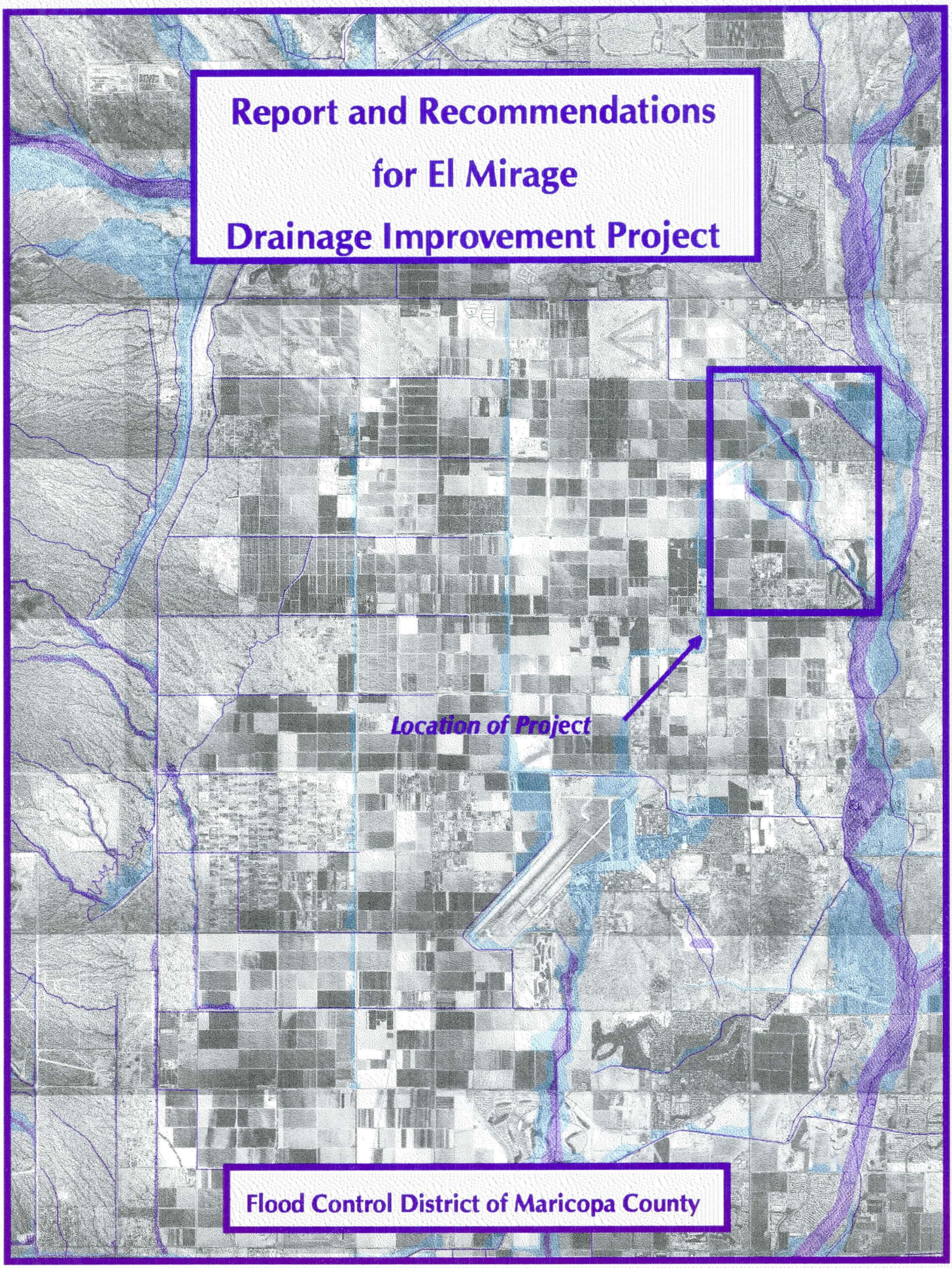
Report and Recommendations for El Mirage Drainage Improvement Project



Flood Control District of Maricopa County

REPORT AND RECOMMENDATIONS

El Mirage 1998 CIP Request
For
El Mirage Drainage Project

By

Gregory L. Jones, P.E.

October 4, 1999

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References:

I. Hydrologic Analysis for Lower El Mirage Wash at El Mirage Road under Future Developed conditions, dated September 14, 1999, prepared by Flood Control District Of Maricopa County
II. Flood Control District Project Proposal From City of El Mirage, dated September 1998, prepared by AN West Inc.
III. White Tanks/Agua Fria Area Drainage Master Study Parts A and B, dated October, 1992 and December 1994 respectively, prepared by WLB Group Inc.

REPORT AND RECOMMENDATIONS

El Mirage 1998 CIP Request
For
El Mirage Drainage Project

By

Gregory L. Jones, P.E.

October 12, 1999

I. Project Background and Description:

The City of El Mirage submitted a project for prioritization in the Capital Improvement Project program in 1998. The project was to improve the El Mirage Wash and the El Mirage Wash Tributary within the city limits of El Mirage to provide a defined channel and reduce the floodplain. During the CIP prioritization the project was ranked number 1with an average score of 81 for the CIP program.

The prominent project features identified in the proposal include improves the channelization of approximately 16,600 linear feet for both of the washes, one railroad crossing, 5 roadway crossings, erosion protection, a regional detention basin, landscaping, and multiple use treatments.

II. History:

The White Tanks Area Drainage Master Plan (ADMP) recommended to maintain the flow capacity of the washes via floodplain management. However, it should be noted that these washes are not defined natural washes due to typical historic agricultural practices to obliterate the natural washes. This is condition is indicated on the Ariel photographs in figure No. A.

Also, in the White Tanks ADMP, it was proposed a regional drain along the Waddell Road (Thunderbird) tie into the El Mirage Wash to take advantage of this natural outfall. However, the El Mirage Wash discharges through the exiting Pueblo El Mirage Country Club, Golf Course and Mobile Home Park (Pueblo Development) which was under development during the course of the White Tank ADMP study. The Pueblo Development was originally designed and initially constructed to the original floodplain delineated by FEMA with a Q of 250 CFS. However, the White Tanks ADMP extended the floodplain due to new HEC 1 data with a new Q of 1800 CFS. This precluded the developer from completing the build out of the Mobile Home Park as originally designed.

III. Land Use:

The adjacent lands to the proposed projects are currently still used primarily for agricultural. The future El Mirage land use plan indicates the areas adjacent to the washes are zoned for individual residential, and include park facilities along the proposed channel and basin alignments as indicated in Figure B. This would provide a multiple use opportunity for the regional out fall as a linear park/trail system to connect the park nodes and recreational use.

IV. Hydrology:

The report entitled, "Hydrologic Analysis for Lower El Mirage Wash at El Mirage Road Under Future Developed Condition", was used as the basis of comparison. The report Hec I analysis modeled the existing condition and the future developed condition. The report concluded that the difference between existing condition and the future condition with on site retention was not significant (829 ac-ft versus 879 ac-ft, and 1768 cfs versus 1798 cfs respectively). Further analysis was performed and it revealed that at the concentration point (CP) number 172 just up stream of the Pueblo Development had two clearly defined peaks in the hydrograph as indicated in Figure C. The first peak

represents the flows from the localized areas and the El Mirage Tributary Wash and thus confirms the findings of the Hydrologic Analysis for Lower El Mirage Wash at El Mirage Road Under Future Developed Conditions.

Based on the hydrograph, and limiting the flows to 1000 cfs through the Pueblo Development the placement of the detention basin could be located anywhere within the water shed. However the most logical choice would be just prior to golf course as proposed by the City of El Mirage.

V. ESTIMATE AND ALTERNATIVES

In the section 2 of this report is a detailed estimate performed by the District to verify the proposed cost by the City of El Mirage. As the case with any independent cost estimate it had some significant differences from the proposal from El Mirage. However the over all magnitude of the cost of the project appear to be within 10% of Each other. The purpose of the District's estimate was to evaluate an alternative of eliminating the basin and continue the channelization through the El Pueblo Golf Course and to establish the District's opinion of allowable project costs. The cost estimates indicated the either option was acceptable since the options were within 0.2% of each other ($12,200.00) and the original proposal by the City of El Mirage being the lowest.

VI. RECOMENDATIONS

The recommendation of this report is to proceed with the El Mirage Drainage Improvement Project. However, there must be some design issues worked out with the City of El Mirage and the re-evaluate the City' cost estimate share based on the findings of the following issues:

1. Provide the HEC 1 and HEC RAS model to demonstrate that the proposed channel, basin, and the improvements to the El Pueblo Golf Course will handle the 100-year design flows.

2. Provide final Designs and Plans for the project for review and approval by the District.

3. Demonstrate that the first flush issue is addressed.

4. Revise the engineering cost estimate to reflect project costs, which are allowable by the district and evaluate the City's participation.

5. Provide the District with the City's design plans and specification for the landscaping and aesthetic treatments.

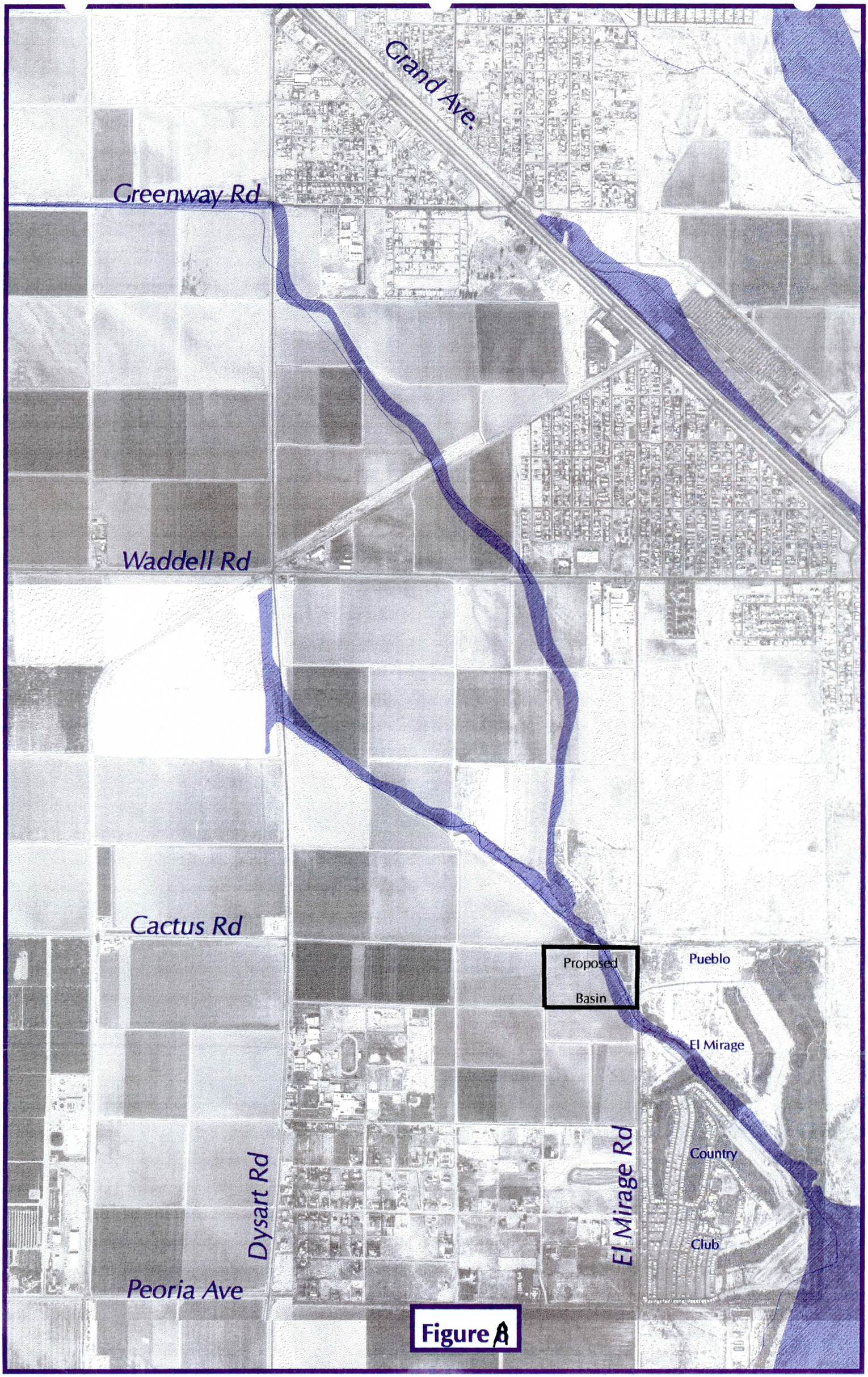
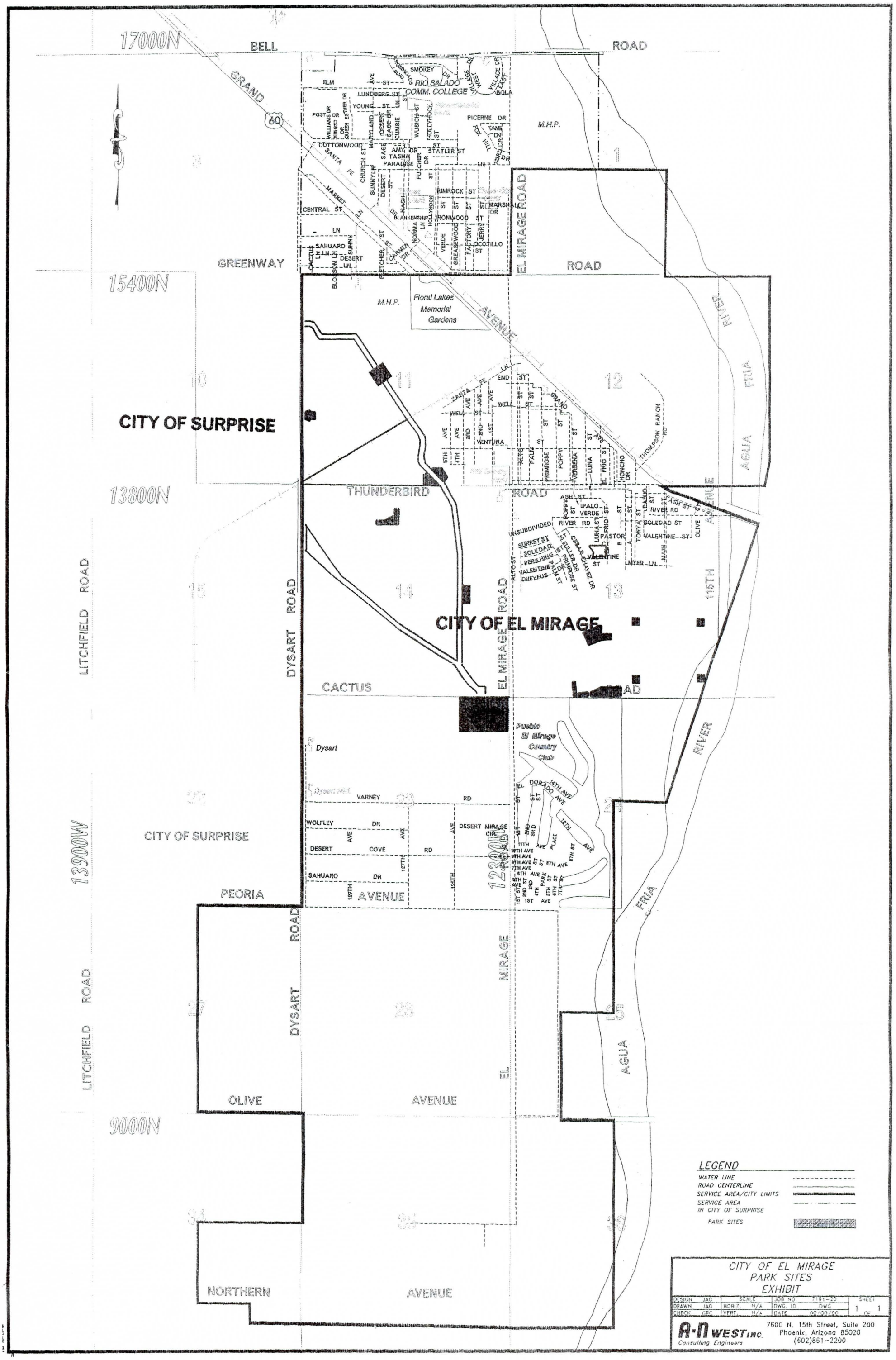

Grand Ave.
Greenway Rd
Waddell Rd
Cactus Rd
Proposed
Basin
Pueblo
El Mirage
Country
Club
El Mirage Rd
Dysart Rd
Peoria Ave

Figure A



LEGEND

- WATER LINE
- ROAD CENTERLINE
- SERVICE AREA/CITY LIMITS
- SERVICE AREA IN CITY OF SURPRISE
- PARK SITES

CITY OF EL MIRAGE
PARK SITES
EXHIBIT

DESIGN	JAG	SCALE	JOB NO. 7191-23	SHEET	
DRAWN	JAG	HORIZ. N/A	DWG. ID. DWG	1	1
CHECK	GRC	VERT. N/A	DATE 00/00/00	OF	

A-N WEST INC.
Consulting Engineers
7600 N. 15th Street, Suite 200
Phoenix, Arizona 85020
(602)861-2200

PEAK DISCHARGE FOR EXISTING CONDITIONS
24 Hr 100 year at CP-172

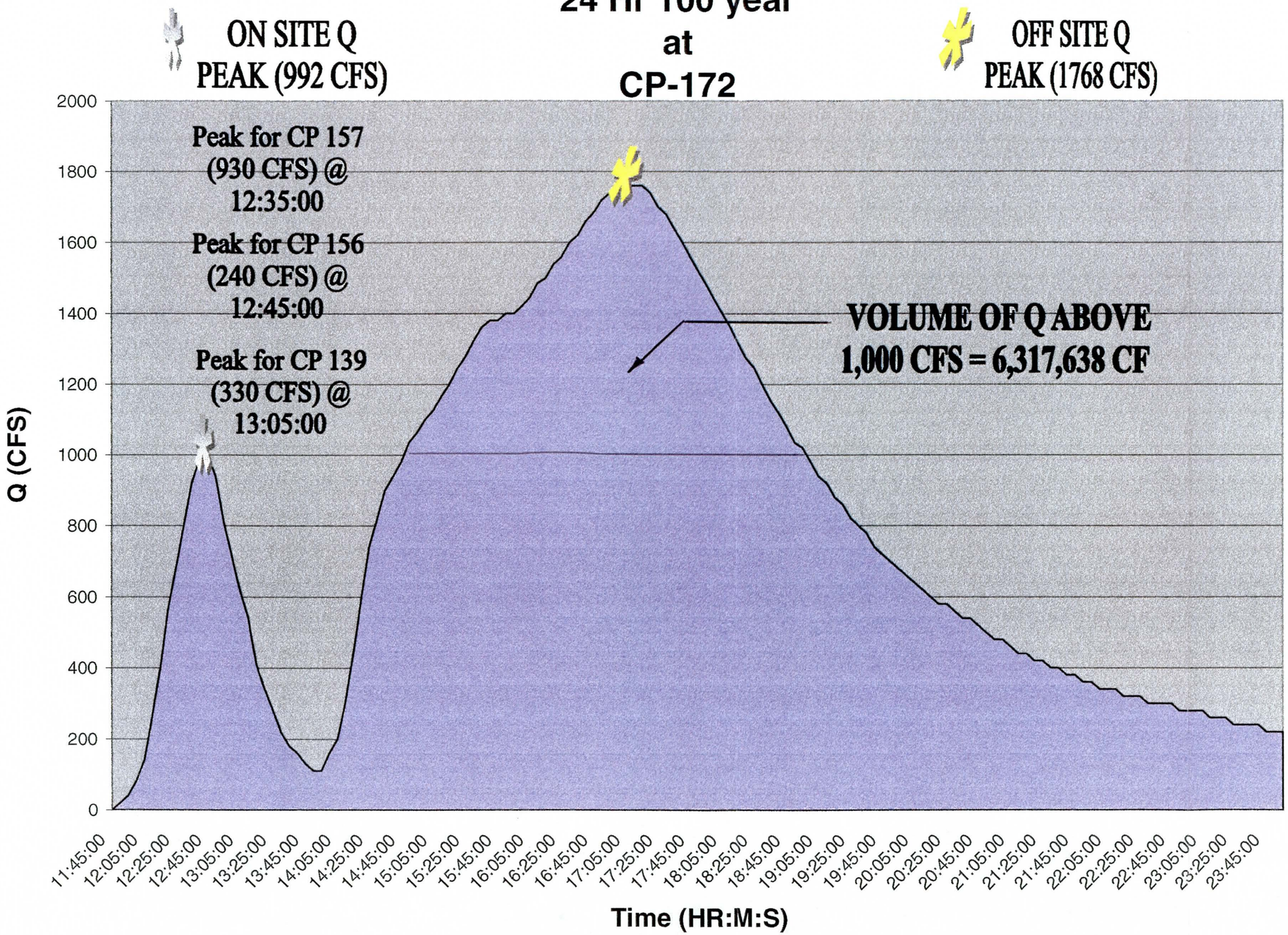


Figure C

El Mirage Drainage Improvement
Project
FCD Estimated Project Cost
9/28/99

OPTION NO. 1
(Use AN-West Base Design for Option Cost)

ITEM	UNIT * COST	TOTAL
1. Channel (17740 LF)		
a. Excavation	175,000 CY * $2.00/CY	350,000.00
b. Access Road	17,740 LF by 10 LF * 2.50/SF	443,500.00
c. Erosion Control		0
Rock (1 ½" Mulch)	.17' by 75% Area (47.1 Acres) / 27 * .85 Ton/CY* $25.00/ton	180,000.00
Grass	25% * 47.1 Acres * $3,800/Acre	45,600.00
Irrigation for Grass	25% of 47.1 Acres * $9,000/Acre	108,000.00
d. Roadway Crossings		0
@ Thunderbird	(3) 8'by 4' by 85' barrel w/ approaches	108,000.00
@ Cactus	(4) 8' by 4' by 85 barrel w/ approaches	160,000.00
@ El Mirage	(4) 8' by 5.5' by 85 barrel w/ approaches	180,000.00
@ N. Dysart	!/2 Street (3) 8' by 4'by 43'	79,450.00
@ S. Dysart	!/2 Street (4) 8' by 5' by 43'	85,750.00
Detours and Paving	Lump sum	150,000.00
e. Rail Road Crossing		0
12' RGRCP	75 LF @ $1,500/LF	187,500.00
Mitered Ends	(2) 12.5 LF @ 1,500/LF + 7000 Labor to Miter	25,750.00
Ex and Compaction	500 CY * 15.00/CY	7,500.00
Bore & Jack	75 LF * $4,500/LF	337,500.00
f. Relocate Existing Utilities	Lump Sum	50,000.00
		0
2. Basin Cost		0
a. Excavation	234,000 CY * $2.00/CY	468,000.00
b. Basin Pipe 18"	300 LF * $85/LF	25,500.00
c. Wier	Lump Sum	50,000.00
		0
3. Golf Course Improvements		0
a. Remove Existing 250 CFS Roadway Crossing	Lump Sum	30,000.00
b. Install 1000 CFS Box	(3) 8' by 4.5' by 48' Box	54,000.00
c.. By Pass and Pavement	Lump Sum	25,000.00
d. Improve Channel in Areas	3,610 CY * $2.00/CY	7,220.00
e. Grass	6 Acres * $3,800/Acre	22,800.00
f. Erosion Control @ Agua	600' by 150' by 1' of 6" rock @ $21/Ton (.85Ton/CY)	59,500.00
4. Other Costs		0
A. Permits		0
404	Lump Sum	13,500.00
Air/Dirt	Lump Sum	10,000.00
SWPP	Lump Sum	5,000.00
		0
Subtotal Project Construction Costs		$3,269,070.00

ITEM	UNIT * COST	TOTAL
Subtotal from Page 1		$3,269,070.00
		0
5. ROW		0
a. Basin	33 ACRES @ $20,000/ACRE	660,000.00
b. Golf Course	6 ACRES @ $45,000/ACRE	270,000.00
		0
6. Landscaping Allowance per FCD Policy		0
a. Basin	33 Acres * $9,000/Acre	297,000.00
b. Channel	47.1 * 10,000/Acre	471,000.00
c. Aesthetic Treatments	3% of $3,269,070.00	98,100.00
		0
7. Engineering	Lump Sum	250,000.00
		0
8. Construction Oversight Cost	8% of 3,269,070.00	261,500.00
		0
TOTAL OPTION 1 COST		**$5,576,670.00**

El Mirage Drainage Improvement
Project
FCD Estimated Project Cost
9/28/99

OPTION NO. 2
(Use AN-West Base Design for Channel and Delete Basin Option)

ITEM	UNIT * COST	TOTAL
1. Channel (17740 LF)		
a. Excavation	175,000 CY * $2.00/CY	350,000.00
b. Access Road	17,740 LF by 10 LF * 2.50/SF	443,500.00
c. Erosion Control		0
Rock (1 ½" Mulch)	.17' by 75% Area (47.1 Acres) / 27 * .85 Ton/CY* $25.00/ton	180,000.00
Grass	25% * 47.1 Acres * $3,800/Acre	45,600.00
Irrigation for Grass	25% of 47.1 Acres * $9,000/Acre	108,000.00
d. Roadway Crossings		0
@ Thunderbird	(3) 8'by 4' by 85' barrel w/ approaches	108,000.00
@ Cactus	(4) 8' by 4' by 85 barrel w/ approaches	160,000.00
@ El Mirage	Improve Existing with new Head and approach	18,000.00
@ N. Dysart	!/2 Street (3) 8' by 4'by 43'	79,450.00
@ S. Dysart	!/2 Street (4) 8' by 5' by 43'	85,750.00
Detours and Paving	Lump sum	150,000.00
e. Rail Road Crossing		0
12' RGRCP	75 LF @ $1,500/LF	187,500.00
Mitered Ends	(2) 12.5 LF @ 1,500/LF + 7000 Labor to Miter	25,750.00
Ex and Compaction	500 CY * 15.00/CY	7,500.00
Bore & Jack	75 LF * $4,500/LF	337,500.00
f. Relocate Existing Utilities	Lump Sum	50,000.00
		0
2. Golf Course Improvements		0
a. Remove Existing 250 CFS Roadway Crossing	Lump Sum	30,000.00
b. Install 1800 CFS Box	(4) 8' by 5.5' by 48' Box	85,000.00
c.. By Pass and Pavement	Lump Sum	25,000.00
d. Improve Channel in Areas	25,000 CY * $2.00/CY	50,000.00
e. Grass	14.7 Acres * $3,800/Acre	55,860.00
f. Erosion Control @ Agua	600' by 280' by 1' of 6" rock @ $21/Ton (.85Ton/CY)	111,100.00
3. Other Costs		0
A. Permits		0
404	Lump Sum	13,500.00
Air/Dirt	Lump Sum	10,000.00
SWPP	Lump Sum	5,000.00
		0
Subtotal Project Construction Costs		$2,722,010.00

ITEM	UNIT * COST	TOTAL
Subtotal from Page 1		$2,722,010.00
		0
4. ROW		0
a. Basin	0	0
b. Golf Course	14.7 ACRES @ $45,000/ACRE	661,500.00
		0
5. Landscaping Allowance per FCD Policy		0
a. Channel	47.1 * 10,000/Acre	471,000.00
b. Aesthetic Treatments	3% of $2,722,010.00	81,6600.00
		0
7. Engineering	Lump Sum	300,000.00
		0
8. Construction Management Cost	8% of 2,722,101.00	217,760.00
		0
9. Lost Revenue/Damages	Lump Sum	400,000.00
		0
TOTAL OPTION 2 – COST		**$5,588,870.00**

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT El Mirage Drainage PAGE 1 OF 5

DETAIL Quantity Est. COMPUTED GLJ DATE 9/17

CHECKED BY _____ DATE _____

1. Quanity Estimate For Channel(s)

a. Assumptions:

i. To Develop Section Use Q From White Tank ADMP Performed By WLB. WLB NOTED That SUN CITY GRAND WOULD Reduce The Flows.

ii. Vary Channel Width Based on Basins & Relate Q

iii. N = .025

iv. Ave Slope = .003 Ft/Ft.

b. "Area/Basin #139"

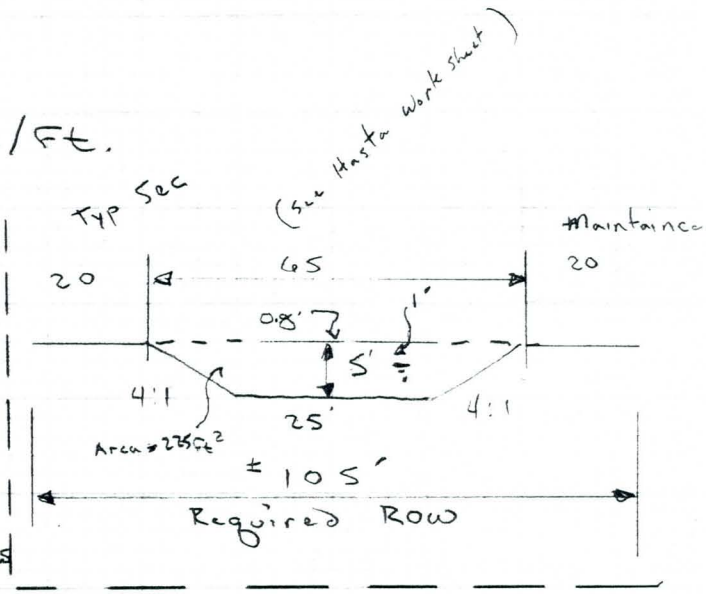
Length ≅ 3,941 Ft

Q = 840 CFS

Area = 225 Ft²

Exc = $\frac{3,941 * 225}{27}$ = 32,850 CY

ROW = Say $\frac{100 * 3,941}{43,560}$ ≅ 9.1 Acres



c. "Area/Basin # 156

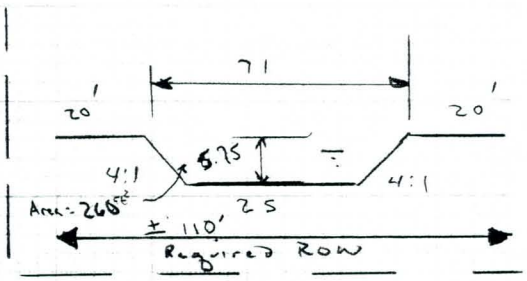
Length ≅ 2,050 (X-sec Same As ABOVE)

Q = 840 CFS

Area = 225 Ft²

Exc. = $\frac{2,050 * 225}{27}$ ≅ 17,100 CY

ROW = $\frac{100 * 2050}{43,560}$ ≅ 4.8 Acres



d. "Area/Basin # 157 For Upper Trib.

Lenght ≅ 4,750

Q = 1200 CFS

Area ≅ 260 Ft²

Exc = $\frac{4,750 * 260 \text{ Ft}^2}{27}$ = 45,740 CY

ROW = $\frac{110 * 4,750}{43,560}$ ≅ 12.0 Acres

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT El Mirage Drainage PAGE 2 OF 5

DETAIL Quantity Est. COMPUTED GLW DATE 9/1

CHECKED BY _____ DATE _____

1. Channel Quantities Est. Continued

E. "Area/Basin #157" LOWER El. Mirage Wash to Confluance w/ Upper Trib

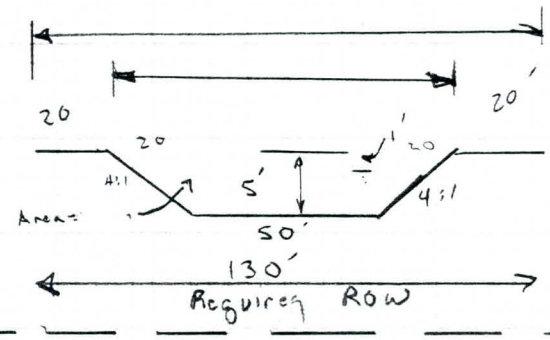
Length ≅ 4,850

Q = 1300 CFS

Area = 350 ft^2

$Exc = \frac{350 * 4850}{27} = 62,870$ CY

$ROW = \frac{130 * 4850}{43,560} = 14.5$ Acres



F. "Area/Basin #157" From Confluance to Basin #172

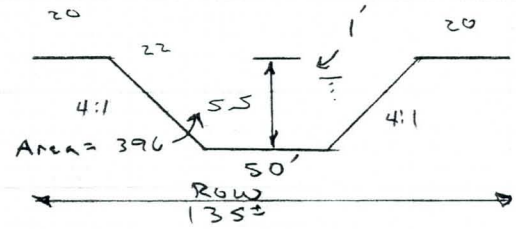
Lenght ≅ 950

Q = 1800 CFS

Area = 396 ft^2

$Exc = \frac{396 * 950}{27} = 13,950$ CY

$ROW = \frac{135 * 950}{43,560} = 3.0$ Acres



H. "Area/Basin #172" to Detentsion Basin

Lenght ≅ 750

Q = 1800 CFS

Area = 396

$Exc = \frac{396 * 750}{27} = 11,000$ CY

$ROW = \frac{135 * 750}{43,560} = 2.4$ ACRES

I. "Area/Basin #172" From Detention to Golf

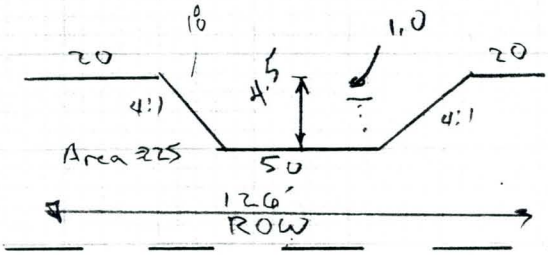
Lenght ≅ 450'

Q = 1000 = CFS

Area = 225 ft^2

$Exc = \frac{225 * 450}{27} = 3750$ CY

$ROW = \frac{126 * 450}{43,560} = 1.3$ Acre



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT EL Mirage Drainage PAGE 3 OF 5

DETAIL Quantity Est COMPUTED GLW DATE 9/17

CHECKED BY _____ DATE _____

J. (Option) GOLF COURSE

i. Existing Channel

Length ≅ 4,000 LF

Q ≅ 600 CFS (w/ No Free Board)

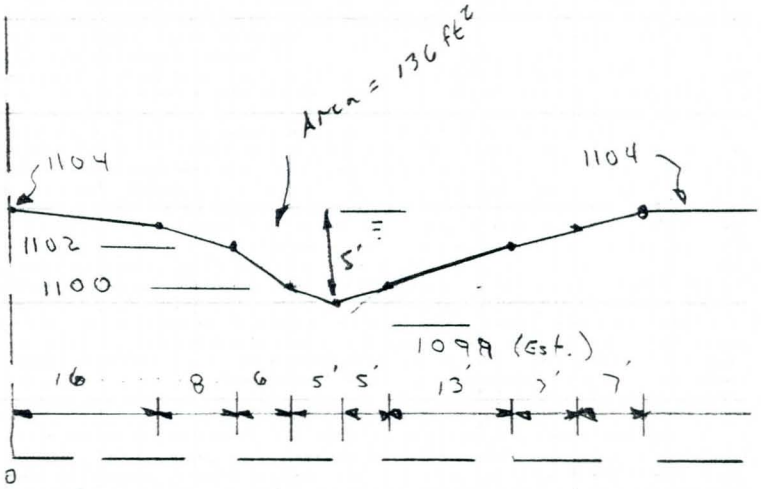
N = .031

A = 136 ft

ROW ≅ $\frac{4,000 * (67' + 40 \text{ Acres})}{43,560}$

= 9.9 Acres *

*(DOES NOT INCLUDE ADD FOR BACK WATER.)



ii. Proposed Improvement To 1800 CFS

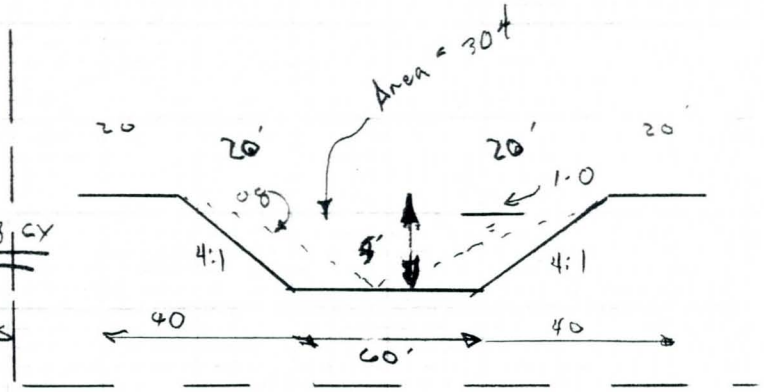
Length ≅ 4,000 ft

Q = 1800 CFS

Area = 304

Exc = $\frac{4000 * (304 - 136)}{27}$ = 24,888 CY

ROW = $\frac{4,000 * 160}{43,560}$ = 14.7 Acres



iii. Proposed Improvement To 1,000 CFS

Length = 4,000 ft

Q = 1,000 CFS

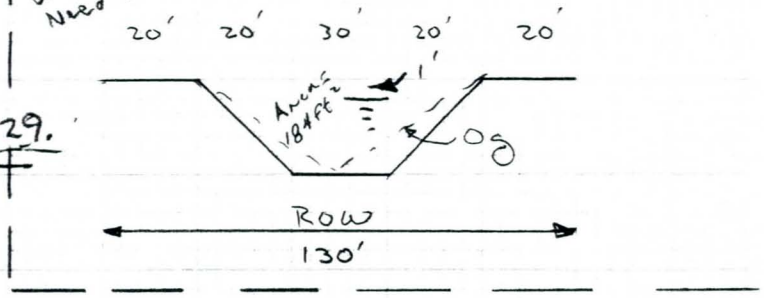
Area = 185

Exc = $\frac{2,000 * (185 - 136)}{27}$ = 3,629.

ROW = $\frac{2,000 * 130'}{43,560}$

= 6 ACRES

Assume only Half Need Improvements



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT El Mirage Drainage PAGE 4 OF 5

DETAIL Quanity Summary COMPUTED GLJ DATE

CHECKED BY DATE

2. Sumary of Quantities

A. Exc. (Required) for Channel (17,740) LF

32,850 CY
17,100 CY
45,740 CY
62,870 CY
11,000 CY
3,750 CY

173,310 CY

B. Golf Course Ex. (Options)

i. Minimual Channelization (W/ Detension Basin)

7,260 CY

ii Max w/ No Detention

24,890 CY

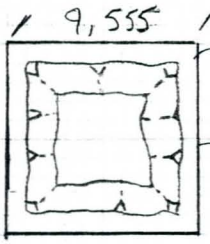
C. Rip Rap Outlet to Aquafria

L. 120 wide by 700 long = [illegible] SY
9

D. Detension Basin

∴ Use Dept = 10' w/ 4:1 side
Add 200' Buffer All Sides
~~Add~~ Round Up to 40 Acres For Parking & Access

Exc. = 6,317,638 ft³ / 27 = 234,000 CY



E. ROW

i Channel w/ Basin w/o Golf = 47.10 + 40.0 = 87.1 Ac
ii Channel w/ Basin w/ Golf = 87.1 + 6.0 = 93.1 Ac
iii Channel w/o Basin w/ Golf = 47.10 + 14.7 = 61.8 Ac

Existing Flood Way & Flood Plain for Channel Area = 408.5 Acres
Existing Flood plain for Channel Area = 90 Acres
Existing Flood WAY & Flood Plain for Golf = 69 Acres
Existing Flood plain for Golf Course = 45 Acres

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT El Mirage Drainage PAGE 5 OF 5

DETAIL Quanity Sumary COMPUTED GLV DATE 9/1

CHECKED BY _____ DATE _____

F. Required on Site (100 Year) Retention (Ac-ft) (Volume)

i. CP 139 = 13 Ac-Ft

ii. CP 156 = 6 Ac-Ft

iii. CP 157 = 26 Ac-Ft

G. Required on Site Retention (Area)
∴ Assume 4:1 & 3' Max Depth w/ 20' Buffer

i. CP 139 = 4.6 Acre area

ii. CP 156 = 2.2 Acre area

iii. CP 157 = 9.0 Acre area.

Total 15.8 Acres

H. Roadway Culverts

1. One Box at Thunderbird Rd w/ ~
Q = 840 CFS

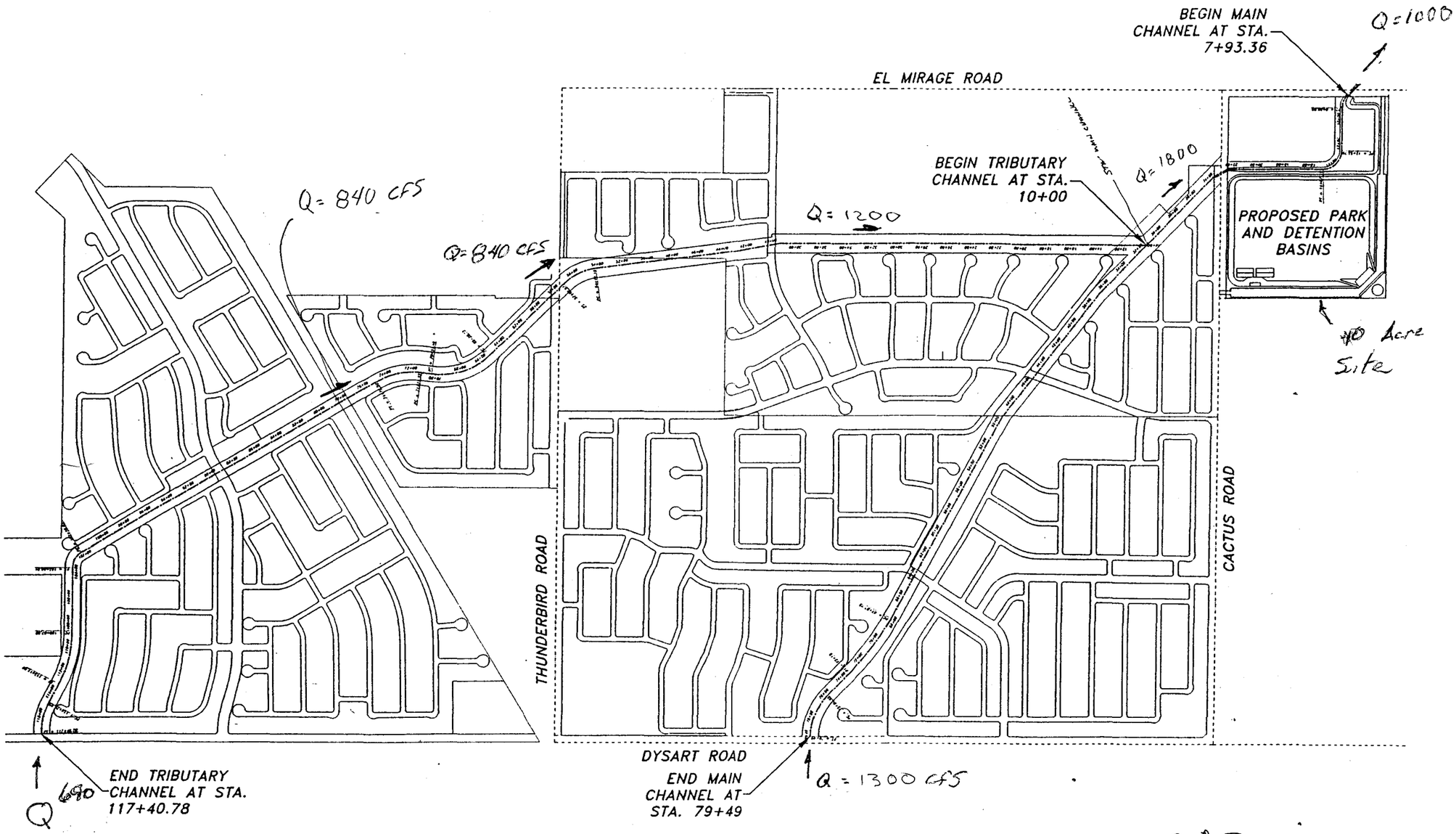
Length = 85
Width = 24 ≃ .908 CY/LF = 77 CY x 3 = 231 CY
Hieght = 4'
Per 8' Barrel

2. Improven Exist El Mirage Box Culvert w/ Wing Walls & Aproach Slab.
Q = 1,000 CFS

3. One Box at Latus Road

Q = 1,800 CFS

Length = 85
Width = 32 ≃ 1 CY/LF = 85 CY * 4 = 340
Hieght = 5.5
Per 8' Barrel



PRELIMINARY DESIGN OF THE EL MIRAGE DRAINAGE CHANNEL

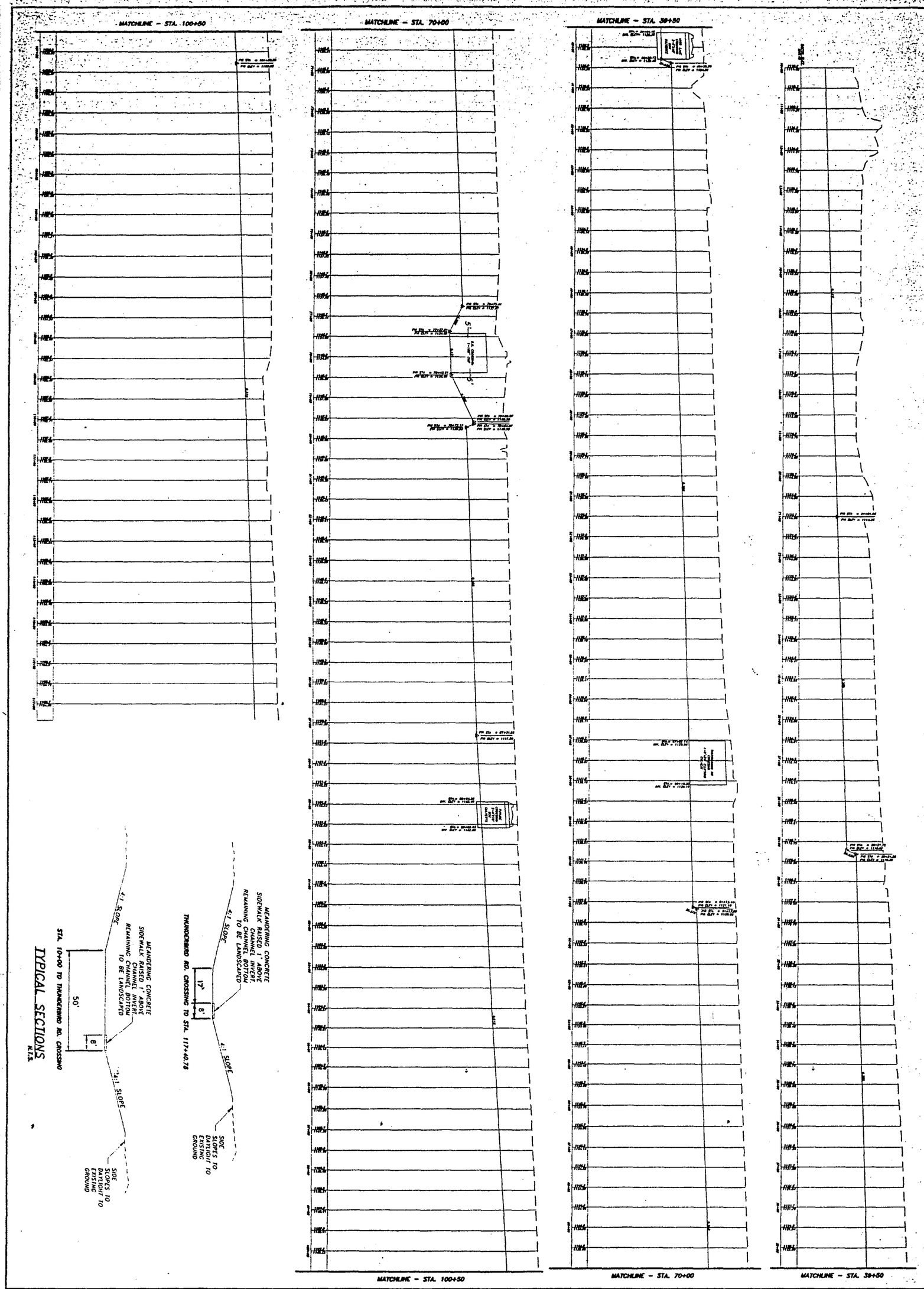
PLAN VIEW OF MAIN AND TRIBUTARY DRAINAGE CHANNELS

A-N WEST INC.
Consulting Engineers
7600 N. 15th Street, Suite 200
Phoenix, Arizona 85020
(602) 861-2200
phoenix@anwest.com

NO	DATE	DESCRIPTION	BY

JOB NO. 7191-16 | DESIGN GAS | SCALE
DWG. ID. 7191B6XHIBI | DRAWN WDR | HORIZ. 1"=400'
DATE 05/10/99 | CHECK LLT | VERT. N/A

SHEET 1 OF 3



SHEET 2 OF 3

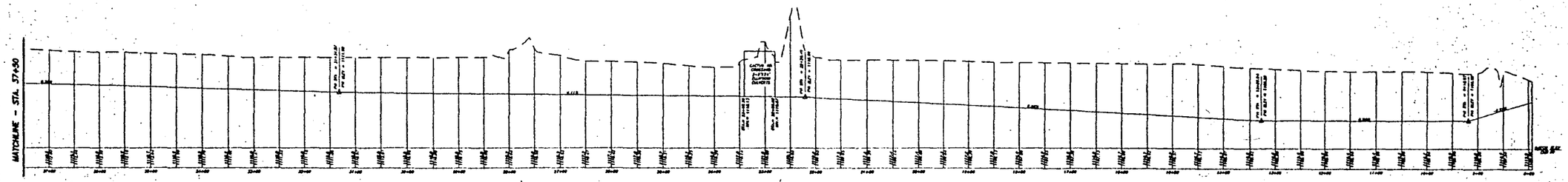
TRIBUTARY CHANNEL PROFILES AND TYPICAL SECTIONS

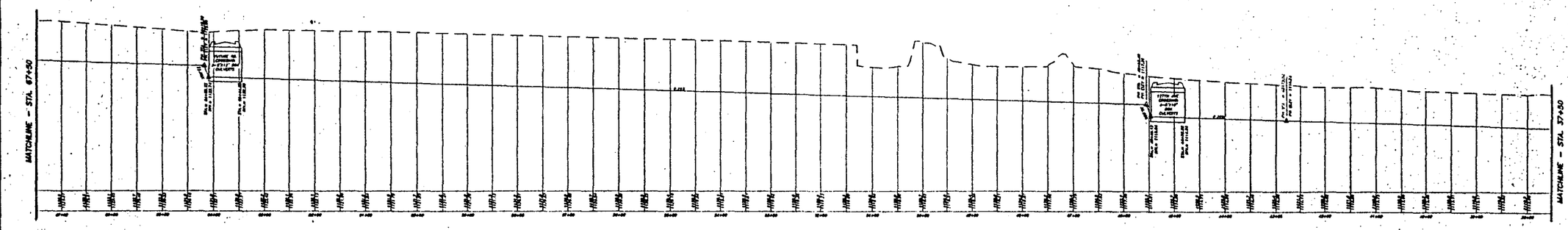
JOB NO.	7191-18	DESIGN	GAS	SCALE	
DWG. ID	7191 18EXHIBIT	DRAWN	WDR	HORIZ.	1"=100'
DATE	05/10/99	CHECK	LLT	VERT.	1"=10'

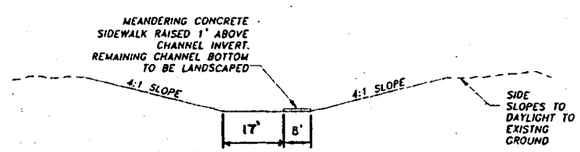
PRELIMINARY DESIGN OF THE EL MIRAGE DRAINAGE CHANNEL

A-N WEST INC.
Consulting Engineers
7600 N. 15th Street, Suite 200
Phoenix, Arizona 85020
(602) 861-2200
phoenix@anwest.com

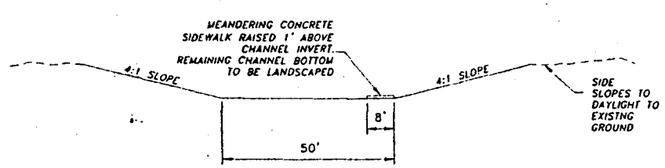
NO	DATE	DESCRIPTION	BY



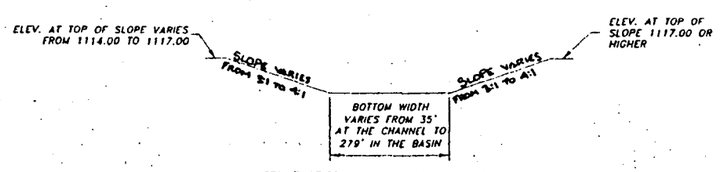




CONFLUENCE AT STA. 31+31.87 TO STA. 79+49



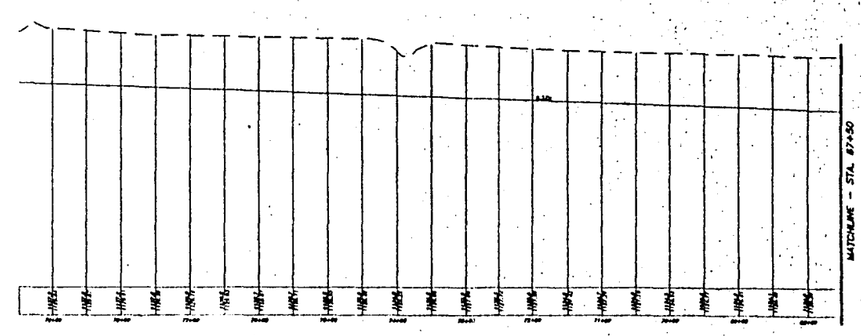
CACTUS RD. CROSSING TO CONFLUENCE AT STA. 31+31.87



STA. 7+93.56 TO CACTUS RD. CROSSING

TYPICAL SECTIONS

N.T.S.



CALL THE WORKING DAYS BEFORE YOU DIG
253-1100
1-800-STAKE-IT
(BLUE STAKE CONTACT)

NO.	DATE	DESCRIPTION	BY

A-N WEST INC.
Consulting Engineers
7600 N. 15th Street, Suite 200
Phoenix, Arizona 85020
(602) 861-2200
phoenix@anwest.com

PRELIMINARY DESIGN OF THE EL MIRAGE DRAINAGE CHANNEL

MAIN CHANNEL PROFILES AND TYPICAL SECTIONS

JOB NO.	7191-18	DESIGN	GAS	SCALE	
DWG. ID.	7191BEFNHBT	DRAWN	WDR	HORIZ.	1"=100'
DATE	05/10/95	CHECK		VERT.	1"=10'

SHEET 3 OF 3

El Mirage Masin No. 139 & 156
Worksheet for Trapezoidal Channel

Project Description	
Project File	e:\glj\projects\el mirage drain\el mirag.fm2
Worksheet	El Mirage Drianage - Basin No. 139 & 156
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.003000	ft/ft
Left Side Slope	4.000000	H : V
Right Side Slope	4.000000	H : V
Bottom Width	25.00	ft
Discharge	860.00	cfs

Results		
Depth	3.93	ft
Flow Area	160.04	ft^2
Wetted Perimeter	57.41	ft
Top Width	56.44	ft
Critical Depth	2.84	ft
Critical Slope	0.010341	ft/ft
Velocity	5.37	ft/s
Velocity Head	0.45	ft
Specific Energy	4.38	ft
Froude Number	0.56	
Flow is subcritical.		

El Mirage Upper Basin No. 157
Worksheet for Trapezoidal Channel

Project Description	
Project File	e:\glj\projects\el mirage drain\el mirag.fm2
Worksheet	Elmirage Drainage - Upper Basin No. 157
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.003000	ft/ft
Left Side Slope	4.000000	H : V
Right Side Slope	4.000000	H : V
Bottom Width	25.00	ft
Discharge	1,200.00	cfs

Results		
Depth	4.66	ft
Flow Area	203.41	ft²
Wetted Perimeter	63.43	ft
Top Width	62.29	ft
Critical Depth	3.43	ft
Critical Slope	0.009827	ft/ft
Velocity	5.90	ft/s
Velocity Head	0.54	ft
Specific Energy	5.20	ft
Froude Number	0.58	
Flow is subcritical.		

El Mirage Lower Basin No. 157
Worksheet for Trapezoidal Channel

Project Description	
Project File	e:\glj\projects\el mirage drain\el mirag.fm2
Worksheet	Elmirage Drainage - Lower Basin No. 157
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.003000	ft/ft
Left Side Slope	4.000000	H : V
Right Side Slope	4.000000	H : V
Bottom Width	50.00	ft
Discharge	1,300.00	cfs

Results		
Depth	3.63	ft
Flow Area	234.08	ft^2
Wetted Perimeter	79.92	ft
Top Width	79.03	ft
Critical Depth	2.57	ft
Critical Slope	0.010214	ft/ft
Velocity	5.55	ft/s
Velocity Head	0.48	ft
Specific Energy	4.11	ft
Froude Number	0.57	
Flow is subcritical.		

El Mirage - Basin 157 Confluance
Worksheet for Trapezoidal Channel

Project Description	
Project File	e:\glj\projects\el mirage drain\el mirag.fm2
Worksheet	El Mirage Drainage - Basin 157 Conflunce
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.003000	ft/ft
Left Side Slope	4.000000	H : V
Right Side Slope	4.000000	H : V
Bottom Width	50.00	ft
Discharge	1,800.00	cfs

Results		
Depth	4.35	ft
Flow Area	292.80	ft^2
Wetted Perimeter	85.83	ft
Top Width	84.76	ft
Critical Depth	3.14	ft
Critical Slope	0.009652	ft/ft
Velocity	6.15	ft/s
Velocity Head	0.59	ft
Specific Energy	4.93	ft
Froude Number	0.58	
Flow is subcritical.		

El Mirage Basin No. 172
Worksheet for Trapezoidal Channel

Project Description	
Project File	e:\glj\projects\el mirage drain\el mirag.fm2
Worksheet	El Mirage Drainage - Basin No. 172
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.003000	ft/ft
Left Side Slope	4.000000	H : V
Right Side Slope	4.000000	H : V
Bottom Width	50.00	ft
Discharge	1,000.00	cfs

Results		
Depth	3.13	ft
Flow Area	195.82	ft^2
Wetted Perimeter	75.83	ft
Top Width	75.05	ft
Critical Depth	2.18	ft
Critical Slope	0.010705	ft/ft
Velocity	5.11	ft/s
Velocity Head	0.41	ft
Specific Energy	3.54	ft
Froude Number	0.56	
Flow is subcritical.		

Existing Golf Course Channel
Worksheet for Irregular Channel

Project Description	
Project File	c:\winnt\profiles\glj\desktop\share\projects\el mirage drain\el mirag.fm2
Worksheet	El Mirage - Golf Course
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Channel Slope	0.003000	ft/ft
Water Surface Elevation	1,104.00	ft

Elevation range: 1,099.00 ft to 1,104.00 ft.

Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	1,104.00	0.00	67.00	0.031
16.00	1,103.00			
24.00	1,102.00			
30.00	1,100.00			
35.00	1,099.00			
40.00	1,100.00			
53.00	1,102.00			
60.00	1,103.00			
67.00	1,104.00			

Results		
Wtd. Mannings Coefficient	0.031	
Discharge	567.28	cfs
Flow Area	136.00	ft^2
Wetted Perimeter	67.91	ft
Top Width	67.00	ft
Height	5.00	ft
Critical Depth	1,102.87	ft
Critical Slope	0.011842	ft/ft
Velocity	4.17	ft/s
Velocity Head	0.27	ft
Specific Energy	1,104.27	ft
Froude Number	0.52	
Flow is subcritical.		

Proposed Golf Course Channel - 1000 CFS
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\winnt\profiles\glj\desktop\share\projects\el mirage drain\el mirag.fm2
Worksheet	El Mirage Prop. Golf Course Channel 1000
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.003000	ft/ft
Depth	4.00	ft
Left Side Slope	4.000000	H : V
Right Side Slope	4.000000	H : V
Bottom Width	30.00	ft

Results		
Discharge	1,020.09	cfs
Flow Area	184.00	ft^2
Wetted Perimeter	62.98	ft
Top Width	62.00	ft
Critical Depth	2.88	ft
Critical Slope	0.010178	ft/ft
Velocity	5.54	ft/s
Velocity Head	0.48	ft
Specific Energy	4.48	ft
Froude Number	0.57	
Flow is subcritical.		

Proposed Golf Course Channel - 1800 CFS
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\winnt\profiles\glj\desktop\share\projects\el mirage drain\el mirag.fm2
Worksheet	El Mirage - Proposed Golf Course Channel
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.003000	ft/ft
Depth	4.00	ft
Left Side Slope	4.000000	H : V
Right Side Slope	4.000000	H : V
Bottom Width	60.00	ft

Results		
Discharge	1,816.70	cfs
Flow Area	304.00	ft^2
Wetted Perimeter	92.98	ft
Top Width	92.00	ft
Critical Depth	2.86	ft
Critical Slope	0.009821	ft/ft
Velocity	5.98	ft/s
Velocity Head	0.55	ft
Specific Energy	4.55	ft
Froude Number	0.58	
Flow is subcritical.		

El Mirage Box @ 4' & 700 CFS
Worksheet for Rectangular Channel

Project Description	
Project File	\\fcdmain\users\glj\projects\el mirage drain\el mirag.fm2
Worksheet	Box Culvert 700 CFS
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Bottom Width

Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.001500	ft/ft
Depth	4.00	ft
Discharge	700.00	cfs

Results		
Bottom Width	19.69	ft
Flow Area	78.77	ft^2
Wetted Perimeter	27.69	ft
Top Width	19.69	ft
Critical Depth	3.40	ft
Critical Slope	0.002432	ft/ft
Velocity	8.89	ft/s
Velocity Head	1.23	ft
Specific Energy	5.23	ft
Froude Number	0.78	
Flow is subcritical.		

El Mirage Box Culvert @ 4-0 & 850 CFS
Worksheet for Rectangular Channel

Project Description	
Project File	\\fcdmain\users\glj\projects\el mirage drain\el mirag.fm2
Worksheet	Box Culvert - 850 CFS
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Bottom Width

Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.001500	ft/ft
Depth	4.00	ft
Discharge	850.00	cfs

Results		
Bottom Width	23.21	ft
Flow Area	92.83	ft^2
Wetted Perimeter	31.21	ft
Top Width	23.21	ft
Critical Depth	3.47	ft
Critical Slope	0.002306	ft/ft
Velocity	9.16	ft/s
Velocity Head	1.30	ft
Specific Energy	5.30	ft
Froude Number	0.81	
Flow is subcritical.		

El Mirage Box @ 4.5' & 1000 CFS
Worksheet for Rectangular Channel

Project Description	
Project File	e:\glj\projects\el mirage drain\el mirag.fm2
Worksheet	Box @ 4' & 1000 CFS
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Bottom Width

Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.001500	ft/ft
Depth	4.50	ft
Discharge	1,000.00	cfs

Results		
Bottom Width	22.96	ft
Flow Area	103.32	ft^2
Wetted Perimeter	31.96	ft
Top Width	22.96	ft
Critical Depth	3.89	ft
Critical Slope	0.002311	ft/ft
Velocity	9.68	ft/s
Velocity Head	1.46	ft
Specific Energy	5.96	ft
Froude Number	0.80	
Flow is subcritical.		

El Mirage Box @ 5.5 & 1300 CFS
Worksheet for Rectangular Channel

Project Description	
Project File	\\fcdmain\users\glj\projects\el mirage drain\el mirag.fm2
Worksheet	Box Culvert 1300 CFS
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Bottom Width

Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.001500	ft/ft
Depth	5.50	ft
Discharge	1,300.00	cfs

Results		
Bottom Width	22.37	ft
Flow Area	123.04	ft^2
Wetted Perimeter	33.37	ft
Top Width	22.37	ft
Critical Depth	4.72	ft
Critical Slope	0.002347	ft/ft
Velocity	10.57	ft/s
Velocity Head	1.73	ft
Specific Energy	7.23	ft
Froude Number	0.79	
Flow is subcritical.		

El Mirage Box @ 5.5 & 1800 CFS
Worksheet for Rectangular Channel

Project Description	
Project File	\\fcdmain\users\glj\projects\el mirage drain\el mirag.fm2
Worksheet	Box Culvert 1800 CFS
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Bottom Width

Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.001500	ft/ft
Depth	5.50	ft
Discharge	1,800.00	cfs

Results		
Bottom Width	29.34	ft
Flow Area	161.36	ft^2
Wetted Perimeter	40.34	ft
Top Width	29.34	ft
Critical Depth	4.89	ft
Critical Slope	0.002129	ft/ft
Velocity	11.16	ft/s
Velocity Head	1.93	ft
Specific Energy	7.43	ft
Froude Number	0.84	
Flow is subcritical.		