DRAINAGE REPORT

BOX CULVERT

at

STATE HIGHWAY 115 &

FISHER CANYON CHANNEL

MASTER

DREXEL, BARRELL & CO.

ENGINEERS — SURVEYORS

1700 38TH STREET BOULDER, COLORADO 80301 (303) 442-4338

DRAINAGE REPORT

BOX CULVERT

at

STATE HIGHWAY 115 &

FISHER CANYON CHANNEL

MASTER

Prepared for

Gates Land Development Co.

Prepared by

Drexel, Barrell & Co.

E-2589

May 25, 1982

CITY OF COLORADO SPRINGS
The "America the Beautiful" City
DEPARTMENT OF PUBLIC WORKS **CITY ENGINEERING DIVISION (303) 578-6606**
30 S. NEVADA SUITE 403 P.O. BOX 1575
COLORADO SPRINGS, COLORADO 80901

July 6, 1982

Barbara N. Weiss
Drexel, Barrell & Co.
1700 38th Street
Boulder, CO 80301

Re: Box Culvert at State Highway 115 & Fisher Canyon Channel

Dear Barbara:

We are in receipt of your drainage report for the referenced project and will file said report subject to the following items:

1. A transition channel is required from the east end of the proposed box culvert to the Cheyenne Meadows Channel. The transition channel must be designed for subcritical flow.

2. The SCS flow quantity given in your previous report must be used to design the capacity of the proposed facilities.

3. This report and the construction design drawings must be approved by the State Highway Department.

The City Engineering Division has no objections to your proceeding with the detailed design drawings subject to the above comments.

Sincerely,

Gary R. Haynes
Assistant City Engineer

for Gerald J. Gromko
City Engineer

GRH/ro

cc: Bob Svejkovsky, Gates Land Company

CERTIFICATIONS

I, Barbara Weiss, a registered engineer in the State of Colorado, hereby certify that the attached drainage plan and report for a box culvert at Fisher Channel at Highway 115, were prepared under my direction and supervision and are correct to the best of my knowledge and belief. I further certify that said drainage report is in accordance with all City of Colorado Springs ordinances, specifications, and criteria to the best of my knowledge.

BARBARA NAN WEISS
REGISTERED
15471
PROFESSIONAL ENGINEER
STATE OF COLORADO

Barbara Weiss

The developer has read and will comply with all of the requirements specified in this drainage report as approved by the City Engineer.

By R F Svejkovsky
Robert F. Svejkovsky
Director of Engineering

DRAINAGE REPORT

BOX CULVERT AT STATE HIGHWAY 115 AND

FISHER CANYON CHANNEL FOR GATES LAND DEVELOPMENT COMPANY

The purpose of this report is to request approval for a proposed box culvert at Fisher Canyon Channel under State Highway 115, Colorado Springs, Colorado. After approval is granted by the City of Colorado Springs, construction plans will be submitted. This report presents the drainage criteria used to design the box culvert.

The 100 year flow in Fisher Canyon Channel at Highway 115 is 1355 cfs. This flow was documented in a report prepared by Drexel, Barrell in August, 1978, (attached). The proposed size for the box culvert is a double 10' x 6' high box which has been approved by the State of Colorado. Please see the attached letter.

An hydraulic analysis was performed to determine the water surface profile thru the culvert. A hand analysis and check with HEC-2 computer program, both utilizing the Standard Step Method, was performed to determine energy losses from the channel section to the box culvert. Because supercritical flow exists the analysis proceeds downstream. Calculations show a double 10' x 6' high box culvert to be adequate. Maximum flow depth is 4'.

Calculations, vicinity map and plan of the culvert and transition follow in the appendix.

Respectfully submitted,

Barbara Weiss

Barbara Weiss

APPENDIX

Description	Exhibit
Drainage Calculations at Star Ranch Road & Highway 115	A
Letter from State	B
Flow analysis	C
Computer analysis	D
Plan of Culvert on topo map	Back Cover

Project	Job No
DRAINAGE - STATE RANCH RD / ST. HWY. 115	E-1986

Client	By	Date
GATES LAND CO.	DH	AUG 78

exhibit A

DRAINAGE CALCULATIONS

STATE RANCH RD
@
STATE HIGHWAY 115

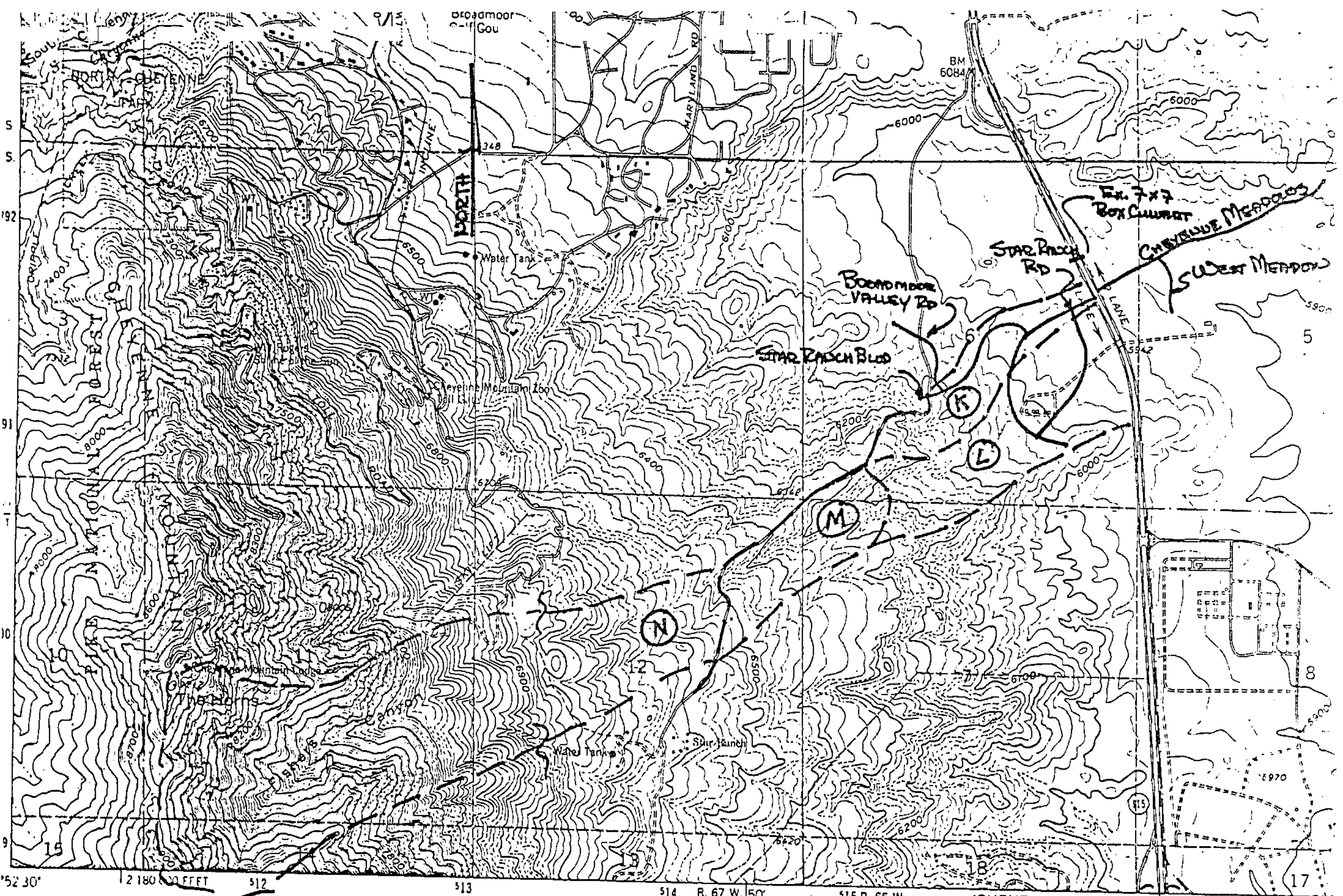
FOR

GATES LAND CO.
AUG 78

DESIGN METHOD:

SCS METHOD, MODIFIED TO COLORADO SPRINGS, STANDARDS

CITY OF COLORADO SPRINGS
"DETERMINATION OF STORM RUNOFF CRITERIA"
MARCH 77



Mapped, edited, and published by the Geological Survey in cooperation with U.S. Corps of Engineers

Control by USGS and USC&GS

Topography by photogrammetric methods from aerial photographs taken 1947 Field checked 1948 Revised from aerial photographs taken 1960 Field checked 1961

Polyconic projection 1927 North American datum

(CHEYENNE MOUNTAIN) 5061 III NE

PENROSE 28 MI
CANON CITY 46 MI

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET

I-1-EF rock outcrop ... 9-40%
X16-F Jar-Tecolote-Gecolote complex 8-16% slopes

APPROX. DRAINAGE BASINS — STAR RANCH RD & ST. HWY. 115

Project: DRAINAGE – STAR RANCH RD / ST. HWY 115 | Job No: E-1986

Client: GATES LAND CO. | By: DH | Date: AUG 78

AREA K – (TRIBUTARY TO STARRANCH ROAD & BOULEVARD)

AREA = 40A

$T_c = \left(\frac{11.9\left(\frac{5300}{5280}\right)^3}{350}\right)^{.385} \times 60 = 16.4 \text{ min.}$

SOIL GROUP = C+ (SCS REGIONAL OFFICE)

CN = 84 (MEDIUM DENSITY HOUSING – 1/4 ACRE)

5 year – 6 hour storm

P = 2.1" ⇒ Q = 0.82"

$q_p = 950$ csm/in.

$q = q_p A Q = (950)\left(\frac{40}{640}\right)(.82) = 48.7$ cfs

100 year – 6 hour storm

P = 3.5" ⇒ Q = 1.94"

$q = (950)\left(\frac{40}{640}\right)(1.94) = 115.2$ cfs

$t_p = 3.16$ hrs ⇒ $t_p = \frac{D}{2} + 0.6t_c = 3.10$ hrs (by Colorado Springs Manual)

$t_b = 8.45$ hrs.

100yr – 6 hr / HISTORIC

CN = 76, P = 3.5" ⇒ Q = 1.36

$q = (950)\left(\frac{40}{640}\right)(1.36) = 80.8$ CFS

$t_p = 3.16$ hr

$t_b = 8.45$ hr

Project: DRAINAGE - STAR RANCH RD / ST. HWY 115 | Job No: E-1986

Client: GATES LAND CO. | By: DH | Date: Aug 78

AREA 1 -

AREA = 178 ACRES

$$T_c = \left(\frac{11.9\left(\frac{5300}{5280}\right)^3}{240}\right)^{.385} \times 60 = 19 \text{ min.}$$

SOIL GROUP = C (SCS REGIONAL OFFICE)

CN = 83 (1/4 acre residential)

5 year - 6 hour storm

P = 2.1" $\Rightarrow$ Q = .76"

$q_p = 900$ csm/in

$q = q_p AQ = 900\left(\frac{178}{640}\right)(.76) = 190$ cfs

100 year - 6 hour storm

P = 3.5" $\Rightarrow$ Q = 1.86"

$q = 465.6$ cfs

$t_p = 3.19$ hrs

$t_b = 8.52$ hrs.

100yr - 6 hr / HISTORIC

CN = 74, P = 3.5" $\Rightarrow$ Q = 1.24

$q = 900\left(\frac{178}{640}\right)(1.24) = 310.4$ cfs

$t_p = 3.19$, $t_b = 8.52$ hr

Project: DRAINAGE - STAR RANCH RD / ST. HWY 115 | Job No: E-1986

Client: GATES LAND CO. | By: DH | Date: AUG 78

AREA M —

AREA = 75.2 A

$T_c = \left(\frac{11.9\left(\frac{3000}{5280}\right)^3}{270}\right)^{.385} \times 60 = 9.4 \text{ min.}$

SOIL GROUP = B (SCS REGIONAL OFFICE)

CN = 75 (1/4 ACRE - RESIDENTIAL)

5 year - 6 hour storm -

P = 2.1" ⇒ Q = 0.43"

$q_p = 1150$ csm/in

$q = q_p A Q = 1150\left(\frac{75.2}{640}\right)(.43) = 58.1$ cfs

100 year - 6 hour storm -

P = 3.5" ⇒ Q = 1.3"

$q = 175.7$ cfs

$t_p = 3.09$ hrs

$t_b = 8.26$ hrs

100yr - 6hr / HISTORIC

CN = 61, P = 3.5" ⇒ Q = 0.59

$q = 1150\left(\frac{75.2}{640}\right)(0.59) = 79.7$ cfs

$T_p = 3.09$ hr $\quad T_b = 8.26$ hr

Project: DRAINAGE – STARZ RANCH RD / ST. HWY 115 | Job No: E-196

Client: GATES LAND CO. | By: DH | Date: AUG 78

AREA N

AREA = 469 A

$T_c = \left(\frac{11.9\left(\frac{11500}{5280}\right)^3}{2550}\right)^{.385} \times 60 = 18.7 \text{ min.}$

SOIL GROUP = B (SCS REGIONAL OFFICE)

CN = 70 (1/4 acre residential & open space)

5 year – 6 hour storm

P = 2.1" ⇒ Q = .28"

$q_p = 905$ csm/in

$q = q_p AQ = (905)\left(\frac{469}{640}\right)(.28) = 185.7$ cfs

100 year – 6 hour storm

P = 3.5" ⇒ Q = 1.01"

$q = 669.8$ cfs

$t_p = 3.19$ hrs.

$t_b = 8.51$

100YR – 6HR / HISTORIC

CN = 61, P = 3.5" Q = 0.59

$q = 905\left(\frac{469}{640}\right)(0.59) = 391.3$ CFS

$t_p = 3.19$ $t_b = 8.51$

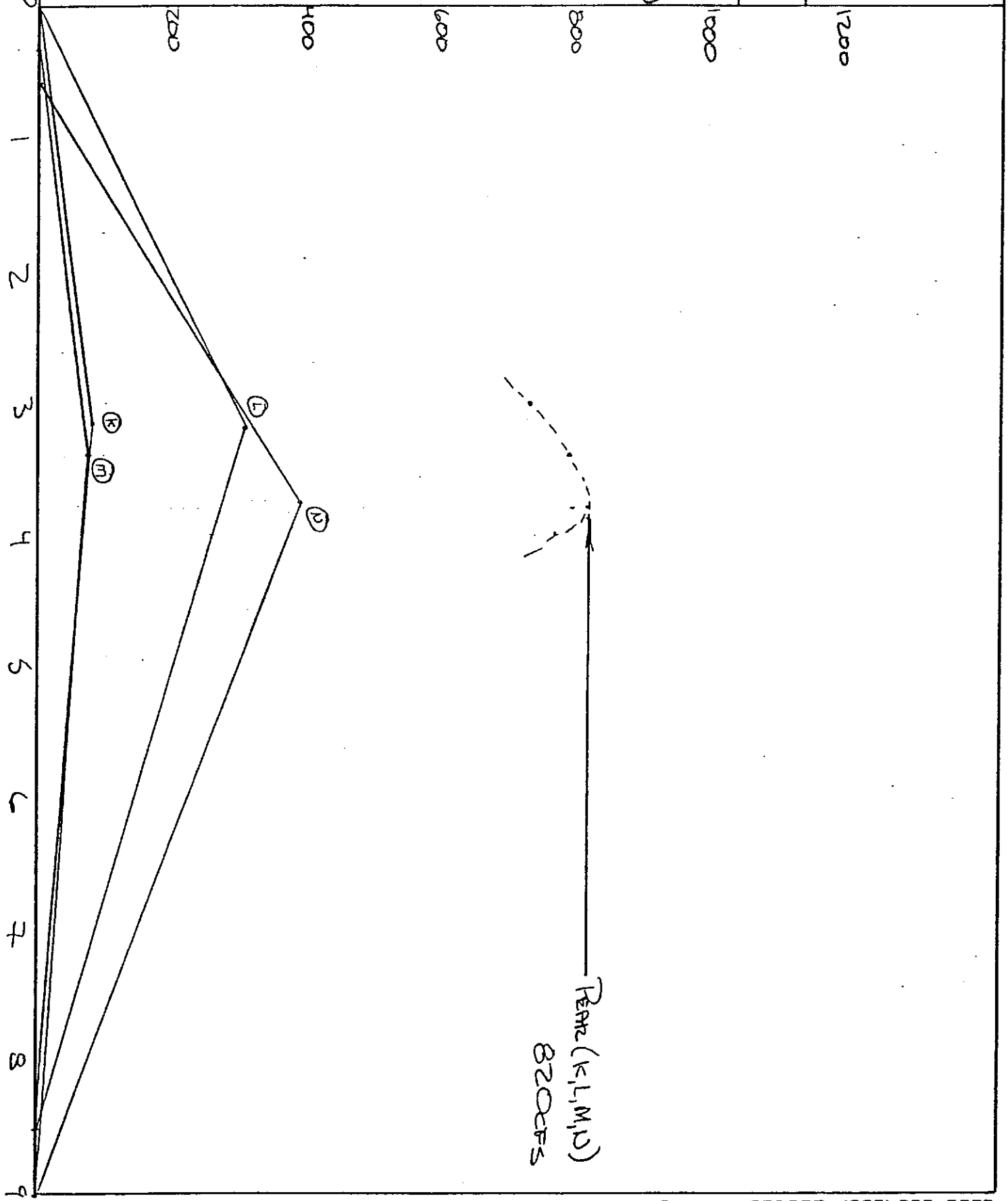
Project: HYDROGRAPHS - 100yr - HISTORIC

Job No: E-1986

Client:

By: DH

Date: Aug 79



1425 PEARL STREET (303) 442-4338
BOULDER, COLORADO 80302

3405 N. EL PASO STREET (303) 633-5029
COLORADO SPRINGS, COLORADO 80907

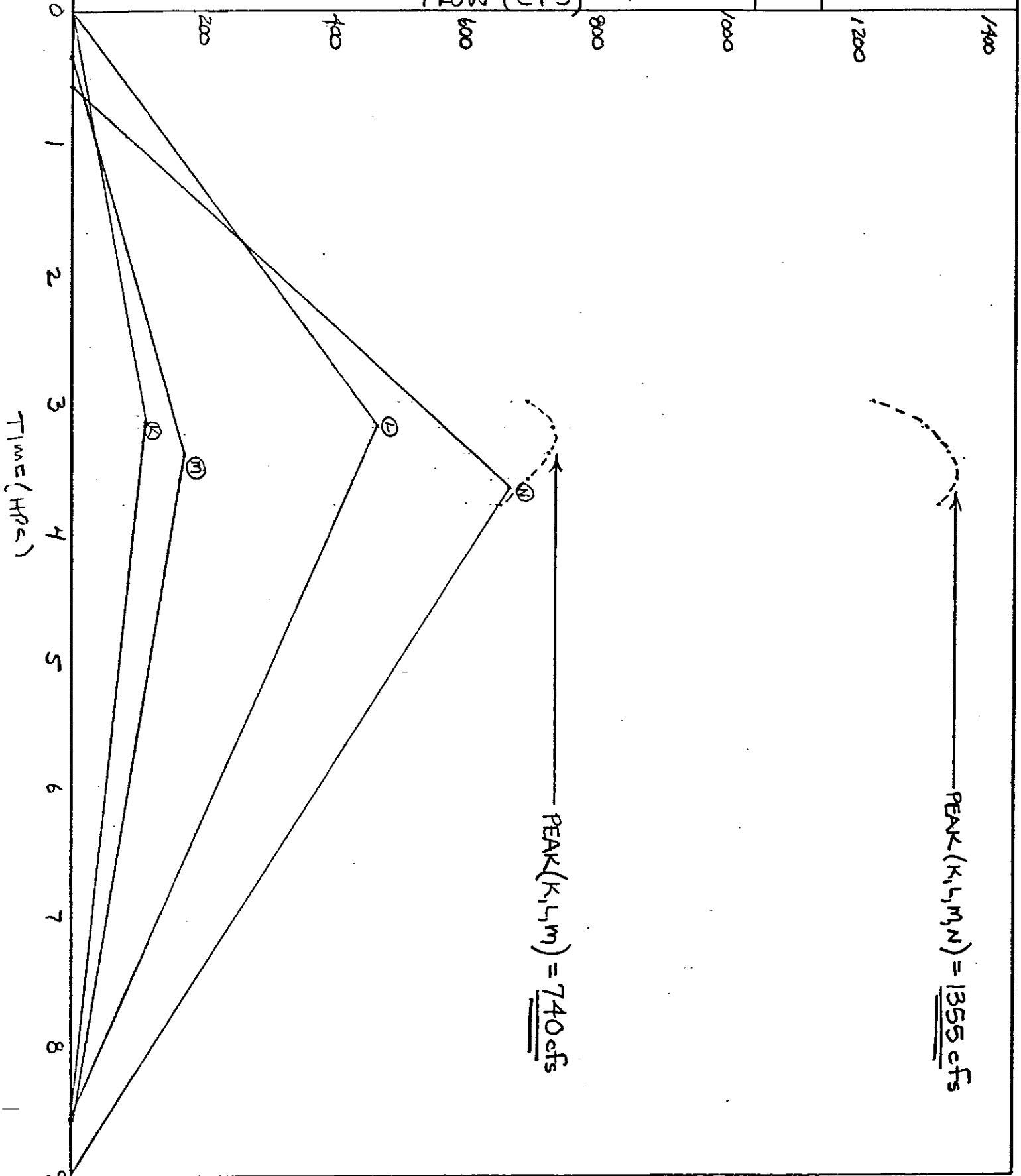
Project: HYDROGRAPHS - 100 YEAR - DEVELOPED

Job No: E-1986

Client:

By: DH

Date: Aug 78



Project: HYDROGRAPHS - 5 YEAR - DEVELOPED

Job No: E-1986

Client:

By: DH

Date: Dec 78

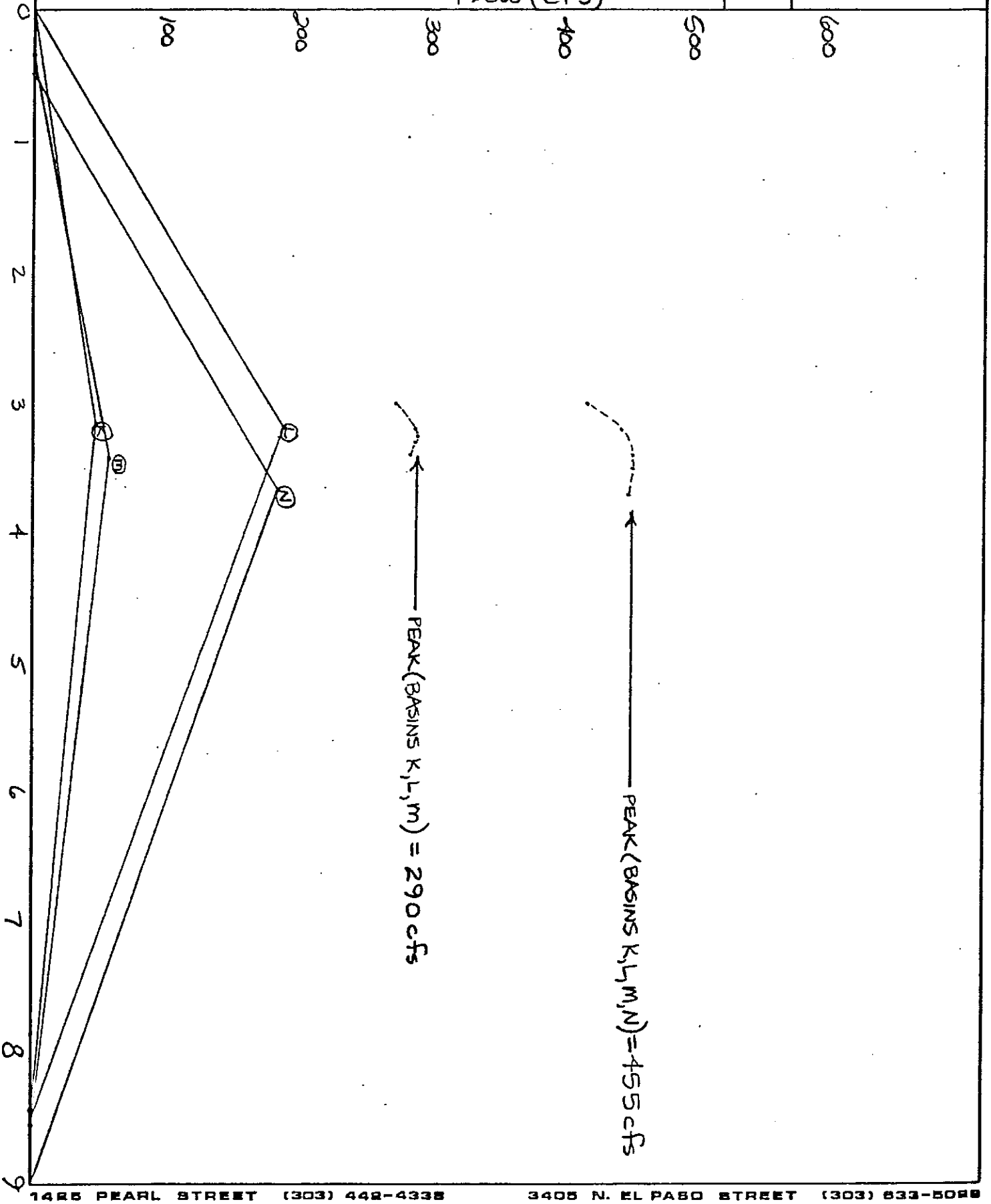


EXHIBIT 6

COLORADO STATE DEPARTMENT OF HIGHWAYS

DIVISION OF HIGHWAYS

May 12, 1982

RECEIVED

MAY 14 '82

GATES LAND COMPANY

Gates Land Company
155 West Lake Avenue
Colorado Springs, CO 80906

ATTENTION: ROBERT F. SVEJKOVSKY, DIRECTOR OF ENGINEERING

Dear Mr. Svejkovsky:

We wish to clarify the intent of your letter of October 13, 1981. If we understand it correctly, Gates Land Company will construct, at its expense, a double 10'x6' concrete box culvert under S.H. 115, south of Star Ranch Road. They require that the Colorado Department of Highways construct and maintain a detour for S.H. 115 traffic during the course of the construction.

If this is your intention please notify us and we will have an agreement written by our Denver Headquarters.

Sincerely,

E. N. HAASE
CHIEF ENGINEER

By H. W. Harris
H. W. HARRIS
District Engineer

HWH:ss

RECEIVED

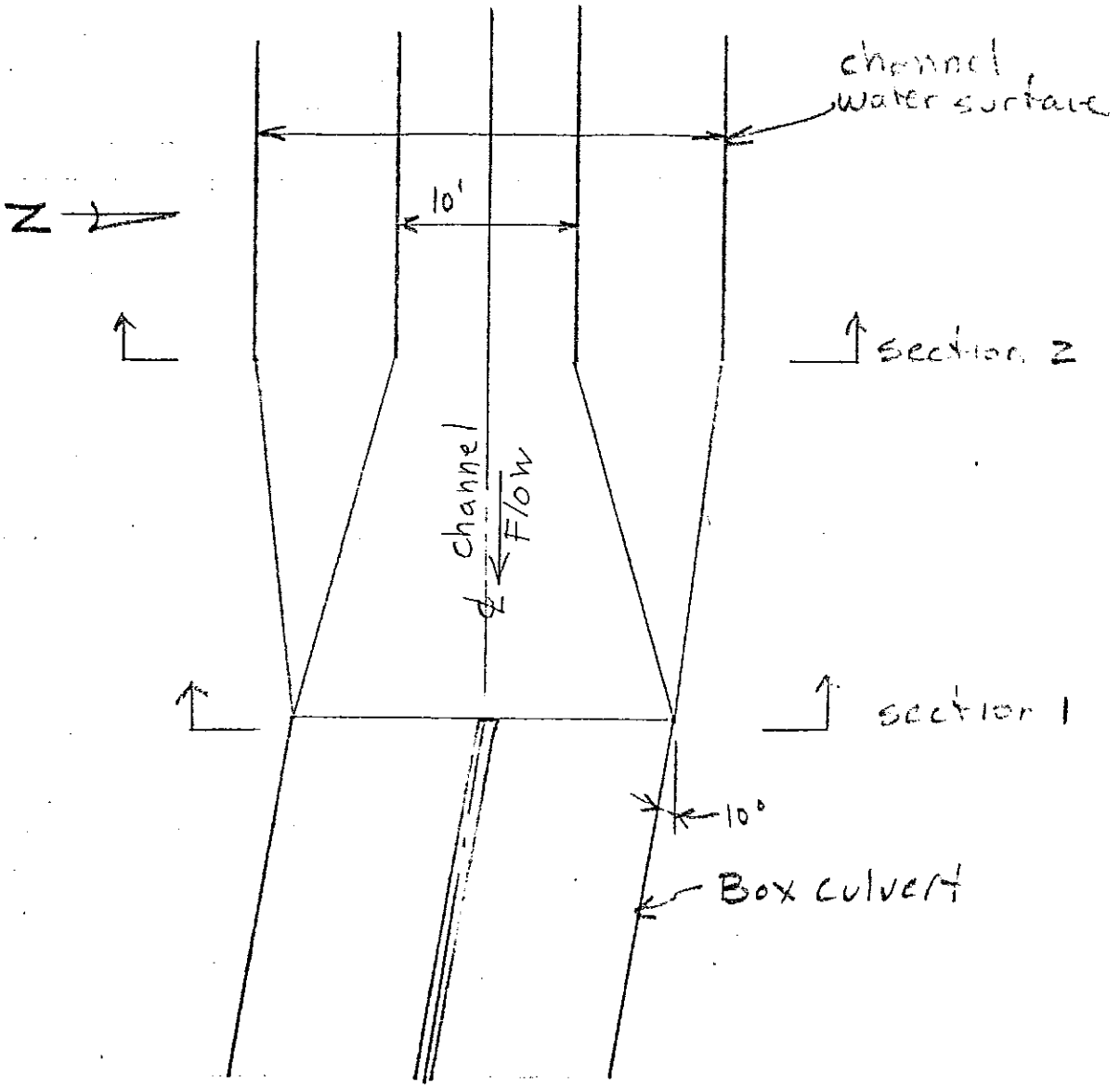
MAY 17 1982

DREXEL BARRELL & CO

905 ERIE AVENUE, P.O. BOX 536 PUEBLO, CO 81002 (303) 544-6286

Project: FISHER CANYON AT Hwy 115 | Job No.:

Client: GATES | EXHIBIT C | By: BNW | Date: 21 MAY 82



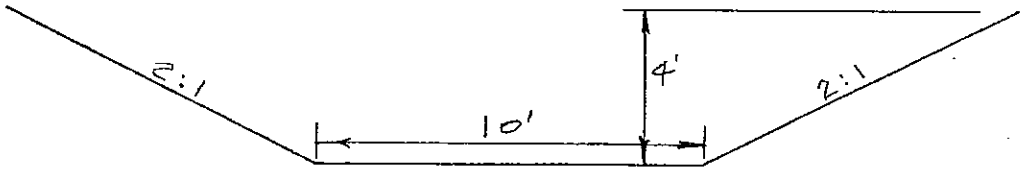
Plan View Transition to Box Culvert

Scale: 1" = 10'

Project: FISHER CANYON AT HWY 115 | Job No: E 2589

Client: GATES | By: BNW | Date: 21 MAY 82

CROSS SECTION OF TRANSITION TO BOX CULVERT



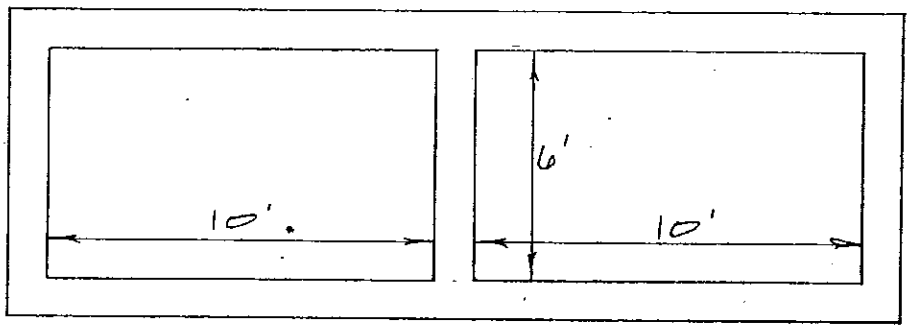
SECTION 2

DESIGN DATA: $S = 1.04\%$ $n = 0.015$ $Q = 1355$ cfs

$D = 4'$ $D_c = 5.7'$ $Z = 2$ $V = 19$ fps

$F = \frac{V}{\sqrt{gL}}$ $L = \frac{7Z}{26} = 2.77$

$F = 2.01$



SECTION 1

DBL. BOX CULVERT

$F = \frac{V}{\sqrt{gL}}$ $L = \frac{69}{20} = 3.45$ @ entrance $F = 1.85$

$D_c = 5.2'$ $S = 1.04\%$ $D_{normal} = 4'$

Project: FISHER CANYON AT Hwy 115 | Job No. E 2589

Client: GATES | By: BNW | Date: 21 May 82

WATER SURFACE ELEVATION

Std. Step Method

a. $WS_2 + \frac{\alpha_2 V_2^2}{2g} = WS_1 + \frac{\alpha_1 V_1^2}{2g} + he$

b. $he = L\bar{S}f + C\left[\frac{\alpha_2 V_2^2}{2g} - \frac{\alpha_1 V_1^2}{2g}\right]$

$L = 20'$ $\alpha = 1.0$ $V_2 = 19$ fps $C = 0.3$

ASSUME $d_1 = 3.45$ $A = 60$ sq ft $\therefore V_1 = 19.6$ fps

$Sf @ 2 = 0.0104$

$Sf_{1/2} @ 1 = \frac{(.015)1355}{1.49(69)(1.6)} = 0.015 = Sf_1$

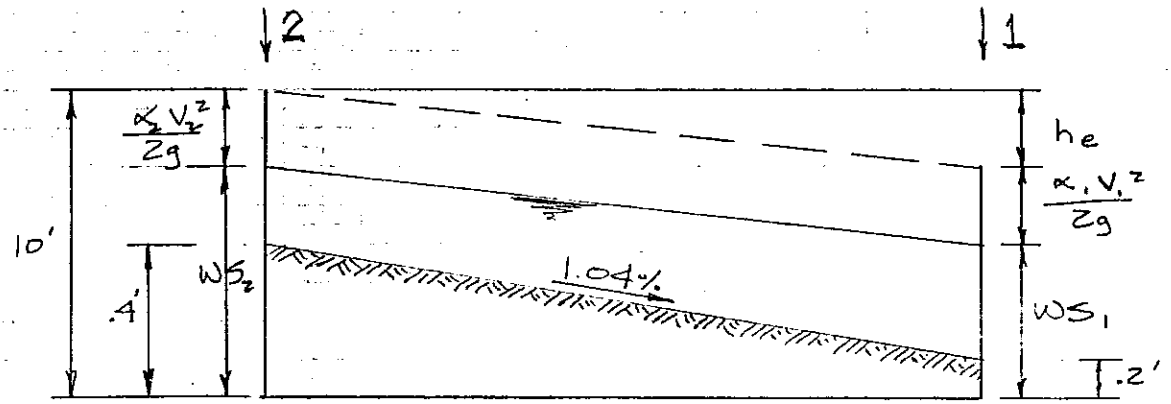
$\bar{S}f = \frac{Sf_1 + Sf_2}{2} = .013$ $\quad \bar{S}f(L) = 0.26$

b.) $he = 0.26 + .3|(5.6 - 5.97)| = 0.37$

$\frac{\alpha_1 V_1^2}{2g} = 5.6$ $\quad \frac{\alpha_2 V_2^2}{2g} = 5.97$

a.) $10 = 3.65 + 5.97 + .37$

$.10 = 9.99$ ✓



```
X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X           X     X
X     X  X        X                       X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                  X
X     X  X        X     X            X
X     X  XXXXXXX   XXXXX             XXXXXXX
```

1

06/04/82. 09.39.10.

****
HEC2 RELEASE DATED NOV 76 UPDATED APRI 1980
ERROR CORR - 01,02,03,04
MODIFICATION - 50,51,52,53,54
****

T1 E2589
T2 GATES
T3

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0.	0.	0.	1.	0.000000	0.00	0.0	1355.	34.200	0.000

NC	0.000	0.000	.015	.100	.300	0.000	0.000	0.000	0.000
X1	1.000	4.000	10.000	40.000	0.000	0.000	20.000	0.000	0.000
GR	35.200	10.000	30.200	20.000	30.200	30.000	35.200	40.000	0.000
X1	1.500	4.000	12.200	37.500	0.000	0.000	0.000	0.000	0.000
GR	35.100	12.200	30.100	17.000	30.100	33.000	35.100	37.500	0.000
X1	2.000	8.000	14.500	35.510	0.000	0.000	10.000	0.000	0.000
GR	36.000	14.500	30.000	14.510	30.000	24.500	36.000	24.510	36.000
GR	30.000	25.510	30.000	35.500	36.000	35.510	0.000	0.000	0.000
X1	3.000	8.000	14.500	35.510	0.000	0.000	0.000	0.000	0.000
GR	35.900	14.500	29.900	14.510	29.900	24.500	35.900	24.510	35.900
GR	29.900	25.510	29.900	35.500	35.900	35.510	0.000	0.000	0.000
EJ	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

1

06/04/82. 09.39.10.

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOEL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

```
GR      35.200      10.000      30.200      20.000      30.200      30.000      35.200      40.000      0.000

X1       1.500       4.000      12.200      37.500       0.000       0.000       0.000       0.000      0.000
GR      35.100      12.200      30.100      17.000      30.100      33.000      35.100      37.500      0.000

X1       2.000       8.000      14.500      35.510       0.000       0.000      10.000       0.000      0.000
GR      36.000      14.500      30.000      14.510      30.000      24.500      36.000      24.510     36.000
GR      30.000      25.510      30.000      35.500      36.000      35.510       0.000       0.000      0.000

X1       3.000       8.000      14.500      35.510       0.000       0.000       0.000       0.000      0.000
GR      35.900      14.500      29.900      14.510      29.900      24.500      35.900      24.510     35.900
GR      29.900      25.510      29.900      35.500      35.900      35.510       0.000       0.000      0.000
EJ       0.000       0.000       0.000       0.000       0.000       0.000       0.000       0.000      0.000
1
 06/04/82.   09.39.10.
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Water surface elevation

```
   SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS    BANK ELEV
   Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
   TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN      SSTA
   SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST

 *PROF 1

 CCHV=    .100 CEHV=    .300
 *SECNO 1.000
      1.00      4.00     34.20     35.85     34.20     39.70      5.50      0.00      0.00     35.20
     1355.        0.     1355.        0.        0.       72.        0.        0.        0.     35.20
      0.00      0.00     18.82      0.00      .000      .015      .000     0.000     30.20     12.00
   .010189         0.        0.        0.         0        10         0      0.00     26.00     38.00
0
 *SECNO 1.500
      1.50      3.64     33.74     35.47      0.00     39.48      5.73       .20       .02     35.10
     1355.        0.     1355.        0.        0.       71.        0.        0.        0.     35.10
       .00      0.00     19.21      0.00      .000      .015      .000      .014     30.10     13.51
   .009913         0.       20.        0.         9        11         0      0.00     22.77     36.27
0
 *SECNO 2.000

 3265 DIVIDED FLOW

      2.00      3.45     33.45     35.22      0.00     39.45      6.00      0.00       .03     36.00
     1355.        0.     1355.        0.        0.       69.        0.        0.        0.     36.00
       .00      0.00     19.66      0.00      .000      .015      .000      .014     30.00     14.50
   .015205         0.        0.        0.         7        11         0      0.00     20.00     35.51
0
 *SECNO 3.000

 3265 DIVIDED FLOW

      3.00      3.49     33.39     35.13      0.00     39.26      5.87       .15       .04     35.90
     1355.        0.     1355.        0.        0.       70.        0.        0.        0.     35.90
       .00      0.00     19.45      0.00      .000      .015      .000      .014     29.90     14.50
   .014756         0.       10.        0.         3        11         0      0.00     20.00     35.51
0
1
 06/04/82.   09.39.10.
```