DEEP-WELL DEWATERING TESTING AT

THE FARO OPEN PIT MINE

003159

Prepared by: Randy Lopaschuk
Senior Project Engineer

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S U M M A R Y

In September, 1981, well testing was performed to determine the groundwater characteristics that influence pumping and drawdown in the Faro pit. The objective of the well testing was to provide data from which the principal factors of aquifer performance could be calculated. The aquifer test consisted of pumping one well and recording both the drawdown in that well and the drawdown caused by this pumping in other nearby observation wells. The data from the tests was analyzed to show the hydraulic characteristics of the aquifer (ore zone). The aquifer characteristics are summarized in the following table:

Permeability	6.7×10^{-4} cm/sec.
Transmissibility	1,143 IGPD/ft.
Storage Coefficient	0.0093

The permeability, transmissibility and storage coefficient values indicate that the ore zone is a semi-confined aquifer that should be able to be dewatered using pumped wells.

Distance-drawdown and time-drawdown graphs were constructed using a range of values for pump discharge. The graphs indicated that a pumping rate of at least 30 IGPM would be desirable for dewatering to continue in advance of mining.

A carefully monitored trial installation is necessary to test the proposed well design. The results of this trial will invariably lead to modifications to the original layout.

Recommendations for future mine dewatering of the Faro pit are discussed in Section 5 of this report.

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1. INTRODUCTION

Surface water and groundwater have become a costly nuisance in the daily mining operations of the Faro pit. Mining, maintenance and blasting costs reflect these problems.

One of the methods that can be used for open pit dewatering is pumping from wells in or around the pit. The advantage of pumping from wells as opposed to pumping from sumps is that the drainage can begin before any excavation takes place and the dewatering can be completed in advance of the mining.

Before a vertical well system can be implemented in the pit, carefully monitored trial installations are necessary to determine the groundwater characteristics that influence pumping and drawdown. This report describes the well testing that took place in September, 1981, and the analysis done to determine the groundwater characteristics of the Faro pit.

2. DEWATERING TESTING

2.1 HISTORY:

In the summer of 1980, Cyprus Anvil had planned to do test dewatering of the ore zone of Faro Zone 3 using in-pit wells. The successful location, execution and interpretation of well tests requires considerable experience and, therefore, D.V. Currie, P. Geol. of Mobile Augers & Research Ltd., was consulted to help in these areas. He concurred with our assumption that the ore zone may be permeable enough for effective dewatering.

The ore was assumed more permeable than the waste because of visual observations made while blasthole drilling in Zone 1 and 2. In areas of contact drilling between ore and waste, there were several instances when the waste holes were dry after drilling and the ore holes, 20 feet away, were full of water.

Observations made on diamond drill core indicated porous and permeable core in the ore zone largely in the form of pyritic sand and vuggy pyrite. Core analysis done on selected samples produced a porosity of 26% and a permeability of 3590 millidarcies on the pyritic sand and a porosity of 20% and a permeability of 370 millidarcies on the vuggy pyrite. Don Currie felt that these porosity and permeability values were high enough for sufficient groundwater movement to make dewatering possible.

The Engineering Department decided to do a pumping test in the ore zone to confirm its theories, but the test drilling was postponed until September, 1981, rather than do it in 1980, to reduce drilling costs. The ore zone to be intercepted was under 600 feet of waste in 1980 and, therefore, the drilling depth could be significantly reduced by a year's waste removal in Zone 3.

2.2 LOCATION:

Test locations were chosen with knowledge of the geology. The ore zone was the desired drilling target for the pump testing and the only area acceptable for testing was in Zone 3. The amount of time spent testing and the location of the test wells was restricted by the daily mining operations.

Three wells were drilled in Zone 3 at the locations shown on Figure 1.

Well #1	7,615.7 N 15,445.6 E Collar Elevation - 3,979 ft. Depth - 250 ft.
Well #2	7,833.6 N 15,051.7 E Collar Elevation - 3,995 ft. Depth - 400 ft.
Well #3	8,139.4 N 14,927.0 E Collar Elevation - 3,997.2 ft. Depth - 500 ft.

Three observation wells were drilled in conjunction with Well #3 (see Figure 3).

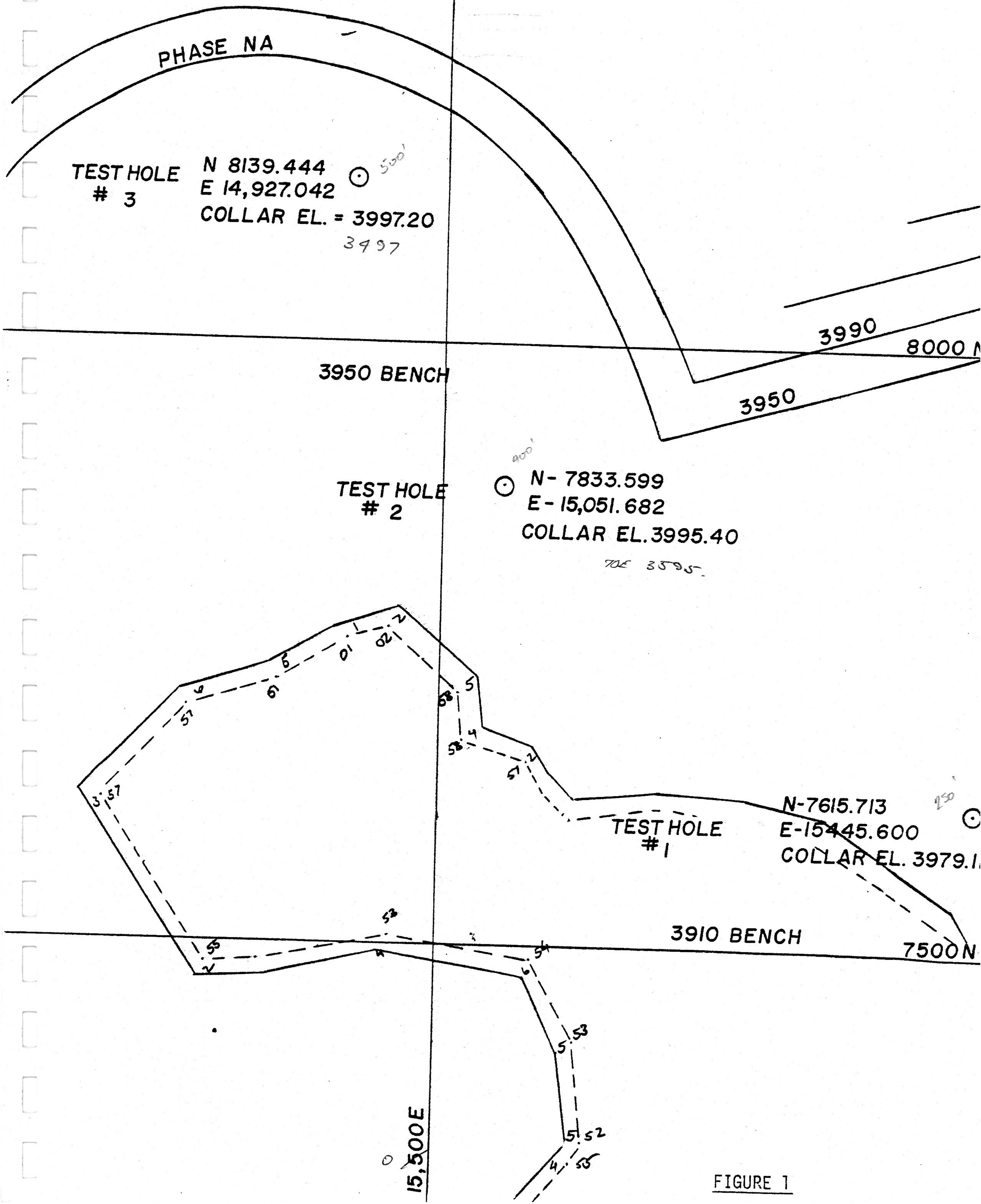
PHASE NA
TEST HOLE # 3
N 8139.444
E 14,927.042
COLLAR EL. = 3997.20
3990
8000 N
3950 BENCH
3950
TEST HOLE # 2
N- 7833.599
E- 15,051.682
COLLAR EL. 3995.40
TEST HOLE #1
N-7615.713
E-15445.600
COLLAR EL. 3979.1
3910 BENCH
7500 N
15,500E

FIGURE 1

2.3 DRILLING METHODS AND EQUIPMENT:

2.3.1 Drilling Method:

All wells and observation holes were drilled using a down the hole percussion hammer drill. Casing was used on the upper sections of each hole because of broken material on the top of the benches. All the drilling was done in bedrock and, fortunately, well casing was not needed to keep the holes open for the period of time required to do the testing. If the rock is found to be poor when drilling, and casing is required for most of the hole's length, then the casing can be advanced as the hole is drilled, allowing notice of any water in the hole.

The drilling was done using air and ground water. No drilling mud was needed because the drilling was done in bedrock which tended to stand up well. Drilling mud can penetrate and thus seal many water bearing fractures and channels. This type of drilling can produce wells of poor yields, and damage to the water bearing zones of the well may be permanent.

The well test holes were drilled at a six inch diameter, which was large enough for a submersible pump. The observation holes were drilled at 5 1/2 inch diameter to reduce the drilling costs.

Figure 2 illustrates the drill through casing hammer method used for drilling the test wells.

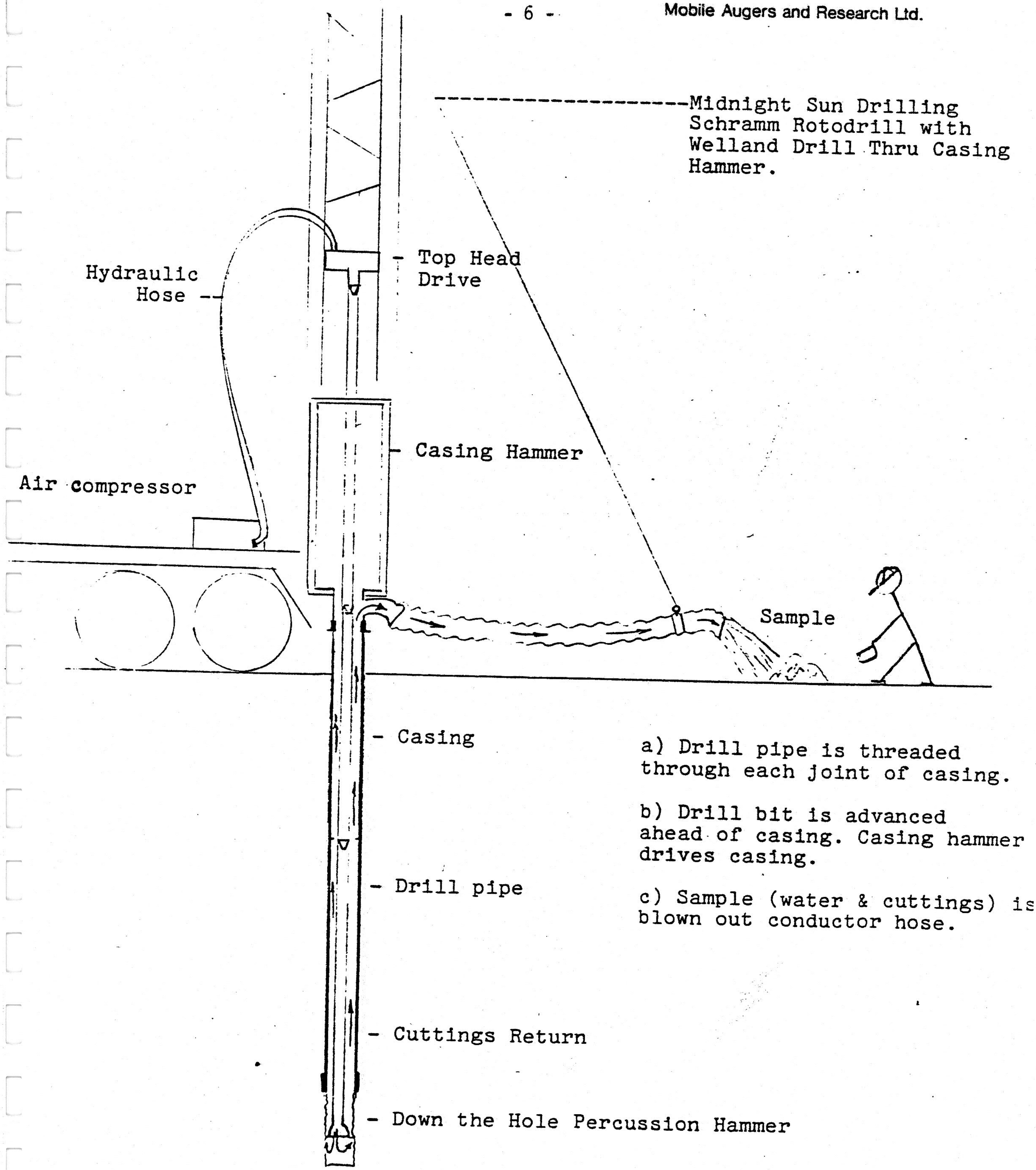

Diagram to illustrate the drill thru casing hammer method.

FIGURE 2

2.3.2 Equipment:

The following equipment was used by the contractor for drilling and pump testing:

- 1981 Schramm T66H with Hawk casing hammer and 600 C.F.M. of on board air mounted on a 1981 G.M.C. tandem.

- Hiab crane and 20' flat deck mounted on a 1980 G.M.C. tandem.

- 25' "A" frame and 20' flat deck mounted on a 1976 Ford.

- 30 K.W. light plant.

- 10 H.P. submersible pump.

Photographs of equipment used are presented in Figures 4 - 9, Appendix D.

2.4 PUMP TESTING:

2.4.1 Introduction:

After each well was drilled, 48 hour pump tests were done to determine well yield and drawdown rate. Results from this initial testing established that Well #3 would provide sufficient groundwater yield for a long term pump test.

The tests required the water to be pumped out of the well at a constant rate over a period of time while observations were made of the water levels in the well or in a number of nearby piezometers.

The 48 hour pump tests provided a method of determining permeability but the long term pump test was the most useful because it also provided regional drawdown information and groundwater parameters.

2.4.2 Long Term Test Configuration:

The layout of and section through the well test are illustrated in Figure 3.

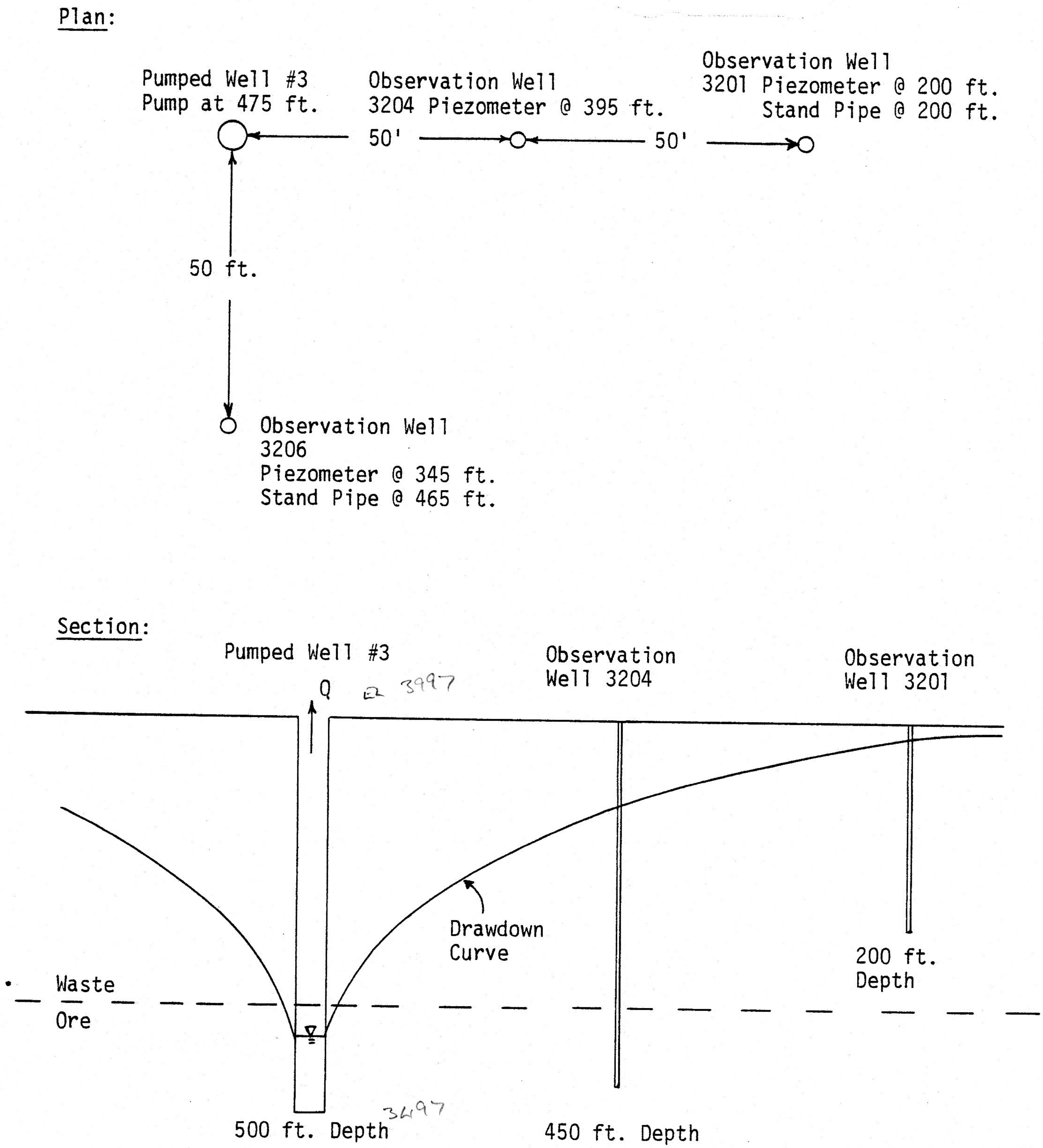

FIGURE 3

PUMP TEST LAYOUT

2.4.3 Pump Test Procedure:

The pump test procedure was as follows:

a) Drilled pumping well and installed 10 H.P. submersible pump 10 feet above bottom of well.

b) Drilled the observation wells and installed pneumatic and standpipe piezometers.

c) Measured the static water levels in the well that was pumped and in all the observation wells.

d) Set the pumping rate at 30 IGPM for the 48 hour tests and at 25 IGPM for the long term test. The pumping rate was controlled by throttling the outlet valve.

e) Started the test at the above mentioned pumping rates and recorded the exact time (this is time zero, $t = 0$).

f) Read and recorded the depths of water in the well and observation wells and the times, for a series of time increments on a logarithmic scale as follows:

   Time since pump started (minutes)
   1, 2, 3, 4, 5, 6, 8, 10, 13, 16, 20, 25, 32, 40, 50, 64, 80, 100, 120, 150, 190, 240, 300, 380, 480, 600, 760, 1000, 1240, 1440
   and then once every four hours.

g) For the recovery test, the pump was stopped and timed water level measurements were taken immediately to determine the rate of recovery, following the same procedure as used in the drawdown test. Recovery measurements were taken until the water levels approached the original static levels.

3. PUMP TEST ANALYSIS

3.1 AQUIFER CHARACTERISTICS:

Very little was known about the specific groundwater parameters of the Faro pit before the pump testing was started. The ore was assumed to be more permeable as a unit than the waste rock based on observation.

The waste rock surrounding the ore zone is basically a metamorphic schist. Assumptions regarding permeability in a metamorphic rock are:

- Permeabilities in the rock mass are so small that they can be regarded as zero in practical problems. Appreciable porosities and permeabilities are developed through fracturing and weathering of the rock.

- The permeability of the rock as a whole is strongly anisotropic.

- Average permeability decreases with depth. The decrease is a combined effect of weight of overlying rock and the tendency of surface disturbances to penetrate only a short distance into bedrock.

- In general, yields of wells are low in almost all metamorphic rocks.

- Difference in well yields reflect difference in degree of weathering and fracturing.

Therefore, if the above assumptions follow, the waste rock can be assumed to be an aquitard* and will only yield any appreciable discharge in a pump test if the well is located in a heavily fractured zone.

If the waste rock is an aquitard, then the ore zone would be a semi-confined or confined aquifer. The success of being able to lower the groundwater level in this confined aquifer is controlled by the following aquifer characteristics:

1) Hydraulic Conductivity (Coefficient of Permeability) -

   The flow of water per unit time per unit area under a gradient of one foot per foot.

2) Thickness and areal extent of the aquifer.

3) Transmissibility (T) -

   A measure of the ability of the entire thickness of a unit of aquifer to transmit water from place to place in response to a unit gradient.

   A field measurement of the permeability of the whole saturated thickness of rock to be drained.

4) Storage Coefficient (S) -

   The volume of water that an aquifer releases from storage per unit surface area per unit change of head.

   Percent of storage that will be yielded to a well.

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* Aquitard - less permeable formation that may contain water but is incapable of transmitting significant quantities of water.

Reliable values for these characteristics permit mathematical projections by standard equations of aquifer behaviour in response to pumping. Particularly important in mining situations is the degree of uniformity of these properties vertically and horizontally within the area influenced by mine pumpage.

The pump testing was performed in order to provide the aquifer characteristics necessary to assess the mine dewatering potential of the ore zone.

3.2 METHOD OF ANALYSIS:

Pumping tests require withdrawal of water from intervals of interest with concurrent measurement of the change in water level in the aquifer of interest. These data are then utilized to compute the pertinent aquifer properties and coefficients described in Section 3.1. One of the most common methods of analysing pumping test data is by using the nonequilibrium, or Theis, equation:

$$ho - h = \frac{Q}{4\pi T} \int_{u}^{\infty} \frac{e^{-u}\,du}{u}$$

where ho-h is drawdown

Q is constant well discharge

T is transmissibility

$$u = \frac{r^2 S}{4Tt}$$

Simpler approximate solutions to the nonequilibrium equation have been developed which are sufficiently accurate for field purposes. Two methods, the Theis method and Jacob method, were used in this study and they are described in more detail in Appendix A.

The assumptions required in applying the above methods are as noted:

1. Aquifer is horizontal
2. Aquifer is confined
3. Aquifer is of infinite extent
4. Aquifer is homogeneous and isotropic
5. Well diameter is infinitesimal
6. Well penetrates entire aquifer
7. Pumping rate is constant
8. One well

These assumptions do not all entirely apply in our test case but the analysis will provide the average values needed as a starting point to determining groundwater movement and drawdowns.

The average values of S and T are obtained in the vicinity of the pumped well by measuring in one or more observation wells the decline of head with time under the influence of a constant pumping rate.

3.3 TEST RESULTS:

3.3.1 Permeability:

From pumping tests, the rock mass permeability can be obtained. The following equation was used to calculate the permeability.

$$K = \frac{2.3\ Q}{4\pi m \Delta_s}$$

where

K = coefficient of permeability
Q = constant pumping rate
m = thickness of saturated aquifer
Δ_s = corrected drawdown per log cycle of time

The coefficient of permeability may also be calculated from measurements of the drawdown at two or more observation wells at the same instant in time using the equation:

$$K = \frac{2.3\ Q}{2\pi m \Delta_s}$$

where

Δ_s = corrected drawdown per log cycle of distance from pumped well

TABLE 1

PERMEABILITY TEST RESULTS

	K (gal./day/ft.^{2})	K (cm/sec.)
Well #3 - Drawdown September 14	10.7	6.1×10^{-4}
Well #3 - Recovery September 16	11.8	6.7×10^{-4}
Well #3 - Drawdown September 21	11.5	6.5×10^{-4}
Well #3 - Drawdown October 1	9.8	5.5×10^{-4}
Well #3 - Recovery October 2	13.9	7.8×10^{-4}
Well #3 - Drawdown October 4	12.4	7.0×10^{-4}
Well #3 - Recovery October 7	11.2	6.3×10^{-4}
Distance - Drawdown Method (Observation Wells)	13.7	7.8×10^{-4}
Average	11.9	6.7×10^{-4}

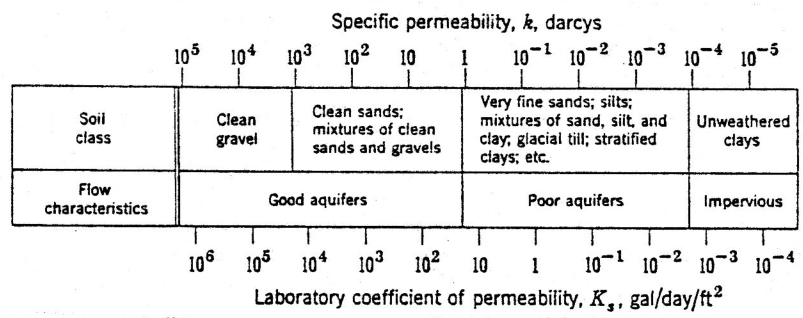
Owing to the complexity of most rock types and the practical difficulties of performing detailed measurements in rock masses at depth, the groundwater flow characteristics of the rock must usually be described by a mass or bulk permeability. Typical permeability values for rock masses are given below:

Degree of Permeability (Rock Masses):

High (well jointed)	10^{-2} to 1 cm/sec.
Moderate (moderately jointed)	10^{-2} to 10^{-5} cm/sec.
Low (with clay filled joints)	10^{-5} to 10^{-7} cm/sec.
Effectively Impermeable	$< 10^{-7}$ cm/sec.

The average permeability test results in Table 1 indicate that the permeability of the ore zone is in the moderate range.

Using another source of permeability ranges shown below, the average test permeability from Table 1 would fall in the range between poor aquifers and good aquifers, confirming the moderate permeability classification.



3.3.2 Transmissibility and Storage Coefficient:

These two aquifer characteristics (T and S) are well defined for confined aquifers (our situation), less meaningful for unconfined aquifers, and are practically meaningless in a 3D analysis.

Methods of analysis for determining T and S from pump test data involved the straight-line method of Jacob and the method of matching to modified Theis-type curves. These methods are described in Appendix A.

The values of T and S obtained from the pump test at Well #3 are given in Table 2 below.

TABLE 2

TRANSMISSIBILITY AND STORAGE COEFFICIENT

Observation Well	Transmissibility (Imp. gpd/ft.) Theis Method	Jacob Method	Storage Coefficient Theis Method	Jacob Method
3201 S	1050	1015	0.0066	0.0060
3206 S	1305	1200	0.0112	0.0132
Average	1143		0.0093	

The range of values for T is 10^2-10^7 gal./day/ft. The pump test indicated a T value in the lower end of this range, suggesting that the ability of the aquifer (ore zone) to transmit water is low but still adequate to permit dewatering.

The range of values for S are:

Confined Aquifer	0.00005 - 0.005
Unconfined Aquifer	0.1 - 0.3

The average S indicated by the pumping tests suggests that the ore zone is a semi-confined aquifer. For dewatering to be effective in a confined aquifer, the pumpage must cause the piezometric level to fall below the base of the confining bed and into the zone being pumped. The success of achieving this transition from a confined aquifer, in which pumping reduces the pore pressure, to a water-table or unconfined aquifer, in which gravity drainage of the water in pore storage takes place, can be measured by the value of S. When the transition or "delayed yield from storage" is achieved, the S values will be in the 0.1-0.3 range and lowering of the water table in the confined aquifer will be possible.

The transition of the S value from 0.009 (our situation) to 0.1 (desired) should take approximately one log cycle of time - one day to ten days, 10 days to 100 days depending on the circumstances of water table lowering which have not yet been tested at Faro.

3.4 DISTANCE-DRAWDOWN AND TIME-DRAWDOWN GRAPHS:

Graphical methods can be used to predict the distance at which a particular drawdown will occur as well as the time it will take to achieve this drawdown. A combination of the Thiem (distance-drawdown) and the storage depletion trend time drawdown of Cooper and Jacob is used.

The storage depletion trend graph shows drawdown versus time; however, a certain length of time is required after pumping begins to establish a straightline relationship. This steady-state relationship is assumed to exist after 10 to 14 days. The distance-drawdown method will, therefore, give amounts of drawdown at varying distances from the pumping well after a given length of time.

Unfortunately, this year's long term pumping tests did not last for two weeks so the distance and time drawdown graphs derived from the tests are not the optimum, but they do provide a starting point to work from.

The graphs are a family of straight curves representing different values of pump discharge. The curves are calculated using the following equation:

$$\Delta_s = \frac{528Q}{T} \quad \text{distance-drawdown}$$

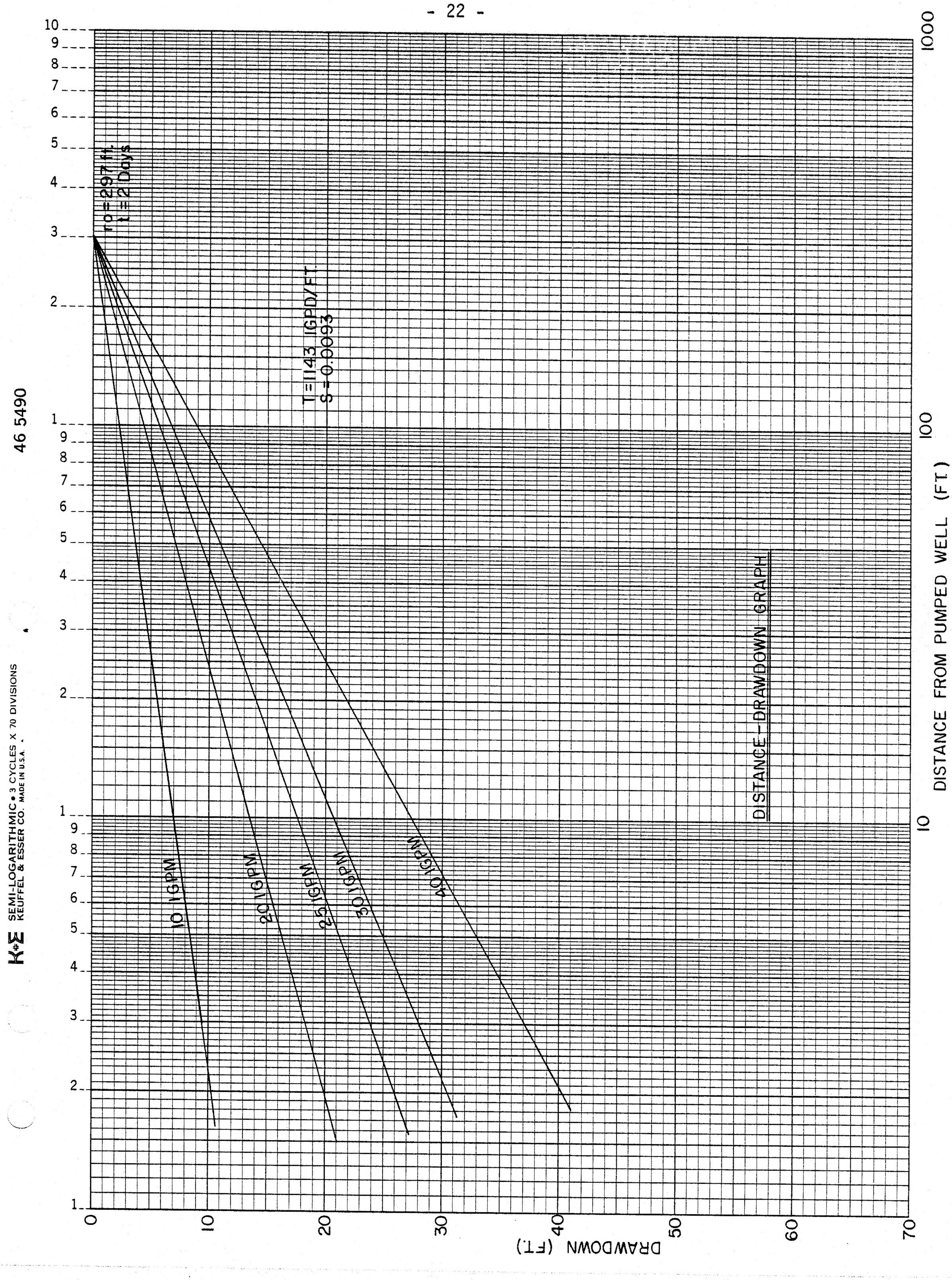
$$r_o^2 = \frac{0.36Tt}{S}$$

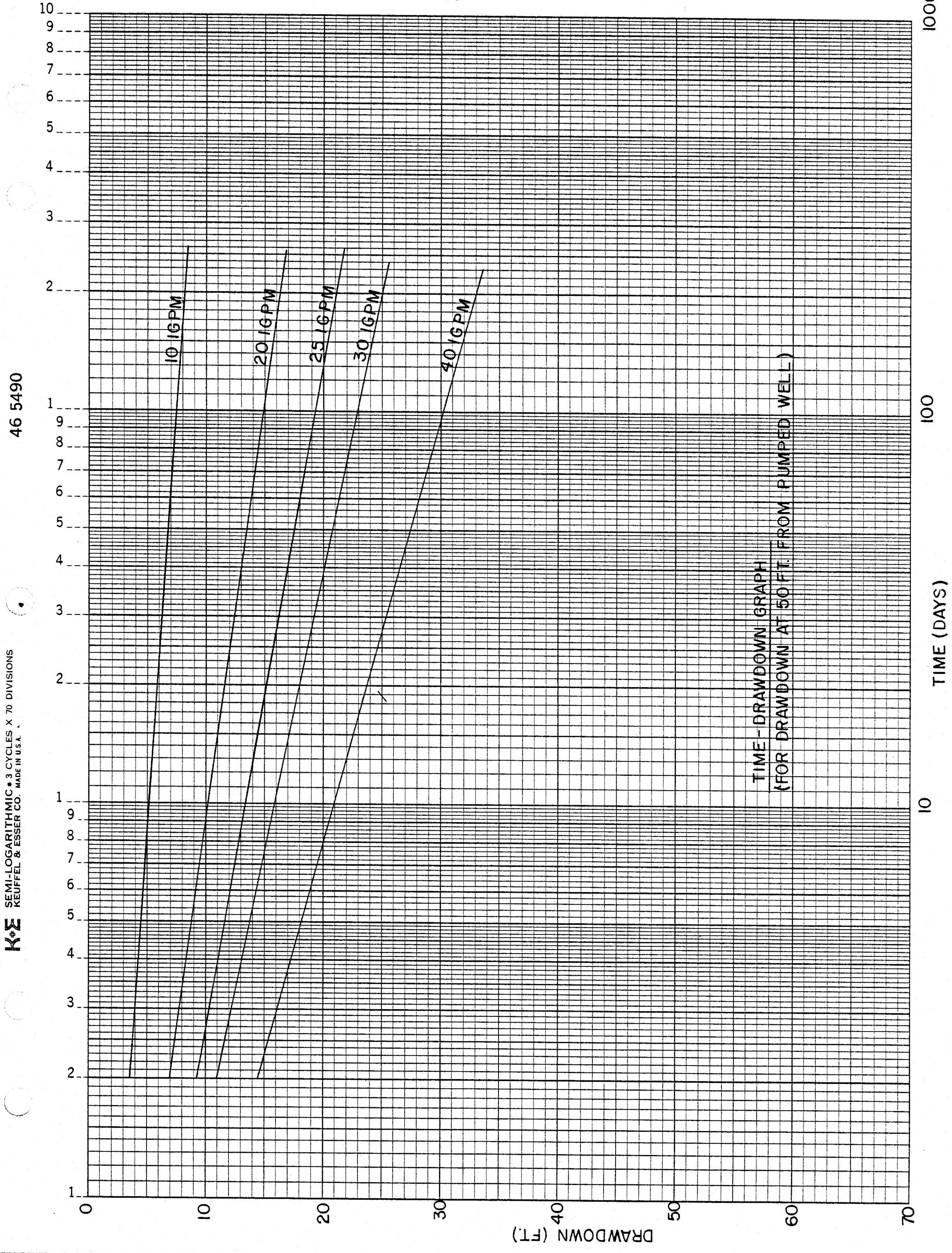
where t is the elapsed time since pumping began in days and all other symbols are as previously described.

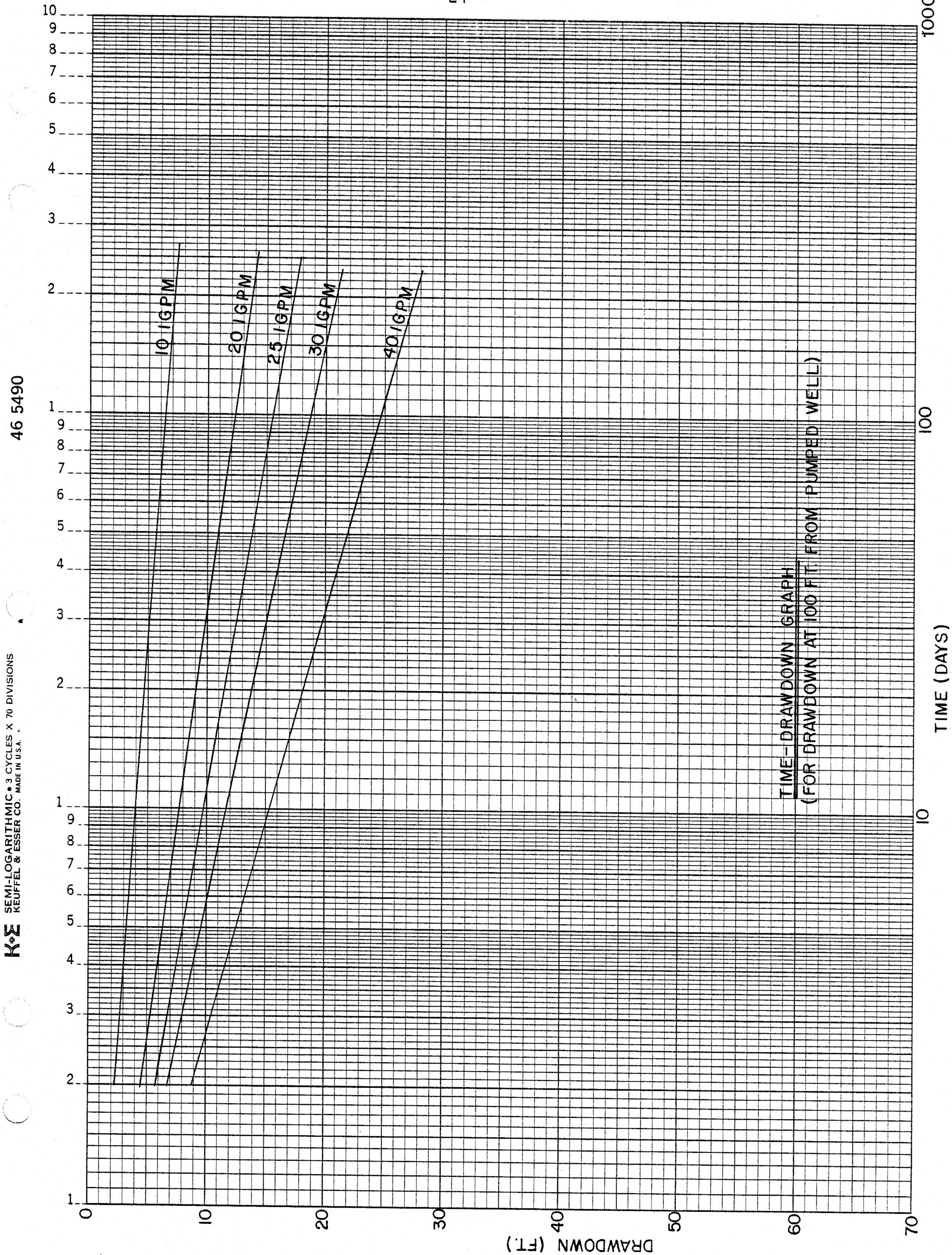
$$\Delta_s = \frac{264Q}{T} \quad \text{time-drawdown}$$

(1/2 the slope of the distance-drawdown graph)

Mine dewatering scenarios for the Faro ore zone can be assessed by using the following distance-drawdowns and time-drawdown graphs.


ro = 297 ft.
t = 2 Days
T = 1143 IGPD/FT
S = 0.0093
DISTANCE–DRAWDOWN GRAPH
10 IGPM
20 IGPM
25 IGPM
30 IGPM
40 IGPM
DISTANCE FROM PUMPED WELL (FT.)
DRAWDOWN (FT.)
0
10
20
30
40
50
60
70
1000
100
10
46 5490
K+E SEMI-LOGARITHMIC • 3 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.


TIME-DRAWDOWN GRAPH
(FOR DRAWDOWN AT 50 FT. FROM PUMPED WELL)
10 IGPM
20 IGPM
25 IGPM
30 IGPM
40 IGPM
TIME (DAYS)
10
100
1000
DRAWDOWN (FT.)
0
10
20
30
40
50
60
70
K+E SEMI-LOGARITHMIC • 3 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 5490


TIME-DRAWDOWN GRAPH
(FOR DRAWDOWN AT 100 FT FROM PUMPED WELL)
10 IGPM
20 IGPM
25 IGPM
30 IGPM
40 IGPM
TIME (DAYS)
DRAWDOWN (FT.)
46 5490
K+E SEMI-LOGARITHMIC • 3 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

4. CONCLUSIONS

4.1 Results from the pump tests confirmed Engineering's previous assumptions that the waste was basically impermeable and that the ore was permeable enough for dewatering purposes. Of the three test wells drilled, one intersected waste for its entire length, one intersected some quartzitic ore, and one intersected a thick section of massive sulfide ore. Only the well that intersected massive sulfides provided enough groundwater recharge for effective dewatering purposes.

4.2 The average permeability of the ore zone was tested to be 6.7×10^{-4} cm/sec. This indicates that the permeability is in the moderate range when considering degree of permeability of rock masses. Generally, it is difficult to predict the effectiveness of a dewatering system prior to installation because of the difficulty of defining, conclusively, the hydraulic parameters for the rock mass. However, as a guide, drainage in rock masses with well developed sets of joints, devoid of infilling (having hydraulic connection), and with an equivalent mass permeability of the order of 10^{-5} cm/sec. or greater, is likely to be successful.

4.3 The aquifer characteristics of the ore zone (T and S) were defined by analysing data from the drawdown tests. The transmissibility (T) of the aquifer suggests that the ability of the ore zone to transmit water is low but still adequate to permit dewatering. The average storage coefficient (S) suggests that the ore zone is a semi-confined aquifer. For dewatering to be effective, the pumpage must cause the water table to fall below the base of the waste rock into the ore zone being pumped.

4.4 The time-drawdown graphs developed for the ore zone indicate that, at a well spacing of 100 feet, a 20 foot ore bench would take 40 days to dewater at 30 IGPM. In the existing Faro Mine Plan, many of the ore benches have less than 40 days production; therefore, dewatering of these benches would have to be started several bench levels in advance of mining requirements.

5. RECOMMENDATIONS FOR FUTURE MINE DEWATERING

5.1 Once a well design has been completed, a carefully monitored trial installation is necessary. The results of this trial will invariably lead to modifications to the original layout. This trial and error approach is the principal method of designing dewatering systems for deep pit excavations in rock; it also reflects the current state of knowledge concerning complex rock masses (Faro situation) in comparison with relatively uniform sedimentary aquifers whose properties are considerably easier to define.

This trial installation should consist of at least two test wells and six observation wells. The test wells would be targeted to penetrate most or all of the thickness of the ore zone. The cost of this well testing would be approximately $80,000.

5.2 When a well design and layout have been determined for the Faro pit, three basic methods of dewatering exist:

1. Start dewatering up to a year in advance of mining requirements. The mining level will gradually gain on the achieved dewatering and, theoretically, dewatering and mining levels should coincide for the last bench.

2. Drill new wells each year and keep the dewatering only one bench ahead of the mining schedule.

3. Install a relatively large number of pumps (the pumps should be able to dewater each bench in a two month period). Turn all pumps on two months before the bench is required; when dewatered, turn most of the pumps off and maintain the water-table elevation.

Method 1 offers limited flexibility, high operating costs and low capital costs. Dewatering would be occurring so slowly for the bottom benches (because of the large amount of time involved) that, if mining rates are increased, limited flexibility is available to increase dewatering rates. To allow for variations in mining schedules and pump down time, moderate overdesign and the use of sump pumps is recommended. The method does have a number of very important advantages. Initial capital costs are low and water-level recovery rates are slow because of the well-developed cone of depression.

Method 2 is very costly because of the large number of different well drilling sessions required. Flexibility is limited, especially if flow rates in new wells do not meet withdrawal requirements for the next bench.

Method 3 has the most potential for cost savings in pit dewatering, but it has practical limitations. It utilizes the concept that the pumping rate for a particular phase should greatly exceed the dewatering rate required to dewater the benches in the time required (i.e., according to the mining schedule), plus the inflow or recharge into the pit area as the cone of depression develops. When the dewatering of a particular bench has been completed, pumping rates can be reduced to match the inflow and, therefore, hold the water table elevation. As dewatering proceeds, higher continuous pumping rates will be needed to maintain dewatered ground. By keeping the cone of depression in the immediate area of the phase to a minimum size, the total volume of water pumped is less. The procedure applies to each bench, with more and more pumps being left operating to maintain the inflow from the large cone of depression for the lower benches. Although capital costs are high, operating costs can be reduced, dependent on power demand. Fast mining rates in the phases are necessary to fully realize the economic advantages of this method. If the mining time is allowed to lag, the economics of Method 3 will approach those of Method 1.

In trying to reach a realistic conclusion as to the most economical method of dewatering, the practical and physical limitations of the mining area must be considered. Thick sections of waste rock add cost and dewatering limitations to Method 1. Operating a large number of pumps on a Phase may congest the mining area, adding a cost to Method 3. Method 2 is risky because of shorter available dewatering times.

Without further testing the most practical and economic dewatering method is difficult to choose at this time.

5.3 If the waste rock has a very slow drainage rate, the upper section of the ore zone may be dry while the waste is still draining. The rate of drain of the waste is a function of its transmissibility. It will be important, therefore, to start dewatering considerably in advance of mining in order to ensure dry waste rock in the pit walls.

Appendix A

APPENDIX A

DESCRIPTIONS OF STUDY METHODS AND GRAPHS

DESCRIPTION OF STUDY METHODS

THEIS METHOD OF SOLUTION:

Using field values, the non-equilibrium equation described in Section 3.2 may be expressed as:

$$ho - h = \frac{114.6\,Q}{T}\,W(u)$$

where

ho -h is drawdown in feet
Q is well discharge in Imp. gal./min.
T is the coefficient of transmissibility in gal./day/ft.
W (u) is the exponential integral termed a "well function"

The argument u is given by:

$$u = \frac{1.56\,r^2\,S}{Tt}$$

where

S is the dimensionless storage coefficient
r is the distance in feet from the discharging well to the observation well
t is the time in days since pumping started

To obtain the formation constants from pumping test data, Theis suggested an approximate solution based on a graphical method of superposition.

A plot on logarithmic paper of W (u) versus u, known as a "type curve", is prepared. Table 4.1 gives values of W (u) for a wide range of u. Values of drawdown ho - h are plotted against values of r^2/t on logarithmic paper of the same size as for the type curve. The observed data curve is superimposed on the type curve, keeping the co-ordinate axes of the two curves parallel, and adjusted until a position is found by trial whereby most of the plotted points of the observed data fall on a segment of the type curve.

An arbitrary point is selected on the coincident segment, and the co-ordinates of this matching point are recorded. With values of W (u), u, ho - h, and r^2/t thus determined, S and T can be obtained.

Walton plotted W (u) versus 1/u and obtained a type curve which was a mirror image of the Theis type curve. Field values of ho - h and t can be plotted directly on log-log paper and a match point obtained.

TABLE 4.1

TABLE 4.1 Values of $W(u)$ for Values of u

(After Wenzel [60])

u	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0
$\times 1$	0.219	0.049	0.013	0.0038	0.0011	0.00036	0.00012	0.000038	0.000012
$\times 10^{-1}$	1.82	1.22	0.91	0.70	0.56	0.45	0.37	0.31	0.26
$\times 10^{-2}$	4.04	3.35	2.96	2.68	2.47	2.30	2.15	2.03	1.92
$\times 10^{-3}$	6.33	5.64	5.23	4.95	4.73	4.54	4.39	4.26	4.14
$\times 10^{-4}$	8.63	7.94	7.53	7.25	7.02	6.84	6.69	6.55	6.44
$\times 10^{-5}$	10.94	10.24	9.84	9.55	9.33	9.14	8.99	8.86	8.74
$\times 10^{-6}$	13.24	12.55	12.14	11.85	11.63	11.45	11.29	11.16	11.04
$\times 10^{-7}$	15.54	14.85	14.44	14.15	13.93	13.75	13.60	13.46	13.34
$\times 10^{-8}$	17.84	17.15	16.74	16.46	16.23	16.05	15.90	15.76	15.65
$\times 10^{-9}$	20.15	19.45	19.05	18.76	18.54	18.35	18.20	18.07	17.95
$\times 10^{-10}$	22.45	21.76	21.35	21.06	20.84	20.66	20.50	20.37	20.25
$\times 10^{-11}$	24.75	24.06	23.65	23.36	23.14	22.96	22.81	22.67	22.55
$\times 10^{-12}$	27.05	26.36	25.96	25.67	25.44	25.26	25.11	24.97	24.86
$\times 10^{-13}$	29.36	28.66	28.26	27.97	27.75	27.56	27.41	27.28	27.16
$\times 10^{-14}$	31.66	30.97	30.56	30.27	30.05	29.87	29.71	29.58	29.46
$\times 10^{-15}$	33.96	33.27	32.86	32.58	32.35	32.17	32.02	31.88	31.76

JACOB METHOD OF SOLUTION:

From drawdown measurements in an observation well during a pumping period, Δ_s and t are known and can be plotted. The slope of the line fitting the data enables the formation constants to be computed. Rapid solutions are obtained from:

$$T = \frac{264Q}{\Delta_s}$$

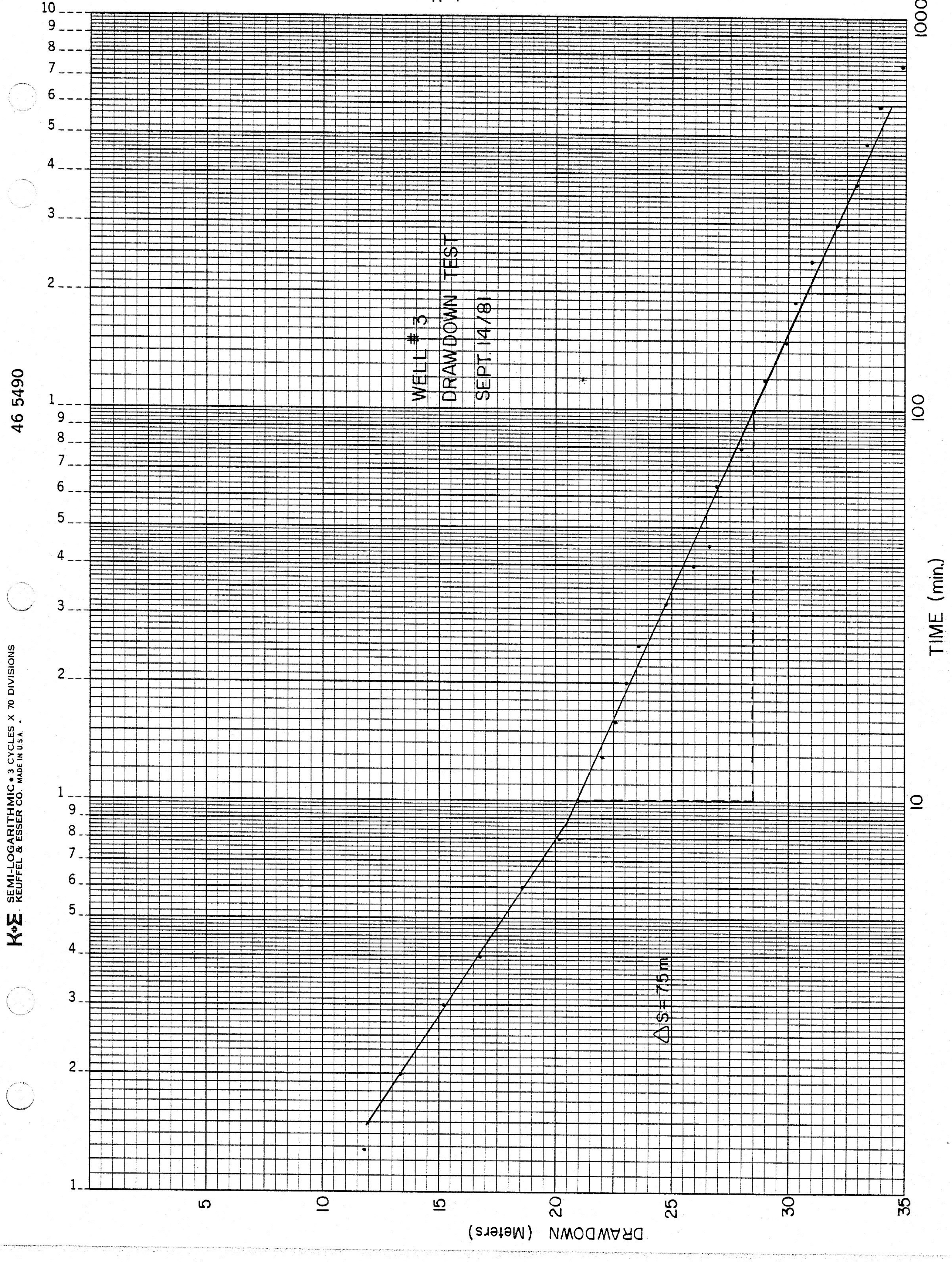
and $$S = \frac{0.36\ Tt_o}{r^2}$$

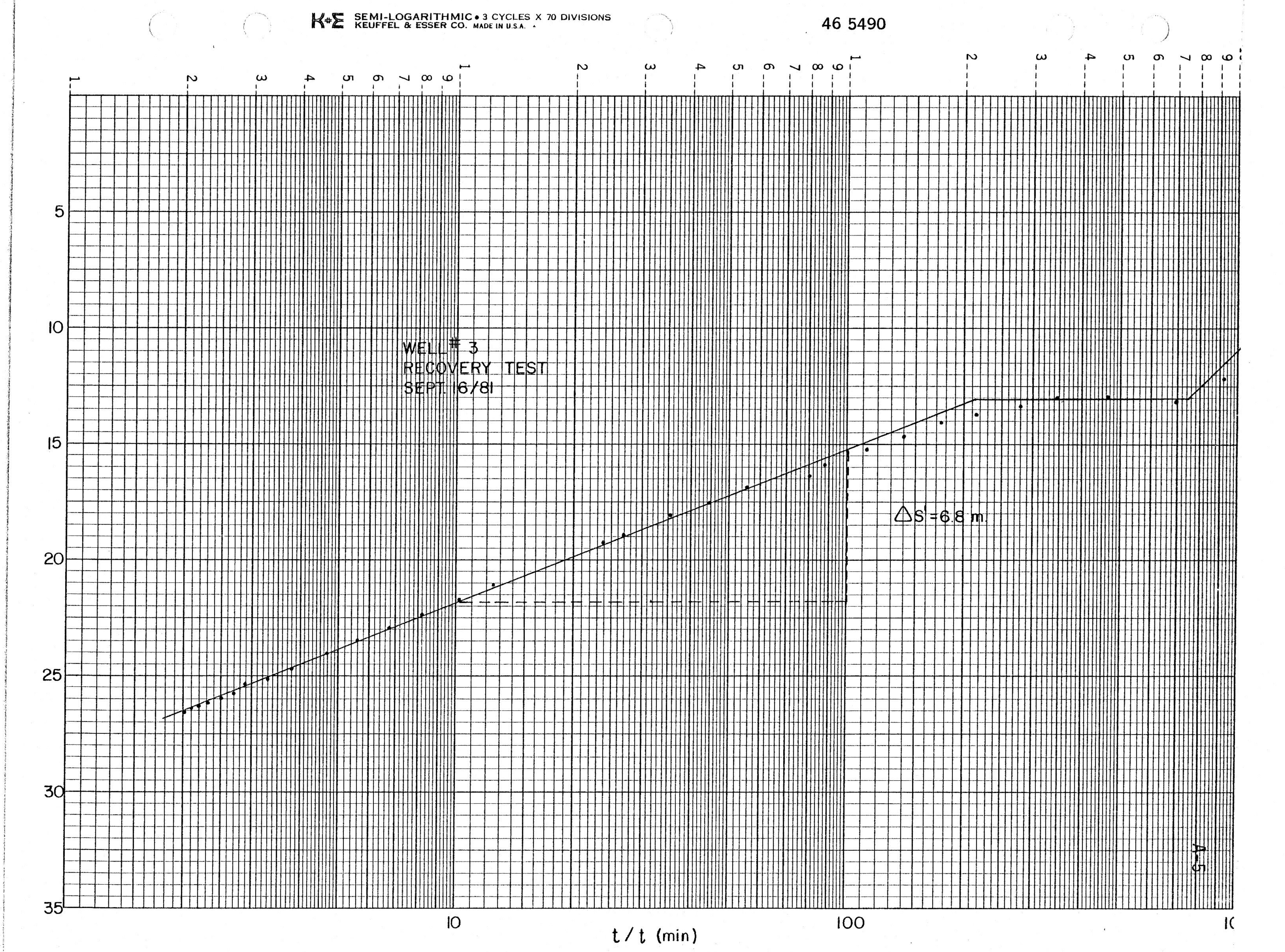
where

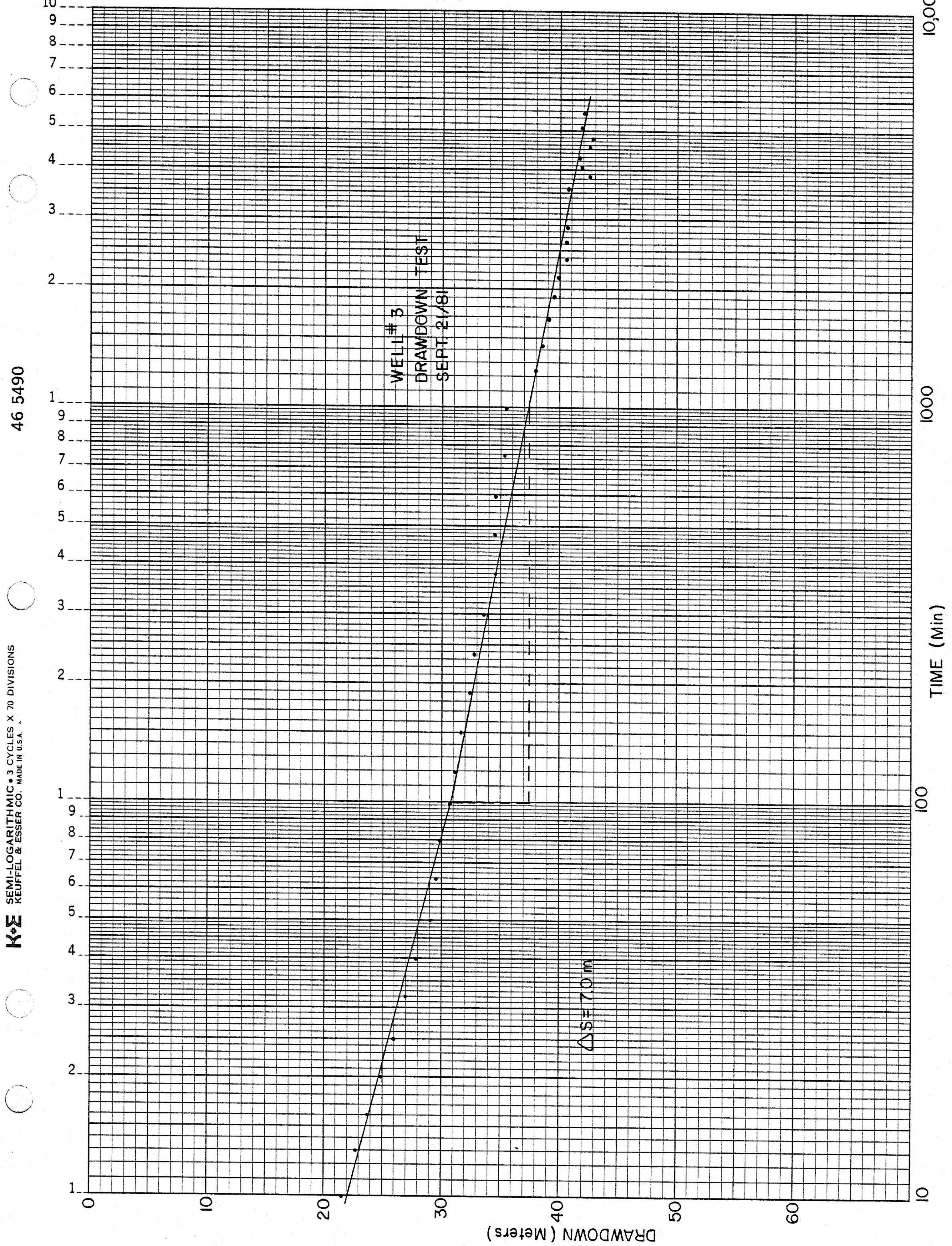
Δ_s is the drawdown difference in feet per log cycle of time

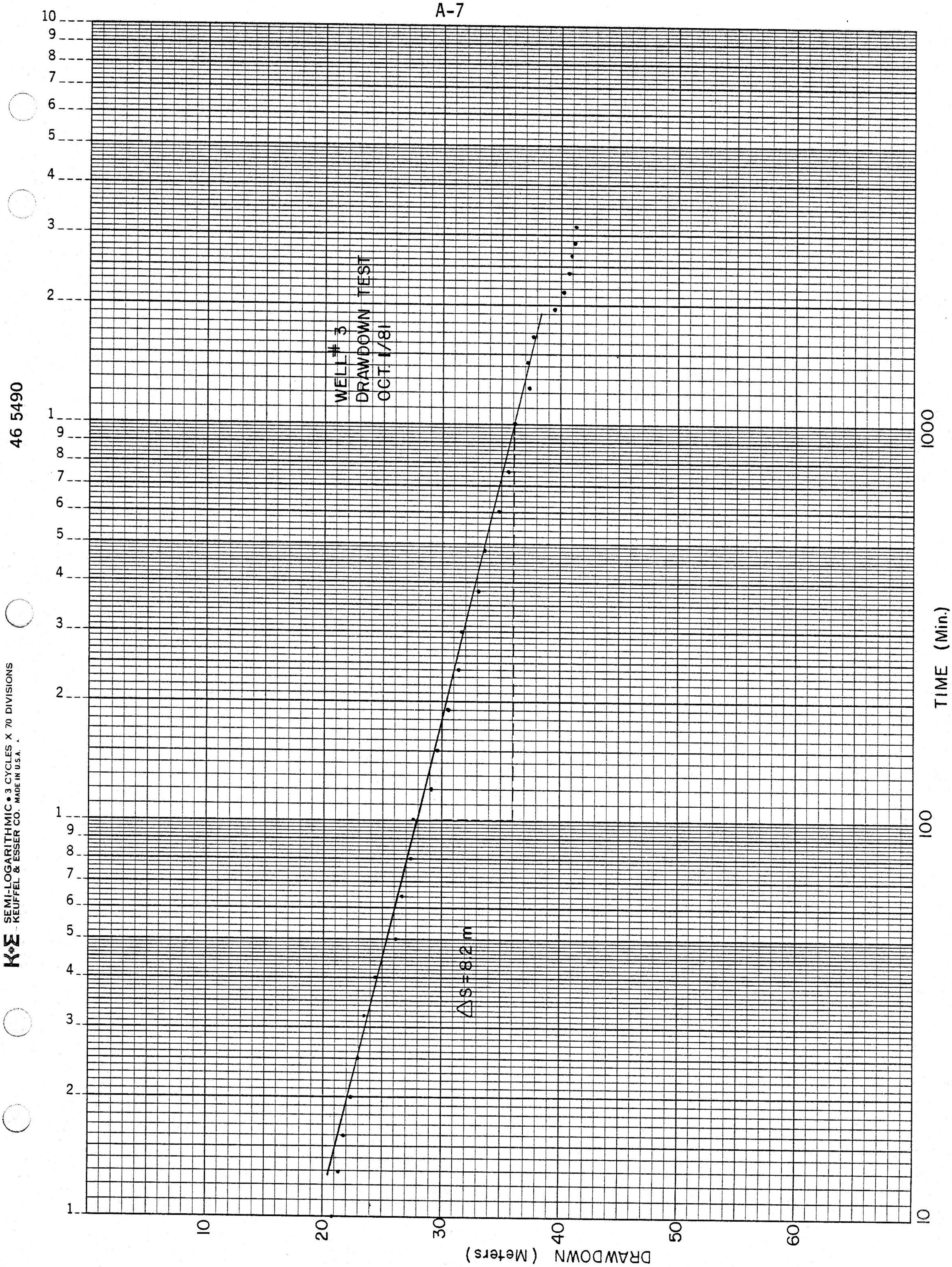
t_o is the time intercept on the zero-drawdown axis

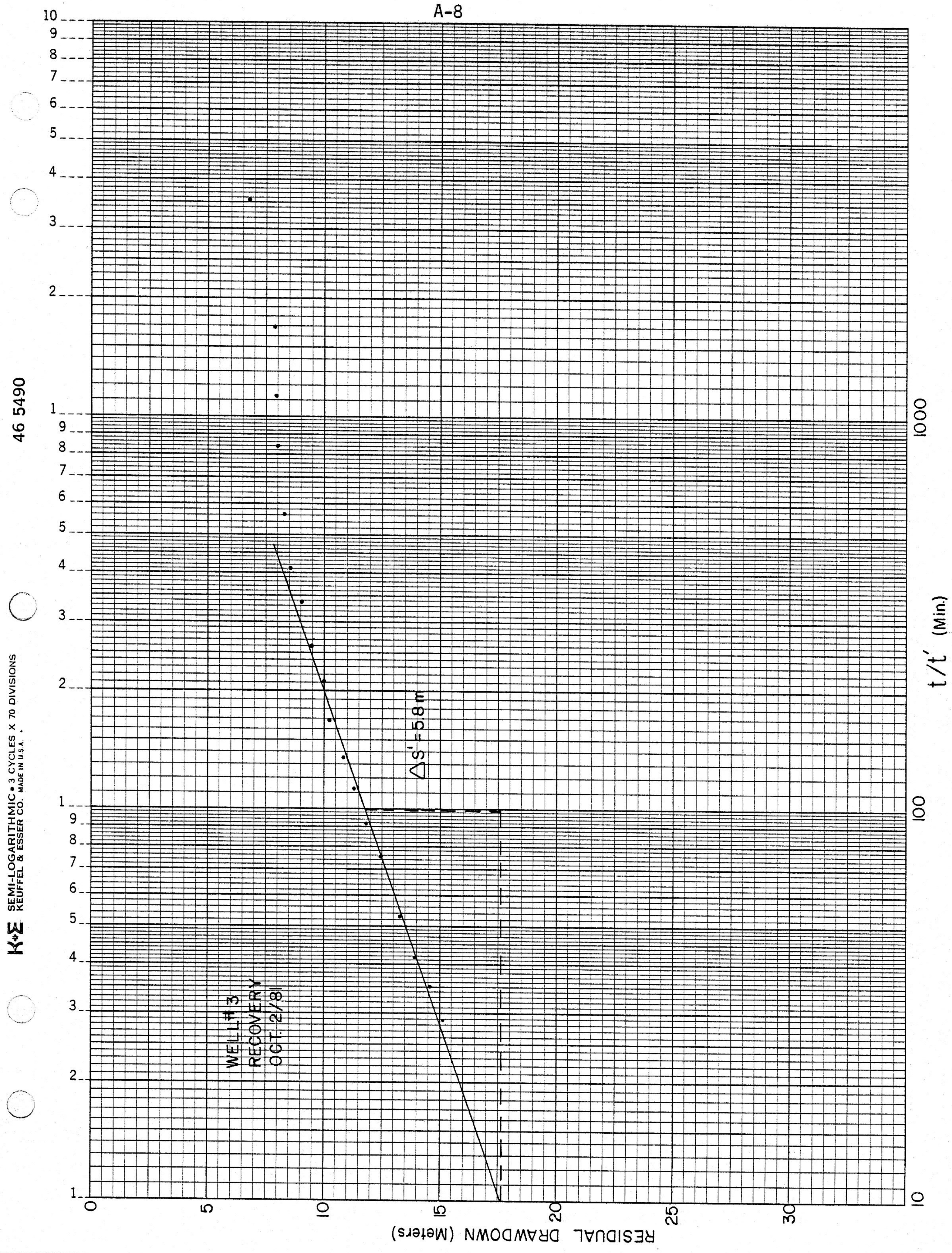
The straight-line approximation for this method should be restricted to values of u less than about 0.01 to avoid large errors.

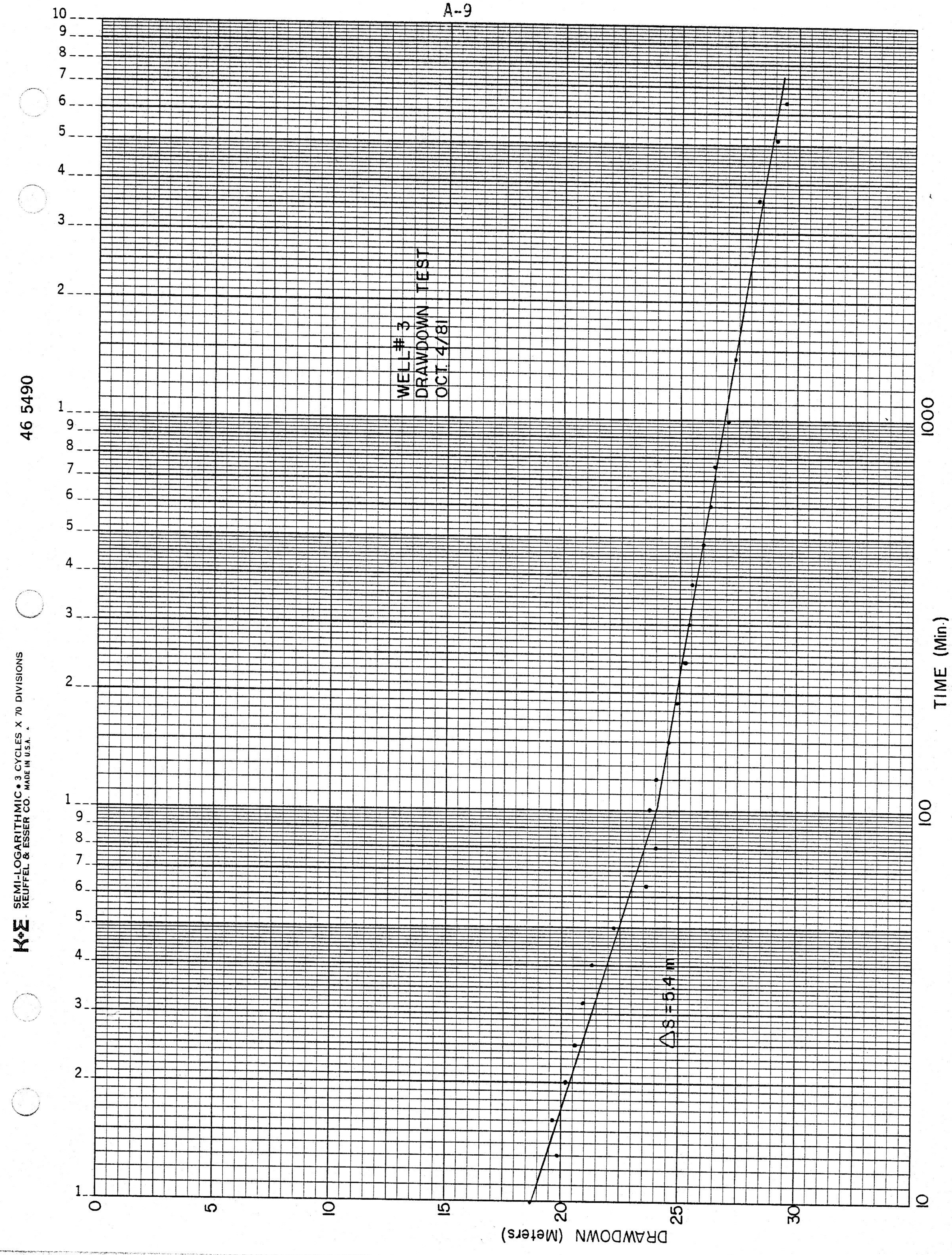

WELL # 3
DRAWDOWN TEST
SEPT. 14/81
ΔS = 7.5 m
TIME (min.)
10
100
1000
DRAWDOWN (Meters)
5
10
15
20
25
30
35
K+E SEMI-LOGARITHMIC • 3 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 5490

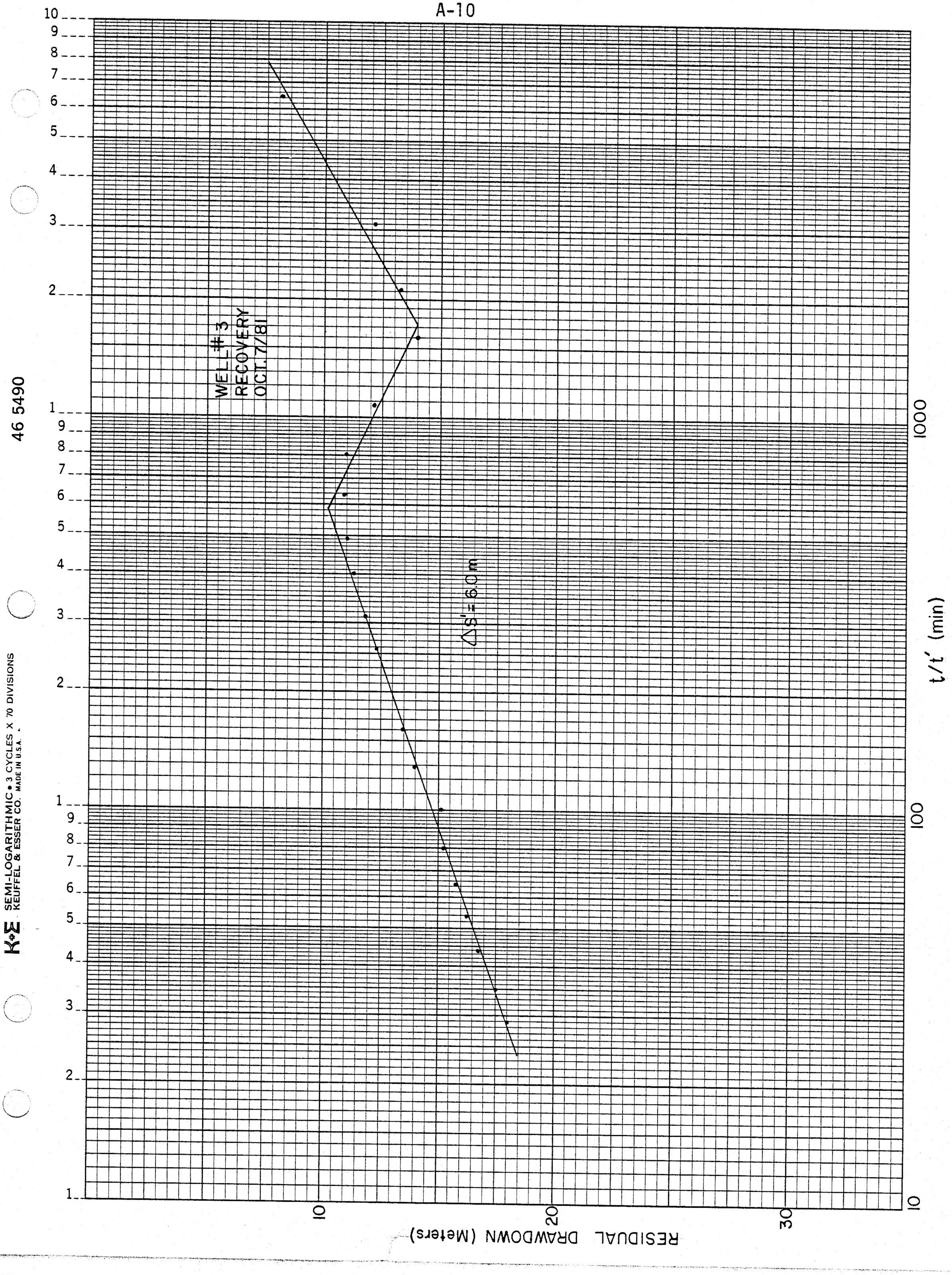

K+E SEMI-LOGARITHMIC • 3 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 5490
WELL # 3
RECOVERY TEST
SEPT. 16/81
ΔS' = 6.8 m
A-5
t / t (min)
10
100

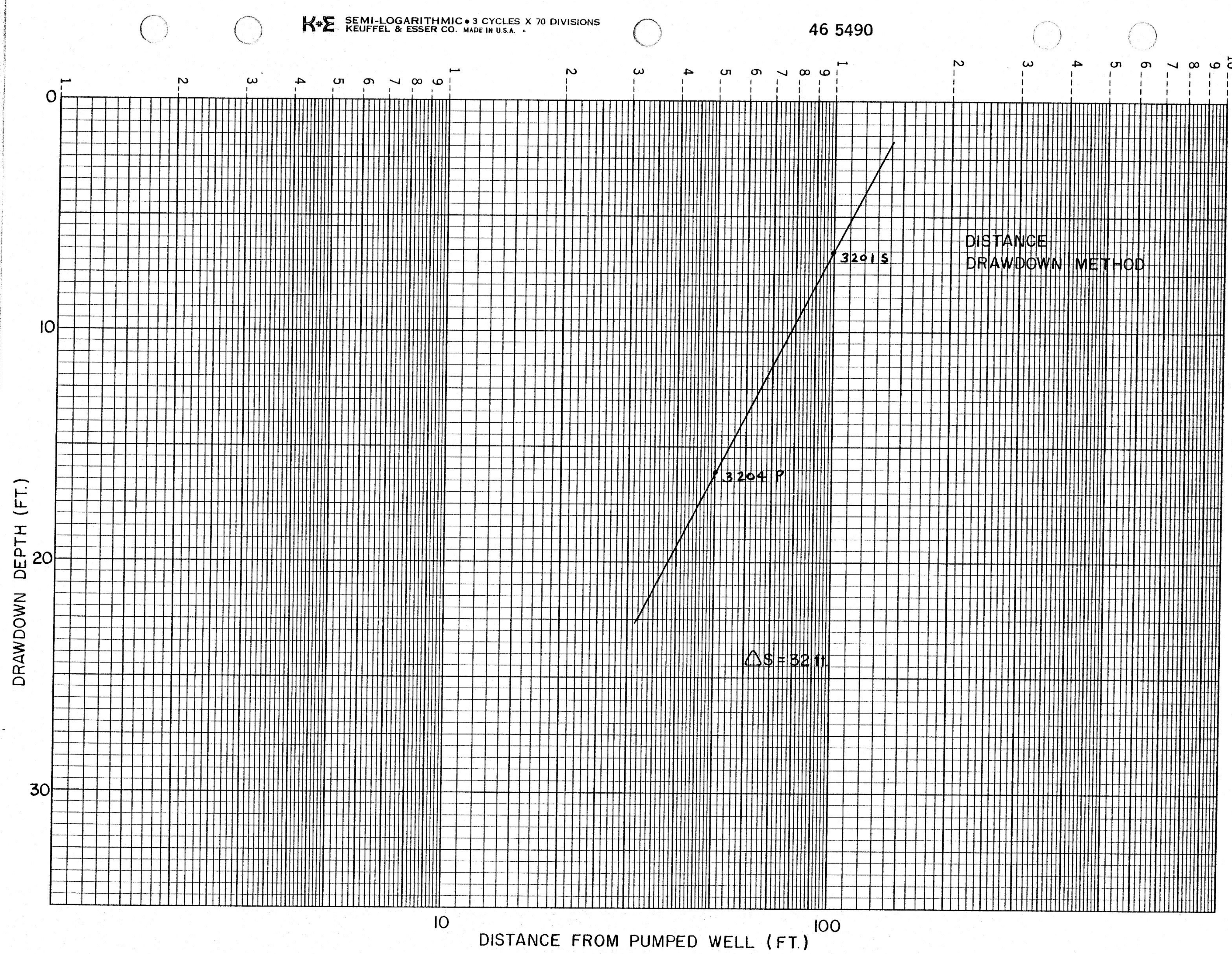

WELL # 3
DRAWDOWN TEST
SEPT 21/81
ΔS = 7.0 m
TIME (Min)
DRAWDOWN (Meters)
10
100
1000
10,000
0
10
20
30
40
50
60
46 5490
SEMI-LOGARITHMIC • 3 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.


WELL # 3
DRAWDOWN TEST
OCT. 1/81
ΔS = 8.2 m
TIME (Min.)
10
100
1000
DRAWDOWN (Meters)
10
20
30
40
50
60
46 5490
K+E SEMI-LOGARITHMIC • 3 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

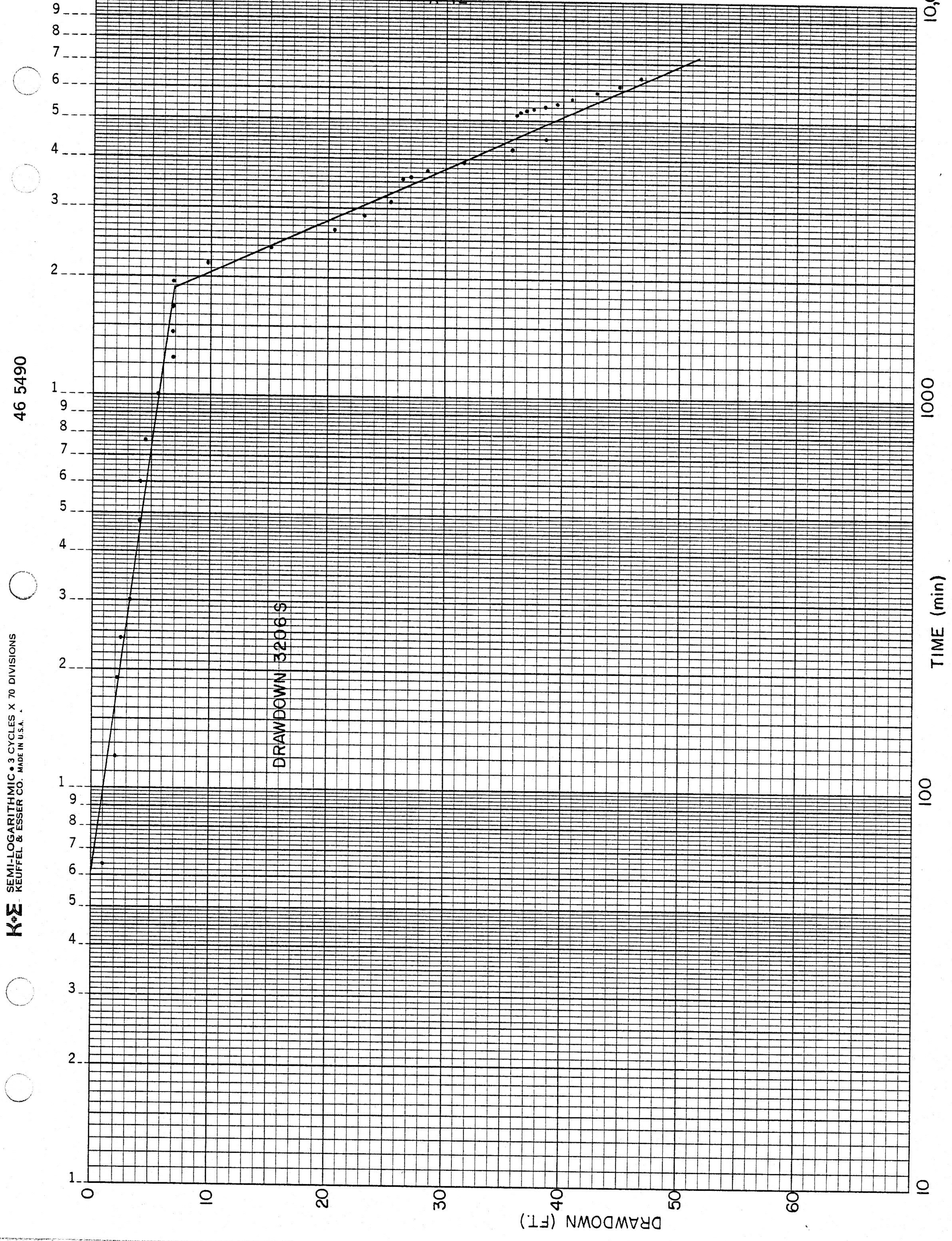

WELL # 3
RECOVERY
OCT. 2/81
ΔS' = 5.8 m
t/t' (Min.)
RESIDUAL DRAWDOWN (Meters)
0
5
10
15
20
25
30
10
100
1000
K+E SEMI-LOGARITHMIC • 3 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 5490

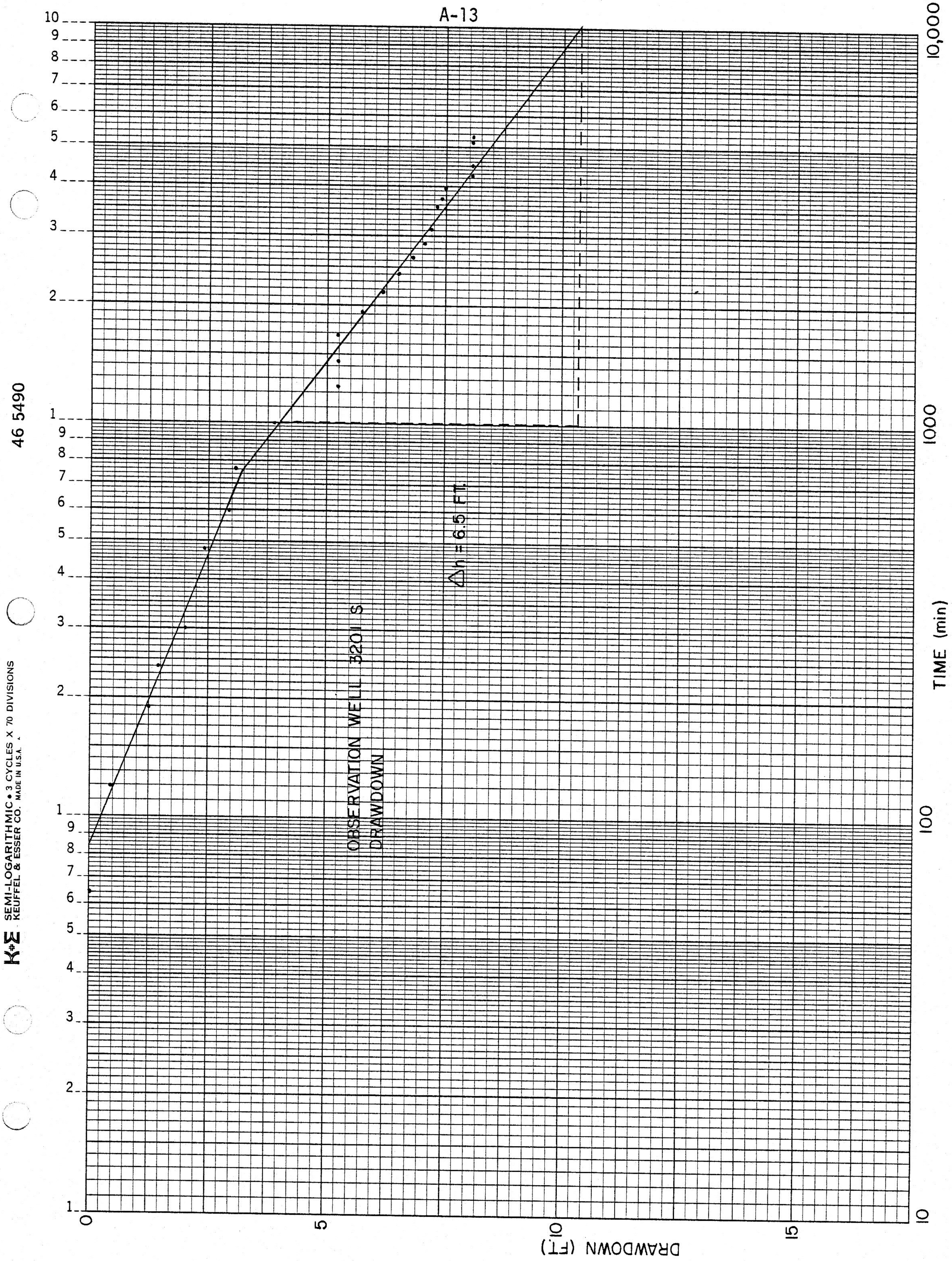

WELL # 3
DRAWDOWN TEST
OCT. 4/81
Δs = 5.4 m
TIME (Min.)
10
100
1000
DRAWDOWN (Meters)
0
5
10
15
20
25
30
46 5490
K+E SEMI-LOGARITHMIC • 3 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

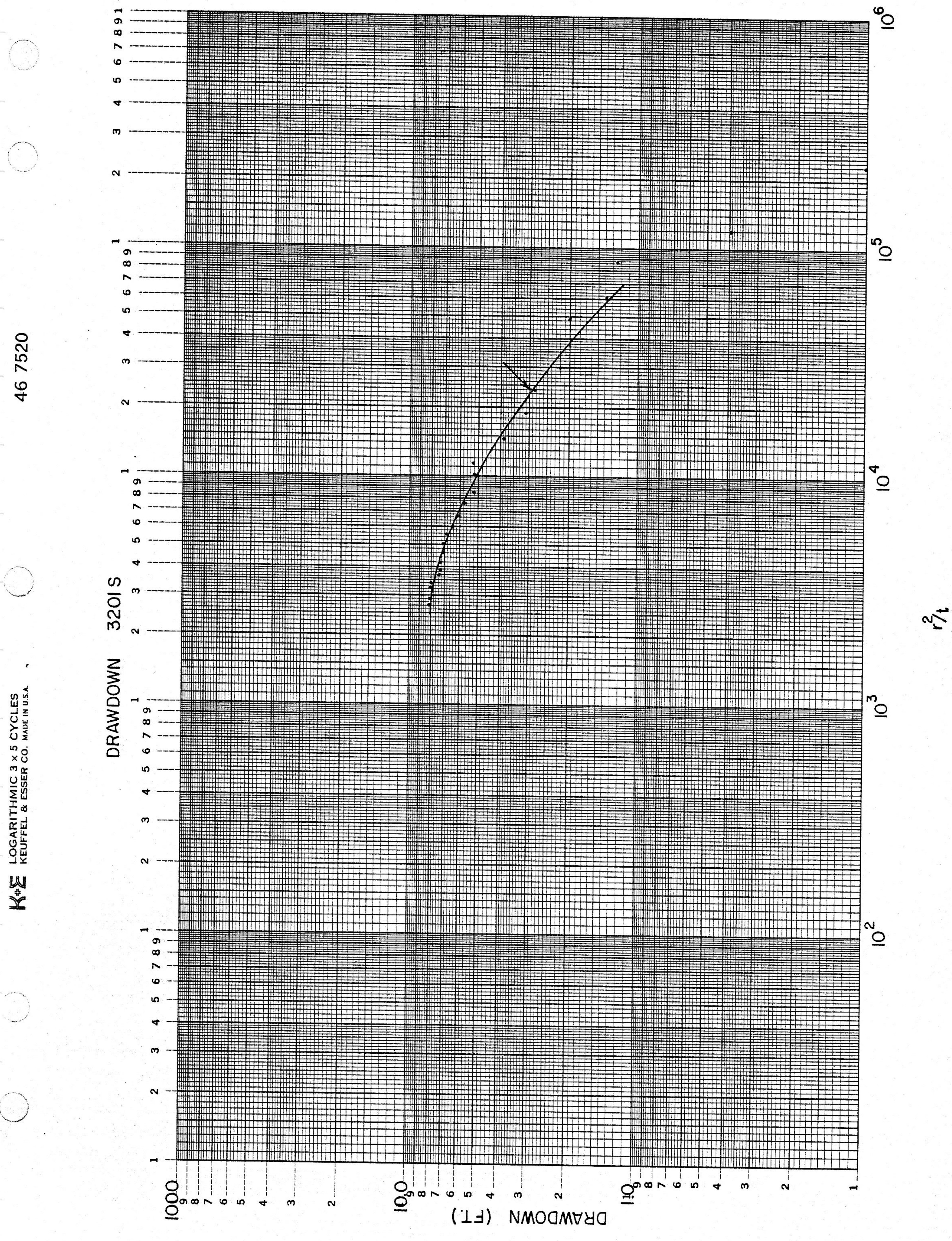

WELL # 3
RECOVERY
OCT. 7/81
ΔS' = 6.0 m
t/t' (min)
10
100
1000
RESIDUAL DRAWDOWN (Meters)
10
20
30
46 5490
K+E SEMI-LOGARITHMIC • 3 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.


K+E SEMI-LOGARITHMIC • 3 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 5490
DISTANCE
DRAWDOWN METHOD
3201 S
3204 P
ΔS = 32 ft.
DRAWDOWN DEPTH (FT.)
0
10
20
30
10
100
DISTANCE FROM PUMPED WELL (FT.)

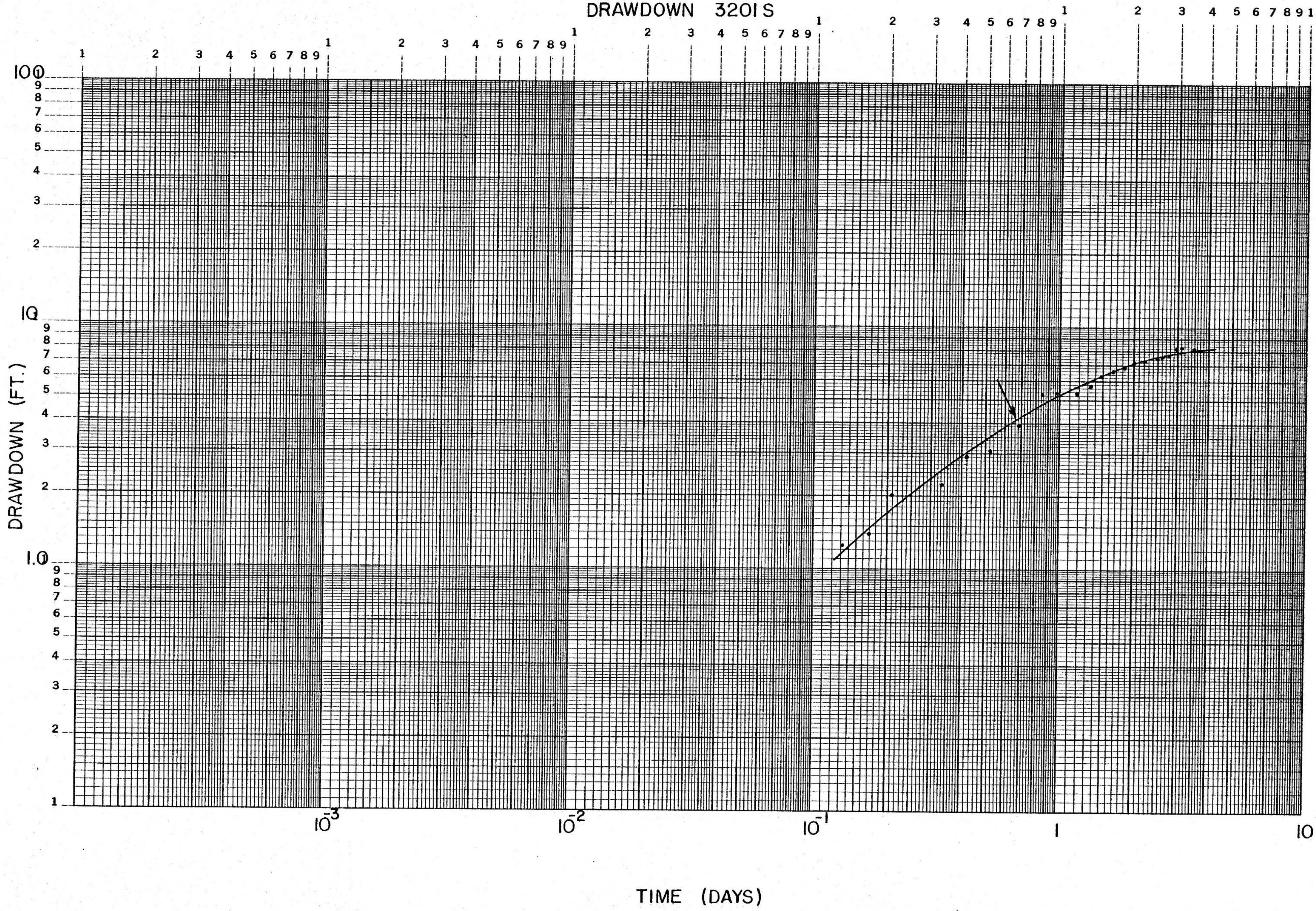
A-12

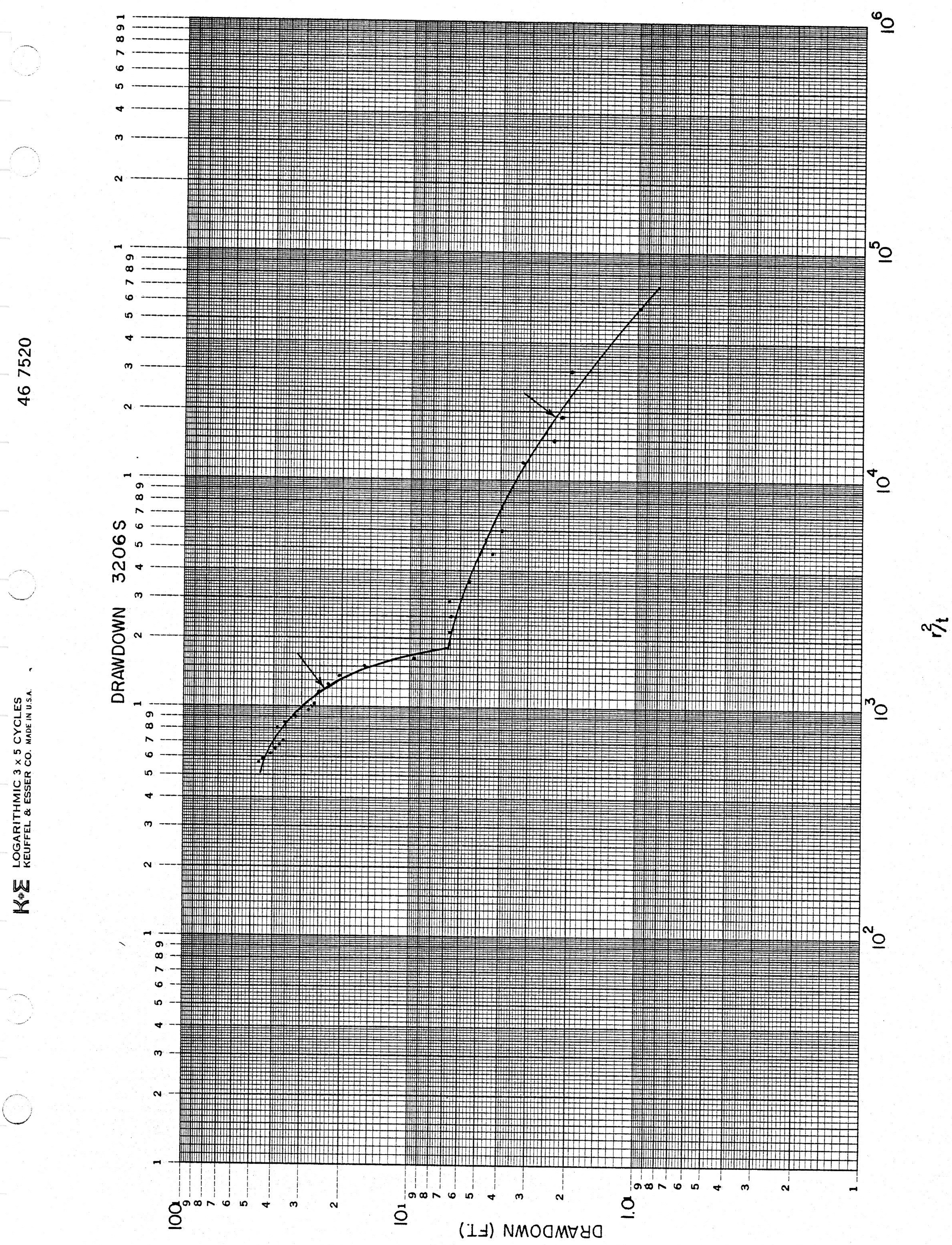

DRAWDOWN 3206 S
TIME (min)
10,000
1000
100
10
DRAWDOWN (FT.)
0
10
20
30
40
50
60
46 5490
K+E SEMI-LOGARITHMIC • 3 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.


OBSERVATION WELL 3201 S
DRAWDOWN
Δh = 6.5 FT.
TIME (min)
10
100
1000
10,000
DRAWDOWN (FT)
0
5
10
15
K+E SEMI-LOGARITHMIC • 3 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 5490


DRAWDOWN 3201 S
46 7520
K+E LOGARITHMIC 3 x 5 CYCLES
KEUFFEL & ESSER CO. MADE IN U.S.A.
DRAWDOWN (FT.)
1000
10.0
1.0
10^2
10^3
10^4
10^5
10^6
r^2/t

DRAWDOWN 3201S




46 7520
LOGARITHMIC 3 x 5 CYCLES
KEUFFEL & ESSER CO. MADE IN U.S.A.
DRAWDOWN 3206S
DRAWDOWN (FT.)
100
10
1.0
r^2/t
10^2
10^3
10^4
10^5
10^6

Appendix B

APPENDIX B

PUMP TEST READINGS AND PIEZOMETER OBSERVATIONS

B-1

Midnight Sun Drilling Co. Ltd.

DATE Sept. 14/81

PAGE NO

PROJECT AQUIFER TEST
LOCATION : Cyprus Anvil Mining Corporation

TIME TEST STARTED: 10:46AM | PRETEST WATER LEVEL: 88:38
AVG. TEST RATE : | CASING ABOVE GROUND:
PUMPING INTERVAL : | TOTAL WELL DEPTH : 500'

TIME SINCE PUMP STARTED (MINUTES)		DEPTH TO WATER	DRAW DOWN	FLOW IGPM	TEMP.	TIME SINCE PUMP STOPPED (MINUTES)		REMARKS
1		99.19	10.81			1		Pump suction
2		101.77	13.39			2		set At 457' 138M
3		103.52	15.14			3		Flow unsettled
4		105.05	16.67	30.4		4		
5						6		
6		106.91	18.53	29.9		8		
8		108.39	20.01	30.1		10		
10		109.37	20.99	29.7	270	13		
13	2:13	110.40	22.02	30.1		16		
16		110.93	22.55	30.4		20		
20		111.40	23.02	29.8		25		
25		111.95	23.57	30.2		32		
32		113.12	24.74	30.1		40		
40		114.19	25.81	30.1	1003	50		35 minutes
50		114.94	26.56	30.4	1487	64		51 minutes
64	3:04	115.20	26.82	30.2	1906	80		65 minutes
80	3:20	116.30	27.92	30.1	2386	100		81 minutes
100	3:40	116.92	28.54	30.2	2960	120		101 minutes
120	4:00	117.375	28.99	29.9	3560	150		121 minutes
150	4:30	118.28	29.90	30.1	4455	190		151 minutes
190	5:10	118.69	30.31	30.1	5240	240		191 minutes (Flow turbine plugged
240	6:00	119.44	31.06	31.0	6657	300		241 min. moment)
300	7:00	120.54	32.16	30.8	8550	380		(Lost indication
380	8:20	121.25	32.87	30.9	10972	480		for several min.)
480	10:00	121.68	33.30	30.7	14036	600		
600	12:00	122.19	33.81	30.2	17642	760		
760	2:20 am	123.28	34.90	29.7	21936	1000		
1000	6:40	124.03	35.65	30.6	29828	1240		
1240	10:40	124.97	36.59	30.2	36458	1440		
1440	2:00 pm	125.01	36.63	30.3	43152			
1680	6:00	125.11	36.73	29.8	50290			

Midnight Sun Drilling Co. Ltd.

DATE

PAGE NO

PROJECT AQUIFER TEST

LOCATION: Cyprus Anvil Mining Corporation

TIME TEST STARTED:

PRETEST WATER LEVEL:

AVG. TEST RATE :

CASING ABOVE GROUND:

PUMPING INTERVAL :

TOTAL WELL DEPTH :

TIME SINCE PUMP STARTED (MINUTES)		DEPTH TO WATER	DRAW DOWN	FLOW IGPM	~~TEMP~~ GALS.	TIME SINCE PUMP STOPPED (MINUTES)		REMARKS
1920	10:00 pm	125.72	37.34	30.2	57608			
2160	2:00 am	125.63	37.25	29.3	64812			
2400	6:00	125.78	37.40	29.8	72026			
2640	10:00	125.68	37.30	30.3	79245			
	11:59	125.65			--			

Midnight Sun Drilling Co. Ltd.

DATE Sept. 16/81

PAGE NO

PROJECT AQUIFER TEST RECOVERY

LOCATION: Cyprus Anvil Mining Corporation

TIME TEST STARTED: 12:25PM | PRETEST WATER LEVEL: 125.65M

AVG. TEST RATE : | CASING ABOVE GROUND:

PUMPING INTERVAL : | TOTAL WELL DEPTH : 500FT. 151.51M

TIME SINCE PUMP STARTED (MINUTES)		DEPTH TO WATER	DRAW DOWN	FLOW IGPM	TEMP	TIME SINCE PUMP STOPPED (MINUTES)		REMARKS
		116.00				12:25 pm		Pump suction
		112.01				12:26		set at 458'
		108.03				12:27		11:59--125.65M
		103.86=				12:28		12;00 stopped
		102.95				12:29		pump
		103.33				12:31		12:07 start pump
		103.07				12:33		
		102.75				12:35		12:08 113:47M
		102.37				12:38		
		101.96				12:41		Total 83247
		101.38				12:45		at 12:25
		100.88				12:50		
		100.31				12:57		
		99.71				1:05 pm		
		99.145				1:15		
		98.54				1:29		
		97.95				1:45		
		97.13				2:12		
		96.84				2:25		
						2:55		Cleared forblast
						3:35		
		94.95				4:25		
		94.30				5:25		
		93.67				6:45		
		93.06				8:25		Added ;-21' L
		92.52				10:25 pm		at 10:00AM pump
		91.98				1:05 am		suction now set
		91.37				5:05		at 478 FT. 144.
		90.92				9:05		.84M
		90.65				12:25		
1680		90.35				4:25		

DATE

Midnight Sun Drilling Co. Ltd.

PAGE NO

PROJECT AQUIFER TEST

LOCATION: Cyprus Anvil Mining Corporation

TIME TEST STARTED:

PRETEST WATER LEVEL:

AVG. TEST RATE :

CASING ABOVE GROUND:

PUMPING INTERVAL :

TOTAL WELL DEPTH :

TIME SINCE PUMP STARTED (MINUTES)	DEPTH TO WATER	DRAW DOWN	FLOW IGPM	TEMP	TIME SINCE PUMP STOPPED (MINUTES)	REMARKS
1920	90.12				8:25	
2160	89.94				12:25 am	
2400	89.78				4:25	
2640	89.62				8:25	
2925	89.50				1:10 pm	

Midnight Sun Drilling Co. Ltd.

DATE Sept. 19/81

PAGE NO

PROJECT AQUIFER TEST

LOCATION: Cyprus Anvil Mining Corporation

TIME TEST STARTED: 10:00AM

PRETEST WATER LEVEL:@9:59am 35.69M

AVG. TEST RATE : 2.1 G.P.M.

CASING ABOVE GROUND: .42M

PUMPING INTERVAL : 60 MIN.

TOTAL WELL DEPTH : ~~72.72~~M 250 FT.

TIME SINCE PUMP STARTED	(MINUTES)	DEPTH TO WATER	DRAW DOWN	FLOW IGPM	TEMP	TIME SINCE PUMP STOPPED	(MINUTES)	REMARKS
1	10:01	37.41	1.72	2.5				Pump suction
2	10:02	38.01	2.32	2.5			set at 204'--61.81M	
5 min.	10:05	39.79	4.10	2.3				
6	10:06	40.55	4.86	2.4				10:03 flow
8	10:08	41.73	6.04	2.5			turbine stopped momen-ta	
10	10:10	42.09	6.40				-rily.	
13	10:13	43.28	7.59	2.3				Total Gallons
16	10:16	45.34	9.65	2.4				14 min. 26gal
20	10:20	48.37	12.68	2.7				17 min. 33gal
25	10:25	51.27	15.58	2.5				21 min. 41 gal
32	10:32	54.37	18.68					26 min. 53 gal
40	10:40	56.91	21.22	2.3				33 min. 68 gal
50	10:50	59.49	23.80	2.4				41 min. 85 gal
64	11:00	61.65	25.96					50 min. 105 gal
80	Dry							60 min. 130 gal
								stopped pump
								at 11:00 level
								taken at 61.65M
								or 203.4' less
								than 1 ft. from suction

Midnight Sun Drilling Co. Ltd.

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DATE ______

PAGE NO ______

PROJECT AQUIFER TEST RECOVERY

LOCATION: Cyprus Anvil Mining Corporation

TIME TEST STARTED: PRETEST WATER LEVEL:

AVG. TEST RATE : CASING ABOVE GROUND:

PUMPING INTERVAL : TOTAL WELL DEPTH :

TIME SINCE PUMP STARTED (MINUTES)	DEPTH TO WATER	DRAW DOWN	FLOW IGPM	TEMP	TIME SINCE PUMP STOPPED (MINUTES)		REMARKS
	60.20				11:01 am	1	
	58.05				11:02	2	
	57.12				11:03	3	~~10:03 flow turbine~~
	56.43				11:04	4	~~stopped momentarily~~
	55.14				11:06	6	
	53.92				11:08	8	
	52.77				11:10	10	
	51.22				11.13	13	~~14 min 26 gals.~~
	49.91				11.16	16	~~17 min 33 gals.~~
	48.44				11.20	20	~~21 min 41 "~~
	47.06				11:25	25	~~26 min 53 "~~
	46.50				11:32	32	~~33 " 68 "~~
	46.08				11:40	40	~~41 " 85 "~~
	45.85				11:50	50	~~105 "~~
	45.60				12:04	64	~~60 " 130 "~~
	45.42				12:20	80	
	45.31				12:40	100	~~Stopped Pump~~
	45.25				1:00	120	~~11:00 level~~
	45.04				1:30	150	~~taken at 61.65~~
	44.75				2:10	190	~~or 203.4' less~~
	44.66				3:00	240	~~than 1' from~~
	44.30				4:00	300	~~suction~~
	43.87				5:20	380	
	43.66				7:00	480	
	42.38				9:00	600	
	42.00				11:40 pm	760	
	42.41				3:40 am	1000	
	42.57				7:40	1240	
	42.62				11:00	1440	

Midnight Sun Drilling Co. Ltd.

WHITEHORSE Y.T.

DATE Sept. 19/81

PAGE NO

PROJECT AQUIFER TEST (Step Draw)
LOCATION: Cyprus Anvil Mining Corporation

TIME TEST STARTED: 2:19PM.

PRETEST WATER LEVEL: 26.86 2:19PM

AVG. TEST RATE :

CASING ABOVE GROUND:

PUMPING INTERVAL :

TOTAL WELL DEPTH : 250ft.

TIME SINCE PUMP STARTED (MINUTES)		DEPTH TO WATER	DRAW DOWN	FLOW IGPM	TEMP	TIME SINCE PUMP STOPPED (MINUTES)		REMARKS
	1	28.16	.94					
	2	28.49	1.27	3				
	3	28.85	1.63					
	4	29.30	2.08					
	6	30.26	3.04					
	8	31.23	4.01					
	10	32.22	5.00					
	13	33.81	5.96					
	15	34.89	7.67	3GPM				
	1	35.54		4				
	2	36.21						
	3	36.93						
	4	37.61						
	6	38.89						
	8	40.24						
	10	41.54						
	13	41.76	4GPM					
	15	42.10	5GPM					
	1	42.36						
	2	43.00						
	3	43.49						
	4	44.31						
	6	46.13						
	8	47.99						
	10	49.72						
	13	51.92						
	15	53.24						
	1	54.10	6GPM.					
	2	55.77						
	4	56.58						
	8	59.64						
	10	61.07						

B-8

Midnight Sun Drilling Co. Ltd.

DATE Sept. 21

abandoned long term test

PAGE NO

PROJECT AQUIFER TEST Cyprus Anvil Mining Corporation
LOCATION :

TIME TEST STARTED: 700pm

PRETEST WATER LEVEL: 88.14M

AVG. TEST RATE :

CASING ABOVE GROUND:

PUMPING INTERVAL : 20160

TOTAL WELL DEPTH : 500 /FT. 151.51M

TIME SINCE PUMP STARTED (MINUTES)		DEPTH TO WATER	DRAW DOWN	FLOW IGPM	TEMP.	TIME SINCE PUMP STOPPED (MINUTES)		REMARKS
1		98.35	10.21	30.		1		Pump suction
2		101.47	13.33			2		set at 479'-145.
3		103.18	15.04			3		=15M
4		104.73	16.59			4		
6		107.14	19.00			6		
8		108.62	20.48			8		
10	7:10 pm	109.71	21.57			10		10 min 291 gals
13		110.91	22.77			13		13 " 379 "
16		111.93	23.79			16		16 " 468 "
20		113.00	24.86			20		20 " 585 "
25		114.18	26.04			25		25 " 737 "
						32		
32		115.10	26.96			40		32 " 949 "
40		115.91	27.77			50		40 " 1187 "
50		117.24	29.10			64		1492 "
64	8:04	117.58	29.44			80		1919 "
80	8:20	118.06	29.92			100		2397 "
100	8:40	118.69	30.55			120		3000 "
120	9:00	119.22	31.08			150		3577 "
150	9:30	119.80	31.66	29.8		190		4512 "
190	10:10	120.45	32.31	30.1		240		5709 "
240	11:00	120.98	32.84	30.4		300		7224 "
300	12:00 am	121.63	33.49	29.9		380		9026 "
380	1:20	122.62	34.48	30.0		480		11476 "
480	3:00	122.65	34.48	30.1		600		14422 "
600	5:00	122.95	34.81	29.9		760		18010 "
760	7:40	123.43	35.29	29.9		1000		22795 "
1000	11:40	123.83	35.69	29.9		1240		29970 "
1240	3:40 pm	126.04	37.90	29.8		1440		37080 "
1440	7:00	126.46	38.32	29.8				43053 "

Midnight Sun Drilling Co. Ltd.

MIDNIGHT SUN DRILLING CO. LTD. WHITEHORSE Y.T.

DATE ______

PAGE NO ______

PROJECT AQUIFER TEST

LOCATION: Cyprus Anvil Mining Corporation

TIME TEST STARTED:

PRETEST WATER LEVEL:

AVG. TEST RATE :

CASING ABOVE GROUND:

PUMPING INTERVAL :

TOTAL WELL DEPTH :

TIME SINCE PUMP STARTED (MINUTES)		DEPTH TO WATER	DRAW DOWN	FLOW IGPM	~~TEMP~~ Gals.	TIME SINCE PUMP STOPPED (MINUTES)		REMARKS
1680	11:00	127.18	39.04	30.0	50239			
1920	3:00 am	127.66=	39.52	30.0	57439			Sept. 23
2160	7:00	127.93	39.79	30.1	64655			
2400	11:00	128.54	40.40	30.1	71865			
2640	3:00	128.62	40.48	30.0	79080			
2880	7:00	128.55	40.41	30.00	86284			72040-30.01 AVG
3120	11:00	128.70	40.56	29.9	93458			71740-29.89 AVG
3360	3:00	128.98	40.84	30.0	100671			7213 -30.05
3600	7:00	129.12	40.98	29.9	107842			7171G-29.87
3840	11:00	130.44	42.30	29.8	115050			7208G-30.03
4080	3:00 pm	129.96	41.82	29.9	122213			7163G-29.84 AVG
4320	7:00	129.71	41.57	30.0	129470			7257G-30.23 AVG
4560	11:00	130.55	42.41	30.0	136697			7227G
4800	3:00	130.82	42.68	30.0	143923			7226G
5040	7:00am	130.10	41.96	30.0	151111			7168
5280	11:00pm	130.13	41.99	29.8	158370			7259 3.24 AVG
5520	3:00pm							
5760	7:00							

B10

Midnight Sun Drilling Co. Ltd.

MIDNIGHT SUN DRILLING CO. LTD. WHITEHORSE Y.T.

DATE Sept. 21

PAGE NO

PROJECT AQUIFER TEST 3206S OBSERVATION WELL

LOCATION: Cyprus Anvil Mining Corporation

TIME TEST STARTED: PRETEST WATER LEVEL:

AVG. TEST RATE : CASING ABOVE GROUND:

PUMPING INTERVAL : TOTAL WELL DEPTH :

TIME SINCE PUMP STARTED (MINUTES)		DEPTH TO WATER	DRAW DOWN	FLOW IGPM	TEMP	TIME SINCE PUMP STOPPED (MINUTES)		REMARKS
130	9:10 pm	193.00	1.0			1:12	267	Sept. 21
150	9:30	193.6	1.6					
195	10:15	194.0	2.0					
243	11:03	194.8	2.8					
304=	12:04 am	195.1	3.1					
385	1:25	195.9	3.9					Sept 22
482	3:02	196.7	4.7					
605	5:05	197.2	5.2					
762	7:42	199.2	7.2					
1010	11:50	238.3	46.3					
1096	1:16 pm	243.0	51.0					
1242	3:42	250.0	58.0					
1447	7:07	256.3	64.3					
1684	11:04	257.1	65.1					
1926	3:06	260.3	68.3					Sept 23
2164	7:04	262.7	70.7					
2405	11:05	263.0	71.0					
2645	3:05	263.6	71.6					Sept 24
2885	7:05	264.0	72.0					
3123	11:03	264.0	72.0					
3367	3:07	265.0	73.0					Sept 24
3605	7:05	265.0	73.0					
3844	11:07	265.6	73.6					
4085	3:05	265.6	73.6					
4325	7:05	266.0	74.0					
4563	11:03	266.1	~~104~~ 74.1					
4805	3:05 am	266.5	74.5					Sept. 25
5044	7:04	266.6	74.6					
5285	7:05	267.0	75.0					
	1:12	267.0						

Midnight Sun Drilling Co. Ltd.

B11

DATE Oct. 1/81

PROJECT AQUIFER TEST Observation Well

LOCATION: 3206 Stand Pipe R

TECHNICIAN:

CASING HEIGHT ABOVE GROUND: M

TOTAL WELL DEPTH: M

PRETEST WATER LEVEL: 262' M

PUMPING INTERVAL: MIN.

TIME TEST STARTED: 11am

AVERAGE TEST RATE:

TIME SINCE PUMP START (MINUTES) DESIRED	ACTUAL	TIME	DEPTH TO WATER (M)	DRAW DOWN (M)	FLOW (IGPM)	TEMP.	TIME SINCE PUMP STOP (MINUTES) TIME	DTW (M)	REMARKS
.5		11am	262						Oct. 1/81
1	64	12N	263	1'					
2	120	1:04pm	264	2'					
3	190	2:03	264.2	2'2"					
4	240	3:03	264.5	2'5"					
6	300	4:48	265'2"	3'2"					
8	480	7:05	266'	4'					
10	600	9:05	266'	4'					
13	760	11:03pm	266'5"	4'5"					
16	1000	3:44am	267'6"	5'6"					Oct. 2/81
20	1240	7:45	268'10"	6'10"					changed to 31 G.P.M.
25	1440	11:05	268'1"	6'7"					@3:15pm Oct 2
32	1680	3:06	268'8"	6'8"					
40	1920	7:05pm	268'9"	6'9"					
50	2160	11:03am	271'8"	9'8"					
64	2400	3:04am	278'1"	16'1"					
80	2640	7:03am	282'6"	20'6"					
100	2880	11:03am	285'	23'					
120	3120	3:03pm	287'4"	25'4"					
150	3360								
190	3600								
240									
300									
380									
480									
600									
760									
1000									
1240									
1440									

B12

Midnight Sun Drilling Co. Ltd.

DATE Oct. 1/81

PROJECT Aquifer Test

Location: 3201 Standpipe

Technician: G.Lynch S. Johnson

Casing Height Above Ground: M

Total Well Depth: M

Pretest Water Level: 82' M

Pumping Interval: Min

Time Test Started: 11am.

Average Test Rate:

Time Since Pump Start (Minutes) Desired	Actual	Time	Depth To Water (M)	Draw Down (M)	Flow (IGPM)	Temp.	Time Since Pump Stop (Minutes) Time	DTW (M)	Remarks 65! +1"
.5		11:am.	82'						Oct.1/81
1	64	12:07	82'						
2	120	1:07	82'5"	5"					
3	190	2:06	83'	1'3"					
4	240	3:07	83'5"	1'5"					
6	300	4:48	84'	2'					
8	480	7 :07	84'2"	2'2"					
10	600	9:03	84'11"	2'11"					
13	760	11:06	85'1"	3'1"					
16	1000	3:42am	85'11"	3'11"					Oct. 2/81
20	1240	7:43	87'3"	5'3"					Changed to 31 gpm
25	1440	11:08	87'3"	5'3"					@3:15pm Oct. 2/81
32	1680	3:04pm	87'3"	5'3"					
40	1920	7:03	87'9"	5'9"					
50	2160	11:02	88'2"	6'2"					
64	2400	3:05	88'6"	6'6"					
80	2640	7:04	88'10"	6'10"					
100	2880	11:07	89'1"	7'1"					
120	3120	3:06pm	89'2"	7'2"					
150	3360								
190	3600								
240									
300									
380									
480									
600									
760									
1000									
1240									
1440									

Midnight Sun Drilling Co. Ltd.

B13

DATE Oct.1--2/81

PAGE NO

PROJECT AQUIFER TEST
LOCATION : Cyprus Anvil Mining Corporation

TIME TEST STARTED: 11am
PRETEST WATER LEVEL: 89.64M
AVG. TEST RATE : 30GPM.
CASING ABOVE GROUND:
PUMPING INTERVAL :
TOTAL WELL DEPTH :

TIME SINCE PUMP STARTED (MINUTES)		DEPTH TO WATER	DRAW DOWN	FLOW IGPM	GALS.	TIME SINCE PUMP STOPPED	AVG. GPM	REMARKS
1	11:01 am	102.54	12.90	27	52	1	52.00	Oct. 1/81
2	11:02	103.97	14.33	29	84	2	42.00	well suction set
3	11:03	105.46	15.82	28	96	3	32.00	at 463'
4	11:04	106.62	16.98	30	111	4	27.75	
5						6		
6	11:06	108.01	18.37	28	165	8	27.50	
8	11:08	108.59	18.95	28	224	10	28.00	
10	11:10	109.72	20.08	29	281	13	28.10	
13	11:13	110.77	21.13	29	368	16	28.31	
16	11:16	111.34	21.70	29	454	20	28.38	
20	11:20	111.93	22.29	29	568	25	28.40	
25	11:25	112.55	22.91	29	711	32	28.44	
32	11:32	113.04	23.40	29	910	40	28.44	
40	11:40	113.86	24.22	28	1106	50	27.65	
50	11:50	115.78	26.14	31	1424	64	28.48	
64	12:04 pm	116.32	26.68	29	1813	80	28.33	
80	12:20	116.84	27.20	29	2291	100	28.64	
100	12:40	117.36	27.72	29	2856	120	28.56	
120	1:00	118.65	29.01	30	3436	150	28.63	
150	1:30	119.24	29.60	30	4341	190	28.94	
190	2:10	119.94	30.30	30	5419	240	28.52	Had to leave tes
240	3:00	120.77	31,13	30	6957	300	28.99	site for 45 min.
300	4:40	121.51	31.87	29	98.12	380	32.71	because of blast
380	5:20	122.68	33.04	30	11090	480	29.18	ing. Return at
480	7:00	123.33	33.69	30	14010	600	29.19	4:35 everything
600	9:00	124.50	34.86	30	17578	760	29.30	running smoothly
760	11:40	125.05	35.41	30	22368	1000	29.43	
1000	3:40 am	125.67	36.03	30	29482	1240	29.48	Oct. 2/81
1240	7:40	126.12	37.28	30	36661	1440	29.56	
1440	11:00	126.80	37.16	30	42580		29.57	
1680	3:00	127.35	37.71	30	49697			

B14

Midnight Sun Drilling Co. Ltd.

DATE ________

PAGE NO ________

PROJECT AQUIFER TEST

LOCATION: Cyprus Anvil Mining Corporation

TIME TEST STARTED:

PRETEST WATER LEVEL:

AVG. TEST RATE :

CASING ABOVE GROUND:

PUMPING INTERVAL :

TOTAL WELL DEPTH :

TIME SINCE PUMP STARTED (MINUTES)		DEPTH TO WATER	DRAW DOWN	FLOW IGPM	XXXX GALS.	TIME SINCE PUMP STOPPED (MINUTES)		REMARKS
1920	7:00 pm	129.11	39.47	31	56992			
2160	11:00	129.87=	40.23	31	64392			
2400	3:00 am	130.40	40.76	31	71729			
2640	7:00	130.55	40.91	31	79040			
2880	11:00	130.74	41.10	31	86343			
3120	3:00	130.80	41.16	31	93617			

DATE

Midnight Sun Drilling Co. Ltd.

Recovery

PAGE NO

PROJECT AQUIFER TEST

LOCATION: Cyprus Anvil Mining Corporation

TIME TEST STARTED: 11:00 a.m. PRETEST WATER LEVEL: 89.64

AVG. TEST RATE : 30 G.P.M. CASING ABOVE GROUND:

PUMPING INTERVAL : TOTAL WELL DEPTH : 500 feet

TIME SINCE PUMP STARTED (MINUTES)		DEPTH TO WATER	DRAW DOWN	FLOW IGPM	~~TEMP~~ GALS.	TIME SINCE PUMP STOPPED (MINUTES)		REMARKS
3355	6:55	114.52			100817	t′	t/t′	Oct. 2nd chang
3356	6:56	107.78	6.74			1	3356	to 31 GPM at
3357	6:57	106.75	7.77			2	1679	3:15 pm 3206 &
3358	6:58	106.65	7.87			3	1119	3201 started
3359	6:59	106.57	7.95			4	840	to rise. Oct 3
3361	7:01	106.32	8.20			6	560	6:55pm had to
3363	7:03	105.95	8.57			8	420	tape recovery
3365	7:05	105.50	9.02			10	337	generator quit
3368	7:08	105.07	9.45			13	259	
3371	7:11	104.55	9.97			16	211	
3375	7:15	104.28	10.24			20	169	
3380	7:20	103.72	10.80			25	135	
3385	7:25	103.15	11.37			30	113	
3392	7:32	102.71	11.81			37	92	
3400	7:40	102.04	12.48			45	76	
3419	7:59	101.16	13.36			64	53	
3435	8:15	100.52	14.0			80	43	
3455	8:35	99.87	14.65			100	35	
3475	8:55	99.36	15.16			120	29	Started test
								at 9:00 am
								Oct. 3/81

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Midnight Sun Drilling Co. Ltd.

DATE Oct. 3/81

PAGE NO 2

PROJECT AQUIFER TEST 3260 Stand Pipe R

LOCATION: Cyprus Anvil Mining Corporation

TIME TEST ~~STARTED:~~ restarted 9:00pm

PRETEST WATER LEVEL: Oct.1/81 262'31GPM.

AVG. TEST RATE :

CASING ABOVE GROUND:

PUMPING INTERVAL :

TOTAL WELL DEPTH :

TIME SINCE PUMP STARTED (MINUTES) Desired	actual	DEPTH TO WATER	DRAW DOWN	FLOW IGPM	TEMP	TIME SINCE PUMP STOPPED (MINUTES)		REMARKS
64	10:00pm	288'3"	26'3"					
120	11:02	289'	27'					
240	1:03 am	290'5"	28'5"					
480	5:03	293'7"	31'7"					
760	9:43	297'4"	35'4"					
1000	1:44 pm	300'4"	38'4"					
1240	5:40	------	------					
1440	9:40							

Desired	Actual							
150pm	11:38 PM	298'	-3'3"				Time Test Restarted	
190am	12:17	298'2"	-3'3"				9:05PM Oct. 4/81	
240	1:07	298'7"	-2'8"				25G.P.M. Pretest	
300	2:08	299'1"	-2'2"				water level 301'3"	
380	3:27	299'9"	-1'6"				@ Time 7:45pm	
480	5:07	300'6"	-9"					
600	7:08	301'6"	3"					
760	9:48am	302'10"	1'7"					
1000	1:50pm	304'9"	3'6"					
1240	5:48	306'8"	5'5"					
1440	9:47	308'7"	7'4"					
1680	1:47am DTW	past end	of tape	Oct 6/81				
1920	5:48							
2160	9:47							
2400	1:48							
2640	5:48							
2880	9:49							
3120	1:50am	Oct. 7/81						
3360	5:49am							

Midnight Sun Drilling Co. Ltd.

DATE

PAGE NO

PROJECT AQUIFER TEST

LOCATION: Cyprus Anvil Mining Corporation

TIME TEST STARTED:

PRETEST WATER LEVEL:

AVG. TEST RATE :

CASING ABOVE GROUND:

PUMPING INTERVAL :

TOTAL WELL DEPTH :

TIME SINCE PUMP STARTED (MINUTES) Desired	Actual	DEPTH TO WATER	DRAW DOWN	FLOW IGPM	TEMP	TIME SINCE PUMP STOPPED (MINUTES)		REMARKS
3840	1:45pm	DTW past end of tape						
4080	5:45							
4320	9:45							
4560	1:45am							
4800	5:45							
5040	9:45am							

Midnight Sun Drilling Co. Ltd.

DATE Oct. 3 and 4

PAGE NO

PROJECT AQUIFER TEST
LOCATION : Cyprus Anvil Mining Corporation

TIME TEST STARTED: 9PM
PRETEST WATER LEVEL: 99:25M -- 9pm
AVG. TEST RATE : 30GPM
CASING ABOVE GROUND:
PUMPING INTERVAL :
TOTAL WELL DEPTH : 500ft.

TIME SINCE PUMP STARTED (MINUTES)		DEPTH TO WATER	DRAW DOWN	FLOW IGPM	GALS.	TIME SINCE PUMP STOPPED (MINUTES)		REMARKS
1	9:01 am	114.34	15.09			1		pretest water
2	9:02	117.31	18.12	35		2		level was 89.64M
3	9:03	118.53	19.28	34		3		
4	9:04	119.28	20.03	32		4		
6	9:06	119.46	20.21	30		6		
						8		
8	9:08	119.72	20.47	31		10		
10	9:10	120.09	20.84	31		13		
13	9:13	120.81	21.56	31		16		
16	9:16	121.53	22.28	31		20		
20	9:20	122.57	23.32	31		25		
25	9:25	123.20	23.95	30	729	32		
32	9:32	123.99	24.74	31	942	40		
40	9:40	125.18	25.93	31	1190	50		
50	9:50	125.58	26.33	31	1497	64		
64	10:04	126.32	27.07	31	1927	80		
80	10:20	126.75	27.50	31	2416	100		
100	10:40	127.20	27.95	31	3024	120		
120	11:00	127.51	28.26	31	3629	150		
150	11:30	128.25	29.00	31	4544	190		
190	12:10 am	128.76	29.51	31	5764	240		
240	1:00	129.40	30.15	31	7296	300		
300	2:00	129.62	30.37	31	9125	380		
380	3:20	130.29	31.04	31	11571	480		30.45 Avg. GPM
480	5:00	130.65	31.40	31	14637	600		30.49 " "
600	7:00	130.93	31.68	31	18307	760		30.51 " "
760	9:40	131.21	31.96	31	23116	1000		30.42 " "
1000	1:40 pm	132.06	32.81	31	30570	1240		30.57 " "
1240						1440		
1440								

B19

Midnight Sun Drilling Co. Ltd.

MIDNIGHT SUN DRILLING CO. LTD — WHITEHORSE Y.T

DATE

PAGE NO

Recovery

PROJECT AQUIFER TEST

LOCATION: Cyprus Anvil Mining Corporation

TIME TEST STARTED:

PRETEST WATER LEVEL:

AVG. TEST RATE :

CASING ABOVE GROUND:

PUMPING INTERVAL :

TOTAL WELL DEPTH :

TIME SINCE PUMP STARTED (MINUTES)	DEPTH TO WATER	DRAW DOWN	FLOW IGPM	TEMP	TIME SINCE PUMP STOPPED (MINUTES)	REMARKS
5:00	116.34					
5:01 d	114.96					
5:02	108.51					
5:03	107.06					Pump stopped sc
5:04	106.75					I started
5:06	106.51					recovery at
5:08	106.04					5:00 pm Oct.3
5:10	105.47					G. Lynch
5:13	105.03					Checked gen-
5:16	104.64					erator every-
5:20	104.12					thing ok. Powe
5:25	103.73					going to pump
5:32	103.32					but for some
5:40	102.70					reason not
5:50	102.12					pumping. Lynch
6:04	101.50					Found problem
6:20	100.82					water truck
6:40	100.28					running over
7:00	99.72					hose caused
7:30	99.11					galvenized pip
8:10	98.37					to slide back
9:00						and kink rubbe
						hose. Lynch
						Started new
						pump test at
						9:00 pm

B20

Midnight Sun Drilling Co. Ltd.

DATE Oct. 3/81

PAGE NO 2

PROJECT AQUIFER TEST 3201 Standpipe

LOCATION: Cyprus Anvil Mining Corporation

TIME TEST STARTED: 9pm

PRETEST WATER LEVEL: 31GPM--82'

AVG. TEST RATE :

CASING ABOVE GROUND:

PUMPING INTERVAL :

TOTAL WELL DEPTH :

TIME SINCE PUMP STARTED (MINUTES) Desired	Actual	DEPTH TO WATER	DRAW DOWN	FLOW IGPM	TEMP	TIME SINCE PUMP STOPPED (MINUTES)	REMARKS Oct. 1/81
64	10:02 PM	89'4"	7'4"				
120	11:05	89'4"	7'4"				
240	1:05	89'5"	7'5"				
480	5:04	89'6"	7'6"				
760	9:47	90'1"	8'1"				
1000	1:48	90'1"	8'1"		Time 7:48	DTW 90'1"	
1240	5:40						
1440	9:40						
Restart	Oct.4/81						Time restart
Desired	Actual						9:05pm Oct.4/8
150	11:40 PM	90'1"	0				25 G.P.M.
190	12:19	90'1"	0				Pretest water
240	1:08	90'1"	0				level 90'1"
300	2:10	90'1"	0				
380	3:28	90'	-1"				
480	5:08	89'8"	-5"				
600	7:09	89'3"	-10"				
760	9:50 am	89'4"	-9"				
1000	1:55	89'4"	-9"				
1240	5:55	89'	-1'1"				
1440	9:49=	88'2"	-1'11"				
1680	1:48	87'8"	-2'5"				
1920	5:47	87'1"	-3'				
2160	9:48	86'10"	-3'3"				
2400	1:48	86'5"	-3'8"				
2640	5:48	86'3"	-3'10"				
2880	9:47	86'1"	-4'				
3120	1:48am	86'1"	-4'				
3360	5:47	86'4"	-3'9"				

B21

Midnight Sun Drilling Co. Ltd.

DATE Oct. 4/81

PAGE NO 2

PROJECT AQUIFER TEST

LOCATION: Cyprus Anvil Mining Corporation

TIME TEST STARTED: PRETEST WATER LEVEL:

AVG. TEST RATE : CASING ABOVE GROUND:

PUMPING INTERVAL : TOTAL WELL DEPTH :

TIME SINCE PUMP STARTED (MINUTES) Desired	Actual	DEPTH TO WATER	DRAW DOWN	FLOW IGPM	TEMP	TIME SINCE PUMP STOPPED (MINUTES)	REMARKS
3600	9:47	86'4"	-3 '9"				
3840	1:48	86'4"	-3'9"				
4080	5:47	86'4"	-3'9"				
4320	9:47	86'5"	3'8"				
4560	1:48am	86'5"	3'8"				
4800	5:45	86'6"	3'7"				
5040	9:48	86'9"	3'4"				
280	1:48pm	87'1"	-3'				
5520	5:48	87'3"	-2'10"				
5760	9:47	87'5"	-2'8"				
6000	1:47	87'7"	-2'6"				
6240	5:47	87'9"	-2'4"				
6415	8:00	87'10"	-2'3"				

B22

Midnight Sun Drilling Co. Ltd.

DATE

PAGE NO

PROJECT AQUIFER TEST Recovery Oct. 9/81

LOCATION: Cyprus Anvil Mining Corporation

TIME ~~TEST~~ Recovery STARTED: 8:00am

PRETEST WATER LEVEL:

AVG. TEST RATE :

CASING ABOVE GROUND:

PUMPING INTERVAL :

TOTAL WELL DEPTH :

TIME SINCE PUMP STARTED (MINUTES)		DEPTH TO WATER	DRAW DOWN	FLOW IGPM	TEMP	TIME SINCE PUMP STOPPED (MINUTES)		REMARKS
8:00am		87'10"						
9:00		87'11"						
10		88'1"						
11:00		89'5"						
12:45 pm		88'3"						
1:45		88'3"						
2:45		88'4"						

B23

Midnight Sun Drilling Co. Ltd.

DATE Oct. 4 and 5

PAGE NO

PROJECT AQUIFER TEST
LOCATION : Cyprus Anvil Mining Corporation

TIME TEST STARTED: 9:05pm
PRETEST WATER LEVEL: 96.10M
AVG. TEST RATE : 25 G.P.M.
CASING ABOVE GROUND:
PUMPING INTERVAL :
TOTAL WELL DEPTH : 500ft.

TIME SINCE PUMP STARTED (MINUTES)		DEPTH TO WATER	DRAW DOWN	FLOW IGPM	Gals.	TIME SINCE PUMP STOPPED (MINUTES)		REMARKS
1	9:06	112.20	16.10	45		1		Got pump going
2	9:07	112.90	16.80	25		2		started pump test
3	9:08	112.63	16.53	24		3		at 9:05 Oct. 4/81
4	9:09	112.48	16.38	23		4		G. Lynch
6	9:11	112.78	16.68	25		6		
8	9:13	113.64	17.54	26		8		
						10		
10	9:15	114.80	18.70	26		13		
13	9:18	115.91	19.81	25	295	16		
16	9:21	115.72	19.62	25	387	20		
20	9:25	116.14	20.14	25	481	25		
25	9:30	116.58	20.58	25	604	32		
32	9:37	116.97	20.87	25	714	40		
40	9:45	117.37	21.27	25	964	50		
50	9:55	118.36	22.26	25	1210	64		
64	10:09	119.72	23.62	26	1565	80		
80	10:25	120.07	23.97	26	1916	100		
100	10:45	119.85	23.75	24	2480	120		
120	11:05	120.08	23.98	25	2973	150		
150	11:35	120.61	24.51	25	3724	190		
190	12:15 am	120.99	24.89	25	4720	240		
240	1:05	121.32	25.22	25	5960	300		At 1:47pm some
300	2:05	121.47	25.37	25	7453	380		problem with
380	3:25	121.64	25.54	25	9433	480		water truck but
480	5:05	122.07	25.97	25	11939	600		only hose disconne
600	7:05	122.35	26.25	25	14948	760		-cted line restored
760	9:45	122.60	26.50	25	18962	1000		Pump test still
1000	1:45 pm	123.08	26.98	25	24987	1240		going alright.
1240	5:45	122.82	26.72	24	30895	1440		G. Lynch
1440	9:45	123.32	27.22	25	36929			

DATE Oct 6+7

Midnight Sun Drilling Co. Ltd.

PAGE NO

PROJECT AQUIFER TEST
LOCATION: Cyprus Anvil Mining Corporation

TIME TEST STARTED: 9:05 p.m. PRETEST WATER LEVEL: 96.10 m
AVG. TEST RATE : 25.4 P.M. CASING ABOVE GROUND:
PUMPING INTERVAL : TOTAL WELL DEPTH : 500

TIME SINCE PUMP STARTED	(MINUTES)	DEPTH TO WATER	DRAW DOWN	FLOW IGPM	~~TEMP~~ Gals.	TIME SINCE PUMP STOPPED	(MINUTES)	REMARKS Avg. GPM
1680	1:45 am	123.19	27.09	25	42965			25.15
1920	5:45	123.26	27.16	25	48980			25.06
2160	9:45	123.01	26.91	25	54966			25.45
2400	1:45 pm	123.24	27.14=	25	60810			25.34
2640	5:45	123.71	27.61	25	66830			25.32
2880	9:45	123.58	27.48	25	72800			24.87
3120	1:45	124.04	27.94	25	78812			25.05
3360	5:45	124.38	28.28	26	84905			25.38
3600	9:45	124.39	28.29	26	91004			25.28
3840	1:45	124.39	28.29	26	97046			25.27
4080	5:45	124.39	28.29	25	103044			25.26
4320	9:45	124.76	28.66	25	109109			25.27
4560	1:45 am	124.89	28.79	25	115182			25.30
4800	5:45	124.98	28.88	25	121257			25.31
5040	9:45	125.03	28.93	25	127330			25.26
5280	1:45 pm	125.23	29.13	25	133314			25.25
5520	5:45	125.33	29.23=	25	139960			25.36
5760	9:45	125.34	29.24	25	145536			23.23
6000	1:45	125.38	29.28	25	151595			25.24
6240	5:45	125.48	29.38	25	157625			25.12
6415	8:00	125.50	29.40	25	161058			25.11

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Midnight Sun Drilling Co. Ltd.

DATE ____________

RECOVERY

PAGE NO ____________

PROJECT AQUIFER TEST

LOCATION: Cyprus Anvil Mining Corporation

TIME TEST STARTED:

PRETEST WATER LEVEL:

AVG. TEST RATE :

CASING ABOVE GROUND:

PUMPING INTERVAL :

TOTAL WELL DEPTH :

TIME SINCE PUMP STARTED	(MINUTES)	DEPTH TO WATER	DRAW DOWN	FLOW IGPM	TEMP	TIME SINCE PUMP STOPPED (MINUTES)	t/t'	REMARKS
6415	8:00	116.91	0			0		
6416	8:01	108.78	8.13			1	6416	
6417	8:02	104.79	12.12			2	3209	
6418	8:03	103.71	13.20			3	2139	
6419	8:04	102.99	13.92			4	1605	
6421	8:06	104.76	12.15			6	1070	
6423	8:08	105.93	10.98			8	803	
6425	8:10	106.09	10.82			10	643	
6428	8:13	105.88	11.03			13	494	
6431	8:16	105.56	11.35			16	402	
6435	8:20	105.10	11.81			20	322	
6440	8:25	104.63	12.28			25	258	
6447	8:32	104.03	12.88			32	201	
6455	8:40	103.46	13.45			40	161	
6465	8:50	102.90	14.01			50	129	
6479	9:04	102.29	14.62			64	101	
6495	9:20	101.69	15.22			80	81	
6515	9:40	101.10	15.81			100	65	
6535	10:00	100.61	16.30			120	54	
6565	10;30	100.19	16.72			150	44	
6605	11:10	99.37	17.54			190	35	
6645	11:50	98.85	18.06			230	29	
6755	1:00 pm	89.14	27.77			300	23	
6835	2:20	87.43	29.48			380	18	

DATE ______

Midnight Sun Drilling Co. Ltd.

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PROJECT AQUIFER TEST

LOCATION: Standpipe 3201 TECHNICIAN:

CASING HEIGHT ABOVE GROUND: M | PUMPING INTERVAL: MIN.

TOTAL WELL DEPTH: M | TIME TEST STARTED:

PRETEST WATER LEVEL, 14 ft.: M | AVERAGE TEST RATE:

TIME SINCE PUMP START (MINUTES)			DEPTH TO WATER	DRAW DOWN	FLOW	TEMP.	TIME SINCE PUMP STOP (MINUTES)		REMARKS
DESIRED	ACTUAL	TIME.	(M)	(M)	(IGPM)		TIME	DTW(M)	
.5	160	9:40pm	14'6"	6"					Sept. 21
1	190	10:10	14'6"	6"					
2	245	11:05	14'6"	6"					
3	306	12:06am	14'7"	7"					Sept. 22
4	383	1:23	14'7"	7"					
6	485	3:05	14'7"	7"					
8	603	5:03	14'7"	7"					
10	765	7:45	14'7"	7"					
13	1005	11:45	14'7"	7"					
16	1250	3:50	14'7"	7"					
20	1442	7:02	14'7"	7"					
25	1688	11:08	14'7"	7"					
32	1923	3:03	14'7"	7"					Sept. 23
40	2167	7:07	14'7"	7"					
50	2403	11:03	14'7"	7"					
64	2650	3:10am	14'7"	7"					
80	2882	7:02	14'7"	7"					
100	3129	7:09	14'7"	7"					
120	3363	3:03	14'7"	7"					Sept. 24
150	3609	7:09	14'7"	7"					
190	3845	11:05	15'	1"					
240	4090	3:10	18'6"	4'6"					
300	4323	7:03	19'	5'					
380	4567	11:07	15'2"	1'2"					
480	4803	3:03	16'	2'					
600	5046	7:06	15'10"	1'10"					Sept. 25
760	5283	11:03	16	2'					
1000									
1240									
1440									

Appendix C

APPENDIX C

DRILLING AND TESTING COSTS

DRILLING AND TESTING COSTS

The actual costs for the well drilling and pump testing are detailed below:

		Cost $
Drilling:		
Mobilization - Demobilization		$ 2,280.00
Drilling: 6" Ø holes @ $15.50/ft. (1,150 ft.)		17,825.00
5 1/2" Ø holes @ $12.85/ft. (1,145 ft.)		14,713.25
Unscheduled Rig Time @ $220/hr. (21 hrs.)		4,620.00
Crew Time @ $35/man/hr.		1,610.00
Supplies: Drive Shoe @ $52.45 x 5		262.25
Sample Bags @ $3.50 x 44		154.00
0.188 Wall Casing @ $7.70/ft. (99 ft.)		762.30
0.280 Wall Casing @ $9.75/ft. (12.5 ft.)		121.88
1" PVC Pipe @ $0.79/ft. (30 ft.)		23.70
1" P x MIP @ $0.90 x 3		2.70
1" P x FIP @ $0.87 x 3		2.61
	Total	$ 42,377.69
Pump Testing:		
Pump Testing @ $85/hr. (179.75 hrs.)		$ 15,278.75
@ $60/hr. (297.5 hrs.)		17,850.00
Generator @ $200/day running (16 days)		3,200.00
@ $100/day standby (9 days)		900.00
3/4 Ton Pickup Truck @ $60/day (38 days)		2,280.00
Flow Meter and Totalizer @ $300/test (4 tests)		1,200.00
Submersible Pump @ $350/test (4 tests)		1,400.00
Crew Travel @ $35/man/hr. (32 hrs.)		1,120.00
Mobilization and Demobilization		1,365.00
Supplies		1,650.05
Credit for Abandoned Test		(7,080.00)
	Total	$ 39,163.80
TOTAL COST FOR DRILLING AND PUMP TESTING		$ 81,541.49

Attached is Midnight Sun Drilling Co.'s quotation for drilling the dewatering holes at Cyprus Anvil in 1981.

MIDNIGHT SUN DRILLING CO. LTD.
WHITEHORSE Y.T.

PHONE (403) 633-3070

P.O. BOX 4391
WHITEHORSE, YUKON
Y1A 3T5

Aug. 11/81

Cyprus Anvil Mining Corporation
Box 1000
Faro, Y.T.

Att: Randy Lopaschuk

Subject: Quotation for drilling de-watering holes at Cyprus Anvil pit.

Dear Sir:

This quotation will be similar to our quotation of May15, 1980 to Mobile Augers and Research Ltd. Some of the hourly unit costs have increased substantially since that time. Since our last quote we have purchased a new 1981 Schramm with 600 C.F.M. of air at 300 P.S.I. which should give us faster penetration and ability to go deeper.

This quotation will be effective unitl Oct. 15, 1981. Please find enclosed our unit cost and proposed list of equipment.

Mobilization--de-mobilization: (for Drilling)

-lump sum --------------- $2,289.00

Drilling:

-rock-Based on 500 holes

-drilling 6" Ø hole in rock with down-hole hammer up to 500'/hole @ $15.50/ft.

-drilling 5½" Ø hole in rock with down-hole hammer up to 500' /hole @ $12.85/ft.

..2/

MIDNIGHT SUN DRILLING CO. LTD.
WHITEHORSE Y.T.

PHONE (403) 633-3070

P.O. BOX 4391
WHITEHORSE, YUKON
Y1A 3T5

Aug. 11/81

Unschedualed Rig Time:

-moving from guard house to site setting-up developing, moving from site to site from mast down to mast up and moving back to guard house estimated 5 hrs./ hole @ $220.00/hr.

Crew Travel:

-from camp to rig and return @ $35.00/hr./man 2 men

Room and Board:

-charged at cost or supplied by Cyprus-Anvil

List Of Equipment:

-1981 Schramm T66H with Hawk casing hammer and 600 C.F.M. of on board air mounted on a 1981 G.M.C. tandem

-Hiab crane and 20' flat deck mounted on a 1980 G.M.C. tandem

-25' "A" frame and 20' flat deck mounted on a 1976 Ford

-30 K.W. light plant

-10 H.P. submersible pump

..3/

PHONE (403) 633-3070

P.O. BOX 4391
WHITEHORSE, YUKON
Y1A 3T5

Aug. 11/81

Mobilization and de-mobilization:(for Aquifer Testing)

-lump sum ---------------- $1,365.00

Aquifer Testing:

-travel from gate to site,
setting-up installing equipment
performing step-draw-down, performing aquifer test,
recover, dismantling equipment and moving-off @ $85.00/hr.
estimated 45 hrs./test

Note: based on 1000 min pumping 1000 min. recovery using a 10 h.p. submersible pump rated at 40 I.G.P.M. from 500'

Rentals:

-10 H.P. submersible/test ------------	$350.00
-30 K.W. light plant running/day -------	$200.00
-30 K.W. light plant stand-by/day ------	$100.00
-digital flow meter and totalizer/test -	$300.00

Room and Board:

-charged at cost or supplied by
Cyprus Anvil

Contingencies:

-freight at cost + 10%
-any supply trips @ $1.50/mile

Yours truly;

David Jamieson

DJ/rj

Appendix D

APPENDIX D

PHOTOGRAPHS

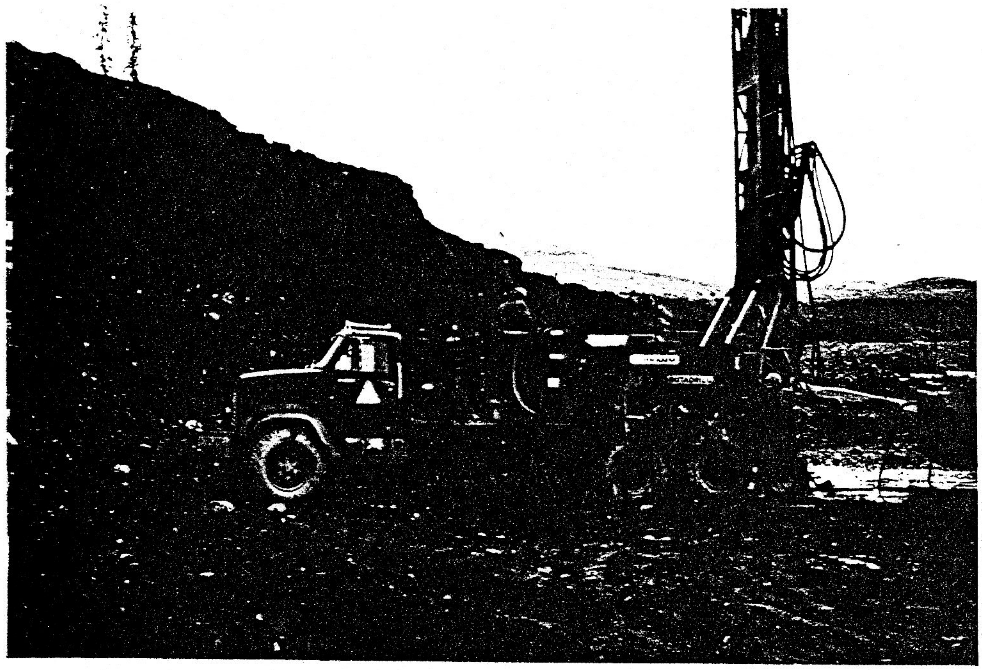


FIGURE 4

1981 SCHRAMM T66H DRILL RIG

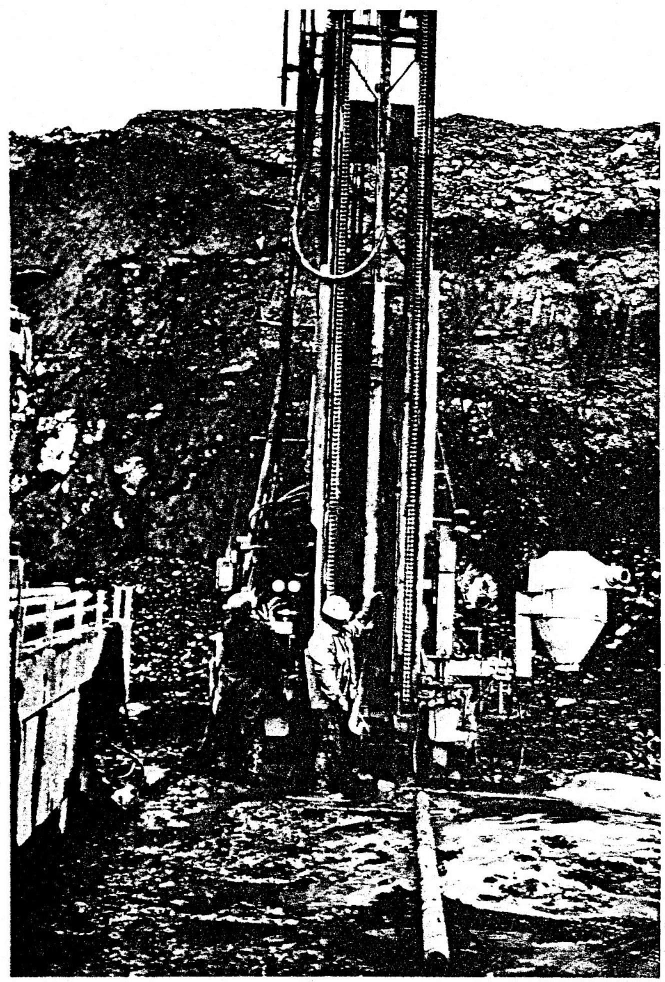


FIGURE 5

ADDING 6" DIAMETER DRILL STEEL

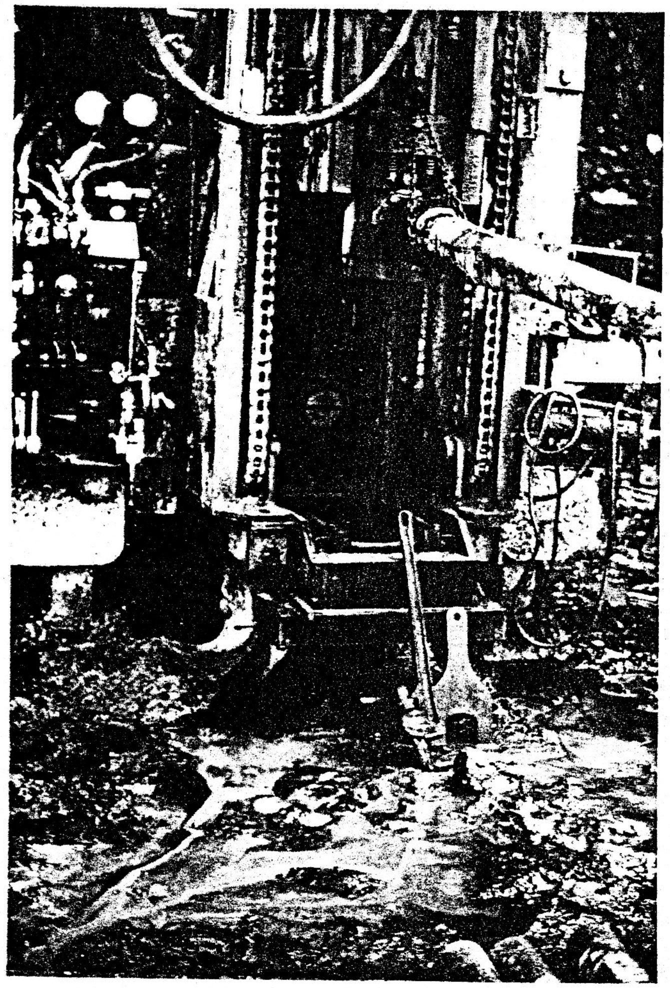


FIGURE 6

CLOSE-UP OF HAWK CASING HAMMER AND TOP DRIVE HEAD

The author

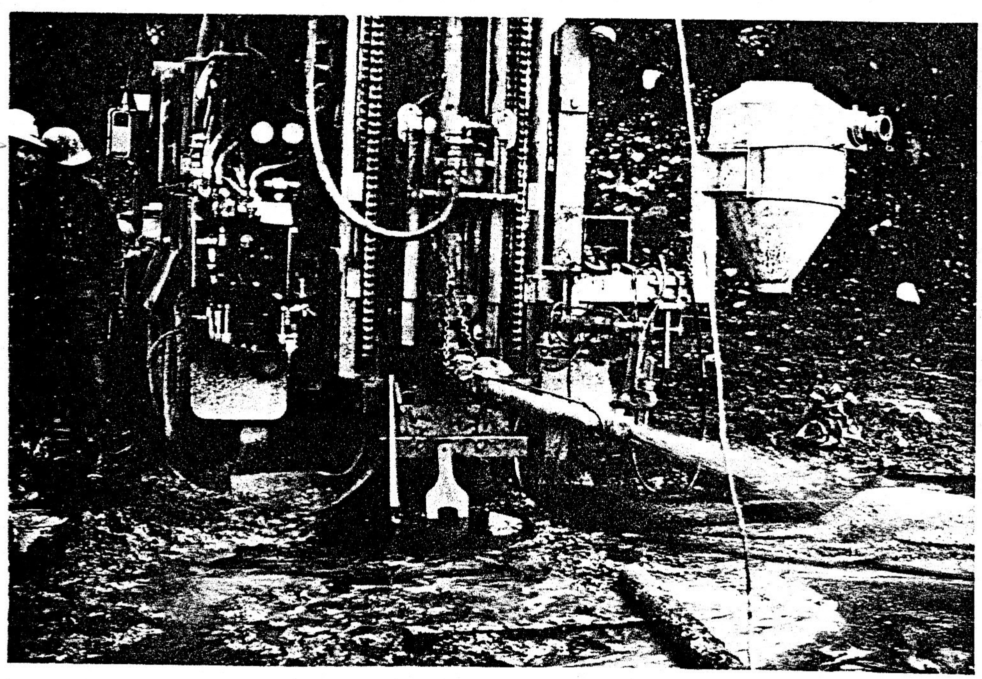
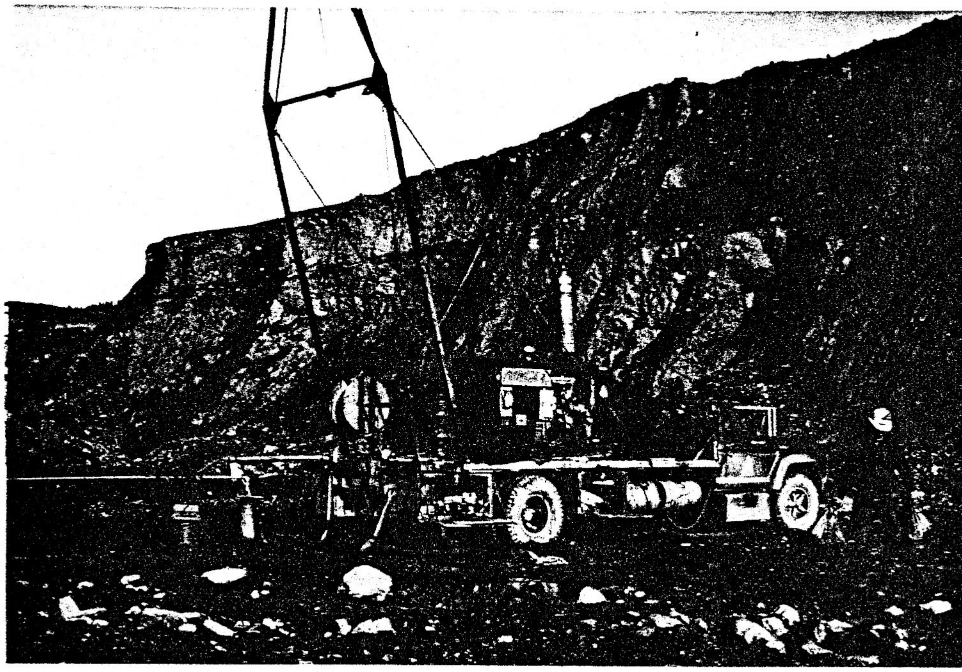


FIGURE 7

ROTARY DRILLING IN PROGRESS



The author again.

FIGURE 8

25 FOOT "A" FRAME FOR PUMP INSTALLATIONS

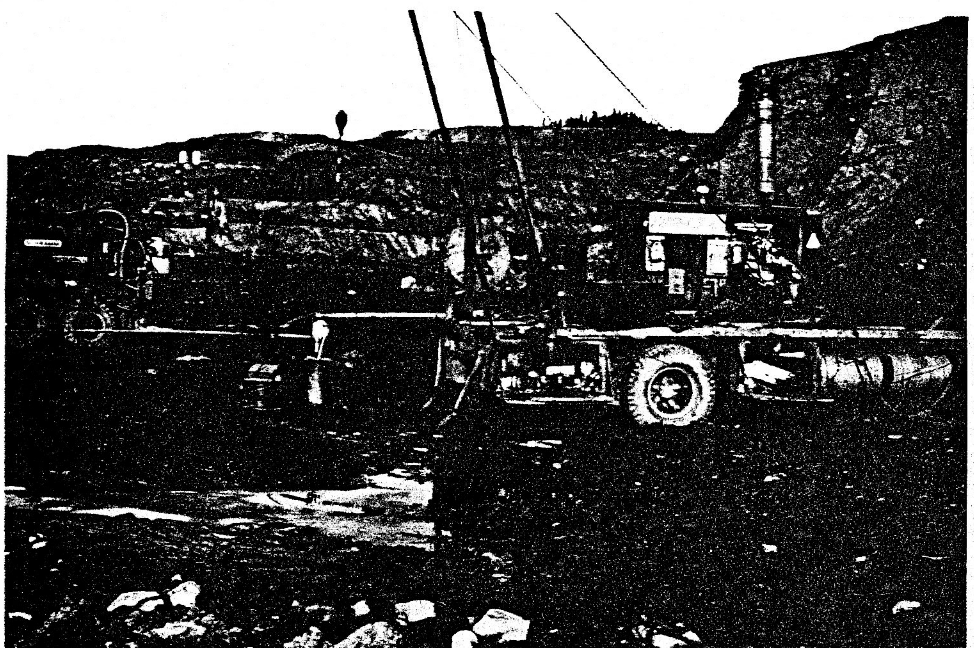


FIGURE 9

PUMP TRUCK AND GENERATOR