

TANQUE VERDE CREEK BANK PROTECTION
NEAR FORTYNINER'S COUNTRY CLUB
ESTATES

INTERIOR DRAINAGE IMPROVEMENTS
CONCEPT REPORT

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PIMA COUNTY DEPARTMENT OF TRANSPORTATION
and
FLOOD CONTROL DISTRICT

FLOOD CONTROL ENGINEERING SECTION

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EXECUTIVE SUMMARY

INTRODUCTION

The ongoing Tanque Verde Creek Feasibility Study, a joint effort between the Pima County Department of Transportation and Flood Control District and the U.S. Army Corps of Engineers, Los Angeles District, proposes to reduce flood damages from both Tanque Verde Creek and offsite flows, as they affect the Fortyniner's Country Club Estates and the Arbor Vista subdivisions. Several alternative solutions have been investigated in the course of this study, the first one being a soil cement levee along the north bank of the Tanque Verde Creek between the Wentworth Road and Tanque Verde Loop Road, as recommended in the Corps of Engineers' Section 205 Reconnaissance Report (1987). Subsequent studies by the Pima County Department of Transportation & Flood Control District have considered different combinations of a levee along the creek and various upstream improvements - including detention and diversion of upstream flows - to reduce flooding caused by runoffs from local drainage areas and tributaries. These studies however indicated that improvement of local drainageways would still be required to reduce flooding from offsite flows. Consequently, local drainage improvement was investigated as a separate alternative independent of the levee project. This report presents an analysis of this alternative, with or without the upstream improvements (detention or diversion).

HYDROLOGY AND INTERIOR DRAINAGE

The Fortyniner's Country Club Estates subdivision is a combination residential area and golf course which lies partly on the toe of an alluvial fan and partly within the geologic floodplain of the Tanque Verde Creek. The offsite flows affecting the study area originate in

a watershed about five square miles in area and extending approximately six miles northeast of the Tanque Verde Creek confluence.

The watershed consists of four subwatersheds, the largest of which is the Fortyniner's Wash having a drainage area of 3.30 square miles and a 100-year peak flow of 2,360 cfs at the confluence. Hundred-year peak flows for the other three subwatersheds vary from 100 to 800 cfs at the Tanque Verde Road crossing.

The interior drainage network within the project area is generally inadequate to convey hundred-year flows from the subwatersheds mentioned above. Conveyance capacities of existing channels vary greatly from reach to reach, and are significantly below 100-year flows in many reaches. Some of the reaches have deteriorated so much, due to lack of maintenance, natural causes or man-made activities, that they are inadequate to convey even the runoffs generated within the subdivision. For example, while the 100-year flows in the lower portion of the Fortyniner's Wash vary from 2,100 to 2,360 cfs, the channel capacities range from only 50 to 1000 cfs.

ALTERNATIVE PLANS TO REDUCE FLOODING

Three alternative plans are proposed to alleviate flooding from offsite flows: (1) Improvement of drainage network to convey existing Q100 flows; (2) Improvement of drainage network in conjunction with an upstream detention basin; (3) Improvement of drainage network in conjunction with an upstream diversion channel.

Plan #1 includes improving the interior drainage network to convey the existing Q100 flows from Fortyniner's Wash, East Fortyniner's Wash, Fortyniner's Tributary Wash, and

LDB- 8 to the confluence at the Tanque Verde Creek. It does not include any upstream detention or diversion. This plan will require approximately 7,500 feet of channel improvement, with about 42,000 cu. yd. of excavation. The proposed improvements will be located entirely within dedicated drainageways. The estimated cost for this plan is \$358,500, which also includes costs of improved dip sections, conveyance structures, golf course crossing reconstruction, and utility relocation.

Plan #2 includes a detention basin on the Fortyniner's Wash northeast of the Wentworth Road - Tanque Verde Road intersection, and improvement of drainage network to convey the detained Q100 flows from the detention basin. Benefits from detention are most noticeable immediately downstream of Tanque Verde Road. Significant channel improvements (about 20,000 cu. yd. of drainage excavation) will still be required in the lower half of the drainage network. The detention basin consists of an earthen embankment with an impervious soil cement core, an outlet structure, and an emergency spillway to pass one-half of the probable maximum flood (in compliance with ADWR guidelines). The total estimated cost for this plan is \$1.48 million including costs for roadway, golf course and utility crossing. The cost of the detention basin (1.11 million) comprises the major part of the total cost, even though the land for the basin is assumed to be available without cost from the University of Arizona.

Plan #3 consists of a diversion channel to convey all of the flow from Fortyniner's Wash upstream of the Tanque Verde Road and Wentworth Road intersection, and drainage improvement to convey the Q100 flows after diversion. Significant channel improvement (about 16,000 cu. yd. of drainage excavation) will still be required even with diversion. Flow

diversion will consist of a earthen levee at the intersection of Tanque Verde Road and Wentworth Road to direct the flow, and a riprap lined channel following the east side of Wentworth Road to convey the diverted flow to the Tanque Verde Creek. The diversion channel will require a series of conveyance structures, including five culverts, and additional land acquisition (about 1.5 acres). The total estimated cost for this plan is \$1.026 million, of which the flow diversion component is \$0.74 million.

THE RECOMMENDED PLAN

The estimated costs for the three proposed plans are \$0.358 million, \$1.484 million, and \$1.026 million for Plan #1 (drainage improvement only), Plan #2 (detention basin and drainage improvement), and Plan #3 (diversion and drainage improvement), respectively.

From a comparison of different features of these plans, of which cost is the prime factor, Plan #1 is the recommended plan. This recommendation takes into account the fact that the other plans (#2 and #3) also require improvement of the same drainageways, though to lesser degree, even with the additional feature (and the associated high costs) of detention basin or diversion channel.

Plan #1 will protect the project area from flooding caused by offsite flows, without detention or diversion facilities. The proposed improvements for this plan will be located entirely within dedicated drainageways and, therefore, no additional land acquisition will be required. This plan can be implemented independently of the Tanque Verde Levee Project, to mitigate flooding due to offsite flows, or it can be built in conjunction with the levee project to mitigate flooding from both offsite and Tanque Verde Creek flows.

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INTRODUCTION

Background

The ongoing Tanque Verde Creek Levee Feasibility Study proposes to reduce flood damages from both Tanque Verde Creek and offsite flows, as they affect the Fortyniner's Country Club Estates and the Arbor Vista subdivisions. Up to this point, the study has considered different combinations of a monolithic levee between Tanque Verde Creek and the subdivisions (for the Tanque Verde Creek flows) and various internal drainage and/or upstream improvements (for the offsite flows).

A previous report entitled: "Tanque Verde Creek Bank Protection Near Fortyniner's Country Club Estates - Interior Drainage Report", prepared in September, 1991, by the PCDOT&FCD Flood Control Engineering Section made qualitative evaluations of the following alternatives:

- I. Tanque Verde levee with outlet structure (no interior drainage improvements).
- II. Tanque Verde Levee with outlet structure, and upstream detention basin to reduce interior overflows.
- III. Tanque Verde Levee with outlet structure, and localized channel improvement and/or levee along interior drainage network, where necessary, to provide flood protection against interior overflows.
- IV. Tanque Verde Levee with outlet structure and a combination of upstream detention basin and interior channel improvement.

The report concluded that Alternative IV appeared to be most feasible on a qualitative basis, and stated the need for a quantitative analysis. It further

stated that if the interior drainage was to be improved independent of the Tanque Verde Creek Levee, localized improvement of the existing channels was preferable to the construction of an upstream detention basin.

Authorization

The U.S. Army Corps of Engineers, Los Angeles District, completed a Section 205 Reconnaissance Report in 1987 (Reference 1), recommending a soil cement levee along the north bank of Tanque Verde Creek. Subsequently, the PCDOT&FCD and the Corps of Engineers have been involved in a joint feasibility study of the recommended alternative, in accordance with a cooperative agreement drawn in 1988. The need for an offsite drainage solution was identified early in the study, and both diversion and detention alternatives were investigated. It soon became apparent that these alternatives would be costly, and would still require localized channel improvement within the country club. Consequently, localized improvement of the drainageways was investigated as a separate alternative, which could be implemented with or without the Tanque Verde Levee.

Purpose

The purpose of this report, is to quantify the costs of the interior drainage improvements necessary to convey the Q100 peak flow, independent of the construction of the Tanque Verde Levee. It considers three proposals:

- Proposal #1) Improvement of the drainage network with existing offsite flows (no detention or diversion).
- Proposal #2) Improvement of the drainage network in conjunction with an upstream detention basin.
- Proposal #3) Improvement of the drainage network in conjunction with an upstream diversion channel.

The cost estimates for each proposal will be itemized for the following components: 1) interior channel excavation and fill, 2) roadway, golf course, and utility crossings, 3) upstream improvements, and 4) outlet and conveyance structures associated with the upstream improvements.

Previous Studies

The following reports (References 2 - 4 respectively), prepared by the PCDOT&FCD Flood Control Engineering Section have addressed offsite hydrology and/or hydraulics for this project:

"Tanque Verde Wash Bank Protection - Hydrology Report", 1988.

"Tanque Verde Creek Bank Protection Near Fortyniner's Country Club Estates - Preliminary Results of Probable Maximum Flood Analyses", July, 1991.

"Tanque Verde Creek Bank Protection Near Fortyniner's Country Club Estates - Interior Drainage Report", September, 1991.

In preparation of the Interior Drainage Report, a search of the files in both the Mapping and Records, and the Planning and Development sections of the PCDOT&FCD was conducted. No record of the original channel design for

Fortyniner's Country Club Estates was located. However, the alignments and widths of the dedicated drainage easements within the estates are indicated on the 1960 Subdivision Plat (Map Book#15, Page#39), and a limited number of cross sections and/or flowlines are indicated on the development, paving, and sewer plans listed below:

- 1) Improvement Plan #72 - "Paving for Fortyniner's Country Club Estates", 1969, Cella Barr Engineers, Tucson, Arizona.
- 2) Improvement Plan #73 - "Paving and Sewer Plans, Fortyniner's Country Club Estates, Unit No. 1", 1961, Blanton and Cole, Tucson, Arizona.
- 3) Improvement Plan #74 - "Paving and Sewer Plans, Fortyniner's Country Club Estates, Unit No. 2", 1961, Blanton and Cole, Tucson, Arizona.
- 4) Improvement Plan #374 - "Grading Plan for Fortyniner's Country Club Estates", 1974, Blanton and Co., Tucson, Arizona.
- 5) Improvement Plan #416A - "Arbor Vista Paving Sewer and Drainage Improvements", 1974, Marum and Marum, Tucson, Arizona.
- 6) Improvement Plan #731 - "Fortyniners Guest Ranch Paving Plans", 1979, Cella, Barr, Evans and Associates, Tucson, Arizona.

EXISTING CONDITIONS

Locations and Boundaries

The Fortyniner's Country Club Estates and the Arbor Vista subdivisions are located in sections 5 and 6 of Township 14 South, Range 16 East. The proposed site of the detention facility is located in section 33 of Township 13

South, Range 16 East. The proposed diversion facility and channel is located in section 33 of Township 13 South, Range 16 East, and section 4 of Township 14 South, Range 16 East. All townships and ranges are based on the Gila and Salt River Base Meridian.

The following is a list of maps pertinent to this project. Unless otherwise noted, all are located in the PCDOT&FCD Mapping and Records Section.

- 1) USGS 7.5 Minute Quadrangles:
 - A) Agua Caliente Hill, 1981.
 - B) Tanque Verde Peak, 1981.
 - C) Tucson, East 1983.
 - D) Sabino Canyon, 1957 - Photo Revised 1971 & 1975.
- 2) Pima County Road Maintenance Status and Flood Plain Limits Atlas, 1991, PCDOT & FCD, Pages 82 and 110.
- 3) 1" = 1000' aerial photos, 13/16 and 14/16, 1983-84.
- 4) 1" = 400' aerial photos, 15/15 and 15/16, 1990.
- 5) 1" = 200' aerial photo-topo, C. I. = 2', Cooper Aerial Survey, T14S, R16E, Sections 5 & 6, 1986.
- 6) 1" = 200' aerial photo-topo, C.I. = 2', "Tanque Verde Bank Protection at Fortyniner's Country Club", The Orthoshop, 1989, located at the PCDOT&FCD - Flood Control Engineering Section.
- 7) 1" = 100' aerial photo-topo, C.I. = 1', "Tanque Verde Bank Protection at Fortyniner's Country Club", The Orthoshop, 1989, located at the PCDOT&FCD - Flood Control Engineering Section.

Physical Characteristics

In general, offsite flows affecting Fortyniner's Country Club Estates and

Arbor Vista originate in the foothills of a fault block mountain range, and continue over an alluvial fan to a confluence with Tanque Verde Creek (Figures 1 and 2). The Fortyniner's Country Club Estates subdivision is a combination residential area and 18 hole golf course which lies partly on the toe of the fan, and partly within the geologic floodplain of Tanque Verde Creek. The portion of the subdivision within the floodplain has been inundated as recently as 1983 in what was estimated to be a 15-year flow event. The entire subdivision relies on a generally inadequate interior drainage network and is thus subject to flooding from offsite flows as well. Arbor Vista is located entirely on the alluvial fan and is drained by an improved network that appears to have deteriorated somewhat. It is subject to only minimal flooding from offsite flows greater than or equal to about Q100.

Hydrology

The complete offsite and interior drainage area characteristics for the project area have been previously described in References 2 - 4. A brief review of the hydrology is included herein.

The offsite flows affecting Fortyniner's Country Club Estates originate in a almost five square mile watershed extending approximately six miles northeast of the Tanque Verde Creek confluence. In this and the previous studies, it has been broken into four major subwatersheds and a number of "Local Drainage Basins" (Figure 1). The subwatersheds are "Fortyniner's Wash" (3.30 square miles),

"Fortyniner's Tributary Wash" (0.27 square miles), "East Fortyniner's Wash" (0.74 square miles), and "Cindy's Wash" (0.53 square miles). All these subwatersheds cross Tanque Verde Road on the north side of the subdivision. Fortyniner's Wash, the primary watercourse, continues to a confluence with Tanque Verde Creek. Fortyniner's Tributary Wash, and East Fortyniner's Wash join Fortyniner's Wash within the country club area. Cindy's Wash, which is separate and drains to its own confluence with Tanque Verde Creek, needs no channel improvements.

In order to evaluate the local runoff within the country club area, eight Local Drainage Basins were delineated (Reference 2). Most are immediately adjacent to, and provide lateral inflow to one of the major washes, and are thus included within those drainage areas. However one of them, Local Drainage Basin 8 (LDB-8), drains to a separate watercourse, which in turn joins Fortyniner's Wash. It is thus treated as a separate subwatershed. The Q100 peak flows for each subwatershed and LDB-8 are listed in Table 1 below.

Table 1: Summary of Q100 Flows Affecting Fortyniner's Country Club.

	Fortyniner's Wash (cfs)	Fortyniner's Tributary Wash (cfs)	East Fortyniner's Wash (cfs)	Cindy's Wash (cfs)	LDB-8 Tributary (cfs)
@ Tanque Verde Rd.	2100	350	800	100	---
@ Fortyniner's Wash	--	370	865	---	150
@ Tanque Verde Cr.	2360	---	---	261	---

Hydraulics

As with the hydrology, a complete account of the interior channel characteristics is given in the previous reports. A brief review of the existing channel conditions is followed by a description of the intended channel conditions as described in the previous improvement plans.

Interior Drainage Network - Existing Conditions

As it currently exists, Fortyniner's Wash extends from the Tanque Verde Creek confluence to Tanque Verde Road (Figure 2). The lower half (stations 0+00 to 31+00) lies within the geologic floodplain and thus has correspondingly low channel slopes, ranging from about 0.20% to 0.70%. The conveyance in the reach has been drastically reduced by man made activities such as fairways or by silting and a lack of maintenance. While the Q100 in this lower portion ranges from 2100 cfs - 2360 cfs, the channel capacities range from only 50 cfs to 1000 cfs. This is despite the fact that the dedicated drainage easement is 100 feet wide between stations 0+00 and 15+00, and 75 feet wide between stations 15+00 and 30+00.

The upper half of Fortyniner's Wash (stations 31+00 to 68+00) is on the toe of the alluvial fan and has channel slopes ranging between 1.0% and 1.6%. With the exception of stations 37+00 - 40+00, where the channel separates the #3 fairway from the #3 tee, the cross section is well defined. The Q100 in this reach is about 2100 cfs while the channel capacities in the defined sections range

from 900 cfs - 2300 cfs. The capacity between 37+00 and 40+00 is limited to about 200 cfs. The width of the dedicated drainage easement throughout this reach is 65 feet.

East Fortyniner's Wash is the largest tributary to Fortyniner's Wash. It extends from station 115+00 (station 15+00 on Fortyniner's Wash) to station 137+00 at Tanque Verde Road. The existing channel can convey the Q100 (800 cfs - 865 cfs) with two exceptions. Between stations 115+00 and 118+50, where the channel is within the floodplain, low channel slopes and apparent infilling by man has limited the channel capacity to between 50 cfs - 150 cfs. Between stations 133+00 and 136+00, the channel crosses the #1 fairway and the conveyance is limited to about 200 cfs. The width of the dedicated drainage easement varies from 70 feet (stations 115+00 - 123+00) to 50 feet (stations 123+00 - Tanque Verde Road).

The LDB-8 tributary, as defined in this report, extends from station 230+00 (station 30+00 on Fortyniner's Wash) to station 261+00 where the 50 foot wide dedicated drainage easement terminates at Cape Horn Drive. The channel has capacity to completely convey the Q100 of 150 cfs.

Fortyniner's Tributary Wash extends from station 347+00 (station 47+00 on Fortyniner's Wash) to station 359+00 at Tanque Verde Road. The existing channel can convey the Q100 of 370 cfs, with the exception of a portion near station 352+00, which conveys only 300 cfs. The dedicated drainage easement is 50 feet wide.

Interior Channel Improvements - Previous Plans

As it currently exists, the entire Fortyniner's Wash channel will require some sort of improvement to convey the existing offsite flows. In addition, each of the above described tributaries will require localized improvements to convey their respective peak flows. A logical first step in determining the extent of the proposed improvements would be to compare the existing conditions with the previous improvement plans to determine: 1) if the specified improvements were ever constructed, and 2) if so, are they adequate to convey the existing offsite flows.

The previous improvement plans specify improved channel flowlines and cross sections, and roadway crossing inverts at a few points along Fortyniner's Wash (Figures 3A - 3C). Between stations 12+84 and 18+68, the 1979 "Fortyniner's Guest Ranch Paving Plans" (#731) by Cella Barr Evans and Associates specify a channel with a 67 foot bottom width, 5.5 foot depth, and 3:1 side slopes. The proposed channel slope is 0.35%, and the proposed flowline is approximately 1.0 to 1.5 feet below that shown on the 1989 photo-topos. Given a Manning's n of 0.035, this configuration will convey approximately 3160 cfs and is thus more than adequate for the Q100.

However, if the proposed section is superimposed on sections derived from the 1989, 1" = 100' photo-topos, it is immediately apparent that given the proposed flowline and the existing topography, a 5.5 foot deep channel could not have been constructed without a two foot levee on either side (Figure 3A). Since

the cross section detail on plan #731 shows that the 3:1 side slopes meet existing ground with no levee, it appears that the section was incorrectly designed, or that the topography in this area was substantially lowered after the plans were complete. In either case, this particular improvement will not convey the existing Q100, unless the flowline is two or three feet lower.

At the Soldier Trail Road, Fortyniner's Drive and Klondike Drive dip crossings (stations 8+00, 21+77 and 27+56 respectively), the 1961 "Paving and Sewer Plans for Fortyniner's Guest Ranch" (#73) by Blanton and Cole specify improved inverts of 2619.7 feet, 2624.4 feet, and 2627.0 feet respectively. Given proper adjustment for the difference in the vertical datum, the specified Soldier Trail Road and Klondike Drive inverts are within 0.5 feet of the elevation shown on the 1989 photo-topos. The specified Fortyniner's drive invert is approximately 1.5 feet below that shown on the topos (Figures 3A and 3B).

Also at Soldier Trail Road and Fortyniner's Drive, the 1969 "Paving for Fortyniner's Country Club Estates" plans (#72) by Cella Barr Engineers show inverts of 2619.53 feet and 2625.68 feet respectively. While the datum for these particular plans is unknown, the two points are within 0.5 feet of the elevations shown on the 1989 photo-topos, indicating that these were, in fact, the last improvements done on these crossings. Thus while there is no evidence that the Fortyniner Guest Ranch Drainage Improvements were ever constructed, it appears that these particular roadway improvements were.

Between stations 48+00 and 68+00, the 1974 "Arbor Vista Paving Sewer

and Drainage Improvements" plans (#416) by Marum and Marum specify a channel with a 13 foot bottom width, a 5 foot depth, and 3:1 side slopes. The proposed channel slope was 1.58% between stations 48+00 and 64+45, and 1.00% between station 64+45 and the invert of a proposed concrete box culvert, which was never built under Tanque Verde Road. With the exception of the reach immediately downstream of the road, the proposed flowline is between 0.0 and 2.0 feet below that shown on the 1989 photo-tops. The existing cross section is quite similar to the cross section specified in the plans, suggesting that the channel was probably improved but has since silted in and/or deteriorated due to a lack of maintenance. Field surveys have verified the existence of a specified concrete drop structure at station 62+50, where the Fortyniner's Wash channel splits into two branches (Figures 3B and 3C).

On East Fortyniner's Wash, plan #731 specifies two different channel configurations. Between stations 115+00 and 123+00, the channel has a bottom width of 52 feet, a depth of 3 feet, 3:1 side slopes, and a slope of 1.14%. Between stations 123+00 and 129+00 (the Fortyniner's Guest Ranch boundary), the channel has a bottom width of 32 feet, a depth of 3 feet, 3:1 side slopes, and a slope of 2.2%. Given a Manning's n of 0.035, the first section will convey 1560 cfs while the second will convey 1400 cfs. Both are more than adequate for the existing Q100. If the improved cross section and flowline are superimposed on the existing topography, it appears that the improvements would have fit within the easement but were never constructed.

On Fortyniner's Tributary Wash, plan #416 specifies a channel with a 19 foot bottom width, a 2.5 foot depth (including 1 foot of freeboard), 3:1 side slopes, and a slope of 0.80%. Given a Manning's n of 0.035, this channel will convey 400 cfs, and is thus adequate for Q100. When compared to existing condition, it appears that this improvement was never built.

MAJOR DESIGN FEATURES

The following sections describe the major design features for three proposed plans: Proposal #1 - Improvement of dedicated drainageways to convey the existing Q100; Proposal #2 - Improvement of dedicated drainage ways to convey the Q100 resulting from upstream detention; and Proposal #3 - Improvement of the dedicated drainageways to convey the Q100 resulting from upstream diversion.

Proposal #1 - Existing Offsite Drainage

Proposal #1 considers improving the interior drainage network to convey the combined Q100 offsite flows from Fortyniners Wash, East Fortyniner's Wash, Fortyniner's Tributary Wash, and LDB-8 to the confluence at Tanque Verde Creek. It includes no upstream detention or diversion. Despite the fact that none of the tributaries cross Tanque Verde Road through an efficient structure, it is assumed that the Q100's at the road enter the subdivision with no attenuation. This assumption ensures that the channels will accommodate any future improvements to the roadway crossings. In an effort to arrive at an absolute minimum cost, freeboard was not considered in the proposed sections and grades.

The proposed flowline and cross sections are shown on Figures 3A - 3C.

Interior Channel Improvements

Beginning at the Tanque Verde Creek confluence (elevation = 2614 feet), a compound flowline developed by the Flood Control Engineering Section will extend through station 48+00, where it will match the flowline specified by the Arbor Vista Paving and Drainage plans (#416). The proposed channel slopes are 0.36% from stations 0+00 to 14+00, 0.50% from stations 14+00 to 32+00, and 1.61% from stations 32+00 to 47+00. The Arbor Vista plans specify a channel slope of 1.58% from station 48+00 to station 65+00, and 1.0% from station 65+00 to the invert of a proposed CBC under Tanque Verde Road (see Outlet and Conveyance Structures below).

The proposed cross sections, which vary according to the width of the drainage easement and the magnitude of the Q100, are described in the following table.

Table 2: Channel Improvements on Fortyniner's Wash with Existing Q100.

Stations	Esmt. Width (ft)	Chan. Slope (%)	Cross Section Variables				Flow Variables			Quantities	
			BW (ft)	SS	D (ft)	TW (ft)	Q (cfs)	D (ft)	V (fps)	Exc. (cy)	Fill (cy)
0+00 - 14+00	100	0.36	60	4:1	4.5-5.5	95-105	2360	4.4	6.9	15850	200
14+00 - 30+00	75	0.50	35	4:1	4.0-5.5	67-79	2100	4.8	8.1	9500	2640
30+00 - 47+00	65	1.61	15	4:1	6.0-8.0	63-79	2100	5.5	10.6	9200	0
47+00 - 68+00	65	1.00-1.58	13	3:1	6.0-8.0	49-61	2100	6.0	11.1	3900	0

Improvements to the three tributaries can be broken into three types. First, each tributary must be graded to match the improved invert at Fortyniner's Wash. Second, each tributary has some portion which must be enlarged to contain the Q100. Third, each tributary could benefit from localized cut and fill to bring the watercourse back into the dedicated easement. While the first two types are necessary to conveyance of Q100, the third is entirely optional. The improved sections are summarized in the following table.

Table 3: Channel Improvements on the Tributaries to Fortyniner's Wash with Existing Q100.

Stations	Esmt. Chan.		Cross Section Variables				Flow Variables			Quantities	
	Width (ft)	Slope (%)	BW (ft)	SS	D (ft)	TW (ft)	Q (cfs)	D (ft)	V (fps)	Exc. (cy)	Fill (cy)
East Fortyniner's Wash											
116+00 - 118+50	70	1.70	40	3:1	3.0-4.0	58-64	870	2.3	7.8	2100	0
133+50 - 137+00	50	EXST.	20	3:1	1.5' Below Flowline	60	800	3.0	7.0	850	215*
LDB-8 Tributary											
230+00 - 234+00	50	0.25	20	4:1						(For realignment only)	750* 400*
254+00 - 256+00	50		40	4:1						(For realignment only)	260* 130*
Fortyniner's Tributary Wash											
347+00- 350+00	50	2.30								No change in the existing section. Grade to match The Fortyniners Wash invert.	445 0
351+50 - 352+50	50	EXST.	25	3:1						(For realignment only)	45* 50*
*Optional cut or fill to realign channel.											

Roadway, Golf Course and Utility Crossings

Roadway crossings. Fortyniner's Wash crosses Soldier Trail Road (station 8+00), Fortyniner's Drive (station 21+77) and Klondike Drive (station 27+56). Given a depth of 5 feet and 20:1 approach slopes, the length of the section will be 250 feet. If the paving is 24 feet wide with 2 inches of asphaltic concrete (AC) over 4 inches of aggregate base (AB), the required quantities for AC and AB at each section are

$$\text{AC: } 250 \times 24 \times 2/12 = 1000 \text{ cf} \times 144 \text{ lbs/cf} \times 1 \text{ ton}/2000\text{lbs} = 72 \text{ tons}$$

$$\text{AB: } 250 \times 24 \times 4/12 = 2000 \text{ cf} / 27\text{cf/cy} = 74 \text{ cy}$$

Golf Course Crossings. Between stations 36+00 and 37+00, Fortyniner's Wash separates the #3 fairway and the #3 tee. The proposed channel improvement will lower the flowline approximately 6 feet. While there appears to be no direct impact on the existing turf, the golf cart access road and any buried utilities crossing the wash will have to be reconstructed. An alternative to channelization is the installation of a 5 cell 6' x 10' x 60' concrete box culvert (CBC) to bridge the wash at this point. Such a structure would cost about \$100,000, and would provide the golfers with access over the wash. However, it is likely that construction of the CBC would still require relocation of any buried utilities.

Between stations 133+50 and 134+50, East Fortyniner's Wash crosses the #1 fairway, and conveyance of the Q100 requires that the flowline be lowered about 1.5 feet (Table 3). Given a top width of 60 feet, roughly 6000 sf of fairway

and any associated irrigation works will need to be reconstructed.

Sewer Crossings. Fortyniner's Wash crosses existing sewer lines at stations 7+35, 21+77, 27+56 and 46+00. The improved flowline is 3.5 feet above the first, at the same elevation as the second, one foot above the third, and three feet above the fourth. Given the need for continual channel maintenance after construction, the crossings at stations 21+77 and 27+56 should be replaced with ductile iron pipe, and should have a 1' x 4' x 100' concrete cut-off wall installed as a grade control on the downstream side (Figures 3A and 3B).

An existing sewer angles across East Fortyniner's Wash from Fortyniner's Drive crossing at station 129+00 to a manhole at 132+00, and then follows the west boundary of the easement to station 136+00. Since the sewer is roughly six feet below the existing flowline, the proposed channel improvements do not appear to have any direct impact, with the possible exception of warping the proposed side slopes around the manhole. There is also a sewer line which follows the east boundary of the Fortyniner's Tributary Wash easement from station 351+00 to the Fortyniner's Wash confluence at station 347+00, but the proposed improvements appear to have little impact.

Power Crossings. Fortyniner's Wash crosses buried power lines at stations 7+50 (Soldier Trail Drive), 8+50, 46+00, and 58+00. In addition, a power line follows the north boundary of the drainage easement between stations 22+50 and 27+50 (Fortyniners drive and Klondike Drive). East Fortyniner's Wash crosses buried

power lines at stations 121+00, 127+00, and 128+00 (Fortyniner's drive), and a line follows the middle of the wash from stations 128+00 to 137+00. The buried depth is currently unknown.

Telephone Crossings. Fortyniner's Wash crosses a buried phone line at Soldier Trail Road, and buried lines parallel the north side of the easement from Fortyniners drive to Klondike Drive, and the south side of the easement from Klondike Drive to Goldust Drive. East Fortyniner's Wash crosses a phone line at Fortyniner's Drive. The depth of these crossings is also currently unknown.

Gasline Crossings. Fortyniner's Wash crosses gaslines at Soldier Trail Road and Klondike Drive, and East Fortyniner's Wash crosses a gasline at Fortyniner Drive. The depths of these crossings is currently unknown.

Upstream Improvements

Proposal #1 does not require any upstream improvement for detention or diversion. However, if the proposed box culvert (see below) under Tanque Verde Road is installed, the inlet will be require localized grading.

Conveyance Structures

The Arbor Vista Paving and Drainage plans (#416) indicate that a 4 cell 8' x 10' concrete box culvert (CBC) was to be placed under Tanque Verde Road at a point approximately 450' west of Wentworth. Assuming inlet control and a headwater/depth ratio of 1.0, such a culvert will convey 3200 cfs (Reference 5), and is thus adequate to convey the entire Q100. Given its proposed location, it

would have conveyed the majority of the Fortyniner's Wash flows which cut across a dedicated drainage area northwest of the Tanque Verde/Wentworth intersection. In its place, Tanque Verde Road has a dip section which conveys only 530 cfs (Reference #4).

Proposal #2 - Detained Offsite Drainage

Proposal #2 considers improving the offsite drainage network within the Fortyniner's Country Club Estates and Arbor Vista subdivisions to convey the detained Q100 flow from the previously described detention basin on Fortyniner's Wash, and the existing offsite flows from East Fortyniner's Wash, the LDB-8 Tributary, and Fortyniner's Tributary Wash. In general, the benefits from detention are most noticeable immediately downstream of Tanque Verde Road. The existing tributary flows still require significant improvements in the lower half of the drainage network. Between stations 0+00 and 30+00, the channel slopes and cross sections detailed in Proposal #1 are applied again, with channel inverts raised one foot higher.

Interior Channel Improvements

Beginning at an elevation (2615) one foot above the existing invert at the confluence at Tanque Verde Creek (2614), a compound flowline will extend through station 34+00 where it will daylight with the existing channel invert. The proposed channel slopes are 0.36% from stations 0+00 to 14+00, 0.50% from stations 14+00 to 30+00, and 1.0% from station 30+00 to 34+00. In addition, the reach crossing the #3 golf hole (stations 36+50 - 40+00) will be locally improved. The proposed sections are described in the following table.

Table 4: Channel Improvements on Fortyniner's Wash with Detained Q100.

Stations	Esmt. Width (ft)	Chan. Slope (%)	Cross Section Variables				Flow Variables			Quantities	
			BW (ft)	SS	D (ft)	TW (ft)	Q (cfs)	D (ft)	V (fps)	Exc. (cy)	Fill (cy)
0+00 - 14+00	100	0.36	60	4:1	3.5-4.5	85-95	1710	3.6	6.2	10700	352
14+00 - 30+00	75	0.50	35	4:1	3.0-4.5	60-70	895	3.1	6.2	5470	860
30+00- 34+00	65	1.00	15	4:1	4.5-6.0	51-63	830	3.4	8.5	150	0
36+50- 40+00	65	1.51**	15	4:1	3.5	45-65	830	3.3	8.8	550	0

** Invert @ Station 36+50 = 2638.7

The only effects that detention on Fortyniner's Wash has on the tributary flows is at the confluences. At the East Fortyniner's Wash confluence, the detained Q100 flowline is one foot higher than that in Proposal #1. Consequently, there is somewhat less excavation. At the LDB-8 Tributary confluence, the excavation is largely to realign the channel, thus any change in flowline has little effect on the excavation quantity. Since there are no improvement required for the detained Q100 upstream of station 40+00, the Fortyniner's Tributary Wash confluence at station 47+00 needs no grading at all.

The previously described improvements for conveyance of the existing Q100 flows in the tributaries are still required. Proposed sections and resulting quantities are summarized in the following table.

Table 5: Channel Improvements on the Tributaries to Fortyniner's Wash with Detained Q100.

Stations	Cross Section Variables					Flow Variables				Quantities	
	Esmt. Width (ft)	Chan. Slope (%)	Cross BW (ft)	Section SS	Variables D (ft)	TW (ft)	Q (cfs)	D (ft)	V (fps)	Exc. (cy)	Fill (cy)
East Fortyniner's Wash											
116+00 - 118+50	70	1.50	40	3:1	3.0-4.0	58-64	870	2.3	8.1	1580	0
133+50 - 137+00	50	EXST.	20	3:1	1.5' Below Flowline	60	800	3.0	7.0	850	215*
LDB-8 Tributary											
230+00 - 234+00	50	0.25	20	4:1	(For realignment only)				750*	400*	
254+00 - 256+00	50		40	4:1	(For realignment only)				260*	130*	
Fortyniner's Tributary Wash											
351+50 - 352+50	50	EXST.	25	3:1	(For realignment only)				45*	50*	0

*Optional cut or fill to realign channel.

Roadway, Golf Course and Utility Crossings

Proposal #2 requires the same roadway, golf course, and utility crossings required in Proposal #1, with a few exceptions. First, since the detained Q100 at the reach crossing golf hole #3 (stations 36+50 - 40+00) is only 830 cfs, the alternative culvert can be reduced to a 4 cell 4' x 10' x 60' CBC costing approximately \$75,000. Second, any of the aforementioned buried utilities upstream of station 40+00 will not have to be relocated.

Upstream Improvements

The key to Proposal #2 is construction of a detention basin on

Fortyniner's Wash, northeast of the Tanque Verde Road and Wentworth Road intersection. The basin, as described in previous Probable Maximum Flood and Interior Drainage Reports (References 3 and 4), consists of an earthen embankment with an impervious soil cement core, an outlet structure, and an emergency spillway. The centerline of the embankment begins at a point approximately 1700 feet north of Tanque Verde Road, just east of Wentworth Road, and extends south to the intersection where it turns east and continues for another 300 feet before terminating at a ridge. The proposed emergency spillway is 700 feet long and lies along the northern most portion the Wentworth Road embankment. It is sized to convey one half of the Probable Maximum Flood at a depth of two feet above the spillway crest.

Outlet and Conveyance Structures

The proposed detention basin outlet structure consists of a 650 foot long, reinforced concrete pipe (RCP) that extends from the invert of the basin, under the intersection, to the existing Fortyniner's Wash channel (south branch). A "slope taper inlet" type entrance structure will be built into the basin side slope. For a 60" RCP, the Q100 outflow is 470 cfs with a velocity of almost 25 fps. Consequently, the downstream channel will require an energy dissipation structure and significant erosion protection.

Proposal #3 - Diverted Offsite Drainage

Proposal #3 considers improving the offsite drainage network within the Fortyniner's Country Club Estates and Arbor Vista subdivisions to convey the

Q100 flows that result when all of the flow from Fortyniner's Wash, upstream of the Tanque Verde Road and Wentworth Road intersection, is diverted to Tanque Verde Creek via a channel following the east side of Wentworth Road. In essence, this is a proposal to convey the existing Q100 flows from the tributaries and local drainage basins only. The proposed cross sections are the same as in Proposal #1, but the flowline ranges from one to two feet higher, and the channel slope near the outlet is somewhat reduced.

Interior Channel Improvements

Beginning at an elevation (2616) two feet above the existing invert at the confluence at Tanque Verde Creek (2614), a compound flowline will extend through station 30+00 where it will intersect with the existing channel invert. The proposed channel slopes are 0.29% from stations 0+00 to 14+00, and 0.56% from stations 14+00 to 30+00. In addition, the reach crossing the #3 golf hole (stations 36+50 - 40+00) will be locally improved. The proposed improvements are described in the following table.

Table 6: Channel Improvements on Fortyniner's Wash with Diverted Q100.

Stations	Esmt. Width (ft)	Chan. Slope (%)	Cross Section Variables				Flow Variables Quantities				
			BW (ft)	SS	D (ft)	TW (ft)	Q (cfs)	D (ft)	V (fps)	Exc. (cy)	Fill (cy)
0+00 - 14+00	100	0.29	60	4:1	3.5-4.5	85-95	1490	3.6	5.6	8610	445
14+00 - 30+00	75	0.56	35	4:1	3.0-4.5	60-70	620	2.5	5.8	3980	1010
36+50-40+00	65	1.51**	15	4:1	3.5	45-65	830	3.3	8.8	550	0

** Invert @ Station 36+50 = 2638.7

As in Proposal #2, the only effects that diversion of Fortyniner's Wash has on the tributary flows is at the confluences. At the East Fortyniner's Wash confluence, the detained Q100 flowline is one foot higher than that in Proposal #1. Consequently, there is somewhat less excavation. The LDB-8 Tributary is unchanged and Fortyniner's Tributary Wash requires no grading at all.

The previously described improvements for conveyance of the existing Q100 flows in the tributaries are still required. Proposed improvements and resulting quantities are summarized in the following table.

Table 7: Channel Improvements on the Tributaries to Fortyniner's Wash with Diverted Q100.

Stations	Esmt. Chan.		Cross Section Variables				Flow Variables			Quantities	
	Width (ft)	Slope (%)	BW (ft)	SS	D (ft)	TW (ft)	Q (cfs)	D (ft)	V (fps)	Exc. (cy)	Fill (cy)
East Fortyniner's Wash											
116+00 - 118+50	70	1.50	40	3:1	3.0-4.0	58-64	870	2.3	8.1	1580	0
133+50 - 137+00	50	EXST.	20	3:1	1.5' Below Flowline	60	800	3.0	7.0	850	215*
LDB-8 Tributary											
230+00 - 234+00	50	0.25	20	4:1	(For realignment only)					750*	400*
254+00 - 256+00	50		40	4:1	(For realignment only)					260*	130*
Fortyniner's Tributary Wash											
351+50 - 352+50	50	EXST.	25	3:1	(For realignment only)					45*	50*

*Optional cut or fill to realign channel.

Roadway, Golf Course and Utility Crossings

Proposal #3 requires the same roadway, golf course, and utility crossings required in Proposal #1, with a few exceptions. First, since the detained Q100 at the reach crossing golf hole #3 (stations 36+50 - 40+00) is only 510 cfs, the alternative culvert can be reduced to a 2 cell 4.5' x 10' x 60' CBC costing approximately \$40,000. Second, any of the aforementioned buried utilities upstream of station 40+00 will not have to be relocated.

Upstream Improvements

The Q100 flows from Fortyniner's Wash meet the Tanque Verde Road and Wentworth Road intersection over an area roughly 1000 feet wide. An earthen levee just east of Wentworth Road, extending from the intersection to a point approximately 1000 feet north of Tanque Verde Road will direct the flow to a single point at the proposed culvert (see below). If the levee is three feet high, with a 10 foot top width and 6:1 side slopes, a total of 3000 cy of compacted fill will be required. Since the existing Wentworth Road right of way is limited, an additional easement will be required for placement of this levee. Given a bottom width of 46 feet and a length of 1000 feet, slightly more than one acre must be acquired.

Diversion Channel and Conveyance Structures

Once the Fortyniner's Wash flows are collected, they must be conveyed along the east side of Wentworth Road to Tanque Verde Creek. From a new

culvert underneath Tanque Verde Road, a variable width, riprap lined channel will convey the flow through a series of small drop structures and CBC's to a point where Wentworth Road meets the Tanque Verde Creek Q100 floodplain. Between this point and Tanque Verde Creek, the offsite drainage will flow overland to the south, along a raised Wentworth Road or the Tanque Verde Creek Levee.

A preliminary estimate indicates that the channel would require approximately 31,414 cy of excavation and 2833 cy of nine inch riprap. In addition, a total of five concrete box culverts will be required to convey Q100 past: Tanque Verde Road, Cape Horn Drive, and three access roads. Given a 9 foot headwater depth, the Q100 of 2100 cfs can be conveyed by a 3 cell 6' x 10' x 60' foot CBC.

As 1200 feet of Wentworth Road is to be raised to act as a levee, the total embankment, given a 40 foot top width and 6:1 side slopes, will require 18385 cy of fill. Repaving the 24 foot section of roadway with four inches of asphaltic concrete (AC) over four inches of course aggregate base (AB) will require 700 tons and 475 cy respectively.

The channel, as sized, will not fit within the Wentworth Road right-of-way. An additional 1.5 acres of property must be acquired between Tanque Verde Road and Tanque Verde Creek.

The following tables summarize the preliminary cost estimates for Proposals #1, #2, and #3.

**Table 8: Quantities and Cost Estimate for Interior Drainage Improvements.
Proposal #1 - Existing Q100**

	Drainage Excavation	Unit Cost	Total Cost
Fortyniner's Wash	38,260 cy	\$3.00	\$114,780
East Fortyniner's Wash	2,950 cy	\$3.00	\$8,850
Fortyniner's Tributary Wash	490 cy	\$3.00	\$1,470
Channel Excavation			<u>\$125,100</u>
Clearing and Grubbing			\$ 20,000
Channel Revegetation (30000 sy @ \$0.72/sy)			\$ 21,600
Channel Excavation, Clearing, and Revegetation			<u>\$166,700</u>
Improved Dip Sections (@ \$5,000 ea.) for Soldier Trail Drive, Fortyniner's Drive, and Klondike Drive			\$15,000
Alternative Culvert at Station 37+00			\$100,000
Golf Course Crossing Reconstruction at Station 134+00			\$ 5,000
Buried Utility Relocation (Sewer, Power, Phone, and Water)			\$ 25,000
Roads, Golf Course, and Utilities			<u>\$145,000</u>
Subtotal			\$311,700
15% Contingency			\$46,755
TOTAL			\$358,455

**Table 9: Quantities and Cost Estimate for Interior Drainage Improvements.
Proposal #2 - Detained Q100**

	Drainage Excavation	Unit Cost	Total Cost
Fortyniner's Wash	16,930 cy	\$3.00	\$ 50,790
East Fortyniner's Wash	2,400 cy	\$3.00	\$7,200
Fortyniner's Tributary Wash	45 cy	\$3.00	\$135
Channel Excavation			<u>\$58,125</u>
Clearing and Grubbing			\$ 20,000
Channel Revegetation: (10000 sy @ \$0.72/sy)			\$7,200
Channel Excavation, Clearing and Revegetation			<u>\$85,325</u>
Improved Dip Sections (@ \$5,000 ea.) for Soldier Trail Drive, Fortyniner's Drive, and Klondike Drive			\$ 15,000
Alternative Culvert at Station 37+00			\$75,000
Golf Course Crossings Reconstruction at Station 134+00			\$5,000
Buried Utility Relocation (Sewer, Power, Phone, and Water)			\$ 20,000
Roads, Golf Course, Utilities			<u>\$115,000</u>
Upstream Improvements: Detention Basin Borrow (157300 cy @ \$6.00/cy)			\$943,800
Conveyance Structures: Detention Outlet (60" RCP in place)			\$ 96,650
Energy Dissipator and Downstream Erosion Protection			\$50,000
Right - of - Way			\$ 25,000
Subtotal			\$1,290,775
15% Contingency			\$193,616
TOTAL			\$1,484,391

**Table 10: Quantities and Cost Estimate for Interior Drainage Improvements.
Proposal #3 - Diverted Q100**

	Drainage Excavation	Unit Cost	Total Cost
Fortyniner's Wash	13,100 cy	\$3.00	\$39,300
East Fortyniner's Wash	2,400 cy	\$3.00	\$7,200
Fortyniner's Tributary Wash	45 cy	\$3.00	\$135
Channel Excavation			<u>\$46,635</u>
Clearing and Grubbing			\$ 20,000
Channel Revegetation: 8000 sy @ \$0.72/sy			\$ 5,760
Channel Excavation, Clearing, Revegetation			<u>\$ 72,395</u>
Improved Dip Sections (@ \$5,000 ea.) for Soldier Trail Drive, Fortyniner's Drive, and Klondike Drive			\$15,000
Alternative Culvert at Station 34+00			\$40,000
Golf Course Crossing Reconstruction at Station 134+00			\$5,000
Buried Utility Relocation (Sewer, Power, Phone, and Water)			\$ 20,000
Roads, Golf Course, Utilities			<u>\$ 80,000</u>
Upstream Improvements:	Tanque Verde Road Culvert Inlet Levee and Grading (3000 cy @\$6.00)		\$60,250
\$18,000			
Conveyance Structures:	Diversion Channel Excavation (31414 cy @ \$3.00)		\$ 94,242
	Diversion Channel Riprap (2833 cy @ \$40.00)		\$113,320
	Concrete Box Culverts (Four ea. @ \$60,250)		\$241,000
	Wentworth Road Compacted Fill (18385 cy @\$6.00)		\$110,310
	Wentworth Road Repaving (4" AC over 4" AB)		\$28,125
	Wentworth Road Utility Relocation		\$15,000
Right - of - Way			\$ 60,000
Subtotal			\$892,642
15% Contingency			\$133,896
TOTAL			\$1,026,538

SUMMARY AND RECOMMENDATION

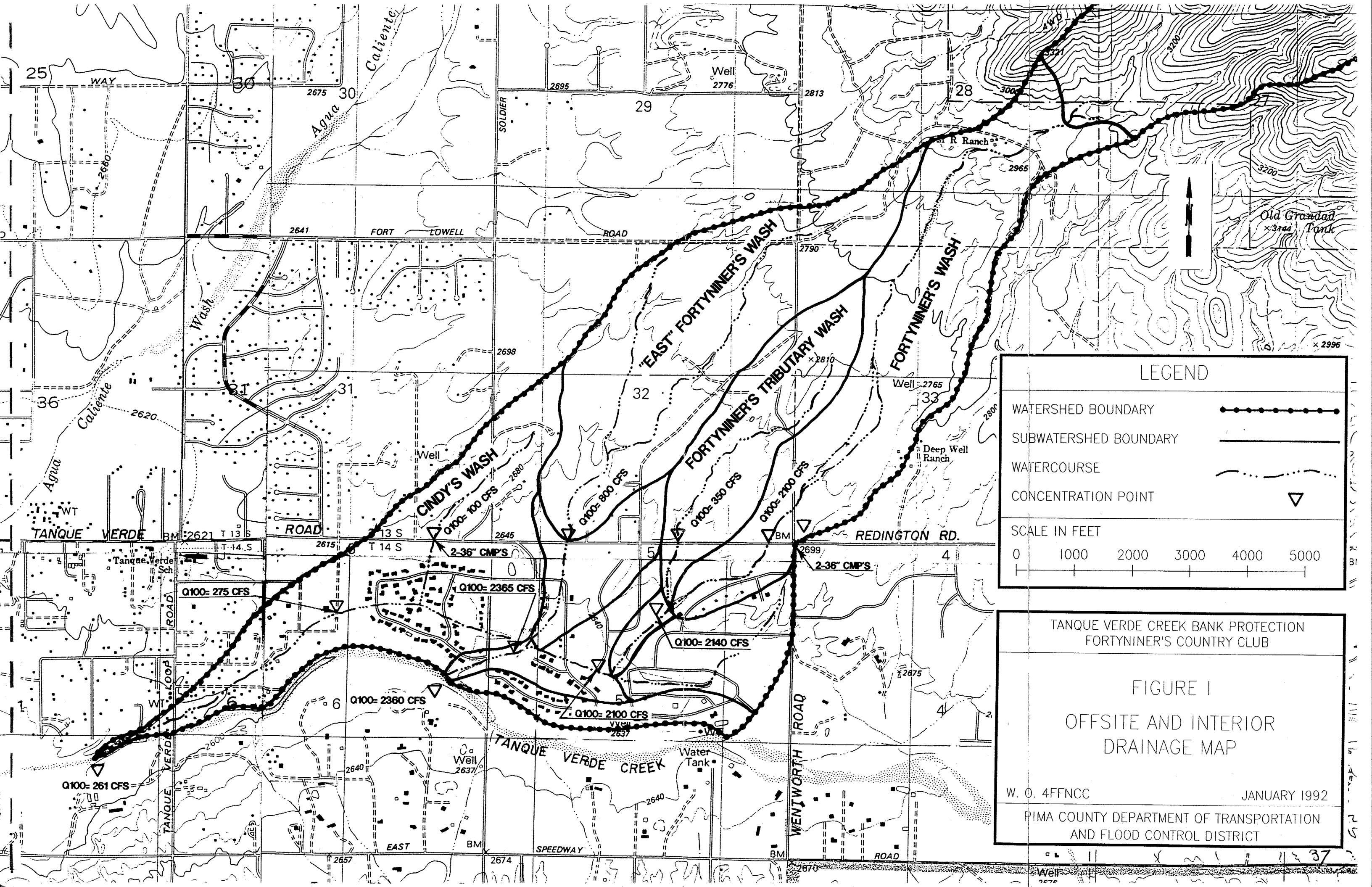
In summary, the offsite drainage affecting the Fortyniner's Country Club Estates and Arbor Vista Subdivisions is a flooding problem that is separate from the flooding caused by the Tanque Verde Creek flow, and can be mitigated independently of the Tanque Verde Creek Levee.

This report estimates the costs of three offsite drainage proposals, which were identified during the feasibility study. Proposal #1 would improve the dedicated drainageways to convey the existing Q100, and would cost \$358,455. Proposal #2 would construct an upstream detention basin and improve the dedicated drainageways to convey the resulting Q100, and would cost \$1,484,391. Proposal #3 would construct an upstream diversion channel and improve the dedicated drainageways to convey the resulting Q100, and would cost \$1,026,538.

Given the large differences in cost, and the fact that Proposals #2 and #3 would affect people and property outside of the subdivisions, Proposal #1 is the recommended alternative. It can be built in conjunction with the Tanque Verde Creek Levee, with the benefit that it will provide a limited amount of material for the levee project; or it can be constructed by the PCDOT & FCD Operations Section and provide flood control benefits independent of the Tanque Verde Creek Levee Project.

REFERENCES

- 1) US Army Corps of Engineers, Los Angeles District. September, 1987. "Tanque Verde Creek - Section 205 Reconnaissance Report". Los Angeles, CA.
- 2) Pima County Department of Transportation and Flood Control District - Flood Control Engineering Section. July, 1988. "Summary of Hydrology Results for Internal Drainage", Tanque Verde Wash Bank Protection Hydrology Report. Tucson, AZ.
- 3) Pima County Department of Transportation and Flood Control District - Flood Control Engineering Section. July, 1991. "Tanque Verde Creek Bank Protection Near Fortyniner's Country Club Estates - Preliminary Results of Probable Maximum Flood Analyses". Tucson, AZ.
- 4) Pima County Department of Transportation and Flood Control District - Flood Control Engineering Section. September, 1991. "Tanque Verde Creek Bank Protection Near Fortyniner's Country Club Estates - Interior Drainage Report". Tucson, AZ.
- 5) Normann, Jerome M., Robert J. Houghtalen, and William J. Johnston. 1985. "Hydraulic Design of Highway Culverts", Hydraulic Design Series No. 5 (HDS-5 or HEC-5). Report No. FHWA-IP-85-15. Federal Highway Administration, McClain, VI.



LEGEND

- WATERSHED BOUNDARY (thick dashed line)
- SUBWATERSHED BOUNDARY (solid line)
- WATERCOURSE (dotted line)
- CONCENTRATION POINT (triangle)

SCALE IN FEET

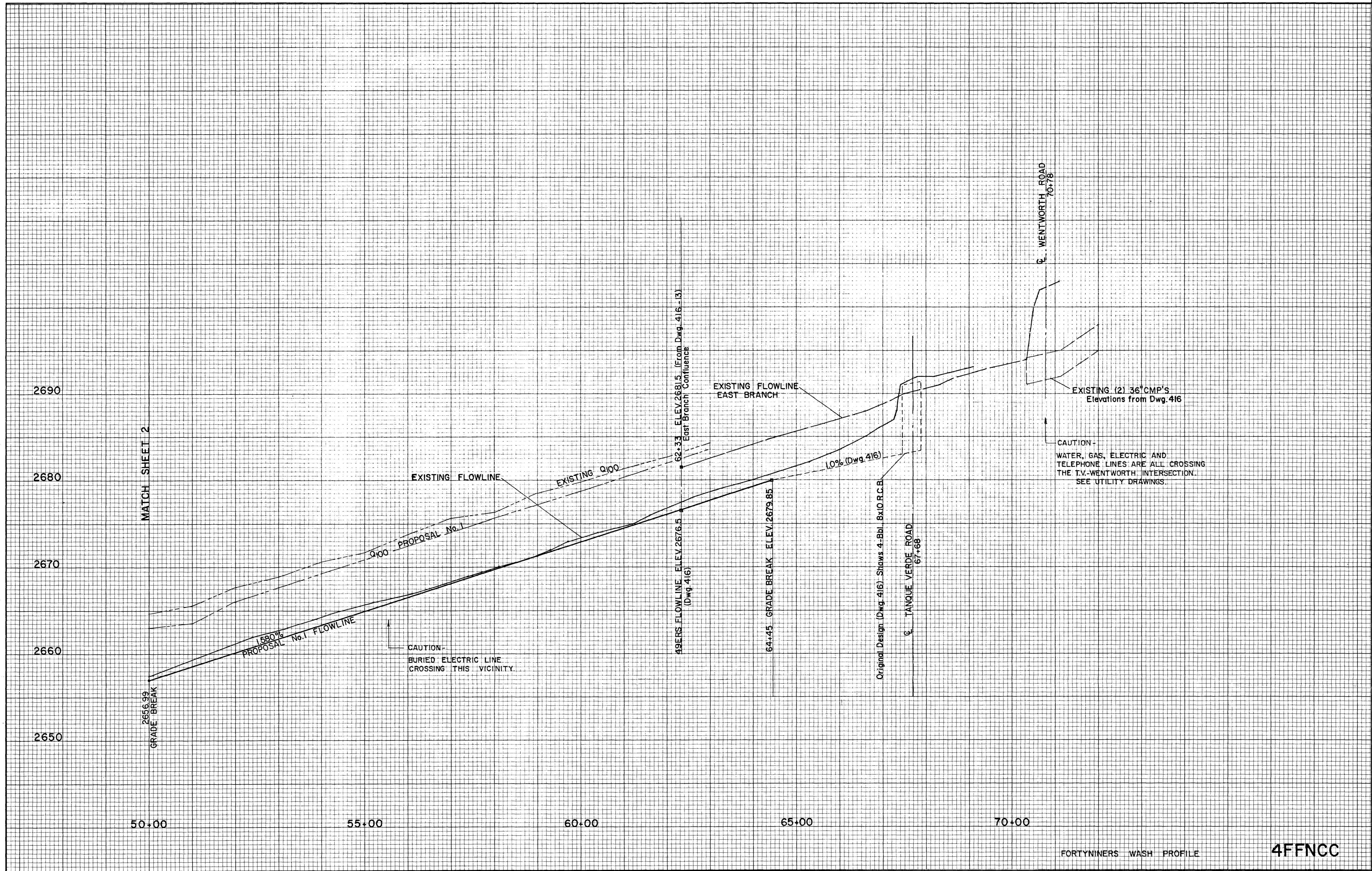
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TANQUE VERDE CREEK BANK PROTECTION
FORTYNINER'S COUNTRY CLUB

FIGURE 1
OFFSITE AND INTERIOR
DRAINAGE MAP

W. O. 4FFNCC JANUARY 1992

PIMA COUNTY DEPARTMENT OF TRANSPORTATION
AND FLOOD CONTROL DISTRICT



FORTYNINERS WASH PROFILE

4FFNCC

SCALES

HORZ.	1" = 100'
VERT.	1" = 5'

SHEET 3 OF 3

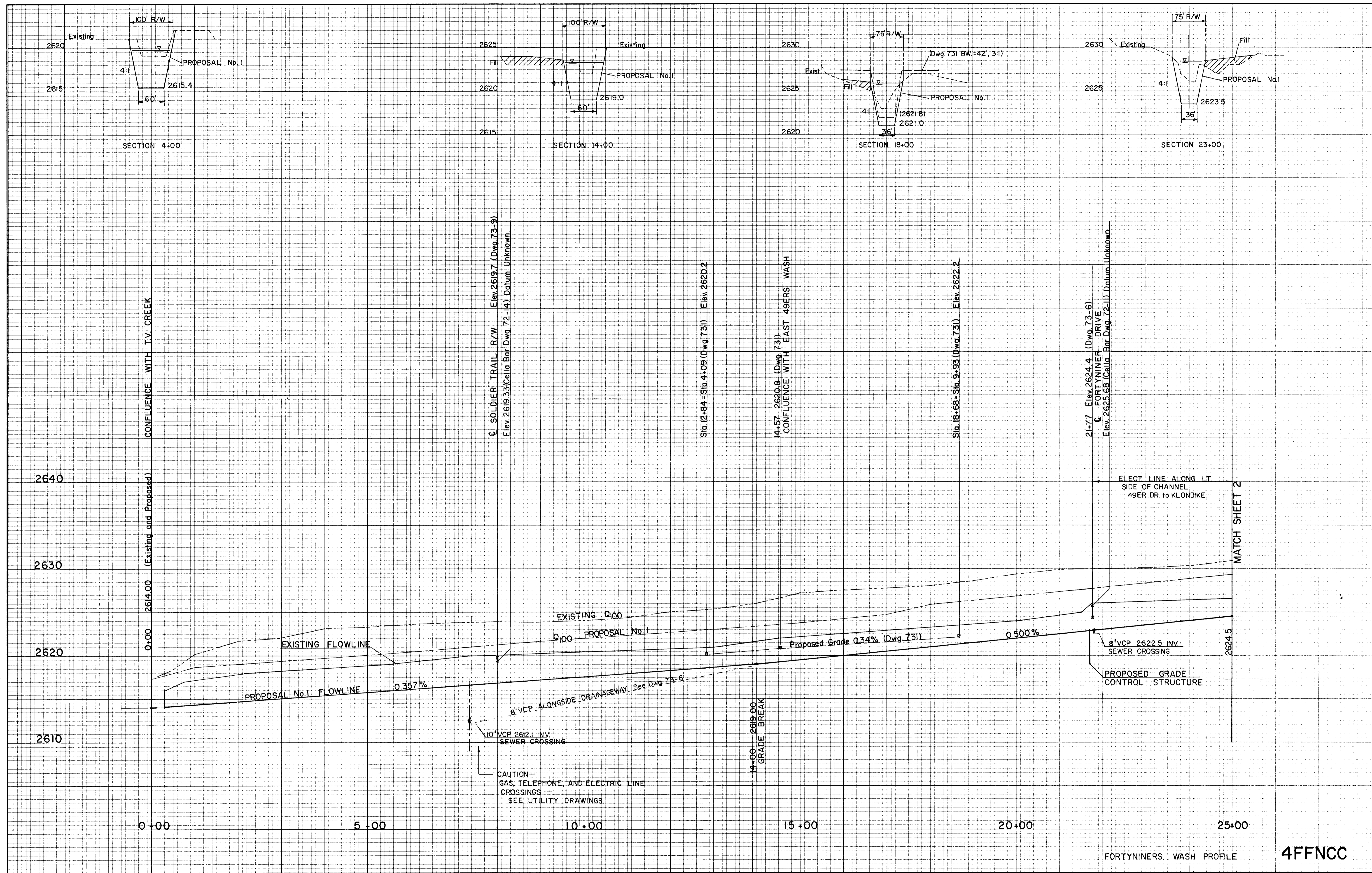
JANUARY 1992

FIGURE 3C

PIMA COUNTY DEPARTMENT OF TRANSPORTATION AND FLOOD CONTROL DISTRICT

NO.	REVISION DESCRIPTION	DIV/SECT.	ENGR.	DATE

DESIGNED	DATE
D. L. Lanz	11-91
L. VanScovak	12-91
CHECKED	
PROJ. ENGR.	Z. Osmolski



SCALES HORZ. 1" = 100'
 VERT. 1" = 5'

FORTYNINERS WASH PROFILE **4FFNCC**

SHEET 1 OF 3

JANUARY 1992 **FIGURE 3A**

PIMA COUNTY DEPARTMENT OF TRANSPORTATION AND FLOOD CONTROL DISTRICT

DESIGNED	D. Lantz	DATE	11-91
DRAWN	L. vonSoyk		
CHECKED			
PROJ. ENGR.	Z. Osmolski		

NO.	REVISION DESCRIPTION	DIV/SECT.	ENGR.	DATE

