N·W

OF 71-311

USGS-474-87

USGS-474-87

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Federal Center, Denver, Colorado 80225

HYDRAULIC TESTING AND SAMPLING OF WATER WELL NUMBER 1, PROJECT WAGON WHEEL, SUBLETTE COUNTY, WYOMING

(Wagon Wheel-1)
March 1971

Open-file Report 71-311

Prepared Under
Agreement No. AT(29-2)-474

for the

Nevada Operations Office
U.S. Atomic Energy Commission

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Federal Center, Denver, Colorado 80225

HYDRAULIC TESTING AND SAMPLING OF WATER WELL NUMBER 1, PROJECT WAGON WHEEL, SUBLETTE COUNTY, WYOMING

By

Paul T. Voegeli, Sr.

Open-File Report 71-311

CONTENTS

Page

Abstract 1

Introduction 2

Geologic setting 4

Hydrology 14

Hydraulic tests 16

Swabbing test 16

Pumping test 19

Chemical analyses of water samples 22

Summary 25

Selected references 26

ILLUSTRATIONS

Figure 1. Map showing site of the Wagon Wheel experiment, Sublette County, Wyo. 3

2. Geophysical and lithologic logs, Wagon Wheel Water Well No. 1, Sublette County, Wyo. . . . . (In pocket)

3. Preliminary map of the Wagon Wheel site showing configuration of the water table 15

4. Construction diagram, Wagon Wheel Water Well No. 1 . . . 17

5. Curve of water-level recovery from the swabbing test of the Wagon Wheel Water Well No. 1 18

6. Curve of water-level drawdown from the pumping test of the Wagon Wheel Water Well No. 1 20

7. Curve of water-level recovery from the pumping test of the Wagon Wheel Water Well No. 1 21

CONTENTS--Continued

TABLES

Page

Table 1. Generalized description of stratigraphic units penetrated in the Pinedale Unit No. 5 well, SE¼ sec. 5, T. 30 N., R. 108 W., Sublette County, Wyo. 5

2. Log of cutting samples from Wagon Wheel Water Well No. 1, SE¼NW¼ sec. 5, T. 30 N., R. 108 W., Sublette County, Wyo. 7

3. Spectrographic, radiochemical, and general chemical analyses of water removed during the swabbing and pumping tests of Wagon Wheel Water Well No. 1 23

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Wagon Wheel-1
March 1971

USGS-474-87

Federal Center, Denver, Colorado 80225

HYDRAULIC TESTING AND SAMPLING OF WATER WELL NUMBER 1, PROJECT WAGON WHEEL, SUBLETTE COUNTY, WYOMING

By

Paul T. Voegeli, Sr.

ABSTRACT

The Wagon Wheel Water Well No. 1 was drilled to obtain hydraulic data and to provide a water supply for the deep drilling program at the site of Project Wagon Wheel, which is aimed at determining the feasibility of nuclear stimulation of natural gas reservoirs.

The well was tested and water samples were collected by swabbing on August 1, 1969, and by pumping on August 26, 1969. In both tests the 760-meter (2,500-foot) section through which the well was drilled was tested through 19 gun-perforated intervals.

The water level in the well prior to the pumping test was 29.9 meters (98.1 feet) below land surface. During the pumping test the water level declined to 47.7 meters (156.6 feet) below land-surface datum while the well was pumped at an average rate of 281 cubic meters per day (51.6 gallons per minute) for 6 hours and 6 minutes. The transmissivity of the aquifer in the vicinity of the well, as computed from the data of the pumping test, was 26 cubic meters per day per meter (2,100 gallons per day per foot), and the specific capacity was 16 cubic meters per day per meter (0.88 gallon per minute per foot) of drawdown.

INTRODUCTION

Project Wagon Wheel, a Plowshare Project, is a cooperative effort of the El Paso Natural Gas Company (EPNG) as operator, the U.S. Atomic Energy Commission (AEC), and the Lawrence Radiation Laboratory.

The purpose of the project is to determine the commercial feasibility of nuclear stimulation of natural-gas reservoirs. The experiment will include: 1) the detonation of a nuclear explosive in gas sands of Paleocene and Cretaceous age--natural-gas formations which are not commercially productive with present conventional methods of gas-field development--and 2) the evaluation of the effect of the detonation on the gas-producing capability of the formations.

The Wagon Wheel Water Well No. 1 was drilled to obtain hydraulic data at the Wagon Wheel site and to provide a water supply for the deep drilling program at the site. The U.S. Geological Survey performed the hydraulic tests and related water quality sampling on behalf of the AEC. This report describes the general geologic and hydrologic features and hydraulic testing of the water well, and presents the results of the chemical and radiochemical analyses.

The Wagon Wheel site is located in the Green River basin, NW¼ sec. 5, T. 30 N., R. 108 W., Sublette County, Wyo. (fig. 1).

The author extends his thanks to Messrs. Jack Shaughnessy and E. S. Oberly, El Paso Natural Gas Company, for their direct and indirect support during the field work.

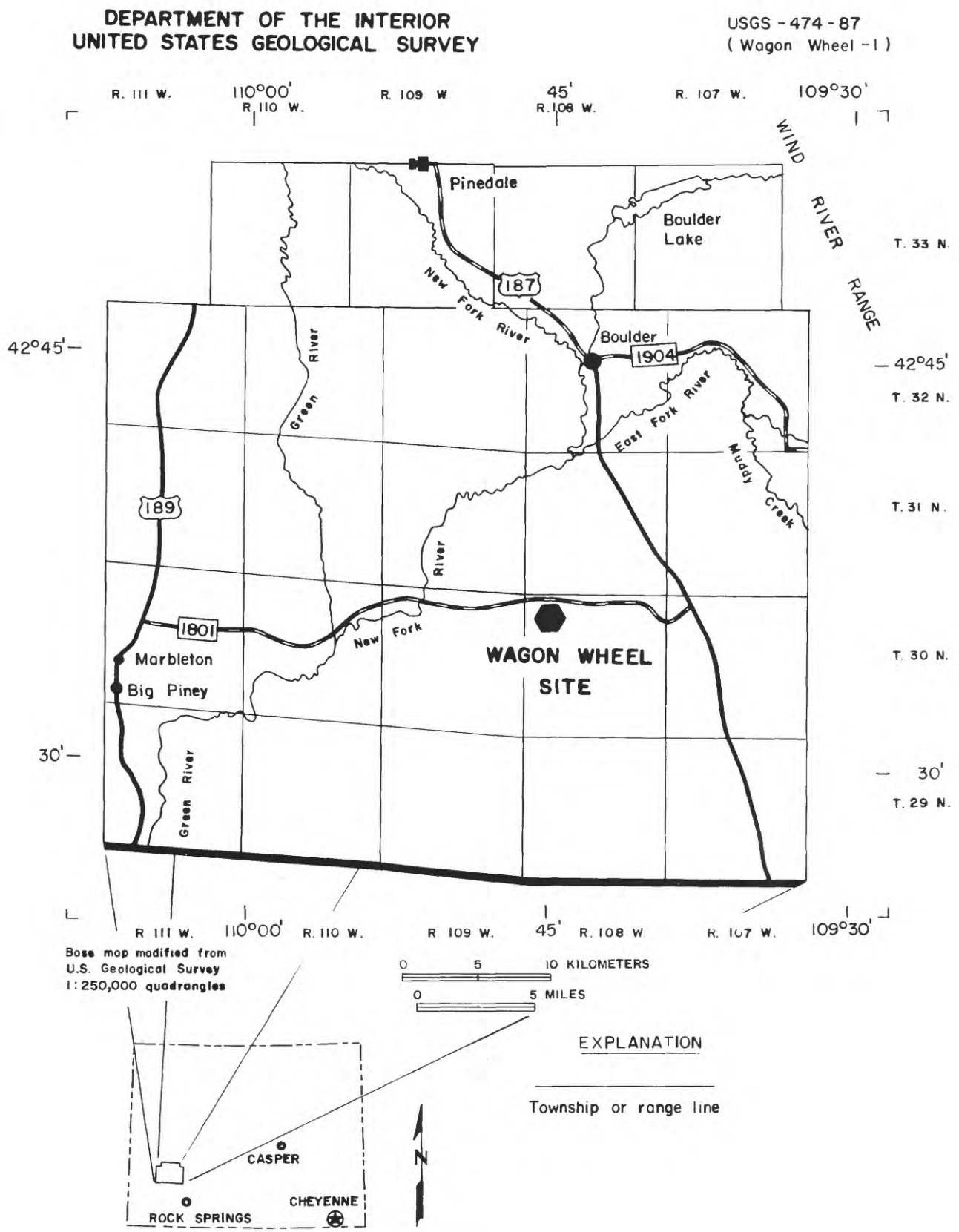


Figure 1.--Site of the Wagon Wheel experiment, Sublette County, Wyo.

GEOLOGIC SETTING

The Project Wagon Wheel site is in the northeastern part of the Green River basin, a large north-trending structural basin in southwestern Wyoming. The basin is drained by the Green River. The Wagon Wheel site drains westward to the New Fork River, a major tributary of the Green River.

The rocks underlying the Wagon Wheel site range in age from Quaternary to Precambrian. The greatest thickness of sedimentary rocks, about 9,000 meters (about 30,000 feet), in the basin is in the deep syncline that trends northwestward through T. 30 N., R. 108 W., parallel to the Wind River Mountains (Krueger, 1960).

Continental sediments greater than 4,600 meters (15,000 feet) thick have been penetrated by drilling in the SE¼ sec. 5, T. 30 N., R. 108 W. (El Paso Natural Gas Company's Pinedale Unit No. 5 well). For the most part, the sediments of Tertiary and Cretaceous age underlying the area in and near the Wagon Wheel site have not been designated as specific formations or members of formations. The complexity of the geologic environment and a lack of data have prevented the establishment of definite upper and lower boundaries of formations. In the EPNG Pinedale Unit No. 5 well, the stratigraphic section was divided into five units on the basis of the section found in the Phillips Daniels No. 1 well (sec. 21, T. 33 N., R. 111 W., Sublette County, Wyo.) which has been designated as the Wyoming Geological Association's type subcrop in the Green River basin. Table 1 presents a general description of the five stratigraphic units established by EPNG for the No. 5 well.

Table 1.--Generalized description of stratigraphic units penetrated in the Pinedale Unit No. 5 well, SE¼ sec. 5, T. 30 N., R. 108 W., Sublette County, Wyo.

Depths are below KB (kelly bushing). Land-surface elev (above mean sea level): 2,147 meters (7,044 feet); KB elev (above mean sea level): 2,151 meters (7,056 feet).

Unit	Depth (meters)	Depth (feet)	Thickness (meters)	Thickness (feet)	General lithology	Geologic age
E	0-2,188	0-7,180	2,188	7,180	Arkosic sandstones and conglomerates interbedded with varicolored claystones. Arkosic sandstones are white, unconsolidated, medium to very coarse grained, angular to subangular, and poorly sorted. Mica, pyrite, numerous granitic grains and pebbles are commonly found in the sandstone bodies, claystones are green, gray-green, in part mottled maroon to red-brown, subwaxy, and micaceous. Near base of unit, claystones appear to become bentonitic.	Eocene and uppermost Paleocene
D	2,188-3,193	7,180-10,475	1,005	3,295	Clay shale and claystone interbedded with massive to thin-bedded sandstones.	Paleocene
C	3,193-3,993	10,475-13,102	800	2,627	Interbedded sandstones, siltstones, and shale.	Cretaceous
B	1/ 3,993-4,235	1/ 13,102-13,895	242	793	Sandstones interbedded with thin shales and siltstone streaks.	Do.
A	4,235-4,577	13,895-15,018	342	1,123	Interbedded shales, siltstones, and thin to medium-bedded sandstones.	Do.

1/ Depth of Unit B may be as much as 4,404 meters (14,450 feet).

The sediments penetrated by Wagon Wheel Water Well No. 1 are described in table 2. The shale associated with the arkosic sandstone is very readily dissolved by drilling fluids and the cuttings returned to the surface are often free of shale. The weakness of the sediments is emphasized by the degree of hole erosion shown on the caliper log on figure 2. The presence of shale stringers and beds is difficult to ascertain on the basis of sample cuttings alone. Geophysical logs (spontaneous potential and resistivity logs, fig. 2) are one of the better sources of information for the determination of the presence of shale bodies at a specific depth.

Table 2.--Log of cutting samples from Wagon Wheel Water Well No. 1, SE¼NW¼ sec. 5, T. 30 N., R. 108 W., Sublette County, Wyo.

(Log modified from field log prepared by Jack Shaughnessy, Geologist, El Paso Natural Gas Company. Depth is in meters and feet below land surface.)

	Thickness		Depth	
	(meters)	(feet)	(meters)	(feet)
No sample	8.5	28	8.5	28
Sand, white, yellow, and pink, coarse to very coarse, unconsolidated, poorly sorted, angular to subangular; contains quartz, mica, and pyrite. Sand probably cemented with soft, clayey, green, green-brown, and maroon shale	3.0	10	11.6	38
Shale and sand as above. With more shale matrix than above	3.0	10	14.6	48
Sand, predominantly brown, in part white, coarse to very coarse from 14.6 to 17.7 meters (48 to 58 feet), very coarse to gravel from 17.7 to 20.7 meters (58 to 68 feet), very coarse from 20.7 to 23.8 meters (68 to 78 feet), unconsolidated, poorly sorted, angular to subangular; contains quartz and feldspars	9.1	30	23.8	78
Sand, white, rose, yellow, and brown, unconsolidated. Increase in green silty shale and feldspars; contains abundant gray bentonitic shale	3.0	10	26.8	88
Shale, green and maroon, silty, highly arenaceous; contains bentonite	3.0	10	29.9	98
No sample	3.0	10	32.9	108
Shale, green and maroon, silty, highly arenaceous; contains bentonite and abundant unconsolidated sand	3.0	10	36.0	118

Table 2.--Log of cutting samples from Wagon Wheel Water Well No. 1, SE¼NW¼ sec. 5, T. 30 N., R. 108 W., Sublette County, Wyo.--Continued

	Thickness		Depth	
	(meters)	(feet)	(meters)	(feet)
No sample	3.0	10	39.0	128
Shale, gray, highly arenaceous, soft; contains mica and pyrite	3.0	10	42.1	138
Shale, green and brown, silty; contains mica and abundant unconsolidated sand	3.0	10	45.1	148
Shale, gray, highly arenaceous, soft; contains bentonite. Increase in unconsolidated sand from 48.2 to 54.3 meters (158 to 178 feet)	9.1	30	54.3	178
Shale, maroon, arenaceous; contains mica and gray bentonite	3.0	10	57.3	188
Shale, gray, arenaceous, soft; contains bentonite and abundant unconsolidated sand	6.1	20	63.4	208
Shale and unconsolidated sand	3.0	10	66.4	218
Sand, unconsolidated; contains gray bentonitic shale	6.1	20	72.5	238
Shale, gray, highly arenaceous, soft; contains bentonite. Could be a shaly bentonitic sandstone?	6.1	20	78.6	258
Sand, white and rose, coarse to very coarse, poorly sorted, angular, frosted; contains quartz, mica, and pyrite	6.1	20	84.7	278
Shale, gray, highly arenaceous, soft; contains bentonite	3.0	10	87.8	288
Sand, white and rose, coarse to very coarse, unconsolidated; poorly sorted, angular, frosted; contains quartz, mica, and pyrite	6.1	20	93.9	308

Table 2.--Log of cutting samples from Wagon Wheel Water Well No. 1, SE¼NW¼ sec. 5, T. 30 N., R. 108 W., Sublette County, Wyo.--Continued

	Thickness		Depth	
	(meters)	(feet)	(meters)	(feet)
Sand, white and rose, coarse to very coarse, unconsolidated, poorly sorted, angular, frosted; contains quartz, mica, and pyrite. Sand is associated with a soft, silty, green, maroon, and gray shale	6.1	20	100.0	328
Sand, white, coarse to very coarse, unconsolidated, poorly sorted, angular to subangular, frosted; contains pyrite, mica, and feldspars. From 106.1 to 109.1 meters (348 to 358 feet) sand is associated with a soft, silty, maroon and green shale	9.1	30	109.1	358
Sand, unconsolidated, associated with a gray, bentonitic shale	3.0	10	112.2	368
Sand, unconsolidated; contains variegated shales	15.2	50	127.4	418
Sand, white, coarse to very coarse, unconsolidated, poorly sorted from 127.4 to 139.6 meters (418 to 458 feet), medium sorted 139.6 to 151.8 meters (458 to 498 feet), angular to subangular, frosted; contains mica, pyrite, and feldspars. From 136.6 to 139.6 meters (448 to 458 feet) sand is associated with a gray, soft bentonitic shale	24.4	80	151.8	498
No sample	3.0	10	154.8	508
Sand, white, coarse to very coarse, unconsolidated, poorly sorted, angular to subangular, frosted; contains mica, pyrite, and feldspars. Sand is associated with a brown, purple, and green shale from 164.0 to 170.1 meters (538 to 558 feet)	15.2	50	170.1	558
Sand, white, yellow, and rose, very coarse to gravel, well sorted, angular to subangular; contains feldspars	6.1	20	176.2	578

Table 2.--Log of cutting samples from Wagon Wheel Water Well No. 1, SE¼NW¼ sec. 5, T. 30 N., R. 108 W., Sublette County, Wyo.--Continued

	Thickness		Depth	
	(meters)	(feet)	(meters)	(feet)
Sand, white, yellow, and rose, very coarse, poorly sorted, angular to subangular; contains feldspars. Most of the sand grains imbedded with variegated shale	9.1	30	185.3	608
Sand, white, yellow, and rose, very coarse, poorly sorted, angular to subangular; contains feldspars. Sand is associated with a gray bentonitic shale. Abundant pieces of green, brown, purple, and maroon shale from 188.4 to 194.5 meters (618 to 638 feet)	12.2	40	197.5	648
Sand, coarse to very coarse, unconsolidated, well sorted; contains feldspars (increase in feldspars). Sand is associated with gray, soft, bentonitic shale from 212.8 to 215.8 meters (698 to 708 feet) and from 218.8 to 221.9 meters (718 to 728 feet)	27.4	90	224.9	738
Sand, very coarse to gravel, unconsolidated, poorly sorted, angular; contains pyrite, feldspars, and mica	3.0	10	228.0	748
Sand, coarse to very coarse from 228.0 to 237.1 meters (748 to 778 feet), very coarse to gravel from 237.1 to 240.2 meters (778 to 788 feet), unconsolidated, well sorted, angular to subangular from 237.1 to 240.2 meters (778 to 788 feet); contains feldspars, trace of variegated shale from 228.0 to 237.1 meters (748 to 778 feet), and abundant pyrite from 237.1 to 240.2 meters (778 to 788 feet)	12.2	40	240.2	788
Sand, coarse to very coarse, well sorted, angular; contains variegated shale	3.0	10	243.2	798

Table 2.--Log of cutting samples from Wagon Wheel Water Well No. 1, SE¼NW¼ sec. 5, T. 30 N., R. 108 W., Sublette County, Wyo.--Continued

	Thickness		Depth	
	(meters)	(feet)	(meters)	(feet)
Sand, coarse to gravel, poorly sorted, angular to subangular; contains variegated shale	3.0	10	246.3	808
Sand, coarse to very coarse, unconsolidated; contains variegated shale and trace of weathered feldspars from 246.3 to 249.3 meters (808 to 818 feet) and feldspars from 249.3 to 258.5 meters (818 to 848 feet)	12.2	40	258.5	848
Sand, white, coarse to very coarse, well sorted, angular to subangular, frosted; contains trace of variegated shale	3.0	10	261.5	858
Sand, very coarse to gravel, poorly sorted, angular; contains a trace of variegated shale. Shale increasing below 264.6 meters (868 feet)	6.1	20	267.6	878
Sand, coarse to very coarse, poorly sorted, angular; contains abundant mica; pyrite, feldspars; purple green-brown sandy very soft shale from 270.7 to 273.7 meters (888 to 898 feet); variegated shale from 276.8 to 285.9 meters (908 to 938 feet); and gray bentonitic shale from 319.4 to 322.5 meters (1,048 to 1,058 feet). All parts of this interval contain shale, below 362.1 meters (1,188 feet) variegated and gray soft bentonitic shale is more abundant	106.7	350	374.3	1,228
Shale, gray, soft, bentonitic; contains abundant coarse to very coarse, poorly sorted, angular sand	3.0	10	377.3	1,238

Table 2.--Log of cutting samples from Wagon Wheel Water Well No. 1, SE¼NW¼ sec. 5, T. 30 N., R. 108 W., Sublette County, Wyo.--Continued

	Thickness		Depth	
	(meters)	(feet)	(meters)	(feet)
Sand, coarse to very coarse, poorly sorted, angular; contains white weathered feldspars from 404.8 to 407.8 meters (1,328 to 1,338 feet). Increase in feldspars from 389.5 to 395.6 meters (1,278 to 1,298 feet). Sand is associated with gray bentonitic shale from 377.3 to 389.4 meters (1,238 to 1,278 feet), gray soft bentonitic shale from 395.6 to 398.7 meters (1,298 to 1,308 feet), and variegated shale from 398.7 to 404.8 meters (1,308 to 1,328 feet)	30.5	100	407.8	1,338
Sand with variegated shale	3.0	10	410.9	1,348
Sand, angular; contains pebbles and variegated shale	12.2	40	423.1	1,388
Sand, very coarse to gravel, unconsolidated, poorly sorted, angular, arkosic; contains pyrite	3.0	10	426.1	1,398
Sand, coarse to very coarse, unconsolidated, well sorted; contains mica, pyrite, and feldspars, gray soft bentonitic shale from 441.4 to 450.5 meters (1,448 to 1,478 feet), and trace of light-brown siliceous siltstone from 450.5 to 453.5 meters (1,478 to 1,488 feet)	27.4	90	453.5	1,488
Sand, coarse to very coarse, unconsolidated, well sorted, angular to subangular, arkosic; contains dark-gray silty shale from 505.4 to 508.4 meters (1,658 to 1,668 feet). No sample from 462.7 to 465.7 meters (1,518 to 1,528 feet).	57.9	190	511.5	1,678
Sand and variegated shale	3.0	10	514.5	1,688

Table 2.--Log of cutting samples from Wagon Wheel Water Well No. 1, SE¼NW¼ sec. 5, T. 30 N., R. 108 W., Sublette County, Wyo.--Continued

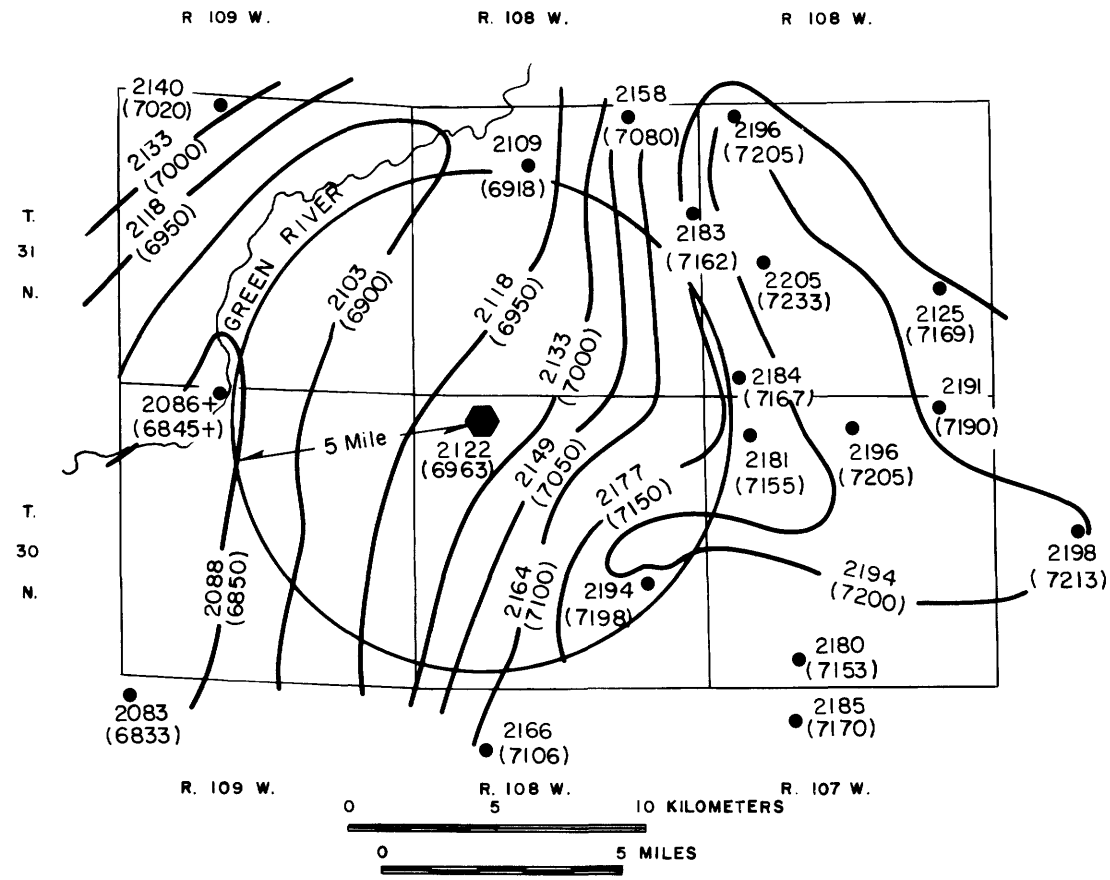
	Thickness		Depth	
	(meters)	(feet)	(meters)	(feet)
Sand, coarse to very coarse, unconsolidated, well sorted, angular to subangular, arkosic; contains variegated shale from 545.0 to 551.1 meters (1,788 to 1,808 feet) and from 651.7 to 657.8 meters (2,138 to 2,158 feet). No sample from 551.1 to 554.1 meters (1,808 to 1,818 feet)	143.3	470	657.8	2,158
Shale, gray, soft, bentonitic	3.0	10	660.8	2,168
Sand, coarse to very coarse, unconsolidated, well sorted, angular to subangular, arkosic	6.1	20	666.9	2,188
Sand associated with variegated shale; contains dark-green silty shale	42.7	140	709.6	2,328
Sand, coarse to very coarse, unconsolidated; contains variegated shale from 709.6 to 718.7 meters (2,328 to 2,358 feet) and gray bentonitic shale from 715.7 to 718.7 meters (2,348 to 2,358 feet)	9.1	30	718.7	2,358
Shale, gray, variegated, bentonitic; contains abundant fine to medium sand	3.0	10	721.8	2,368
Sand, coarse to very coarse, unconsolidated	3.0	10	724.8	2,378
Shale, gray, bentonitic; contains abundant fine to medium unconsolidated sand	6.1	20	730.9	2,398
Shale, variegated and sand	3.0	10	734.0	2,408
Sand, coarse to very coarse, unconsolidated; contains variegated shale	21.3	70	755.3	2,478
Shale, gray, soft, bentonitic; contains abundant fine to medium unconsolidated sand and brown bentonitic shale	3.0	10	758.3	2,488

HYDROLOGY

Because of the wide variety of conditions that existed during the time the sediments in the Green River basin were being deposited, the hydrologic environment of the Wagon Wheel site is complex. Sediments of Tertiary and Late Cretaceous age underlying the Wagon Wheel site contain many sizes of particles deposited under a variety of conditions. At some places, silt- and clay-size sediments predominate and elsewhere sand-size particles are most abundant. Individual stratigraphic units vary markedly in thickness and lateral extent in the basin; overlapping lenses of sandstone and claystone are common.

Ground water occurs in the area under both water-table and artesian conditions. Water-table conditions exist primarily in recharge areas and in thin alluvium in the stream valleys. Water enters the artesian system(s) at the outcrops, where precipitation or surface runoff enters the system directly. Artesian heads vary with depths of aquifers. The artesian heads decrease with depth in and near the recharge areas, but increase with depth in and near the discharge areas along the major stream valleys, because many of the aquifers are poorly connected hydraulically. Some of the water-bearing units are hydraulically connected, so that water moves freely from one unit to another.

The water level in the Wagon Wheel water well conforms to the regional pattern of the water levels in wells near the site (fig. 3). The direction of initial ground-water movement from the Wagon Wheel water well is to the west-northwest.



2166 (7106) — Well in Wasatch Formation. Number indicates elevation of water level, in meters (feet) above mean sea level

2122 (6963) — Wagon Wheel site. Number indicates elevation of water level in meters (feet) above mean sea level in the Wagon Wheel water well

2195 (7200) — Water-table contours showing altitude of water table in meters (feet) above mean sea level. Contour interval about 15 meters (50 feet)

Hydrology by P. T. Voegeli, Sr.
Water-table contours based primarily on data from Hydrologic Investigations Atlas HA-290, by G. E. Welder (1968)

Figure 3.--Preliminary map of the Wagon Wheel site showing configuration of the water table.

Hydraulic Tests

The drilling of Wagon Wheel Water Well No. 1 was completed July 27, 1969, and casing was then set. Nineteen intervals totaling 52.1 meters (171 feet) were gun-perforated (fig. 4). The well was tested by swabbing on August 1, 1969, and by pumping on August 26, 1969.

Swabbing Test

A total of 32 swab runs were made and about 27.9 cubic meters (7,380 gallons) of water were extracted from the well during the 7 hours and 13 minutes of swabbing. The well was swabbed through 5.1-centimeter (2-inch) ID tubing that extended to 731.5 meters (2,400 feet). The water level was measured with an electrical deep-well measuring device before, during, and after swabbing of the well. Measurement of the water level in the well was made in the annular space between the tubing and the 19.4-centimeter ($7\frac{5}{8}$-inch) casing. The water level before swabbing was 29.1 meters (95.5 feet) below land surface. One hour and 25 minutes after swabbing was stopped, the water level was 31.0 meters (101.7 feet) below land surface.

The specific capacity of the well, based on swabbing at an average discharge of 92.6 cubic meters per day (17.0 gallons per minute), was 4.1 cubic meters per day per meter (0.23 gallon per minute per foot) of drawdown. The transmissivity of the aquifer in the vicinity of the well, as computed from the recovery curve, was 26 cubic meters per day per meter (2,100 gallons per day per foot) (fig. 5).

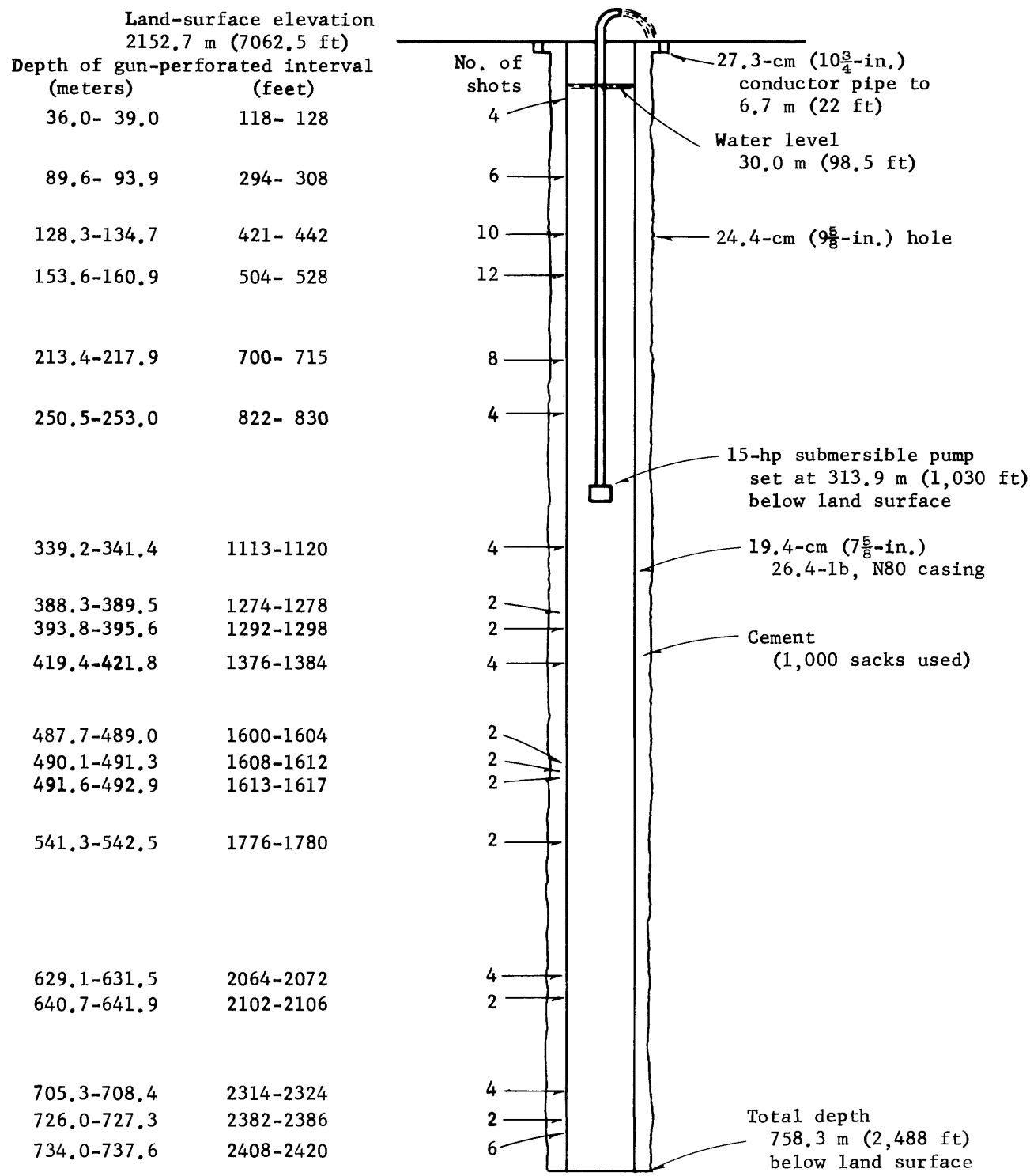


Figure 4.--Construction diagram, Wagon Wheel Water Well No. 1.

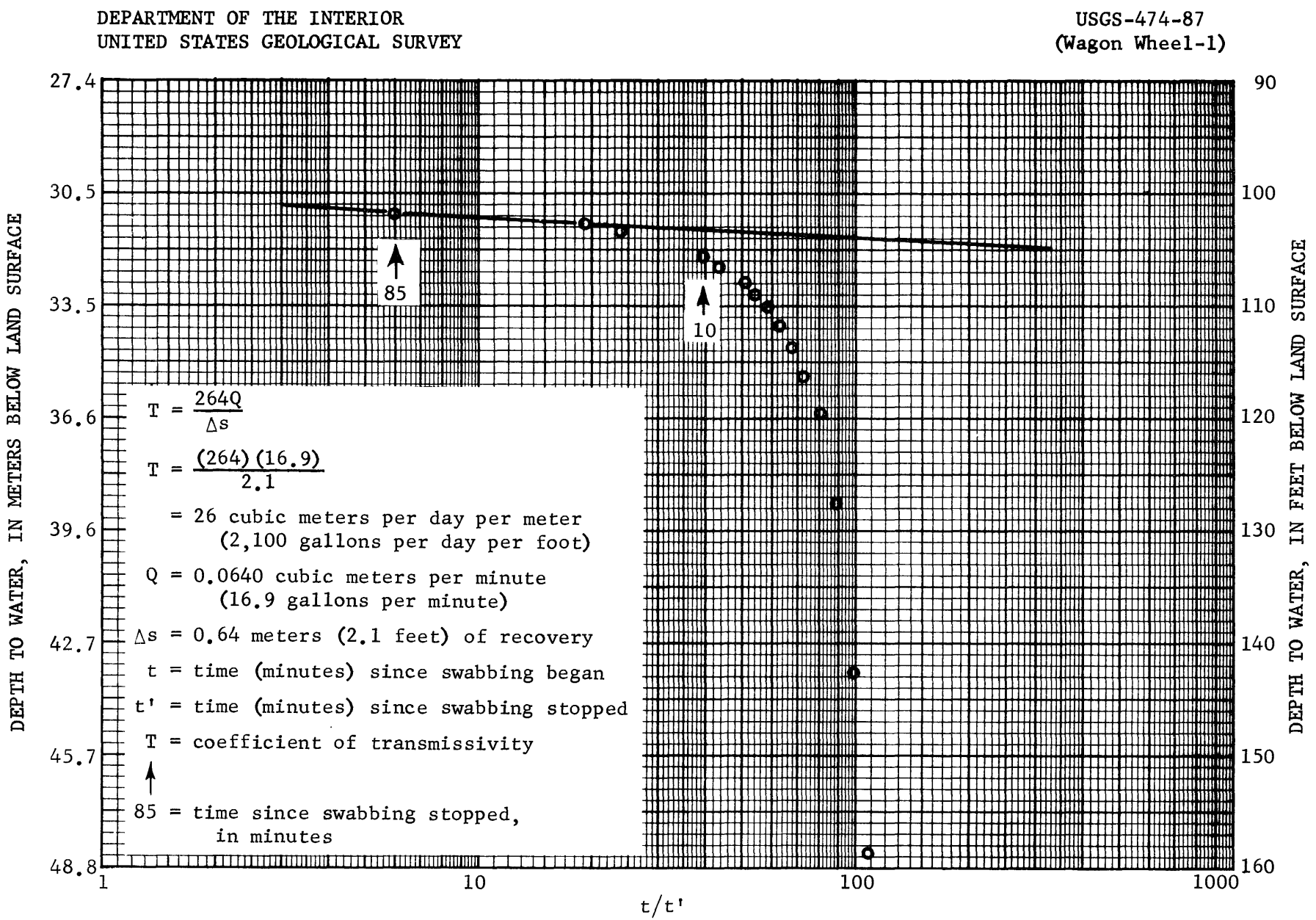


Figure 5.--Curve of water-level recovery from the swabbing test of the Wagon Wheel Water Well No. 1.

Pumping Test

The well was pumped with a submersible pump set at a depth of 313.9 meters (1,030 feet). Pumping continued for 6 hours and 6 minutes and produced 71.4 cubic meters (18,875 gallons) (water-meter measurement) of water. The water level was measured with an electric-contact tape ("M-scope") before, during, and after pumping of the well. Measurement of the water level in the well was made in the annular space between the pump column and the 19.4-centimeter ($7\frac{5}{8}$-inch) casing. The water level prior to pumping was 29.9 meters (98.1 feet) below land surface. Two hours and 40 minutes after pumping was stopped, the water level was 30.8 meters (101.0 feet) below land surface.

The specific capacity of the well, based on the 6 hour and 6 minute pumping test at an average discharge of 281 cubic meters per day (51.6 gallons per minute), was 16 cubic meters per day per meter (0.88 gallon per minute per foot) of drawdown. The drawdown was 17.8 meters (58.4 feet) during the test. The transmissivity of the aquifer in the vicinity of the well, as computed from the drawdown and recovery curves, was 26 cubic meters per day per meter (2,100 gallons per day per foot) (figs. 6 and 7).

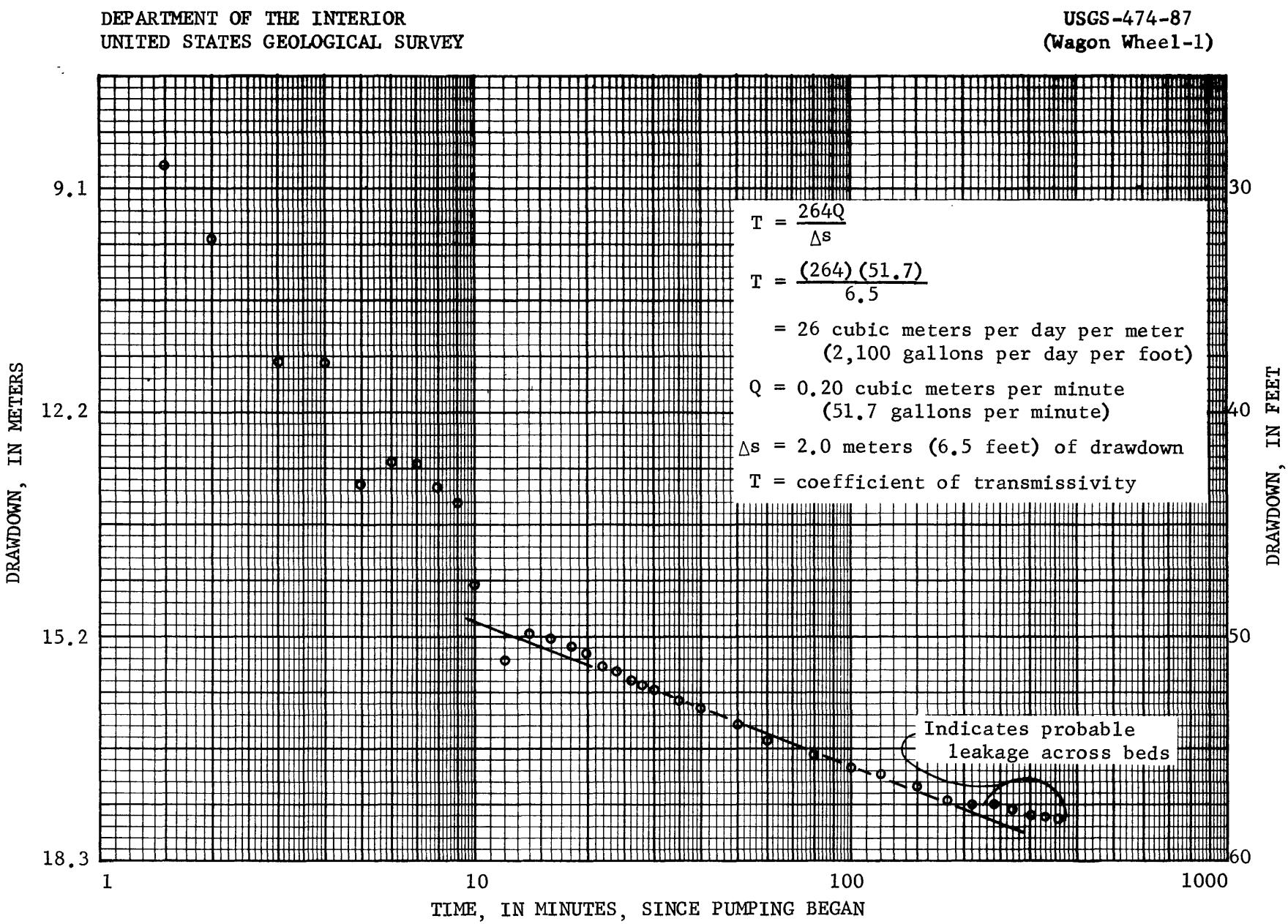


Figure 6.--Curve of water-level drawdown from the pumping test of the Wagon Wheel Water Well No. 1.

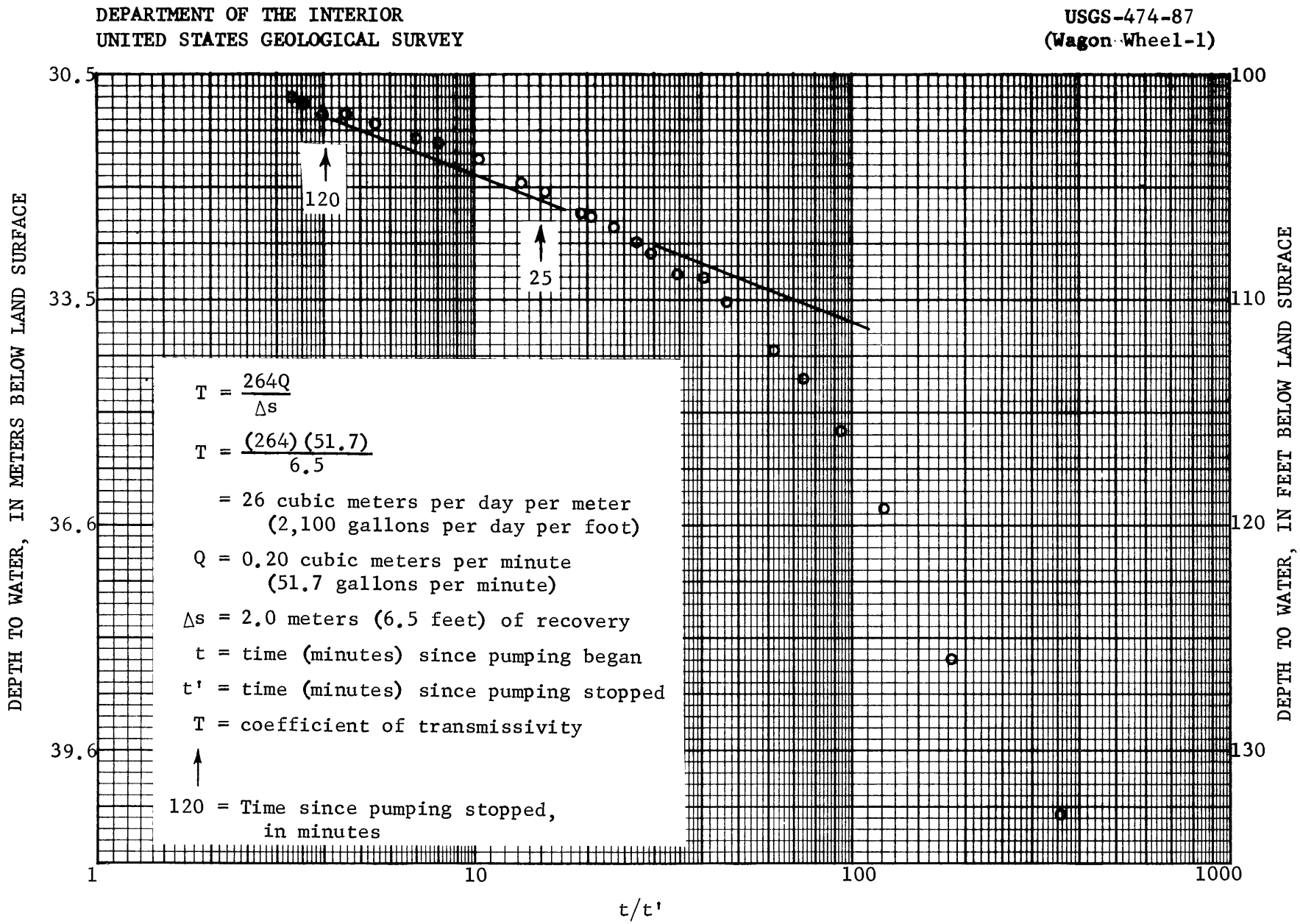


Figure 7.--Curve of water-level recovery from the pumping test of the Wagon Wheel Water Well No. 1.

CHEMICAL ANALYSES OF WATER SAMPLES

Two water samples were collected from the well during the swabbing and pumping tests. Table 3 shows the results of the laboratory analyses of the samples. The water from the swabbing test contains much more barium, boron, copper, lead, iron, and sulfate, and less sodium and chloride than the water from the pumping test. The numerical differences between the constituents may be attributed to the fact that the sample from the swabbing test was obtained only a few days after the well was completed. The swab water sample was probably still contaminated by drilling mud and the cement placed behind the casing. The pumped sample was obtained after at least 132 cubic meters (35,000 gallons) of water had been produced from the well, and it is more representative of the formation water.

The U.S. Geological Survey analyzed the samples for tritium content. The values reported for both samples were below 300 tritium units, the detection level for the analytical method used.

Table 3.--Spectrographic, radiochemical, and general chemical analyses of water removed during the swabbing and pumping tests of Wagon Wheel Water Well No. 1

(Analyses by U.S. Geological Survey)

Field data

	Date of collection	Time	Removed prior to collection		Temperature		pH	Specific conductance (micromhos per cm at 25°C)
			gallons	cubic meters	°C	°F		
Swabbing test sample	8- 1-69	1549	6,700	25	20.0	68.0	10.1	760
Pumping test sample	8-26-69	1450	11,700	44.3	19.0	66.2	9.1	1,050

Spectrographic analyses
(micrograms per liter)

Element	Swabbing test sample	Pumping test sample
Aluminum (Al)	--	30
Barium (Ba)	160	27
Beryllium (Be)	.1	<.5
Bismuth (Bi)	<1	<9
Boron (B)	780	80
Cadmium (Cd)	<10	<9
Chromium (Cr)	40	<9
Cobalt (Co)	<2	<5
Copper (Cu)	260	.7
Gallium (Ga)	--	ND
Germanium (Ge)	<8	<9
Iron (Fe)	--	40
Lanthanum (La)	--	--
Lead (Pb)	240	<9
Manganese (Mn)	--	2
Molybdenum (Mo)	16	<5
Nickel (Ni)	28	<5
Silver (Ag)	<.4	<.5
Strontium (Sr)	--	65
Tin (Sn)	<8	<9
Titanium (Ti)	<2	<2
Vanadium (V)	50	<9
Ytterbium (Yb)	--	--
Yttrium (Y)	--	--
Zinc (Zn)	90	<90
Zirconium (Zr)	ND	ND

--Not determined < Less than ND Specifically sought, not detected

Table 3.--Spectrographic, radiochemical, and general chemical analyses of water removed during the swabbing and pumping tests of Wagon Wheel Water Well No. 1--Continued

Radiochemical analyses

Element	Swabbing test sample	Pumping test sample
Uranium (micrograms per liter)	<0.4	--
Radium, as Ra^{226} (picocuries per liter)	.07	--
Gross beta, as Sr^{90}-Y^{90} (picocuries per liter)	5.4	1.8
Gross alpha, as U equivalent (micrograms per liter)	7.7	1.9

-- Not determined < Less than

General chemical analyses
(milligrams per liter)

	Swabbing test sample	Pumping test sample
Silica (SiO_2)	21	13
Aluminum (Al)	1.4	<.10
Iron (Fe)	6.0	.08
Manganese (Mn)	.05	.010
Strontium (Sr)	.11	.10
Calcium (Ca)	4.1	3.0
Magnesium (Mg)	2.6	.1
Sodium (Na)	182	249
Potassium (K)	4.0	1.3
Lithium (Li)	<.01	.01
Bicarbonate (HCO_3)	--	119
Carbonate (CO_3)	75	21
Chloride (Cl)	158	266
Copper (Cu)	.27	.02
Fluoride (F)	11	15
Hydroxide (OH)	4	--
Nitrate (NO_3)	<.1	.1
Phosphate (PO_4)	.14	<.01
Selenium (Se)	<.001	.019
Sulfate (SO_4)	35	1.1
Zinc (Zn)	.09	.06
Boron (B)	.27	.51
Dissolved solids		
Res. on evap. at 180°C	612	631
Calculated	497	629
Hardness as $CaCO_3$		
Total	21	8
Non-carbonate	0	0
Specific conductance (μmhos per cm at 25°C)	841	1,250
pH	9.7	8.9
Percent sodium	94	98
Sodium-adsorption ratio (SAR)	17	38

-- Not determined < Less than

SUMMARY

The hydraulic data obtained in the Wagon Wheel Water Well No. 1 are summarized in the following table:

Test	Average yield		Drawdown		Specific capacity		Transmissivity	
	(m^3 pd)	(gpm)	(m)	(ft)	(m^3 pd per m of drawdown)	(gpm per ft of drawdown)	(m^3 pd per m)	(gpd per ft)
Swabbing	92.9	17.0	23±	74±	4.1	0.23	26	2,100
Pumping	281	51.6	17.8	58.4	16	.88	26	2,100

SELECTED REFERENCES

Krueger, M. L., 1960, Occurrence of natural gas in the western part of Green River basin in Overthrust belt of southwestern Wyoming and adjacent areas: Guidebook, 15th Ann. Field Conf., 1960, Wyoming Geol. Assoc., p. 195-209.

Welder, G. E., 1968, Ground-water reconnaissance of the Green River basin, southwestern Wyoming: U.S. Geol. Survey Hydrol. Inv. Atlas HA-290.