENDIX F

LABORATORY RESULTS

Office and Laboratories:
Lexington, Kentucky
Madisonville, Kentucky
Paducah, Kentucky
Pikeville, Kentucky

McCOY
& McCOY, INC.

Environmental Consultants

P. O. Box 238 • 85 East Noel Avenue • Madisonville, Kentucky • Phone 502-821-7375

REPORT DATE: 6/24/82

PAGE NO: 1

Dames & Moore
Attn: Steve Lamb
3399 Tates Creek Road
Lexington, KY 40502

Location No.: ICRC Sample #1

Sample Date: 4/15/82

REPORT OF CHEMICAL ANALYSIS

TEST DESCRIPTION	UNIT	RESULTS
Arsenic	ppm	0.019
Barium	ppm	0.20
Cadmium	ppm	<0.001
Chromium	ppm	0.001
Copper	ppm	<0.03
Iron	ppm	3.70
Lead	ppm	0.001
Manganese	ppm	0.11
Mercury	ppb	<0.2
Selenium	ppm	<0.001
Silver	ppm	<0.001
Zinc	ppm	<0.03
Chloride	ppm	10.0
Fluoride	ppm	0.23
TDS	ppm	404.0
Turbidity	N.T.U.	31
Color	P.C.U.	45
Corrosivity	L.I.	0.63
Acidity	ppm	-17.2
TSS	ppm	6.0
Hardness	ppm	299.0
Sulfate	ppm	108.0
Odor	T.O.N.	1
pH	STD	7.85
Sodium	ppm	11.5

Office and Laboratories:
Lexington, Kentucky
Madisonville, Kentucky
Paducah, Kentucky
Pikeville, Kentucky

McCOY
& McCOY, INC.

Environmental Consultants

P. O. Box 238 • 85 East Noel Avenue • Madisonville, Kentucky • Phone 502-821-7375

REPORT DATE: 6/24/82

PAGE NO: 2

Dames & Moore
Attn: Steve Lamb
3399 Tates Creek Road
Lexington, KY 40502

Location No.: ICRC Sample #1

Sample Date: 4/15/82

R E P O R T O F C H E M I C A L A N A L Y S I S

TEST DESCRIPTION	UNIT	RESULTS
Calcium	ppm	86.8
Silica	ppm	17.0
Cyanide	ppm	< 0.02
Nitrate	ppm	< 0.1
Hydrogen Sulfide	ppm	< 0.01
Carbonate	ppm	0.0
MBAS	ppm	< 0.10

Appearance - Low suspended solids, light brown appearance.

All analysis performed as per 15th Edition Standard Methods for Water and Wastewater Analysis and EPA Methods for Chemical Analysis of Water & Waste #60014-79-020.

By Don Webb
For McCoy & McCoy, Inc.

Office and Laboratories:
Lexington, Kentucky
Madisonville, Kentucky
Paducah, Kentucky
Pikeville, Kentucky

McCOY
& McCOY, INC.

Environmental Consultants

P. O. Box 238 • 85 East Noel Avenue • Madisonville, Kentucky • Phone 502-821-7375

REPORT DATE: 6/24/82

PAGE NO: 1

Dames & Moore
Attn: Steve Lamb
3399 Tates Creek Road
Lexington, KY 40502

Location No.: ICRC Sample #2

Sample Date: 4/15/82

REPORT OF CHEMICAL ANALYSIS

TEST DESCRIPTION	UNIT	RESULTS
Arsenic	ppm	0.018
Barium	ppm	0.20
Cadmium	ppm	< 0.001
Chromium	ppm	0.014
Copper	ppm	< 0.03
Iron	ppm	3.52
Lead	ppm	0.001
Manganese	ppm	0.12
Mercury	ppb	< 0.2
Selenium	ppm	< 0.001
Silver	ppm	< 0.001
Zinc	ppm	< 0.03
Chloride	ppm	11.0
Fluoride	ppm	0.22
TDS	ppm	404.0
Turbidity	N.T.U.	32
Color	P.C.U.	51.0
Corrosivity	L.I.	0.74
Acidity	ppm	-17.4
TSS	ppm	8.0
Hardness	ppm	303.0
Sulfate	ppm	108.0
Odor	T.O.N.	1
pH	STD	7.87
Sodium	ppm	11.8

Office and Laboratories:
Lexington, Kentucky
Madisonville, Kentucky
Paducah, Kentucky
Pikeville, Kentucky

McCOY
& McCOY, INC.

Environmental Consultants

P. O. Box 238 • 85 East Noel Avenue • Madisonville, Kentucky • Phone 502-821-7375

REPORT DATE: 6/24/82

PAGE NO: 2

Dames & Moore
Attn: Steve Lamb
3399 Tates Creek Road
Lexington, KY 40502

Location No.: ICRC Sample #2

Sample Date: 4/15/82

REPORT OF CHEMICAL ANALYSIS

TEST DESCRIPTION	UNIT	RESULTS
Calcium	ppm	83.4
Silica	ppm	15.8
Cyanide	ppm	<0.02
Nitrate	ppm	<0.1
Hydrogen Sulfide	ppm	<0.01
Carbonate	ppm	0.0
MBAS	ppm	<0.10

Appearance - Low suspended solids, light brown appearance.

All analysis performed as per 15th Edition Standard Methods for Water and Wastewater Analysis and EPA Methods for Chemical Analysis of Water & Waste #60014-79-020.

By *Sam Wolfe*
For McCoy & McCoy, Inc.

Office and Laboratories:
Lexington, Kentucky
Madisonville, Kentucky
Paducah, Kentucky
Pikeville, Kentucky

McCOY
& McCOY, INC.

Environmental Consultants

P. O. Box 238 • 85 East Noel Avenue • Madisonville, Kentucky • Phone 502-821-7375

REPORT DATE: 6/24/82

PAGE NO: 1

Dames & Moore
Attn: Steve Lamb
3399 Tates Creek Road
Lexington, KY 40502

Location No.: ICRC Sample #3

Sample Date: 4/16/82

REPORT OF CHEMICAL ANALYSIS

TEST DESCRIPTION	UNIT	RESULTS
Arsenic	ppm	0.018
Barium	ppm	0.20
Cadmium	ppm	<0.001
Chromium	ppm	0.005
Copper	ppm	<0.03
Iron	ppm	3.83
Lead	ppm	0.001
Manganese	ppm	0.12
Mercury	ppb	<0.2
Selenium	ppm	<0.001
Silver	ppm	<0.001
Zinc	ppm	<0.03
Chloride	ppm	13.5
Fluoride	ppm	0.22
TDS	ppm	414.0
Turbidity	N.T.U.	32
Color	P.C.U.	55.0
Corrosivity	L.I.	0.76
Acidity	ppm	-18.0
TSS	ppm	8.0
Hardness	ppm	317.0
Sulfate	ppm	105.0
Odor	T.O.N.	1
pH	STD	7.89
Sodium	ppm	11.6

Office and Laboratories:
Lexington, Kentucky
Madisonville, Kentucky
Paducah, Kentucky
Pikeville, Kentucky

McCOY
& McCOY, INC.

Environmental Consultants

P. O. Box 238 • 85 East Noel Avenue • Madisonville, Kentucky • Phone 502-821-7375

REPORT DATE: 6/24/82

PAGE NO: 2

Dames & Moore
Attn: Steve Lamb
3399 Tates Creek Road
Lexington, KY 40502

Location No.: ICRC Sample #3

Sample Date: 4/16/82

REPORT OF CHEMICAL ANALYSIS

TEST DESCRIPTION	UNIT	RESULTS
Calcium	ppm	83.0
Silica	ppm	19.7
Cyanide	ppm	<0.02
Nitrate	ppm	<0.1
Hydrogen Sulfide	ppm	<0.01
Carbonate	ppm	0.0
MBAS	ppm	0.10

Appearance - Low suspended solids, light brown appearance.

All analysis performed as per 15th Edition Standard Methods for Water and Wastewater Analysis and EPA Methods for Chemical Analysis of Water & Waste #60014-79-020.

By

Don Wolf
For McCoy & McCoy, Inc.

Office and Laboratories:
Lexington, Kentucky
Madisonville, Kentucky
Paducah, Kentucky
Pikeville, Kentucky

McCOY
& McCOY, INC.

Environmental Consultants

P. O. Box 238 • 85 East Noel Avenue • Madisonville, Kentucky • Phone 502-821-7375

REPORT DATE: 6/24/82

PAGE NO: 1

Dames & Moore
Attn: Steve Lamb
3399 Bates Creek Road
Lexington, KY 40502

Location No.: ICRC Sample #4.

Sample Date: 4/16/82

REPORT OF CHEMICAL ANALYSIS

TEST DESCRIPTION	UNIT	RESULTS
Arsenic	ppm	0.018
Barium	ppm	0.19
Cadmium	ppm	<0.001
Chromium	ppm	0.001
Copper	ppm	<0.03
Iron	ppm	3.40
Lead	ppm	0.001
Manganese	ppm	0.12
Mercury	ppb	<0.2
Selenium	ppm	<0.001
Silver	ppm	<0.001
Zinc	ppm	0.05
Chloride	ppm	11.0
Fluoride	ppm	0.19
TDS	ppm	408.0
Turbidity	N.T.U.	30
Color	P.C.U.	37.0
Corrosivity	L.I.	0.74
Acidity	ppm	-17.2
TSS	ppm	10.0
Hardness	ppm	303.0
Sulfate	ppm	110.0
Odor	T.O.N.	1
pH	STD	7.88
Sodium	ppm	11.6

Office and Laboratories:
Lexington, Kentucky
Madisonville, Kentucky
Paducah, Kentucky
Pikeville, Kentucky

McCOY
& McCOY, INC.

Environmental Consultants

P. O. Box 238 • 85 East Noel Avenue • Madisonville, Kentucky • Phone 502-821-7375

REPORT DATE: 6/24/82

PAGE NO: 2

Dames & Moore
Attn: Steve Lamb
3399 Tates Creek Road
Lexington, KY 40502

Location No.: ICRC Sample #4

Sample Date: 4/16/82

REPORT OF CHEMICAL ANALYSIS

TEST DESCRIPTION	UNIT	RESULTS
Calcium	ppm	81.6
Silica	ppm	17.0
Cyanide	ppm	< 0.02
Nitrate	ppm	< 0.1
Hydrogen Sulfide	ppm	< 0.01
Carbonate	ppm	0.0
MBAS	ppm	0.17

Appearance - Low suspended solids, light brown appearance.

All analysis performed as per 15th Edition Standard Methods for Water and Wastewater Analysis and EPA Methods for Chemical Analysis of Water & Waste #60014-79-020.

By Don Webb
For McCoy & McCoy, Inc.

Office and Laboratories:
Lexington, Kentucky
Madisonville, Kentucky
Paducah, Kentucky
Pikeville, Kentucky

McCOY
& McCOY, INC.

Environmental Consultants

P. O. Box 238 • 85 East Noel Avenue • Madisonville, Kentucky • Phone 502-821-7375

REPORT DATE: 6/24/82

PAGE NO: 1

Dames & Moore
Attn: Steve Lamb
3399 Bates Creek Road
Lexington, KY 40502

Location No.: ICRC Sample #5

Sample Date: 4/16/82

REPORT OF CHEMICAL ANALYSIS

TEST DESCRIPTION	UNIT	RESULTS
Arsenic	ppm	0.018
Barium	ppm	0.18
Cadmium	ppm	<0.001
Chromium	ppm	0.001
Copper	ppm	<0.03
Iron	ppm	3.23
Lead	ppm	0.001
Manganese	ppm	0.11
Mercury	ppb	<0.2
Selenium	ppm	<0.001
Silver	ppm	<0.001
Zinc	ppm	<0.03
Chloride	ppm	12.0
Fluoride	ppm	0.21
TDS	ppm	410.0
Turbidity	N.T.U.	30
Color	P.C.U.	28.0
Corrosivity	L.I.	0.78
Acidity	ppm	-19.6
TSS	ppm	11.0
Hardness	ppm	325.0
Sulfate	ppm	108.0
Odor	T.O.N.	1
pH	STD	7.91
Sodium	ppm	11.5

Office and Laboratories:
Lexington, Kentucky
Madisonville, Kentucky
Paducah, Kentucky
Pikeville, Kentucky

McCOY
& McCOY, INC.

Environmental Consultants

P. O. Box 238 • 85 East Noel Avenue • Madisonville, Kentucky • Phone 502-821-7375

REPORT DATE: 6/24/82

PAGE NO: 2

Dames & Moore
Attn: Steve Lamb
3399 Tates Creek Road
Lexington, KY 40502

Location No.: ICRC Sample #5

Sample Date: 4/16/82

REPORT OF CHEMICAL ANALYSIS

TEST DESCRIPTION	UNIT	RESULTS
Calcium	ppm	82.4
Silica	ppm	17.0
Cyanide	ppm	< 0.02
Nitrate	ppm	< 0.1
Hydrogen Sulfide	ppm	< 0.01
Carbonate	ppm	0.0
MBAS	ppm	0.16

Appearance - Low suspended solids, light brown appearance.

All analysis performed as per 15th Edition Standard Methods for Water and Wastewater Analysis and EPA Methods for Chemical Analysis of Water & Waste #60014-79-020.

By *Sam Wolf*
For McCoy & McCoy, Inc.

Office and Laboratories:
Lexington, Kentucky
Madisonville, Kentucky
Paducah, Kentucky
Pikeville, Kentucky

McCOY
& McCOY, INC.

Environmental Consultants

P. O. Box 238 • 85 East Noel Avenue • Madisonville, Kentucky • Phone 502-821-7375

REPORT DATE: 6/24/82

PAGE NO: 1

Dames & Moore
Attn: Steve Lamb
3399 Tates Creek Road
Lexington, KY 40502

Location No.: ICRC Sample #6

Sample Date: 4/16/82

REPORT OF CHEMICAL ANALYSIS

TEST DESCRIPTION	UNIT	RESULTS
Arsenic	ppm	0.017
Barium	ppm	0.19
Cadmium	ppm	<0.001
Chromium	ppm	0.056
Copper	ppm	<0.03
Iron	ppm	2.93
Lead	ppm	<0.001
Manganese	ppm	0.10
Mercury	ppb	<0.2
Selenium	ppm	<0.001
Silver	ppm	<0.001
Zinc	ppm	<0.03
Chloride	ppm	9.0
Fluoride	ppm	0.22
TDS	ppm	404.0
Turbidity	N.T.U.	29
Color	P.C.U.	28.0
Corrosivity	L.I.	0.75
Acidity	ppm	-19.6
TSS	ppm	13.0
Hardness	ppm	305.0
Sulfate	ppm	108.0
Odor	T.O.N.	1
pH	STD	7.89
Sodium	ppm	11.6

Office and Laboratories:
Lexington, Kentucky
Madisonville, Kentucky
Paducah, Kentucky
Pikeville, Kentucky

McCOY
& McCOY, INC.

Environmental Consultants

P. O. Box 238 • 85 East Noel Avenue • Madisonville, Kentucky • Phone 502-821-7375

REPORT DATE: 6/24/82

PAGE NO: 2

Dames & Moore
Attn: Steve Lamb
3399 Tates Creek Road
Lexington, KY 40502

Location No.: ICRC Sample #6

Sample Date: 4/16/82

REPORT OF CHEMICAL ANALYSIS

TEST DESCRIPTION	UNIT	RESULTS
Calcium	ppm	81.7
Silica	ppm	18.5
Cyanide	ppm	< 0.02
Nitrate	ppm	< 0.1
Hydrogen Sulfide	ppm	< 0.01
Carbonate	ppm	0.0
MBAS	ppm	0.20

Appearance - Low suspended solids, light brown appearance.

All analysis performed as per 15th Edition Standard Methods for Water and Wastewater Analysis and EPA Methods for Chemical Analysis of Water & Waste #60014-79-020.

By Steve Wolf
For McCoy & McCoy, Inc.

Office and Laboratories:
Lexington, Kentucky
Madisonville, Kentucky
Paducah, Kentucky
Pikeville, Kentucky

McCOY
& McCOY, INC.

Environmental Consultants

P. O. Box 238 • 85 East Noel Avenue • Madisonville, Kentucky • Phone 502-821-7375

REPORT DATE: 6/24/82

PAGE NO: 2

Dames & Moore
Attn: Steve Lamb
3399 Tates Creek Road
Lexington, KY 40502

Location No.: ICRC Sample #7

Sample Date: 4/17/82

REPORT OF CHEMICAL ANALYSIS

TEST DESCRIPTION	UNIT	RESULTS
Calcium	ppm	85.5
Silica	ppm	18.5
Cyanide	ppm	< 0.02
Nitrate	ppm	< 0.1
Hydrogen Sulfide	ppm	< 0.01
Carbonate	ppm	0.0
MBAS	ppm	0.19

Appearance - Low suspended solids, light brown appearance.

All analysis performed as per 15th Edition Standard Methods for Water and Wastewater Analysis and EPA Methods for Chemical Analysis of Water & Waste #60014-79-020.

By Don Welch
For McCoy & McCoy, Inc.

Office and Laboratories:
Lexington, Kentucky
Madisonville, Kentucky
Paducah, Kentucky
Pikeville, Kentucky

McCOY
& McCOY, INC.

Environmental Consultants

P. O. Box 238 • 85 East Noel Avenue • Madisonville, Kentucky • Phone 502-821-7375

REPORT DATE: 6/24/82

PAGE NO: 1

Dames & Moore
Attn: Steve Lamb
3399 Bates Creek Road
Lexington, KY 40502

Location No.: ICRC Sample #7

Sample Date: 4/17/82

REPORT OF CHEMICAL ANALYSIS

TEST DESCRIPTION	UNIT	RESULTS
Arsenic	ppm	0.018
Barium	ppm	0.20
Cadmium	ppm	< 0.001
Chromium	ppm	0.002
Copper	ppm	< 0.03
Iron	ppm	2.99
Lead	ppm	0.001
Manganese	ppm	0.09
Mercury	ppb	< 0.2
Selenium	ppm	< 0.001
Silver	ppm	< 0.001
Zinc	ppm	< 0.03
Chloride	ppm	11.0
Fluoride	ppm	0.22
TDS	ppm	404.0
Turbidity	N.T.U.	30
Color	P.C.U.	35.0
Corrosivity	L.I.	0.79
Acidity	ppm	-19.2
TSS	ppm	11.0
Hardness	ppm	317.0
Sulfate	ppm	108.0
Odor	T.O.N.	1
pH	STD	7.91
Sodium	ppm	11.6

APPENDIX G
QUALITY ASSURANCE AUDITS

Dames & Moore

1550 Northwest Highway
Park Ridge, Illinois 60068
(312) 297-6120
TWX: 910-253-4097 Cable address: DAMEMORE

April 15, 1982

McCoy & McCoy, Inc.
85 East Noel Avenue
Madisonville, Kentucky 42431

Attention: Mr. Scott R. Smith
Director of Mining

Gentlemen:

Re: Dames & Moore Prequalification Audit

Attached is Dames & Moore's report of the quality assurance prequalification audit conducted on March 24, 1982 of the McCoy & McCoy, Inc. environmental laboratory in Madisonville, Kentucky.

We are satisfied with the McCoy & McCoy quality assurance program and its implementation at the Madisonville laboratory. No adverse findings were noted during the audit; one observation was made. Dames & Moore, therefore, recommends that McCoy & McCoy be accepted as a qualified sub-contractor.

I wish to thank Messrs. Smith, Chaney and Leasure for their cooperation and courtesy extended to the Dames & Moore audit team.

Should you have any questions concerning this audit report, please do not hesitate to call.

Very truly yours,

DAMES & MOORE

Elizabeth Neskow
Certified Lead Auditor

EN:jag

Attachment

cc: S. Lamb - LX
J. Knauss - LX
A. Pisano - SR
H. Chan - SF
Project File - LX

AUDIT REPORT

I. PURPOSE OF AUDIT

This prequalification audit was conducted on McCoy & McCoy, Inc. Environmental Consultants to evaluate the acceptability of their quality assurance program, their technical work and financial standing. The audit was performed for the International Coal Refining Company project, Dames & Moore Lexington, Kentucky office.

II. AUDIT BASIS

This audit was performed in compliance with the Dames & Moore Quality Assurance Manual, third edition dated October 1979, QA Procedure 4.10 - Prequalification of Suppliers/Subcontractors, and the Project QA Plan.

III. TIME AND PLACE

The audit was conducted on March 24, 1982 at the McCoy & McCoy Madisonville, Kentucky laboratory at 11:30 a.m.

IV. PERSONNEL CONTACTED

Scott R. Smith - Director of Mining
Gerald L. Chaney - Laboratory Supervisor
H. Brooks Leasure - Vice President

V. DAMES & MOORE AUDIT TEAM MEMBERS

Kurt O. Thomsen - Project Hydrologist
Elizabeth Neskow - Certified Lead Auditor

VI. SUMMARY OF EVENTS

A. Initial Meeting

The audit team members met with Messrs. Smith, Chaney and Leasure to present the audit agenda and review the audit checklist. The auditor indicated those areas of interest and what type of documentation she would like to review.

AUDIT REPORT (continued)

B. Physical Audit

All items in the checklist were discussed in detail. McCoy & McCoy prepared an extensive book containing responses to the checklist items, sample forms, job descriptions of personnel working on the Dames & Moore project, and general information about the firm and various laboratory procedures. Where applicable, Mr. Smith and Mr. Chaney provided documentation as verification of QA activities and proper implementation of the McCoy & McCoy QA program.

Messrs. Smith and Chaney then led the Dames & Moore auditors on a tour of the laboratory. Random samples were tracked from receipt inspection through the entire testing process to completion and data analysis. Several Dames & Moore samples were reviewed that were in the testing process. All aspects of receipt inspection, document control, testing, shipping and recording were viewed and noted.

C. Exit Interview

At the conclusion of the audit, a brief meeting was held during which the auditors indicated that they were pleased with the McCoy & McCoy QA program and its satisfactory implementation at the Madisonville, Kentucky laboratory. No adverse findings were noted.

VII. OBSERVATIONS

During the tour of the facility, Mr. Thomsen discussed with Mr. Chaney certain aspects of the standard curve data and recommended that the following practice be followed in order to achieve a more correct curve.

It is recommended that linear regression analysis of the standard curve data be conducted as a routine practice. This type of analysis results in an equation for the line which best fits the data. The equation is in the form of: $y = a + bx$

where x = independent variable (concentration)
 y = dependent variable (%T, peak height, etc.)
 a = intercept
 b = slope

This equation is rearranged and used to calculate concentrations from instrument output data:

AUDIT REPORT (continued)

$$x = \frac{y - a}{b}$$

The concentrations resulting from the use of the above equation are not significantly better than those arrived at through the use of current practices, but they have more credibility due to the statistics involved.

Manipulation of linear regression analysis data allows the laboratory personnel to maintain statistically sound tracking records for methodologies and/or instruments over time. This data can be used to test if $a = 0$ and to determine confidence interval (99 or 95%) for the intercept. If $a = 0$ is found to be true, one has the expected results. An intercept (a) greater than zero may indicate a response by the reagents used in the blank or contamination of the blank. If shown to be consistent, this response can be subtracted from all data points. If the intercept (a) is less than zero, adsorption and/or an unknown reaction may be occurring.

A comparison should be made between the current regression line and a previous or generic regression line. A generic regression line is one which is developed by determining the average intercept ($\bar{a}$) and slope ($\bar{b}$) of a series of regressions. The equation for a generic line is:

$$y = \bar{a} + \bar{b}x$$

Once a statistical comparison has been made, the current data is used to determine a new generic line. All of the above statistical manipulations are outlined in most statistics text books such as:

Brownlee, K.A. 2nd ed. (1965) Statistical Theory and Methodology In Science and Engineering. John Wiley & Sons, Inc., New York.

VIII. FOLLOW-UP

As no adverse findings were noted during this prequalification audit, it is recommended that McCoy & McCoy be accepted as a qualified subcontractor for aquatic laboratory testing and analysis. A technical surveillance of work in process will be scheduled at a later date in order to verify implementation of the McCoy & McCoy QA program. McCoy & McCoy will be notified in advance of this date.