HYDROLOGIC AND HYDRAULIC ANALYSIS

AND RECOMMENDED GUIDELINES FOR

MILLSTONE MANOR #6

Registered Professional Engineer (Civil)
CERTIFICATE NO.
20903
JAMES
RAYMOND
DEGROOD
Date signed 6/20/88
ARIZONA, U.S.A.

PREPARED BY:
Pima County Department of
Transportation and Flood
Control District

Principle Investigators:
Terry Hendricks
Jonathan Fuller

James R. DeGrood, P.E., Supervisor
Permits & Compliance Section

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Registered Professional Engineer
CERTIFICATE NO.
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Date signed
ARIZONA, U.S.A.

002

MILLSTONE MANOR #6 - DRAINAGE INVESTIGATION

By: Jon Fuller and Terry Hendricks

Date: June 17, 1988

INTRODUCTION

Millstone Manor #6 is a subdivision that was recorded in the mid-1950's. Crossing diagionally from the northeast to the southwest is a sixty foot drainageway which was platted and never constructed. All records indicate no engineering took place with regards to the potential for drainage improvements within Millstone Manor #6. Recently, property owners graded several lots and opened a flow path along the platted drainageways. This report will address what the natural floodprone areas are and will recommend how future permits should be processed.

WATERSHED CHARACTERISTICS

Millstone Manor #6 is affected by the Ironwood Wash watershed (see Exhibit A) The watershed was analyzed at the apex of a fan that lies upstream of the subdivision. Ironwood Wash a has a drainage area of 2041.6 acres 53% of which have Type D soils. The rest of the soils are Type B. The 100-year discharge was calculated to be 2958 cfs. The hydrologic data sheets can be found at the end of this report.

STUDY ASPECTS

How the Ironwood Wash affects the subdivision was difficult to ascertain due to the upstream fan. This fan has two outlets, one diagonally through the subdivision, the other to the south and parallel to the Neal Avenue alignment.

In determining the flow through the subdivision, four cross-sections were taken through the fan area (San Joaquin Road, #1, #2, #3). These cross-sections are shown on Exhibit B. To determine the flow split throughout Millstone Manor #6, Mannings equation was used to determine surface elevations across the entire cross-section. Then with this elevation, the proportioned discharge through the western split of the fan was determined. The cross section data points and calculations are shown in the fan analysis section of this report. The table below summarizes this analysis:

WESTERN ALLUVIAL SPLIT FROM THE IRONWOOD WASH

Cross Section	Water Surface Elevation	Discharge
San Joaquin Rd.	2441.03 ft	1741 cfs
1	2444.31 ft	1535 cfs
2	2447.28 ft	1355 cfs
3	2451.66 ft	265 cfs


Old Tucson
Ironwood Wash Watershed
Scale 1" ~ 1000'
N
Photo 1984
Millstone Manor #6
San Joaquin
Bopp Road
Exhibit A

SAN JOAQUIN RD.
SAN JOAQUIN RD.
2440
2430
2450
2450
x 2441.3
2439.0
2440
N 432,000
E 735,000
x 2436.8
2440
2440
2440
x 2444.9
432,000
E 736,000
2440
x 2434.2
2439.9
2440
2440
2440
2440
x 2436.4
x 2437.1
E 735,000
N 431,000
2430
x 2426.1
x 2429.0
2430
March 1980
Scale 1" = 100
2 foot Contours
Boundary
analysis

In order to determine the nature of this fan, research into historical photos and a field investigation was made. The historical photos show the wash is shifting more towards the east. Attached you will find a 1941 photograph. Note how much more pronounced the wash is through the Millstone Manor subdivision. The field investigation revealed the old flow path to the west is catching debris. It also indicated more active vegetation growing in the split. Such growth could induce even more debris entrapment.

Our field observations also indicated the embankments are very shallow (18 inches to 2 feet) and the wash bed is relatively flat with very large aggregate (D50 = 5/8 inch). The overbank areas are coated with fine silty aluvian which indicate frequent channel overtopping. Further down at the El Paso Natural Gas gas line right-of-way are some earth berms which will induce most of the sheet flooding to the east.

Based on all of the above findings we felt the regulatory discharge towards Millstone Manor #6 should be set at 1000 cfs. It should be noted since this is an alluvial fan there exists strong possibility of further avulsion which may reduce or increase discharge through the subdivision. The apex of the fan is in an area not maintained by Pima County.

HEC-2 ANALYSIS

The existing flood limits for the Ironwood Wash breakout channel flowing through Millstone Manor #6 were determined using the Army Corps of Engineers computer model HEC-2. Output files from the computer runs are included as Appendix 1.

Topographic cross section data was obtained from 1 inch = 100 feet, 2-foot contour interval aerial 1984 photo-topography. Hydraulic parameters were estimated by analysis of aerial photographs and by field checking. 19 cross sections were defined in the reach from the northeast corner of Millstone Manor to the southwest side. Water surface profiles for discharges of 500, 750, 1000 and 1250 cfs. were determined. The flood limits for the 1000 cfs. discharge are shown on figure #1.

The main flow channel does not have sufficient capacity between Claude and Edward Streets (cross sections 15 - 19). Therefore, a split flow analysis using the normal depth option was executed for the low capacity reach. The total breakout discharge was then routed through the breakout channel which runs north of Edward Street. The flood limits for this secondary flow path are also shown on figure #1. The flood limits downstream of the breakout on the main channel are based on discharges reduced by the amount of breakout flow.

PERMIT REQUIREMENTS

The floodplain mapping represented in this report reflects only on the western braid of the Ironwood Wash. Sheet flooding problems may occure in other portions of the subdivision. Due to the relatively flat cross sectional topography other lots may be adversely affected. Because of the small lot size

Photo Date
3-16-83

Scale
1:14060

N

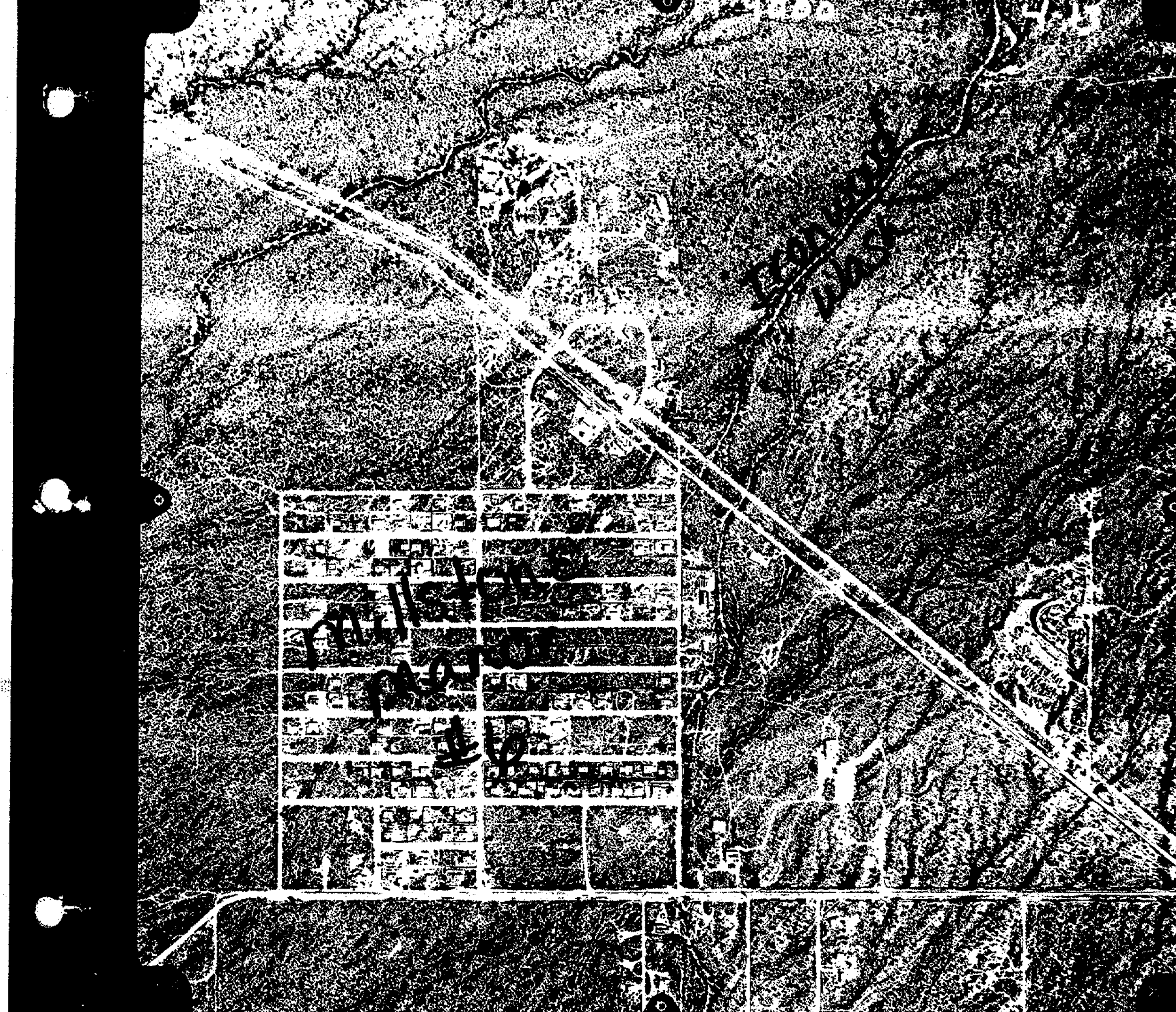
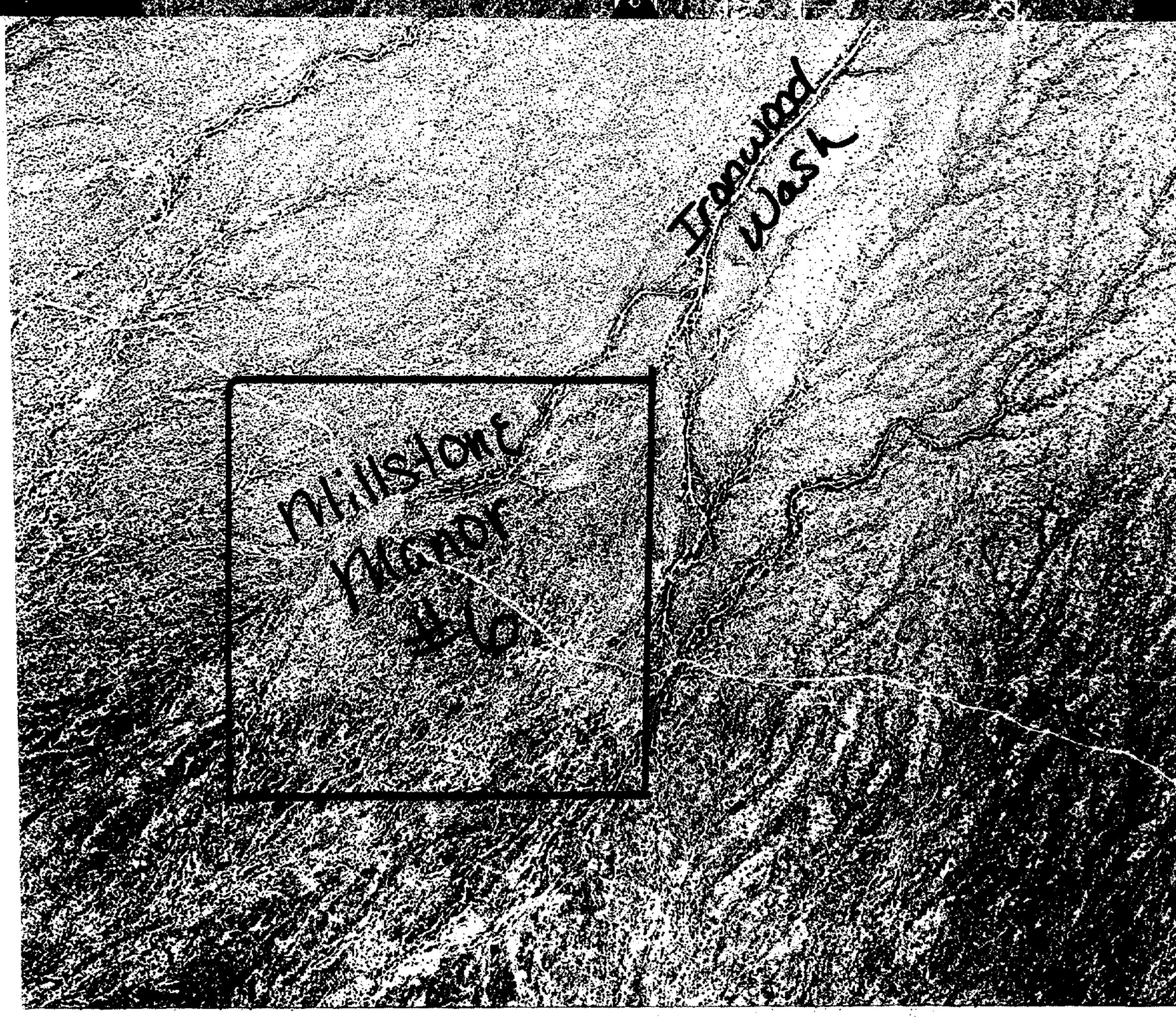


Photo Date
3-26-41



x

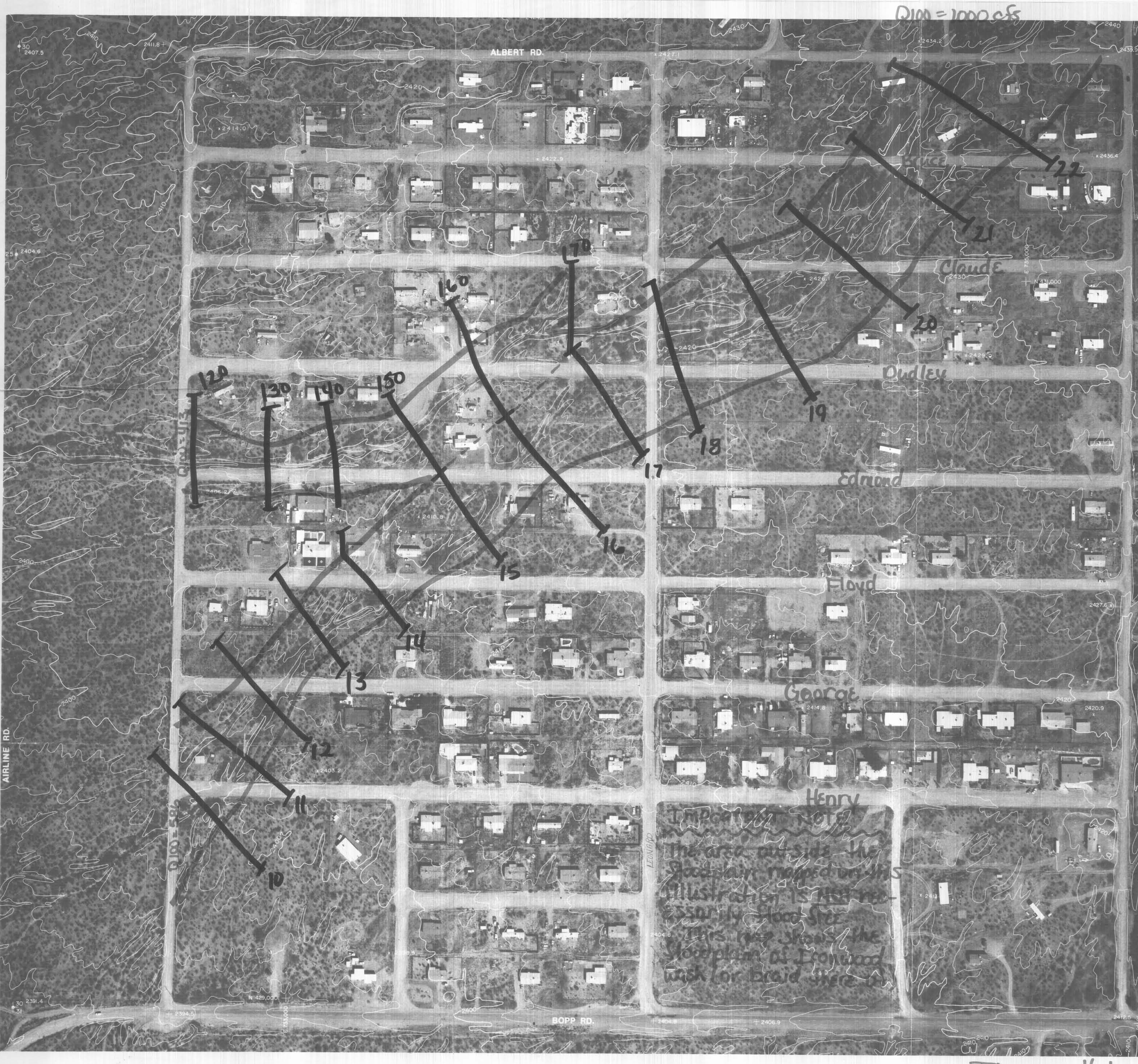

Q100 = 1000 cfs
ALBERT RD.
Bruce
Claude
Dudley
Edmond
Floyd
George
Henry
BOPP RD.
AIRLINE RD.
NEAL AVE.
LEONARD
Q100 = 413
Q100 = 586
120
130
140
150
160
170
10
11
12
13
14
15
16
17
18
19
20
21
22
Important Note
The area outside the floodplain mapped on this illustration is not necessarily flood free. This map shows the floodplain of Ironwood wash (or braid there of).

Figure #1

(67 feet by 116 feet) the improper development of some lots may induce adverse drainage conditions on adjacent parcels. In general, the most severe sheet flooding (separate from the Ironwood Wash) would occur in the southern and northwestern portions of the subdivision. This general rule would have some exceptions.

To assist the Permits & Compliance Section in processing permits, each and every lot was looked at (based on the March 1984 topography) for flood suceptibility. Attached is a subdivision plat that has been highlighted to help with the permitting process. The plat should be used as a tool, field investigations are encouraged for each application. This would be especially true for applications for walls or closed type fencing (ie: chain-link fencing.

The permit requirements map (Figure #2) is basically consistant with previous Floodplain Use Permits issued (Figure #3).

SUMMARY AND FURTHER RECOMMENDATION

A major portion of the Millstone Manor #6 subdivision is affected by the Ironwood Wash. The distribution of flow through the development is controlled by a fan upstream. The attached mapping should be used as a tool to assist Pima County Department of Transportation and Flood Control District in processing Floodplain use Permits. Once accepted, this information would need to be available to the general public.

FLOODPLAIN MAPPING AND PERMIT REQUIREMENTS
MILLSTONE MANOR #6

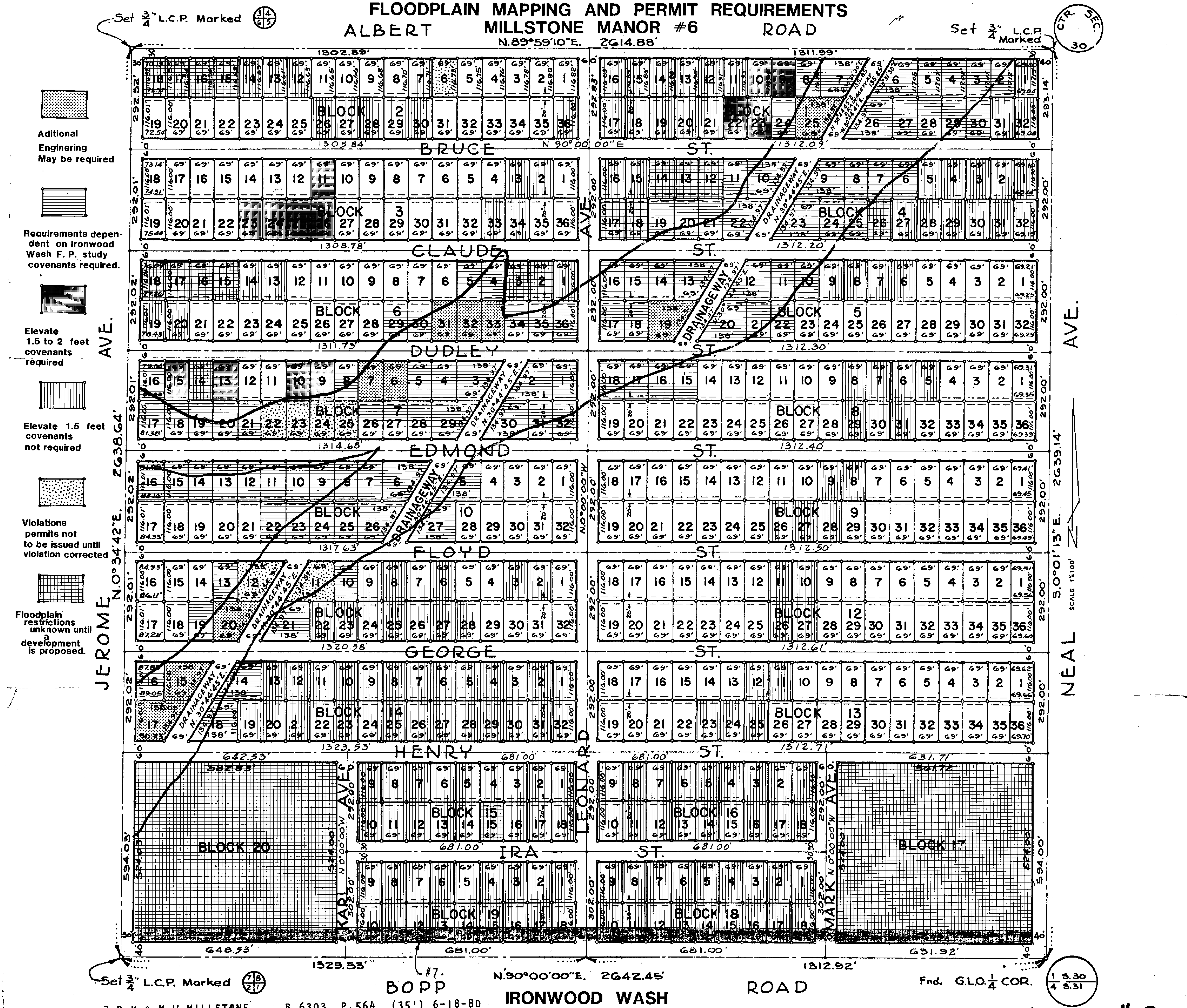
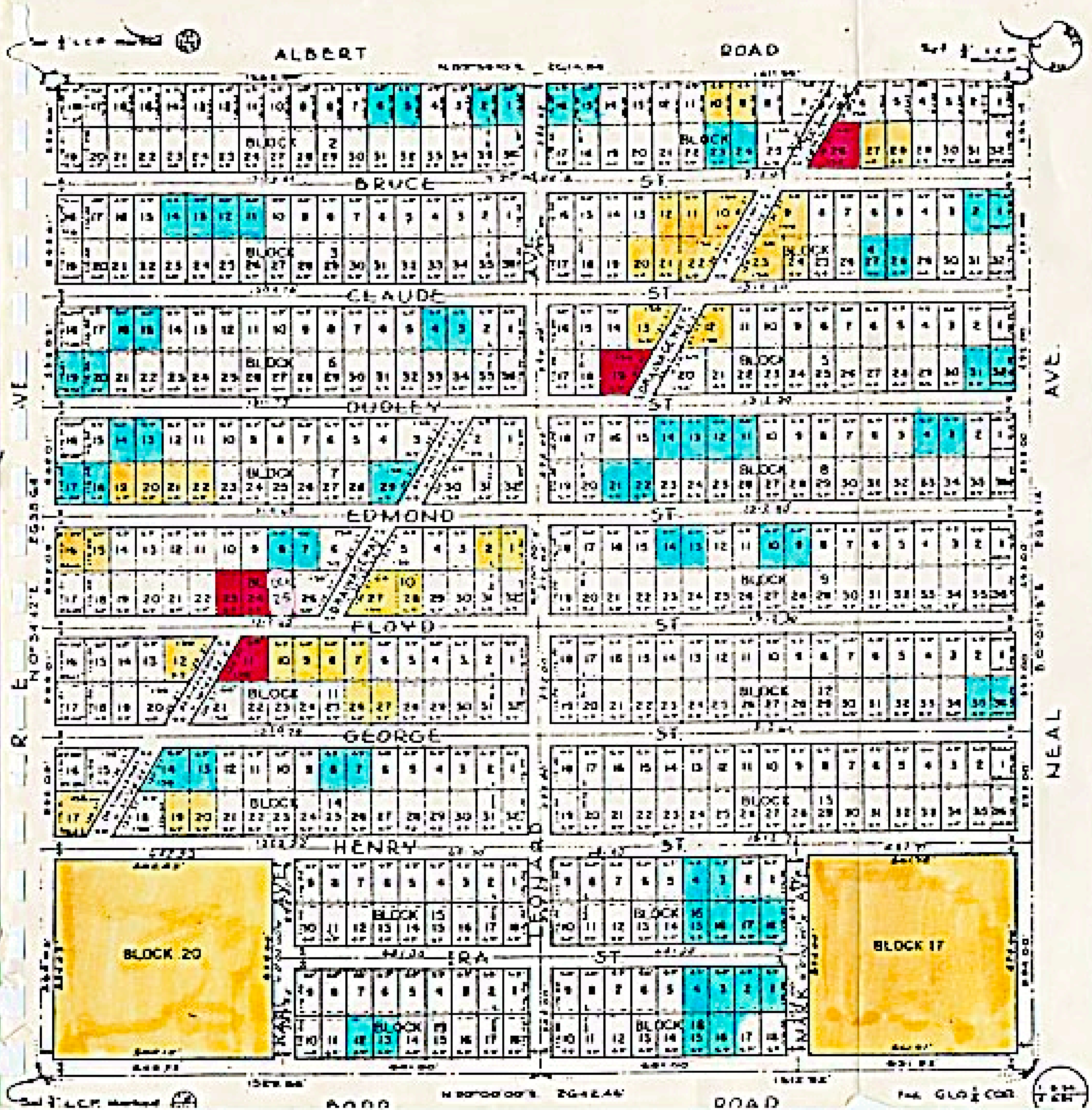


Figure #2

11-82



PAST DEVELOPMENTS REVIEWED BY FLOODPLAIN MANAGEMENT *

- The proposed use required additional engineering and/or drainage improvements. Some applicants have yet to supply additional engineering consequently some permits may not have been issued.

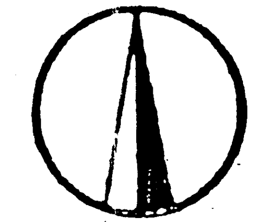
- Covenants were required. Mobile Homes were to be elevated 1.5 to 3 feet. Some Mobile Homes were to placed on elevated pads. Other Mobile Home requirements included erosion setbacks and the placement of the structure parallel to the flow path. Closed type fences were either to be setback from property lines and/or elevated.

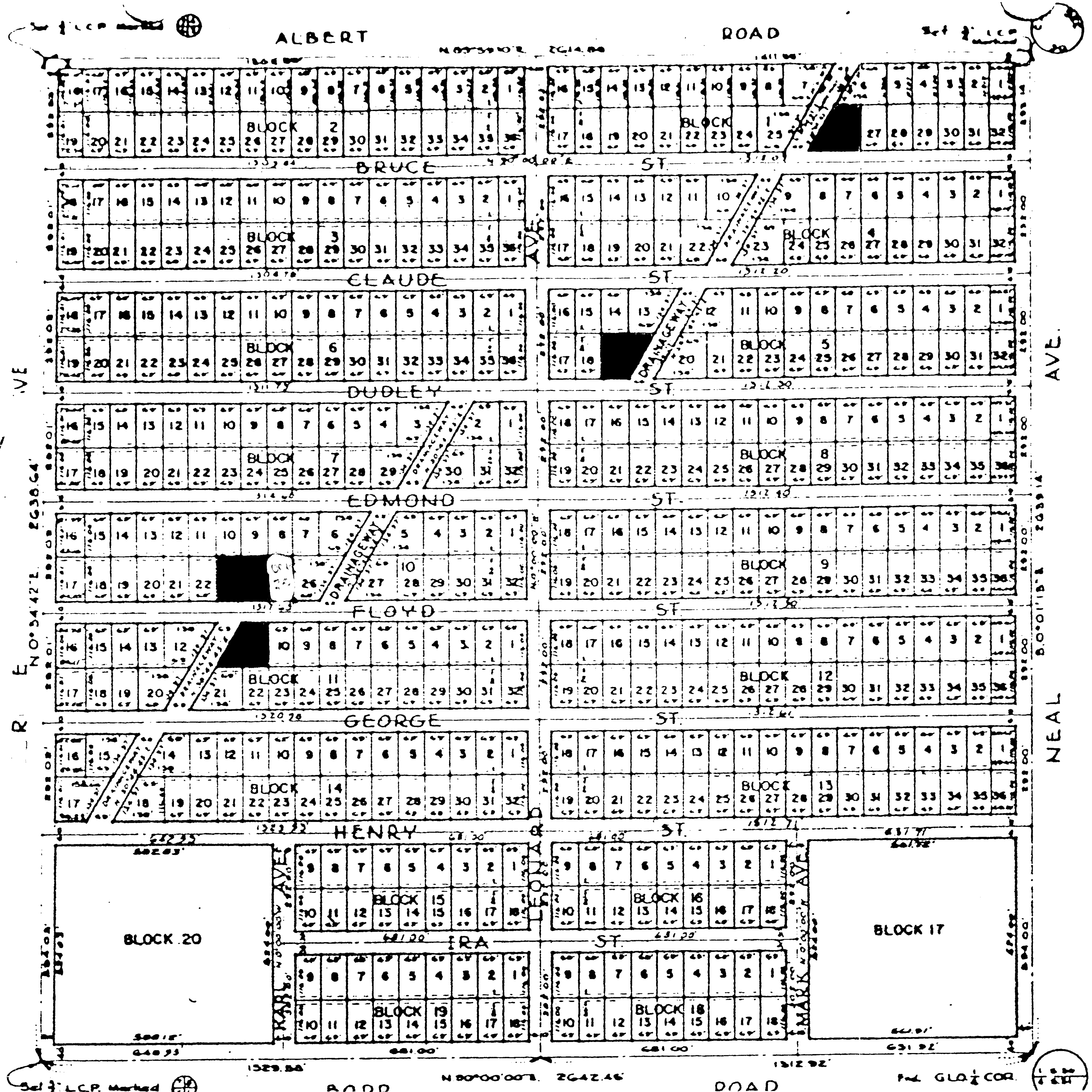
- Mobile Homes were to be elevated 1.5 to 2 feet. Other improvements were also permitted. Covenants were not required.

*This illustration does not reflect the review work performed or the permits issued by the Central Permit Section of the Pima County Planning Department.

Figure #3

N 11-82





PAST DEVELOPMENTS REVIEWED BY FLOODPLAIN MANAGEMENT *

-The proposed use required additional engineering and/or drainage improvements. Some applicants have yet to supply additional engineering consequently some permits may not have been issued.

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*This illustration does not reflect the review work performed or the permits issued by the Central Permit Section of the Pima County Planning Department.

Figure #3

FAN ANALYSIS

The following is an analysis of flows through the alluvial fan upstream of Millstone Manor #6. The cross-sections are shown on Exhibit B of this report. Using the design discharge, the water surface elevation was determined across the fan using the Mannings equation. Then with this elevation, the western split flow discharge was determined for each cross-section.

JOB #
millstone manor
BY: fuller
3/15/88

CROSS SECTION san joaquin rd *Entire X-section*

STATION	0.00	ELEVATION	60.00
STATION	0.01	ELEVATION	42.00
STATION	18.00	ELEVATION	40.00
STATION	26.00	ELEVATION	38.00
STATION	48.00	ELEVATION	36.50
STATION	59.00	ELEVATION	38.00
STATION	70.00	ELEVATION	40.00
STATION	100.00	ELEVATION	40.50
STATION	125.00	ELEVATION	40.00
STATION	130.00	ELEVATION	40.00
STATION	297.00	ELEVATION	42.00
STATION	400.00	ELEVATION	42.50
STATION	560.00	ELEVATION	42.00
STATION	590.00	ELEVATION	40.00
STATION	700.00	ELEVATION	38.60
STATION	760.00	ELEVATION	40.00
STATION	790.00	ELEVATION	40.50
STATION	790.01	ELEVATION	60.00

RESULTS

Manning's 'n' 0.040
Channel Slope 1.200%
W.S. Elevation 41.03 Ft.
Area 585.67 SF
Wetted Perimeter 423.91 Ft.
Near Bank Station 8.7
Far Bank Station 790.0
Discharge 2956.58 cfs
Velocity 5.05 fps
Froude Number 1.03
Total Energy Elevation 41.43 Ft.
Conveyance %26989.80
Maximum Depth 4.53 Ft.
Hydraulic Depth 0.75 Ft.

JOB #
millstone manor
BY: fuller
3/15/88

CROSS SECTION rd a *western split analysis*

STATION	450.00	ELEVATION	60.00
STATION	450.01	ELEVATION	42.25
STATION	560.00	ELEVATION	42.00
STATION	590.00	ELEVATION	40.00
STATION	700.00	ELEVATION	38.60
STATION	760.00	ELEVATION	40.00
STATION	790.00	ELEVATION	40.50
STATION	790.01	ELEVATION	60.00

RESULTS

Manning's 'n' 0.040
Channel Slope 1.200%
W.S. Elevation 41.03 Ft.
Area 325.46 SF
Wetted Perimeter 216.04 Ft.
Near Bank Station 574.6
Far Bank Station 790.0
Discharge 1740.51 cfs
Velocity 5.35 fps
Froude Number 0.77
Total Energy Elevation 41.47 Ft.
Conveyance %15888.63
Maximum Depth 2.43 Ft.
Hydraulic Depth 1.51 Ft.

JOB #
millstone manor
BY: fuller
3/15/88

CROSS SECTION 1 Entire X-section

STATION	0.00	ELEVATION	56.00
STATION	0.01	ELEVATION	44.50
STATION	8.00	ELEVATION	44.00
STATION	11.00	ELEVATION	42.00
STATION	18.00	ELEVATION	40.00
STATION	25.00	ELEVATION	39.50
STATION	30.00	ELEVATION	40.00
STATION	45.00	ELEVATION	42.00
STATION	68.00	ELEVATION	42.00
STATION	107.00	ELEVATION	44.00
STATION	190.00	ELEVATION	45.00
STATION	247.00	ELEVATION	44.00
STATION	269.00	ELEVATION	44.00
STATION	330.00	ELEVATION	45.70
STATION	445.00	ELEVATION	44.00
STATION	525.00	ELEVATION	44.00
STATION	532.00	ELEVATION	42.00
STATION	630.00	ELEVATION	44.00
STATION	704.00	ELEVATION	42.00
STATION	717.00	ELEVATION	42.00
STATION	738.00	ELEVATION	44.00
STATION	738.01	ELEVATION	56.00

RESULTS

Manning's 'n' 0.040
Channel Slope 1.600%
W.S. Elevation 44.31 Ft.
Area 572.74 SF
Wetted Perimeter 496.80 Ft.
Near Bank Station 3.0
Far Bank Station 738.0
Discharge 2959.09 cfs
Velocity 5.17 fps
Froude Number 1.03
Total Energy Elevation 44.73 Ft.
Conveyance %23393.67
Maximum Depth 4.81 Ft.
Hydraulic Depth 0.78 Ft.

JOB #
millstone manor
BY: fuller
3/15/88

CROSS SECTION 1a *Western Split Analysis*

STATION	400.00	ELEVATION	60.00
STATION	400.01	ELEVATION	45.00
STATION	445.00	ELEVATION	44.00
STATION	525.00	ELEVATION	44.00
STATION	532.00	ELEVATION	42.00
STATION	630.00	ELEVATION	44.00
STATION	704.00	ELEVATION	42.00
STATION	717.00	ELEVATION	42.00
STATION	738.00	ELEVATION	44.00
STATION	738.01	ELEVATION	60.00

RESULTS

Manning's 'n' 0.040
Channel Slope 1.600%
W.S. Elevation 44.31 Ft.
Area 318.99 SF
Wetted Perimeter 307.68 Ft.
Near Bank Station 431.1
Far Bank Station 738.0
Discharge 1535.50 cfs
Velocity 4.81 fps
Froude Number 0.83
Total Energy Elevation 44.67 Ft.
Conveyance %12139.20
Maximum Depth 2.31 Ft.
Hydraulic Depth 1.04 Ft.

JOB #
millstone manor
BY: fuller
3/15/88

CROSS SECTION 2 Entire Cross-section

STATION	0.00	ELEVATION	60.00
STATION	0.01	ELEVATION	50.00
STATION	65.00	ELEVATION	48.00
STATION	89.00	ELEVATION	46.00
STATION	113.00	ELEVATION	46.00
STATION	144.00	ELEVATION	44.00
STATION	150.00	ELEVATION	42.50
STATION	160.00	ELEVATION	44.00
STATION	180.00	ELEVATION	46.00
STATION	194.00	ELEVATION	46.00
STATION	271.00	ELEVATION	48.00
STATION	400.00	ELEVATION	49.00
STATION	560.00	ELEVATION	48.00
STATION	629.00	ELEVATION	46.00
STATION	692.00	ELEVATION	46.00
STATION	782.00	ELEVATION	48.00
STATION	790.00	ELEVATION	48.00
STATION	894.00	ELEVATION	46.00
STATION	921.00	ELEVATION	46.00
STATION	969.00	ELEVATION	46.00
STATION	1000.00	ELEVATION	47.00
STATION	1000.01	ELEVATION	60.00

RESULTS

Manning's 'n' 0.040
Channel Slope 1.600%
W.S. Elevation 47.28 Ft.
Area 577.27 SF
Wetted Perimeter 507.09 Ft.
Near Bank Station 73.7
Far Bank Station1000.0
Discharge 2957.47 cfs
Velocity 5.12 fps
Froude Number 1.14
Total Energy Elevation 47.68 Ft.
Conveyance %23380.87
Maximum Depth 4.78 Ft.
Hydraulic Depth 0.62 Ft.

JOB #
millstone manor
BY: fuller
3/15/88

CROSS SECTION 2a *Western Split analysis*

STATION	580.00	ELEVATION	60.00
STATION	580.01	ELEVATION	47.60
STATION	629.00	ELEVATION	46.00
STATION	692.00	ELEVATION	46.00
STATION	782.00	ELEVATION	48.00
STATION	790.00	ELEVATION	48.00
STATION	894.00	ELEVATION	46.00
STATION	921.00	ELEVATION	46.00
STATION	969.00	ELEVATION	46.00
STATION	1000.00	ELEVATION	47.00
STATION	1000.01	ELEVATION	60.00

RESULTS

Manning's 'n' 0.040
Channel Slope 1.600%
W.S. Elevation 47.28 Ft.
Area 305.36 SF
Wetted Perimeter 332.70 Ft.
Near Bank Station 589.8
Far Bank Station1000.0
Discharge 1355.25 cfs
Velocity 4.44 fps
Froude Number 0.91
Total Energy Elevation 47.59 Ft.
Conveyance %10714.19
Maximum Depth 1.28 Ft.
Hydraulic Depth 0.74 Ft.

JOB #

BY:

CROSS SECTION 3 *Entire X-section*

STATION	0.00	ELEVATION	60.00
STATION	0.01	ELEVATION	52.30
STATION	9.00	ELEVATION	52.00
STATION	35.00	ELEVATION	50.00
STATION	81.00	ELEVATION	50.00
STATION	100.00	ELEVATION	49.00
STATION	150.00	ELEVATION	49.00
STATION	164.00	ELEVATION	50.00
STATION	280.00	ELEVATION	50.40
STATION	380.00	ELEVATION	52.00
STATION	430.00	ELEVATION	51.50
STATION	460.00	ELEVATION	52.00
STATION	582.00	ELEVATION	52.00
STATION	633.00	ELEVATION	50.00
STATION	633.01	ELEVATION	60.00

RESULTS

Manning's 'n' 0.040
Channel Slope 1.400%
W.S. Elevation 51.66 Ft.
Area 554.77 SF
Wetted Perimeter 415.13 Ft.
Near Bank Station 13.4
Far Bank Station 633.0
Discharge 2958.60 cfs
Velocity 5.33 fps
Froude Number 0.99
Total Energy Elevation 52.10 Ft.
Conveyance %25004.73
Maximum Depth 2.66 Ft.
Hydraulic Depth 0.90 Ft.

K

JOB #

BY:

CROSS SECTION 3a *Western Split Analysis*

STATION	280.00	ELEVATION	60.00
STATION	280.01	ELEVATION	50.40
STATION	380.00	ELEVATION	52.00
STATION	430.00	ELEVATION	51.50
STATION	460.00	ELEVATION	52.00
STATION	582.00	ELEVATION	52.00
STATION	633.00	ELEVATION	50.00
STATION	633.01	ELEVATION	60.00

RESULTS

Manning's 'n' 0.040
Channel Slope 1.400%
W.S. Elevation 51.66 Ft.
Area 86.79 SF
Wetted Perimeter 149.64 Ft.
Near Bank Station 280.0
Far Bank Station 633.0
Discharge 265.33 cfs
Velocity 3.06 fps
Froude Number 1.09
Total Energy Elevation 51.81 Ft.
Conveyance 2242.48
Maximum Depth 1.66 Ft.
Hydraulic Depth 0.25 Ft.

HYDROLOGIC DATA SHEET

Project Name and Location: Millstone Manor #6

Drainage Concentration Point: 1000 feet upstream of San Joaquin Rd.

Watershed Area (A): 2041.6 (acres) / square miles.

Length of Watercourse (L_c): 25,250 ft. Length to Center of Gravity (L_{ca}): 13,250 ft

Incremental Change in Length (L_i) - ft.	Incremental Change in Elevation (H_i) - ft
3500	332
21,750	399

Mean Slope (S_c): .0216 ft./ft. Watershed Type(s): 53% Mountain, 47% Valley (future)

Basin Factor (n_b): .043 (future) Flood Frequency: 100 yrs

P_{24} (24 hour): 4.69 in. Areal Value: ______ in.

P_6 (6 hour): 3.69 in. Areal Value: ______ in.

P_1 (1 hour): 2.68 in. Areal Value: ______ in.

P_2 (2 hour): 3.02 in. Areal Value: ______ in.

P_3 (3 hour): ______ in. Areal Value: ______ in.

Soil Group(s): 53% D, 47% B Cover Type(s): Desert Brush

Cover Density (pervious areas): 20% Impervious Cover: 0% (future

CN(s): 91, 83 (curve number) (pervious & impervious areas) CN^*(s): 93.22, 87.09 (adjusted curve number)

Runoff to Rainfall Ratio(s), (C): .73, .55 (pervious areas) N/A (impervious areas

Runoff Supply Rate (q): .647 i in./hr. (function of i)

Time of Concentration (T_c): 103 $i^{-.4}$ hrs./mins. (function of i)

Iterative Solution of T_c: 75 hrs./(mins.)

Rainfall Intensity (i) at T_c: 2.22 in./hr.

Runoff Supply Rate (q) at T_c: 1.44 in./hr.

Equation for T_c:

$$T_c = \frac{n_b}{50} \frac{(L_c L_{ca})^{.3}}{(S_c)^{.4}} q^{-.4} \text{ hours.}$$

Peak Discharge:

1.008 qA (acres): ______ cfs.

645.33qA (square miles): 2958 cfs.

Note: For impervious areas, $CN^* = 99$ (constant).

21

RAINFALL DATA SHEET

Return Period (Years)	Precipitation Values (inches)			
	6 Hour Duration		24 Hour Duration	
	Map Value	Corrected Value	Map Value	Corrected Value
2	1.6	1.61	1.93	1.95
5	2.1	2.13	2.6	2.62
10	2.45	2.47	3.01	3.06
25	3.09	2.90	3.7	3.65
50	3.30	3.31	4.2	4.18
100	3.63	3.69	4.7	4.69

$X_3 = 3.69''$

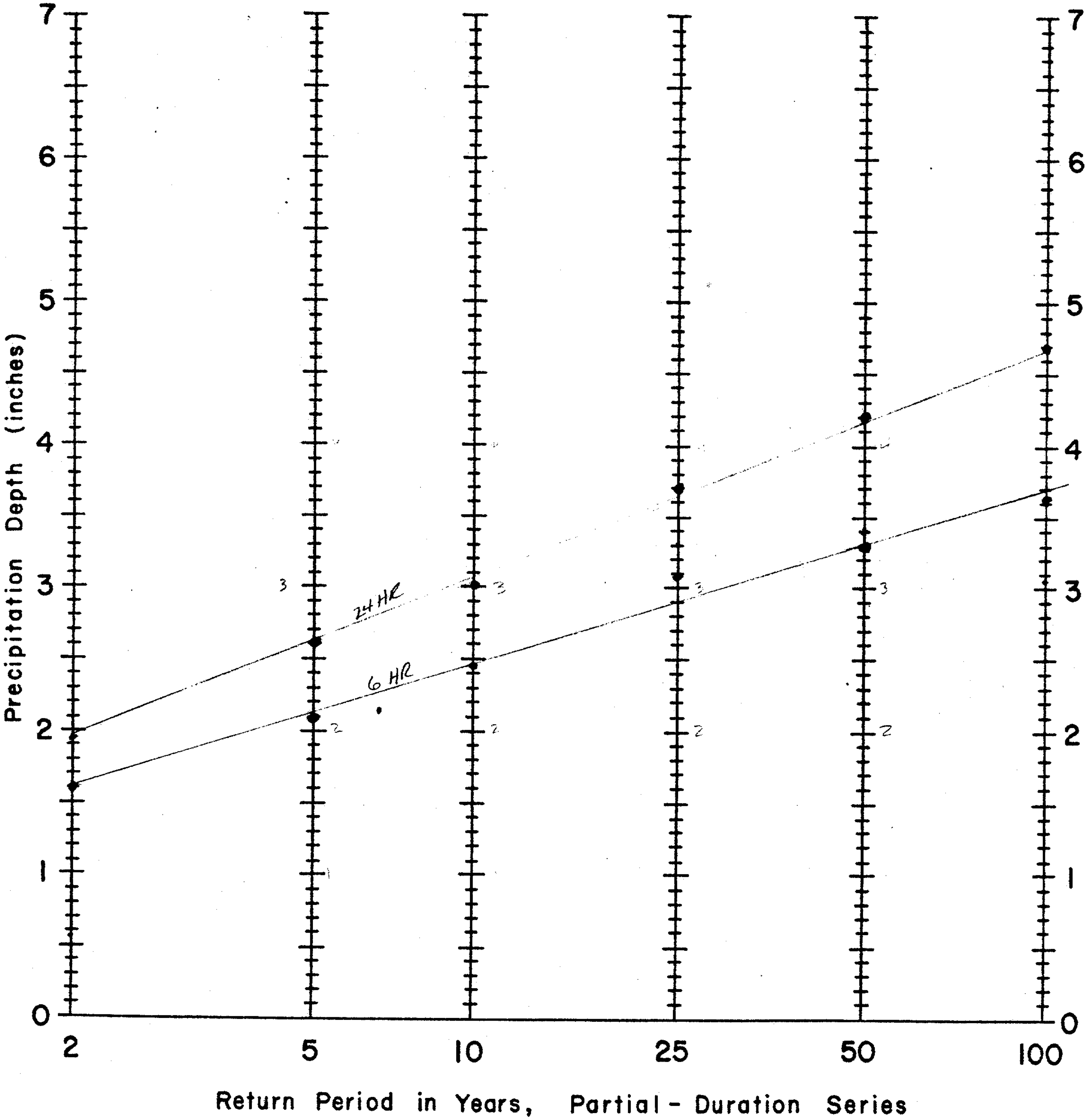
$X_4 = 4.69''$

$Y_{100} = 0.494 + 0.755 \left(X_3^2 / X_4 \right)$

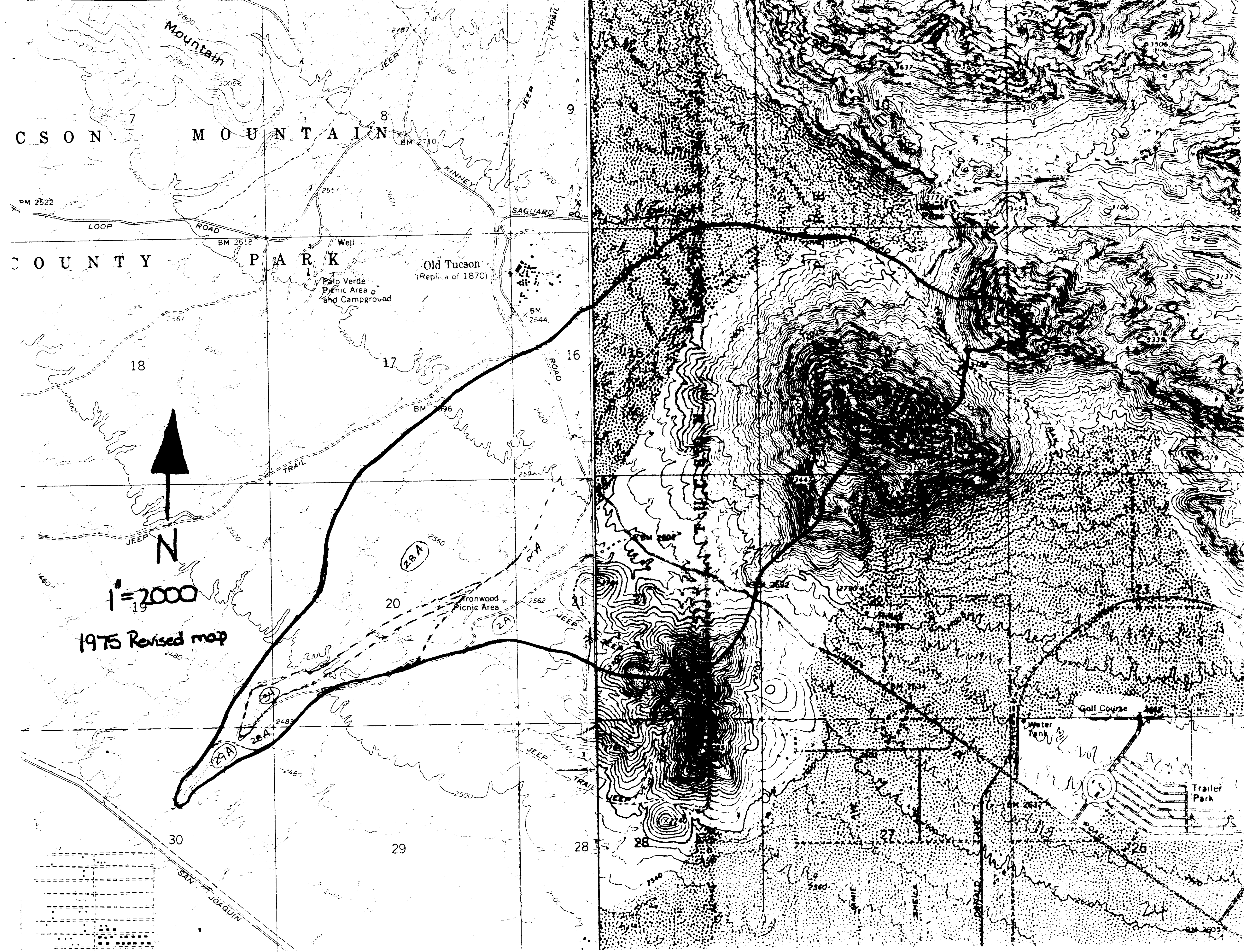
$Y_{100} = 2.68''$

$\frac{3.69^2}{4.69} = 2.90$

Latitude ____________ Longitude ____________



Precipitation Depth Versus Return Period For Partial - Duration Series


Mountain
CSON MOUNTAIN
COUNTY PARK
LOOP ROAD
SAGUARO RD
KINNEY
JEEP TRAIL
Well
Old Tucson
(Replica of 1870)
Palo Verde Picnic Area and Campground
Tronwood Picnic Area
Golf Course
Water Tank
Trailer Park
SAN JOAQUIN
N
1" = 2000
1975 Revised map

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*******************************************************          **************************************
* WATER SURFACE PROFILES                              *          * U.S. ARMY CORPS OF ENGINEERS       *
* VERSION OF NOVEMBER 1976                            *          * THE HYDROLOGIC ENGINEERING CENTER  *
* UPDATED MAY 1984                                    *          * 609 SECOND STREET, SUITE D         *
* IBM-PC-XT VERSION AUGUST 1985                       *          * DAVIS, CALIFORNIA 95616            *
* RUN DATE  04-19-88    TIME  12:19:18                *          * (916) 440-2105 (FTS) 448-2105      *
*******************************************************          **************************************
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```
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
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THIS RUN EXECUTED 04-19-88

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**************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
  ERROR CORR -  01,02,03,04,05,06
  MODIFICATION -  50,51,52,53,54,55,56
  IBM-PC-XT VERSION AUGUST 1985
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SPLIT FLOW BEING PERFORMED


SF  NORMAL DEPTH METHOD USED -- BREAKOUT IS SUBCRITICAL


JC
JP     0       0       0       0       0

TN  CROSS SECTION  12 TO 13  --  FLOW TO LEFT OVERBANK
NS     2     12      13      -1    .045    .005
NG     0   403.7     220   406.2

TN  CROSS SECTION  13 TO 14  --  FLOW TO LEFT OVERBANK
NS     2     13      14      -1    .045    .005
NG     0   406.2     200   408.5

TN  CROSS SECTION  14 TO 15  --  FLOW TO RIGHT OVERBANK (TRIB)
NS     2     14      15      -1    .045    .005
NG     0     410     270   412.5

TN  CROSS SECTION  15 TO 16  --  FLOW TO RIGHT OVERBANK (TRIB)
NS     2     15      16      -1    .045    .005
NG     0   412.5     230     415

TN  CROSS SECTION  16 TO 17  --  FLOW TO RIGHT OVERBANK (TRIB)
NS     2     16      17      -1    .045    .005
NG     0     415     275     418

TN  CROSS SECTION  17 TO 18  --  FLOW TO RIGHT OVERBANK (TRIB)
NS     2     17      18      -1    .045    .005
NG     0     418     280   421.7
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T1 FLOOD PLAIN DELINEATION FOR
T2 MILLSTONE MANOR DRAINAGEWAY--EXISTING CONDITIONS
T3 IRONWOOD WASH BREAK-OUT    JON FULLER 3/23/88

J1  ICHECK    INQ      NINV      IDIR     STRT     METRIC    HVINS    Q        WSEL     FQ

     0.       2.       0.        0. -1.000000     .00       .0      0.   400.000    .000

J2  NPROF     IPLOT    PRFVS     XSECV    XSECH    FN        ALLDC    IBW      CHNIM    ITRACE

     1.000    .000    -1.000     .000     .000     .000      .000     .000     .000     .000


NC      .045      .045      .040      .100      .300      .000      .000      .000      .000      .000
QT     4.000   500.000   750.000  1000.000  1250.000      .000      .000      .000      .000      .000
X1    10.000     8.000   174.000   230.000      .000      .000      .000      .000      .000      .000
GR   400.000      .000   398.000   125.000   400.000   140.000   400.000   174.000   399.000   195.000
GR   400.000   230.000   400.000   285.000   400.000   400.000      .000      .000      .000      .000

X1    11.000     9.000   120.000   130.000   200.000   150.000   180.000      .000      .000      .000
X3    10.000      .000      .000      .000      .000      .000      .000      .000      .000      .000
GR   402.000      .000   400.000    50.000   400.500    85.000   400.000   120.000   400.000   130.000
GR   401.000   170.000   400.000   209.000   400.000   213.000   402.000   440.000      .000      .000

X1    12.000     7.000    80.000   100.000   160.000   190.000   170.000      .000      .000      .000
GR   403.700      .000   402.000    80.000   401.000    90.000   402.000   100.000   404.000   220.000
GR   404.000   310.000   404.200   343.000      .000      .000      .000      .000      .000      .000

X1    13.000     7.000    33.000    56.000   210.000   230.000   210.000      .000      .000      .000
GR   406.200      .000   406.000    15.000   404.000    33.000   403.600    47.000   404.000    56.000
GR   406.000   140.000   407.500   270.000      .000      .000      .000      .000      .000      .000

X1    14.000     7.000     8.000    70.000   200.000   190.000   200.000      .000      .000      .000
GR   408.500      .000   408.000     8.000   406.000    15.000   406.000    32.000   408.000    70.000
GR   408.000   182.000   410.000   270.000      .000      .000      .000      .000      .000      .000

X1    15.000     6.000    61.000   131.000   300.000   320.000   300.000      .000      .000      .000
GR   412.800      .000   412.000    61.000   410.000    80.000   412.000   131.000   412.000   172.000
GR   412.500   270.000      .000      .000      .000      .000      .000      .000      .000      .000

X1    16.000     5.000   281.000   301.000   280.000   260.000   230.000      .000      .000      .000
GR   416.400      .000   416.000   190.000   414.000   281.000   414.000   301.000   415.000   400.000

X1    17.000     6.000   150.000   191.000   220.000   270.000   260.000      .000      .000      .000
GR   420.000      .000   418.000    55.000   418.000   150.000   417.500   170.000   418.000   191.000
GR   418.000   384.000      .000      .000      .000      .000      .000      .000      .000      .000

X1    18.000     4.000   110.000   280.000   200.000   260.000   240.000      .000      .000      .000
GR   421.000      .000   420.000   110.000   420.000   280.000   421.700   370.000      .000      .000
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X1	19.000	14.000	234.000	287.000	300.000	235.000	270.000	.000	.000	.000
GR	425.300	.000	424.000	120.000	424.000	166.000	423.000	205.000	424.000	234.000
GR	424.000	250.000	422.000	260.000	424.000	287.000	422.100	333.000	424.000	378.000
GR	424.000	400.000	423.600	440.000	424.000	468.000	425.000	505.000	.000	.000
X1	20.000	8.000	135.000	258.000	310.000	230.000	275.000	.000	.000	.000
GR	428.000	.000	426.200	80.000	426.000	135.000	426.000	258.000	428.000	275.000
GR	427.000	315.000	428.000	350.000	428.500	375.000	.000	.000	.000	.000
X1	21.000	8.000	129.000	204.000	270.000	260.000	265.000	.000	.000	.000
GR	431.000	.000	430.000	68.000	430.000	129.000	429.500	150.000	430.000	176.000
GR	430.000	204.000	430.000	230.000	431.000	340.000	.000	.000	.000	.000
X1	22.000	10.000	245.000	372.000	250.000	250.000	250.000	.000	.000	.000
GR	434.500	.000	434.000	28.000	434.000	163.000	433.500	195.000	434.000	219.000
GR	434.000	245.000	432.000	279.000	432.000	295.000	434.000	372.000	434.200	400.000
EJ	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

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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 10.000

3265 DIVIDED FLOW

3720 CRITICAL DEPTH ASSUMED

10.00	1.47	399.47	399.47	400.00	399.79	.33	.00	.00	400.00
366.	351.	15.	0.	75.	6.	0.	0.	0.	400.00
.00	4.67	2.45	.00	.045	.040	.045	.000	398.00	33.38
.030326	0.	0.	0.	0	18	0	.00	128.71	211.31

*SECNO 11.000

11.00	1.18	401.18	.00	.00	401.22	.04	1.60	.03	400.00
366.	142.	28.	196.	83.	12.	138.	1.	1.	400.00
.03	1.72	2.40	1.42	.045	.040	.045	.000	400.00	20.48
.003344	200.	180.	150.	5	0	0	.00	326.55	347.03

*SECNO 12.000

3685 20 TRIALS ATTEMPTED WSEL.CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

12.00	2.09	403.09	403.09	.00	403.46	.36	1.07	.10	402.00
366.	75.	195.	96.	28.	32.	36.	1.	2.	402.00
.04	2.68	6.12	2.68	.045	.040	.045	.000	401.00	28.55
.014689	160.	170.	190.	20	17	0	.00	137.05	165.60

*SECNO 13.000

13.00	1.97	405.57	.00	.00	405.83	.26	2.37	.01	404.00
366.	29.	204.	134.	11.	41.	52.	2.	2.	404.00
.06	2.58	5.00	2.59	.045	.040	.045	.000	403.60	18.86
.008466	210.	210.	230.	3	0	0	.00	103.11	121.97

*SECNO 14.000

14.00	1.79	407.79	.00	.00	408.26	.47	2.36	.06	408.00
366.	0.	366.	0.	0.	67.	0.	2.	3.	408.00
.07	.00	5.50	.00	.045	.040	.045	.000	406.00	8.73
.018066	200.	200.	190.	2	0	0	.00	57.32	66.05

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

*SECNO 15.000

15.00	2.17	412.17	411.91	.00	412.46	.28	4.18	.02	412.00
366.	1.	356.	10.	1.	82.	10.	3.	4.	412.00
.09	.68	4.34	.96	.045	.040	.045	.000	410.00	47.84
.011047	300.	300.	320.	10	9	0	.00	157.98	205.83

*SECNO 16.000

3280 CROSS SECTION 16.00 EXTENDED .16 FEET

16.00	1.16	415.16	.00	.00	415.34	.18	2.87	.01	414.00
369.	79.	107.	183.	31.	23.	65.	3.	5.	414.00
.11	2.58	4.61	2.81	.045	.040	.045	.000	414.00	228.27
.012646	280.	230.	260.	4	0	0	.00	171.73	400.00

*SECNO 17.000

3280 CROSS SECTION 17.00 EXTENDED .51 FEET

17.00	1.02	418.52	.00	.00	418.63	.11	3.28	.01	418.00
474.	124.	111.	240.	52.	31.	99.	4.	6.	418.00
.13	2.36	3.54	2.41	.045	.040	.045	.000	417.50	40.86
.013023	220.	260.	270.	5	0	0	.00	343.14	384.00

*SECNO 18.000

18.00	.84	420.84	.00	.00	420.95	.11	2.32	.00	420.00
500.	62.	409.	30.	38.	142.	18.	5.	8.	420.00
.16	1.61	2.88	1.61	.045	.040	.045	.000	420.00	18.31
.007680	200.	240.	260.	4	0	0	.00	305.82	324.13

*SECNO 19.000

3265 DIVIDED FLOW

19.00	1.80	423.80	423.77	.00	424.08	.27	3.08	.05	424.00
500.	56.	147.	296.	22.	30.	73.	6.	9.	424.00
.18	2.55	4.90	4.35	.045	.040	.045	.000	422.00	173.62
.020114	300.	270.	235.	11	17	0	.00	204.50	454.32

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

*SECNO 20.000

20.00	.96	426.96	.00	.00	427.08	.12	2.99	.01	426.00
500.	136.	357.	7.	60.	118.	4.	7.	11.	426.00
.20	2.28	3.03	1.69	.045	.040	.045	.000	426.00	46.38
.007080	310.	275.	230.	4	0	0	.00	219.74	266.13

*SECNO 21.000
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

21.00	1.07	430.57	430.57	.00	430.82	.25	3.21	.04	430.00
500.	149.	258.	93.	46.	54.	32.	8.	12.	430.00
.22	3.27	4.75	2.86	.045	.040	.045	.000	429.50	29.40
.025122	270.	265.	260.	2	8	0	.00	263.04	292.44

*SECNO 22.000

3265 DIVIDED FLOW

22.00	1.95	433.95	.00	.00	434.15	.19	3.32	.01	434.00
500.	12.	488.	0.	11.	136.	0.	9.	13.	434.00
.24	1.10	3.58	.00	.045	.040	.045	.000	432.00	166.46
.008205	250.	250.	250.	4	0	0	.00	173.94	369.92

TN CROSS SECTION 12 TO 13 -- FLOW TO LEFT OVERBANK

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
.0	.00	.00	.00	220.0	.0

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
.00	.00	.00	.00	.00	.00	7	403.093	405.570	12.000	13.000

TN CROSS SECTION 13 TO 14 -- FLOW TO LEFT OVERBANK

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
.0	.00	.00	.00	200.0	.0

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
.00	.00	.00	.00	.00	.00	7	405.570	407.789	13.000	14.000

TN CROSS SECTION 14 TO 15 -- FLOW TO RIGHT OVERBANK (TRIB)

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
.0	.00	.00	.00	270.0	.0

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
.00	.00	.00	.00	.00	.00	7	407.789	412.172	14.000	15.000

TN CROSS SECTION 15 TO 16 -- FLOW TO RIGHT OVERBANK (TRIB)

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
6.0	.43	.16	.08	230.0	75.5

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
2.62	2.62	.15	2.62	2.62	.15	7	412.172	415.160	15.000	16.000

TN CROSS SECTION 16 TO 17 -- FLOW TO RIGHT OVERBANK (TRIB)

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
93.0	1.13	.52	.34	275.0	275.0

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
105.45	105.46	.01	108.07	108.08	.01	7	415.160	418.516	16.000	17.000

TN CROSS SECTION 17 TO 18 -- FLOW TO RIGHT OVERBANK (TRIB)

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
27.1	.95	.52	.26	280.0	105.0

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
25.67	25.67	.03	133.75	133.75	.00	7	418.516	420.840	17.000	18.000

THIS RUN EXECUTED 04-19-88

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 HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
 ERROR CORR -  01,02,03,04,05,06
 MODIFICATION -  50,51,52,53,54,55,56
 IBM-PC-XT VERSION AUGUST 1985
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T1
T2
T3 Q = 750

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0.	3.	0.	0.	-1.000000	.00	.0	0.	600.000	.000

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	2.000	.000	-1.000	.000	.000	.000	.000	.000	.000	.000

34

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 2

CCHV= .100 CEHV= .300

*SECNO 10.000

3265 DIVIDED FLOW

3720 CRITICAL DEPTH ASSUMED

10.00	1.63	399.63	399.63	400.00	399.97	.35	.00	.00	400.00
479.	448.	32.	0.	93.	11.	0.	0.	0.	400.00
.00	4.83	2.88	.00	.045	.040	.045	.000	398.00	23.34
.028278	0.	0.	0.	0	10	0	.00	148.95	216.93

*SECNO 11.000

11.00	1.33	401.33	.00	.00	401.38	.05	1.37	.03	400.00
479.	181.	34.	264.	97.	13.	169.	1.	1.	400.00
.03	1.88	2.59	1.56	.045	.040	.045	.000	400.00	17.00
.003353	200.	180.	150.	4	0	0	.00	345.80	362.80

*SECNO 12.000

3685 20 TRIALS ATTEMPTED WSEL.CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

12.00	2.25	403.25	403.25	.00	403.65	.39	1.08	.10	402.00
479.	109.	231.	139.	37.	35.	47.	2.	2.	402.00
.04	2.96	6.58	2.96	.045	.040	.045	.000	401.00	21.02
.014950	160.	170.	190.	20	17	0	.00	154.17	175.20

*SECNO 13.000

13.00	2.18	405.78	.00	.00	406.08	.30	2.42	.01	404.00
479.	41.	249.	190.	14.	46.	67.	2.	3.	404.00
.05	2.83	5.45	2.85	.045	.040	.045	.000	403.60	16.95
.008655	210.	210.	230.	2	0	0	.00	113.95	130.90

*SECNO 14.000

7185 MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

14.00	2.16	408.16	408.16	.00	408.56	.40	2.01	.03	408.00
479.	0.	460.	19.	0.	89.	18.	3.	3.	408.00
.06	.67	5.18	1.05	.045	.040	.045	.000	406.00	5.47
.012132	200.	200.	190.	3	5	0	.00	183.48	188.96

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

*SECNO 15.000

7185 MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

15.00	2.26	412.26	412.26	.00	412.65	.39	3.94	.00	412.00
479.	3.	453.	23.	3.	88.	17.	3.	5.	412.00
.08	1.00	5.15	1.37	.045	.040	.045	.000	410.00	41.30
.014171	300.	300.	320.	3	8	0	.00	181.32	222.63

*SECNO 16.000

3280 CROSS SECTION 16.00 EXTENDED .37 FEET

16.00	1.37	415.37	.00	.00	415.56	.18	2.89	.02	414.00
499.	111.	127.	262.	43.	27.	87.	4.	6.	414.00
.10	2.58	4.61	3.02	.045	.040	.045	.000	414.00	218.44
.010059	280.	230.	260.	5	0	0	.00	181.56	400.00

*SECNO 17.000

3280 CROSS SECTION 17.00 EXTENDED .63 FEET

17.00	1.13	418.63	.00	.00	418.80	.17	3.24	.00	418.00
703.	189.	152.	363.	65.	36.	121.	5.	7.	418.00
.12	2.90	4.21	2.99	.045	.040	.045	.000	417.50	37.70
.015233	220.	260.	270.	5	0	0	.00	346.30	384.00

*SECNO 18.000

3280 CROSS SECTION 18.00 EXTENDED .05 FEET

18.00	1.04	421.04	.00	.00	421.18	.14	2.38	.00	420.00
750.	114.	583.	53.	60.	178.	29.	7.	9.	420.00
.15	1.89	3.27	1.83	.045	.040	.045	.000	420.00	.00
.007245	200.	240.	260.	3	0	0	.00	335.57	335.57

*SECNO 19.000

7185 MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

19.00	2.05	424.05	424.05	.00	424.31	.26	3.00	.04	424.00
750.	119.	172.	459.	39.	39.	108.	8.	11.	424.00
.16	3.02	4.36	4.24	.045	.040	.045	.000	422.00	115.78
.020585	300.	270.	235.	9	22	0	.00	353.91	469.69

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

*SECNO 20.000

3265 DIVIDED FLOW

20.00	1.19	427.19	.00	.00	427.36	.17	3.05	.01	426.00
750.	217.	520.	13.	82.	147.	7.	9.	13.	426.00
.19	2.64	3.54	1.71	.045	.040	.045	.000	426.00	35.80
.007162	310.	275.	230.	5	0	0	.00	246.94	321.81

*SECNO 21.000

7185 MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

21.00	1.23	430.73	430.73	.00	431.05	.32	3.21	.04	430.00
750.	235.	357.	157.	63.	67.	48.	11.	15.	430.00
.20	3.74	5.36	3.25	.045	.040	.045	.000	429.50	18.23
.024406	270.	265.	260.	2	8	0	.00	292.27	310.51

*SECNO 22.000

22.00	2.18	434.18	.00	.00	434.42	.24	3.36	.01	434.00
750.	70.	678.	1.	54.	166.	2.	12.	17.	434.00
.22	1.30	4.09	.61	.045	.040	.045	.000	432.00	17.94
.008505	250.	250.	250.	4	0	0	.00	379.21	397.15

37

TN CROSS SECTION 12 TO 13 -- FLOW TO LEFT OVERBANK

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
.0	.00	.00	.00	220.0	.0

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
.00	.00	.00	.00	.00	.00	7	403.253	405.778	12.000	13.000

TN CROSS SECTION 13 TO 14 -- FLOW TO LEFT OVERBANK

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
.0	.00	.00	.00	200.0	.0

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
.00	.00	.00	.00	.00	.00	7	405.778	408.158	13.000	14.000

TN CROSS SECTION 14 TO 15 -- FLOW TO RIGHT OVERBANK (TRIB)

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
.0	.00	.00	.00	270.0	.0

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
.00	.00	.00	.00	.00	.00	7	408.158	412.258	14.000	15.000

TN CROSS SECTION 15 TO 16 -- FLOW TO RIGHT OVERBANK (TRIB)

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
26.1	.76	.37	.19	230.0	139.7

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
19.97	19.97	.02	19.97	19.97	.02	7	412.258	415.374	15.000	16.000

TN CROSS SECTION 16 TO 17 -- FLOW TO RIGHT OVERBANK (TRIB)

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
138.2	1.48	.63	.50	275.0	275.0

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
203.92	203.97	.02	223.90	223.94	.02	7	415.374	418.631	16.000	17.000

TN CROSS SECTION 17 TO 18 -- FLOW TO RIGHT OVERBANK (TRIB)

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
43.2	1.08	.63	.32	280.0	136.9

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
46.71	46.73	.03	270.61	270.67	.02	7	418.631	421.040	17.000	18.000

Q100

THIS RUN EXECUTED 04-19-88

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HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
ERROR CORR -  01,02.03,04,05,06
MODIFICATION -  50,51,52,53,54,55,56
IBM-PC-XT VERSION AUGUST 1985
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Q_{100} = 1000cfs

T1
T2
T3 Q = 1000

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0.	4.	0.	0.	-1.000000	.00	.0	0.	400.000	.000

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	3.000	.000	-1.000	.000	.000	.000	.000	.000	.000	.000

Q100

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 3

CCHV= .100 CEHV= .300

*SECNO 10.000

3265 DIVIDED FLOW

3720 CRITICAL DEPTH ASSUMED

10.00	1.74	399.74	399.74	400.00	400.12	.38	.00	.00	400.00
586.	537.	49.	0.	106.	15.	0.	0.	0.	400.00
.00	5.07	3.22	.00	.045	.040	.045	.000	398.00	16.29
.028410	0.	0.	0.	0	7	0	.00	163.16	220.88

*SECNO 11.000

11.00	1.45	401.45	.00	.00	401.50	.05	1.35	.03	400.00
586.	217.	39.	329.	110.	14.	198.	1.	1.	400.00
.03	1.98	2.72	1.66	.045	.040	.045	.000	400.00	13.92
.003284	200.	180.	150.	4	0	0	.00	362.86	376.78

*SECNO 12.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

12.00	2.38	403.38	403.38	.00	403.80	.42	1.07	.11	402.00
586.	143.	261.	182.	45.	38.	57.	2.	2.	402.00
.04	3.18	6.95	3.18	.045	.040	.045	.000	401.00	14.99
.015155	160.	170.	190.	20	17	0	.00	167.90	182.89

*SECNO 13.000

13.00	2.35	405.95	.00	.00	406.29	.33	2.47	.01	404.00
586.	52.	289.	245.	17.	50.	80.	3.	3.	404.00
.05	3.05	5.83	3.06	.045	.040	.045	.000	403.60	15.43
.008868	210.	210.	230.	2	0	0	.00	122.58	138.01

*SECNO 14.000

7185 MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

14.00	2.32	408.32	408.32	.00	408.72	.40	1.96	.02	408.00
586.	1.	525.	60.	1.	99.	38.	3.	4.	408.00
.06	1.02	5.33	1.58	.045	.040	.045	.000	406.00	2.93
.011145	200.	200.	190.	2	8	0	.00	193.01	195.94

Q_{100}

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

*SECNO 15.000

7185 MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

15.00	2.42	412.42	412.42	.00	412.80	.38	3.53	.00	412.00
586.	9.	518.	59.	7.	100.	35.	4.	5.	412.00
.08	1.30	5.20	1.68	.045	.040	.045	.000	410.00	28.67
.012260	300.	300.	320.	2	8	0	.00	226.43	255.10

*SECNO 16.000

3280 CROSS SECTION 16.00 EXTENDED .48 FEET

16.00	1.48	415.48	.00	.00	415.70	.23	2.89	.02	414.00
628.	143.	152.	334.	50.	30.	97.	5.	6.	414.00
.10	2.87	5.13	3.45	.045	.040	.045	.000	414.00	213.76
.011329	280.	230.	260.	5	0	0	.00	186.24	400.00

*SECNO 17.000

3280 CROSS SECTION 17.00 EXTENDED .77 FEET

17.00	1.27	418.77	.00	.00	418.96	.19	3.25	.00	418.00
921.	254.	185.	482.	81.	42.	148.	6.	8.	418.00
.12	3.14	4.42	3.25	.045	.040	.045	.000	417.50	33.88
.013854	220.	260.	270.	5	0	0	.00	350.12	384.00

*SECNO 18.000

3280 CROSS SECTION 18.00 EXTENDED .19 FEET

18.00	1.18	421.18	.00	.00	421.36	.18	2.40	.00	420.00
1000.	173.	749.	78.	76.	202.	37.	8.	10.	420.00
.14	2.29	3.71	2.07	.045	.040	.045	.000	420.00	.00
.007900	200.	240.	260.	3	0	0	.00	342.94	342.94

*SECNO 19.000

19.00	2.19	426.19	426.13	.00	426.48	.28	3.08	.03	424.00
1000.	184.	224.	592.	58.	47.	136.	10.	12.	426.00
.16	3.18	4.74	4.36	.045	.040	.045	.000	422.00	102.07
.019056	300.	270.	235.	12	17	0	.00	373.12	475.19

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

*SECNO 20.000

3265 DIVIDED FLOW

20.00	1.37	427.37	.00	.00	427.58	.21	3.10	.01	426.00
1000.	299.	678.	23.	100.	169.	13.	11.	14.	426.00
.18	2.98	4.02	1.73	.045	.040	.045	.000	426.00	27.94
.007684	310.	275.	230.	5	0	0	.00	269.55	327.99

*SECNO 21.000

7185 MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

21.00	1.38	430.88	430.88	.00	431.24	.36	3.28	.04	430.00
1000.	323.	448.	229.	80.	78.	65.	13.	16.	430.00
.19	4.04	5.77	3.49	.045	.040	.045	.000	429.50	8.16
.022986	270.	265.	260.	2	5	0	.00	318.63	326.79

*SECNO 22.000

3280 CROSS SECTION 22.00 EXTENDED .14 FEET

22.00	2.33	434.33	.00	.00	434.60	.27	3.35	.01	434.00
1000.	157.	835.	8.	91.	186.	7.	14.	18.	434.00
.21	1.73	4.49	1.19	.045	.040	.045	.000	432.00	9.00
.008777	250.	250.	250.	3	0	0	.00	391.00	400.00

Q100

TN CROSS SECTION 12 TO 13 -- FLOW TO LEFT OVERBANK

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
.0	.00	.00	.00	220.0	.0

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
.00	.00	.00	.00	.00	.00	7	403.382	405.952	12.000	13.000

TN CROSS SECTION 13 TO 14 -- FLOW TO LEFT OVERBANK

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
.0	.00	.00	.00	200.0	.0

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
.00	.00	.00	.00	.00	.00	7	405.952	408.317	13.000	14.000

TN CROSS SECTION 14 TO 15 -- FLOW TO RIGHT OVERBANK (TRIB)

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
.0	.00	.00	.00	270.0	.0

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
.00	.00	.00	.00	.00	.00	7	408.317	412.424	14.000	15.000

TN CROSS SECTION 15 TO 16 -- FLOW TO RIGHT OVERBANK (TRIB)

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
47.4	.90	.48	.24	230.0	198.4

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
42.46	42.58	.27	42.46	42.58	.27	7	412.424	415.478	15.000	16.000

Q100

TN CROSS SECTION 16 TO 17 -- FLOW TO RIGHT OVERBANK (TRIB)

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
171.4	1.70	.77	.62	275.0	275.0

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
292.30	291.92	.13	334.77	334.50	.08	7	415.478	418.769	16.000	17.000

TN CROSS SECTION 17 TO 18 -- FLOW TO RIGHT OVERBANK (TRIB)

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
64.4	1.23	.77	.38	280.0	167.5

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
79.29	79.45	.20	414.06	413.95	.03	7	418.769	421.183	17.000	18.000

THIS RUN EXECUTED 04-19-88

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 HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
 ERROR CORR -  01,02,03,04,05,06
 MODIFICATION -  50,51,52,53,54,55,56
 IBM-PC-XT VERSION AUGUST 1985
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T1
T2
T3 Q = 1250

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0.	5.	0.	0.	-1.000000	.00	.0	0.	400.000	.000

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	15.000	.000	-1.000	.000	.000	.000	.000	.000	.000	.000

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 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 4


CCHV=    .100 CEHV=    .300
*SECNO 10.000

3265 DIVIDED FLOW

3720 CRITICAL DEPTH ASSUMED
    10.00    1.83   399.83   399.83   400.00   400.23      .40      .00      .00   400.00
     679.    612.      67.       0.     117.      19.       0.       0.       0.   400.00
      .00    5.22     3.47      .00     .045     .040     .045     .000   398.00    10.58
  .028123      0.       0.       0.        0       12        0      .00   174.67   224.07


*SECNO 11.000
    11.00    1.54   401.54      .00      .00   401.60      .06     1.34      .03   400.00
     679.    248.      44.     387.     120.      15.     223.       1.       1.   400.00
      .03    2.07     2.83     1.74     .045     .040     .045     .000   400.00    11.52
  .003257    200.     180.     150.        4        0        0      .00   376.20   387.71


*SECNO 12.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
    12.00    2.48   403.48   403.48      .00   403.92      .45     1.08      .12   402.00
     679.    172.     287.     220.      51.      40.      65.       2.       2.   402.00
      .04    3.36     7.27     3.36     .045     .040     .045     .000   401.00    10.57
  .015548    160.     170.     190.       20       17        0      .00   177.96   188.53


*SECNO 13.000
    13.00    2.48   406.08      .00      .00   406.44      .35     2.50      .01   404.00
     679.     64.     318.     298.      20.      52.      91.       3.       3.   404.00
      .05    3.22     6.06     3.26     .045     .040     .045     .000   403.60     8.86
  .008850    210.     210.     230.        2        0        0      .00   138.23   147.09


*SECNO 14.000
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
    14.00    2.42   408.42   408.42      .00   408.83      .41     1.93      .02   408.00
     679.      2.     580.      97.       1.     105.      51.       4.       4.   408.00
      .06    1.23     5.51     1.89     .045     .040     .045     .000   406.00     1.23
  .010947    200.     200.     190.        2        8        0      .00   199.39   200.62
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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

*SECNO 15.000
3280 CROSS SECTION 15.00 EXTENDED .03 FEET

7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

15.00	2.53	412.53	412.53	.00	412.91	.38	3.42	.00	412.00
679.	16.	570.	93.	11.	107.	49.	5.	5.	412.00
.08	1.47	5.32	1.89	.045	.040	.045	.000	410.00	20.57
.011680	300.	300.	320.	2	8	0	.00	249.43	270.00

*SECNO 16.000
3280 CROSS SECTION 16.00 EXTENDED .58 FEET

16.00	1.58	415.58	.00	.00	415.84	.26	2.92	.01	414.00
753.	175.	174.	404.	57.	32.	107.	6.	7.	414.00
.10	3.09	5.51	3.79	.045	.040	.045	.000	414.00	209.23
.012002	280.	230.	260.	5	0	0	.00	190.77	400.00

*SECNO 17.000
3280 CROSS SECTION 17.00 EXTENDED .88 FEET

17.00	1.38	418.88	.00	.00	419.10	.21	3.25	.00	418.00
1133.	319.	217.	598.	95.	47.	171.	7.	8.	418.00
.11	3.36	4.66	3.50	.045	.040	.045	.000	417.50	30.67
.013298	220.	260.	270.	5	0	0	.00	353.33	384.00

*SECNO 18.000
3280 CROSS SECTION 18.00 EXTENDED .32 FEET

18.00	1.31	421.31	.00	.00	421.53	.21	2.43	.00	420.00
1250.	235.	910.	104.	90.	224.	46.	9.	10.	420.00
.13	2.62	4.07	2.28	.045	.040	.045	.000	420.00	.00
.008322	200.	240.	260.	3	0	0	.00	349.65	349.65

*SECNO 19.000

19.00	2.33	424.33	424.24	.00	424.63	.30	3.08	.02	424.00
1250.	257.	272.	721.	77.	55.	162.	11.	12.	424.00
.15	3.34	4.99	4.45	.045	.040	.045	.000	422.00	89.38
.017439	300.	270.	235.	8	17	0	.00	390.90	480.27

48

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

*SECNO 20.000

3265 DIVIDED FLOW

20.00	1.51	427.51	.00	.00	427.77	.26	3.14	.00	426.00
1250.	382.	831.	36.	116.	186.	20.	13.	15.	426.00
.17	3.29	4.46	1.85	.045	.040	.045	.000	426.00	21.55
.008285	310.	275.	230.	5	0	0	.00	287.97	333.03

*SECNO 21.000

3280 CROSS SECTION 21.00 EXTENDED .02 FEET

7185 MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

21.00	1.52	431.02	431.02	.00	431.40	.38	3.33	.04	430.00
1250.	412.	531.	306.	98.	88.	84.	15.	16.	430.00
.18	4.23	6.02	3.66	.045	.040	.045	.000	429.50	.00
.021141	270.	265.	260.	2	5	0	.00	340.00	340.00

*SECNO 22.000

3280 CROSS SECTION 22.00 EXTENDED .26 FEET

22.00	2.47	434.47	.00	.00	434.77	.30	3.36	.01	434.00
1250.	250.	984.	16.	120.	202.	10.	17.	19.	434.00
.20	2.08	4.88	1.61	.045	.040	.045	.000	432.00	2.13
.009314	250.	250.	250.	3	0	0	.00	397.87	400.00

TN CROSS SECTION 12 TO 13 -- FLOW TO LEFT OVERBANK

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
.0	.00	.00	.00	220.0	.0

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
.00	.00	.00	.00	.00	.00	10	403.475	406.082	12.000	13.000

TN CROSS SECTION 13 TO 14 -- FLOW TO LEFT OVERBANK

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
.0	.00	.00	.00	200.0	.0

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
.00	.00	.00	.00	.00	.00	10	406.082	408.423	13.000	14.000

TN CROSS SECTION 14 TO 15 -- FLOW TO RIGHT OVERBANK (TRIB)

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
.1	.14	.03	.02	270.0	5.1

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
.01	.01	2.06	.01	.01	2.06	10	408.423	412.530	14.000	15.000

TN CROSS SECTION 15 TO 16 -- FLOW TO RIGHT OVERBANK (TRIB)

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
69.9	1.05	.58	.30	230.0	230.0

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
73.70	73.69	.02	73.71	73.70	.02	10	412.530	415.577	15.000	16.000

TN CROSS SECTION 16 TO 17 -- FLOW TO RIGHT OVERBANK (TRIB)

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
201.0	1.89	.88	.73	275.0	275.0

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
380.66	380.70	.01	454.37	454.39	.00	10	415.577	418.884	16.000	17.000

TN CROSS SECTION 17 TO 18 -- FLOW TO RIGHT OVERBANK (TRIB)

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH
86.1	1.36	.88	.44	280.0	194.8

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
116.70	116.74	.03	571.07	571.13	.01	10	418.884	421.313	17.000	18.000

51

THIS RUN EXECUTED 04-19-88

****
HEC2 RELEASE DATED NOV 76 UPDATED MAY 1984
ERROR CORR - 01,02,03,04,05,06
MODIFICATION - 50,51,52,53,54,55,56
IBM-PC-XT VERSION AUGUST 1985
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

OOO WASH BREAK-OUT J0

SUMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10K*S	VCH	AREA	.01K
*	10.000	.00	.00	.00	398.00	366.25	399.47	399.47	399.79	303.26	2.45	81.29	21.03
*	10.000	.00	.00	.00	398.00	479.39	399.63	399.63	399.97	282.78	2.88	103.60	28.51
*	10.000	.00	.00	.00	398.00	585.94	399.74	399.74	400.12	284.10	3.22	121.19	34.76
*	10.000	.00	.00	.00	398.00	678.93	399.83	399.83	400.23	281.23	3.47	136.62	40.48
	11.000	180.00	.00	.00	400.00	366.25	401.18	.00	401.22	33.44	2.40	232.04	63.34
	11.000	180.00	.00	.00	400.00	479.39	401.33	.00	401.38	33.53	2.59	278.77	82.79
	11.000	180.00	.00	.00	400.00	585.94	401.45	.00	401.50	32.84	2.72	322.41	102.25
	11.000	180.00	.00	.00	400.00	678.93	401.54	.00	401.60	32.57	2.83	358.00	118.96
*	12.000	170.00	.00	.00	401.00	366.25	403.09	403.09	403.46	146.89	6.12	95.85	30.22
*	12.000	170.00	.00	.00	401.00	479.39	403.25	403.25	403.65	149.50	6.58	119.14	39.21
*	12.000	170.00	.00	.00	401.00	585.94	403.38	403.38	403.80	151.55	6.95	139.80	47.60
*	12.000	170.00	.00	.00	401.00	678.93	403.48	403.48	403.92	155.48	7.27	156.05	54.45
	13.000	210.00	.00	.00	403.60	366.25	405.57	.00	405.83	84.66	5.00	103.64	39.81
	13.000	210.00	.00	.00	403.60	479.39	405.78	.00	406.08	86.55	5.45	126.72	51.53
	13.000	210.00	.00	.00	403.60	585.94	405.95	.00	406.29	88.68	5.83	146.74	62.22
	13.000	210.00	.00	.00	403.60	678.93	406.08	.00	406.44	88.50	6.06	163.37	72.17
	14.000	200.00	.00	.00	406.00	366.25	407.79	.00	408.26	180.66	5.50	66.60	27.25
*	14.000	200.00	.00	.00	406.00	479.39	408.16	408.16	408.56	121.32	5.18	107.26	43.52
*	14.000	200.00	.00	.00	406.00	585.94	408.32	408.32	408.72	111.45	5.33	137.14	55.50
*	14.000	200.00	.00	.00	406.00	678.93	408.42	408.42	408.83	109.47	5.51	158.02	54.89
	15.000	300.00	.00	.00	410.00	366.25	412.17	411.91	412.46	110.47	4.34	93.21	34.85
*	15.000	300.00	.00	.00	410.00	479.39	412.26	412.26	412.65	141.71	5.15	107.75	40.27
*	15.000	300.00	.00	.00	410.00	585.94	412.42	412.42	412.80	122.60	5.20	141.53	52.92
*	15.000	300.00	.00	.00	410.00	678.94	412.53	412.53	412.91	116.80	5.32	167.05	62.82
	16.000	230.00	.00	.00	414.00	368.88	415.16	.00	415.34	126:46	4.61	118.96	32.80
	16.000	230.00	.00	.00	414.00	499.36	415.37	.00	415.56	100.59	4.61	157.12	49.79
	16.000	230.00	.00	.00	414.00	628.41	415.48	.00	415.70	113.29	5.13	176.04	59.04
	16.000	230.00	.00	.00	414.00	752.64	415.58	.00	415.84	120.22	5.51	194.80	68.70

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	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10K*S	VCH	AREA	.01K
	17.000	260.00	.00	.00	417.50	474.33	418.52	.00	418.63	130.23	3.54	183.06	41.56
	17.000	260.00	.00	.00	417.50	703.29	418.63	.00	418.80	152.33	4.21	222.67	56.98
	17.000	260.00	.00	.00	417.50	920.71	418.77	.00	418.96	138.54	4.42	270.98	78.22
	17.000	260.00	.00	.00	417.50	1133.30	418.88	.00	419.10	132.98	4.66	312.14	98.28
	18.000	240.00	.00	.00	420.00	500.00	420.84	.00	420.95	76.80	2.88	198.31	57.06
	18.000	240.00	.00	.00	420.00	750.00	421.04	.00	421.18	72.45	3.27	268.05	88.12
	18.000	240.00	.00	.00	420.00	1000.00	421.18	.00	421.36	79.00	3.71	315.33	112.51
	18.000	240.00	.00	.00	420.00	1250.00	421.31	.00	421.53	83.22	4.07	359.20	137.02
	19.000	270.00	.00	.00	422.00	500.00	423.80	423.77	424.08	201.14	4.90	125.26	35.25
*	19.000	270.00	.00	.00	422.00	750.00	424.05	424.05	424.31	205.85	4.36	187.08	52.27
	19.000	270.00	.00	.00	422.00	1000.00	424.19	424.13	424.48	190.56	4.74	241.10	72.44
	19.000	270.00	.00	.00	422.00	1250.00	424.33	424.24	424.63	174.39	4.99	293.60	94.66
	20.000	275.00	.00	.00	426.00	500.00	426.96	.00	427.08	70.80	3.03	181.33	59.42
	20.000	275.00	.00	.00	426.00	750.00	427.19	.00	427.36	71.62	3.54	236.57	88.62
	20.000	275.00	.00	.00	426.00	1000.00	427.37	.00	427.58	76.84	4.02	282.23	114.08
	20.000	275.00	.00	.00	426.00	1250.00	427.51	.00	427.77	82.85	4.46	322.35	137.33
*	21.000	265.00	.00	.00	429.50	500.00	430.57	430.57	430.82	251.22	4.75	132.39	31.55
*	21.000	265.00	.00	.00	429.50	750.00	430.73	430.73	431.05	244.06	5.36	177.99	48.01
*	21.000	265.00	.00	.00	429.50	1000.00	430.88	430.88	431.24	229.86	5.77	223.21	65.96
*	21.000	265.00	.00	.00	429.50	1250.00	431.02	431.02	431.40	211.41	6.02	269.50	85.97
	22.000	250.00	.00	.00	432.00	500.00	433.95	.00	434.15	82.05	3.58	147.34	55.20
	22.000	250.00	.00	.00	432.00	750.00	434.18	.00	434.42	85.05	4.09	221.95	81.32
	22.000	250.00	.00	.00	432.00	1000.00	434.33	.00	434.60	87.77	4.49	283.60	106.74
	22.000	250.00	.00	.00	432.00	1250.00	434.47	.00	434.77	93.14	4.88	331.99	129.52

OOD WASH BREAK-OUT JO

SUMMARY PRINTOUT TABLE 150

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
*	10.000	366.25	399.47	.00	.00	-.53	128.71	.00
*	10.000	479.39	399.63	.16	.00	-.37	148.95	.00
*	10.000	585.94	399.74	.11	.00	-.26	163.16	.00
*	10.000	678.93	399.83	.09	.00	-.17	174.67	.00
	11.000	366.25	401.18	.00	1.71	.00	326.55	180.00
	11.000	479.39	401.33	.15	1.70	.00	345.80	180.00
	11.000	585.94	401.45	.12	1.71	.00	362.86	180.00
	11.000	678.93	401.54	.10	1.71	.00	376.20	180.00
*	12.000	366.25	403.09	.00	1.91	.00	137.05	170.00
*	12.000	479.39	403.25	.16	1.93	.00	154.17	170.00
*	12.000	585.94	403.38	.13	1.94	.00	167.90	170.00
*	12.000	678.93	403.48	.09	1.94	.00	177.96	170.00
	13.000	366.25	405.57	.00	2.48	.00	103.11	210.00
	13.000	479.39	405.78	.21	2.53	.00	113.95	210.00
	13.000	585.94	405.95	.17	2.57	.00	122.58	210.00
	13.000	678.93	406.08	.13	2.61	.00	138.23	210.00
	14.000	366.25	407.79	.00	2.22	.00	57.32	200.00
*	14.000	479.39	408.16	.37	2.38	.00	183.48	200.00
*	14.000	585.94	408.32	.16	2.36	.00	193.01	200.00
*	14.000	678.93	408.42	.11	2.34	.00	199.39	200.00
	15.000	366.25	412.17	.00	4.38	.00	157.98	300.00
*	15.000	479.39	412.26	.09	4.10	.00	181.32	300.00
*	15.000	585.94	412.42	.17	4.11	.00	226.43	300.00
*	15.000	678.94	412.53	.11	4.11	.00	249.43	300.00
	16.000	368.88	415.16	.00	2.99	.00	171.73	230.00
	16.000	499.36	415.37	.21	3.12	.00	181.56	230.00
	16.000	628.41	415.48	.10	3.05	.00	186.24	230.00
	16.000	752.64	415.58	.10	3.05	.00	190.77	230.00
	17.000	474.33	418.52	.00	3.36	.00	343.14	260.00
	17.000	703.29	418.63	.11	3.26	.00	346.30	260.00
	17.000	920.71	418.77	.14	3.29	.00	350.12	260.00
	17.000	1133.30	418.88	.12	3.31	.00	353.33	260.00
	18.000	500.00	420.84	.00	2.32	.00	305.82	240.00
	18.000	750.00	421.04	.20	2.41	.00	335.57	240.00
	18.000	1000.00	421.18	.14	2.41	.00	342.96	240.00
	18.000	1250.00	421.31	.13	2.43	.00	349.65	240.00

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
	19.000	500.00	423.80	.00	2.96	.00	204.50	270.00
*	19.000	750.00	424.05	.24	3.01	.00	353.91	270.00
	19.000	1000.00	424.19	.15	3.01	.00	373.12	270.00
	19.000	1250.00	424.33	.14	3.02	.00	390.90	270.00
	20.000	500.00	426.96	.00	3.15	.00	219.74	275.00
	20.000	750.00	427.19	.24	3.15	.00	246.94	275.00
	20.000	1000.00	427.37	.18	3.18	.00	269.55	275.00
	20.000	1250.00	427.51	.14	3.18	.00	287.97	275.00
*	21.000	500.00	430.57	.00	3.61	.00	263.04	265.00
*	21.000	750.00	430.73	.16	3.54	.00	292.27	265.00
*	21.000	1000.00	430.88	.15	3.51	.00	318.63	265.00
*	21.000	1250.00	431.02	.14	3.51	.00	340.00	265.00
	22.000	500.00	433.95	.00	3.39	.00	173.94	250.00
	22.000	750.00	434.18	.23	3.45	.00	379.21	250.00
	22.000	1000.00	434.33	.15	3.45	.00	391.00	250.00
	22.000	1250.00	434.47	.14	3.45	.00	397.87	250.00

SUMMARY OF ERRORS AND SPECIAL NOTES

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CAUTION  SECNO=   10.000  PROFILE= 1  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   10.000  PROFILE= 2  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   10.000  PROFILE= 3  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   10.000  PROFILE= 4  CRITICAL DEPTH ASSUMED

CAUTION  SECNO=   12.000  PROFILE= 1  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   12.000  PROFILE= 1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION  SECNO=   12.000  PROFILE= 1  20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION  SECNO=   12.000  PROFILE= 2  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   12.000  PROFILE= 2  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION  SECNO=   12.000  PROFILE= 2  20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION  SECNO=   12.000  PROFILE= 3  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   12.000  PROFILE= 3  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION  SECNO=   12.000  PROFILE= 3  20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION  SECNO=   12.000  PROFILE= 4  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   12.000  PROFILE= 4  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION  SECNO=   12.000  PROFILE= 4  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION  SECNO=   14.000  PROFILE= 2  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   14.000  PROFILE= 2  MINIMUM SPECIFIC ENERGY
CAUTION  SECNO=   14.000  PROFILE= 3  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   14.000  PROFILE= 3  MINIMUM SPECIFIC ENERGY
CAUTION  SECNO=   14.000  PROFILE= 4  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   14.000  PROFILE= 4  MINIMUM SPECIFIC ENERGY

CAUTION  SECNO=   15.000  PROFILE= 2  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   15.000  PROFILE= 2  MINIMUM SPECIFIC ENERGY
CAUTION  SECNO=   15.000  PROFILE= 3  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   15.000  PROFILE= 3  MINIMUM SPECIFIC ENERGY
CAUTION  SECNO=   15.000  PROFILE= 4  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   15.000  PROFILE= 4  MINIMUM SPECIFIC ENERGY

CAUTION  SECNO=   19.000  PROFILE= 2  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   19.000  PROFILE= 2  MINIMUM SPECIFIC ENERGY

CAUTION  SECNO=   21.000  PROFILE= 1  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   21.000  PROFILE= 1  MINIMUM SPECIFIC ENERGY
CAUTION  SECNO=   21.000  PROFILE= 2  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   21.000  PROFILE= 2  MINIMUM SPECIFIC ENERGY
CAUTION  SECNO=   21.000  PROFILE= 3  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   21.000  PROFILE= 3  MINIMUM SPECIFIC ENERGY
CAUTION  SECNO=   21.000  PROFILE= 4  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   21.000  PROFILE= 4  MINIMUM SPECIFIC ENERGY
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THIS RUN EXECUTED 04-19-88

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**************************************************
 HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
 ERROR CORR -  01,02,03,04,05,06
 MODIFICATION -  50,51,52,53,54,55,56
 IBM-PC-XT VERSION AUGUST 1985
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MILLSTONE MANOR #6 - DRAINAGE INVESTIGATION

By: Jon Fuller and Terry Hendricks

Date: March 18, 1988

INTRODUCTION

Millstone Manor #6 is a subdivision that was recorded in the mid-1950's. Crossing diagionally from the northeast to the southwest is a sixty foot drainageway which was platted and never constructed. This report will outline the hydrology and hydraulic problems associated with primarily the lots in Blocks 1, 4, and 5.

PROBLEM

All records indicate no engineering took place with regards to the potential for drainage improvements within Millstone Manor #6. Recently, property owners graded Lots 9-12, 20-24, Block 4; Lots 12, 13 and 19, Block 5; and opened a flow path along the platted drainageways which were never constructed. This report will address what the flooding potential is for these lots, how future permits should be processed and what type of flood problems can be expected.

WATERSHED CHARACTERISTICS

Millstone Manor #6 is affected by the Ironwood Wash watershed (see Exhibit A. The watershed was analyzed upstream of the avulsion that affects the subdivision. It has a drainage area of 2041.6 acres 53% of which have Type D soils. The rest of the soils are Type B. The 100-year discharge was calculated to be 2958 cfs. The hydrologic data sheets can be found at the end of this report.

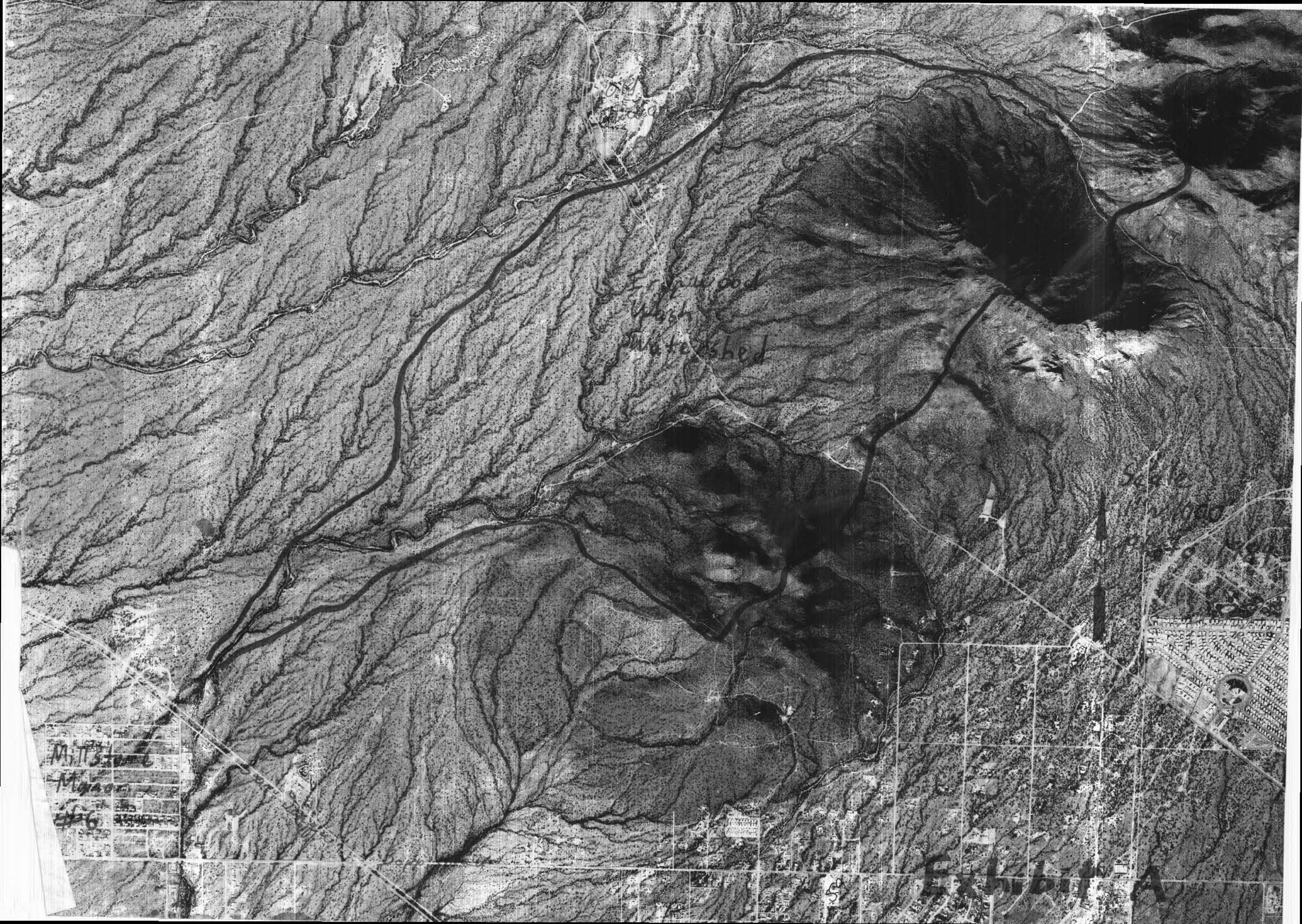
STUDY ASPECTS

By far the largest aspect as to how the Ironwood Wash affects the subdivision is how flows are dispersed through the alluvial fan to the north. This fan has two outlets, one diagonally through the subdivision, the other to the south and parallel to the Neal Avenue alignment.

In determining the flow through the subdivision, four cross-sections were taken through the fan area (San Joaquin Road, #1, #2, #3). These cross-sections are shown on Exhibit B. In his analysis to determine the flow split throughout Millstone Manor #6, Jon first determined the water surface elevation across the entire cross-section. Then with this elevation, he determined the proportioned discharge through the western split of the fan. The cross section data points are contained in Packet #1. The table below summarizes this analysis:

WESTERN ALLUVIAL SPLIT FROM THE IRONWOOD WASH

Cross Section	Water Surface Elevation	Discharge
San Joaquin Rd.	2441.03 ft	1741 cfs
1	2444.31 ft	1535 cfs
2	2447.28 ft	1355 cfs
3	2451.66 ft	265 cfs


Old
Wash
Watershed
Scale
Millstone
Manor
Exhibit A


Albert Road
Bruce St
Claude St
Dudley St
Neal Ave
NEAL AVE
SAN JOAQUIN RD
10 9 8 7 6 5
23 24 25 26 27 28
11 10 9 8 7
19 20 21 22 23 24 25
14 13 12 11 10 9
19 20 21 22 23 24
x 2441.8
x 2435.5
x 2441.3
2439.0
x 2436.8
N 432,000
E 735,000
2434.2
2439.9
x 2436.4
x 2444.9
N 431,000
x 2429.0
Exhibit B
Photo March 1984
Scale 1" = 100'
2 foot contours
Boundary for split flow analysis
100 year flood plain
20 - Lot #
N

In order to determine the nature of this fan, Jon and I researched historical photos and performed a field investigation. The historical photos show the wash is shifting more towards the east. Attached you will find a 1941 photograph. Note how much more pronounced the wash is through the Millstone Manor subdivision. The field investigation revealed the old flow path to the west is catching debris. It also indicated more active vegetation growing in the split. Such growth could induce even more debris entrapment.

Our field observations also indicated the embankments are very shallow (18 inches to 2 feet) and the wash bed is relatively flat with very large aggregate (D50 = 5/8 inch). The overbank areas are coated with fine silty aluvian which indicate frequent channel overtopping. Further down, the El Paso Natural Gas gas line right-of-way has some earth berms which will induce most of the sheet flooding to the east.

Based on all of the above findings Jon and I felt the regulatory discharge should be set at 1000 cfs. It should be noted since this is an alluvial fan there exists strong possibility of further avulsions which may reduce or increase discharge through the subdivision. The avulsion is in an area not maintained by Pima County.

EXISTING CONDITIONS

Using the 1000 cfs as the regulatory flow I calculated the flood limits through Blocks 1, 4, and 5 of Millstone Manor #6. The cross-sections are labeled 4, 5, and 6 on Exibit B. The cross-sections were measured from left to right looking upstream. The input data for these cross-sections is as follows:

Cross-Section 4 — Channel Slope = 0.004 — n-value = 0.045

Station	Elevation	Station	Elevation
0	2436 *	158	2434
20	2434	195	2434
115	2432	230	2434
122	2431.2	280	2436 *
134	2432		

Cross-Section 5 — Channel Slope = 0.011 — n-value = 0.045

Station	Elevation	Station	Elevation
0	2430	175	2428
48	2428	188	2428
50	2427.9	195	2426.2
55	2428	202	2428
85	2428	240	2428
93	2427	270	2429
103	2428	300	2428
150	2428	305	2428
160	2427	375	2430

Cross-Section 6 Station	Channel Slope Elevation	= 0.012 Station	n-value = 0.045 Elevation
0	2424	212	2423.2
98	2422.2	227	2422
135	2423.3	231	2421.2
159	2422	270	2422
165	2421.6	380	2424
177	2422		

* Ending elevations were raised to contain flow.

Please note there is a very slight break out of flow near Block 7, Lot 1. The summary of these calculations are on Exhibit C.

PERMIT REQUIREMENTS

Figure 1 is a Mannings run of what the improvement 60 foot drainage right-of-way would need to be to contain the 1000 cfs. For simplicity, vertical embankments were assumed. Under these improved conditions the depth of flow through the drainageways would be near 2.5 feet. (see Exhibit D). The existing constructed channel invert lie approximately 6 inches below the natural wash beds and there is a potential for break-out. Consequently, my recommendations for permits are as follows:

Lots	Block	Requirements
9 & 10	1	Fill cannot be placed in wash braid. Mobile to be orientated parallel to flow. No setback required. Covenants are optional.
9 & 10	4	Structure to be parallel to flow and elevated 3 feet above the invert of the adjacent drainageway. A solid structural toe for support of trailer is required due to potential scour from overbank flows. The toe down for this structural support should be to the invert of the adjacent drainageway. Covenants are required.
11 & 12	4	18 inch elevation required, covenants are optional
20 & 21	4	Same as above
22-24	4	Same as Lots 9 & 10, Block 4
12 & 13	5	Same as lots 9 & 10, Block 4
19	5	Not permittable without engineering analysis. The blockage of flow on this parcel will damage both public and private improvements. All violations on this lot must be rectified.

FURTHER RECOMMENDATIONS

Most of the flood free lots in Millstone Manor #6 have been developed. This office will need to formulate a strategy for permitting on the remaining flood prone lots. Several decisions need to be made in this regard. One of which is how far should the County go into the construction of the drainageway. It is my recommendation we generate more accurate floodplain maps for this subdivision in order for us to make the wisest decisions. I have started to accumulate information for this subdivision to begin this process. We may wish to have Jon finish work on this.

APPROVED BY:

James DeGrood, P.E., Supervisor,
Permits & Compliance Section

Date

RTH:tf

EXHIBIT C

FLOODPLAIN CALCULATION ON CROSS SECTIONS 4, 5, AND 6
BASED UPON THE I CHANNEL PROGRAM

OPERATOR :TERRY HENDRICKS
PROJECT :MILLSTONE MANOR#6 X-SECTION#4
DATE : 03/21/88

Max elev 2436.00 Max flow 3609.58 Min elev 2431.20

999.91 CFS channelized flow rate at a level of 2434.52 feet.
down a slope of .009000 ft. drop / ft. run .

START	END	ELEV	AREA	PERIM	FLOW RT	VELOCITY	OV
14.77	243.08	2434.52	279.25	228.52	999.91	3.58	

OPERATOR :TERRY HENDRICKS
PROJECT :MILLSTONE MANOR#6 X-SECTION#5
Date : 03/21/88

Max elev 2430.00 Max flow 3132.12 Min elev 2426.20

999.50 CFS channelized flow rate at a level of 2429.03 feet.
down a slope of .011000 ft. drop / ft. run .

START	END	ELEV	AREA	PERIM	FLOW RT	VELOCITY	OV
23.30	341.02	2429.03	300.18	318.44	999.50	3.33	

OPERATOR :TERRY HENDRICKS
PROJECT :MILLSTONE MANOR#6 X-SCTION#6
Date : 03/21/88

Max elev 2424.00 Max flow 2096.45 Min elev 2421.20

1000.51 CFS channelized flow rate at a level of 2423.44 feet.
down a slope of .012000 ft. drop / ft. run .

START	END	ELEV	AREA	PERIM	FLOW RT	VELOCITY	OV
30.72	348.96	2423.44	292.64	318.49	1000.51	3.42	

EXHIBIT D

FLOW CALCULATIONS FOR THE CONTAINMENT OF 1000 CFS WITHIN THE 60 FOOT DRAINAGEWAY (VERTICAL SIDE SLOPES ASSUMED)

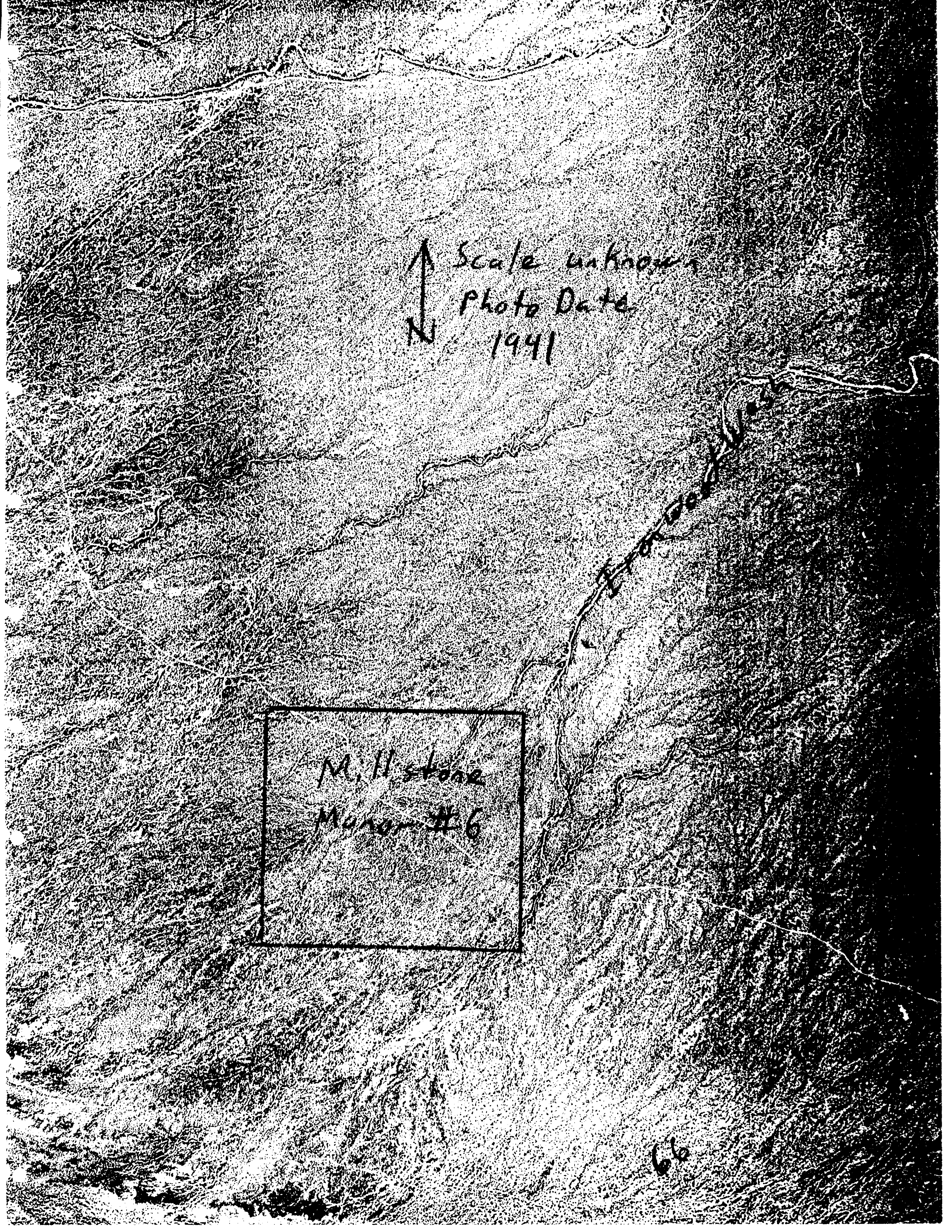
NORMAL and CRITICAL DEPTH PROGRAM

TRAPEZOIDAL and RECTANGULAR CHANNELS

Newton's Method

Input	Output
	NORMAL DEPTH = 2.341
FLOW RATE, cfs = ? 1000	VELOCITY = 7.120
	TOP WIDTH, ft = 60.000
MANNING'S COEFFICIENT = ? .035	AREA = 140.457
	WET PERIM = 64.682
CHANNEL SLOPE, ft/ft = ? .01	HYD RAD = 2.172
	CONVEYANCE = 9999.999
CHANNEL BOTTOM WIDTH = ? 60	DM = 2.341
	E = 3.128
SIDE SLOPE RATIO (h/v) = ? 0	FROUDE NO. = 0.820
	CRITICAL DEPTH, ft = 2.051
	VELOCITY @ CRITICAL DEPTH, ft/sec = 8.126
	CRITICAL SLOPE, ft/ft = 0.015

Hit (Return) Key to Continue . . .


Scale unknown
photo Date
1941
N
Millstone
Manor #6

HYDROLOGIC DATA SHEET

Project Name and Location: Millstone Manor #6

Drainage Concentration Point: 1000 feet upstream of San Joaquin Rd.

Watershed Area (A): 2041.6 (acres)/square miles.

Length of Watercourse (L_c): 25,250 ft. Length to Center of Gravity (L_{ca}): 13,250 ft.

Incremental Change in Length (L_i) - ft.	Incremental Change in Elevation (H_i) - ft.
3500	332
21,750	399

Mean Slope (S_c): .0216 ft./ft. Watershed Type(s): 53% Mountain, 47% Valley (future)

Basin Factor (n_b): .043 (future) Flood Frequency: 100 yrs.

P_{24} (24 hour): 4.69 in. Areal Value: ______ in.

P_6 (6 hour): 3.69 in. Areal Value: ______ in.

P_1 (1 hour): 2.68 in. Areal Value: ______ in.

P_2 (2 hour): 3.02 in. Areal Value: ______ in.

P_3 (3 hour): ______ in. Areal Value: ______ in.

Soil Group(s): 53% D, 47% B Cover Type(s): Desert Brush

Cover Density (pervious areas): 20% Impervious Cover: 0% (future)

CN(s): 91, 83 (curve number) (pervious & impervious areas) CN^*(s): 93.22, 87.09 (adjusted curve number)

Runoff to Rainfall Ratio(s), (C): .73, .55 (pervious areas) N/A (impervious areas)

Runoff Supply Rate (q): .647 i in./hr. (function of i)

Time of Concentration (T_c): 103 $i^{-.4}$ hrs./mins. (function of i)

Iterative Solution of T_c: 75 hrs./(mins.)

Rainfall Intensity (i) at T_c: 2.22 in./hr.

Runoff Supply Rate (q) at T_c: 1.44 in./hr.

Equation for T_c:

$$T_c = \frac{n_b}{50} \frac{(L_c L_{ca})^{.3}}{(S_c)^{.4}} q^{-.4} \text{ hours.}$$

Note: For impervious areas, $CN^* = 99$ (constant).

Peak Discharge:

1.008 qA (acres): ______ cfs.

645.33qA (square miles): 2958 cfs.

RAINFALL DATA SHEET

Return Period (Years)	Precipitation Values (inches)			
	6 Hour Duration		24 Hour Duration	
	Map Value	Corrected Value	Map Value	Corrected Value
2	1.6	1.61	1.93	1.95
5	2.1	2.13	2.6	2.62
10	2.45	2.47	3.01	3.06
25	3.09	2.90	3.7	3.65
50	3.30	3.31	4.2	4.18
100	3.63	3.69	4.7	4.69

$X_3 = 3.69''$

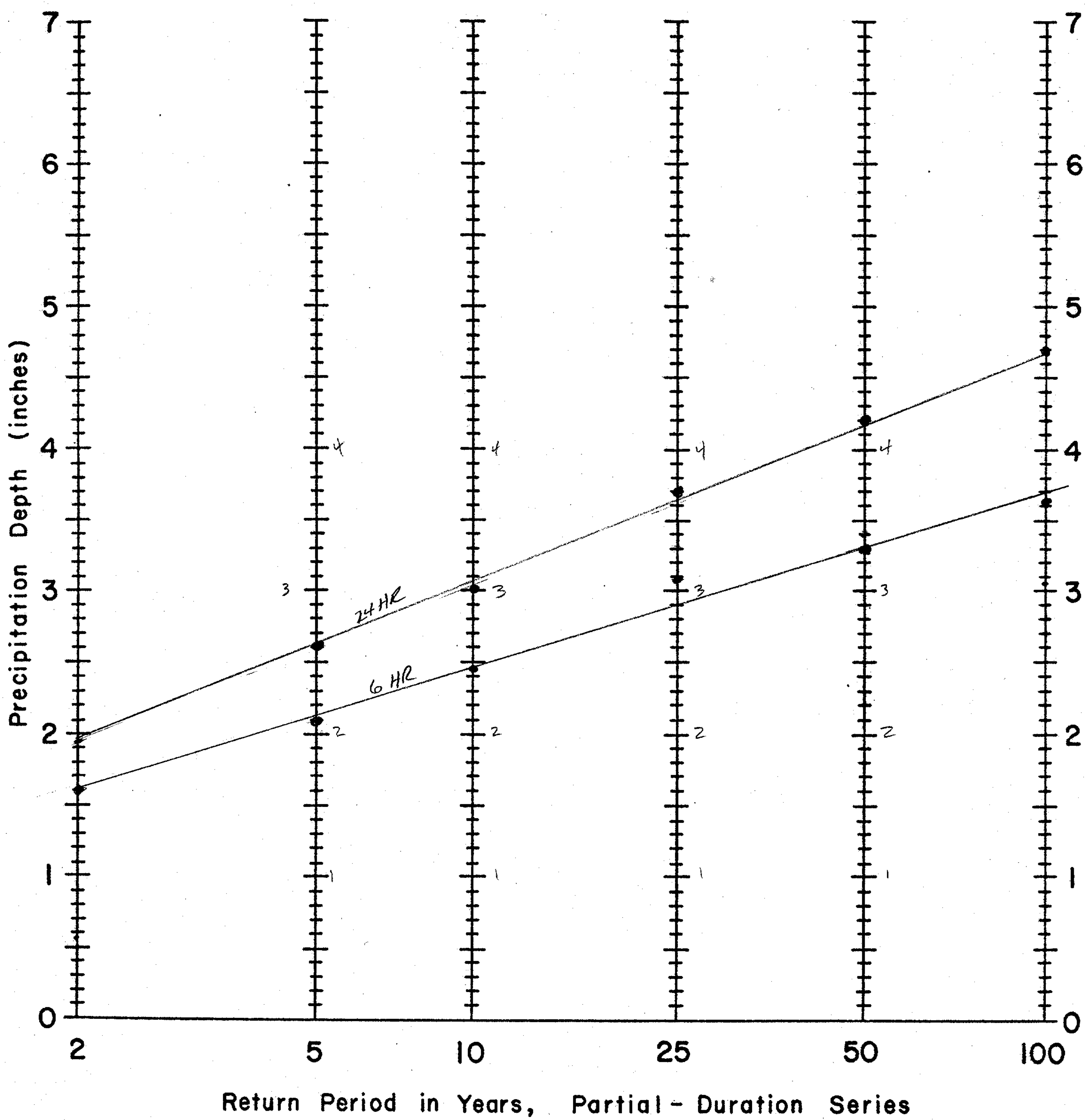
$X_4 = 4.69''$

$$Y_{100} = 0.494 + 0.755 \left(X_3^2 / X_4 \right)$$

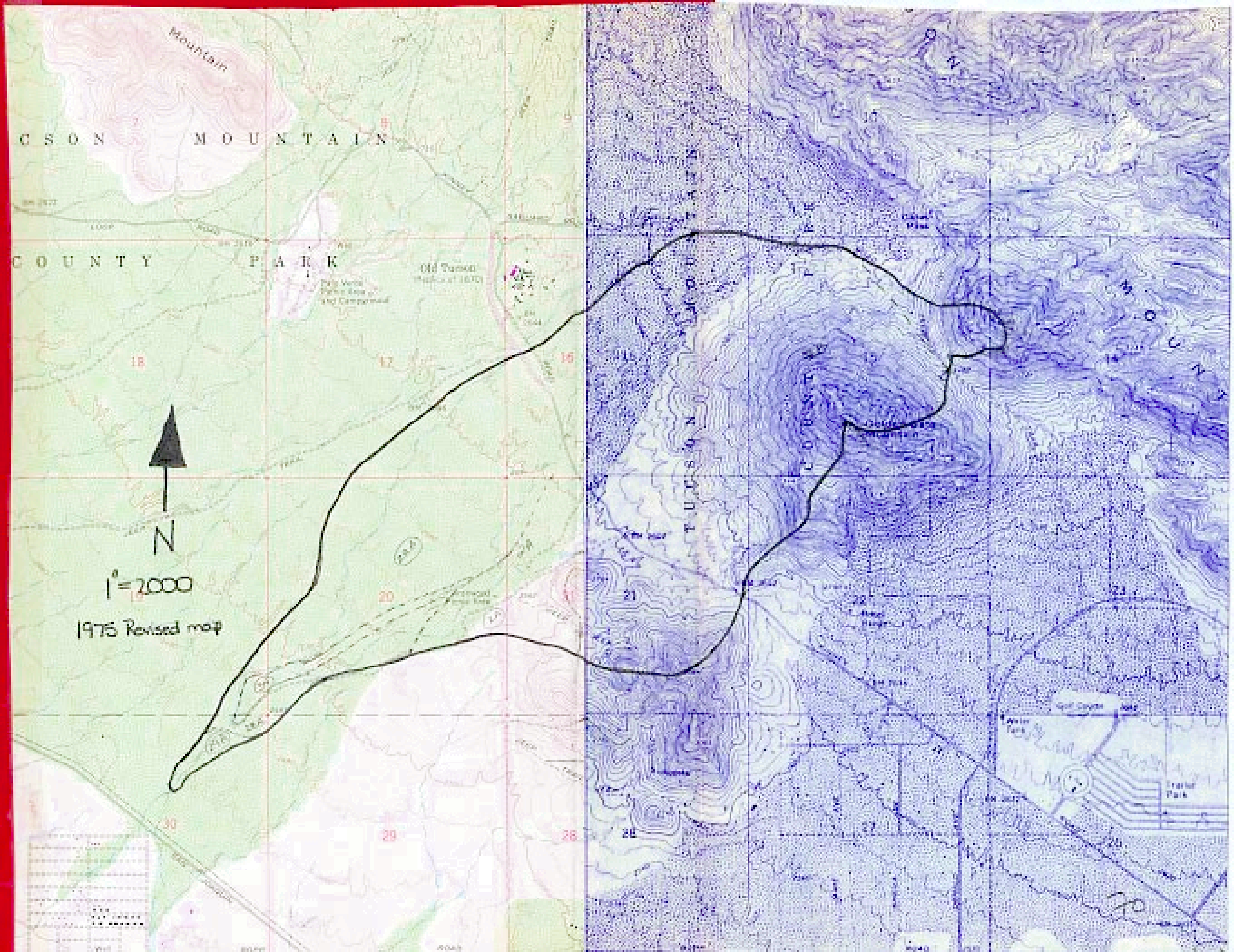
$Y_{100} = 2.68''$

$$\frac{3.69^2}{4.69} = 2.90$$

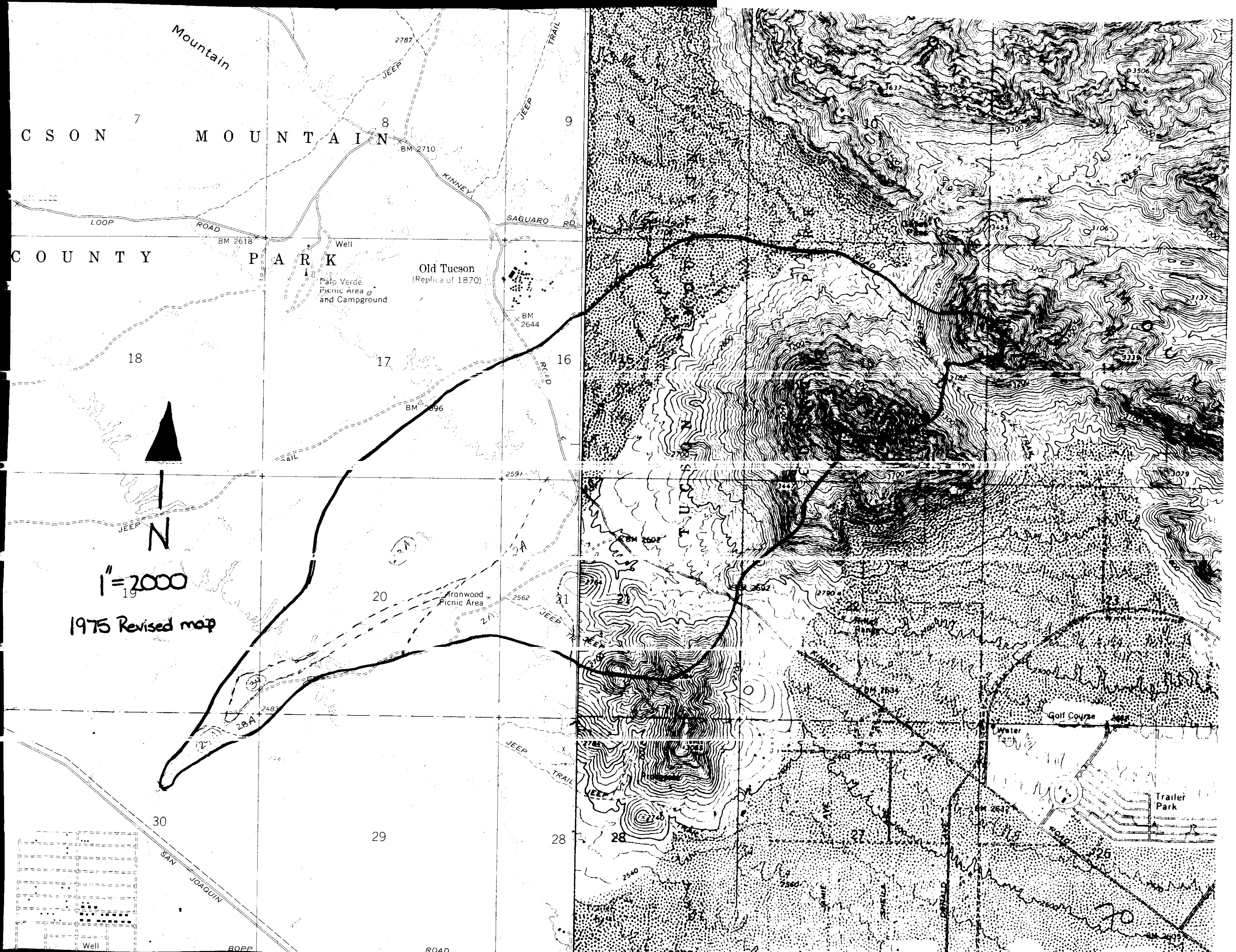
Latitude ____________ Longitude ____________



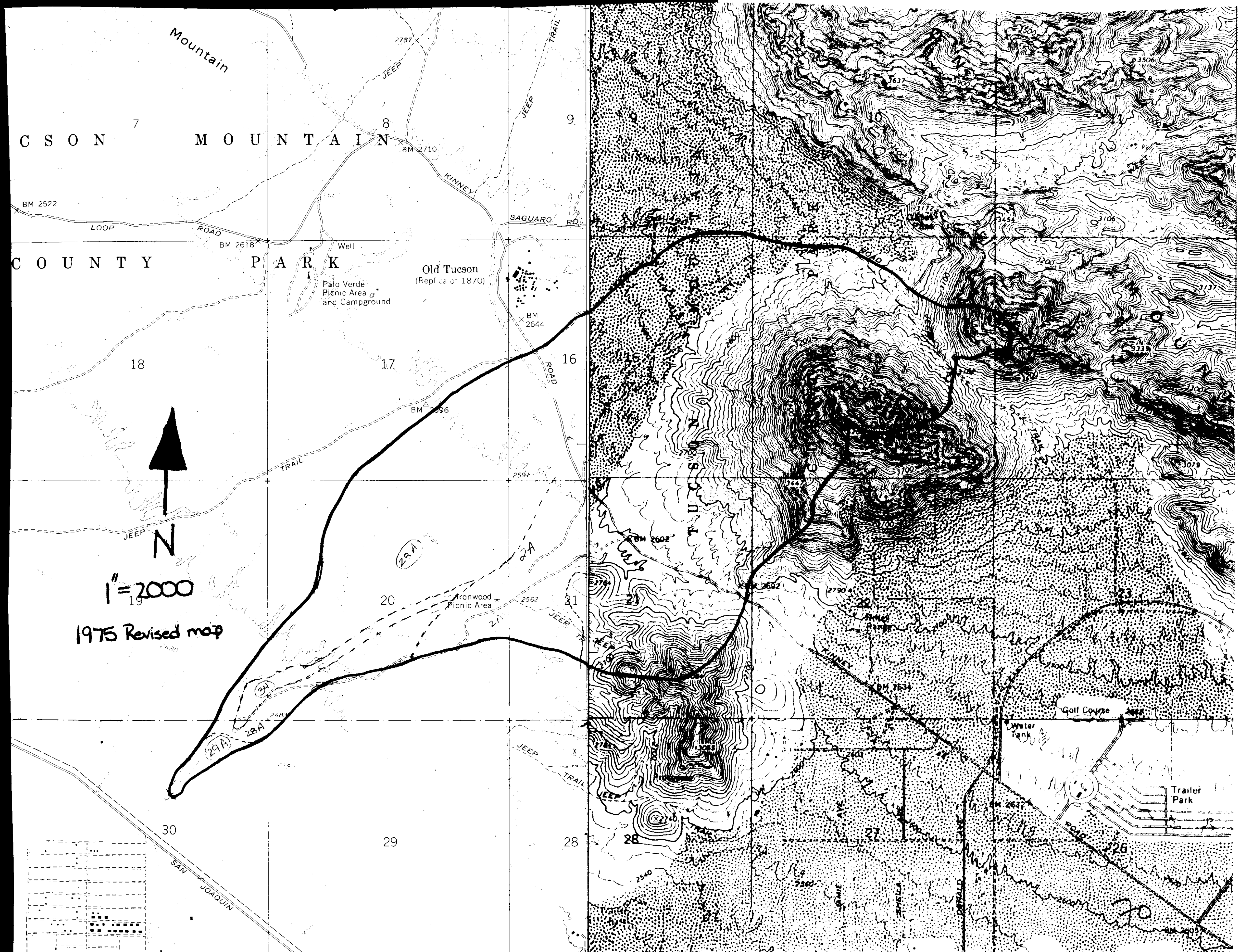
Precipitation Depth Versus Return Period For Partial - Duration Series



Mountain
CSON MOUNTAIN
COUNTY PARK
Old Tucson
TUCSON
N
1" = 2000
1975 Revised map



Mountain
CSON MOUNTAIN
COUNTY PARK
LOOP ROAD
BM 2618
Well
Old Tucson
(Replica of 1870)
Palo Verde Picnic Area and Campground
KINNEY
SAGUARO RD
BM 2710
BM 2644
BM 2596
JEEP
JEEP TRAIL
Ironwood Picnic Area
SAN JOAQUIN
ROAD
Well
Golf Course
Water Tank
Trailer Park
1"=2000
1975 Revised map
N



Mountain
CSON MOUNTAIN
COUNTY PARK
Old Tucson
(Replica of 1870)
Palo Verde
Picnic Area
and Campground
Ironwood
Picnic Area
Well
LOOP ROAD
SAGUARO RD
KINNEY ROAD
JEEP TRAIL
SAN JOAQUIN
BOPP ROAD
BM 2522
BM 2618
BM 2710
BM 2644
BM 2596
Golf Course
Water Tank
Trailer Park
N
1" = 2000
1975 Revised map

Potential Drainage Improvements

Millstone Manor Number 6

Improvement Options and Costs

PREPARED BY:
Pima County Department of
Transportation and Flood
Control District

Primary Investigator
Terry Hendricks
Principal Hydrologist

APPROVED BY
Kevin Eubanks, P.E.
Section Manager
Floodplain Management

POTENTIAL DRAINAGE IMPROVEMENTS
MILLSTONE MANOR NUMBER 6

By: Terry Hendricks

Date: October 19, 1989

INTRODUCTION

Millstone Manor #6 is a subdivision that lies in the Southwest Quarter of Section 30, Township 14 South, Range 12 East. The subdivision plat, recorded on May 21, 1956, was never approved by the County Engineer or the Board of Supervisors. Within the last two years approximately seven lots have been developed within the low lying areas of the subdivision. In addition, the summer monsoons of 1988 and 1989 have resulted in an increasing demand by the residents of the subdivision to have Pima County construct and maintain drainage improvements to reduce the flood impacts. This report has been generated to assess structural options to control the flooding through the subdivision.

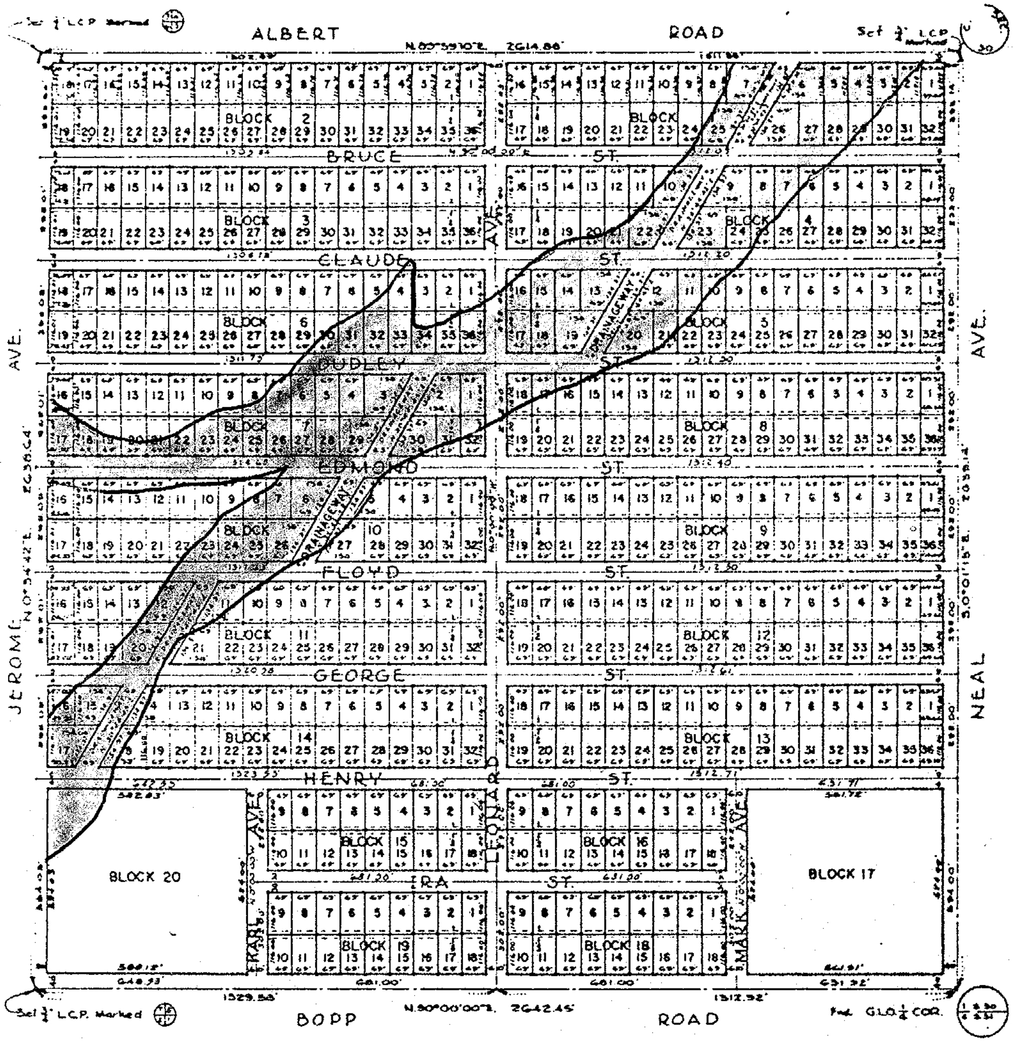
HYDROLOGY

The hydrology for the watershed affecting the Millstone Manor #6 subdivision is documented in a report by Jon Fuller and Terry Hendricks dated June 17, 1988. A copy of their report (Hydrologic and Hydraulic Analysis and Recommended Guidelines for Millstone Manor #6) is on file with Pima County Floodplain Management. The report includes a permit requirement map which is currently being used as a guideline for regulating development within the subdivision. Figure 1 shows the floodplain that was determined based on this report.

The subdivision is affected by the Ironwood Wash. The Watershed is 2,041.6 acres in size. The one hundred year peak discharge was estimated to be 2,958 cubic feet per second (cfs). Just upstream of the development is a bifurcation. Analysis of this split indicated approximately one third of the regulatory flow crosses diagonally through the subdivision, the other two thirds flows southerly, and eventually down the Neal Avenue road alignment (yet to be mapped). Historical photos show the primary flow forty years ago was diagonally through the subdivision and not around it. This is nearly opposite of the current distributary flow conditions. The 1,000 cfs crossing through the subdivision splits again. There are several places where the invert of the natural flow path lies

72

11-82



SCALE 1" = 200'

DEDICATION

We the undersigned hereby certify that we are the sole owners of the land shown on this plat, and that we have caused the same to be subdivided in the manner here shown and furthermore, we do dedicate to the public use all roads, drainageways and easements as designated hereon, with an additional 5' aerial or overhead easement on each side of said easements for wires and cross-arms etc. on power and pole lines.

Donald M. Millstone

Naomi W Millstone

State of Arizone } ss
County of Pima }

The foregoing instrument was acknowledged before me this 12th day of May 1956, by Donald M. Millstone and Neomi W. Millstone husband and wife.

Notary Public

My Commission Expires January 20, 1960

State of Arizona } ss No. 30382 Fee $5.00
County of Pima }

Filed for record at the request of Donald M. Millstone and Noomi W. Millstone, husband and wife.
Date May 21, 1956 Time 10:47 M.
Book 11 Maps and Plats, Page 82 thereof
Witness my hand and seal of office, day and year above written

Anna Sullinger
County Recorder

By ________ Deputy

NOTES

Bearings shown on this plat are based upon the bearing of the south line of section 30, as shown on General Land office plat of T-14-S., R-12-E.
- Represents 5/8" Iron Pin Set.
- Represents 3/4" Lead Capped Pipe Set unless otherwise noted.
- Represents 20' utility easement, 10' each side of lot line.

APPROVALS

County Engineer ________ Date ________

BOARD OF SUPERVISORS

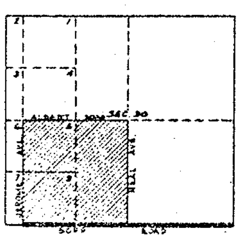
I, Richard E. Kolb, Clerk of the Board of Supervisors, hereby certify that this Plat was approved by the Board of Supervisors of Pima County, State of Arizona on this ___ day of ______ 1956

Clerk, Board of Supervisors ________ Date ________

CERTIFICATION OF SURVEY

I hereby certify that I completed the survey of property shown by this plat in April, 1956

Registered Land Surveyor



LOCATION
SECTION 30, T-14-S, R-12-E. G.&S.R.B.&M., PIMA CO., ARIZ. NOT TO SCALE.

MILLSTONE MANOR No. 6

BEING A SUBDIVISION OF THE E.1/2 OF SW1/4 AND LOTS 5 & 6 OF SECTION 30 T.-14-S., R.-12-E., G.&S.R.B.&M. PIMA COUNTY, ARIZONA

Figure 1
Ironwood Wash Floodplain (west braid only)

COPY OF RECORDED SUBDIVISION PLAT FURNISHED BY Arizona Land Title and Trust Company

significantly outside the platted drainageways.

FIELD INVESTIGATION

A field investigation was warranted to determine the design discharge and to assess different improvement options. Upstream of the bifurcation, Ironwood wash is an incised channel (figure 2). Stereo photographs show the channel is well incised in the upstream watershed. This is atypical of most of the watersheds that feed into Avra Valley from the Tucson Mountains.

Figure 2 Looking upstream within the Ironwood Wash. The photograph was taken upstream of the bifurcation.

Soils in and around the bifurcation region vary in composition. The channel bed through the split flow area is composed of coarse gravel and angular cobbles. The abundance of rock within the channel (figure 3) will have an armoring effect which would prevent the wash from deepening. The overbank soils consist of fine silty sands (figure 4). Just downstream of the split the rock content within the overbank flow path increases (figure 5). Due to the abundance of small rocks and the amount of fine erodible soils around the channel banks there will continue to be changes in the proportions of discharge into and around the subdivision.

Figure 3 Composition of the wash bed is made up of small angular rock which would reduce the potential for the channel to deepen.

Figure 4 This photograph shows the fine soils in the overbank region of the distributary flow.

Figure 5 Downstream of the bifurcation, in the overbank flow areas, the rock content of the soils increases.

The vegetation will also effect the distribution of flows. The vegetation within the split flow area consists of large mesquite, palo verde, and ironwood trees. In addition there are copious amounts of a variety of desert brush.

Figure 6 is a photograph taken within the Ironwood wash looking downstream. The litter from the vegetation is creating natural debris dams which have had the effect of removing more flow from going through Millstone Manor Number 6.

ASSUMPTIONS AND COSTS

In determining the various improvement options several assumptions had to be made. Some of the specific assumptions for each alternative will be discussed in the next section of the report.

Due to the variability of flow distribution upstream of the subdivision a design discharge of 1,500 cfs was used. It should be noted that this design value will be too low if western avulsion occurs upstream of San Joaquin Road. Judging the vegetation patterns in the historical photos, such a scenario is not improbable. This report does not address the potential to make improvements within the bifurcation area.

Figure 6 This photograph is taken looking downstream at a natural debris dam. The debris in the background is limiting the runoff through the subdivision.

Figure 7 shows the three alignments studied for structural improvements. The alignments have been put on an overlay on an aerial in order for the reader to understand the alignments in respect to the developed conditions. Two of the alternatives follow a natural flow path. The other represents a diversionary channel. Figure 7 does not show the width of the alternatives. Those will be described within tables 1.1, 2.1, and 3.1 in the next section.

All of the proposals will increase the discharge onto federally owned land. The impacts of increased discharge on these parcels has not been assessed. It should be pointed out that the U. S. Government owns all of the land between the western edge of the subdivision and the Central Arizona Project Canal. It is likely some work will be needed downstream of any of the three alignments in order to properly daylight constructed channels. Such work would need to be properly approved by the appropriate federal agency.

Costs were determined based on information given to the author from various individuals within the department. The cost assessments made in this report are general in nature. Each alternative has an associated contingency cost. Contingency costs vary with each alternative. Those alternatives which would need more site specific hydraulic designed improvements have the high contingency costs.

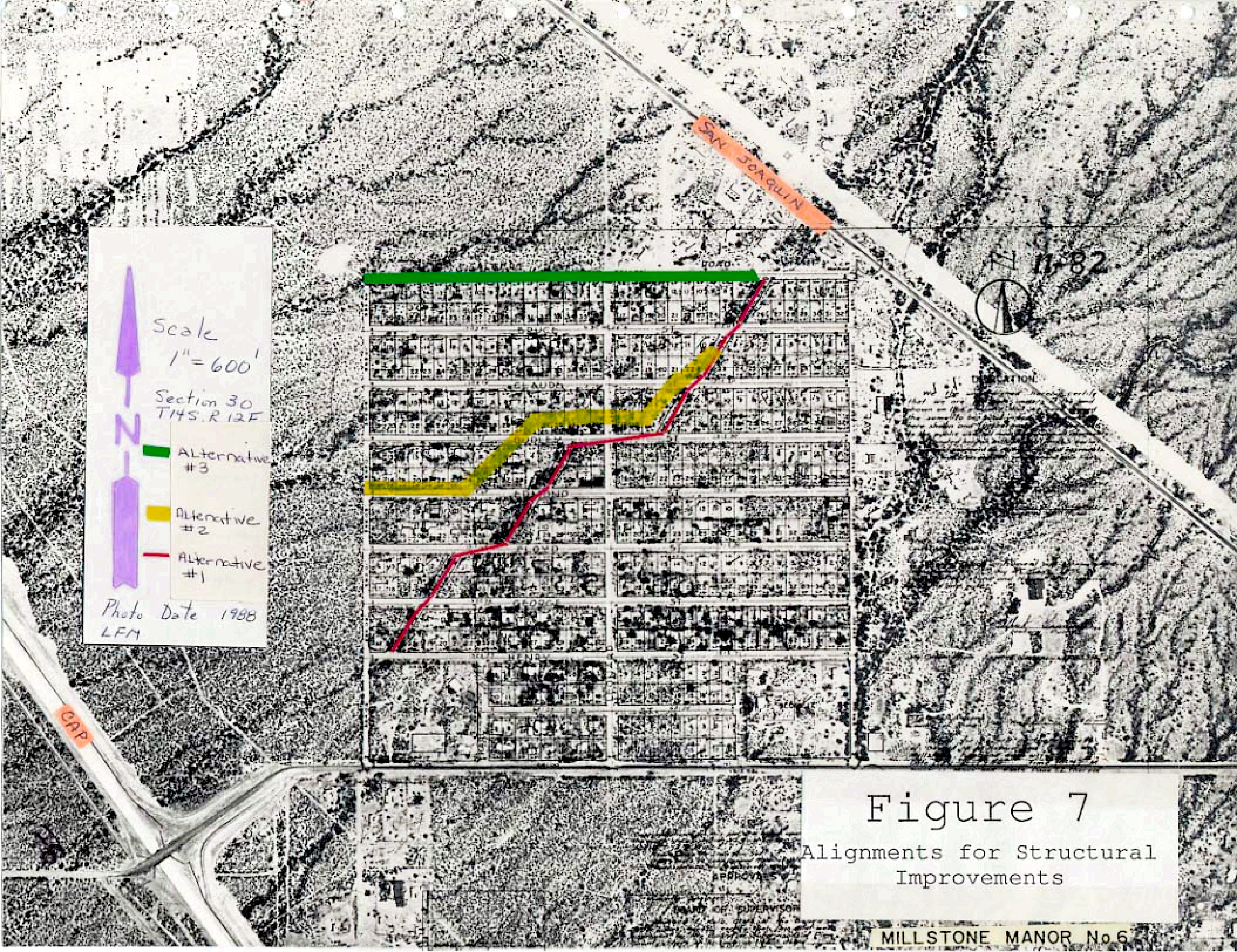


Figure 7

Alignments for Structural Improvements

In many areas the invert of the natural wash system lies outside of the proposed drainageway alignments. It is likely areas on private property will need to be filled. This report does not reflect costs associated with material placed outside of the alignments shown on figure 7.

FINDINGS

ALTERNATIVE 1 The first alternative studied places the design discharge through the platted drainageways. The platted drainageways roughly follow one of the flow paths within the subdivision. Because the right-of-way is narrow (sixty feet) a fully lined channel is necessary. The lack of maintenance easements adjacent to the channel require the bottom of the channel to be the maintenance access. Due to the weight of our equipment the bottom of the channel would have to be constructed with concrete rather than gunite.

The average slope for this channel is 0.01 ft./ft. A Mannings roughness coefficient of 0.02 was used for a fully lined concrete channel with one to one gunite side slopes. The hydraulic assessment of this channel can be found on table 1.1.

Table 1.1
Hydraulic Parameters for Alternative #1

LEFT SIDE SLOPE	1 TO 1
RIGHT SIDE SLOPE	1 TO 1
BOTTOM WIDTH (FT.)	42
CHANNEL SLOPE (FT./FT.)	0.011
N-VALUE	0.02
DEPTH OF FLOW (FT.)	2.50
DISCHARGE (cfs)	1,500
VELOCITY (FT./SEC.)	13.46
AREA (SQUARE FT.)	111.43
WETTED PERIMETER (FT.)	49.08
FROUDE NUMBER	1.54

The costs for alternative 1 is shown on table 1.2. This alignment did not necessitate the purchase of any right-of-way with the exception of a small portion of land at the outlet to the drainageway in block 20. In order to fully assess this option, more detailed engineering is needed. Such an analysis may demonstrate the need for additional land in those areas where the channel will have to make abrupt turns (Dudley and Floyd Streets), and where the natural invert lies significantly outside the

79

platted alignment (Blocks 5, 10, and 11).

Table 1.2
Cost Breakdown for Alternative Number 1

Totally lined channel 1890 feet		
Concrete bottom	79,380 square ft.	$227,830
1 to 1 Gunite side slopes	161.7 cubic yards	$ 4,851
Grubbing	2.6 acres	$ 1,301
Earthwork	7787.5 cubic yards	$ 19,469
Subtotal		$253,451
Six dip sections 200 ft. by 50 ft.		
Twelve 3 ft. by 1 ft. by 100 ft. cut-off-walls	1,200 linear feet	$ 48,000
Twelve 2 ft. by 1 ft headers	600 linear feet	$ 9,000
Four inches aggregate base	733 cubic yards	$ 4,767
Two inches asphaltic concrete	370 cubic yards	$ 20,300
Ammonium Lignin Sulphonate	6,667 square yards	$ 11,667
Earthwork	2,400 cubic yards	$ 6,000
Subtotal		$ 99,734
Two inverted crown roads/drainageways total length 900 feet		
Earthwork	4,000 cubic yards	$ 10,000
Four 3 ft. by 1 ft. by 60 ft. cut-off-walls	240 linear feet	$ 9,600
Six 2 ft. by 1 ft. headers	360 linear feet	$ 5,400
Six inch aggregate base	1,000 cubic yards	$ 6,050
Three inch asphaltic concrete	500 cubic yards	$ 27,405
Ammonium Lignin Sulphonate	6,000 square yards	$ 10,500
Subtotal		$ 68,955
Other costs		
Land	22,500 square feet	$ 9,000
Engineering		$ 18,000
Contingencies (15% of total cost)		$ 67,371
Subtotal		$ 94,371
Grand Total		$516,511

ALTERNATIVE 2 The second alternative also follows a natural flow path. With this option The concrete drainageways within blocks 1 and 4 would still need to be constructed. Runoff would diverge from the platted drainageways in block 5 and follow the western flow split through blocks 6 and 7. Due to the small lot sizes extensive right of way would need to be acquired. Some of the right-of-way acquisition would include the purchase of residential structures (figures 8 and 9). The alignment would allow a wider channel to be constructed and thus eliminate the need for bed and bank erosion control structures. In addition this alignment would have fewer dip sections and no inverted crown roads.

The average slope for this channel was 0.013 ft./ft. A Mannings roughness coefficient of 0.03 was used for the earthen channel. The hydraulics for the concrete lined channel would be the same as that shown in table 1.1. The hydraulics of the earthen channel through blocks 5, 6, and 7 can be found in table 2.1. The costs for alternative 2 are detailed in table 2.2.

Table 2.1
Hydraulic Parameters for Alternative #2
Earthen channel only

LEFT SIDE SLOPE	3 TO 1
RIGHT SIDE SLOPE	3 TO 1
BOTTOM WIDTH (FT.)	82
CHANNEL SLOPE (FT./FT.)	0.013
N-VALUE	0.03
DEPTH OF FLOW (FT.)	2.03
DISCHARGE (cfs)	1,500
VELOCITY (FT./SEC.)	8.58
AREA (SQUARE FT.)	174.84
WETTED PERIMETER (FT.)	92.84
FROUDE NUMBER	1.10

Figure 8 This photograph was taken looking west on Edmond. The channel for alternative 2 would lie to the right of the truck and through the area where the mobile homes are in the background.

Table 2.2
Cost Breakdown for Alternative Number 2

Property acquisition *		
Lot 13, Block 5	land and single-wide mobile	$ 27,000
Lot 19, Block 5	land and single-wide mobile	$ 27,000
Lots 17, 18 Block 5	land	$ 6,000
Lots 31, 32 Block 6	land and single-wide mobile	$ 28,000
Lots 33, 34 Block 6	land and masonry home	$ 55,000
Lots 35, 36 Block 6	land and single-wide mobile	$ 6,000
Lots 5, 6 Block 7	land and single-wide mobile	$ 28,000
Lots 7, 8 Block 7	land and single-wide mobile	$ 28,000
Lots 17, 18 Block 7	land and single-wide mobile	$ 28,000
Lots 19, 20 Block 7	land and single-wide mobile	$ 28,000
Lots 21, 22 Block 7	land and double-wide mobile	$ 41,000
Lots 23, 24 Block 7	land	$ 6,000
Lots 25, 26 Block 7	land	$ 6,000
Subtotal		$314,000
Totally lined channel 540 feet		
Concrete bottom	22,680 square feet	$ 79,380
1 to 1 Gunite side slopes	46.2 square yards	$ 1,386
Grubbing	0.74 acres	$ 372
Earthwork	2,225 cubic yards	$ 5,563
Subtotal		$ 86,701
Two paved dip sections 200 ft. by 50 ft.		
Earthwork	800 cubic yards	$ 2,000
Four 3 ft. by 1 ft. by 50 ft. cut-off-walls	200 linear feet	$ 8,000
Four 2ft. by 1ft. headers	200 linear feet	$ 3,000
Four inch aggregate base	244 cubic yards	$ 1,589
Two inch asphaltic concrete	123 cubic yards	$ 6,767
Ammonium Lignin Sulphonate	2,222 square yards	$ 3,889
Subtotal		$ 25,245
Earthen channel 1859 feet long		
Grubbing	4.25 acres	$ 2,124
Earthwork	14,544 cubic yards	$ 36,362
Subtotal		$ 38,486
Other costs		
Engineering		$ 10,000
Contingencies (10% of total cost)		$ 47,443
Subtotal		$ 57,443
Grand total		$521,872

* All of the land acquisition lies within Millstone Manor Number 6

8V

Figure 9 This photograph was taken looking north at the home on lots 33 and 34 block 6. With alternative 2 this home would have to be purchased.

ALTERNATIVE 3 The last alternative studied was that of a diversionary channel adjacent to and north of the Albert Road alignment. Lots 1, 10, 11, and 12 of Tucson Mountain Park Estates would need to be purchased for drainage right-of-way. Right of way will also have to be purchased within a parcel of land owned by the Marana School District. The channel would lie along the right side of the road shown on figure 10.

As was the case with the earthen channel portion of alternative 2, the wider channel will not need to be stabilized with concrete. The average slope of the channel was calculated to be 0.014 ft./ft. Hydraulic information for the typical channel can be found on table 3.1. Cost estimates for this channel are on table 3.2.

Table 3.1
Hydraulic Parameters for Alternative #3

LEFT SIDE SLOPE	3 TO 1
RIGHT SIDE SLOPE	3 TO 1
BOTTOM WIDTH (FT.)	80
CHANNEL SLOPE (FT./FT.)	0.014
N-VALUE	0.03
DEPTH OF FLOW (FT.)	1.97
DISCHARGE (cfs)	1,500
VELOCITY (FT./SEC.)	8.88
AREA (SQUARE FT.)	168.86
WETTED PERIMETER (FT.)	92.43
FROUDE NUMBER	1.15

Figure 10 This photograph was taken looking west down the Albert road alignment. Alternative 3 would lie to the right of the road.

Table 3.2
Cost Breakdown for Alternative Number 3

Property Acquisition *		
Lot 1	land and single-wide mobile	$ 39,424
Lot 10	land and single-wide mobile	$ 39,424
Lot 11	land and single-wide mobile	$ 39,424
Lot 12	land and double-wide mobile	$ 52,424
Marana School District	land	$ 45,455
Subtotal		$216,151
Earthwork (2,300 foot long channel)		
Grubbing	5.28 acres	$ 2,640
Excavation	19,167 cubic yards	$ 47,917
Subtotal		$ 50,557
Other		
Engineering		$ 7,000
Contingencies (10%)		$ 27,371
Subtotal		$ 34,371
Grand total		$301,079

*All lots lie within Tucson Mountain Park Estates

CONCLUSIONS

All three alternatives studied for structural improvements to reduce the size of the Ironwood Wash Floodplain through Millstone Manor #6 are costly. Two alternatives involve extensive right-of-way acquisition. The bifurcation upstream of the development is subject to change. Therefore the design discharge could be exceeded even though the design flow is currently greater than the current regulatory flow.

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The assumptions and calculations contained in this report are general in nature. This information has been prepared to assist the Flood Control District in deciding the best course of action to manage the floodplain through the subdivision. Additional information used in formulating this report can be found in the Floodplain Management Section.

APPENDIX

COST ASSUMPTIONS

LAND

Undeveloped land -residential	40¢ per square foot
Undeveloped land -Marana School District	$30,000 per acre
Large lot adjacent to platted drainageway Millstone Manor Number 6	$ 5,000
Two adjacent 69 by 100 foot lots Millstone Manor Number 6	$ 6,000

IMPROVEMENTS

Single-wide mobile home	$22,000
Double-wide mobile home	$35,000
House (land included)	$55,000

EARTHWORK

Grubbing	$ 500/acre
Excavation	$ 2.50/cubic yard

CONCRETE

Concrete -4 inches thick with steel	$ 3.50/square foot
Gunite -4 inches thick with wire	$ 30/cubic yard
Cut-off-wall -3 by 1 feet with steel and excavation	$ 40/lineal foot
Headers -2 by 1 feet with steel and excavation	$ 15/lineal foot

ROAD

Aggregate base, installed	$ 6.50/cubic yard
Asphaltic concrete, installed	$ 54.81/cubic yard
Ammonium Lignin Sulphonate	$ 1.75/square yard

8

MEMORANDUM

Department of Transportation and Flood Control District

DATE: August 8, 1996

TO: Tim Morrison, Manager
Floodplain Management

FROM: John Hays, Hydrologist
Floodplain Management

SUBJECT: **Millstone Manor Number 6**

My investigation of the flooding and erosion problems experienced by Millstone Manor Number 6 on the night of August 1, 1996 indicates that the drainages, a portion of Ironwood Wash, through the subdivision are inadequate to convey flow through the subdivision. A number of the channels in the development have been blocked and/or diverted by fencing, walls, fill, and buildings. The flow through the area did not follow the floodplain for Ironwood Wash, as shown in *Potential Drainage Improvements: Millstone Manor Number 6, Improvement Options and Costs* prepared by Terry Hendricks for Pima County Flood Control District October 9, 1989. Attached is a copy of Figure 1 from the report. The floodplain of Ironwood wash is highlighted orange, and the location and direction of flows from the August 1 event are indicated by red arrows. The depth of flow in most of these areas exceeded one foot, and in some areas exceeded 2.5 feet.

A 1988 study by Jon Fuller and Terry Hendricks (*Hydrologic and Hydraulic Analysis and Recommended Guidelines for Millstone Manor #6*) determined that the watershed for Ironwood Wash is 2,041.6 acres in size. The peak discharge for the 100-year event was estimated to be 2,958 cubic feet per second (cfs). The analysis showed a split in flow upstream of the subdivision. The split was a result of debris dams created by the vegetation in the area. Analysis of the split showed that approximately one third of the flow of Ironwood Wash was being conveyed by the branch that ran through the subdivision. Historic photos from the analysis indicated that the primary flow had been through Millstone Manor #6 forty years earlier. The study also mentioned that the soil conditions within the watershed, the channels of Ironwood Wash would be more subject to lateral migration than down cutting. It also indicated the possibility of the primary flow naturally returning to the branch which runs through the subdivision.

On August 7, 1996, I investigated the area of the split in flow. Erosion in the area indicates the primary flow is returning to the branch of Ironwood Wash affecting Millstone Manor #6. The mapped floodplain in the subdivision is no longer representative of the flooding potential in the area. Flooding potential to life and property in the area has increased. I would suggest you look into the possibility of a new study and/or policy for the area.

JEH

Attachment: 1

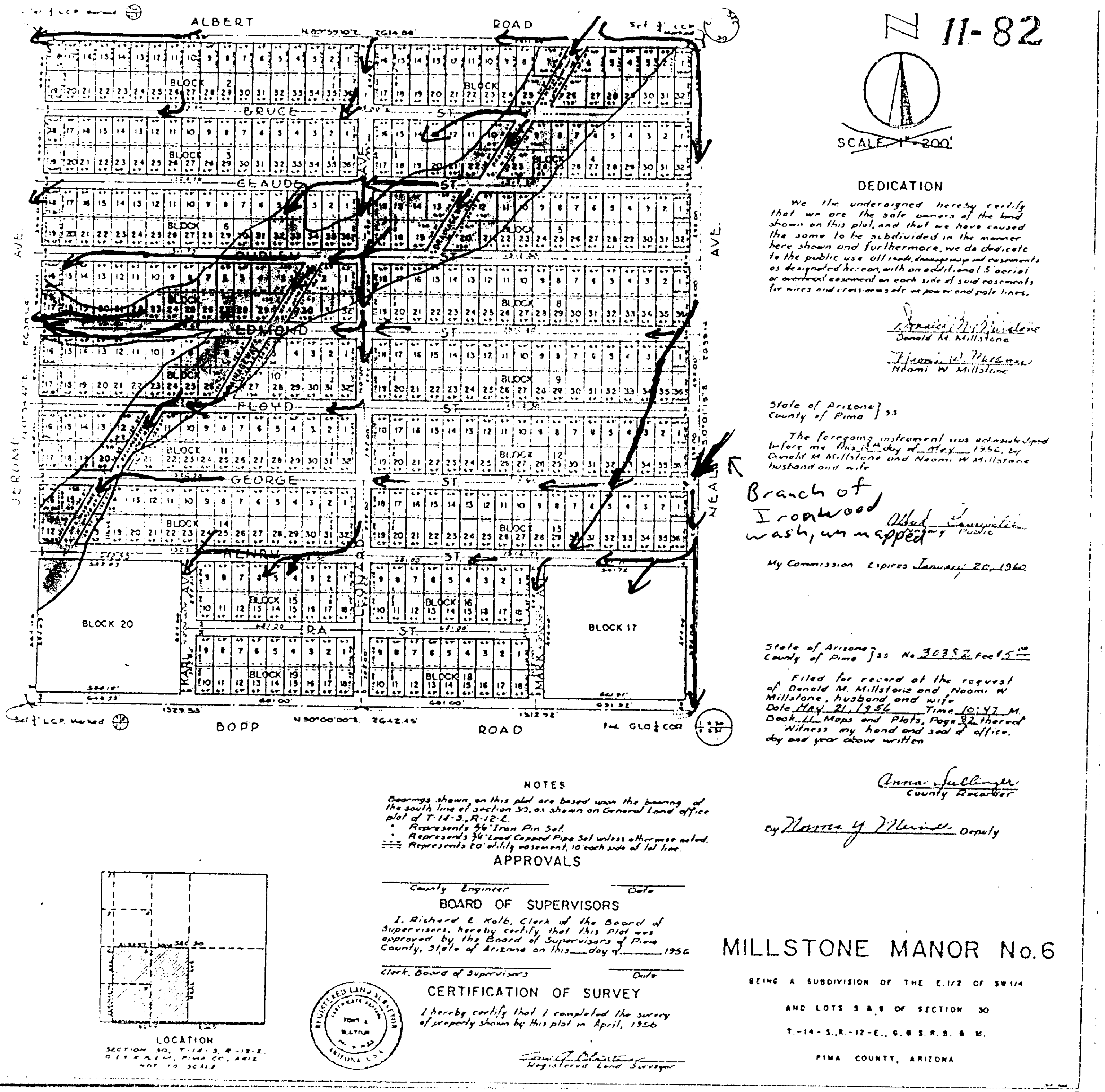

Figure 1
Ironwood Wash Floodplain
(west braid only)

significantly outside the platted drainageways.

FIELD INVESTIGATION

A field investigation was warranted to determine the design discharge and to assess different improvement options. Upstream of the bifurcation, Ironwood wash is an incised channel (figure 2). Stereo photographs show the channel is well incised in the upstream watershed. This is atypical of most of the watersheds that feed into Avra Valley from the Tucson Mountains.

Figure 2 Looking upstream within the Ironwood Wash. The photograph was taken upstream of the bifurcation.

Soils in and around the bifurcation region vary in composition. The channel bed through the split flow area is composed of coarse gravel and angular cobbles. The abundance of rock within the channel (figure 3) will have an armoring effect which would prevent the wash from deepening. The overbank soils consist of fine silty sands (figure 4). Just downstream of the split the rock content within the overbank flow path increases (figure 5). Due to the abundance of small rocks and the amount of fine erodible soils around the channel banks there will continue to be changes in the proportions of discharge into and around the subdivision.

89

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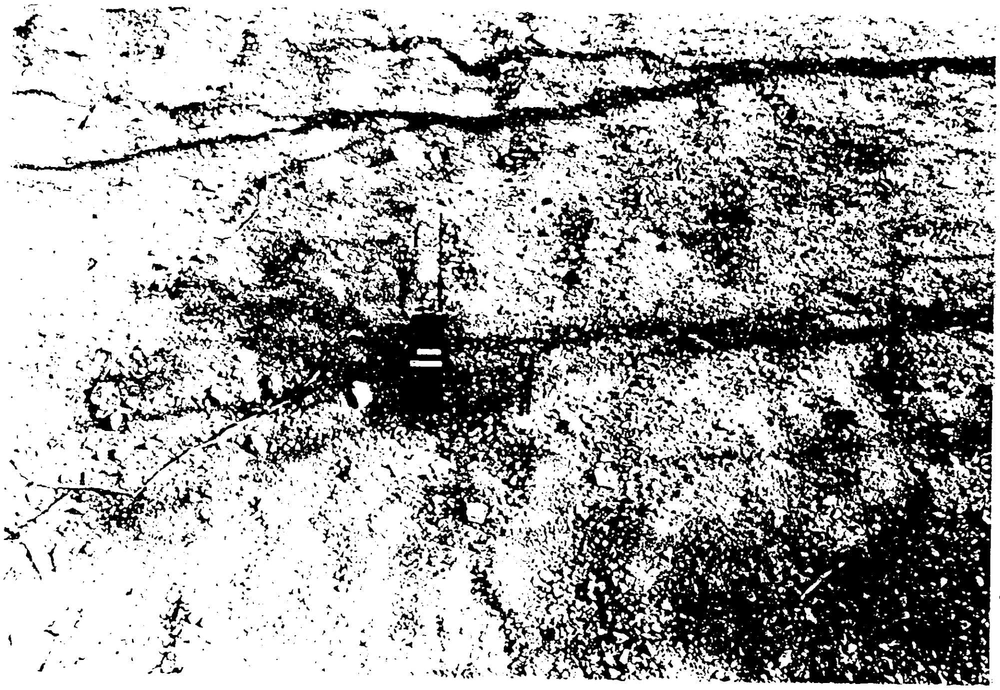

Figure 3 Composition of the wash bed is made up of small angular rock which would reduce the potential for the channel to deepen.

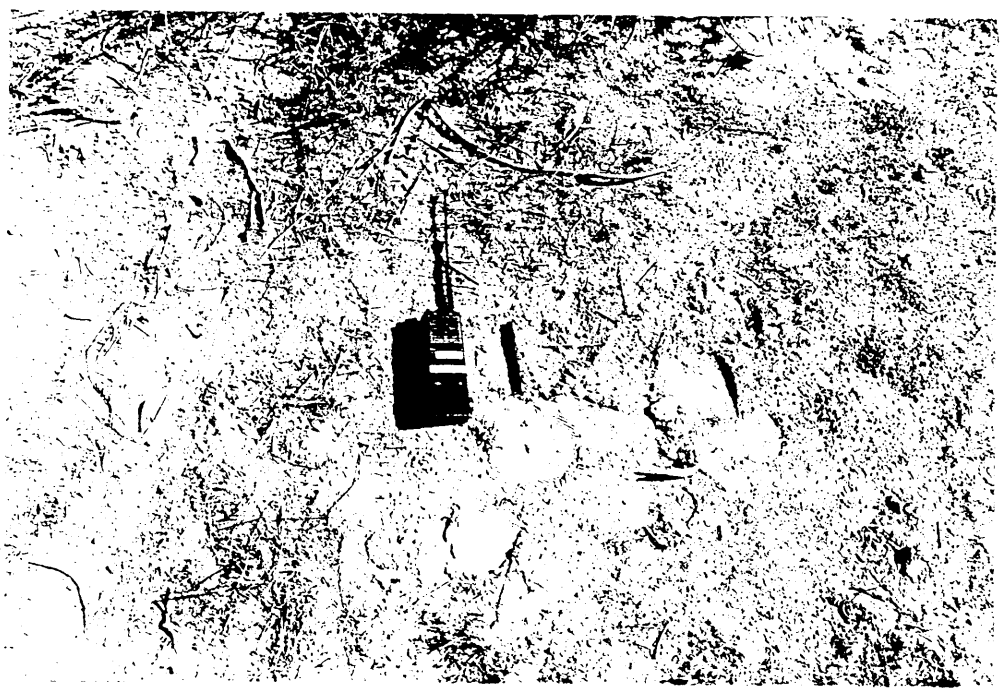

Figure 4 This photograph shows the fine soils in the overbank region of the distributary flow.

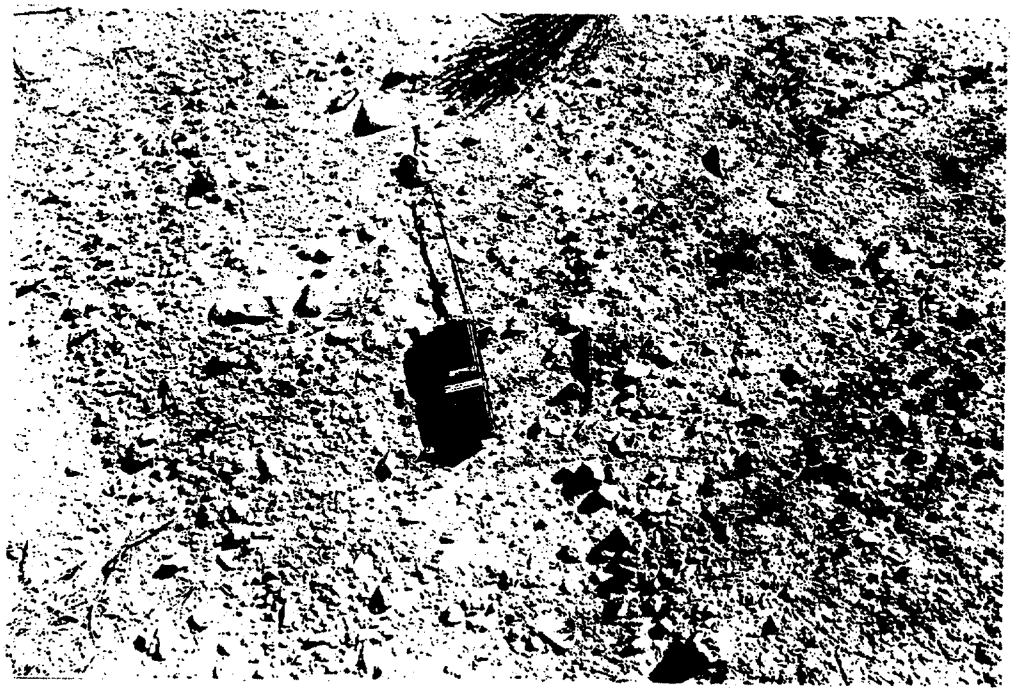

Figure 5 Downstream of the bifurcation, in the overbank flow areas, the rock content of the soils increases.

The vegetation will also effect the distribution of flows. The vegetation within the split flow area consists of large mesquite, palo verde, and ironwood trees. In addition there are copious amounts of a variety of desert brush.

Figure 6 is a photograph taken within the Ironwood wash looking downstream. The litter from the vegetation is creating natural debris dams which have had the effect of removing more flow from going through Millstone Manor Number 6.

ASSUMPTIONS AND COSTS

In determining the various improvement options several assumptions had to be made. Some of the specific assumptions for each alternative will be discussed in the next section of the report.

Due to the variability of flow distribution upstream of the subdivision a design discharge of 1,500 cfs was used. It should be noted that this design value will be too low if western avulsion occurs upstream of San Joaquin Road. Judging the vegetation patterns in the historical photos, such a scenario is not improbable. This report does not address the potential to make improvements within the bifurcation area.

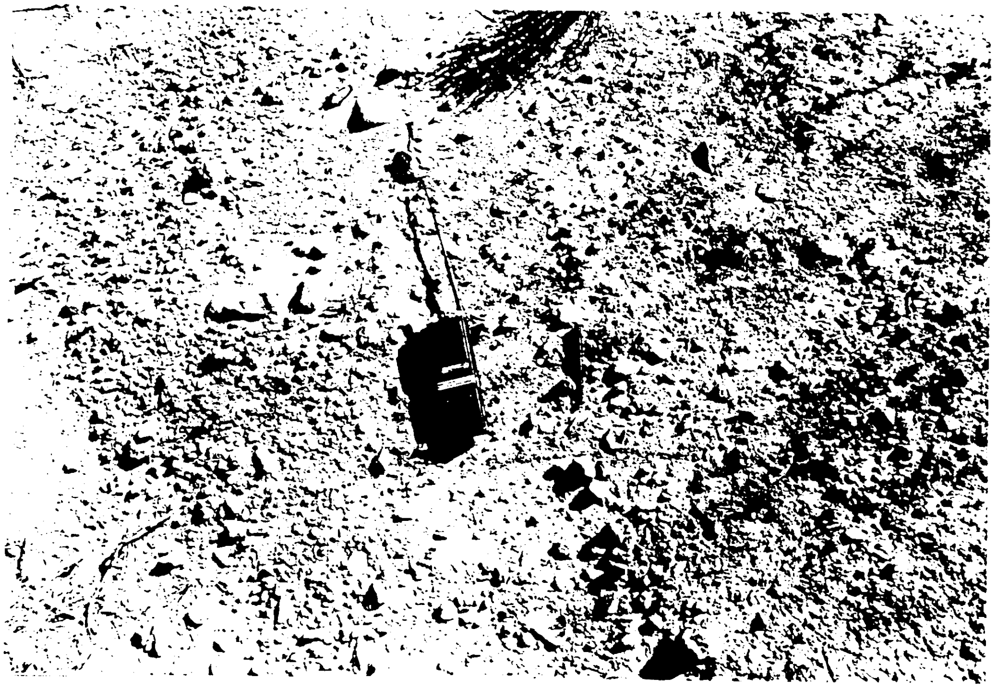

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Figure 7 shows the three alignments studied for structural improvements. The alignments have been put on an overlay on an aerial in order for the reader to understand the alignments in respect to the developed conditions. Two of the alternatives follow a natural flow path. The other represents a diversionary channel. Figure 7 does not show the width of the alternatives. Those will be described within tables 1.1, 2.1, and 3.1 in the next section.

All of the proposals will increase the discharge onto federally owned land. The impacts of increased discharge on these parcels has not been assessed. It should be pointed out that the U. S. Government owns all of the land between the western edge of the subdivision and the Central Arizona Project Canal. It is likely some work will be needed downstream of any of the three alignments in order to properly daylight constructed channels. Such work would need to be properly approved by the appropriate federal agency.

Costs were determined based on information given to the author from various individuals within the department. The cost assessments made in this report are general in nature. Each alternative has an associated contingency cost. Contingency costs vary with each alternative. Those alternatives which would need more site specific hydraulic designed improvements have the high contingency costs.

Potential Drainage Improvements

Millstone Manor Number 6

Improvement Options and Costs

PREPARED BY:
Pima County Department of Transportation and Flood Control District

Primary Investigator
Terry Hendricks
Principal Hydrologist

APPROVED BY

Kevin Eubanks, P.E.
Section Manager
Floodplain Management

POTENTIAL DRAINAGE IMPROVEMENTS
MILLSTONE MANOR NUMBER 6

By: Terry Hendricks

Date: October 19, 1989

INTRODUCTION

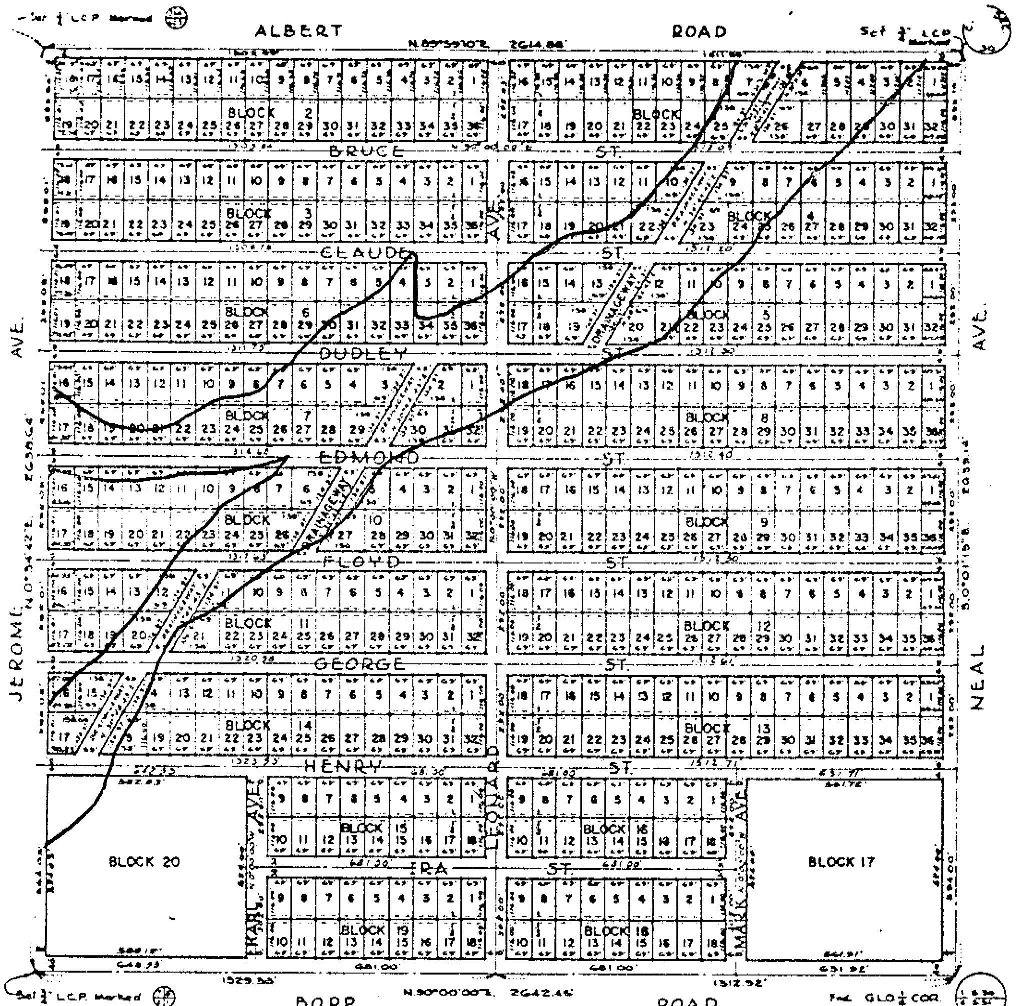
Millstone Manor #6 is a subdivision that lies in the Southwest Quarter of Section 30, Township 14 South, Range 12 East. The subdivision plat, recorded on May 21, 1956, was never approved by the County Engineer or the Board of Supervisors. Within the last two years approximately seven lots have been developed within the low lying areas of the subdivision. In addition, the summer monsoons of 1988 and 1989 have resulted in an increasing demand by the residents of the subdivision to have Pima County construct and maintain drainage improvements to reduce the flood impacts. This report has been generated to assess structural options to control the flooding through the subdivision.

HYDROLOGY

The hydrology for the watershed affecting the Millstone Manor #6 subdivision is documented in a report by Jon Fuller and Terry Hendricks dated June 17, 1988. A copy of their report (Hydrologic and Hydraulic Analysis and Recommended Guidelines for Millstone Manor #6) is on file with Pima County Floodplain Management. The report includes a permit requirement map which is currently being used as a guideline for regulating development within the subdivision. Figure 1 shows the floodplain that was determined based on this report.

The subdivision is affected by the Ironwood Wash. The Watershed is 2,041.6 acres in size. The one hundred year peak discharge was estimated to be 2,958 cubic feet per second (cfs). Just upstream of the development is a bifurcation. Analysis of this split indicated approximately one third of the regulatory flow crosses diagonally through the subdivision, the other two thirds flows southerly, and eventually down the Neal Avenue road alignment (yet to be mapped). Historical photos show the primary flow forty years ago was diagonally through the subdivision and not around it. This is nearly opposite of the current distributary flow conditions. The 1,000 cfs crossing through the subdivision splits again. There are several places where the invert of the natural flow path lies

11-82



SCALE 1" = 200'

DEDICATION

We the undersigned hereby certify that we are the sole owners of the land shown on this plat, and that we have caused the same to be subdivided in the manner here shown and furthermore, we do dedicate to the public use all roads, drainageways and easements as designated hereon, with an additional 5' aerial or overhead easement on each side of said easements for wires and cross-arms etc. on power and pole lines.

Donald M. Millstone

Neomi W Millstone

State of Arizona }
County of Pima } ss

The foregoing instrument was acknowledged before me this 18th day of May 1956, by Donald M. Millstone and Neomi W. Millstone husband and wife.

Notary Public

My Commission Expires January 20, 1960

State of Arizona }
County of Pima } ss No 30392 Fee $5.00

Filed for record at the request of Donald M. Millstone and Neomi W. Millstone, husband and wife.
Date May 21, 1956 Time 10:47 M.
Book 11 Maps and Plats, Page 82 thereof
Witness my hand and seal of office, day and year above written

Anna Sullinger
County Recorder

By Norma Y. Merrill Deputy

NOTES

Bearings shown on this plat are based upon the bearing of the south line of section 30, as shown on General Land office plat of T-14-S., R-12-E.

- Represents 5/8" Iron Pin Set.
- Represents 3/4" Lead Capped Pipe Set unless otherwise noted.

=== Represents 20' utility easement, 10' each side of lot line.

APPROVALS

County Engineer ____ Date ____

BOARD OF SUPERVISORS

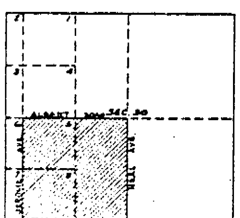
I, Richard E. Kolb, Clerk of the Board of Supervisors, hereby certify that this Plat was approved by the Board of Supervisors of Pima County, State of Arizona on this ___ day of ______ 1956

Clerk, Board of Supervisors ____ Date ____

CERTIFICATION OF SURVEY

I hereby certify that I completed the survey of property shown by this plat in April, 1956

Registered Land Surveyor



LOCATION
SECTION 30, T-14-S, R-12-E.
G.&S.R.B.&M., PIMA CO., ARIZ.
NOT TO SCALE.

MILLSTONE MANOR No.6

BEING A SUBDIVISION OF THE E.1/2 OF SW1/4
AND LOTS 5 & 8 OF SECTION 30
T.-14-S.,R.-12-E., G.&S.R.B.&M.
PIMA COUNTY, ARIZONA

... OF RECORDED SUBDIVISION PLAT FURNISHED BY Arizona Land Title and Trust Company

Figure 1
Ironwood Wash Floodplain
(west braid only)

095

significantly outside the platted drainageways.

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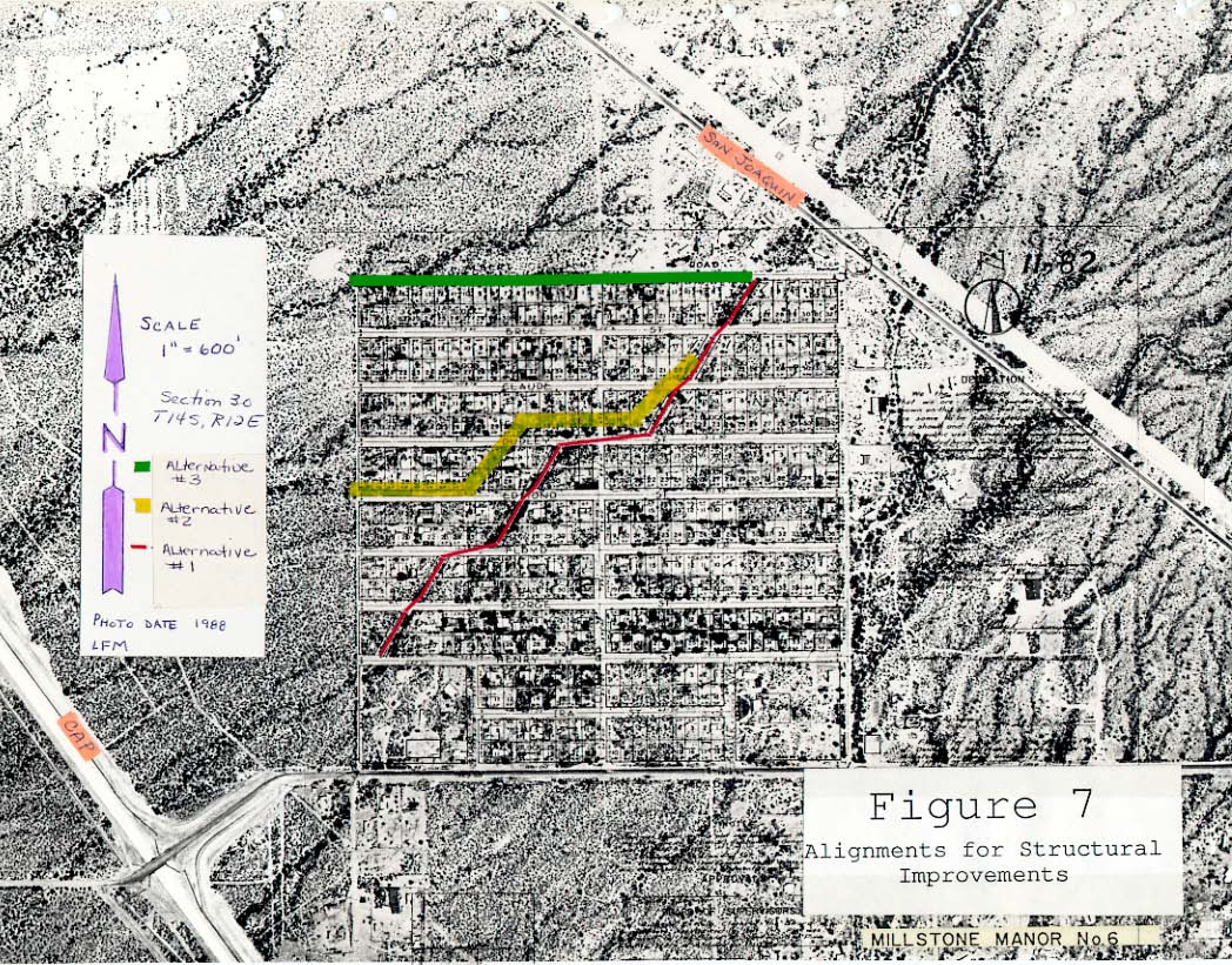

Figure 7

Alignments for Structural Improvements

for alternative 2 are detailed in table 2.2.

Table 2.1
Hydraulic Parameters for Alternative #2
Earthen channel only

LEFT SIDE SLOPE	3 TO 1
RIGHT SIDE SLOPE	3 TO 1
BOTTOM WIDTH (FT.)	82
CHANNEL SLOPE (FT./FT.)	0.013
N-VALUE	0.03
DEPTH OF FLOW (FT.)	2.03
DISCHARGE (cfs)	1,500
VELOCITY (FT./SEC.)	8.58
AREA (SQUARE FT.)	174.84
WETTED PERIMETER (FT.)	92.84
FROUDE NUMBER	1.10

Figure 8 This photograph was taken looking west on Edmond. The channel for alternative 2 would lie to the right of the truck and through the area where the mobile homes are in the background.

Figure 9 This photograph was taken looking north at the home on lots 33 and 34 block 6. With alternative 2 this home would have to be purchased.

ALTERNATIVE 3 The last alternative studied was that of a diversionary channel adjacent to and north of the Albert Road alignment. Lots 1, 10, 11, and 12 of Tucson Mountain Park Estates would need to be purchased for drainage right-of-way. Right of way will also have to be purchased within a parcel of land owned by the Marana School District. The channel would lie along the right side of the road shown on figure 10.

As was the case with the earthen channel portion of alternative 2, the wider channel will not need to be stabilized with concrete. The average slope of the channel was calculated to be 0.014 ft./ft. Hydraulic information for the typical channel can be found on table 3.1. Cost estimates for this channel are on table 3.2.

Table 3.1
Hydraulic Parameters for Alternative #3

LEFT SIDE SLOPE	3 TO 1
RIGHT SIDE SLOPE	3 TO 1
BOTTOM WIDTH (FT.)	80
CHANNEL SLOPE (FT./FT.)	0.014
N-VALUE	0.03
DEPTH OF FLOW (FT.)	1.97
DISCHARGE (cfs)	1,500
VELOCITY (FT./SEC.)	8.88
AREA (SQUARE FT.)	168.86
WETTED PERIMETER (FT.)	92.43
FROUDE NUMBER	1.15

Figure 10 This photograph was taken looking west down the Albert road alignment. Alternative 3 would lie to the right of the road.

Table 3.2
Cost Breakdown for Alternative Number 3

Property Acquisition *		
Lot 1	land and single-wide mobile	$ 39,424
Lot 10	land and single-wide mobile	$ 39,424
Lot 11	land and single-wide mobile	$ 39,424
Lot 12	land and double-wide mobile	$ 52,424
Marana School District	land	$ 45,455
Subtotal		$216,151
Earthwork (2,300 foot long channel)		
Grubbing	5.28 acres	$ 2,640
Excavation	19,167 cubic yards	$ 47,917
Subtotal		$ 50,557
Other		
Engineering		$ 7,000
Contingencies (10%)		$ 27,371
Subtotal		$ 34,371
Grand total		$301,079

*All lots lie within Tucson Mountain Park Estates

CONCLUSIONS

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107