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Reduction of Infiltration by Zone Pumping

EPARTMENT OF THE INTERIOR ● FEDERAL WATER POLLUTION CONTROL ADMINISTRATION

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WP-20-22	Polymers for Sewer Flow Control.

REDUCTION OF GROUND-WATER INFILTRATION INTO SEWERS BY ZONE PUMPING AT MERIDIAN, IDAHO

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION

GRANT 29-IDA-2

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CONSULTING ENGINEERS
2500 Kootenai, Boise, Idaho 83705
917 Eighth Ave., Lewiston, Idaho 83501

June, 1969

FWPCA Review Notice

This report has been reviewed by the Federal Water Pollution Control Administration and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Federal Water Pollution Control Administration.

ABSTRACT

The purpose of this study was to determine if the lowering of the high water table by pumping in a given area of the City of Meridian would eliminate infiltration of ground water to the municipal sewers. If the infiltration could be eliminated, the large volume of sewage flow that occurs during the irrigation season would be greatly reduced. Sewage flows in excess of the capacity of the sewage treatment plant are now bypassed to a small stream.

It was contemplated that the test results from this study could be used to predict the lowering of water table in other areas in the City of Meridian. The topography, geology, precipitation, as well as local irrigation programs are so irregular in character that no definite criteria could be set up to predict what would occur in other areas. It is concluded that each area would have to be studied independently to decide the depth of well, pump capacity and local affecting conditions.

It is also concluded that the cost of capital investment, cost of operation of these pumping projects in the entire Meridian area to lower the water table would be too expensive to accomplish the purpose of lowering the water table below the sewers so as to materially decrease the flow of infiltration water to the sewage treatment plant. It would be less expensive to build holding lagoons or a separate lagoon system to treat the excess flow to the sewage treatment plant during the irrigation period. This report was submitted in fulfillment of Grant 29-IDA-2 between the Federal Water Pollution Control Administration and the City of Meridian, Idaho.

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REDUCTION OF GROUND-WATER INFILTRATION INTO SEWERS BY ZONE PUMPING AT MERIDIAN, IDAHO

1. INTRODUCTION

1. Nature of Project

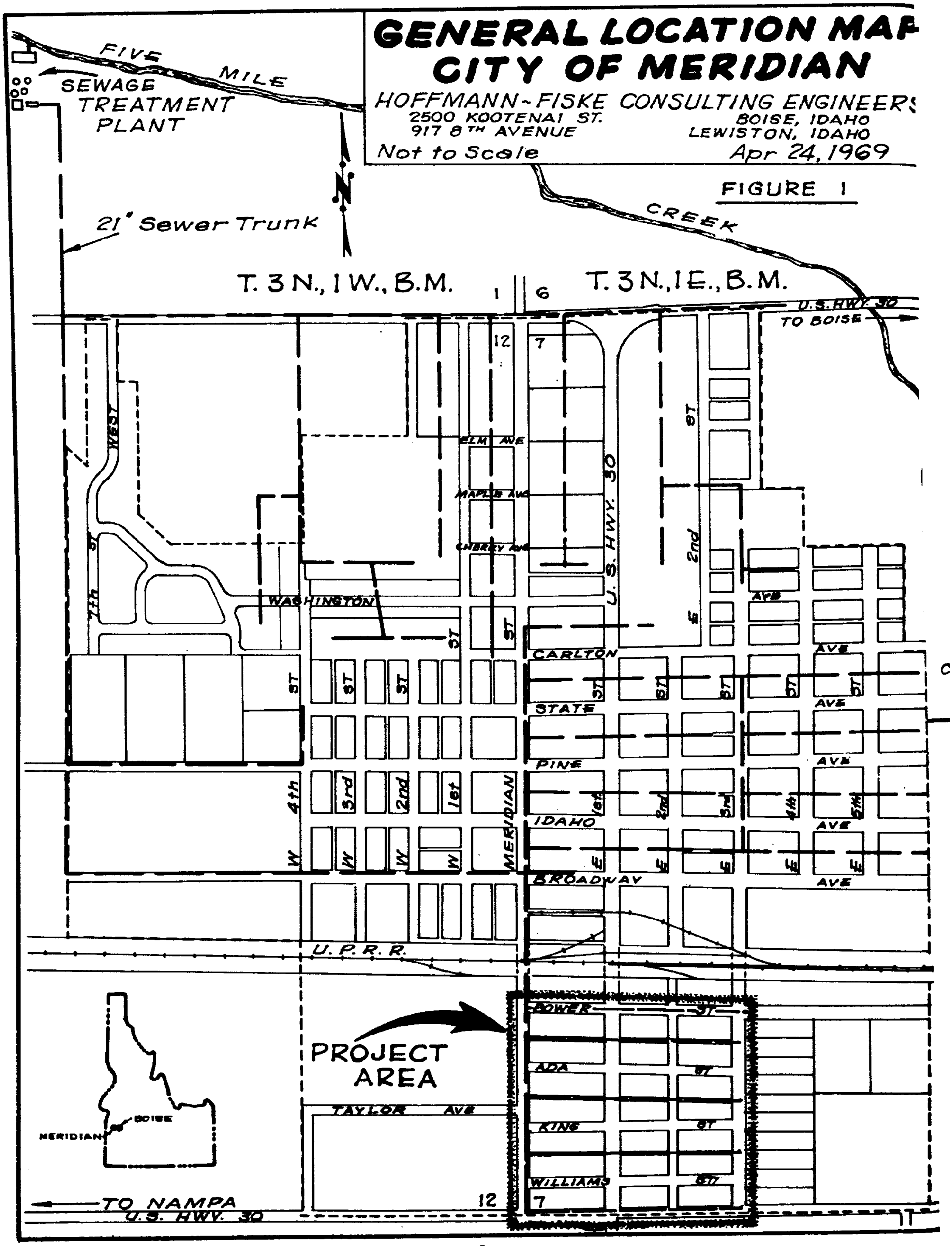
The sewer systems in several of the south central cities of Idaho have been troubled by the infiltration of irrigation water into the sewers. As a result the sewage treatment facilities are overtaxed during the irrigation season. The situation at Meridian, Idaho, is unique in that the overtaxing of the sewage treatment plant comes during the dry summer months from the infiltration of irrigation water rather than in the winter during heavy rainfall period.

The City of Meridian Sewage System consists of several laterals throughout the City which connect to a 21 inch trunk sewer that leads to a secondary treatment plant Northwest of the City Center. The effluent from the sewage plant flows into Five Mile Creek which runs Northwesterly through the area. See Figure No. 1.

The Sewage Treatment Plant is designed for a flow of 1500 g.p.m. (2,160,000 g.p.d.). The plant takes care of the sewage treatment during the winter months, but during the summer months there are some flows over 2,160,000 gallons per day. The extra flow is a result of infiltration of ground water during the irrigation season. In some areas the ground water rises to within 18 inches of the ground surface. As a result of this heavy infiltration a great deal of untreated sewage bypasses the sewage treatment plant and flows into Five Mile Creek. Five Mile Creek meanders westerly through a farming area to the Boise River which eventually flows into the Snake River near Parma, Idaho.

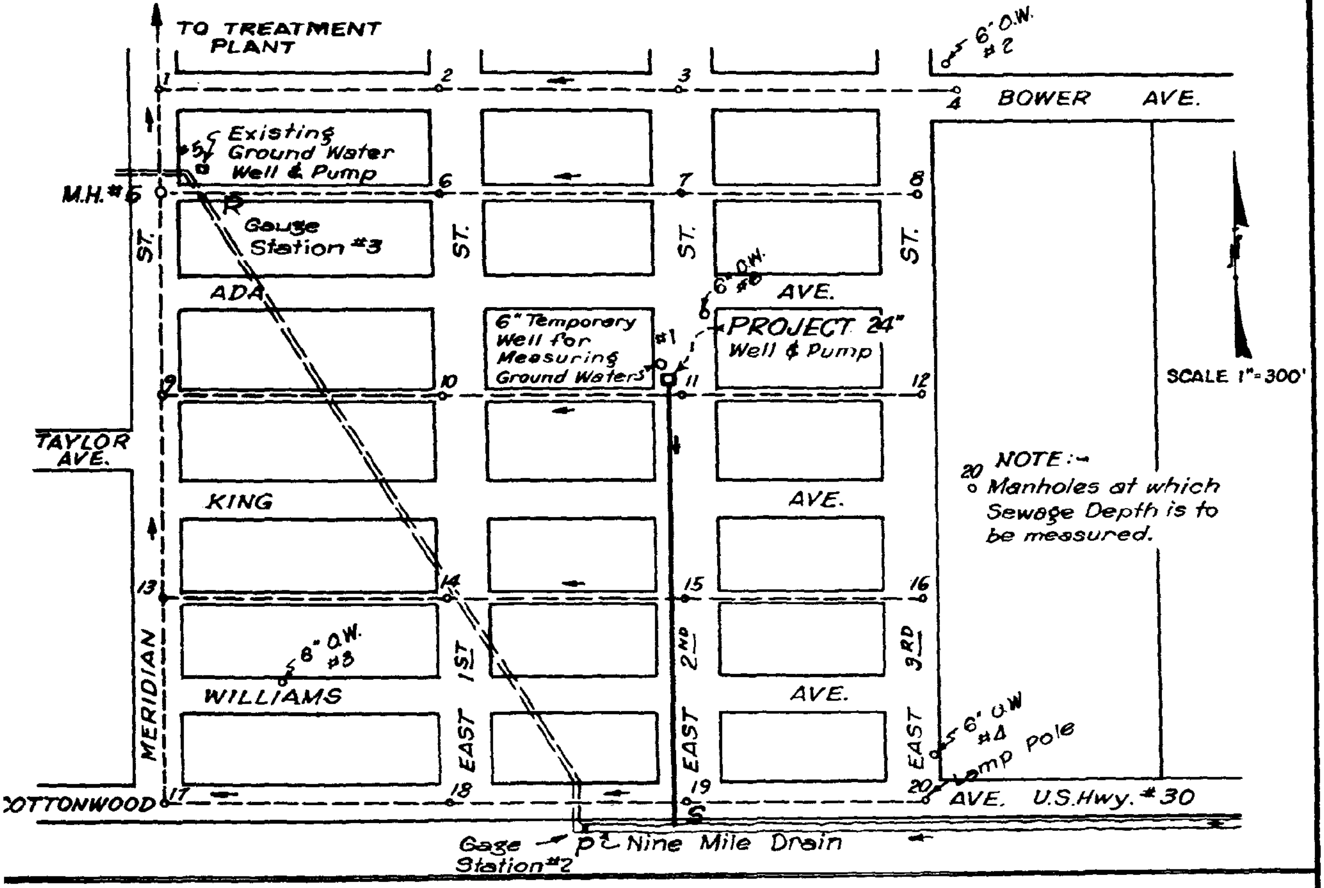
One of the areas of high water table is in the southwest portion of the City. It is a residential area bounded on the north by Bower Street; on the south by Cottonwood Avenue; on the west by Meridian Street and on the east by East 3rd Street. See Figure 2. The ground water in this area was only 18 inches below ground surface at this point. This is probably the most critical area in the City of Meridian.

The basic idea of this project was to install a shallow well pump in the center of the above area, which is the approximate low point of the area, and study the lowering of the water table to determine the zone of influence of the well. If the pumping were

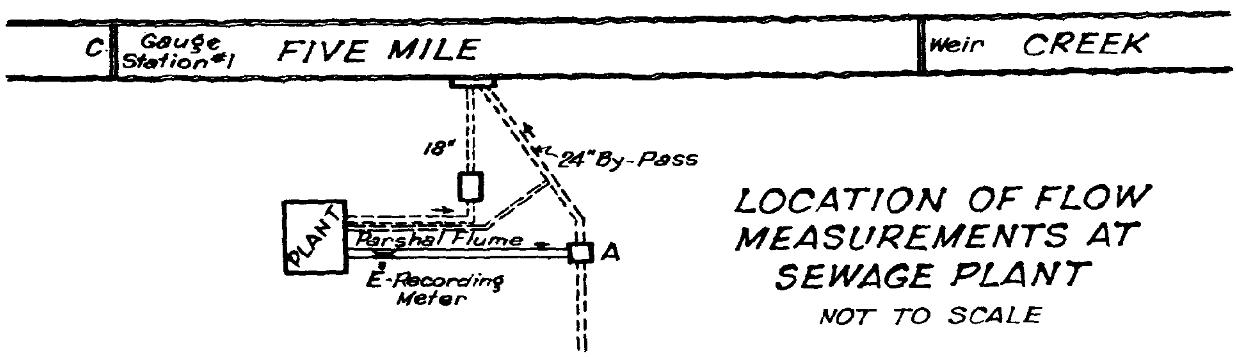

GENERAL LOCATION MAP
CITY OF MERIDIAN
HOFFMANN-FISKE CONSULTING ENGINEERS
2500 KOOTENAI ST. BOISE, IDAHO
917 8TH AVENUE LEWISTON, IDAHO
Not to Scale
Apr 24, 1969
FIGURE 1
FIVE MILE CREEK
SEWAGE TREATMENT PLANT
21" Sewer Trunk
T. 3 N., 1 W., B.M.
T. 3 N., 1 E., B.M.
U.S. HWY. 30
TO BOISE
WASHINGTON
CARLTON
STATE
PINE
IDAHO
BROADWAY
AVE
U.P.R.R.
POWER ST
ADA ST
TAYLOR AVE
KING ST
WILLIAMS ST
PROJECT AREA
TO NAMPA
U.S. HWY. 30
MERIDIAN
BOISE

GROUND WATER PROGRAM

MERIDIAN PUMP PROJECT



PLAN



LOCATION OF FLOW MEASUREMENTS AT SEWAGE PLANT

NOT TO SCALE

FIGURE 2

HOFFMANN & FISKE CONSULTING ENGINEERS
2500 KOOTENAI STREET BOISE, IDAHO.
917 8TH AVENUE LEWISTON, IDAHO.
JULY 25, 1967.

REV. 6/3/68

able to keep the ground water level below the sewers, the irrigation infiltration would be reduced and the flow to the sewage plant during the irrigation period would be reduced. The study was to determine if it would be economically feasible to install these pumps throughout the City and thus eliminate the sewage bypassing the sewage treatment plant during the summer months.

A 100 foot well was drilled as shown on Figure 2 at the alley between Ada & King Avenues on East 2nd. This was completed on December 21, 1967. A 500 g.p.m. pump was installed on June 23, 1968, and the City of Meridian construction crew completed construction of the 8 inch transite line to the Nine Mile Drain as shown on Figure 2 at the same time. The pump was started on June 26, 1968, at a capacity of 200 g.p.m. and pumped at this capacity until July 17, 1968. On July 17, 1968, the pumping capacity was changed to 350 g.p.m. and on August 7, 1968, the pump was opened to its full capacity. Depending on the elevation of ground water this varied from 570 to 660 g.p.m. The pump was left at its maximum pumping capacity from August 7, 1968, until the writing of this report and will continue to operate at full capacity until ground-water conditions warrant making a change.

2. <u>Findings</u>

The following are the findings of the study of the Meridian Drainage Project, Meridian, Idaho:

a. The ground-water level in the Meridian area is a factor in the infiltration of water into the sewer system. The water table rises in the summer due to irrigation water percolating into the ground. In the winter excessive rainfall and snow melt also percolate into the ground.

b. The flow in the sewer lines is affected by the ground-water level. The higher the ground-water level, the greater the head on the sewers and therefore the greater the rate of infiltration. There is no doubt that the sewer lines constructed of vitrified clay pipe during the 1930's have defective joints and broken sections that contribute to this infiltration.

c. The flow through the sewage plant varys a great deal from summer to winter months because of the infiltration of irrigation water into the sewers. The records show some 1,150,000 gallons per day bypassing the sewage in the peak summer flow. This is untreated water and sewage that flows into Five Mile Creek.

d. The flow in Five Mile Creek varies from 10 c.f.s. in winter to 45 c.f.s. in summer. There is contamination of Five Mile Creek from the sewage which bypasses the sewage plant during the summer months. Due to the greater flow of water in summer months there is more oxygen available and a greater flow for dilution of sewage.

e. The ground water pumped from the drainage well into the Nampa Meridian Drainage Canal has low bacteria count and B.O.D. demand indicating that the waters are not contaminated and can be used for irrigation purposes.

f. The water levels in the different areas of the project area were not lowered uniformly with the pump operating 24 hrs. a day. The ground-water levels fluctuate due to the impact of local irrigation, rain and snow fall.

g. The total cost of the construction project was as follows:

Construction Costs		
a.	Contracts	$11,745.67
b.	Force Account	4,227.85
c.	Engineering	6,265.00
d.	Legal	100.00
e.	Administration	450.00
f.	O & M	1,711.48
	Total Cost Project	$24,500.00

h. The cost of operating the pump 24 hours a day at full capacity is about $1.75 per day to pump an average 850,000 gallons of ground water.

i. Pumping the ground water lowered the water table below the sewers for about a two block square area. This affected the amount of flow into the sewers and thus the flow through the sewage treatment plant.

j. Pumping in the winter months lowered the water table as it was affected by periodic rains and snow melt.

k. The results of this study did not result in any empirical formula to predict the results of drainage pumping in other areas of City of Meridian. The subterranean geology as well as the irrigation, topography and precipitation make this impossible.

l. A drainage pump will lower the water table below the sewers, but each area will have to be studied independently to decide the depth of well, pump capacity and waste way for pumped water. This area was an ideal area as far as costs are concerned. Elimination of waste water in other sections of City could present a problem.

m. All construction should be in the winter months so that the high water table will not present problems.

n. The City of Meridian consists of approximately 140 square blocks in area which means about 70 units. 70 units at an average cost of $40,000. per unit would mean a capital outlay of $2,800,000. This would mean a power bill of $122.50 a day in addition.

There are other benefits derived from the pumping operations besides the lowering of the infiltration into the sewer lines. Several basements in the area have been dry as a result of the drop in water table in the zone of influence of the pumping well. Actually the water pumped into the Nine Mile Draw could be used for irrigation and a benefit thus derived from the presently wasted flow. Some people have shallow wells used for irrigating their own properties. Some of these have gone dry as a result of lowering ground water. If the water table could be lowered it would make all types of construction, particularly utility construction, less expensive. At present utility construction is limited to the winter months when the water table is down.

3. Conclusions

a. There is no doubt that the drainage project accomplished the purpose of lowering the water table below the sewers within a two block area, but no definite criteria was established by the project so that formula could be set up for future projects.

b. The cost for installing pumping stations throughout the City of Meridian would be prohibitive in cost. It would be cheaper to build a holding lagoon or separate lagoon system to take care of the surplus irrigation water that infiltrates into the sewer lines.

II. DESCRIPTION OF PROJECT AREA

1. Location

The City of Meridian is located in Southwestern Idaho, 8 miles West of Boise, Idaho. See Figure 1. It is the center of a farming area and known as the "Heart of The Dairyland". Meridian has a population of 2146 in accordance with the 1965 special census. The topography of the area slopes to the northwest draining towards the Boise River which is four miles north of Meridian. The ground in the Boise Valley is somewhat uniform in its geological formation. There are generally 3 to 4 feet of rich top soil, then 6 to 18 inches of caliche hardpan; then gravel and sand strata to at least 50 feet. The project area is in the southeastern part of Meridian. Bounded by Bower Avenue on the north; Meridian Street on the west; Cottonwood Avenue on the south; and East 3rd on the east. This area is 3 blocks square. See Figure 2.

2. Climate

The climate in general may be described as dry and temperate, with sufficient variation to be stimulating. Summer maximums generally are reached in late afternoon followed by rapidly falling temperatures after sunset.

The normal precipitation pattern in the Boise Area shows a winter maximum and a very pronounced summer minimum. The greatest 24 hour precipitation was 2.24 inches on June 11-12, 1958. The average annual rainfall is 12 inches. During the year June, 1967, to June, 1968, the major periods of rainfall were 1.0 inch in June, 1967; 0.4 inch in October 1967; 4.0 inches snow and rainfall between Jan. 1, 1968, and April 1, 1968; and the balance of 2.1 inches fell at odd times during the year for a total of 7.5 inches.

3. Irrigation

The irrigation season in the Meridian Area starts in the middle of April and runs to the middle of October. Generally the water is distributed to the area in a main canal. From the main canal laterals lead out to the various areas, usually in the street right-of-way or alleys. The property owners take their water out of the laterals for their particular property. Generally it is done on a local weekly distribution plan, depending on the property area. By mutual agreement, days of the week may be exchanged or if it rains for a few days some people may not irrigate. Thus the surcharge of ground water has no particular predictable pattern. This was in evidence at the observation wells which would have the local water table rise during the days of irrigation and then gradually subside until the next irrigation rotation.

4. Sewage Collection, Treatment and Disposal at Meridian

Most of the sewers in the residential areas were constructed during the W.P.A. days and were not well constructed. The sewers are mainly vitrified clay tile. Over the years since 1930's the ground water has raised and lowered several times in the gravel and sand formations, leaching out the fines from the gravel causing voids in the strata which resulted in unequal settlement of the pipe, causing some of the joints to open. Whenever the water table rose, the water infiltrated into the sewers.

The City of Meridian Sewage System consists of several 8 inch laterals feeding into 12 & 15 inch collector sewers, which eventually empty into a 21 inch trunk sewer that runs Northwest into a secondary treatment plant Northwest of the City Center. The effluent from the sewage plant flows into Five Mile Creek which runs northwesterly thru the area to the Boise River. The Sewage Plant is designed for a flow of 2,160,000 gallons per day. The treatment plant takes care of the sewage treatment during the winter months, but during the summer months there are some flows of 3,620,000 gallons per day. The extra flow is a result of the infiltration of ground water during the irrigation season. As a result of this heavy infiltration, a great deal of untreated sewage has to bypass the treatment plant and flow into Five Mile Creek. Five Mile Creek meanders northwesterly through farming area to the Boise River, which eventually empties into the Snake River near Parma, Idaho. On August 24, 1968, as much as 1,460,000 gallons per day bypassed the sewage treatment plant.

5. Problems in Operating The Combined Sewer System

The sewage plant is designed for a maximum flow of 1500 gallons per minute (2,160,000 gallons per day). During the irrigation period between April 15 and October 15 each year the infiltration into sewer commences to build up until a peak of almost 3,620,000 gallons per day flows to the plant. The sewers are not designed as a combined sewer, but due to poor original construction, there are open joints and poor house connections, as well as, pieces of vitrified clay pipe broken out of the pipe line. As the townspeople start their irrigation, the ground-water level builds up and is soon under a head which forces the water into sewer pipes making a combined sewer of the lines. In some of the 8 inch lines that have a normal flow of 1 to 2 inches during winter months the pipe is entirely full in the middle of the irrigation period.

The sewage plant, of course, is not designed to take a flow of nearly 3,620,000 gallons per day; so the excess of 1,460,000 gallons is bypassed into Five Mile Creek which has a flow of 20-30 c.f.s. during the summer months. This stream flows northwest to the Boise River and adds to its pollution.

It can readily be seen that if some method could be devised to prevent the irrigation water from infiltrating into the sewers, the load on the sewage plant would be substantially reduced. One method would be to dig up the sewers and relay them or lay a parallel line. This cost would be prohibitive in the paved streets. Another method to reduce the infiltration would be to lower the water table below the sewers by the operation of a pumped well.

III. PROJECT CONSTRUCTION

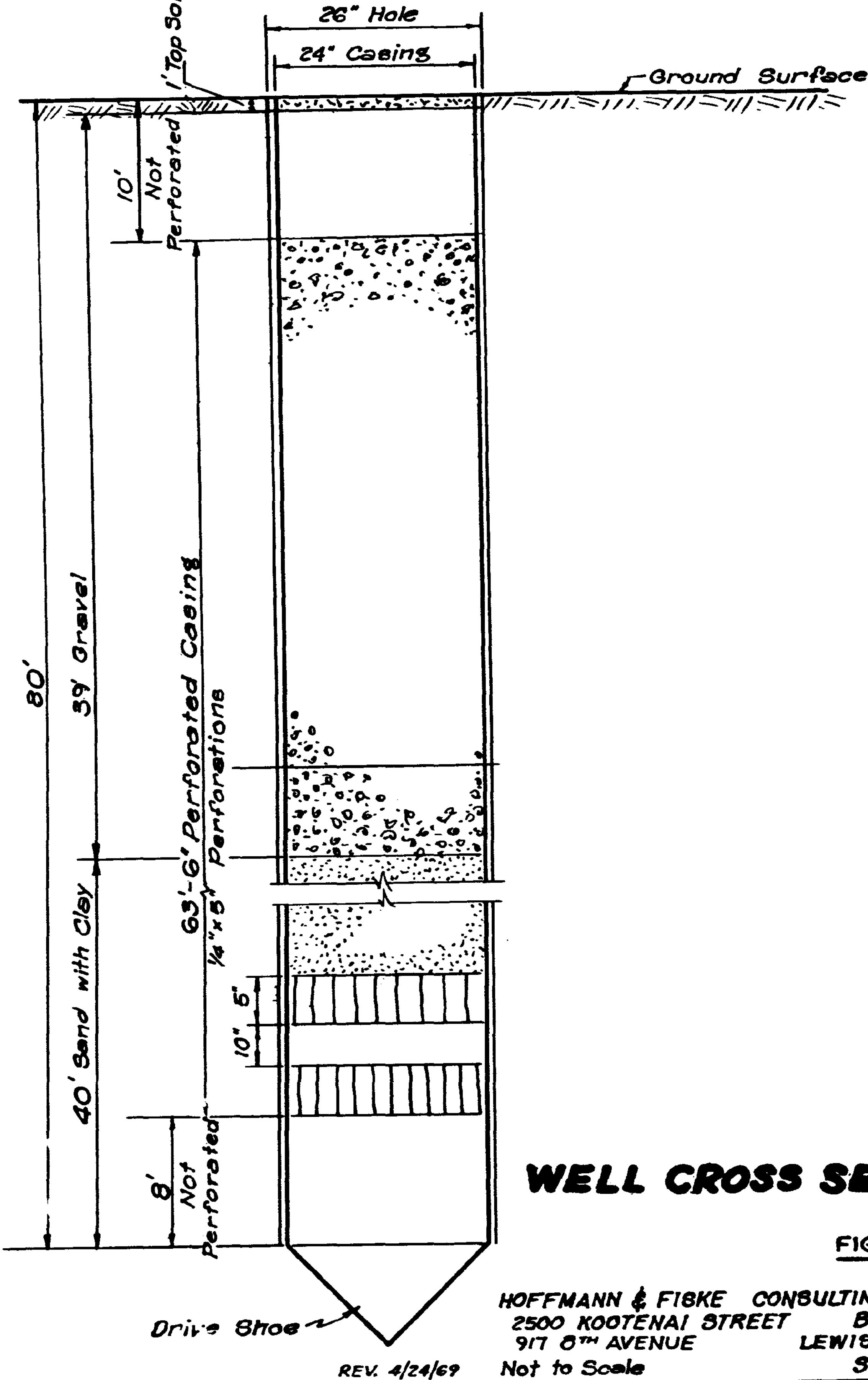
1. Production Well

Bids were advertised on the drilling of a 24-inch diameter well to 100 feet as shown on Figure 3 and bids were open on October 26, 1967. The Contract was awarded to Witt & Sons Drilling of Caldwell, Idaho. The final well was 80 feet and cased 81.6 feet. The casing was perforated from 9 to 72 feet. The perforations were 1/4 x 5 inches spaced 9 inches horizontally and 5 inches apart vertically. The well was developed and gravel packed from November 30, 1967, until December 21, 1967. The well was tested for a period of 16 hours. The first day the well was tested at a flow of 300 g.p.m to 1,000 g.p.m. with an 8 inch turbine pump with 60 feet of column. The static water level was 5 feet below the top of casing. The pumping level was 31 to 34 feet below the top of casing which corresponds to a draw down of 26 to 29 feet. At the end of the 16 hour test the pumping rate was 913 g.p.m. with a draw down of 29 feet. The static water level was 6.5 feet below casing at termination of pumping. The log of the well is shown on Figure 3.

Bids were advertised and opened on April 9, 1968, for a vertical turbine pump to pump 500 g.p.m. This was the type of pump and the capacity specified after a study of the test well data.

The specifications for the operating conditions of the well were as follows:

1. Inside diameter of well - 24 inches.
2. Depth of Well - 80 feet.
3. Static water level below topwell - 5 feet.
4. Pumping level below topwell - 40 feet.
5. Pumping head above top of well - 10 feet.



WELL CROSS SECTIO

FIGURE 3

HOFFMANN & FISKE CONSULTING ENGINEE
2500 KOOTENAI STREET BOISE, IDAH
917 8TH AVENUE LEWISTON, IDAH
Not to Scale SEPT. 18, 196

6. Total pump head - 50 feet.
7. Capacity of well - 500 g.p.m.
8. Power characteristics - 220 V., 3 phase, 60 cycles.
9. Normal rotative speed - 1760 R.P.M. maximum.

A venturi type, direct acting controller, water level indicator and appurtenances were included in the bid. A recording meter to indicate the depth of water in the well, with a shut off control at 40 feet was also specified. It was desired to control the flow from the pump, if required, so that the water table would be kept just below the level of the lowest sewer in the study area. Mayne Pump Co., of Boise, Idaho, was awarded the Contract. See Figures 4 & 5.

The construction of 812 feet of 8 inch Transite pipe and a pump pit were constructed by force account by the City of Meridian forces. All construction work was completed on June 23rd, 1968.

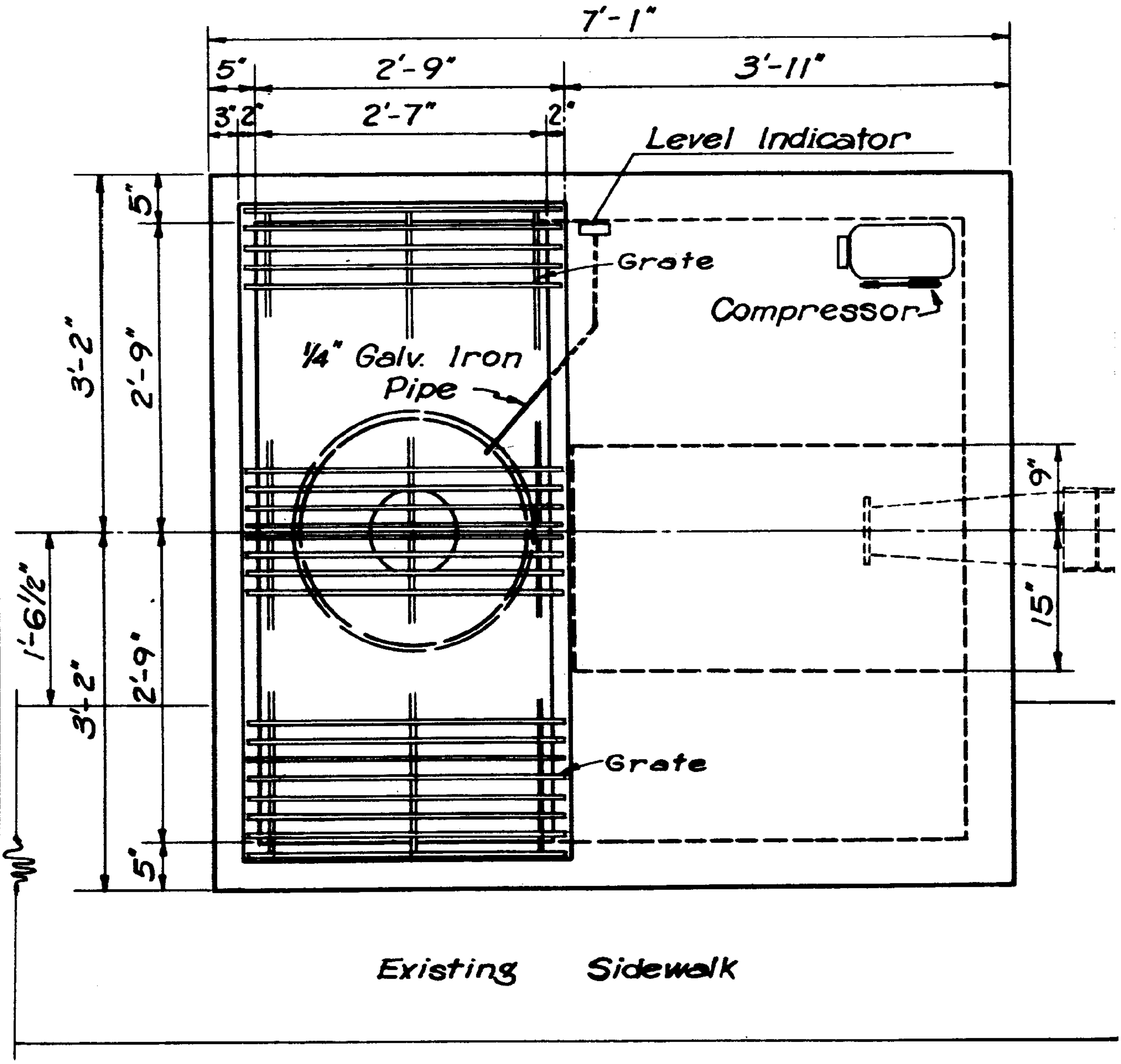
The pump was started on June 26th, 1968, at 200 g.p.m.

2. Observation Wells

Four observation wells were constructed prior to the starting of the pump on June 26, 1968, as shown on Figure 6. These wells were constructed by digging holes approximately 14 to 16 feet deep, installing a 6 inch corrugated pipe and back filling with gravel. Except for the top 2 to 3 feet, the 6 inch observation well pipes were in gravel. The wells used finally are Nos. 2, 3, 4 and 6. Well No. 5 as shown on Figure 2 is a drainage well owned by the Nampa Meridian Irrigation Company that is next to Nine Mile Draw and pumps directly into it. It was mutually intended to use this well as an observation well, but it was inconvenient to obtain access to measuring the water depth because of the construction of the unit, thus this observation well was abandoned. Wells Nos. 2, 3 and 4 were constructed Sept. 18, 1967. Well No. 6 was constructed June 20, 1968. The depth of water in wells Nos. 2,3 and 4 were measured by means of electrical resistance measuring device. Depths to water were measured weekly prior to use of recording meters. Recording meters were the Belfort Co. Catalogue No. 5-FW-4* and were installed June 1, 1969.

The location of the observation wells from the pumped well is as follows:

* Use of product and company names is for identification only and does not constitute endorsement by the U.S. Department of the Interior or the Federal Water Pollution Control Administration.



PLAN OF PUMP PIT

FIGURE 4

HOFFMANN – FISKE CONSULTING ENGINEER
2500 KOOTENAI STREET BOISE, IDAHO
917 8TH AVENUE LEWISTON, IDAHO
Scale: 3/4" = 1'-0" Apr. 25, 1969

SECTION THRU PUMP PIT

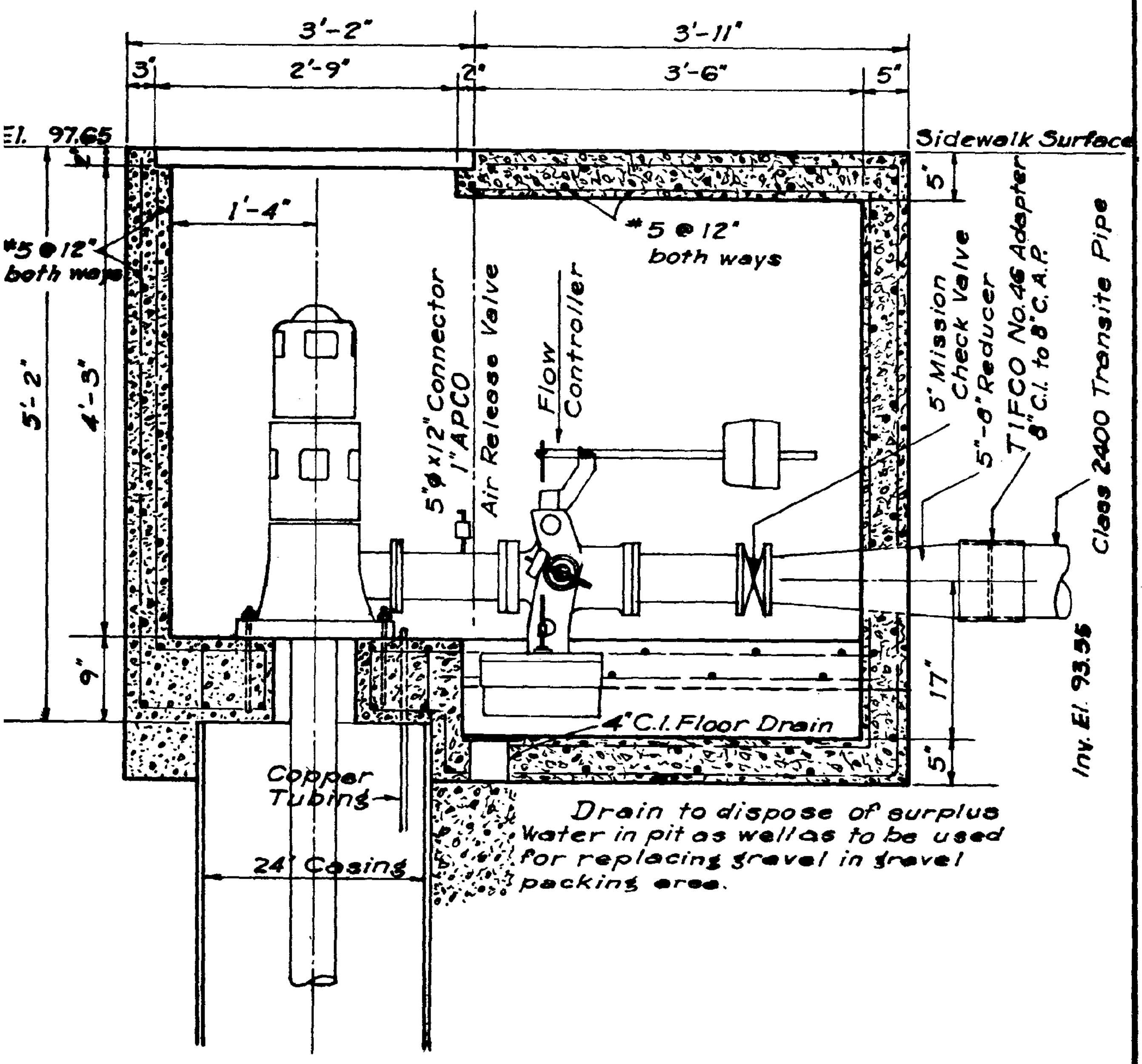


FIGURE 5

HOFFMANN – FISKE CONSULTING ENGINEERS
2500 KOOTENAI STREET BOISE, IDAHO
917 8TH AVENUE LEWISTON, IDAHO
Scale : 3/4" = 1'-0" Apr 24, 1969

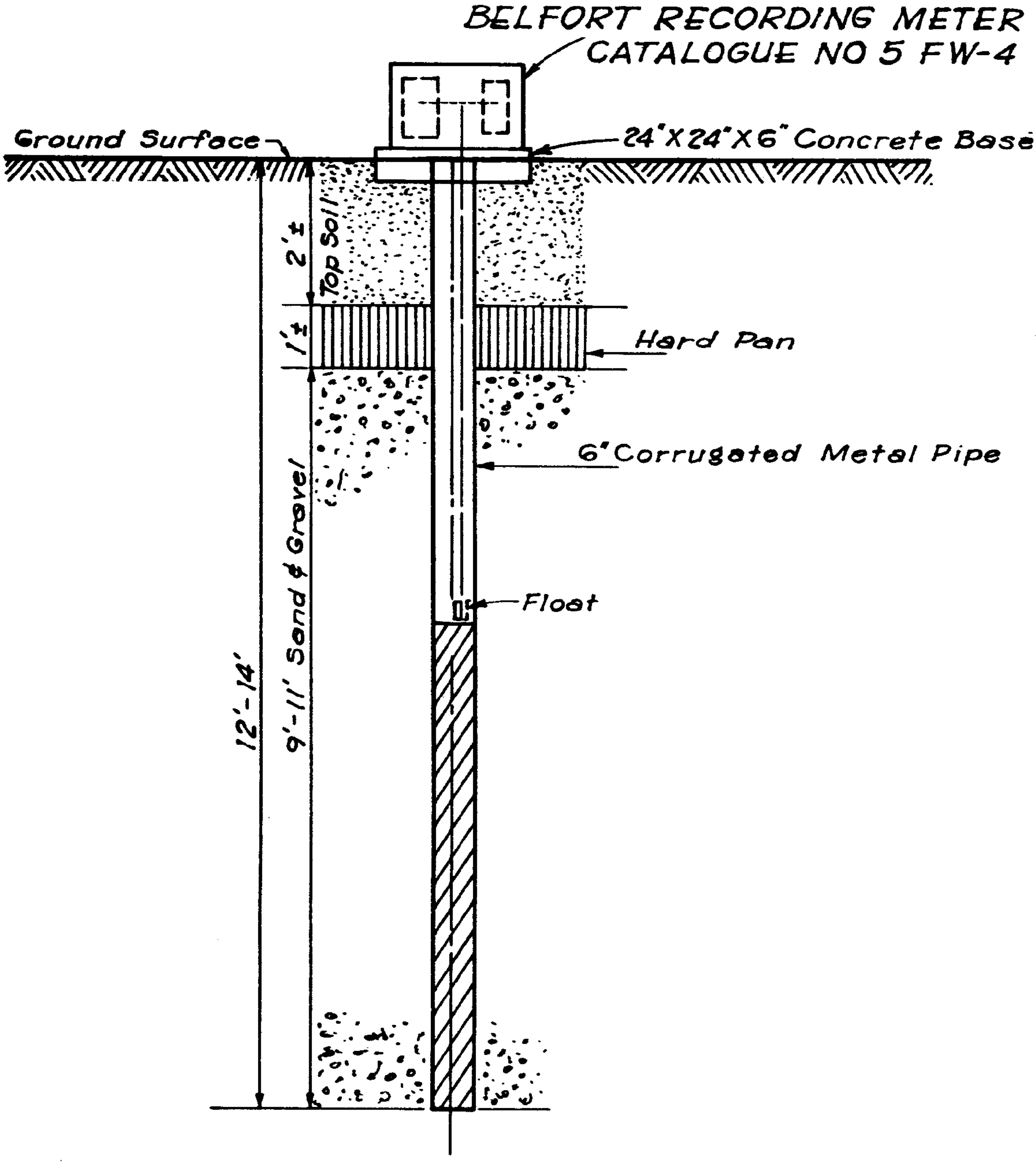


DIAGRAM TYPICAL OBSERVATION WELL

FIGURE 6

HOFFMANN-FISKE CONSULTING ENGINEERS
2500 KOOTENAI STREET BOISE, IDAHO
917 8TH AVENUEC LEWISTON, IDAHO
Not to Scale Apr. 24, 1969

See Figure 2.

Observation Well No.	Distance From Pumped Well (feet)
2	688
3	630
4	769
6	98

Other data on the Observation Wells is as follows:

Observation Well No.	G D Elevation	Elevation Bottom Well	Elevation Water Level 6/28/68 and Zero Elevation on Guage
2	2610.83	2598.08	2600.98
3	2605.59	2593.79	2600.09
4	2606.01	2596.16	2603.66
6	2601.96	2590.51	2598.76

All data is on U.S. Coast & Geodetic Control.

The level of water in each well was plotted weekly so that a study could be made when the water table was below the grade of the sewers in the vicinity of the wells.

3. Flow-Measuring Systems

Several flow measurements were made in the study. A Leopold-Stevens type "F" recorder * was installed at M.H. #5 to indicate the depth of flow in this manhole which was indicative of the flow of sewage in the area under study. Some troubles were encountered in the function of the unit and as a result there were some blank periods of recording.

The existing recording meter at the sewage plant was used to record the amount of sewage flowing through the sewage plant. Since the pumps to the primary clarifier could only handle 1500 g.p.m. (2,160,000 gallons per day) any flow in excess would bypass the sewage plant and discharge into Five Mile Creek.

The flow on Five Mile Creek was measured by means of a staff gage a hundred yards below the sewer out fall. The flow in the

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creek was calibrated by a current meter and flow curve established. The minimum measured flow was about 10 c.f.s. and the maximum flow about 45 c.f.s. The B.O.D. was found to be about 55 p.p.m. during the low winter flows and 200 p.p.m. in the high summer flows. Suspended solids were 32 p.p.m.; total solids about 627 p.p.m.; and the bacteria count was 20 m.p.n. in March, 1968. The floating materials consist of grass, twigs, paper, and other debris. There is a healthy growth of water crest, lillies and grass along Five Mile Creek at waters edge.

IV. PROJECT OPERATION

1. Initial Pumping Period

The initial pumping started on June 26th, 1968, and the pump was set at 200 g.p.m. and run until July 17, 1968. The water in the well would drop until the people in the immediate area would start irrigating. This flood irrigating would cause the level in the wells to rise and then subside after irrigating. Actually there was no true pattern as to how the neighborhood irrigation would affect the water level in the wells. To try and use the formula developed by Theis, Wenzel and Jacob produced such erratic results due to the surcharging of ground water by surface irrigation, the idea was abandoned. The curves indicating the lowering of water table were plotted on logarithmic scale, but no data could be obtained from them that was of any value except that over a long period of time the ground water was dropping. The cost for pumping 200 g.p.m. was $1.33 per day of 24 hours. See Figure 7.

2. Intermediate Pumping Period

On July 17th, 1968, the pumping capacity was changed from 200 g.p.m. to 350 g.p.m. This was continued until August 7, 1968. The same trouble was encountered at this pumping capacity because the water in observation well would fluctuate, but at the end of the period there was a definite decline in the water level. There really was no definite period when the ground-water level would stabilize; so it was decided on August 7th to increase the pumping capacity to the maximum, which at the existing water table elevation was 665 gallons per minute. The cost for pumping 350 g.p.m. was $1.54 per day of 24 hours. See Figure 8.

3. Final Pumping Period

On August 7th, 1968, the control valve was opened to maximum capacity and was kept at this maximum until March 11, 1969, when it had to be turned off for a ten day period so the Nampa Meridian Irrigation District could clean the Canal into which the pumped ground water was discharged. During this pumping period the ground water level varied due to irrigation, rain, and snow fall. Each of these would recharge the ground water temporarily. After a few days of pumping the ground water level would return to the level prior to the temporary distrubance. The cost for pumping maximum capacity 570-660 g.p.m. was $1.75 per day of 24 hours. See Figure 9.

From the performance curve of the Johnson Pump * the following is a table which shows the amount pumped and the level of water in the well casing:

Pumping Capacity for Given Ground Water Depth Below Pump

Lift in Well	Head Loss Above Ground	Total Dynamic Head	GPM Pumping
50	10	60	----
40	10	50	570
39	10	49	580
38	10	48	585
37	10	47	590
36	10	46	600
35	10	45	605
34	10	44	610
33	10	43	615
32	10	42	620
31	10	41	625
30	10	40	630
29	10	39	635
28	10	38	640
27	10	37	645
26	10	36	650
25	10	35	655
24	10	34	660
23	10	33	665

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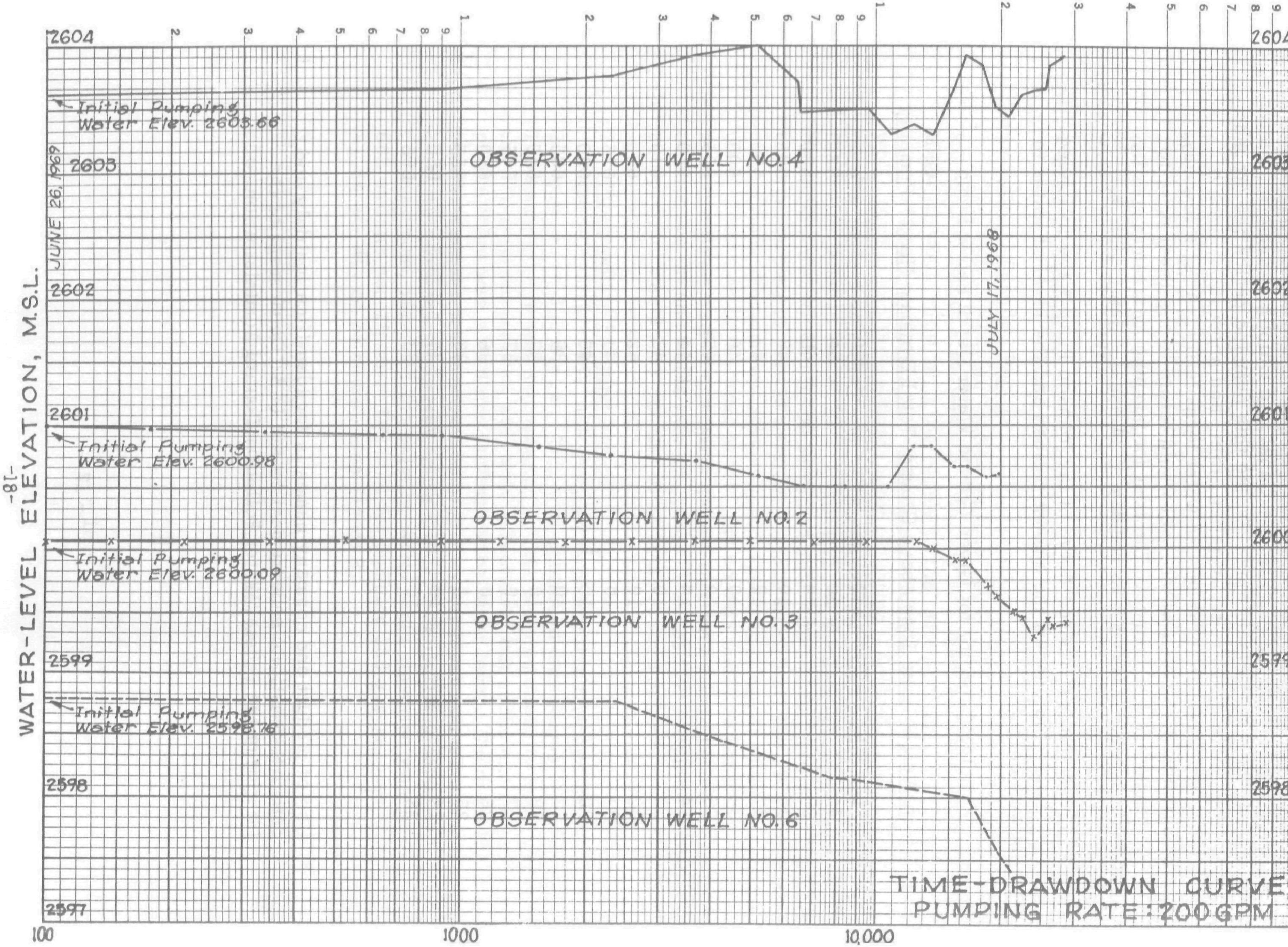

WATER-LEVEL ELEVATION, M.S.L.
2604
2603
2602
2601
2600
2599
2598
2597
100
1000
10,000
Initial Pumping Water Elev. 2603.66
OBSERVATION WELL NO.4
JUNE 26, 1969
JULY 17, 1968
Initial Pumping Water Elev. 2600.98
OBSERVATION WELL NO.2
Initial Pumping Water Elev. 2600.09
OBSERVATION WELL NO.3
Initial Pumping Water Elev. 2598.76
OBSERVATION WELL NO.6
TIME-DRAWDOWN CURVE
PUMPING RATE: 200 GPM

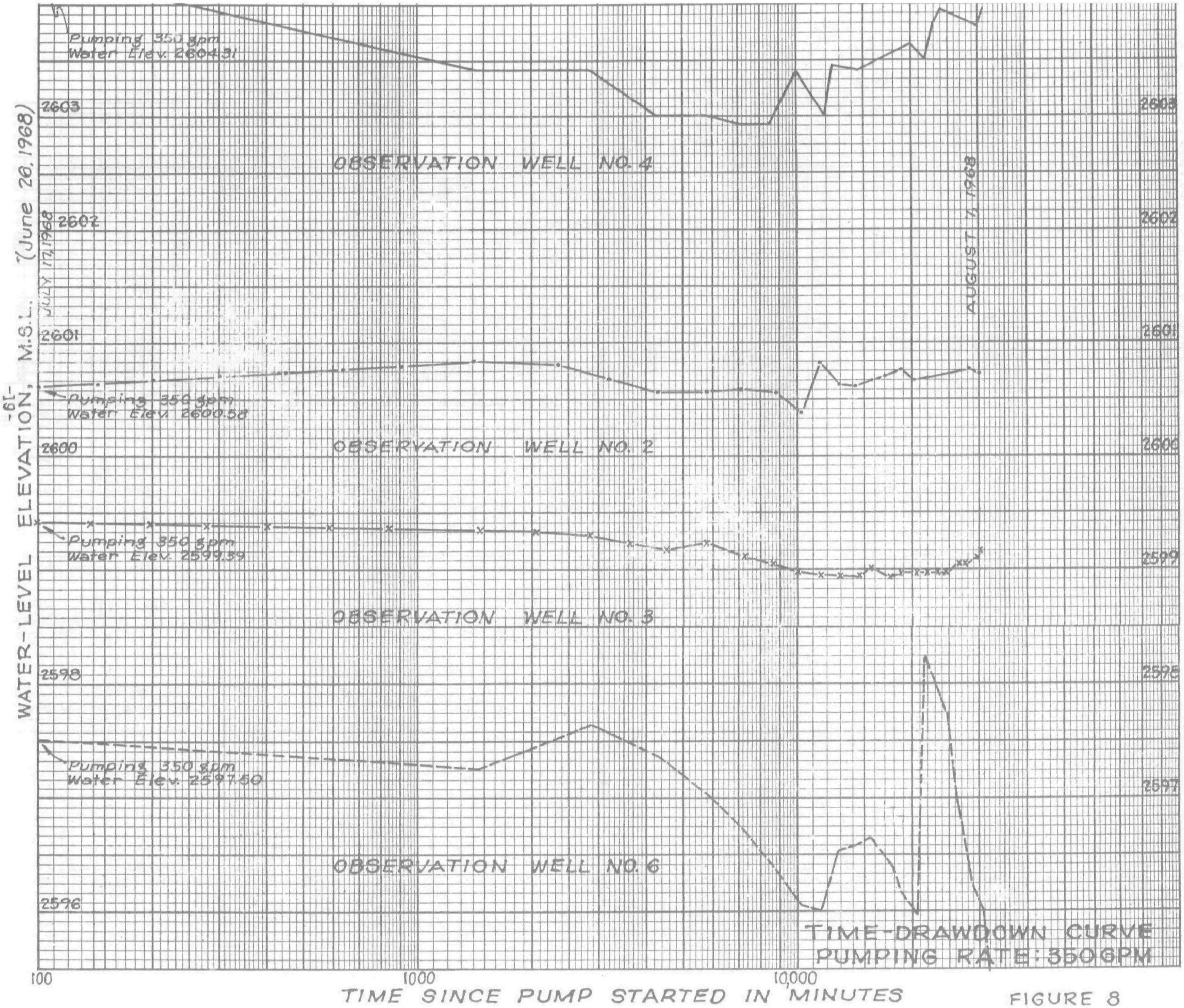
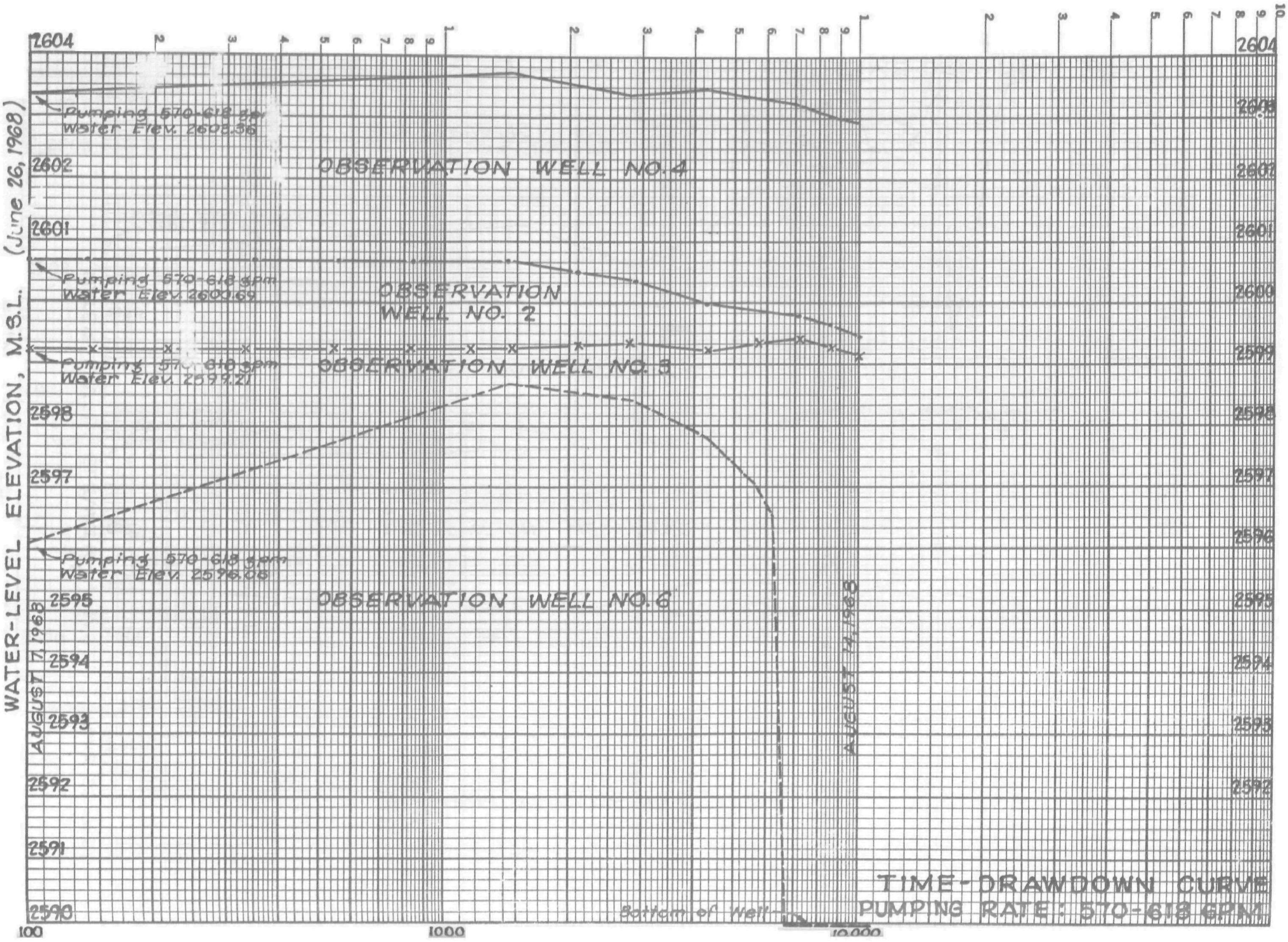

Pumping 350 gpm
Water Elev. 2604.31
2603
OBSERVATION WELL NO. 4
2602
2601
Pumping 350 gpm
Water Elev. 2600.58
OBSERVATION WELL NO. 2
2600
Pumping 350 gpm
Water Elev. 2599.39
2599
OBSERVATION WELL NO. 3
2598
Pumping 350 gpm
Water Elev. 2597.50
2597
OBSERVATION WELL NO. 6
2596
JULY 17, 1968
(June 26, 1968)
AUGUST 7, 1968
WATER-LEVEL ELEVATION, M.S.L.
100
1000
10,000
TIME SINCE PUMP STARTED IN MINUTES
TIME-DRAWDOWN CURVE
PUMPING RATE: 350GPM

FIGURE 8



WATER-LEVEL ELEVATION, M.S.L. (June 26, 1968)
Pumping 570-618 gpm
Water Elev. 2603.36
OBSERVATION WELL NO. 4
Pumping 570-618 gpm
Water Elev. 2600.69
OBSERVATION WELL NO. 2
Pumping 570-618 gpm
Water Elev. 2599.21
OBSERVATION WELL NO. 3
Pumping 570-618 gpm
Water Elev. 2596.06
OBSERVATION WELL NO. 6
AUGUST 7, 1968
AUGUST 14, 1968
Bottom of Well
TIME-DRAWDOWN CURVE
PUMPING RATE: 570-618 GPM
100
1000
10,000
2604
2603
2602
2601
2600
2599
2598
2597
2596
2595
2594
2593
2592
2591
2590

During the months of January, February and March the well capacity was varying due to recharge from rain and snow fall.

At the date of shutting off the pump for ditch cleaning, the water table was below each of the observation wells, just being at the bottom of Well No. 4.

The following is a table showing the zone of influence of the well in line with the observation wells. See Figures 10, 11 & 12.

Line of Observation Well	Distance From Well to Zero Influence (feet)
6-2	1000
6-3	3500
6-4	1500

4. Presentation of Data

Figure 13 indicates graphically the results of all the field data accumulated. Some area data is missing due to malfunction of the recording device or recorder missed collecting data on schedule.

a. Observation Wells

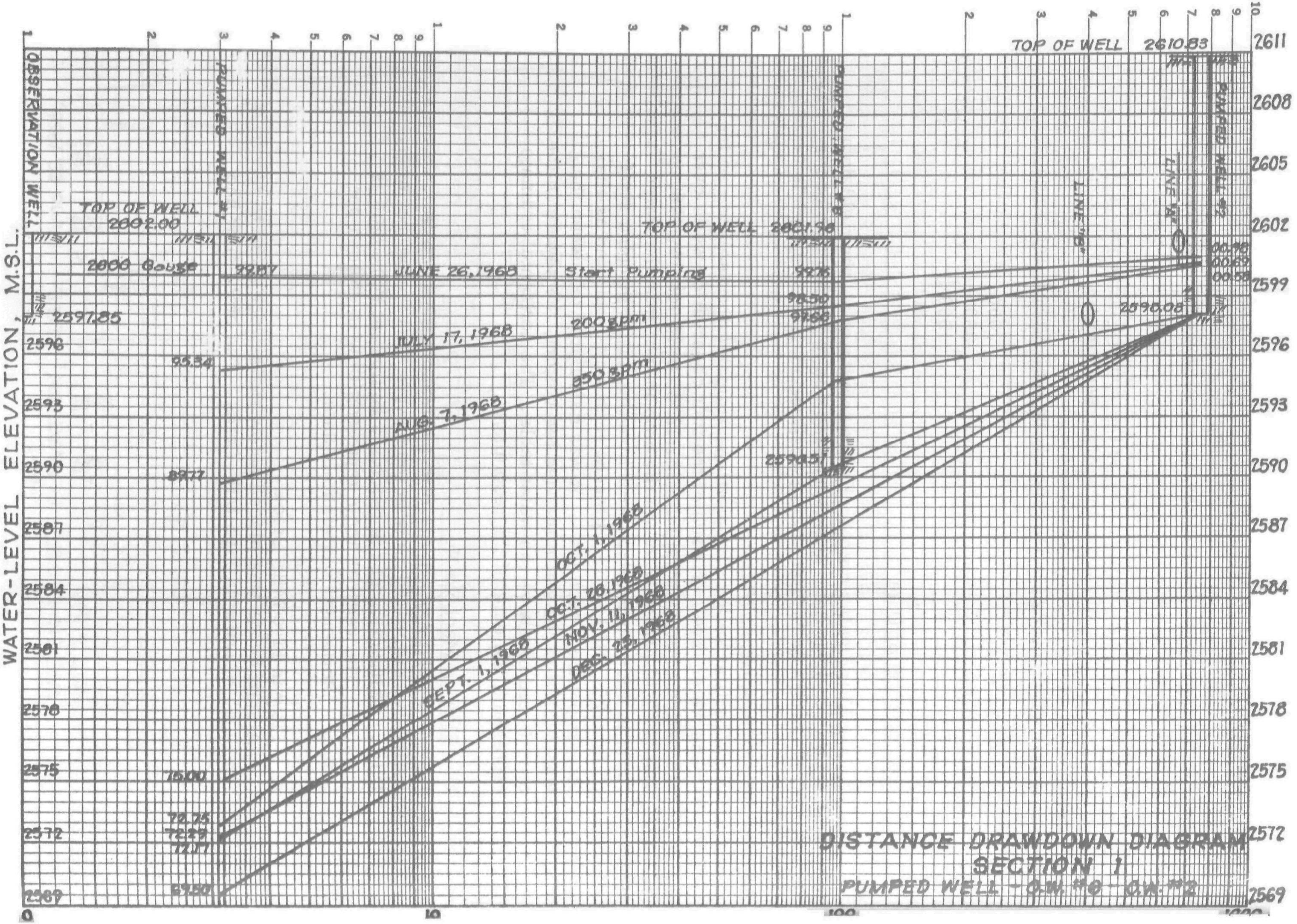
The first series of 4 plottings indicates the rise and decline of the water levels in each of the four observation wells over the period of study from June 26, 1968, to March 11, 1969. The vertical scale indicates the drop in feet from the water level in each observation well from the initial pumping start of June 26, 1968. The bottom of each well is plotted as the lowest point in each well. It was calculated that when the water table in the wells reached the bottom, the sewers in the area would be above the water table. The horizontal ordinate represents the date of the recording.

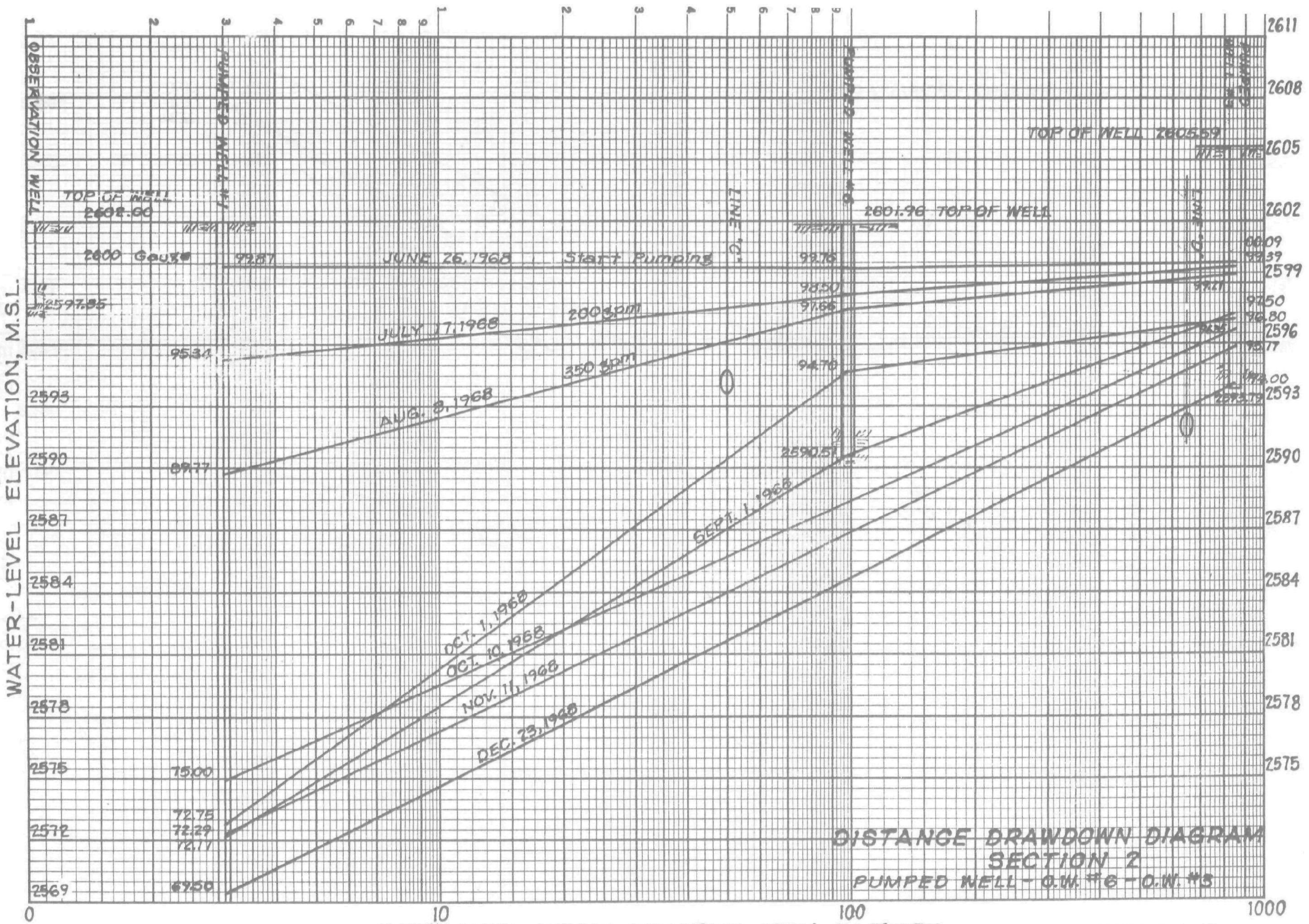
b. Flow in Manhole No. 1

This chart records the flow in Manhole #5 which is indicative of the total flow in the sewers from the project area. Due to malfunction of the recording equipment some data is missing. The vertical scale represents flow in gallons per minute. Horizontal scale shows date.

c. Flow in Five Mile Creek

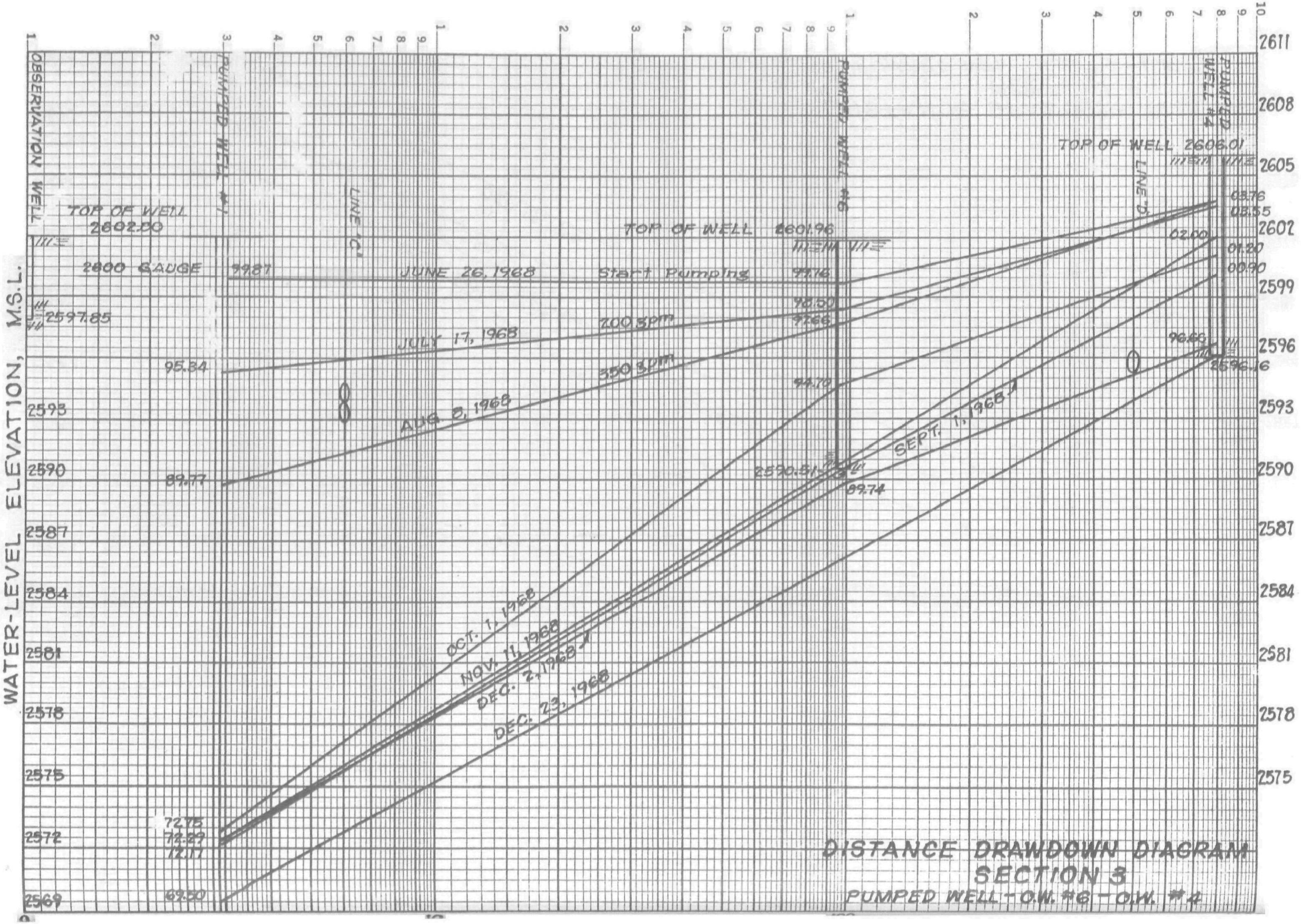
A staff gauge was placed below the sewage plant to record the depth of water in Five Mile Creek. The creek flow had


WATER-LEVEL ELEVATION, M.S.L.
OBSERVATION WELL
PUMPED WELL #1
PUMPED WELL #
PUMPED WELL #2
LINE "B"
LINE "A"
TOP OF WELL 2602.00
TOP OF WELL 2601.96
TOP OF WELL 2610.83
2600 Gauge
2597.85
JUNE 26,1968
Start Pumping
JULY 17, 1968
200 gpm
AUG. 7, 1968
350 gpm
SEPT. 1, 1968
OCT. 1, 1968
OCT. 26, 1968
NOV. 11, 1968
DEC. 23, 1968
2590.51
2598.08
95.34
89.77
75.00
72.75
72.29
72.17
69.50
99.76
98.50
97.66
00.96
00.69
00.55
DISTANCE DRAWDOWN DIAGRAM
SECTION 1
PUMPED WELL - O.W. #8 - O.W. #2
2611
2608
2605
2602
2599
2596
2593
2590
2587
2584
2581
2578
2575
2572
2569
0
10
100
1000



OBSERVATION WELL
PUMPED WELL #1
PUMPED WELL #6
PUMPED WELL #5
TOP OF WELL 2602.00
2600 Gauge
2597.85
99.87
JUNE 26, 1968 Start Pumping
JULY 17, 1968
200 gpm
95.34
AUG. 8, 1968
350 gpm
89.77
LINE "C"
LINE "D"
2601.96 TOP OF WELL
TOP OF WELL 2605.59
99.76
98.50
97.66
94.70
2590.51
SEPT. 1, 1968
OCT. 1, 1968
OCT. 10, 1968
NOV. 11, 1968
DEC. 23, 1968
75.00
72.75
72.29
72.17
69.50
00.09
99.39
97.41
97.50
96.80
95.77
94.00
2593.79
WATER-LEVEL ELEVATION, M.S.L.
DISTANCE FROM PUMPED WELL IN FEET
0
10
100
1000
2611
2608
2605
2602
2599
2596
2593
2590
2587
2584
2581
2578
2575
2572
2569
DISTANCE DRAWDOWN DIAGRAM
SECTION 2
PUMPED WELL - O.W. #6 - O.W. #5

FIGURE 11


DISTANCE DRAWDOWN DIAGRAM
SECTION 3
PUMPED WELL - O.W. #6 - O.W. #4
WATER-LEVEL ELEVATION, M.S.L.
OBSERVATION WELL
PUMPED WELL #1
LINE "C"
PUMPED WELL #6
LINE "D"
PUMPED WELL #4
TOP OF WELL 2602.00
TOP OF WELL 2601.96
TOP OF WELL 2606.01
2600 GAUGE
2597.85
2590.51
2596.16
JUNE 26, 1968
Start Pumping
JULY 17, 1968
AUG. 8, 1968
SEPT. 1, 1968
OCT. 1, 1968
NOV. 11, 1968
DEC. 2, 1968
DEC. 23, 1968
700 3PM
350 3PM
99.87
99.76
98.50
97.66
94.70
95.34
89.77
89.74
72.75
72.29
72.17
69.50
03.76
03.55
02.00
01.20
00.90
96.66
2611
2608
2605
2602
2599
2596
2593
2590
2587
2584
2581
2578
2575
2572
2569

been calibrated for various depth by flow meter and curve plotted for the station. The vertical scale indicates the flow in Five Mile Creek in cubic feet per second and the horizontal scale the date.

d. Flow thru Sewage Treatment Plant

This graph is a record of flow in sewage treatment plant from June 1, 1967, to March 11, 1969. The vertical scale shows flow in gallons per day. The maximum flow through the treatment plant is 2,160,000 gallons per day and any flow larger than this means the surplus has to be bypassed.

e. Domestic Water Pumped

This is a daily record of domestic water pumped from the four wells. The vertical scale is in hundreds of thousands of gallons per day. The horizontal scale represents the date.

f. Ground Water Pumped

This graph indicates the periods of pumping the drain well pump for 200 g.p.m.; 350 g.p.m. and maximum capacity of pump.

g. Irrigation Season

This plot represents the irrigation period for the time of the project study.

h. Precipitation

This graph represents the precipitation daily for the period of the study. The vertical ordinate is inches of precipitation.

V. ANALYSIS OF DATA

1. Observation Wells

A general observation of each of the curves for the wells shows that the water in each dropped from the initial day of start of the pump June 26, 1968, until the date of ending the test March 11, 1969. It can be readily seen that the local irrigation program effects the water table to such an extent that no real correlation by formula (Theis, Wenzel, Jacob) could be obtained from the available data, but all cases the water table receded to the bottom of the observation wells. Well No. 2 reached the bottom on August 25th, 1968; Well No. 3 on June 4, 1969; Well No. 4 on Nov. 28, 1968; Well No. 6 as early as August 13, 1968. Well No. 6 was affected by rainfall and snow melting period in January and February 1969. Well No. 3 was affected by the rainfall and snow in January and February. When the water level reached bottom of wells No. 2 and No. 4 there was a rise above the bottom. It can be seen that the pumps must continue all winter to keep the water table below the sewers or when they are shut off in winter the water table would rise because of rainwater and snow melt penetrating the gravel strata raising the water table.

The water table at any time is not the same on all observation wells which indicates that due to the variable impervious hard pan strata, probable clay barriers, the water table is not the same throughout the project area. From this study it would not be possible to predict what would happen in other areas of the City as there is no correlation between the effects of pumping on each of the observation wells, except that eventually if pumped long enough the water would be lowered below the invert of sewers. The pumping capacity of the well should be, ideally, that it could be set so that it would keep the water table below the sewers in the area under study. I would recommend a variable speed motor with controls to keep the water table just below the deepest sewer. In our study a constant speed Motor of 1750 R.P.M. was used to produce 500 g.p.m. under total pump head of 50 feet. The pump was set wide open on August 7, 1968, and was still pumping at full capacity on March 11, 1969. The flow varied from 620 g.p.m. to 665 with a total head varying from 43 feet to 33 feet.

The water was discharged into a drain ditch by agreement with the Nampa Meridian Irrigation District. This water was put to useful irrigation use as the bacteria count was low.

2. Flow in Manhole #5

The records on flow in Manhole No. 5 were poor at certain times during the test period. The recorder was found to be rubbing against some supports; so that the recordings were not correct.

The maximum water table is generally reached during September each year and remains practically static until through December when it starts to recede.

The graph shows that the flow went from 200 g.p.m. in the end of March, 1968, to a high of 790 g.p.m. in first of July, 1968. After the pumping started on June 26, 1968, the flow in the sewer at Manhole No. 5 receded to 400 g.p.m. in first part of September and diminished to around 220 g.p.m. in October. Thus the pumping did have some effect.

During the winter months of December, 1968 - January, 1969, the flow increased again, but this was affected by rainfall and melted snow entering the gravel strata and infiltrating into the sewers.

3. Flow in Five Mile Creek

The chart on flow in Five Mile Creek shows that during the winter months and early spring the flow is down to 10 c.f.s. and gradually rises as the area enters the irrigation season and irrigation is started. It acts as a drain for the area and surplus water flows into the Creek. It reached a high of 45 c.f.s. in September and receded to 20 c.f.s. in December, 1968, rising and falling during the winter from rain and snow melt. During the summer months there is enough flow to dilute the treated sewage and give some dilution to the 1,150,000 g.p.d. of untreated sewage bypassed from June to September when this untreated sewage is added to Five Mile Creek.

4. Domestic Water Pumped

The domestic water supply for Meridian varies from minimum 200,000 g.p.d. during the winter months to 700,000 maximum g.p.d. during summer months. It can be noted during rainfall period in the summer the water use drops on days of precipitation. The amount of water entering sewers from domestic use rises during summer months. Thus during summer months there are major contributions to sewers from both irrigation and domestic water waste.

Records The area of influence is on an average about 1000 feet from pump location. This would mean many wells in the entire City area to lower the water table entirely below sewers. This area is about 3 city blocks square. The initial capital cost of the project was about $15,000. The pumps should last 20 years before replacement or this would be at a cost of $750. a year, per unit. The power cost per day of $1.75 per day is negligible for benefit derived.

5. Irrigation Season

The irrigation season runs from April 15 to the first week in October. The flow through the sewage plant shows the influence of the irrigation water. A general schedule for each area is set up for irrigation, but it is greatly affected by the whims of the users, precipitation, and other factors. Due to these variable factors, the actual surcharge of ground water is difficult to predict with so many variables. Actually if the City of Meridian decides to install pumps in the balance of the City to lower the water table I do not believe that any data was obtained from this study to formulate a definite pattern of action in other areas. The zone of influence varied in a line from the pump to each of the observation wells. The geology of each area would have to be studied, as well as the irrigation program, drain ditches in the area. There is no doubt that pumping will lower the water table, but each area would have its own peculiarities and I would recommend a study of each area with a variable speed motor pump to determine what capacity pump would best suit the local conditions.

6. Daily Precipitation

The daily precipitation chart indicates the rainfall for the full period of the study. The records indicate that the year 1967 was a dry year with 7.68 inches; the year 1968 was a relatively wet year with 13.08 inches rainfall. Actually the month of August 1968 was a wet month. Also there was quite a bit of precipitation during November and December, 1968, and January and February, 1969, were real wet months.

During the winter months of December, 1968, and January-February, 1969, the heavy rainfall and snow melt affected the level in the observation wells as well as the total daily flow through the sewage plant. In addition to irrigation water, rain water and snow melt penetrates the ground water strata.

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BIBLIOGRAPHIC: City of Meridian, Idaho
Sewer Infiltration Reduction by Zone Pumping - Hoffmann and Fiske-FWPCA Publication DAST 9-1969.

ABSTRACT: The intent of this project was to demonstrate the reduction of ground-water infiltration into sanitary sewers by pump down of the water table in the sewer area assuming the geology, precipitation and local irrigation practices were ameanable to rapid and wide zones of influence. The water table was lowered below the sewer and reduced the volume of flow to the treatment plant. The water table was not lowered uniformly. For 140 square blocks 70 pump units would be required at an average cost of $40,000 per unit with a total power bill of $122.50 per day. This is not economically favorable when compared with other corrective measures. This report was submitted in fulfillment of Grant No. 29-IDA-2.

ACCESSION No.

KEY WORDS

Infiltration

Volume Reduction

Surcharging

Zone-pumping

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