CAMP DRESSER & McKEE INC.

MEMORANDUM

TO: Jeff Saunders

FROM: Gordon McCurry

PROJECT: South Cavalcade RI/FS CDM # 143-TS1-Admin

SUBJECT: Shallow Zone pump test analysis

DATE: 7-26-88

Enclosed please find calculations for preliminary values of transmissivity, storage coefficient and hydraulic conductivity for the shallow zone aquifer at the South Cavalcade site. I've also included copies of my time vs drawdown and distance vs drawdown plots so you could see better how the aquifer responded.

The pump test ran at too high a rate for the spacing of observation wells present. After taking into account well bore storage effects and an apparent increase in the discharge rate at $t \approx 80$ minutes, a rather limited dataset was available for analysis. The constraint of keeping $u \leq 0.05$ for the Jacob straight line method further decreased the useable dataset.

Nevertheless, the aquifer values that were derived from this analysis (see section 8, page 4 of calculations) are as follows:

$T \approx 750$ gpd/ft

$S \approx 0.002$ to 0.003

$K \approx 88.2$ gpd/ft^2 ≈ 0.004 cm/sec ≈ 12 ft/day

Please give me a call if you would like to discuss these analyses. Have fun in Pittsburgh!

1012370

006394

006394

PROJECT P[redacted] test | JOB NO. 143 | COMPUTED BY SM
DETAIL m[redacted] calculations | DATE CHECKED [redacted] | DATE 7-26-88
CHECKED BY | PAGE NO 1

(A) WELL BORE & CASING STORAGE CALCS for KER-1 (pump well)

1. INPUTS

1 cubic ft = 7.48 gallons
Area = πr^2
Well diameter = 4 inch ; radius = 2 inch = 0.167 ft = r_c
well bore diameter ≈ 12 inch ; radius = 6 inch = 0.50 ft = r_b
Saturated thickness ≈ (18' − 9.63) = 8.37 (for KER-1)
≈ (18' − 9.32) ≈ 8.68 (for KER-2)
≈ (18 − 9.30) ≈ 8.70 (for KER-3)

Effective sat. thickness for pump well = pump intake depth − SWL
≈ 16.71 − 9.63 = 7.08 ft

Q = constant = 1.25 gpm

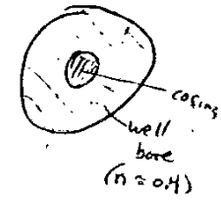
2. Duration of well casing dewatering effects

Casing volume per vertical foot
= $(\pi)(r^2)(1\ ft)(7.48\ gal/ft^3)$
= $(\pi)(0.167)^2(1)(7.48)$ = 0.655 gallons/foot

Volume of H_2O in pump well (down to pump intake level)
= (7.08 ft)(0.655 gal/ft)
= 7.64 gallons

Duration for casing dewatering = volume/pump rate
= 7.64 gal / 1.25 gpm = 3.7 minutes

3 Duration of well bore + casing dewatering effects



Borehole (annulus) volume:
= (borehole area − casing area)(porosity of borehole)(1 ft vertical)(7.48 gal/ft³)
= $(\pi(0.50^2) - \pi(0.167^2))(0.40)(1\ ft)(7.48\ gal/ft^3)$
= (0.785 − 0.088)(0.4)(7.48)
= 2.08 gal/vertical foot in annulus

(2.08 gal/ft)(7.08 ft) = 14.76 gal in annulus

Borehole + casing volume:
= annulus volume + casing volume
= 14.76 gal + 7.64 gal
= 22.4 gal in annulus + casing

Time required to dewater annulus + casing volume
= (annulus + casing volume)/pump rate
= 22.4 gal / 1.25 gpm
≈ 18 minutes to dewater. CONCLUSION: DISREGARD ALL TEST DATA FOR t ≤ 18 min

006395

PROJECT Drawdown – Time
DETAIL T & S calculations
JOB NO. [illegible]
DATE CHECKED [illegible]
CHECKED BY
COMPUTED BY SM
DATE 7-26-84
PAGE NO 2

(B) TRANSMISSIVITY AND STORAGE COEFFICIENT CALCULATIONS

(1.) Basic Equations

$$T = \frac{264\,Q}{\Delta S}$$

For T = transmissivity, in gpd/Ft
Q = pumping rate, in gpm = 1.25
ΔS = drawdown per log cycle, in feet

$$S = \frac{0.3\,T\,t_o}{r^2}$$

For S = storage coefficient (unitless)
T = transmissivity, in gpd/Ft
t_o = time, in days, at zero drawdown
r = distance from pump well, in feet

(2.) Well KER-1 (pump well)

$$T = \frac{(264)(1.25\text{ gpm})}{1.3\text{ Ft}} = 254\text{ gpd/Ft}$$

006396

(3a) Well KER-2

$$T_1 = \frac{(264)(1.25\text{ gpm})}{0.61\text{ Ft}} = 541\text{ gpd/Ft} \quad (767)$$

$$S_1 = \frac{(0.3)(541\,\frac{\text{gpd}}{\text{Ft}})(0.0026\text{ days})}{(8\text{ Ft})^2} = 0.007 \quad (.0016)$$

(3b) Test for validity in applying Jacob straight line method

$$U \overset{?}{\leq} 0.05$$

$$U = \frac{1.87\,r^2 S}{T t} \quad \therefore\ t = \frac{1.87\,r^2 S}{T U}$$

For $U \leq 0.05$, T and S defined above, the KER-2 drawdown-time curve is valid when

$$t \geq \frac{(1.87)(8\text{ Ft})^2(0.007)}{(541\text{ gpd/Ft})(0.05)} = 0.031\text{ days}\left(\frac{24\text{ hr}}{\text{day}}\right)\left(\frac{60\text{ min}}{\text{hr}}\right) = \underline{44.6\text{ minutes}}$$

(3c) using data between 44.6 and 75 minutes:

$$T_2 = \frac{264\,(1.25\text{ gpm})}{(0.43\text{ Ft})} = \underline{767\text{ gpd/Ft}}$$

PROJECT Drawdown-time
DETAIL T & S calculations
JOB NO
DATE CHECKED
CHECKED BY
COMPUTED BY SM
DATE 7-26-88
PAGE NO 3

(3c) continued

$$S_2 = \frac{(0.3)(767\ gpd/ft)(0.00044\ day)}{(8\ ft)^2} = 0.0016 \simeq \underline{\underline{0.002}}$$

(3d) check on T_2, S_2 values

$$t \geq \frac{1.87\ r^2 S}{T\ u} = \frac{1.87\ (8\ ft)^2 (0.002)}{(767\ gpd/ft)(0.05)} = 0.0062\ days = 9\ minutes \checkmark$$

(4a) <u>WELL KER-3</u>

$$T_1 = \frac{264\ (1.25\ gpm)}{0.23\ ft} = 1435\ gpd/ft$$

$$S_1 = \frac{(0.3)(1435\ gpd/ft)(0.0082\ days)}{(34.2\ ft)^2} = 0.003$$

(4b) <u>Test for validity in applying Jacob straight line method</u>

$$u = \frac{1.87\ r^2 S}{T\ t} \overset{?}{\leq} 0.05$$

For $u \leq 0.05$, T and S defined above, the KER-3 drawdown-time curve is valid when

$$t \geq \frac{1.87\ (342\ ft)^2\ (0.003)}{(1435\ gpd/ft)(0.05)} = 0.0915\ days = \underline{\underline{132\ minutes}}$$

conclusion: T and S values in (4a) above <u>not</u> <u>valid</u> by this method

006397

PROJECT Drawdown - Distance DATE CHECKED COMPUTED BY S M
DETAIL T calculations CHECKED BY DATE 7-26-88
PAGE NO 4

(5) Basic Equations

$T = \frac{528\ Q}{\Delta S}$ For T = transmissivity, in gpd/ft
Q = discharge in gpm = 1.25
ΔS = drawdown per log cycle, in feet

$S = \frac{0.3\ T t}{r_0^2}$ For T = transmissivity, in gpd/ft
t = time since pumping started, in days
r_0 = distance intercept at drawdown = 0

(6) Time = 30 minutes

$T_{30} = \frac{(528)(1.25)}{0.73} = \underline{904\ gpd/ft}$

$S_{30} = \frac{(0.3)(904)(0.0208)}{(44)^2} = 0.0029 \simeq \underline{0.003}$

(7) Time = 60 minutes

$T_{60} = \frac{(528)(1.25)}{0.95} = \underline{695\ gpd/ft}$

$S_{60} = \frac{(0.3)(695)(0.0417)}{(50)^2} = 0.0035 \simeq \underline{0.003}$

(8) Summary of Analyses

(a) most likely T value (from (3c) and (7) above) ≃ 750 gpd/ft
(b) most likely S value (from (3c), (6) and (7) above) = 0.002 to 0.003
(c) based on an aquifer saturated thickness of 8.5 feet (from A(1) above)

$T = kb \quad \therefore k = T/b$

$k = \frac{750\ gpd/ft}{8.5\ ft} = \underline{88.2\ gpd/ft^2}$

∴ k = 0.004 cm/sec
= 12 ft/day

006398

K+E SEMI-LOGARITHMIC 4 CYCLES X 70 DIVISIONS KEUFFEL & ESSER CO.

46 6010

Drawdown vs Time

Drawdown (ft) Depth to Water (ft)

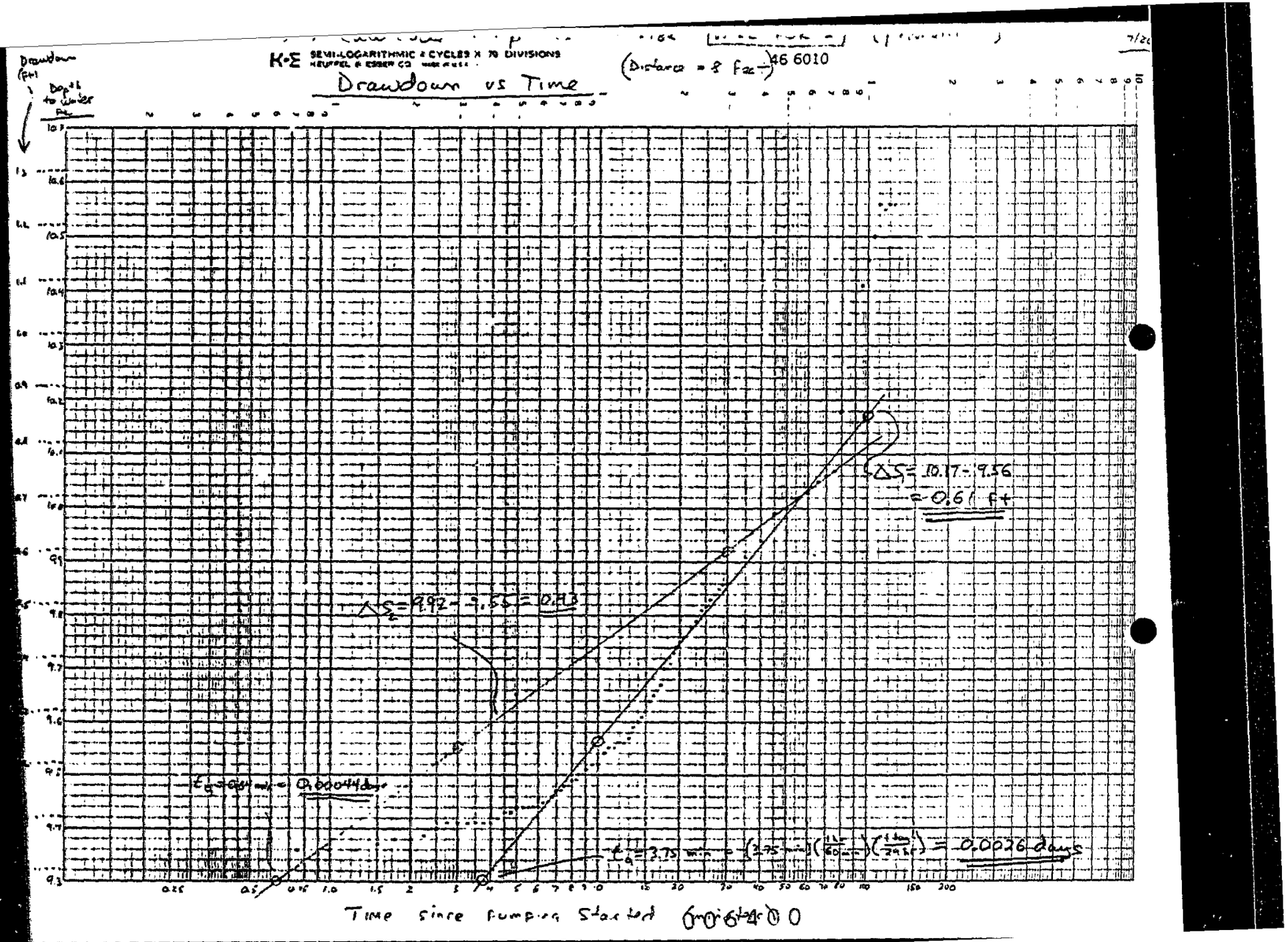
$\Delta S = 13.81 - 11.81$

$= 1.30$ ft

TIME (min)

006399

006399


K+E SEMI-LOGARITHMIC 4 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO.
46 6010
Drawdown vs Time
(Distance = 8 feet)
Drawdown (ft)
Depth to water ft
ΔS = 10.17 - 9.56
= 0.61 ft
ΔS = 9.92 - 9.55 = 0.43
t = 0.00044 days
t = 3.75 min = (3.75 min)(1 hr / 60 min)(1 day / 24 hr) = 0.0026 days
Time since pumping started

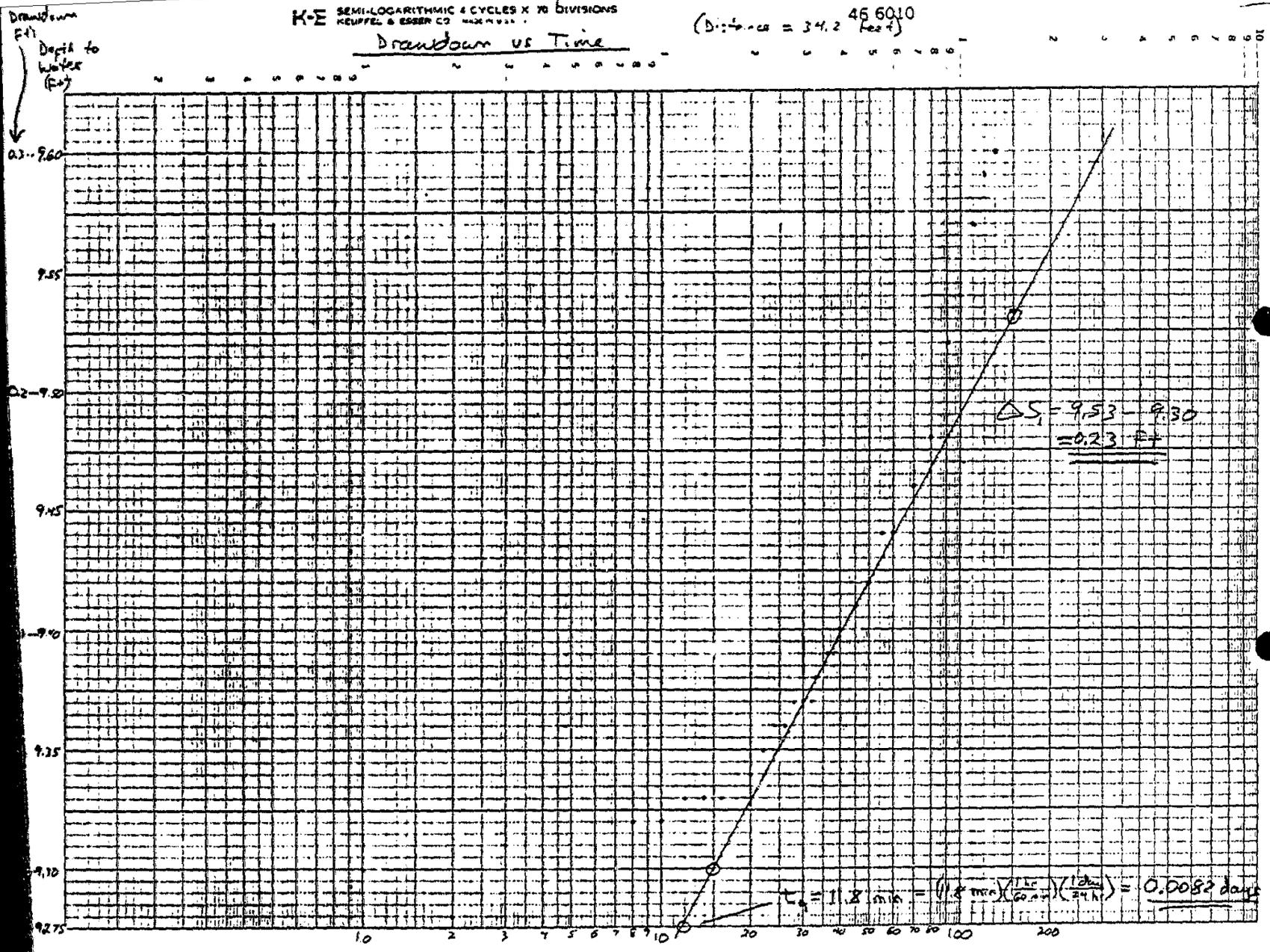
006400

K-E SEMI-LOGARITHMIC 4 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO.

46 6010

(Distance = 34.2 feet)

Drawdown vs Time

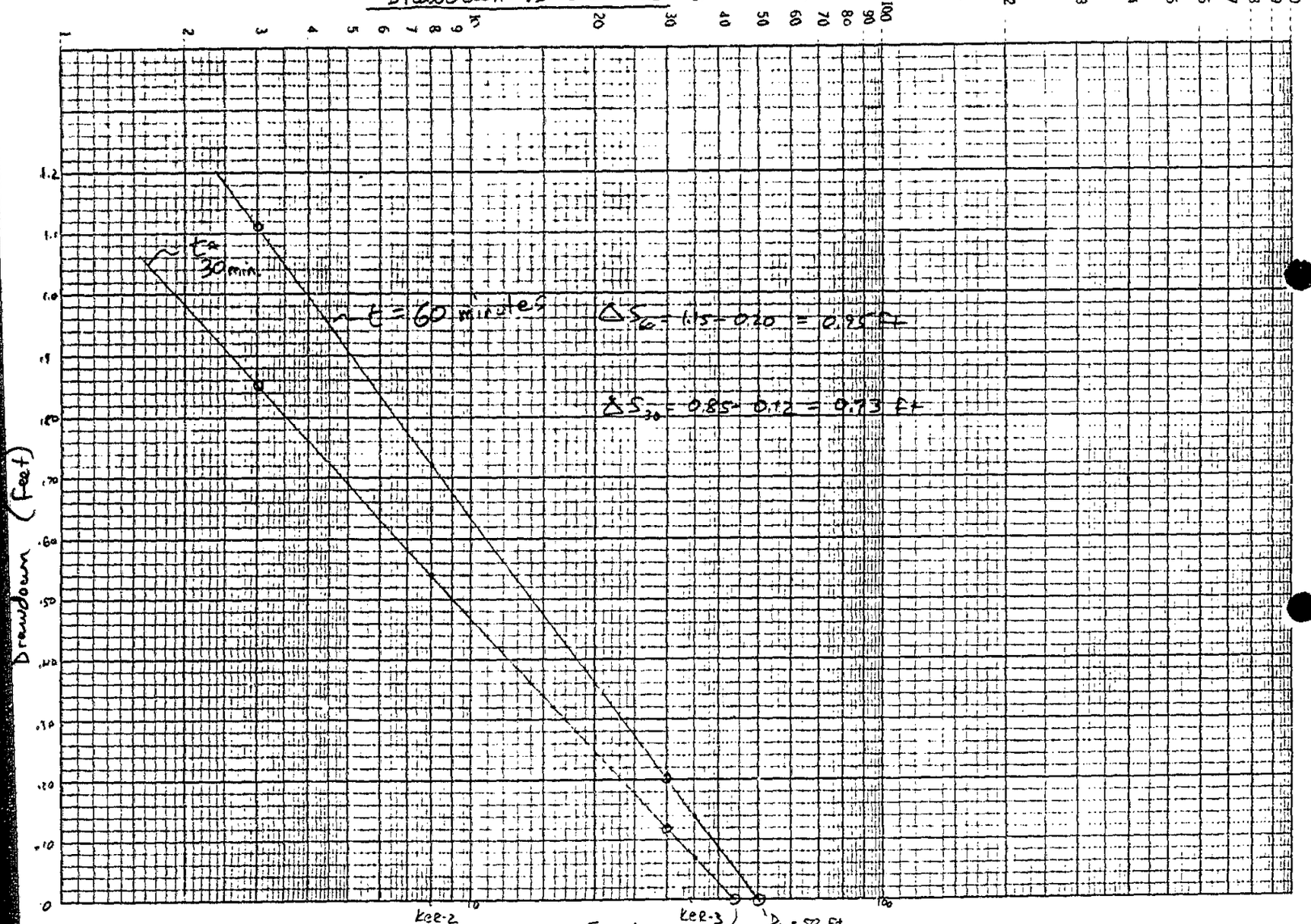


006401

South Cavalcade Pump 1951 - 01/15/88

K·E SEMI-LOGARITHMIC • 3 CYCLES X 70 DIVISIONS KEUFFEL & ESSER CO. MADE IN U.S.A. 46 5490

Drawdown vs Distance (for t=30, t=60 minutes)



006402