



WATER-RIGHT DOCKET

Ozark National Scenic Riverways

Docket No: 1

WELL. OWLS BEND, NORTH

Supporting Hydro Data

05-19-1972: memorandum to office of natural science studies from supervisory hydraulic engineer regarding water right docket #1

May 19, 1972

of Natural Science Studies, WASO
ion: Chief, Division of Water Resources

From: Supervisory Hydraulic Engineer, MWR

Subject: Water Right Docket #1, Owls Bend, North, Ozark NSR

Enclosed for your information and files are copies of the Drillers Log, U.S. Geological Survey Water Analysis of August 18, 1969, and an Electric Log dated May 3, 1968.

Please add these to Water Right Docket #1, Owls Bend, North, also referred to as Powder Mill Ferry. Additional material will be transmitted when received by this office.

(Sgd.) Richard W. Ketcham
Richard W. Ketcham

Enclosures

cc:
Supt., Ozarks

MWR-PS Mr Reid

RWKetcham:sg

Driller's Log

<u>Depth</u>	<u>Thickness</u>	<u>Formation</u>
0-36	36	Residuum
36-56	20	Lime; water
56-80	14	Lime and flint; water up to 10+ gpm.
80-170	90	Lime, little sand; 30 gpm @ 135 ft. gradual increase in flow.
170-180	10	Open.
180-185	5	Loose and shelly; 40 gpm.
185-200	15	Solid lime and flint; water 60 gpm.
200-303	100	Solid lime and flint; gradual increase in flow to 100 gpm.

UNITED STATES DEPARTMENT OF THE INTERIOR
 GEOLOGICAL SURVEY
 WATER ANALYSIS

2GW

Location 29N-2W-16bba Powder Mill Ferry County Shannon
 Source Drilled Well Depth (ft) 307 Diam (in.) 6 1/4
 Cased to (ft) 202 Date drilled 6-4-68 Point of coll. @ Pump House
 Owner National Park Service
 Treatment Potosi Dolomite Use Visitors Center
 WBF Potosi Dolomite Yield 50 gpm
 Temp (°F) 59 Appear. when coll. Slightly turbid
 Collected 8-15-69 By W. S. Oakes
 Remarks Field Conductance 345 mmhos #

	ppm	epm		ppm	epm
Silica (SiO ₂)	7.3		Bicarbonate (HCO ₃)	222	3.64
Aluminum (Al)			Carbonate (CO ₃)	0	0
Iron (Fe)	.85				
			Sulfate (SO ₄)	2.6	.05
			Chloride (Cl)	.7	.02
			Fluoride (F)	.0	.00
Calcium (Ca)	39	1.95		.6	.01
Magnesium (Mg)	22	1.81	Nitrate (NO ₃)		
Sodium (Na)	1.6	.07	Phosphorus (PO ₄)	.01	
Potassium (K)	.7	.02			
Total		3.85	Total		3.72

	ppm		
Dissolved solids:		Specific conductance (micromhos at 25° C)	344
Calculated	182	pH	7.9
Residue on evaporation at 180°C	186	Color	3
Hardness as CaCO ₃	188		
Noncarbonate	6		

Lab. No. _____ Field No. _____ Project _____
 *Chlorinator off; Flushed pressure tank. Sample collected
 1 hour after pumping.



UNITED STATES
DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY
Water Resources Division
P.O. Box 340
Rolla, Missouri 65401

January 20, 1971

Mr. Don Barrett
U.S. Department of Interior
National Park Service
Western Service Center
450 Golden Gate Ave., Box 36035
San Francisco, California 94102

Dear Mr. Barrett:

Enclosed are reports of the wells drilled at Round Spring, Alley Spring and Big Spring. Each report consists of:

1. Location map of well with respect to the 50-year flood.
2. Description of the drilling and completion of the well.
3. Insoluble residue log by Missouri Geological Survey.
4. Driller's log.
5. Pump test data and drawdown curves.
6. Water analysis by Missouri Geological Survey.
7. Copy of strip chart from observation well at Round Spring only.

In addition we are furnishing a summary of the data obtained from the ~~six~~ wells drilled to date and their relationships to the knobs area in the vicinity of Eminence and Two Rivers and to the specific capacity map of the southern part of Missouri taken from Mineral and Water Resources of Missouri.

Time spent on the well drilling activities at the three sites consisting of well location, drilling, pump testing and report writing is summarized below:

Walter Oakes	34 days well location, drilling & pump testing.
Gerald Feder	2 days pump testing.
Leo Emmett	4 days pump testing & data analysis.
E. J. Harvey	6 days, drilling, pump testing & report writing.

It has been a pleasure to work with you on the drilling activities. If you have any questions regarding these reports or the data gathered please do not hesitate to write us.

Sincerely,

E. J. Harvey

*E. J. Harvey
Assistant District Chief*

Enclosures

SUMMARY

We are including a summary of the drilling to date in the tabulation below. The wells are listed in the order of decreasing specific capacities.

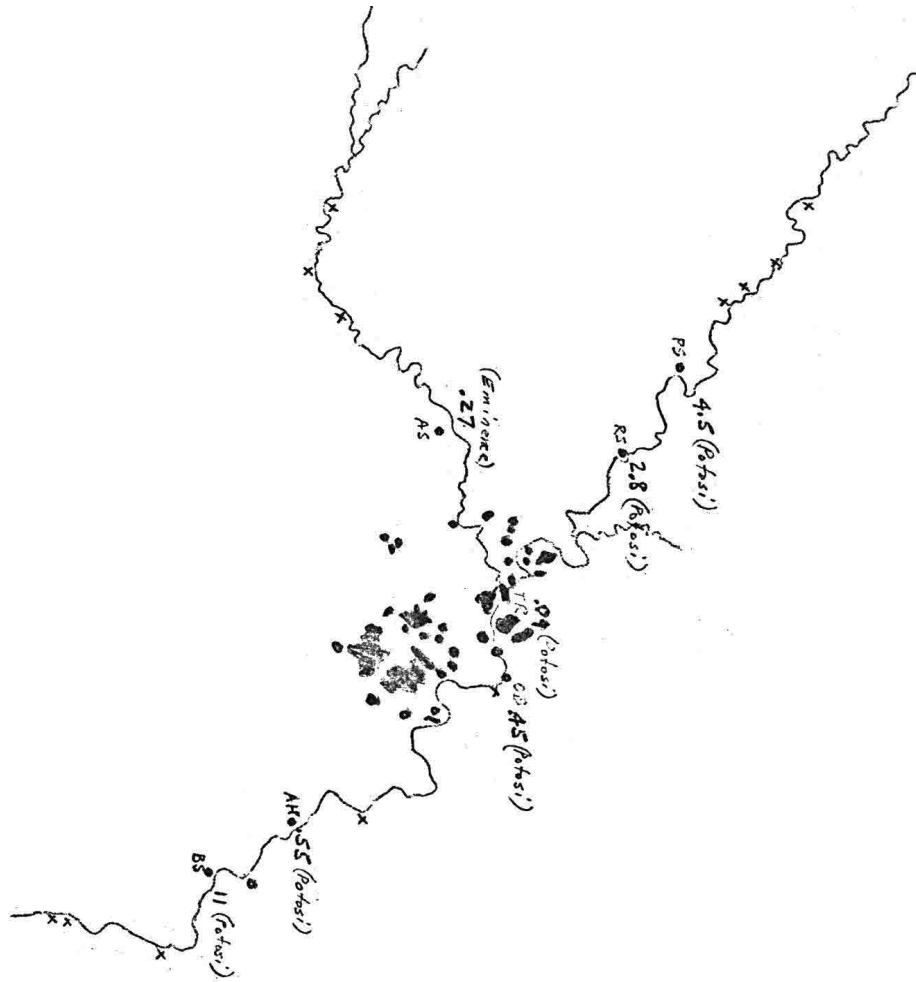
<u>Site</u>	<u>Formation penetrated</u>	<u>T.D.</u>	<u>Casing depth</u>	<u>Open Hole Dia.</u>	<u>Length</u>	<u>Yield</u>	<u>DD</u>	<u>Sp. Cap.</u>
Big Spring	Potosi 190-520	520	370	8	150	230	20	11
Pulltite Spring	Potosi 240-310	308	205	6	103	118	26	4.5
Round Spring	Potosi 180-400	400	200	8	200	120	43	2.8
Austin House	Potosi 225-250	250	200	8	50	6	11	.55 *
Owls Bend	Potosi 75±303	303	202	6	101	50	112	.45
Alley Spring	Eminence 475-650	650	300	8	350	55	214	.26
Two Rivers	Potosi 160-350	350	100	8	250	11	110	.10

Some significance may become apparent from a comparison of the results in the tabulation, the graphs of the wells drilled, and the map showing their locations with respect to the igneous knobs in the area around Eminence. The wells at Big Spring, Pulltite Spring, Round Spring, Owls Bend and Two Rivers penetrated a substantial part of the Potosi section. The Austin House well penetrated a small part of the section. Big Spring well is located farthest from the center of the igneous knobs and had the highest specific capacity (11 gpm per foot of drawdown). Pulltite Spring well is a little closer in and has a good specific capacity (4.5 gpm per foot of drawdown). Austin House well, although it penetrated only a few feet of the Potosi, had a specific capacity that was much lower than those at Pulltite and Round Springs, but was higher than those obtained at Owls Bend and Two Rivers. Owls Bend well near the eastern flank of the knobs area had a rather low specific capacity for the thickness of Potosi penetrated but not as low as that of the Two Rivers well which probably penetrated most of the Potosi section. The Two Rivers well is essentially surrounded by igneous knobs. The well at Alley Spring did not penetrate the Potosi and for this reason is not included in the comparison.

* Rounding of numbers I had done in the past accounts for some small differences in the two tables and the figures shown on the map.

The comparison suggests that circulation of water in the Potosi is slower and retarded in the knobs area perhaps because of lack of fracture and bedding plane openings through which water might travel. Mineralization along fractures may have sealed openings to retard flow. Whatever the cause, lower yields might be expected in the knobs area and higher yields outside the knobs. Of course exceptions to this probably will be found as additional sites are developed.

Projected yields for various pumping levels				
SWL (feet)	PWL (feet)	DD (feet)	Yield (gpm)	Sp. Cap. (gpm/ft)
BIG SPRING				
53	78	25	280	11
	100	47	515	
	150	97	1,007	
	370	317	3,500	Bottom of casing
PULLTITE SPRING				
32	58	26	118	4.5
	100	68	306	4.5
	150	118	530	4.5
	200	168	760	4.5 Bottom of casing
ROUND SPRING				
80	123	43	120	2.8
	150	70	196	2.8
	175	95	266	2.8
	200	120	336	Bottom of casing
AUSTIN HOUSE				
57	102	45	23	.51
	150	93	47	
	200	143	73	Bottom of casing
OWLS BEND				
45	155	110	50	.45
	200	155	70	Bottom of casing
ALLEY SPRING				
55	270	215	58	.27
	300	245	66	Bottom of casing
TWO RIVERS				
92	210	118	11	.09
				This pumping level is 110 ft. below bottom of casing.



X Proposed future sites
4.5 Specific capacity
Taneke Knobs

conado Dolomite at an average depth of 500 to 600 feet. The wells that produce from this section are ideal for clubs, schools, small towns, and industries.

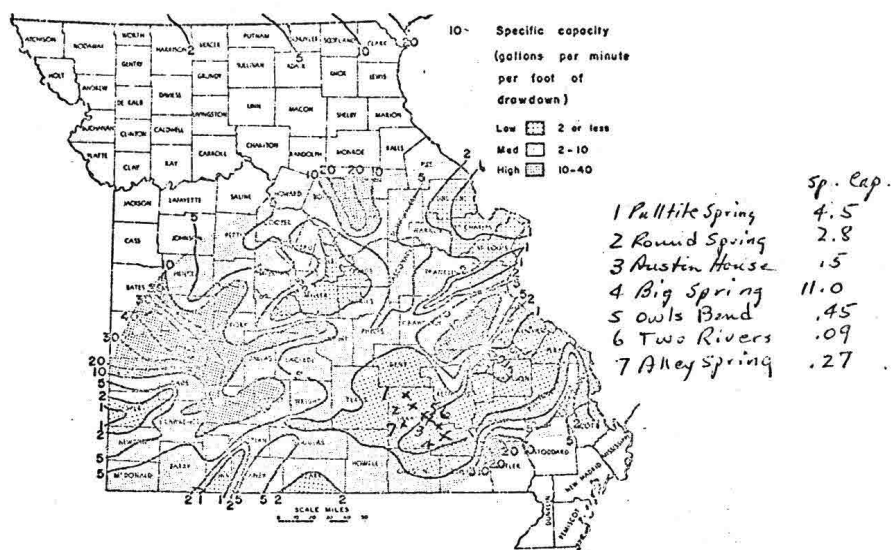


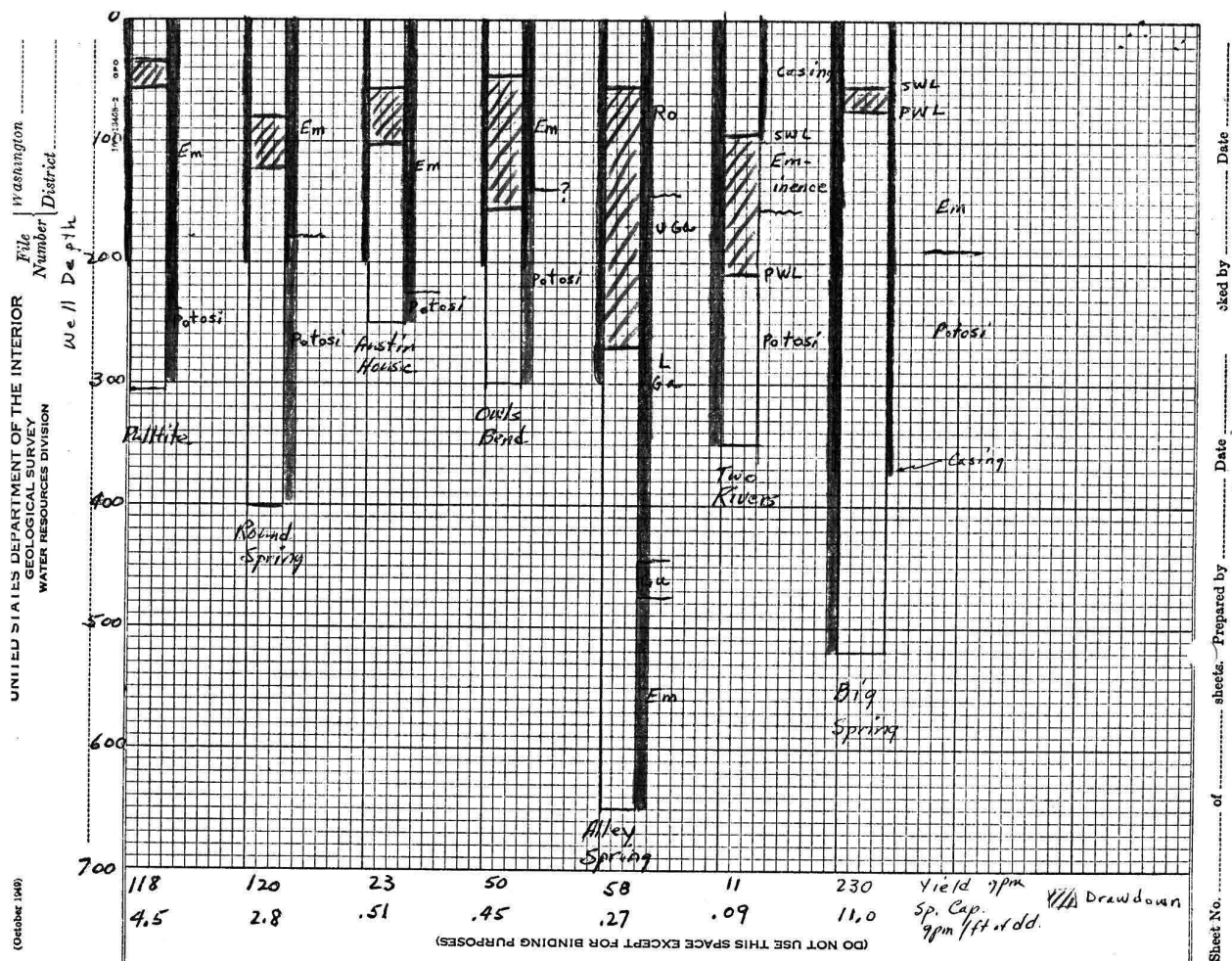
FIGURE 66.—Specific capacities of typical wells in the Ozarks.

Throughout the area numerous municipal and industrial wells yield 500 to 1,000 gallons per minute. These wells vary in depth. Wells that produce 300 to 500 gallons per minute average 1,000 to 1,500 feet in depth. Wells at Springfield in Greene County, for example, average 1,400 to 1,700 feet in depth and produce 300 to 1,000 gallons per minute. Wells at Rolla in Phelps County and Sullivan in Franklin County are 1,000 to 1,200 feet in depth and produce 400 to 600 gallons per minute.

Throughout the area requirements of 15 to 25 gallons per minute can normally be met by drilling to a depth of 300 to 350 feet through the Roubidoux Formation. This is usually an ideal depth for farm wells. Private wells for farms and dwellings in the central Ozarks average 300 feet in depth, whereas in the southwest part of the State the average depth to the Roubidoux is 800 feet.

Descriptions of aquifers

Lamotte Sandstone.—The Lamotte Sandstone is geologically the oldest aquifer in the State and is the basal unit of the Cambrian Sys-





UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Water Resources Division
P.O. Box 340
Rolla, Missouri 65401

August 2, 1968

Mr. Garland Moore
Washington Service Center
National Park Service
Arlington, Va. 22200

Dear Garry,

As part of our report on the well at the Owl's Bend site we are submitting the enclosed water analysis made by the Missouri Geological Survey. We sent a sample also to our laboratory at Little Rock and will send a copy of that analysis as soon as we receive it.

The sample was collected toward the end of the eight-hour pump test before the water had entirely cleared. The only abnormal characteristic of the water seems to be the iron content. This should decline to acceptable limits with use of the well.

Sincerely yours,

E. J. Harvey
Assistant District Chief

Enclosure

8/5

P.S. We ran the Hanna way log at Pullright Spring and got to the bottom. Made a good log.

MISSOURI DIVISION GEOLOGICAL SURVEY AND WATER RESOURCES
Rolla, Missouri

County: *Shannon* Source: *Well T.D. 303' 200'csg. S.W.L. 45'*
 Owner: *Park Service*
 Location: *Sec. 16, T29N, R3W at Owl's Bend, on Current River*
 Analysis No: *6226* Date Collected: *6-17-68* Analyst: *M.E. Phillips*
 Collector: *E.J. Harvey* Date Analyzed: *7-29-68*

CONSTITUENTS	IN PARTS PER MILLION
Turbidity	<i>light-colored</i> Suspended Matter <i>Passes thru Filter Paper</i>
Odor	<i>None</i>
pH	<i>7.6</i>
Alkalinity (CaCO ₃)	<i>193.0</i>
Phenolphthalein	<i>12.0</i>
Methyl Orange	<i>181.0</i>
Carbonate (CO ₃)	<i>7.2</i>
Bicarbonate (HCO ₃)	<i>220.8</i>
Silica (SiO ₂)	<i>6.2</i>
Oxides (Al ₂ O ₃ , Fe ₂ O ₃ , TiO ₂ , etc.)	<i>5.2</i>
Calcium (Ca)	<i>36.5</i>
Magnesium (Mg)	<i>21.0</i>
Sodium (Na) ~~and Potassium (K) as Na~~	<i>1.8</i>
~~Potassium K~~	<i>0.8</i>
Total Manganese (Mn)	<i>0.20</i>
Total Iron (Fe)	<i>20.8</i>
Dissolved Iron	
Precipitated Iron	
Sulfate (SO ₄)	<i>1.2</i>
Chloride (Cl)	<i>4.5</i>
Nitrate (NO ₃)	<i>0.0</i>
Fluoride (F)	<i>0.0</i>
Total Suspended Matter	
Total Dissolved Solids	<i>203.</i>
Total Hardness	<i>177.6</i>
Carbonate Hardness	<i>177.6</i>
Non-carbonate Hardness	<i>0.0</i>

Remarks:

Copies to:



UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Water Resources Division
P.O. Box 340
Rolla, Missouri 65401

Handwritten signatures and initials in the top right corner.

June 24, 1968

Mr. Garland Moore
Washington Service Center
National Park Service
Arlington, Va. 22200

Dear Mr. Moore:

Enclosed is our report on the well at *Owls Bend, North.* (Powder Mill Ferry.) We will send the mineral analysis of the water as soon as it is received. Enclosed are the following:

1. Description of drilling, pumping test procedures and well logging.
2. Sample log furnished by Mr. Robert Knight, geologist, Missouri Geological Survey and Water Resources.
3. Electric (Widco) log of well from 202 to 303 feet. (We sent a copy of the electric log of the upper part of the well).
4. Gamma ray log of entire well.
5. Water-level measurements taken during the pumping test.

If you have any questions about the interpretation of the enclosed, please let us know. It has been a pleasure working with you, Troy Carr, and Dave Thompson on this project.

Sincerely yours,

Handwritten signature of E. J. Harvey.

E. J. Harvey
Assistant District Chief

Enclosures

OWL'S BEND WELL

Powder Mill Ferry Site

The well first penetrated about 36 feet of slick, bally clay with no measureable water yield. At the top of the bedrock was a rubbly, weathered zone which yielded about 10 gpm (gallons per minute). From 36 feet to 170 feet the drilling was fairly uniform with mostly slow, hard drilling with a few open zones. The yield through this section increased to about 30 gpm. At 170 feet a 10 foot cavity was encountered. The bit dropped to 180 feet where it encountered a very loose, cherty-drusy zone 5 feet thick. This zone yielded the first white, shelly chert cuttings characteristic of the Potosi Formation. The yield through this zone increased to about 40 gpm and the water became quite muddy. Between 185-200 feet the drilling was quite hard and slow with a gradual increase in flow to 60 gpm. Between 200 and 303 feet the drilling was fairly uniform with mostly hard, slow drilling and some loose porous zones. The yield gradually increased to 100 gpm.

Constant caving of material from the loose zone underlying the cavity at 170 feet caused much trouble in the completion of the well. The first geophysical logger (STAR JET) could not penetrate the cave zone despite several attempts by the driller to clear the hole. Reaming the hole and setting the casing was also very difficult due to the cave zone. Despite long periods of blowing cuttings from the hole, more cuttings would fall into the hole from the cave zone. After the casing was finally set at 202 feet, 123 sacks of cement grout was used to cement the casing. Most of the cement apparently went to fill the cave zone and the overlying cavity. No cement appeared at the surface. After the cement dried the plug was drilled out and the hole was cleaned out to the bottom. The hole was blown with air and surged several times to develop it. After 4 hours of blowing, the well produced about 60 gpm. On June 13th, a 7½ horsepower submersible pump was set at 190 feet and an 8-hour pump test made. The well was pumped at 50 gpm for 6 hours with 112 feet of drawdown giving a specific capacity of about 0.45 gallons per minute per foot of drawdown. The well was then pumped at 20 gpm for 2 hours and the water level recovered to 90 feet, giving a specific capacity of about 0.45 gallons per minute per foot of drawdown. At the end of the test the water level was still recovering so that the final specific capacity probably would have been greater than 0.45 gallons per minute per foot of drawdown.

The water was still slightly muddy when pumped at 50 gpm, but cleared considerably when pumped at 20 gpm. The well should gradually clear up as it is pumped. The present pump installation calls for a 20 gpm yield with a pump setting of 200 feet. If at a future date 50 gpm is required from the well it could easily be obtained with a larger pump set at 200 feet. Note on the enclosed semi-logarithmic plot of the water-level data that the water level was declining at a slow, though uniform, rate from about 120 to 360 minutes when the yield was decreased to 20 gpm. Extending the drawdown curve the measured data shows that with continuous pumping of 50 gpm for 1 week would result in a pumping level of about 180 feet.

After the pump test was completed a gamma-ray log of the entire hole was run. An electric log of the portion of the hole below the casing was also run to fill in most of the portion missed during the first attempt to log the hole.

STATE OF MISSOURI
DIVISION OF
GEOLOGICAL SURVEY AND WATER RESOURCES

LOG NO.
23327

OWNER
S. G. Park Service

COUNTY
Shannon

FARM
Powder Mill Campsite

WELL NO.

DRILLER
L. D. Doughtard

DATE
2/2/68

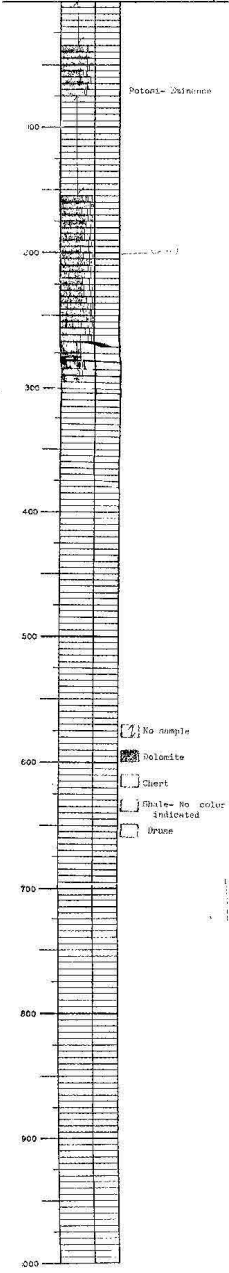
ELEV.
625'

PROD.
1.2' at 10'

LOGGED BY
H. L. Davis

INDEX SHEET NO.

REMARKS
23327-23328



Owls Bend Well - Pump Test

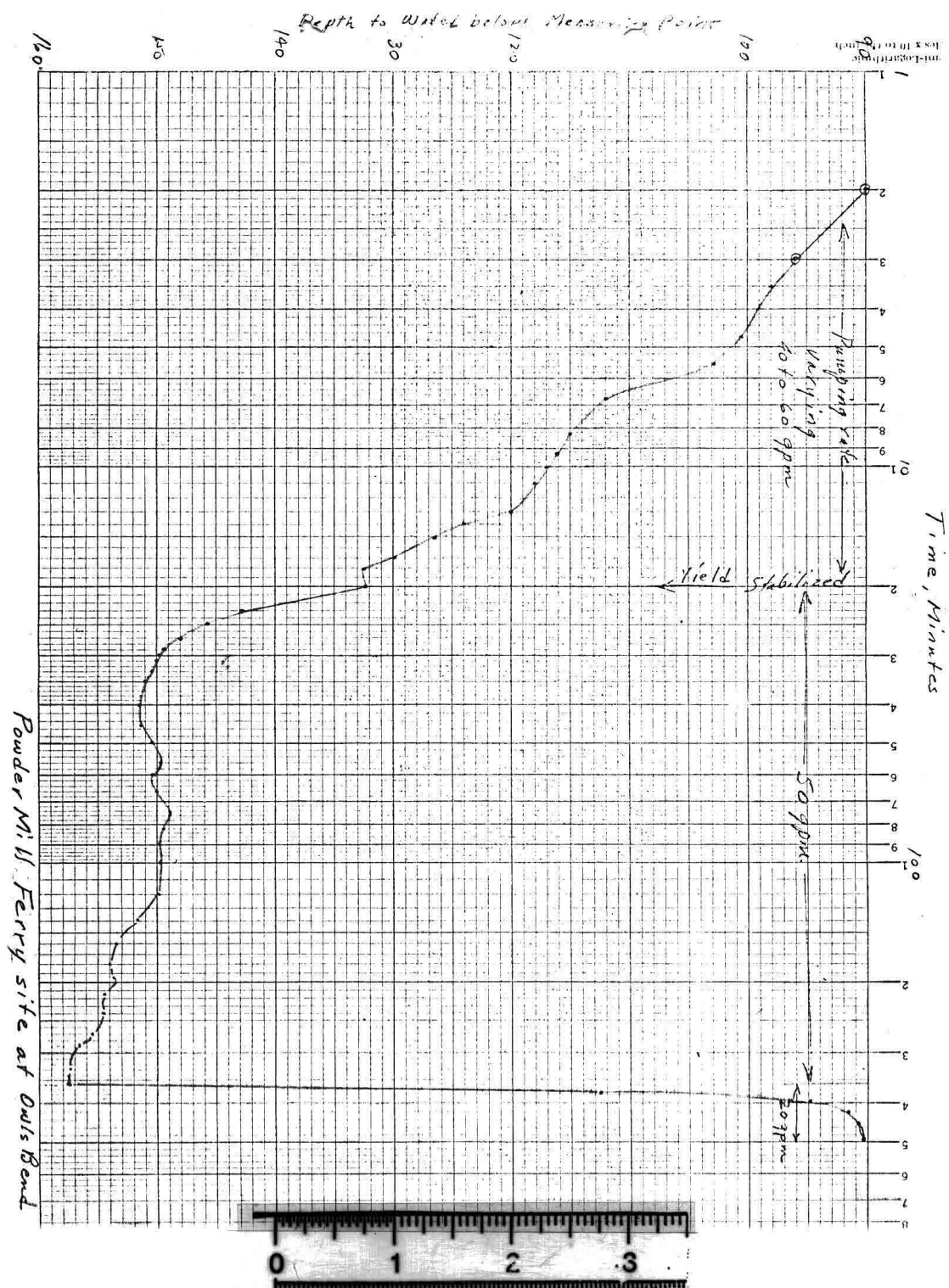
June 13, 1968

G. L. Feder & E. J. Harvey
K. D. Brashears & Troy Carr

Pumping Rate (gal per min)	Time from Start (min)	Depth to Water (feet)	Remarks
0	-1 min.	44.67	Measuring point top of table 3.2' above ground level.
40	0	---	Pump turned on at 1625 hrs.
40	2 55 sec.	90.0	Water reddish brown at start.
40	3 00 sec.	96.0	Clearing as pumping continued.
46	4 40 sec.	96.0	
46	5 30 sec.	105.8	
50	6 45 sec.	112.0	
50	8 20 sec.	115.0	
50	9 15 sec.	116.0	
50	10 00 sec.	117.0	
40	11 00 sec.	118.0	
40	13 00 sec.	119.0	
50	14 00 sec.	124.0	
50	15 00 sec.	126.4	
43	17 00 sec.	130.0	
60	18 00 sec.	132.3	
40	20 00 sec.	132.2	
50	23 00 sec.	142.7	
50	25 00 sec.	145.7	
50	27 00 sec.	148.0	
50	29 00 sec.	149.4	
50	30 00 sec.	149.8	
50	31 00 sec.	150.0	
50	33 00 sec.	150.4	
50	35 00 sec.	151.0	
50	40 00 sec.	151.45	
50	45 00 sec.	151.30	Conductance 370 mhos - Temp. 59°F
50	50 00 sec.	150.40	
50	56 00 sec.	149.85	
50	60 00 sec.	150.4	
50	66 00 sec.	150.0	
50	75 00 sec.	148.9	
50	82 00 sec.	149.4	Water Temp. 59°F.
50	90 00 sec.	149.8	
50	101 00 sec.	149.7	
50	120 00 sec.	149.9	
50	140 00 sec.	151.6	
50	160 00 sec.	153.2	
50	180 00 sec.	154.0	
50	195 00 sec.	153.6	
50	215 00 sec.	154.3	Time - 2020 hrs.--Cond. 360 at 59
50	240 00 sec.	154.5	
50	270 00 sec.	155.5	
50	300 00 sec.	156.6	
50	330 00 sec.	157.2	
50	360 00 sec.	157.2	
20	365 00 sec.	---	Cut pump back to 20 gpm.
20	375 00 sec.	112.4	Water clearing, much lighter than it was at end of 50 gpm. pumping period.
20	395 00 sec.	94.8	
20	420 00 sec.	91.5	
20	450 00 sec.	90.7	Cond. 360 at 59°F.
20	485 00 sec.	90.3	Water still clearing. Water sample taken.

Pump turned off at about 490 minutes.

6/14/68 at 0900 hrs. W.L. 43.95' below kelly. Turned pump on at 0930, at 1030 hrs. W.L. 85.2 at 20 gpm. Conductance of water 380 at 59°F., water samples taken. Water still slightly turbid. At 1100 hrs. W.L. 85.9'. Samples for mineral analysis taken at 480 minutes after pump was turned on.



Other Supporting Information

Form Approved
OMB No. 158-R0116

U.S. ENVIRONMENTAL PROTECTION AGENCY WATER PROGRAM OPERATIONS (WH-450) WASHINGTON, D.C. 20460		INVENTORY OF PUBLIC WATER SUPPLIES* (See instructions on the reverse)		KEY IDENTIFICATION NUMBER 1 2 3 4 5 6 7 8 9 10 11 12 13 14														
NAME OF WATER UTILITY 15 USNPS OZARK NATL SCENIC RIVERWAY 46																		
ADDRESS 47 PO BOX 448 76																		
CITY 77 YAN BUREN 101																		
COUNTY 102 SHANNON 126																		
STATE 127 MO 128		ZIP 129 63965 133		PHONE AREA CODE 134 314 136														
				TELEPHONE NUMBER 137 3234236 143														
UTILITY OWNER (Check one) (144)																		
☐ MUNICIPALITY, DISTRICT, ETC. ☐ INVESTOR ☒ FEDERAL ☐ STATE ☐ OTHER (Specify in remarks)																		
RETAIL POPULATION SERVED 145 * 1500 153		NUMBER SERVICES 154 4 160		NUMBER METERS 161 1 167														
NUMBER OF WHOLESALE CUSTOMERS 168 0 170																		
PREDOMINANT CHARACTERISTIC(S) OF YOUR SERVICE AREA																		
COMMUNITY COMPANY TOWN RECREATION AREA MOBILE HOME PARK INSTITUTION SCHOOL OR COLLEGE MOTEL RESTAURANT SERVICE STATION CAMPGROUND PICNIC AREA LODGE WIRING SKI RESORT BATHING AREA VISITOR CENTER HIGHWAY SAFETY REST AREA AIRPORT OTHER (Specify in remarks)																		
CAPACITIES																		
PRODUCTION, NORMAL OPERATION (Gal/Day) 190 25000 199		EMERGENCY POWER ONLY (Gal/Day) 200 0 209																
DISTRIBUTION STORAGE, GRAVITY FLOW (Gallons) 210 20000 219																		
PRODUCTION																		
AVERAGE DAY (Gal/Day) 220 5000 229		MAXIMUM DAY (Gal/Day) 230 8000 239																
DATE FORM COMPLETED 240 XS MO 243																		
SOURCE																		
NO.		NAME		INTAKE LOCATION			MARK (One only)		TREATMENT								LAB CONTROL	
				LATITUDE LONGITUDE														
0 1		R WELL		37 10 54 91 10 20			X										XXX	
0 2		R																
0 3		R																
0 4		R																
REMARKS (Up to 50 characters) (783 - 832)						INCLUDES AVERAGE DAILY SUMMER VISITATION												
						POWER MILL												

INSTRUCTIONS

1. **IDENTIFICATION NUMBER** – This is a 14 digit code number that geographically identifies the location of the utility. It will be filled in by EPA personnel.
2. **NAME OF WATER UTILITY** – This is the complete, official name of the utility.
3. **ADDRESS** – This is the mailing address of the utility (*this may be but does not necessarily have to be the physical location of the treatment plant*).
4. **CITY, COUNTY, STATE** – This is the city, county and state of the mailing address of the utility.
5. **ZIP CODE** – This is the zip code of the mailing address of the utility.
6. **IS THE UTILITY OWNED BY A MUNICIPALITY, DISTRICT, INVESTOR OWNER, STATE OR OTHER** (*specify in remarks*) – Place an **X** in the box that describes the type of ownership of the utility.
7. **RETAIL POPULATION SERVED - NUMBER SERVICES, METERS** – Fill in these boxes with the most current information available. Do Not include the population served by water utilities that purchase water from you wholesale.
8. **NUMBER OF WHOLESALE CUSTOMERS** – In cases where water is sold to wholesale customers (*customers who buy water from you for resale*) fill in the boxes with the number of this type of customer.
9. **WHAT IS THE CHARACTERISTIC(S) OF YOUR SERVICE AREA?** – Place an **X** in the boxes necessary to describe the predominant characteristic(s) of your service area.
10. **CAPACITIES** – Fill in these boxes with the most current information available. Report all storage that does not have to be pumped into the system, whether it is elevated or ground storage.
11. **PRODUCTION** – Fill in these boxes with the most current information available.
12. **DATE FORM COMPLETED** – Fill in the numeric designation of the month (01 - 12) and the last two digits of the year when the form was completed.
13. **REMARKS** – Additional information can be provided (*maximum of 50 Alpha and/or Numeric characters*).
14. **SOURCE AND TREATMENT** – Write in the spaces below Name the name of the river, lake, other utility, well field, or other source from which the supply of water is taken. Circle "R" for regular source or "A" for auxiliary source. If more than one source is used, use separate lines for each source. If more than four sources are used, then list on a second form starting with 05. Place an **X** in the block(s) for the types of treatment rendered the raw water. Mark each source separately.
15. **INTAKE LOCATION** – Latitude and Longitude of intake.
16. **LABORATORY CONTROL** – Place an **X** in the box for the type of types of laboratory analyses made at the treatment facility. Leave these blocks blank if no laboratory analyses are performed.

July 31, 1969

L54-MW

Memorandum

To: Supervisory Hydrologist, Division of Water Resources, SSC
From: Hydrologist, Division of Water Resources
Subject: Project Completion Reports for water systems at Owls Bend
and Pulltite Springs, Ozark

Please reproduce and distribute pertinent portions of the subject
completion reports for insertion in the docket assemblies.

The completion reports are identified as follows:

Owls Bend

Work Order No. 614-211702.
PCP No. B-7, U-9.
Date Started-3-16-68; Date completed 9-23-68.
Water system - pump, underground 10,000 gal.
Concrete water reservoir, etc.

Pulltite Springs

Work Order No. 614-211703.
PCP No. B-11, U-11.
Date started 7-9-68; Date completed 11-8-68.
Water system - pumps, 100,000 gal. ground level
Steel reservoir, etc.

(Signed)

V. A. Berté

cc:
MW-Mr. Reed, 801 Bg., Room 718

VABerté:ljc

463-6-20 e.8

W. R. Coppy

EW

L54 WSC-OLW

June 19, 1968

Memorandum

To: Chief, Design and Construction, PSC

From: Chief, Office of Land and Water Rights, WSC

Subject: Owls Bend Test Well results - Contract No. 14-10-6:960-114

On June 17 Edward J. Harvey of the U. S. Geological Survey, Rolla, Missouri, called to let us know that

1. The Tennessee U. S. Geological Survey people had made an electric and gamma-ray log of the well at Owls Bend (Powder Mill Ferry). The Tennessee office will not charge us for this service.
2. That the pump test at the Owls Bend well revealed the following:

Static water level 45 feet from top of casing.
Drawdown at 50 g.p.m. was 112 feet or 157 feet from top of casing.
At the end of six hours of pumping at 50 g.p.m. the pumping rate was cut back to 20 g.p.m.
At the end of two hours the well had recovered 67 feet or to a depth of 90 feet from top of casing.

A quick computation will reveal the following specific capacitance of the well at 50 g.p.m. is 0.445 gallons per foot of drawdown and at 20 g.p.m. the water level regained 67 feet when the pumping rate was decreased by 30 g.p.m. where the computed specific capacitance is 0.447 gallons per foot of drawdown.

In any event this is a successful well. If a total flow of 20 g.p.m. is all that is desired the minimum depth the submersible pump should be located in the well is equivalent to the following:

Depth = Depth of Static Water Level from top of casing
+ 20(0.447) + Safety factor depth.

The safety factor depth is included to account for the normal fluctuation in static water level which could be as much as 50 feet. Hence, the minimum depth of the pump as measured from the top of casing should be 104 feet at 20 g.p.m. For 50 g.p.m. the minimum depth of the pump as measured from the top of casing should be 117 feet.

If funds permit it would be desirable to locate the pump at a depth of 295 feet for maximum use of the well.

Richard L. Stanton

Richard L. Stanton

cc:
Regional Director, Midwest
Superintendent, Ozark
Chief, Branch of Water Resources, WASO

483-7-15 67

L54 WSC-OLW

July 13, 1967

1. Reed 7/13
2. Reed
3. Reed

Memorandum

To: Chief, Branch of Water Resources, WASO
From: Chief, Office of Land and Water Rights, WSC
Subject: Trip report of Garland Moore to Ozark National
Scenic Riverways

Enclosed is a copy of the subject trip report made in connection with our Water Rights and Water Resources acquisition program for the 1967 fiscal year.

Richard L. Stanton

Enclosure

cc:
Regional Director, Midwest w/c of enc.
Superintendent, Ozark w/c of enc.
Chief, D&C, PSC w/c of enc.
WASO Mr. Reed w/c of enc.
OLW



UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
WASHINGTON PLANNING AND SERVICE CENTER
1730 NORTH LYNN STREET
ARLINGTON, VIRGINIA 22209

IN REPLY REFER TO:

LS4 WSC-OLW

July 13, 1967

Memorandum Report

To: Chief, Office of Land and Water Rights, WSC

From: Hydraulic Engineer, Garland Moore, Office of Land and Water Rights, WSC

Subject: Preliminary Water Resources investigation at Ozark National Scenic Riverways, June 26 through June 30

In response to Acting Regional Director Rundell's memorandum of June 8, to Chief, Office of Land and Water Rights, Washington Planning and Service Center, the undersigned visited the Scenic Riverways to do the necessary preliminary investigation on the water resources potential of the Owls Bend Area of the Ozarks.

A meeting was held in the Superintendent's office in Van Buren, Missouri with the following in attendance:

Vernon E. Hennesay	Superintendent
Donald W. Marshall, P. E. Sr. San. Engineer	U. S. Public Health Service
C. Gordon Cummings Chief Engineer, Design	National Park Service Philadelphia Service Center
Garland Moore Hydraulic Engineer	National Park Service Washington Service Center
E. Eugene Cann Hydraulic Engineer	U. S. Geological Survey Rolla, Missouri
E. J. Harvey District Geologist	U. S. Geological Survey Rolla, Missouri

Dick Youse
Chief Ranger

National Park Service
Ozark National Scenic Riverways

J. Warren Smith
Chief, General Engineer

Missouri Division of Health

Anthony Homyk
District Engineer

U. S. Geological Survey
Rolla, Missouri

The purpose of the meeting was:

1. To become acquainted with the U. S. Geological Survey personnel and to outline our requirements of the U. S. Geological Survey participation in this program.
2. To orient myself with the immediate and long range needs of the Riverways.

During the meeting, the U. S. Geological Survey was informed that the Owls Bend Area had the highest priority of work at this time and that their technical assistance was requested in the drilling of the well; we would require that a geo-hydrological study be made on the availability of ground water in 17 other sites to be developed along the Current and Jack Forks Rivers. Historical data of floods in the area should also be prepared and included in this report.

Mr. Homyk agreed and will prepared a proposal with cost estimates for our acceptance as soon as he receives a copy of the General Development Plan of the Ozark National Scenic Riverways, NSR-OZA-MP-1 (being assembled).

Development - Schedule:

In accordance with the "Proposed Role of Missouri Parks in Ozark National Scenic Riverways - Public Law 88-492," enacted on August 27, 1964, wherein the Secretary of the Interior with the concurrence of the State of Missouri shall include in the OZNSR the following State Parks: Big Spring, Allen Spring, and Round Spring. It will probably develop that when title of the land is transferred to the Government. The three state parks will receive top priority insofar as construction is concerned in order to update its physical facilities. The transfer of title of these lands was delayed in the State Legislative Committee this fiscal year. The most optimistic date I have received when we shall be able to do any exploratory well drilling and construction in the area

will be in the 1970 fiscal year. Development priorities have been continually shifting because of land acquisition difficulties and other reasons.

OWLS BEND

The present development envisioned for the east side of the Current River at Owls Bend are: Tract 710, campground, 183 sites; and in Tract 714, the Visitor Center; residences; 100 picnic sites with 4 comfort stations and parking areas, and Ferry launching facilities. The estimated water demand as shown in Table I is 28,500 gallons per day.

TABLE I
ESTIMATED WATER DEMAND
East Owls Bend

	<u>Sites</u>	<u>Persons</u>	<u>Gal./Per.</u>	<u>Total</u>
Campground	183	640	20	12,800 gallons
Picnic Area	100	350	10	3,500
Visitor Center		1,500	3	4,500
Residence		4	150	600
Concession		1,500	3	4,500
Concession Residence		4	150	600
				<u>28,500 g.p.d.</u>

A flow of 40 gallons per minute will supply the necessary water demand base on 12 hours pumping day.

Storage Capacity: Based on information of General Engineering Handbook and Safety Manual - minimum 100,000 gallon tank is required.

During the afternoon of June 27, we visited the Owls Bend Site. Mr. Harvey, District Geologist of the U. S. Geological Survey commented that we could drill a well any place in the area with equal chance of striking water.

During the ground reconnaissance the possibility of locating an ample supply of water in the following areas were also investigated:

1. Current River
2. Powder Mill Springs
3. Powder Mill Creek

CURRENT RIVER - Not Recommended

The Current River is not recommended as the intake structures required will invade the scenic beauty of the River which the Government has dedicated itself to protect and preserve.

POWDER MILL SPRINGS - Not Recommended

Powder Mill Springs is presently located on Missouri State land, and has interpretative value. The solution channel from which Powder Mill Springs originates has been explored by some organizations and has surrendered fossils of prehistoric animals.

POWDER MILL CREEK - Conditionally recommended

Powder Mill Creek receives its water from both surface drainage and springs. Water received from this source may require extensive water treatment and thereby too costly at this time. (Recommendation is conditionally withheld until advances in technology makes it an economic project.

Wells - Recommended

Wells drilled in this area should produce at least 50 gallons per minute. The Missouri Geological Survey has estimated that we should drill at least a 500 feet deep well with the upper 50 feet being cased and pressure grouted..

Drilling should be extended beyond the Potosi dolomite in order to reduce the chances of contamination from higher elevation groundwater.

The contract should call for the well to be acidized in order to increase the yield of the well.

To date, Wage Rate Determinations have been requested from the Department of Labor, draft of the test well drilling specification is being prepared for comments.

LOCATION OF WELL SITES (See Figure 1)

The undersigned recommends that any one of the three sites to be drilled depending upon the final selection of the location of the reservoir and the availability of land.

Plan A calls for the base of the reservoir to be located at the 950 feet elevation beside the abandoned Highway 106 in Government owned Tract No. 701. Access to the reservoir

(service road) will be by the abandoned Highway 106 which may require some road realignment and blading to remove underbrush. The major portion of the service road is located in Tract 710 presently owned by the State of Missouri but within the authorized external boundaries of the Riverways.

Locating the reservoir at the site will afford the Service the following advantages:

1. Provide 100-150 feet head of pressure at the highest point to be developed as shown in the advance print of the area on hand.
2. Provide sufficient pressure for expansion of physical facilities to higher elevations should this be required in the future.
3. Access to reservoir is already provided which may also double as part of a trail system.
4. Provide for a single water and distribution system with gravity flow to the entire development, thus minimizing maintenance of the system.

PLAN B (Primary) calls for the reservoir to be located in the northeastern corner of Tract 714 which is in process of being acquired by the Government. The base elevation of the reservoir should be located at the 700 feet elevation which will provide the entire development to be located in Tract 714, only with a pressure head of 125 to 150 feet.

Access to the reservoir will have to be constructed. It is estimated that the road will be approximately 1,000 feet long at 5% grade of which approximately 950 feet will be located in the Tract 710.

PLAN B (Alternate) An alternate solution exists for this reservoir site in which the entire length of the service road can be located within Tract 714. Entire length of road will be in excess of 3,000 feet and terminating within the areas to be inundated by floods.

Well locations for Plan A or B (primary and alternate) should be located as close to the present alignment of Highway 106 and service roads as possible. All well sites to be located

in Tract 710 will be out of the flood plains, whereas the well site in Tract 714 will be the flood plains and subject to flooding.

LAND

In reviewing the land status of property in the Owls Bend Area, we find that Tracts 701 and 703 are Government property; Tracts 707 and 714 are in process of being acquired by the Government; Tracts 702, 704 to 706, and 710 are still in private or state ownership.

Mr. John Wright, Lands Acquisition Officer, of the Office of Land and Water Rights stationed at Eminence, informed us that he will keep us posted as to when we will be permitted to start exploratory test well drilling in Tract 714.

Tract 714, where the present development will take place can be described as consisting of 39.9 acres of mountainous terrain with limited development possibilities and the remaining 41.4 acres as flood plains. Areas to be inundated by different flood frequencies is shown in Table II.

TABLE II

<u>Flood Frequency</u>	<u>Area Flooded</u>	<u>Area Not Flooded</u>
50 years	41.1 acres	0
5 years	38.5 acres	2.6
Mean Annual (2.33 yr.)	33.5 acres	7.6

See Figure 2 for pictorial description.

Any major development in the flood plains will necessarily have to be located within the 2.6 acres left reasonably dry by the 5 year flood frequency.

When reviewing flood frequency data, it should be remembered that a 50 year flood so computed has one chance in 50 or a 0.02 average chance of occurring as an annual flood in any year.

FREQUENCY OF FLOODS

The estimate of the frequency of floods was derived from continuous records from 1922 to 1964 by the U. S. Geological Survey and the Missouri Geological Survey on the Current River near Eminence, Missouri as shown in Table III.

Analysis of the data will show that floods have occurred most often during the months of March, April, May, June, and the least likely month for floods to occur is August.

TABLE III

	<u>No. of Times</u>	<u>Variation of</u>	
		Gauge Height (MSL)	Discharge (CFS)
January	8	574.5 - 591.2	4,850 - 53,000
February	8	572.0 - <u>598.5</u> ^W	21,300 - <u>88,500</u>
March	12	575.4 - 593.2	6,250 - 59,600
April	15	575.8 - 590.1	8,000 - 47,600
May	21	575.8 - 592.2	7,250 - 58,400
June	12	575.2 - 593.1	6,920 - 59,400
July	5	579.6 - 583.3	15,000 - 25,300
August	1	<u>592.77</u>	<u>60,000</u>
September	4	579.7 - 580.7	15,000 - 18,200
October	5	577.1 - 584.4	10,700 - 29,000
November	6	576.1 - 583.0	7,860 - 25,800
December	4	584.3 - 595.8	21,600 - <u>75,100</u>

It may be of interest to note that the last 50 year flood occurred on February 10, 1966 when the flood waters crested at elevation 598.5 feet above MSL at a point five miles upstream of Powder Mill Ferry.

FLOOD DAMAGE - OWLS BEND

The estimated cost of flood damage per flood is \$10,000 if we assume total loss of all tables, garbage cans with lids for 100 picnic sites, limited road repairs, cleanup and cost of retrieving garbage cans and table from downstream. Painting the interior and exterior of 4 comfort stations will also be required.

LOW - WATER FREQUENCIES OF CURRENT RIVER

Low-flow characteristics of a stream determine its ultimate use by man. Potential water users need reliable information concerning low-flow characteristics if they are to intelligently assess the surface water situation in a given locale.

The magnitude and frequency of annual low flows for the Current River at Eminence and Van Buren and the Jacks Fork River at Eminence are shown in Figure 3. Flow Duration Data at the same locations are shown in Figure 4.

Minimum streamflows in the Current River usually occur during the fall or late summer. At long-time continuous-record stations, more record minimum flows have occurred in August than any other month, with September and October in second and third place respectively.

OTHER AREAS

The undersigned also visited the Missouri Geological Survey at Rolla, Missouri and met with Mr. D. Fuller, Chief, Division of Ground Waters and Mr. Knight, Senior Geologist, during which the undersigned was informed that all water right litigation has been determined by the courts and that the State owned all rivers within the low water mark in each bank.

Round Spring State Park: Visited with State Park Superintendent Jim Harcraft who mentions that a single well of unknown size and depth supplied the entire area with water. Sewer facilities consisted of septic tanks and dry pit privies.

Pulltite Springs: Mr. Reary, owner. The Government has an option on the land but has not take over possession as yet. The Reary's plan to leave the land on/about November 30, 1967. Water is supplied from a six-inch diameter well, 180 feet deep at an elevation above the 1966-50 year flood level. The water from the well is murky when the River water is also murky suggesting a possible direct connection between the two by solution channels. The well is located about 1,000 feet from the river. Sewer system consists of septic tanks and dry pit privies which occasionally surfaces during heavy visitor use.

Big Springs, Allen Springs State Parks: Both areas receive heavy visitors' use during the summer months. Water and sewer systems were not investigated but is understood to be inadequate.

Rhymer Ranch: A former resort area with ram-shackle buildings in various stages of disrepair. The area to be developed is high above the flood level of the area.

CHEMICAL QUALITY

Chemical quality is an important aspect of future water developments. A study of water quality characteristics is beyond the scope of this memorandum, however, a brief summary of the chemical quality from October, 1962 to June, 1963, is shown in Table IV.

During extended dry periods when the ground-water reservoir is the major source of stream flow, the concentration of dissolved mineral is usually at its maximum. Surface runoff usually has a diluting effect in stream water because it is in contact with soluble matter for a shorter period of time than ground water.

The chemical analysis presented in Table IV represents analysis taken during relatively low flows probably represents the upper reaches of the chemical consistency of the Current River. Higher flows will undoubtedly have a diluting effect.

Although the State of Missouri has not as yet finalized its water quality standard for the Current River Basin, we can assume, for this presentation that it will approximate the readings given in Table IV.

In reviewing several plans for the area, it was noted that septic tanks were to be employed with locations in the flood plains. It is recommended that a more sophisticated system of sewerage treatment be employed which will be compatible with the topography of the area involved and with the honey-combed geology to prevent salting the river with nutrients which will increase algae growth in the river.

REFERENCES

Letter from Mr. William C. Hayes, State Geologist of the State of Missouri, Division of Geological Survey and Water Resources to Mr. Vernon E. Hennessay, Superintendent of Ozark National Scenic Riverways, October 11, 1966.

Geology of the Eminence and Cardareva Quadrangus by Josiah Bridge - Second Series Vol. XXIV - 1930, Missouri Bureau of Geology and Mines.

Low-Flow Characteristics of Missouri streams by John Skelton. Water Resources Report 20 of the Missouri Geological Survey and Water Resources.

Information and graphs received from Mr. Homyk, District Engineer of the U. S. Geological Survey at Rolla, Missouri.

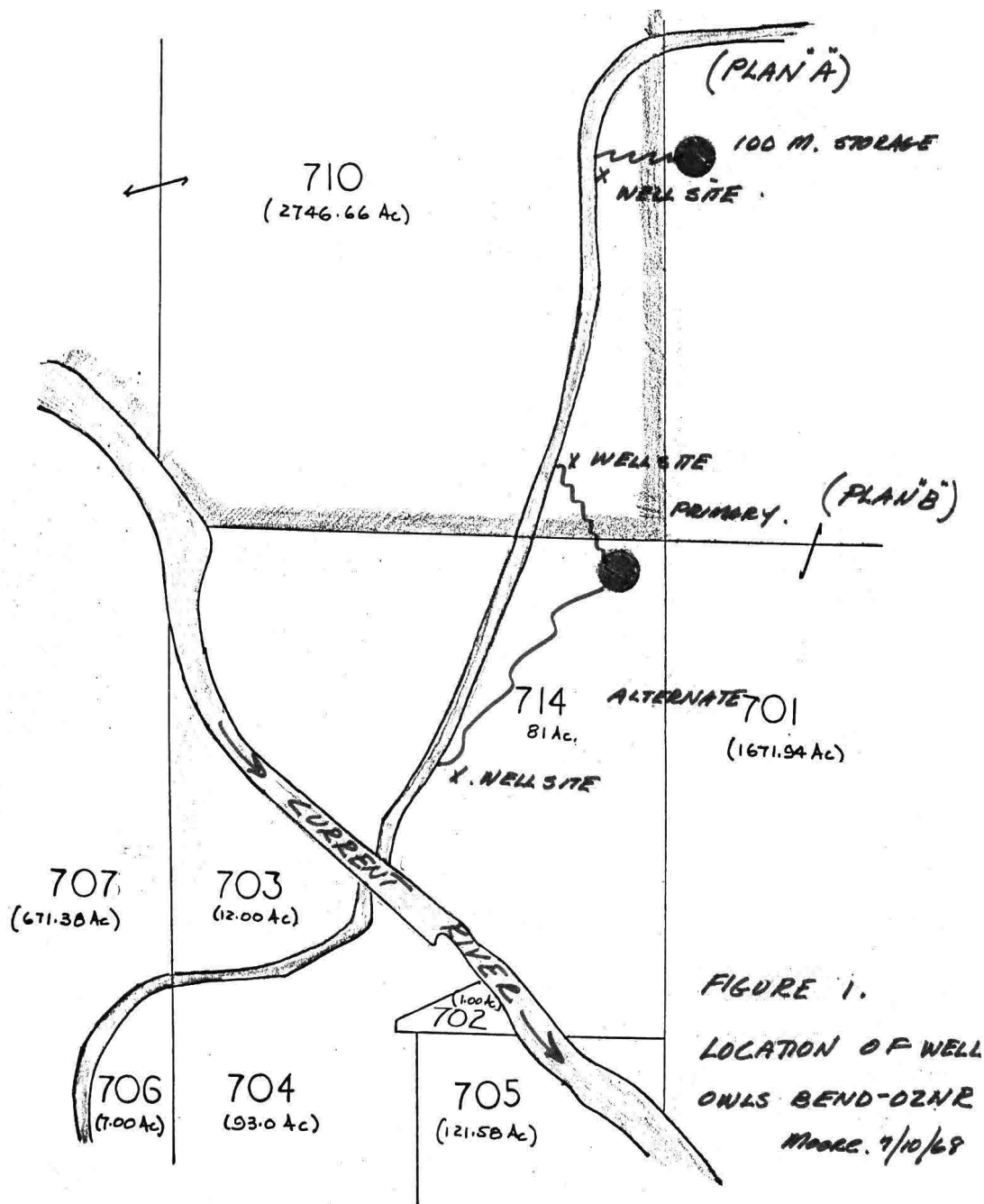
CONCLUSIONS AND RECOMMENDATIONS

The undersigned recommends:

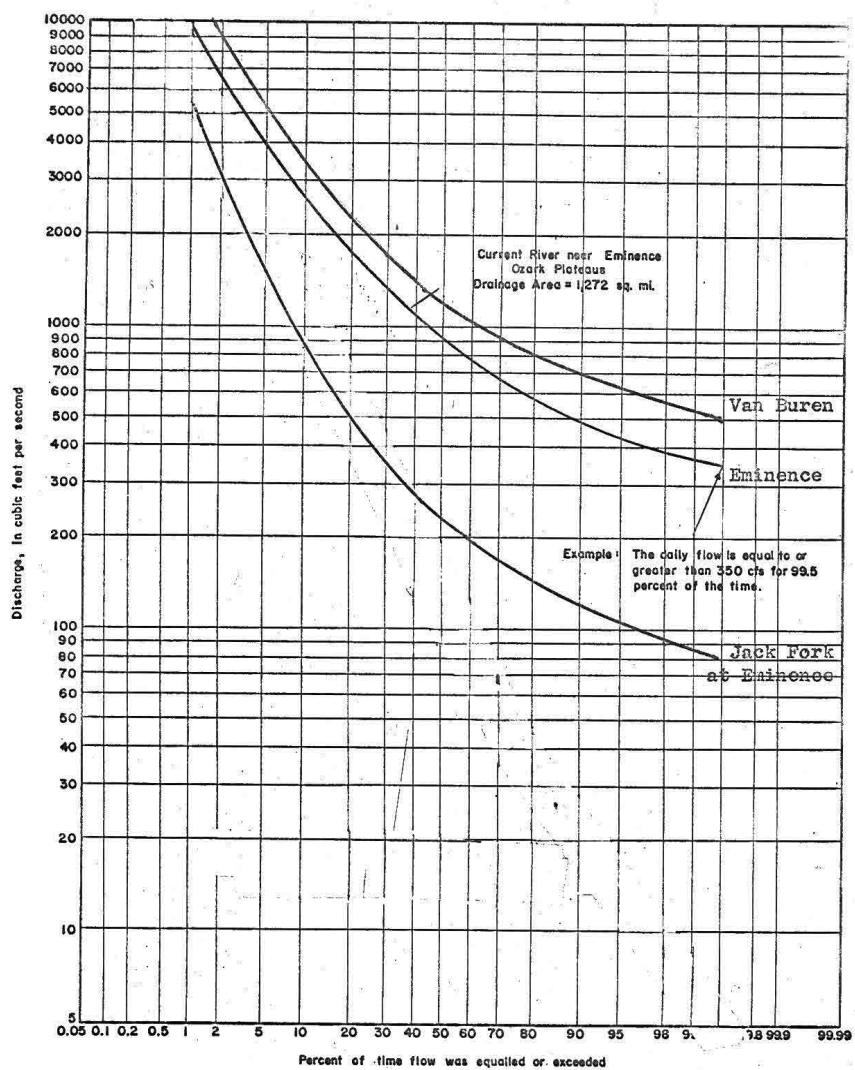
1. That sufficient funds be provided in our program to permit the U. S. Geological Survey to conduct a geo-hydrological study of the other 17 sites to be developed.
2. To begin exploratory well drilling in the Owls area of the Ozarks upon receiving clearance from the Lands Unit of the Office of Land and Water Rights and receive word from the Philadelphia Design and Construction Office as to the location of the reservoir for the area.
3. That development be reduced to a minimum in the flood plains of Tract 714 and encouraged in the areas where space is available in Tracts 707 and that portion of Tract 710 to the north of Tract 714 which are less likely to be inundated by flood waters.
4. That all septic tanks and pit privies be removed from the flood plains so as to reduce the possibilities of contaminating the Current River with pollutants and violating the Missouri Water Quality Standards for the Current River Basin.
5. That future water resources investigation work will involve future exploratory well drilling at each development site with the technical assistance of the U. S. Geological Survey.



Garland Moore
Hydraulic Engineer

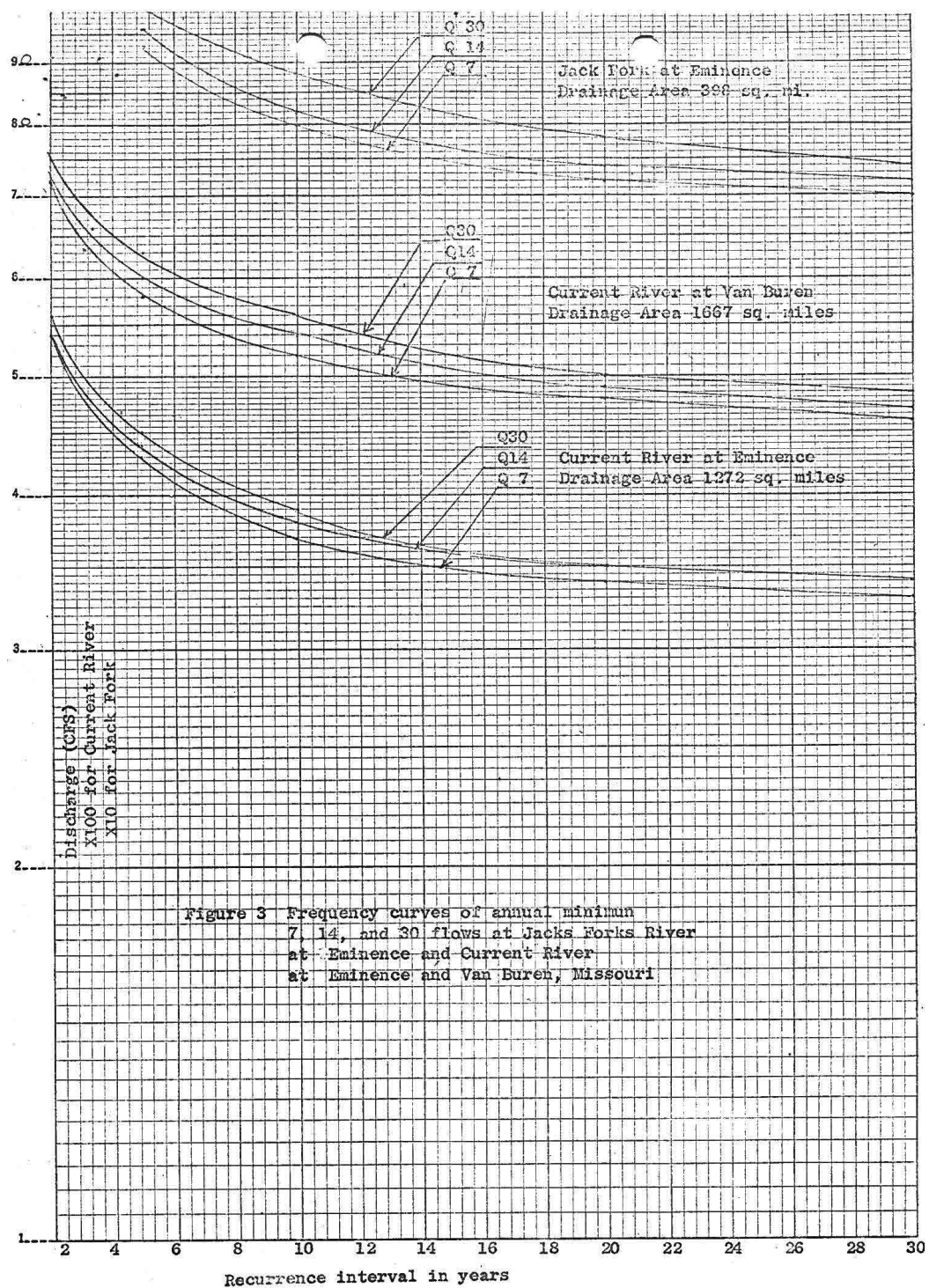


MISSOURI GEOLOGICAL SURVEY AND WATER RESOURCES



Flow, in cubic feet per second, which was equalled or exceeded for indicated percent of time

Fig. 4.



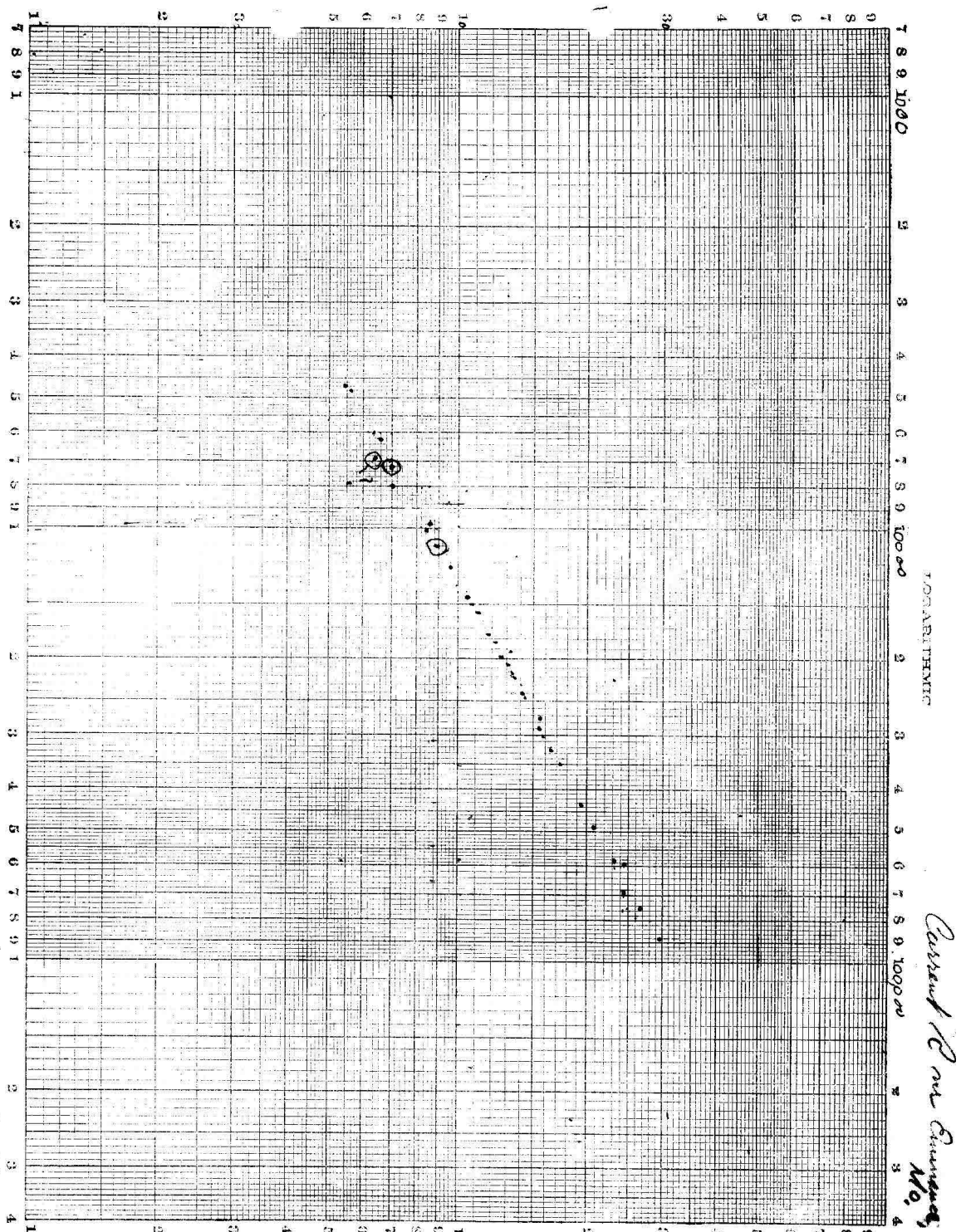


TABLE III

WHITE RIVER BASIN

139

665. Current River near Eminence, Mo.

Location.--Lat 37°11'00", long 91°15'30" in SW¼ sec.15, T.29 N., R.3 W., 1 mile downstream from Jacks Fork, 8 miles northeast of Eminence, and at mile 123.0.

Drainage area.--1,272 sq mi.

Gage.--Nonrecording prior to Dec. 8, 1934; recording thereafter. Prior to Oct. 20, 1921, at site 1,200 ft upstream at different datum. Datum of present gage is 568.82 ft above mean sea level, datum of 1929.

Stage-discharge relation.--Defined by current-meter measurements below 48,000 cfs.

Historical data.--Floodmark for flood in March 1904 was 36 ft above water surface at a point 1 mile upstream from present gage at the time gage in use prior to Oct. 20, 1921, read 1.65 ft.

Remarks.--Base for partial-duration series, 12,000 cfs.

Peak stages and discharges

Water year	Date	Gage height (feet)	Discharge (cfs)	Water year	Date	Gage height (feet)	Discharge (cfs)
1922	Nov. 19, 1921	14.2	25,800	1941	Apr. 17, 1941	5.11	4,210
	Mar. 31, 1922	11.5	17,600				
	Apr. 17, 1922	11.0	16,400	1942	Nov. 1, 1941	9.70	11,100
1923	Feb. 1, 1923	13.4	23,700	1943	Dec. 27, 1942	26.97	75,100
	Mar. 16, 1923	13.5	24,000		May 11, 1943	21.49	49,800
	May 16, 1923	12.5	21,200		May 19, 1943	14.56	23,400
1924	June 21, 1924	6.4	6,920	1944	Apr. 23, 1944	9.97	11,400
1925	Apr. 28, 1925	7.0	8,000	1945	Feb. 22, 1945	13.20	19,800
1926	Oct. 17, 1925	8.3	10,700		Feb. 26, 1945	14.59	23,700
1927	Apr. 1, 1927	14.1	25,100		Mar. 7, 1945	12.40	17,700
	Apr. 15, 1927	16.0	39,000		Mar. 31, 1945	16.25	28,800
	Apr. 19, 1927	12.1	19,500		Apr. 2, 1945	12.35	17,700
	May 25, 1927	12.0	19,000		Apr. 14, 1945	21.23	47,600
	June 2, 1927	20.0	43,800		June 10, 1945	14.50	22,800
1928	Dec. 14, 1927	15.5	27,900		June 17, 1945	13.46	20,600
	June 9, 1928	24.3	59,400	1946	Feb. 14, 1946	18.96	39,800
	June 13, 1928	21.0	46,900		Mar. 6, 1946	11.67	16,300
1929	Jan. 25, 1929	10.3	13,600		May 16, 1946	10.89	14,300
	May 13, 1929	13.8	21,200		May 25, 1946	20.20	44,300
	June 13, 1929	9.8	12,500		Aug. 14, 1946	25.95	60,200
1930	Jan. 14, 1930	10.2	13,600	1947	Nov. 10, 1946	12.00	17,000
1931	Mar. 8, 1931	6.6	6,250		Apr. 25, 1947	14.7	25,300
1932	Jan. 23, 1932	5.7	4,850	1948	June 19, 1948	10.52	13,400
1933	Apr. 16, 1933	17.9	35,900	1949	Jan. 19, 1949	12.6	18,800
	May 14, 1933	21.4	48,300		Jan. 25, 1949	20.40	45,000
1934	Sept. 15, 1934	5.47	4,760		Feb. 15, 1949	15.77	28,900
1935	Mar. 11, 1935	24.35	59,600		June 13, 1949	10.6	13,800
	June 3, 1935	12.62	19,500		July 8, 1949	11.10	15,000
	June 26, 1935	11.50	16,700	1950	Jan. 4, 1950	22.35	53,000
1936	Nov. 10, 1935	7.27	7,860		Jan. 14, 1950	12.95	20,700
1937	Jan. 15, 1937	13.05	20,500		Apr. 3, 1950	15.23	21,300
	May 3, 1937	13.35	21,600		May 10, 1950	20.6	47,300
1938	Feb. 18, 1938	16.48	31,200		May 12, 1950	12.80	20,100
	Mar. 29, 1938	10.16	13,700		June 10, 1950	13.00	20,700
	May 23, 1938	14.64	25,700	1951	Feb. 19, 1951	13.20	21,300
	July 17, 1938	10.75	15,000		July 1, 1951	13.47	22,200
1939	Apr. 17, 1939	19.43	41,100		July 11, 1951	12.90	20,400
1940	Apr. 17, 1940	8.64	9,790		July 15, 1951	14.50	25,300
				1952	Nov. 24, 1951	9.70	12,500
					Mar. 11, 1952	12.37	19,000
					Apr. 15, 1952	12.92	20,400
				1953	Mar. 4, 1953	7.29	7,790
				1954	May 28, 1954	7.00	7,250

7-170
(October 1952)
FLOOD DATA

TABLE III UNITED STATES DEPARTMENT OF THE INTERIOR GEOLOGICAL SURVEY WATER RESOURCES DIVISION

100
File 40
7-0665

Flood data for Current River near Eminence, Mo.
Drainage area 1272 square miles. Period of record 1921-55
Flood data for momentary peak discharges greater than 12,000 cfs.

WATER YEAR	DATE	GAGE HEIGHT (feet)	DISCHARGE		ANNUAL FLOODS		PARTIAL DURATION SERIES		REMARKS
			CFS	RATIO TO Q ₁₀	ORDER (M)	RECURRENT INTERVAL (Years)	ORDER (M)	RECURRENT INTERVAL (Years)	
1953	Mar. 4, 1953	7.29	7,790						12:00 p.m.
1954	May 28, 1954	7.00	7,250						10 p.m.
1955	Mar. 21, 1955	17.30	35,000						8 a.m.
1956	May 15, 1956	23.27	58,400						
1957	Apr. 4, 1957	20.97	48,900						
	22	13.47	22,200						
	27	13.05	20,700						
	May 11	9.62	12,300						
	17	10.55	14,500						
	23	17.32	35,000						
	26	12.70	19,900						
1958	Dec. 17, 1957	13.30	21,600						
	Mar. 24, 1958	15.91	30,100						
1959	Nov. 17, 1958	11.14	15,700	✓					
1960	Dec. 28, 1959	16.57	32,500	✓					
1961	Mar. 7, 1961	10.84	15,000	✓					
	May 8, 1961	19.55	43,500	✓					
1962	Mar. 21, 1962	12.10	18,200	✓					
1963	May 17, 1963	14.13	24,000	✓					
	May 26, 1963	14.20	24,300	✓					
1964	Mar. 10, 1964	11.82	12,700	✓					0.600
	Apr. 6, 1964	15.62	29,000	✓					0.400
1965	Apr. 6, 1965	8.96	11,000	✓					
1966	Feb. 18, 1966	27.64	88,500						

Graphical mean annual flood (Q₁₀) _____ cfs for period _____

Sheet _____ of _____ Listed by E.H.S. Date 12/20/55 Checked by WKA Date _____

Supt. _____ Fiscal _____
 P&I _____ Secretary _____
 Maint. _____ File _____
 Lands _____

Table IV

CHEMICAL ANALYSES OF MISSOURI SURFACE WATERS--Continued

(Constituent concentrations in parts per million)

(Constituent concentrations in parts per million)																								
Date of Collection	Discharge (cfs)	Temperature (°F)	Silica (SiO ₂)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Organic ammonia nitrogen (N)	Bicarbonate (HCO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrite (NO ₂)	Nitrate (NO ₃)	Phosphate (PO ₄)	Dissolved solids (residue at 180° C)	Hardness as CaCO ₃	Specific conductance (micro-mhos at 25° C)	pH	Color	Turbidity	
																				Calcium, magnesium	Non-carbonate			
T-0616, BLACK RIVER BELOW ANNAPOLIS																								
10-7-62	395	76	--	--	--	--	--	--	1.4	0.36	156	0	4.0	2.0	--	--	1.4	0.03	al32	124	220	8.2	0	2
11-5-62	155	50	--	--	--	--	--	--	1.3	0.8	166	0	2.2	3.0	--	--	1.4	0.09	al11	140	235	8.0	--	2
12-3-62	142	52	--	--	--	--	--	--	1.0	0.8	168	0	2.0	1.5	0.1	--	1.2	0.06	al11	139	234	8.0	--	2
1-7-63	350	43	--	--	--	--	--	--	1.3	--	143	0	8.6	0.8	--	--	6.1	0.09	al35	126	209	8.0	--	5
2-4-63	187	39	--	--	--	--	--	--	1.2	--	158	0	3.4	1.0	--	--	1.4	0.04	al38	123	229	8.0	--	2
3-11-63	425	49	--	--	--	--	--	--	1.1	--	139	0	5.2	2.0	--	--	1.9	0.00	al25	123	208	8.1	--	2
4-8-63	381	24	--	--	--	--	--	--	1.0	--	114	0	5.6	1.2	--	--	1.9	0.04	al04	93	172	8.1	4	2
5-6-63	383	23	--	0.00	0.00	21	13	--	1.1	0.8	123	0	4.8	1.6	0.02	--	1.2	0.01	al01	105	181	8.0	--	2
6-3-63	502	73	--	--	--	--	--	--	1.0	--	114	0	4.8	1.4	--	--	0.8	0.01	al03	100	171	8.1	--	2

7-0616. BLACK RIVER BELOW ANNAPOLIS

7-0670. CURRENT RIVER AT VAN METER

10-7-62	1,300	70	--	--	--	--	--	--	2.0	0.38	104	0	2.2	2.0	--	1.8	0.03	al13	170	287	8.2	4	4
11-5-62	778	48	--	--	--	--	--	--	2.0	0.8	104	0	2.2	2.0	--	1.8	0.06	al16	171	293	8.2	--	2
12-3-62	725	52	--	--	--	--	--	--	2.1	0.8	224	0	2.0	2.0	1	1.4	0.06	al81	185	301	8.2	--	1
1-7-63	1,140	44	--	--	--	--	--	--	2.2	--	213	0	7.6	2.4	--	1.9	0.05	al82	183	303	8.2	--	2
2-4-63	783	40	--	--	--	--	--	--	2.1	--	213	0	1.6	3.0	--	1.5	0.05	al79	180	298	8.2	--	2
3-11-63	1,700	52	--	--	--	--	--	--	1.9	--	186	0	4.4	2.0	--	2.0	0.01	al66	160	276	8.1	--	2
4-8-63	1,560	56	--	--	--	--	--	--	1.2	--	167	0	3.6	1.2	--	1.2	0.03	al44	142	239	8.1	--	2
5-6-63	64	64	--	--	--	20	--	--	1.8	--	194	0	3.8	3.4	0	1.3	0.03	al34	162	271	8.2	--	2
6-3-63	2,720	69	--	--	--	--	--	--	1.1	--	136	0	4.2	2.2	--	1.3	0.03	al19	120	199	8.0	--	2

7-1864. CENTER CREEK NEAR CANTERVILLE

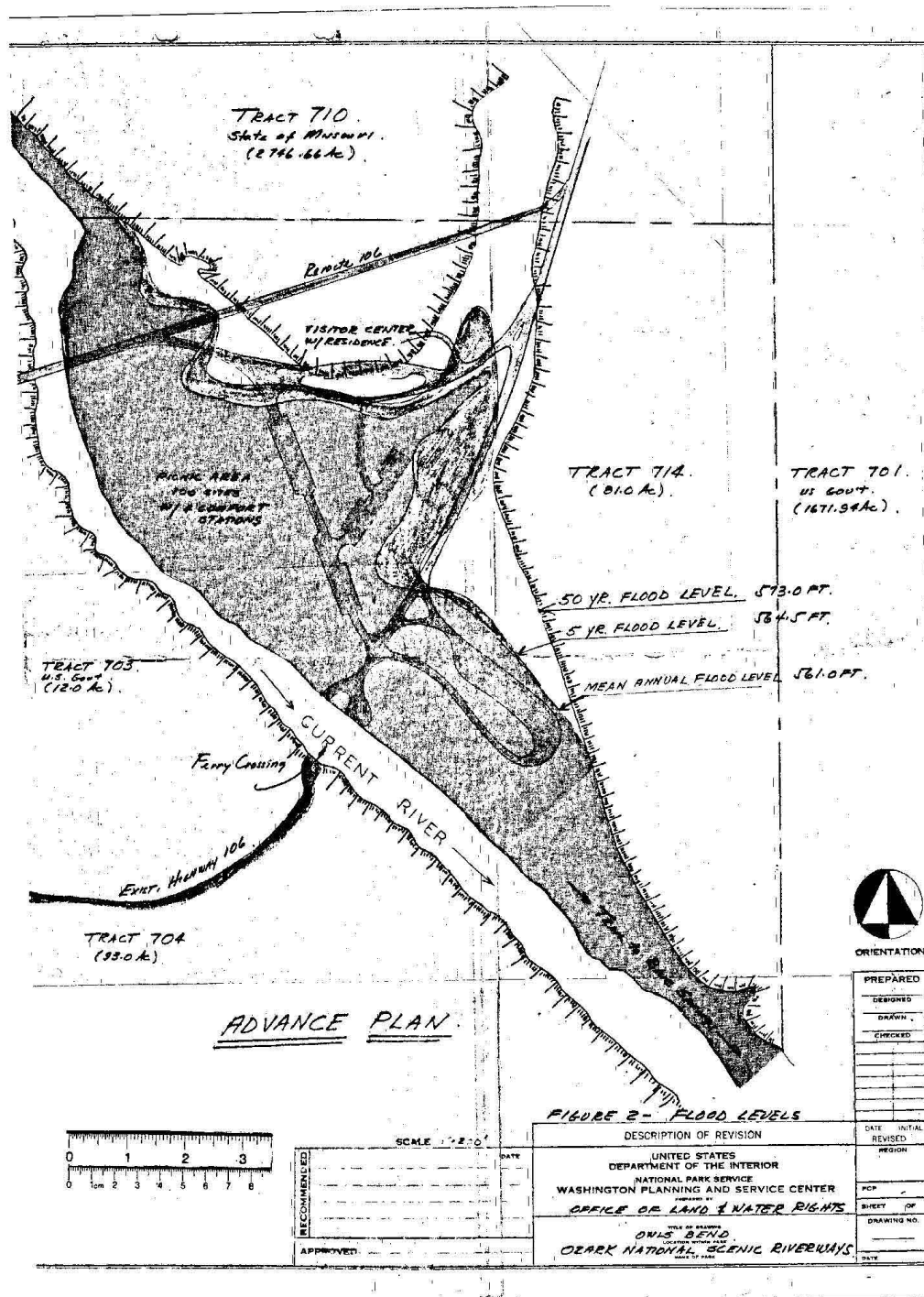
8-10-62	182	70	--	0.02	0.02	64	13	0.02	2.6	1.5	94	0	87	2.0	1.2	55	21	379	213	136	7.9	85	7
9-10-62	182	69	--	--	--	--	--	--	2.6	1.5	124	0	33	2.0	5.3	17	17.6	205	136	136	7.9	--	3
10-11-62	182	41	--	--	--	--	--	--	1.8	2.7	124	0	7.0	3.3	--	31	13	285	170	170	7.9	--	2
11-8-62	59	43	--	--	--	--	--	--	1.7	7.3	123	0	46	2.3	--	32	13	374	170	170	7.5	--	2
1-11-63	112	46	--	--	--	--	--	--	6.1	20.3	102	0	78	10	--	32	9.1	288	160	176	7.2	--	5
2-8-63	140	47	--	--	--	--	--	--	4.9	6.1	102	0	34	14	--	28	9.1	329	192	155	7.0	--	5
3-14-63	62	59	--	--	--	--	--	--	11	13	100	0	5.2	14	--	28	9.1	210	154	160	7.2	--	7
4-12-63	15	59	--	0.00	0.00	87	35	0.00	2.2	16	74	0	131	16	0.00	91	15	292	201	119	7.2	--	1
5-10-63	17	77	--	0.00	0.00	87	35	0.00	2.2	16	74	0	131	16	0.00	91	15	292	201	119	7.2	--	1
6-10-63	17	77	--	0.00	0.00	87	35	0.00	2.2	16	74	0	131	16	0.00	91	15	292	201	119	7.2	--	1
8-28-63	26	55	--	0.00	0.00	72	4.2	0.02	2.2	2.2	106	0	119	13	0.02	47	33	317	197	147	7.1	7	6

7-1870. SHOAL CREEK ABOVE JOPLIN

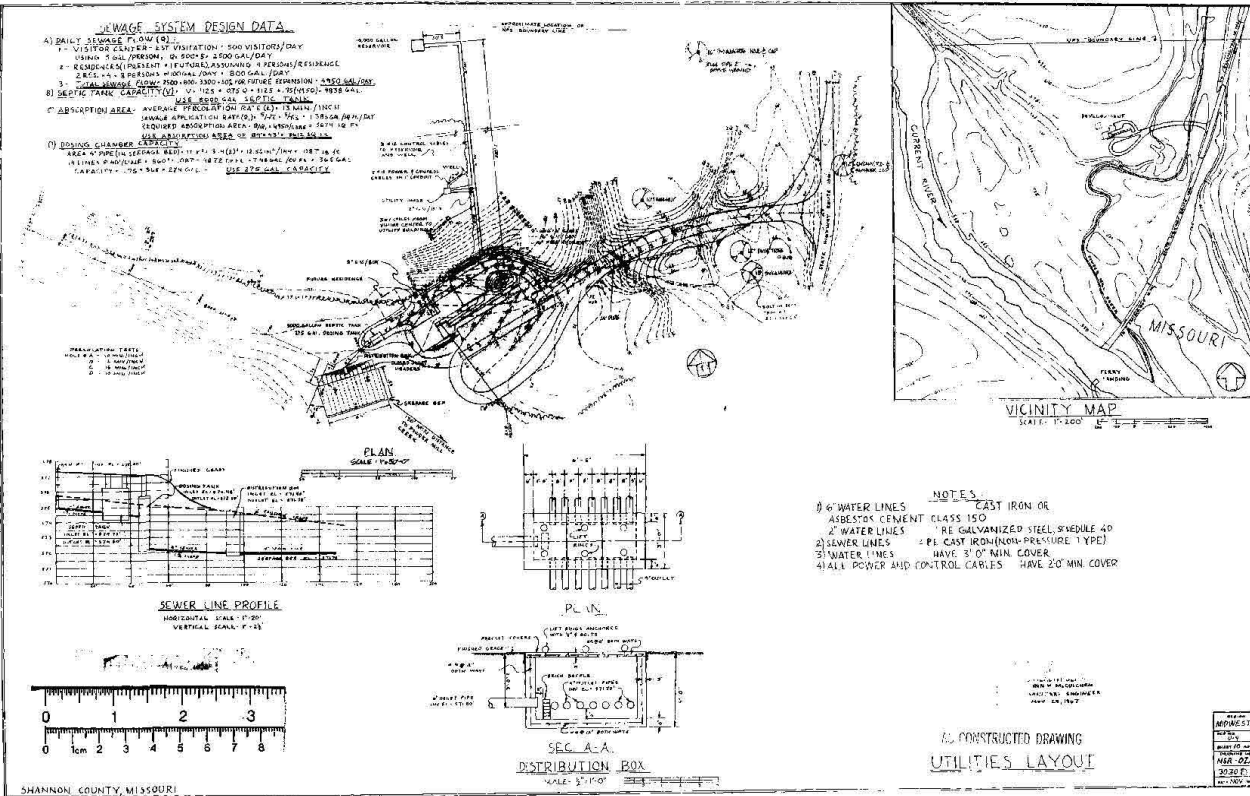
8-25-62	682	74	--	0.02	0.02	46	2.6	0.02	4.5	1.9	164	0	7.0	4.8	--	5.7	0.06	al12	138	177	8.0	--	10
9-10-62	452	70	--	--	--	--	--	--	3.2	1.9	134	0	9.6	6.0	1	7.3	0.03	al19	126	227	8.1	5	30
10-11-62	415	70	--	--	--	--	--	--	3.4	--	136	0	6.8	6.0	--	7.3	0.03	al18	126	234	8.1	--	10
11-8-62	282	61	--	--	--	--	--	--	3.8	1.3	136	0	16.8	6.0	--	6.1	0.06	al18	126	234	8.1	--	10
1-11-63	233	43	--	--	--	--	--	--	3.7	1.3	136	0	16.8	6.0	--	6.1	0.06	al18	126	234	8.1	--	10
2-8-63	186	46	--	--	--	--	--	--	4.1	--	159	0	12.8	3.6	--	6.6	0.04	al19	135	231	8.1	--	7
3-14-63	318	49	--	--	--	--	--	--	3.1	--	131	0	6.8	4.5	--	9.1	0.15	al15	122	226	8.1	--	4
4-12-63	160	59	--	--	--	--	--	--	3.9	--	145	0	6.6	7.6	--	3.0	0.18	al15	122	226	8.1	--	4
5-10-63	111	79	--	0.00	0.00	51	2.4	0.00	4.3	1.5	157	0	7.6	6.4	0.06	3.8	0.18	al14	139	234	8.1	3	10
6-7-63	101	77	--	--	--	--	--	--	4.5	--	159	0	8.6	5.3	--	4.1	0.11	al13	142	237	8.0	--	10

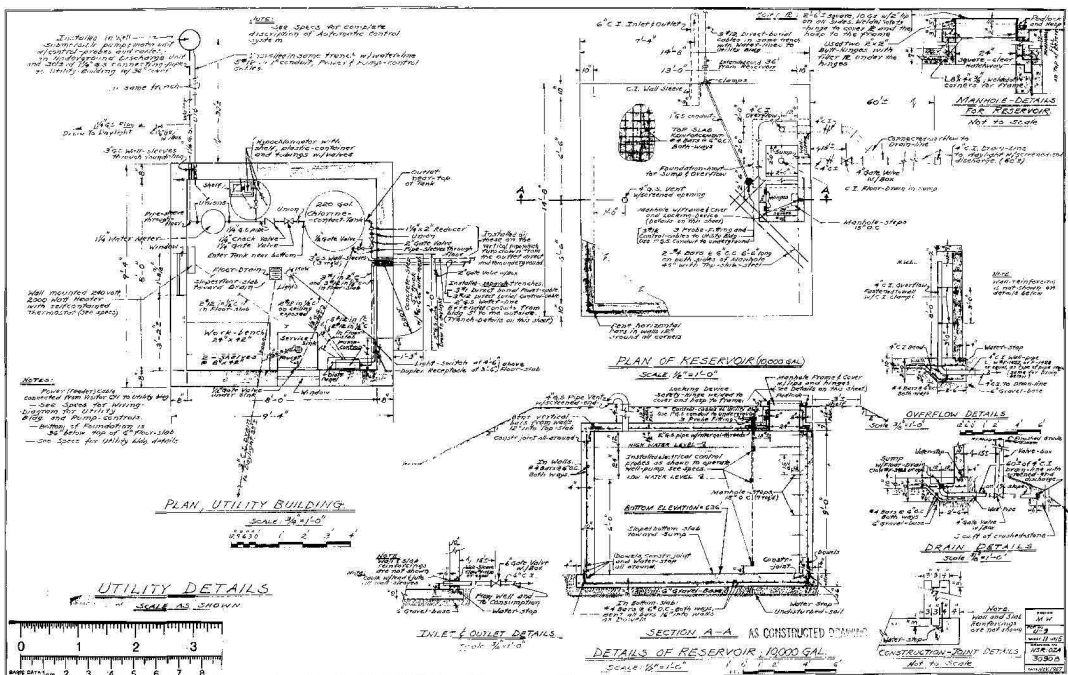
a Calculated from specific conductance

b Daily mean discharge



- [illegible]





Docket Information

Number of Documents in Docket 50

Documents Dated from 6/13/1967 to 5/19/1972

Docket Compiled: 6/7/2011