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CMG DRAINAGE ENGINEERING, INC.

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ENGINEERING ANALYSIS AND RECOMMENDATIONS
FOR GREEN VALLEY DRAINAGEWAY #9
BETWEEN LA CANADA DRIVE AND THE
SAN IGNACIO DE LA CANOA LAND GRANT BOUNDARY

Prepared by:

CMG DRAINAGE ENGINEERING, INC.
201 N. STONE AVENUE, STE. 200
TUCSON, AZ 85701

For:

PIMA COUNTY DEPARTMENT OF TRANSPORTATION
AND FLOOD CONTROL DISTRICT
1313 S. MISSION RD.
TUCSON, AZ 85713

JANUARY 12, 1989

Registered Professional Engineer (Civil)
CERTIFICATE NO.
15275
CLINTON MURRAY
GLASS
Date Signed
ARIZONA, U.S.A.

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Registered Professional Engineer (Civil) CERTIFICATE NO. 15275 CLINTON MURRAY GLASS Date Signed 1/12/89 ARIZONA, U.S.A.

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Registered Professional Engineer (Civil)
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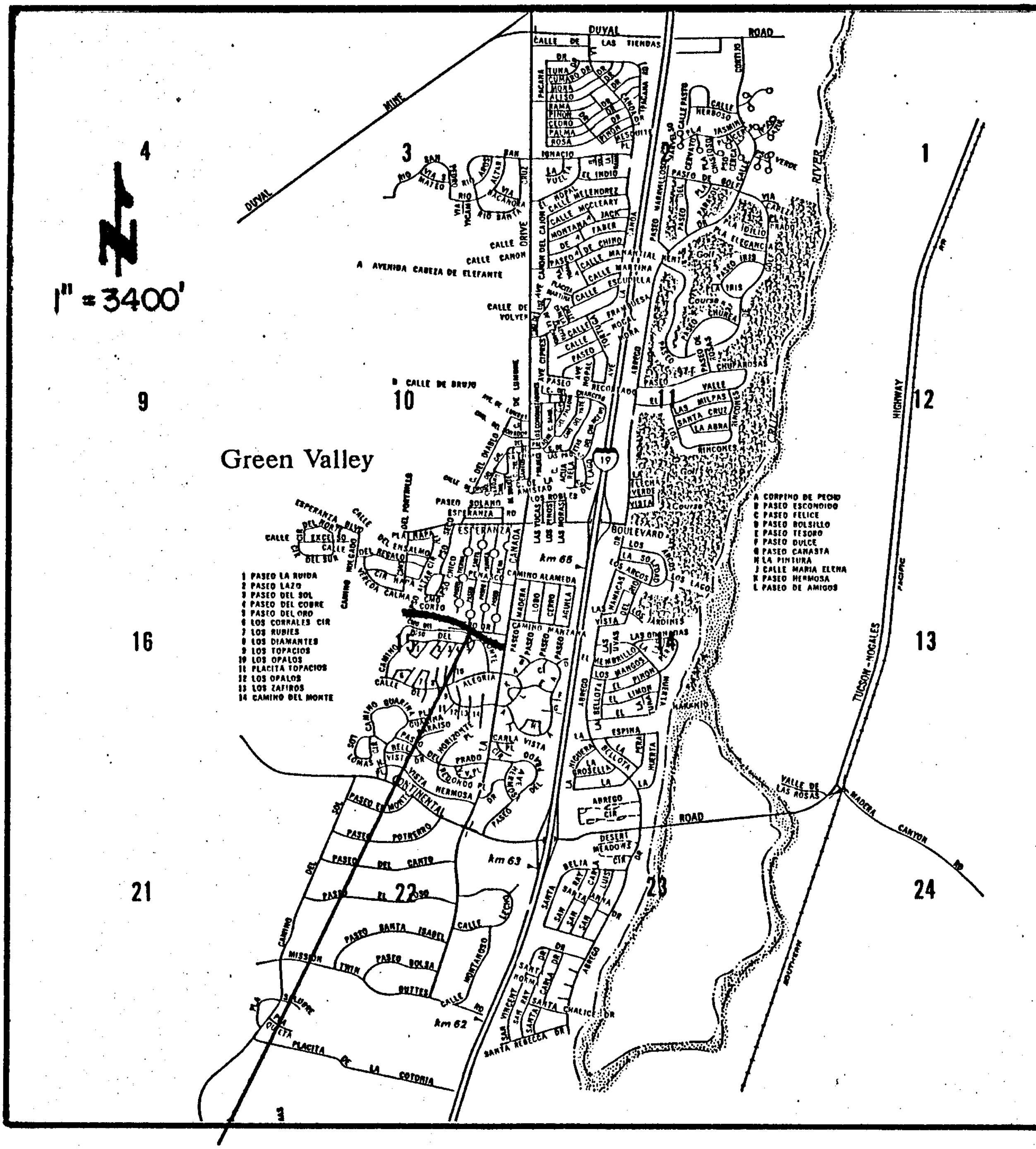
I. INTRODUCTION

This report was prepared by CMG Drainage Engineering, Inc. (CMG) under the authority of the Pima County Department of Transportation and Flood Control District (PCDOT & FCD). It presents the results of an engineering analysis performed by CMG to assess the existing potential for flooding and erosion along Green Valley Drainageway #9 and presents conceptual plans for recommended improvements. The reach of Green Valley Drainageway #9 considered as a part of this study extends from La Canada Drive at the downstream end to the La Canoa Land Grant Boundary at the upstream end. The location of the proposed project is shown on Figure 1. The scope of work for this study is in Appendix A of this report.



THIS PROJECT

FIGURE I
LOCATION MAP

II. HYDROLOGIC ANALYSIS

The purpose of this section is to summarize the results of the hydrologic analysis of the Drainageway #9 watershed performed using the U.S. Army Corps of Engineers HEC-1 Flood Hydrograph package. This analysis was performed to determine the effects of various alterations which have been made to the upstream watershed.

Figure 2 (attached) shows the watersheds tributary to Drainageway #9 which were analyzed using the HEC-1 program. Sub-basins 1 through 9 as shown on Figure 2 are drainage areas which do not naturally contribute runoff to Drainageway #9 but which have had their watercourses diverted. In addition to the diversions described above, a detention/retention area has been created at Concentration Point #5. The excavated area at CP#5 creates approximately 200 ac-ft of retention storage (i.e. storage with no positive outflow) plus additional detention storage above the point at which outflow begins.

The HEC-1 model was developed by first determining the 100-year peak discharges for the individual sub-basins shown in Figure 1 using the procedure as outlined in the Pima County Hydrology Manual (September 1979). Using the results of the sub-basin peak discharge determinations, 100-year flood hydrographs were developed for each sub-basin using the synthetic hydrograph described in the Pima County Detention/Retention Manual (February 1987). The individual flood hydrographs were used as direct input into the HEC-1 model.

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The individual flood hydrographs were then routed through downstream sub-basins using the normal-depth storage and outflow option of the modified puls routing method. The above method uses an 8-point cross section as representative of the routing reach to compute storage/outflow characteristics for the channel. Routed hydrographs were then combined with direct input hydrographs for the downstream sub-basins at confluence points.

Three different conditions were evaluated using the HEC-1 model including:

a) no accounting for the detention/retention storage referenced above,

b) accounting for the detention/retention storage, and

c) accounting for the detention storage only.

The third condition (accounting for the detention storage only) was modeled in order to account for the possibility of the retention storage portion of the excavated area being filled at the time of the occurrence of the 100-year event.

The results of the HEC-1 modeling yielded the following peak discharges on Drainageway #9 at Concentration Point #9 (La Canada Drive):

a) 5982 cfs with no accounting for detention/retention storage,

b) 2814 cfs with accounting for detention/retention storage, and

c) 4102 cfs with accounting for detention storage only.

Assuming that the integrity of the above-described detention area is viable during the modeled event, use of the 4102 cfs peak discharge for Drainageway #9 hydraulic and geomorphic analyses would appear to be prudent. Use of the 4102 cfs discharge acknowledges the possibility of the retention storage portion of the excavated area being unavailable at the time of occurrence of the 100-year event. The 4102 cfs discharge was chosen by the PCDOT & FCD for use in performing hydraulic and geomorphic computations after review of the hydrologic analysis (separate letter dated August 29, 1988, from CMG).

Hydrologic data sheets for the individual sub-basins and input/output for the three HEC-1 models used in determining the above discharges are contained in Appendix B of this report.

III. HYDRAULIC ANALYSIS FOR EXISTING CONDITIONS

A hydraulic analysis of Drainageway #9 was performed for the existing conditions 100-year peak discharge using the U.S. Army Corps of Engineers HEC-2 backwater program. The HEC-2 model was developed using the 1986 1" = 200' scale topographic mapping provided by Pima County. Figure 3 shows the cross section locations and the existing conditions 100-year floodplain for the study reach. Figure 3 also shows existing improvements along and adjacent to the study reach including improvements at the La Canada Drive crossing, improvements immediately downstream of the Apero Drive alignment, and improvements located immediately upstream of the land grand boundary. In performing the hydraulic analysis a Manning's roughness coefficient of .030 was used to model the main channel area. A coefficient of .050 was used for most overbank areas. Because of the steep slope of the channel through the study reach, the HEC-2 model was set up as a super critical run. The results of the hydraulic analysis indicate velocities ranging from 17 to 25 feet per second within the channel which has an overall slope of approximately 2.5%. Depths of flow ranged from 4.1 to 6.7 feet along most of the project reach with slightly lower flow depths along the downstream end of the reach near La Canada Drive where the channel is somewhat wider and shallower.

Flooding during the 100-year event was determined to be contained within the channel along most of the study reach. However, the somewhat wider, shallower sub-reach referenced above was determined to be the site of overbank flooding. The overbank flooding occurs on the north side of the channel through the townhomes located within Block 8 of Tucson Green Valley Unit #1 (cross sections #4, #5, and #6 on Figure 3). The volume of overbank flooding was determined to be approximately 236 cfs for the 100-year event. The input and output for the HEC-2 model are included in Appendix C of this report.

IV. GEOMORPHIC ANALYSIS FOR EXISTING CONDITIONS

4.1 Qualitative Geomorphology

The study reach of Drainageway #9 runs through a relatively urbanized area with development along the channel dating back to the early 1960's. Review of a 1964 aerial photo indicates that most natural channels in the area are fairly sinuous and braided. The aerial photo also indicates that the channel alignment and cross section along the study reach were modified at the time of development. The present day channel is a well defined sand bed channel varying in depth from approximately 3 to 7 feet. The sideslopes of the channel are relatively steep, varying from approximately 3:1 to 1:1 in most locations. Vegetation along the channel consists mainly of desert broom and other opportunistic plants which generally occur along improved or otherwise disturbed drainageways. Review of a 1986 aerial photo indicates that the overall channel alignment has undergone little change since the time of initial development within the area. However, field investigation did reveal some erosion of the banks indicated by scallop-shaped cut-bank areas.

While the horizontal alignment of the channel has remained fairly constant, there appears to have been some change in the channel bed profile during the last 20 years. Review of Pima County Wastewater Management plans for a sewer line crossing constructed in 1968 indicates a channel bed elevation 2 feet lower than the bed elevation indicated for the same location by the 1986 topographic mapping referenced in Section III. The deposition indicated by the above elevation difference occurs within the wider and shallower downstream sub-reach (also referenced in Section III). In addition to being somewhat wider and shallower than the rest of the study reach, this sub-reach is located downstream from an approximately 40° bend in the channel. The apparent deposition along this sub-reach is probably the result of lower velocities caused by the less efficient hydraulics of the wider, shallower channel and, to a lesser extent, energy dissipation caused by the upstream bend.

Field observations also revealed what appeared to be a headcut toward the upstream end of the study reach. Evaluation of the 1986 topographic mapping indicates that the profile along this reach is relatively smooth which suggests that the isolated condition observed in the field was more likely the result of exposure of a hardpan layer within the channel. However, the overall channel slope is somewhat steeper at the upstream end of the study reach, which suggests that the overall long-term trend along the channel may be toward degradation.

4.2 Quantitative Analysis

4.2.1 Single Event Scour Analysis

This section discusses the quantitative analysis performed to assess the potential for vertical and lateral movement of the channel during a single 100-year event. The quantitative analysis was performed using the hydraulic data derived from the HEC-2 analysis described in Section III.

Using the equation for scour depth found in the Pima County Drainage Development and Channel Design Standards, the potential for vertical scour of the existing channel bed was estimated to be approximately 7 feet. Using the equation for scour width from the same source, the potental for lateral scour was estimated to be approximately 25 feet. At the location of the 40° bend referenced in Section 4.1, the lateral scour potential was determined to be approximately 70 feet. Although bank protection has been installed along the outside bank of this bend, the toe down is not buried to a depth adequate enough for the improvements to remain viable during the 100-year event. Supporting calculations for the above analyses are contained in Appendix D of this report.

4.2.2 Equilibrium Slope Analysis

A quantitative analysis was performed to develop an estimate of the magnitude of long-term aggradation/degradation for existing channel conditions along the study reach. The procedure used to make this determination was the equilibrium slope analysis. The methodology used for equilibrium slope determination consisted of computing the upstream sediment supply and the local sediment transport capacity at different locations within the project reach. The slope of the channel is adjusted upward or downward until transport capacity within a given reach equals the upstream supply. The natural channel cross section upstream of existing development was chosen as the upstream supply reach. The 10-year discharge was used as the dominant discharge in performing the equilibrium slope analysis.

The results of the equilibrium slope analysis are summarized in Table 1. Review of the transport rates and associated equilibrium slopes for the upstream supply reach and the four cross-section locations analyzed along the project reach show that the equilibrium slopes for the study reach are all less than the existing slope indicating a long-term trend toward degradation. Table 1 also reveals that the equilibrium slope generally

TABLE 1 - SUMMARY OF RESULTS OF

EQUILIBRIUM SLOPE ANALYSIS

Reach	Existing Slope	Equilibrium Slope (ft/ft)
Upstream Supply	.0235	.0235
Sections 11-14	.0350	.0145
Sections 7-10	.0233	.0164
Sections 4-6	.0233	.0186

decreases in the upstream direction suggesting greater potential for degradation at the upstream end of the project reach, a result which is supported by the observations made in the qualitative analysis. The input and output for the equilibrium slope analysis and supporting documentation for the procedure are contained in Appendix D of this report.

V. DESCRIPTION AND EVALUATION OF EXISTING IMPROVEMENTS

Figure 3 shows the existing improvements along and adjacent to the study reach. These improvements were described briefly in Section III and consist of the spillway and box culvert crossing improvements at La Canada Drive, bank protection improvements over approximately a 400-foot length on the north bank adjacent to the Block 8 of Tucson Green Valley Unit #1, and the existing channel improvements located upstream of the land grant boundary.

The box culvert and spillway improvements located at the La Canada Drive crossing are adequate to accommodate the 100-year flood as defined by this study. The existing channel improvements located upstream of the land grant boundary also are adequate, although the improvements on the south bank of this reach are designed for an event with a more frequent return interval than those on the north bank.

The bank protection improvements along the north bank adjacent to Block 8 of the Tucson Green Valley Unit #1 are the only improvements actually located within the study reach. The improvements along this bank consist of a combination of placed riprap and concrete lining. Field investigation indicates that the toe-down depth for these improvements is less than 2 feet, which is significantly less than the scour depths predicted to occur during the 100-year event along the study reach. Because of this and the difficulties associated with retrofitting the existing improvements to matched the proposed design cross section (i.e. location), it probably will not be possible to incorporate the existing improvements into the proposed improvements described in Section VI.

VI. PROPOSED IMPROVEMENTS

Conceptual design improvements were developed for implementation along the study reach to mitigate the potential for overbank flooding within Block 8 of Tucson Green Valley Unit #1 discussed in Section III and the potential for short-term and long-term scour along the entire study reach as described in Section IV. The following sub-sections discuss the proposed design and recommended phasing and the associated costs and constraints. Figure 4 shows the plan and profile for the proposed improvements. The reader is referred to Figure 4 in the following sub-sections which describe the proposed improvements.

6.1 Design Cross Sections and Profile

Two design cross sections were developed for the study reach based on the 100-year discharge of 4102 cfs. The design cross sections are described by Section A-A' of Figure 4. The cross section proposed for use between station 0+00 and station 7+00 has a 38-foot wide natural bottom with lined sideslopes at 1:1. The topwidth of the bank-protected channel is approximately 54 feet. This cross section, which is narrower than the cross section proposed for the majority of the study reach, is recommended because of the potential problem associated with excessive widening of the existing channel near the Community Water Company of Green Valley storage reservoir located near the land grant boundary. This section is also recommended between station 0+00 and 7+00 because the existing right-of-way at this location is only 54 feet in width and because the topography along this alignment allows for a somewhat deeper channel than the downstream portion of the study reach.

The channel reach between station 7+00 and station 23+00 is wider and shallower than the upstream reach described above. For this reason, a 50-foot bottomwidth channel is proposed for this sub-reach. The topwidth of the bank-protected channel is approximately 63.5 feet, while the existing right-of-way for most of this reach is 65 feet in width.

The channel depths of 5.75 and 6.50 feet indicated on Figure 4 include freeboard requirements as described on page III-10 in the Pima County Drainage Development and Channel Design Standards. The toe-down depths of 5.75 and 7.50 feet below the stable channel slopes indicated on Figure 4 were determined using the scour depth equation from the Pima County Drainage Development and Channel Design Standards. Supporting calculations for the channel design are contained in Appendix E of the report.

The cross section shown in Section A-A' on Figure 4 was developed assuming construction using either gunite or riprap for stabilization of the banks. Details A1 and A2 on Figure 4 show alternative design half-sections assuming gunite stabilization and riprap stabilization, respectively. It should be noted that the riprap section shown in Detail A2 will require approximately 5 feet more right-of-way than the cross section indicated by Detail A1, which was the cross section assumed in developing the channel topwidths referenced above (see Section 6.4 for more details on right-of-way requirements).

The proposed alignment and profile for the design cross section, including profiles for the top and toe of bank protection, are shown on Figure 4.

The design channel flowline generally follows the existing channel flowline, matching the invert of the spillway to the La Canada Drive box culvert crossing located at the downstream end of the study reach. In an effort to minimize the costs associated with right-of-way acquisition, the geometry of the cross section was designed to fit within the existing right-of-way along most portions of the study reach. However, because the existing channel is relatively shallow at the downstream-most end, implementation of the proposed improvements along the existing channel bed profile may require some berming along the north bank of the channel where the proposed top-of-bank profile lies above the existing top of bank.

In order to avoid the need for berming of the bank as described above, the proposed improvements could be constructed along an alternative profile by lowering the design flowline 2 feet below the invert the spillway referenced above. The flowline profile would transition back to the original design flowline at station 7+00. The alternative profile would eliminate the need for berming along the downstream end of the north bank. However, the alternative profile would involve removal of a portion of the spillway inlet to the La Canada Drive box culvert.

The proposed improvements are not anticipated to have any impact to areas located downstream of the La Canada box culvert crossing. This is because the box culvert at La Canada acts as a hydraulic control, confining the 100-year discharge to the box culvert. Consequently, the proposed improvements do not result in any net change in the downstream hydraulics.

6.2 Grade Stabilization

The bed of the channel must be stabilized using grade control structures to control long-term degradation. Analysis of the proposed design cross section utilizing the same method described in Section 4.2.2 indicates that the equilibrium slopes for the proposed channel design are .0166 ft/ft between station 0+00 and station 7+00, and .0181 ft/ft between station 7+00 and station 20+33. By comparison, the design flowline slopes are .0307 and .0240, respectively. The proposed locations for the grade control structures are indicated on Figure 4. A conceptual profile through an individual grade control is shown in Detail B on Figure 4. The depths of burial for the grade control structures were determined using the equations for cut-off wall design shown in the Pima County Drainage Development and Channel Design Standards. Supporting calculations for the design of the grade control structures are contained in Appendix E of this report.

6.3 Recommended Phasing

A two-phase construction plan is proposed should funds not be available for the entire project. Phase I would include components of the project needed to mitigate overbank flooding through Block 8 of Tucson Green Valley Unit #1. Specifically, Phase I of the project includes the construction of the portion of the bank protection located along the north bank of the channel adjacent to Block 8 of Tucson Green Valley Unit #1 between stations 12+50 and 20+33, installation of the downstream-most grade control structure shown on Figure 4, and bank protection of the south bank between station 15+50 and station 17+50. Bank protection of the south bank as shown on Figure 5 will ensure the integrity of the

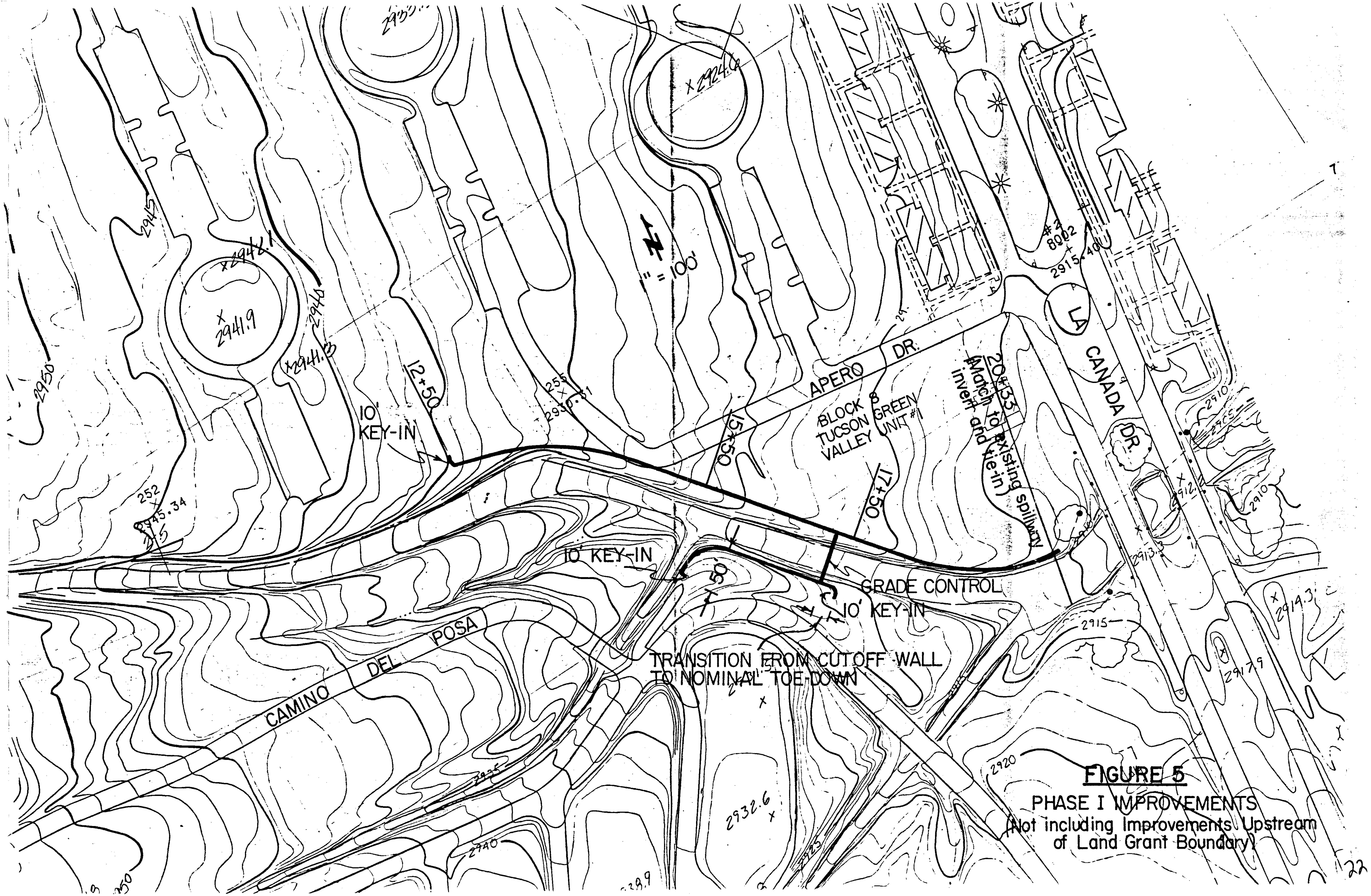

FIGURE 5
PHASE I IMPROVEMENTS
(Not including Improvements Upstream of Land Grant Boundary)

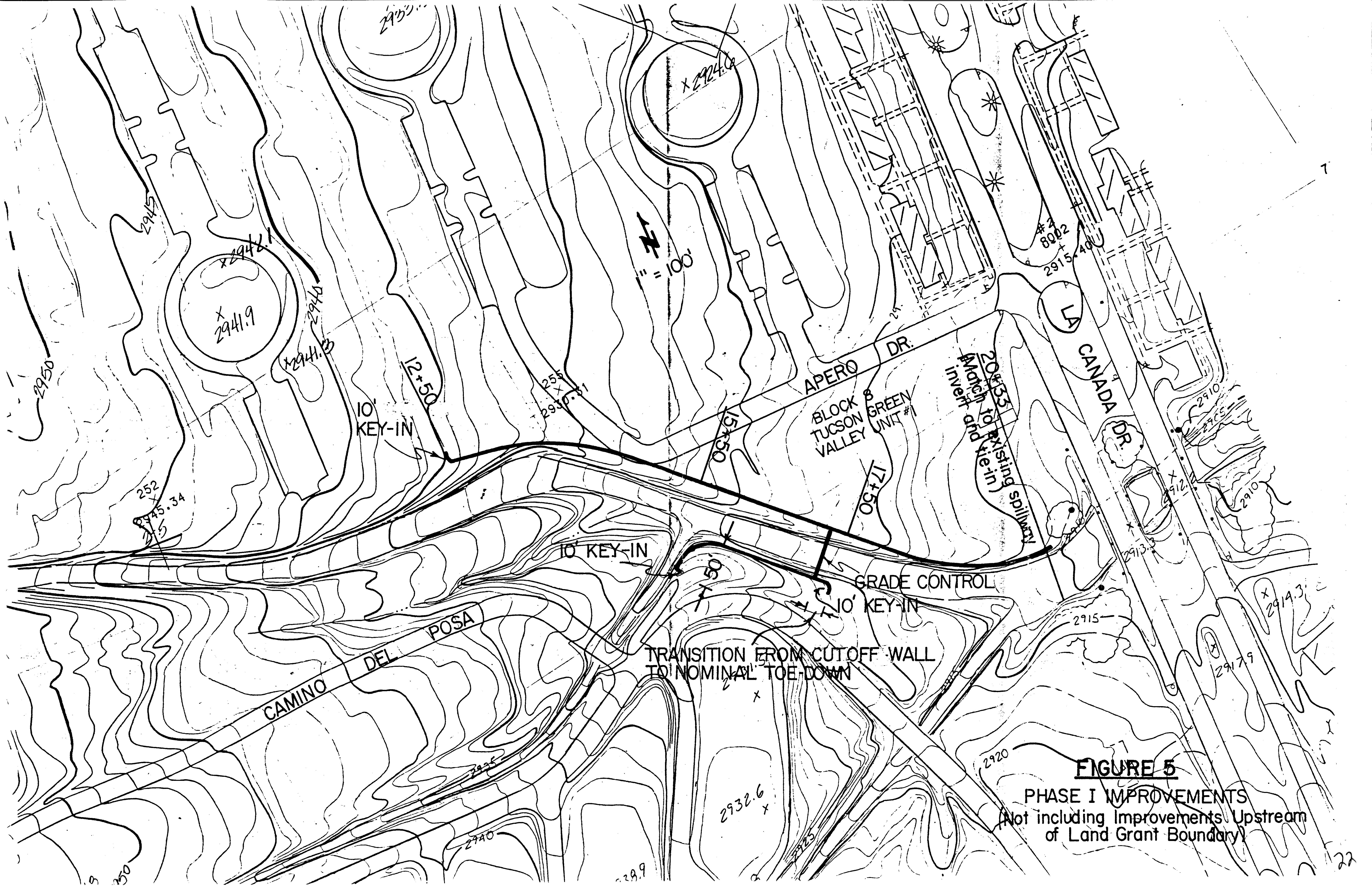

FIGURE 5

PHASE I IMPROVEMENTS
(Not including Improvements Upstream of Land Grant Boundary)

grade control structure until construction of bank protection along the remaining portion of the south bank.

Because of concern regarding the potential for additional scour on the south bank of the channel resulting from bank protection along the north bank only and confinement of the 236 cfs overbank discharge to the main channel, an analysis was performed to determine the potential for additional scour. The results of the analysis indicates that the potential for additional scour is minimal at most and would certainly not be anticipated to be a problem within the timeframe between the Phase I and later improvements.

It is also recommended that the initial phase of the project include construction of the improvements proposed between station 0+00 (i.e. the land grant boundary) and station -0+70. These improvements include the transition from the existing 50-foot bottomwidth improved channel located upstream of the land grant boundary, to the proposed 38-foot bottomwidth channel which begins at the land grant boundary, and the grade control structure located at station 0+00. Construction of these improvements as a part of Phase I will serve to protect the existing improvements located upstream of the land grant boundary from the long-term degradation predicted as a part of this study.

6.4 <u>Existing Right-of-Way and Utility Constraints</u>

The location of the existing drainage right-of-way shown on Figure 4 and utilities shown on Figure 6 are only approximate. No survey was included in the scope of work to tie right-of-way limits to the topographic mapping or to field locate utilities. The best available data has been used to depict existing right-of-ways and utilities on the concept plans and to acknowledge how the project improvements integrate with these constraints. However, more detailed surveys will be required as a part of final design studies to accurately determine right-of-way location and utility relocation requirements.

The existing right-of-way varies in width from 50 to 65 feet along the project reach. The proposed channel improvements will fit within existing right-of-way width of 54 feet between station 0+00 and station 7+00. Therefore, no additional right-of-way should be required along this reach. The existing right-of-way for channel improvements is 65 feet in width along most of the length of the study reach downstream of station 7+00. Two exceptions to this are the reaches located between station 7+00 and 8+50, and between approximately station 10+00 and station 14+00, where the existing right-of-way widths are 54 feet and 50 feet, respectively. Along these two reaches, additional right-of-way will be required to accommodate the proposed channel section. Table 2 summarizes the proposed design channel topwidths, existing right-of-way widths, and additional right-of-way widths required along the study reach.

A 16-foot access easement exists from approximately station 2+00 to station 7+00, and a 15-foot access and utility easement exists from station 7+00 to station 20+33. The drainage easement may be used to meet additional right-of-way needs between station 10+00 and station 14+00, but not between station 7+00 and station 8+50 since the easement is also planned to serve as a private street (Paseo Tierra).

TABLE 2 - SUMMARY OF DESIGN CHANNEL TOPWIDTHS

AND EXISTING AND REQUIRED RIGHT-OF-WAY WIDTHS

		Required R.O.W. Width (Ft)		Additional ROW Width Needed (ft)	
Reach (Station)	Existing ROW Width (ft)	Gunite-Lined Section	Riprap-Lined Section	Gunite-Lined Section	Riprap-Lined Section
0+00 to 7+00	54.0	53.0	58.5	0.0	4.5
7+00 to 8+50	54.0	63.5	68.0	9.5	14.0
8+50 to 10+00	65.0	63.5	68.0	0.0	3.0
10+00 to 14+00	50.0	63.5	68.0	13.5	18.0
14+00 to 20+33	65.0	63.5	68.0	0.0	4.5

Figure 6 shows the approximate location of the existing utilities along the study reach of Drainageway #9. Five utilities maintain facilities along the project reach including:

- Community Water Company of Green Valley
- Tucson Electric Power Company
- Pima County Wastewater Department
- Southwest Gas Corporation
- Cook Cablevision

As indicated on Figure 6, most of the utilities appear to be outside of the channel right-of-way or adjacent to the channel banks. Review of available information indicated that the Pima County Wastewater Department maintains an 8-inch sewer line crossing approximately 500 feet upstream of the La Canada Drive culvert crossing. This crossing is located approximately 7 feet below the existing channel grade and is concrete-encased. This crossing does not appear to conflict with the proposed improvements. Inspection of the plans for the aforementioned culvert crossing at La Canada Drive also indicate the existence of a sewer line crossing located immediately upstream of the concrete spillway to the box culvert. The depth of burial of this line is not known; however, it should be possible to pass the existing sewer line through any proposed improvements utilizing a sleeve that would fit through the toe-down of the proposed bank protection. Discussions with Southwest Gas indicate that the gasline located along the south bank of the study reach immediately upstream of La Canada Drive may be located within the channel. This gas line may need to be relocated in order to implement the proposed improvements. Details regarding the profiles and precise alignments of the other utilities shown on Figure 6 were not available.

6.5 Cost Estimates for Conceptual Improvements

Tables 3A and 3B list the estimated costs associated with implementation of the improvements described above. Tables 3A and 3B show the estimated costs for improvements proposed for the initial phase and for the entire project for the gunite and riprap bank protection alternatives, respectively.

TABLE 3A - COST ESTIMATE FOR PROPOSED IMPROVEMENTS

ASSUMING GUNITE BANK PROTECTION

Item	Unit	Qty	Unit Cost	Total Cost
PHASE I ONLY:				
Construction:				
6" Gunite Bank Protection	S.Y.	1,990	$ 30	$ 59,700
Concrete for Cutoff Walls	C.Y.	36	150	5,400
			Subtotal	65,100
Contingencies @ 20% of subtotal				13,020
Engineering and Construction Management @ 10% of subtotal				6,510
			Total	$ 84,630
TOTAL PROJECT:				
Construction:				
6" Gunite Bank Protection	S.Y.	7,680	$30	$ 230,400
Concrete for Cutoff Walls	C.Y.	165	150	24,750
Right-of-Way Acquisition	Sq. Ft.	6,825	3	20,475
			Subtotal	$ 275,625
Contingencies @ 20% of subtotal				55,125
Engineering and Construction Management @ 10% of subtotal				27,563
			Total	$ 358,313

TABLE 3B - COST ESTIMATE FOR PROPOSED IMPROVEMENTS

ASSUMING RIPRAP BANK PROTECTION

Item	Unit	Qty	Unit Cost	Total Cost
PHASE I ONLY:				
Construction:				
Rail and Rock Bank Protection	L.F.	1,123	$ 135*	$ 151,600
Concrete for Cutoff Walls	C.Y.	36	150	5,400
			Subtotal	157,000
Contingencies @ 20% of subtotal				31,400
Engineering and Construction Management @ 10% of subtotal				15,700
			Total	204,100
TOTAL PROJECT:				
Construction:				
Rail and Rock Bank Protection	L.F.	4,200	135	567,000
Concrete for Cutoff Walls	C.Y.	165	150	24,750
Right-of-Way Acquisition	Sq. Ft.	15,750	3	47,250
			Subtotal	639,000
Contingencies @ 20% of subtotal				127,800
Engineering and Construction Management @ 10% of subtotal				63,900
			Total	$ 830,700

*Based on 1984 unit cost for ADOT C-17.10 Type-2 Rail Bank Protection

VII. SUMMARY OF RESULTS AND RECOMMENDATIONS

The previous sections of this report have presented the methodologies and results of the hydraulic and geomorphic analysis for existing conditions and proposed improvements along Green Valley Drainageway #9 between La Canada Drive and the San Ignacio De La Canoa land grant boundary. This section of the report summarizes the results of the analysis and the recommendations for mitigation of existing problems..

The results of the hydrologic analysis using the U.S. Army Corps of Engineers HEC-1 model provided a peak discharge of 4102 cfs. This discharge was used in the analysis of existing conditions and in the design of proposed improvements.

The results of the hydraulic analysis of existing conditions indicate that the 100-year peak discharge of 4102 cfs is contained within the channel banks along most of the study reach. However, some overbank flooding was determined to occur along the north bank of the channel adjacent to Block 8 of Tucson Green Valley Unit #1. The overbank flooding impacts a number of townhomes located within Block 8.

The results of the geomorphic analysis indicate that, in general, the horizontal alignment of the channel appears to be relatively stable, with only 25 feet of lateral scour during the 100-year event along most of the study reach, increasing to 70 feet at the location of a sharp bend in the channel just upstream of the Block 8 area referenced above. The results of the geomorphic analysis also indicate a long-term trend toward overall degradation of the channel bed along the study reach, particularly along the upstream-most portion.

Existing channel improvements along the study area consist of the La Canada Drive box culvert improvements and the channel improvements upstream of the land grant boundary. These improvements are located at the extremities of the study reach. Within the study reach, existing improvements are limited primarily to an approximately 400-foot section of bank protection improvements along the north bank adjacent to the Block 8 area. These improvements consist of a combination of placed riprap and concrete lining with a minimal toe down. The improvements along the north bank adjacent to the Block 8 area were considered to be inadequate for the 100-year event.

Conceptual design improvements were developed for implementation along the study reach to mitigate the potential for overbank flooding within the Block 8 area and to mitigate the potential for short-term and long-term scour along the entire study reach. The proposed improvements call for construction of an improved channel along the general alignment and profile of the existing channel. The proposed channel has a natural bottom varying in width from 38 feet at the upstream end of the study reach to 50 feet at the downstream end. The banks of the channel section are proposed to be lined utilizing either gunite or riprap. Details for both gunite and rock-and-rail bank protection were developed. Design recommendations for stabilization of the channel bed profile using grade control structures were also developed. The plan and profile for the proposed improvements, including cross section and bank protection details, are shown on Figure 4. The total cost for the proposed improvements was estimated to be $358,313 using the gunite-lined alternative, and $830,700 using the riprap-lined alternative.

A plan for phasing of the proposed improvements was also developed in the event that funding for the entire project was not immediately available. The initial phase of the project would include approximately 800 lineal feet of bank protection along the north bank of the channel adjacent to the Block 8 area, installation of the downstream-most grade control, and construction of approximately 200 lineal feet of bank protection on the south bank of the channel at the location of the above-referenced grade control structure. The Phase I improvements also call for construction of the transition from the existing channel improvements located upstream of the land grant boundary to the proposed channel cross section at the land grant boundary including construction of the grade control structure. The total cost for the Phase I improvements was estimated to be approximately $84,630 using the gunite-lined section, and $204,100 using the riprap-lined section.

The proposed improvements were generally designed to be accommodated within the existing right-of-way. However, approximately 6,900 square feet of additional right-of-way will be required to accommodate the gunite-lined alternative, while approximately 16,000 square feet of additional right-of-way will be required to accommodate the riprap-lined alternative. A more detailed description of the locations where additional right-of-way will be needed is provided in Table 2. Review of available information on existing utilities indicate that 5 public and private agencies maintain facilities along the project reach. Most of the utilities appear to be outside of the existing channel right-of-way or adjacent to the channel banks. However, there are a number of below-grade crossings of the channel and possibly one gas line running parallel to and within the channel. Construction of this project may require relocation of some of these utilities. It should be noted that no survey was included in the scope of work to tie right-of-way limits to the existing topographic mapping or to field locate utilities. The best data available was used to depict existing right-of-ways and utilities on the concept plans and to acknowledge how the project improvements integrate with these constraints. However, more detailed surveys will be required as a part of final design studies to accurately determine right-of-way location and utility relocation requirements.

Review of the cost estimates listed above indicate that the gunite lining alternative is considerably less costly than the riprap lining alternative. This is primarily due to the higher effective per lineal foot cost of the rail-and-rock bank protection when compared with the gunite lining alternative. However, a portion of the cost difference is due to the additional right-of-way needed to accommodate the riprap-lined section as shown on Figure 4. Because of the lower cost associated with the gunite lining alternative and the higher compatibility of this alternative with existing right-of-way, it is recommended that the gunite lining alternative be used for the project. It is also recommended that, at a minimum, the Phase I improvements be constructed as soon as possible to mitigate the existing potential for 100-year flooding of the Block 8 area and to protect existing improvements.

APPENDIX A

SCOPE OF WORK

CONTRACT
NO. 07-04-C-110131-0588
AMENDMENT NO. ____
This number must appear on all invoices, correspondence, and documents pertaining to this contract.

CONTRACT BETWEEN PIMA COUNTY FLOOD CONTROL DISTRICT
AND
CMG DRAINAGE ENGINEERING
FOR
GEOMORPHIC ANALYSIS: GREEN VALLEY DRAINAGEWAY #9

This Agreement is made and entered into this 21st day of June, 1988, between Pima County Flood Control District, hereinafter called OWNER and CMG Drainage Engineering hereinafter called CONSULTANT.

I. SCOPE OF WORK

The CONSULTANT shall perform an geomorphic analysis of Green Valley drainageway #9. The specific scope of work is as follows:

1. Conduct a field visit to identify site-specific problem areas.

2. Obtain sediment samples for equilibrium slope and aggradation/degradation analysis.

3. Conduct hydraulic computations (HEC-II model) for determination of flow conditions along entire project reach.
[illegible]

4. Conduct equilibrium slope analysis to determine long-term degradation potential and identify need for grade stabilization structures. Also address aggradation potential during low flows to evaluate if the design channel cross-section should be oversized to account for deposition.

5. Develop concept plans for grade stabilization structures to control headcutting in the area between Camino Portillo and the Green Valley Villas subdivision.

6. Evaluate potential for and quantity of overbank flooding along the reach to the Villas subdivision.

7. Conduct an evaluation for determination of bed and bank erosion potential and channel stabilization needed along the north channel bank adjacent to the Villas subdivision and downstream to La Canada Drive. The design concept will attempt to minimize bank erosion as much as possible so as to reduce construction costs.

8. Determine potential for impacts to downstream properties as a result of planned improvements.

9. Develop concept plans for channel widening and bank protection along the reach adjacent to the Villas subdivision which will include typical cross-sections, and

10. Determine additional right-of-way needs.

11. Prepare rough cost estimates for proposed drainageway improvement plan.

12. Prepare project report development with the OWNER's staff during the concept study and during plan preparation to be conducted by the OWNER.

13. Coordinate project development with the OWNER's staff during the concept study and during plan preparation to be conducted by the OWNER.

14. Obtain data on existing utilities within the project area for incorporation into concept plans.

The Consultant shall perform the following additional services:

1) Assess the hydrology of the watersheds involved and perform hydrologic routing of the flows through the watershed to determine the correct design discharge. This routing should include the reservoir routing located upstream of waste stock piles located at the northeast corner of Duval Mine Road and Mission Road. The routing should also consider the effects of the runoff if this retention area is filled.

APPENDIX B

HYDROLOGIC DATA SHEETS AND HEC-1 INPUT/OUTPUT

PROJECT NAME AND LOCATION: GREEN VALLEY D.W. #9 (JOB#: 88021)

DRAINAGE CONCENTRATION POINT: SUBBASIN # 1

WATERSHED AREA (A): 764.00 acres

LENGTH OF WATERCOURSE (Lc): 28050. ft

LENGTH TO CENTER OF GRAVITY (Lca): 14000. ft

INCREMENTAL CHANGE IN LENGTH (Li) - ft	INCREMENTAL CHANGE IN ELEV (Hi) - ft
2500.	355.0
5300.	200.0
8000.	200.0
12250.	230.0

MEAN SLOPE (Sc): .0260 ft BASIN FACTOR (Nb): .0350

WATERSHED TYPE(S): FOOTHILLS

RAINFALL VALUES

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
P 1	1.43	1.76	1.98	2.27	2.53	2.79
P 2	1.55	1.94	2.20	2.53	2.83	3.13
P 3	1.63	2.06	2.34	2.70	3.03	3.35
P 6	1.79	2.28	2.60	3.02	3.40	3.78
P24	2.10	2.74	3.16	3.71	4.21	4.70

SOIL GROUPS

10. % B, CN= 83, COVER TYPE= DESERT BRUSH , COVER DENSITY= 20 %
90. % D, CN= 91, COVER TYPE= DESERT BRUSH , COVER DENSITY= 20 %

IMPERVIOUS COVER= 0. %

RAINFALL/RUNOFF AND PEAK DISCHARGE DATA

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
RUNOFF SUPPLY RATE (q/i):	.413	.531	.591	.652	.695	.730
Tc (FUNCTION OF i) :	97.48	88.19	84.49	81.24	79.16	77.63
SOLUTION OF Tc (MINUTES):	102	77	67	58	53	49
RAINFL INT. @ Tc (IN/HR):	.890	1.411	1.799	2.316	2.760	3.208
RUNOFF RATE @ Tc (IN/HR):	.368	.749	1.063	1.510	1.919	2.342
PEAK DISCHARGE (CFS) :	283.	577.	818.	1163.	1478.	1804.

PROJECT NAME AND LOCATION: GREEN VALLEY D.W. # 9 (JOB# 88021)

DRAINAGE CONCENTRATION POINT: SUBBASIN # 2

WATERSHED AREA (A): 501.38 acres

LENGTH OF WATERCOURSE (Lc): 13500. ft

LENGTH TO CENTER OF GRAVITY (Lca): 7000. ft

INCREMENTAL CHANGE IN LENGTH (Li) - ft	INCREMENTAL CHANGE IN ELEV (Hi) - ft
7250.	200.0
6250.	140.0

MEAN SLOPE (Sc): .0250 ft BASIN FACTOR (Nb): .0350

WATERSHED TYPE(S): FOOTHILLS

RAINFALL VALUES

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
P 1	1.43	1.76	1.98	2.27	2.53	2.79
P 2	1.55	1.94	2.20	2.53	2.83	3.13
P 3	1.63	2.06	2.34	2.70	3.03	3.35
P 6	1.79	2.28	2.60	3.02	3.40	3.78
P24	2.10	2.74	3.16	3.71	4.21	4.70

SOIL GROUPS

5. % B, CN= 83, COVER TYPE= DESERT BRUSH , COVER DENSITY= 20 %
95. % D, CN= 91, COVER TYPE= DESERT BRUSH , COVER DENSITY= 20 %

IMPERVIOUS COVER= 0. %

RAINFALL/RUNOFF AND PEAK DISCHARGE DATA

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
RUNOFF SUPPLY RATE (q/i):	.424	.542	.602	.662	.705	.739
Tc (FUNCTION OF i) :	63.93	57.98	55.60	53.51	52.18	51.20
SOLUTION OF Tc (MINUTES):	54	42	37	33	30	28
RAINFL INT. @ Tc (IN/HR):	1.540	2.236	2.738	3.361	4.001	4.574
RUNOFF RATE @ Tc (IN/HR):	.654	1.212	1.647	2.225	2.821	3.382
PEAK DISCHARGE (CFS) :	330.	612.	833.	1125.	1426.	1709.

PROJECT NAME AND LOCATION: GREEN VALLEY D.W. # 9

DRAINAGE CONCENTRATION POINT: SUBBASIN # 3

WATERSHED AREA (A): 152.43 acres

LENGTH OF WATERCOURSE (Lc): 6250. ft

LENGTH TO CENTER OF GRAVITY (Lca): 3200. ft

INCREMENTAL CHANGE IN LENGTH (Li) - ft	INCREMENTAL CHANGE IN ELEV (Hi) - ft
6250.	170.0

MEAN SLOPE (Sc): .0272 ft BASIN FACTOR (Nb): .0350

WATERSHED TYPE(S): 1

RAINFALL VALUES

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
P 1	1.43	1.76	1.98	2.27	2.53	2.79
P 2	1.55	1.94	2.20	2.53	2.83	3.13
P 3	1.63	2.06	2.34	2.70	3.03	3.35
P 6	1.79	2.28	2.60	3.02	3.40	3.78
P24	2.10	2.74	3.16	3.71	4.21	4.70

SOIL GROUPS

30. % B, CN= 83, COVER TYPE= DESERT BRUSH , COVER DENSITY= 20 %
70. % D, CN= 91, COVER TYPE= DESERT BRUSH , COVER DENSITY= 20 %

IMPERVIOUS COVER= 0. %

RAINFALL/RUNOFF AND PEAK DISCHARGE DATA

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
RUNOFF SUPPLY RATE (q/i):	.369	.486	.547	.611	.657	.694
Tc (FUNCTION OF i) :	41.03	36.74	35.03	33.53	32.57	31.86
SOLUTION OF Tc (MINUTES):	30	23	20	18	17	15
RAINFL INT. @ Tc (IN/HR):	2.254	3.239	3.948	4.769	5.469	6.360
RUNOFF RATE @ Tc (IN/HR):	.831	1.574	2.161	2.913	3.592	4.413
PEAK DISCHARGE (CFS) :	128.	242.	332.	448.	552.	678.

PROJECT NAME AND LOCATION: GREEN VALLEY D.W. # 9

DRAINAGE CONCENTRATION POINT: SUBBSIN # 4

WATERSHED AREA (A): 155.19 acres

LENGTH OF WATERCOURSE (Lc): 4000. ft

LENGTH TO CENTER OF GRAVITY (Lca): 2000. ft

INCREMENTAL CHANGE IN LENGTH (Li) - ft	INCREMENTAL CHANGE IN ELEV (Hi) - ft
4000.	80.0

MEAN SLOPE (Sc): .0200 ft BASIN FACTOR (Nb): .0350

WATERSHED TYPE(S): FOOTHILLS

RAINFALL VALUES

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
P 1	1.43	1.76	1.98	2.27	2.53	2.79
P 2	1.55	1.94	2.20	2.53	2.83	3.13
P 3	1.63	2.06	2.34	2.70	3.03	3.35
P 6	1.79	2.28	2.60	3.02	3.40	3.78
P24	2.10	2.74	3.16	3.71	4.21	4.70

SOIL GROUPS

100. % D, CN= 91, COVER TYPE= DESERT BRUSH , COVER DENSITY= 20 %

IMPERVIOUS COVER= 0. %

RAINFALL/RUNOFF AND PEAK DISCHARGE DATA

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
RUNOFF SUPPLY RATE (q/i):	.436	.553	.613	.672	.715	.748
Tc (FUNCTION OF i) :	32.97	29.97	28.77	27.72	27.05	26.55
SOLUTION OF Tc (MINUTES):	22	18	16	14	13	12
RAINFL INT. @ Tc (IN/HR):	2.696	3.697	4.405	5.382	6.178	7.029
RUNOFF RATE @ Tc (IN/HR):	1.174	2.045	2.698	3.618	4.416	5.261
PEAK DISCHARGE (CFS) :	184.	320.	422.	566.	691.	823.

PROJECT NAME AND LOCATION: GREEN VALLEY D.W. #9

DRAINAGE CONCENTRATION POINT: 5

WATERSHED AREA (A): 313.00 acres

LENGTH OF WATERCOURSE (Lc): 6500. ft

LENGTH TO CENTER OF GRAVITY (Lca): 3250. ft

INCREMENTAL CHANGE IN LENGTH (Li) - ft	INCREMENTAL CHANGE IN ELEV (Hi) - ft
6500.	130.0

MEAN SLOPE (Sc): .0200 ft BASIN FACTOR (Nb): .0350

WATERSHED TYPE(S): FOOTHILLLS

RAINFALL VALUES

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
P 1	1.43	1.76	1.98	2.27	2.53	2.79
P 2	1.55	1.94	2.20	2.53	2.83	3.13
P 3	1.63	2.06	2.34	2.70	3.03	3.35
P 6	1.79	2.28	2.60	3.02	3.40	3.78
P24	2.10	2.74	3.16	3.71	4.21	4.70

SOIL GROUPS

20. % B, CN= 83, COVER TYPE= DESERT BRUSH , COVER DENSITY= 20 %
80. % D, CN= 91, COVER TYPE= DESERT BRUSH , COVER DENSITY= 20 %

IMPERVIOUS COVER= 0. %

RAINFALL/RUNOFF AND PEAK DISCHARGE DATA

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
RUNOFF SUPPLY RATE (q/i):	.391	.508	.569	.631	.676	.712
Tc (FUNCTION OF i) :	46.07	41.48	39.65	38.04	37.01	36.25
SOLUTION OF Tc (MINUTES):	35	27	24	21	19	18
RAINFL INT. @ Tc (IN/HR):	2.040	2.958	3.571	4.383	5.165	5.857
RUNOFF RATE @ Tc (IN/HR):	.797	1.504	2.032	2.767	3.492	4.171
PEAK DISCHARGE (CFS) :	252.	474.	641.	873.	1102.	1316.

PROJECT NAME AND LOCATION: GREEN VALLEY D.W. #9

DRAINAGE CONCENTRATION POINT: 6

WATERSHED AREA (A): 137.00 acres

LENGTH OF WATERCOURSE (Lc): 5600. ft

LENGTH TO CENTER OF GRAVITY (Lca): 2800. ft

INCREMENTAL CHANGE IN LENGTH (Li) - ft	INCREMENTAL CHANGE IN ELEV (Hi) - ft
5600.	50.0

MEAN SLOPE (Sc): .0089 ft BASIN FACTOR (Nb): .0350

WATERSHED TYPE(S): FOOTHILLS

RAINFALL VALUES

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
P 1	1.43	1.76	1.98	2.27	2.53	2.79
P 2	1.55	1.94	2.20	2.53	2.83	3.13
P 3	1.63	2.06	2.34	2.70	3.03	3.35
P 6	1.79	2.28	2.60	3.02	3.40	3.78
P24	2.10	2.74	3.16	3.71	4.21	4.70

SOIL GROUPS

100. % C, CN= 88, COVER TYPE= DESERT BRUSH , COVER DENSITY= 20 %

IMPERVIOUS COVER= 0. %

RAINFALL/RUNOFF AND PEAK DISCHARGE DATA

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
RUNOFF SUPPLY RATE (q/i):	.336	.457	.521	.587	.636	.675
Tc (FUNCTION OF i) :	61.81	54.65	51.86	49.43	47.89	46.75
SOLUTION OF Tc (MINUTES):	52	39	34	30	27	25
RAINFL INT. @ Tc (IN/HR):	1.569	2.359	2.897	3.588	4.254	4.881
RUNOFF RATE @ Tc (IN/HR):	.527	1.078	1.509	2.108	2.705	3.295
PEAK DISCHARGE (CFS) :	73.	149.	208.	291.	374.	455.

PROJECT NAME AND LOCATION: GREEN VALLEY D.W. # 9

DRAINAGE CONCENTRATION POINT: SUBBASIN #7

WATERSHED AREA (A): 691.46 acres

LENGTH OF WATERCOURSE (Lc): 18750. ft

LENGTH TO CENTER OF GRAVITY (Lca): 10000. ft

INCREMENTAL CHANGE IN LENGTH (Li) - ft	INCREMENTAL CHANGE IN ELEV (Hi) - ft
11500.	270.0
7250.	140.0

MEAN SLOPE (Sc): .0217 ft BASIN FACTOR (Nb): .0350

WATERSHED TYPE(S): FOOTHILLS

RAINFALL VALUES

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
P 1	1.43	1.76	1.98	2.27	2.53	2.79
P 2	1.55	1.94	2.20	2.53	2.83	3.13
P 3	1.63	2.06	2.34	2.70	3.03	3.35
P 6	1.79	2.28	2.60	3.02	3.40	3.78
P24	2.10	2.74	3.16	3.71	4.21	4.70

SOIL GROUPS

20. % C, CN= 88, COVER TYPE= DESERT BRUSH , COVER DENSITY= 20 %
80. % D, CN= 91, COVER TYPE= DESERT BRUSH , COVER DENSITY= 20 %

IMPERVIOUS COVER= 0. %

RAINFALL/RUNOFF AND PEAK DISCHARGE DATA

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
RUNOFF SUPPLY RATE (q/i):	.416	.534	.594	.655	.699	.734
Tc (FUNCTION OF i) :	83.74	75.76	72.58	69.80	68.02	66.71
SOLUTION OF Tc (MINUTES):	81	60	54	47	43	40
RAINFL INT. @ Tc (IN/HR):	1.089	1.761	2.143	2.680	3.165	3.654
RUNOFF RATE @ Tc (IN/HR):	.452	.940	1.273	1.756	2.212	2.681
PEAK DISCHARGE (CFS) :	315.	655.	887.	1224.	1542.	1869.

PROJECT NAME AND LOCATION: GREEN VALLEY D.W. # 9

DRAINAGE CONCENTRATION POINT: SUBBASIN #8

WATERSHED AREA (A): 748.86 acres

LENGTH OF WATERCOURSE (Lc): 18920. ft

LENGTH TO CENTER OF GRAVITY (Lca): 9460. ft

INCREMENTAL CHANGE IN LENGTH (Li) - ft	INCREMENTAL CHANGE IN ELEV (Hi) - ft
11950.	320.0
8500.	140.0

MEAN SLOPE (Sc): .0216 ft BASIN FACTOR (Nb): .0350

WATERSHED TYPE(S): FOOTHILLS

RAINFALL VALUES

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
P 1	1.43	1.76	1.98	2.27	2.53	2.79
P 2	1.55	1.94	2.20	2.53	2.83	3.13
P 3	1.63	2.06	2.34	2.70	3.03	3.35
P 6	1.79	2.28	2.60	3.02	3.40	3.78
P24	2.10	2.74	3.16	3.71	4.21	4.70

SOIL GROUPS

53. % B, CN= 83, COVER TYPE= DESERT BRUSH , COVER DENSITY= 20 %
40. % C, CN= 88, COVER TYPE= DESERT BRUSH , COVER DENSITY= 20 %
7. % D, CN= 91, COVER TYPE= DESERT BRUSH , COVER DENSITY= 20 %

IMPERVIOUS COVER= 0. %

RAINFALL/RUNOFF AND PEAK DISCHARGE DATA

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
RUNOFF SUPPLY RATE (q/i):	.277	.396	.461	.530	.581	.623
Tc (FUNCTION OF i) :	97.34	84.44	79.47	75.17	72.44	70.45
SOLUTION OF Tc (MINUTES):	102	72	60	52	47	43
RAINFL INT. @ Tc (IN/HR):	.890	1.497	1.984	2.498	2.988	3.487
RUNOFF RATE @ Tc (IN/HR):	.247	.593	.914	1.323	1.735	2.171
PEAK DISCHARGE (CFS) :	186.	447.	690.	999.	1310.	1639.

PROJECT NAME AND LOCATION: GREEN VALLEY D.W. # 9

DRAINAGE CONCENTRATION POINT: SUBBASIN # 9

WATERSHED AREA (A): 143.70 acres

LENGTH OF WATERCOURSE (Lc): 6500. ft

LENGTH TO CENTER OF GRAVITY (Lca): 3200. ft

INCREMENTAL CHANGE IN LENGTH (Li) - ft	INCREMENTAL CHANGE IN ELEV (Hi) - ft
6500.	165.0

MEAN SLOPE (Sc): .0254 ft BASIN FACTOR (Nb): .0350

WATERSHED TYPE(S): FOOTHILLS

RAINFALL VALUES

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
P 1	1.43	1.76	1.98	2.27	2.53	2.79
P 2	1.55	1.94	2.20	2.53	2.83	3.13
P 3	1.63	2.06	2.34	2.70	3.03	3.35
P 6	1.79	2.28	2.60	3.02	3.40	3.78
P24	2.10	2.74	3.16	3.71	4.21	4.70

SOIL GROUPS

40. % B, CN= 83, COVER TYPE= DESERT BRUSH , COVER DENSITY= 20 %
60. % C, CN= 88, COVER TYPE= DESERT BRUSH , COVER DENSITY= 20 %

IMPERVIOUS COVER= 0. %

RAINFALL/RUNOFF AND PEAK DISCHARGE DATA

	EVENT					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
RUNOFF SUPPLY RATE (q/i):	.287	.406	.471	.539	.590	.632
Tc (FUNCTION OF i) :	47.20	41.07	38.70	36.65	35.36	34.41
SOLUTION OF Tc (MINUTES):	36	27	23	20	18	17
RAINFL INT. @ Tc (IN/HR):	2.011	2.958	3.651	4.519	5.317	6.025
RUNOFF RATE @ Tc (IN/HR):	.576	1.200	1.718	2.437	3.138	3.806
PEAK DISCHARGE (CFS) :	83.	174.	249.	353.	454.	551.

GREEN VALLEY DRAINAGEWAY #9
#88021

FILE	DESCRIPTION	
88021A.H1I	HEC1 - NORMAL DEPTH WITH NO DET. BASIN 1 MIN. TIME INTERVAL	Q_{100} = 5982 cfs
88021B.H1I	HEC1 - NORMAL DEPTH WITH EMPTY DET. BASIN 1 MIN. TIME INTERVAL	Q_{100} = 2814 cfs
88021C.H1I	HEC1 - NORMAL DEPTH WITH FULL DET. BASIN 1 MIN. TIME INTERVAL	Q_{100} = 4102 cfs

DETENTION BASIN HAS ~250 AC·FT
OF STORAGE BEFORE OUTFLOW BEGINS

88021A.H1I

```
ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

ID        GREEN VALLEY DRAINAGEWAY    #88021
ID        NORMAL DEPTH ROUTING
ID        FILE : 88021A.H1I
IT        1                         200
IO        5

KK        1
KM        INFLOW HYDROGRAPH FOR BASIN: 1
QI      0.     11.     22.     33.     44.     69.     97.    124.    151.    182.
QI    214.    246.    278.    313.    349.    386.    422.    464.    509.    554.
QI    599.    645.    691.    737.    783.    832.    887.    942.    997.   1055.
QI   1127.   1198.   1269.   1339.   1405.   1470.   1535.   1601.   1650.   1700.
QI   1749.   1804.   1774.   1741.   1707.   1674.   1637.   1600.   1563.   1525.
QI   1489.   1452.   1416.   1379.   1344.   1310.   1276.   1242.   1208.   1176.
QI   1143.   1111.   1081.   1055.   1029.   1003.    977.    949.    921.    894.
QI    866.    841.    815.    790.    764.    742.    719.    696.    673.    652.
QI    630.    609.    587.    568.    550.    532.    514.    496.    478.    460.
QI    442.    427.    413.    400.    386.    372.    359.    345.    332.    320.
QI    310.    301.    291.    282.    272.    263.    253.    244.    237.    229.
QI    222.    214.    207.    200.    192.    185.    179.    174.    169.    163.
QI    158.    153.    148.    142.    138.    135.    132.    129.    126.    123.
QI    119.    116.    113.    110.    107.    103.    100.     97.     94.     91.
QI     88.     86.     84.     82.     80.     77.     75.     73.     71.     69.
QI     67.     65.     63.     61.     59.     57.     54.     53.     52.     51.
QI     50.     49.     48.     47.     46.     44.     43.     42.     41.     40.
QI     39.     38.     37.     36.     35.     34.     33.     32.     31.     30.
QI     30.     29.     28.     27.     26.     25.     24.     23.     23.     22.
QI     21.     21.     20.     20.     19.     19.     19.     18.     18.     17.
QI     17.     16.     16.     16.     15.     15.     14.     14.     14.     14.
QI     14.     13.     13.     13.     13.     13.     13.     12.     12.     12.
QI     12.     12.     12.     11.     11.     11.     11.     11.     10.     10.
QI     10.     10.     10.     10.      9.      9.      9.      9.      9.      9.
QI      8.      8.      8.      8.      8.      7.      7.      7.      7.      7.
QI      7.      6.      6.      6.      6.      6.      6.      5.      5.      5.
QI      5.      5.      5.      4.      4.      4.      4.      4.      3.      3.
QI      3.      3.      3.      3.      2.      2.      2.      2.      2.      2.
QI      1.      1.      1.      1.      1.      0.      0.      0.      0.

KK        2
KM        INFLOW HYDROGRAPH FOR BASIN: 2
QI      0.     15.     30.     47.     84.    121.    159.    202.    246.    291.
QI    340.    390.    445.    506.    567.    629.    691.    753.    824.    898.
QI    973.   1065.   1161.   1257.   1346.   1435.   1521.   1588.   1655.   1709.
QI   1655.   1610.   1563.   1513.   1462.   1412.   1363.   1314.   1266.   1220.
QI   1174.   1129.   1085.   1041.   1004.    969.    934.    897.    860.    822.
QI    788.    754.    720.    689.    658.    628.    599.    569.    542.    518.
QI    494.    469.    445.    421.    400.    382.    363.    345.    327.    308.
QI    295.    282.    269.    256.    244.    231.    221.    211.    201.    191.
QI    181.    172.    165.    158.    150.    143.    136.    131.    126.    122.
QI    118.    114.    109.    105.    101.     96.     92.     88.     84.     81.
QI     78.     75.     72.     69.     67.     64.     61.     58.     55.     53.
QI     50.     49.     47.     46.     45.     43.     42.     40.     39.     37.
QI     36.     34.     33.     32.     31.     29.     28.     27.     26.     25.
QI     23.     22.     21.     20.     20.     19.     18.     18.     17.     17.
QI     16.     15.     15.     14.     14.     13.     13.     13.     13.     12.
```

LINE	ID	1	2	3	4	5	6	7	8	9	10
54	QI	12.	12.	12.	12.	11.	11.	11.	11.	10.	10.
55	QI	10.	10.	9.	9.	9.	9.	8.	8.	8.	8.
56	QI	8.	7.	7.	7.	7.	6.	6.	6.	6.	5.
57	QI	5.	5.	5.	4.	4.	4.	4.	3.	3.	3.
58	QI	3.	3.	2.	2.	2.	2.	1.	1.	1.	1.
59	QI	0.	0.								
60	KK	3									
61	KM	INFLOW HYDROGRAPH FOR BASIN: 3									
62	QI	0.	8.	16.	36.	56.	80.	103.	130.	157.	189.
63	QI	223.	257.	291.	330.	370.	418.	471.	522.	571.	615.
64	QI	652.	678.	646.	620.	592.	564.	537.	510.	485.	459.
65	QI	435.	411.	391.	372.	351.	331.	311.	292.	275.	258.
66	QI	241.	225.	211.	198.	184.	171.	159.	149.	138.	128.
67	QI	119.	112.	105.	98.	91.	86.	80.	75.	69.	65.
68	QI	61.	57.	53.	51.	48.	46.	44.	41.	39.	36.
69	QI	34.	32.	31.	29.	28.	26.	24.	23.	21.	20.
70	QI	19.	18.	18.	17.	16.	15.	14.	14.	13.	12.
71	QI	12.	11.	10.	10.	9.	8.	8.	8.	7.	7.
72	QI	7.	6.	6.	6.	5.	5.	5.	5.	5.	5.
73	QI	5.	4.	4.	4.	4.	4.	4.	4.	4.	3.
74	QI	3.	3.	3.	3.	3.	3.	2.	2.	2.	2.
75	QI	2.	2.	2.	2.	1.	1.	1.	1.	1.	1.
76	QI	1.	1.	0.	0.	0.					
77	KK										
78	KM	COMBINING RUNOFF FROM BASINS #1 - #3									
79	HC	3									
80	KK										
81	KM	ROUTING RUNOFF #1 - #3 THROUGH BASIN #4									
82	RS	7	FLOW	-1	0						
83	RC	0.055	0.045	0.055	4000	0.020					
84	RX	0	80	150	188	238	276	376	426		
85	RY	120	110	100	95	95	100	110	120		
86	KK	4									
87	KM	INFLOW HYDROGRAPH FOR BASIN: 4									
88	QI	0.	11.	24.	51.	80.	112.	146.	182.	224.	269.
89	QI	315.	361.	414.	469.	539.	610.	676.	738.	788.	823.
90	QI	780.	744.	707.	670.	634.	599.	564.	531.	499.	472.
91	QI	446.	419.	391.	366.	341.	318.	296.	274.	255.	237.
92	QI	219.	201.	187.	173.	159.	146.	137.	127.	118.	109.
93	QI	102.	94.	87.	81.	75.	70.	65.	61.	58.	55.
94	QI	52.	49.	45.	42.	39.	37.	35.	33.	31.	29.
95	QI	27.	25.	24.	23.	21.	20.	19.	18.	17.	16.
96	QI	15.	14.	13.	13.	12.	11.	10.	9.	9.	9.
97	QI	8.	8.	7.	7.	6.	6.	6.	6.	6.	6.
98	QI	5.	5.	5.	5.	5.	5.	4.	4.	4.	4.
99	QI	4.	4.	3.	3.	3.	3.	3.	2.	2.	2.
100	QI	2.	2.	2.	1.	1.	1.	1.	1.	1.	0.
101	QI	0.									

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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 102          KK
 103          KM        COMBINING OUTFLOW FROM 4 AND HYDROGRAPH 4
 104          HC       2

 105          KK
 106          KM        ROUTE COMBINED FLOW FROM #4 THROUGH BASIN #5
 107          RS      11    FLOW      -1       0
 108          RC   0.055   0.045   0.055    6500   0.020
 109          RX       0     100     150     188     263     300     350     450
 110          RY     120     110     100      95      95     100     110     120

 111          KK       5
 112          KM        INFLOW HYDROGRAPH FOR BASIN: 5
 113          QI      0.     15.     29.     60.     96.    136.    179.    223.    271.    320.
 114          QI    380.    440.    501.    563.    630.    703.    782.    876.    971.   1058.
 115          QI   1146.   1217.   1283.   1316.   1249.   1204.   1154.   1104.   1056.   1007.
 116          QI    961.    915.    871.    827.    786.    752.    717.    680.    644.    609.
 117          QI    575.    543.    512.    482.    454.    425.    401.    377.    353.    329.
 118          QI    308.    290.    272.    254.    236.    223.    210.    198.    185.    174.
 119          QI    164.    154.    144.    134.    127.    120.    113.    106.    101.     96.
 120          QI     92.     88.     84.     79.     75.     71.     67.     63.     60.     58.
 121          QI     55.     52.     49.     46.     44.     41.     39.     37.     36.     34.
 122          QI     33.     31.     30.     29.     27.     26.     25.     23.     22.     21.
 123          QI     20.     19.     18.     16.     15.     15.     14.     14.     13.     13.
 124          QI     12.     11.     11.     10.     10.     10.     10.      9.      9.      9.
 125          QI      9.      9.      8.      8.      8.      8.      7.      7.      7.      7.
 126          QI      6.      6.      6.      6.      5.      5.      5.      5.      5.      4.
 127          QI      4.      4.      4.      3.      3.      3.      3.      2.      2.      2.
 128          QI      2.      2.      1.      1.      1.      1.      0.      0.

 129          KK
 130          KM        COMBINE OUTFLOW FROM #5 WITH HYDROGRAPH #5
 131          HC       2

 132          KK
 133          KM        ROUTE COMBINATION THROUGH BASIN #6
 134          RS      13    FLOW      -1       0
 135          RC   0.055   0.045   0.055    5600  0.0089
 136          RX       0     100     150     188     263     300     350     450
 137          RY     120     110     100      95      95     100     110     120

 138          KK       6
 139          KM        INFLOW HYDROGRAPH FOR BASIN: 6
 140          QI      0.      4.      8.     15.     25.     35.     47.     59.     72.     85.
 141          QI     99.    114.    131.    149.    166.    184.    202.    222.    243.    265.
 142          QI    292.    319.    346.    371.    396.    417.    436.    455.    442.    429.
 143          QI    416.    402.    387.    373.    359.    345.    332.    319.    306.    294.
 144          QI    281.    270.    260.    250.    239.    229.    218.    209.    199.    189.
 145          QI    181.    172.    163.    155.    147.    140.    133.    126.    119.    112.
 146          QI    107.    101.     96.     91.     86.     81.     77.     73.     70.     66.
 147          QI     63.     60.     57.     54.     51.     48.     46.     44.     42.     40.
 148          QI     38.     35.     34.     33.     32.     31.     29.     28.     27.     26.
 149          QI     24.     23.     22.     21.     21.     20.     19.     18.     17.     17.
 150          QI     16.     15.     14.     13.     13.     13.     12.     12.     11.     11.
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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 151          QI     11.     10.     10.      9.      9.      9.      8.      8.      8.      7.
 152          QI      7.      7.      6.      6.      6.      5.      5.      5.      5.      5.
 153          QI      4.      4.      4.      4.      4.      4.      4.      4.      3.      3.
 154          QI      3.      3.      3.      3.      3.      3.      3.      3.      3.      3.
 155          QI      3.      3.      2.      2.      2.      2.      2.      2.      2.      2.
 156          QI      2.      2.      2.      2.      2.      2.      2.      1.      1.      1.
 157          QI      1.      1.      1.      1.      1.      1.      1.      1.      1.      1.
 158          QI      1.      1.      0.      0.      0.      0.      0.      0.      0.      0.

 159          KK
 160          KM          COMBINE OUTFLOW FROM 6 WITH WITH HYDROGRAPH 6
 161          HC

 162          KK      7
 163          KM          INFLOW HYDROGRAPH FOR BASIN: 7
 164          QI      0.     13.     26.     39.     60.     92.    124.    156.    193.    231.
 165          QI    269.    308.    351.    394.    437.    486.    540.    593.    647.    701.
 166          QI    756.    810.    869.    934.    999.   1064.   1144.   1228.   1312.   1395.
 167          QI   1472.   1550.   1627.   1693.   1752.   1810.   1869.   1830.   1790.   1751.
 168          QI   1709.   1665.   1621.   1577.   1534.   1491.   1447.   1405.   1364.   1324.
 169          QI   1283.   1244.   1206.   1167.   1129.   1098.   1068.   1037.   1006.    973.
 170          QI    940.    907.    877.    847.    817.    787.    760.    733.    706.    680.
 171          QI    655.    629.    604.    582.    561.    540.    519.    497.    476.    455.
 172          QI    438.    421.    405.    389.    373.    357.    341.    328.    317.    306.
 173          QI    294.    283.    272.    261.    251.    242.    233.    224.    215.    207.
 174          QI    198.    189.    183.    177.    171.    164.    158.    152.    146.    142.
 175          QI    138.    134.    131.    127.    123.    119.    116.    112.    108.    104.
 176          QI    101.     97.     93.     90.     88.     85.     83.     80.     78.     75.
 177          QI     73.     70.     68.     65.     63.     61.     58.     56.     55.     53.
 178          QI     52.     51.     49.     48.     47.     45.     44.     43.     42.     40.
 179          QI     39.     38.     37.     36.     34.     33.     32.     31.     30.     29.
 180          QI     28.     27.     26.     25.     24.     23.     22.     22.     21.     21.
 181          QI     20.     20.     19.     19.     18.     18.     17.     17.     16.     15.
 182          QI     15.     15.     15.     14.     14.     14.     14.     13.     13.     13.
 183          QI     13.     13.     12.     12.     12.     12.     12.     11.     11.     11.
 184          QI     11.     11.     10.     10.     10.     10.     10.      9.      9.      9.
 185          QI      9.      9.      8.      8.      8.      8.      7.      7.      7.      7.
 186          QI      7.      6.      6.      6.      6.      6.      5.      5.      5.      5.
 187          QI      5.      4.      4.      4.      4.      4.      3.      3.      3.      3.
 188          QI      2.      2.      2.      2.      2.      1.      1.      1.      1.      1.
 189          QI      0.      0.      0.

 190          KK
 191          KM          COMBINE OUTFLOW 6 WITH HYDRO 7
 192          HC

 193          KK
 194          KM          ROUTE COMBINATION THROUGH BASIN #8
 195          RS      31    FLOW      -1       0
 196          RC   0.055   0.045   0.055   18920  0.0216
 197          RX       0     100     150     188     308     346     396     496
 198          RY     120     110     100      95      95     100     110     120
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LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 199         KK      8
 200         KM        INFLOW HYDROGRAPH FOR BASIN: 8
 201         QI      0.     11.     22.     33.     47.     74.    101.    128.    157.    188.
 202         QI    220.    251.    286.    322.    358.    394.    438.    482.    527.    572.
 203         QI    617.    663.    708.    757.    811.    865.    919.    982.   1052.   1122.
 204         QI   1193.   1259.   1323.   1388.   1453.   1502.   1551.   1600.   1639.   1599.
 205         QI   1567.   1534.   1499.   1462.   1425.   1388.   1352.   1316.   1280.   1244.
 206         QI   1210.   1176.   1142.   1109.   1077.   1045.   1012.    982.    957.    931.
 207         QI    906.    879.    852.    824.    797.    771.    746.    721.    696.    673.
 208         QI    651.    628.    606.    585.    563.    542.    522.    505.    487.    469.
 209         QI    451.    433.    416.    398.    384.    370.    357.    343.    330.    317.
 210         QI    303.    291.    281.    272.    263.    253.    244.    235.    226.    218.
 211         QI    210.    203.    195.    188.    181.    173.    166.    161.    156.    151.
 212         QI    146.    140.    135.    130.    126.    123.    120.    117.    113.    110.
 213         QI    107.    104.    101.     98.     95.     91.     88.     85.     82.     79.
 214         QI     77.     75.     73.     71.     69.     67.     65.     63.     61.     59.
 215         QI     57.     55.     53.     50.     49.     48.     47.     46.     44.     43.
 216         QI     42.     41.     40.     39.     38.     37.     36.     35.     34.     33.
 217         QI     32.     31.     30.     29.     28.     27.     27.     26.     25.     24.
 218         QI     23.     22.     21.     20.     20.     19.     19.     18.     18.     17.
 219         QI     17.     17.     16.     16.     15.     15.     14.     14.     14.     13.
 220         QI     13.     13.     13.     12.     12.     12.     12.     12.     12.     11.
 221         QI     11.     11.     11.     11.     11.     10.     10.     10.     10.     10.
 222         QI      9.      9.      9.      9.      9.      9.      8.      8.      8.      8.
 223         QI      8.      8.      7.      7.      7.      7.      7.      7.      6.      6.
 224         QI      6.      6.      6.      5.      5.      5.      5.      5.      5.      4.
 225         QI      4.      4.      4.      4.      4.      3.      3.      3.      3.      3.
 226         QI      3.      2.      2.      2.      2.      2.      1.      1.      1.      1.
 227         QI      1.      1.      0.      0.      0.      0.

 228         KK
 229         KM        COMBINE OUTFLOW FROM #8 WITH HYDROGRAPH #8
 230         HC      2

 231         KK      9
 232         KM        INFLOW HYDROGRAPH FOR BASIN: 9
 233         QI      0.      6.     13.     26.     42.     59.     78.     97.    118.    140.
 234         QI    166.    192.    218.    245.    276.    307.    345.    385.    425.    462.
 235         QI    497.    525.    551.    530.    511.    490.    468.    447.    426.    406.
 236         QI    387.    367.    349.    331.    316.    301.    285.    269.    254.    240.
 237         QI    226.    213.    200.    188.    176.    166.    155.    145.    135.    126.
 238         QI    119.    111.    103.     96.     91.     85.     80.     75.     70.     66.
 239         QI     62.     58.     54.     51.     48.     45.     42.     41.     39.     37.
 240         QI     35.     33.     31.     30.     28.     26.     25.     24.     23.     22.
 241         QI     20.     19.     18.     17.     16.     15.     15.     14.     14.     13.
 242         QI     12.     12.     11.     11.     10.     10.      9.      8.      8.      7.
 243         QI      7.      7.      6.      6.      6.      6.      5.      5.      5.      5.
 244         QI      4.      4.      4.      4.      4.      4.      4.      4.      4.      3.
 245         QI      3.      3.      3.      3.      3.      3.      3.      3.      3.      2.
 246         QI      2.      2.      2.      2.      2.      2.      2.      2.      2.      1.
 247         QI      1.      1.      1.      1.      1.      1.      1.      1.      1.      0.
 248         QI      0.      0.      0.      0.
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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 249          KK
 250          KM         COMBINE OUTFLOW #8 AND HYDROGRAPH #9
 251          HC
 252          ZZ
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                   FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985
  U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616
                                        ****


                   GREEN VALLEY DRAINAGEWAY     #88021
                   NORMAL DEPTH ROUTING
                   FILE : 88021A.H1I

  5 IO        OUTPUT CONTROL VARIABLES
                    IPRNT          5  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

    IT        HYDROGRAPH TIME DATA
                     NMIN          1  MINUTES IN COMPUTATION INTERVAL
                    IDATE     1    0  STARTING DATE
                    ITIME       0000  STARTING TIME
                       NQ        200  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE     1    0  ENDING DATE
                   NDTIME       0319  ENDING TIME

                COMPUTATION INTERVAL     .02 HOURS
                     TOTAL TIME BASE    3.32 HOURS

        ENGLISH UNITS

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN     8870. TO    172622.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN     7098. TO    176538.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN     7622. TO    117766.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN    10795. TO    231088.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)
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RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	1	1804.	.68	470.	470.	470.	.00		
HYDROGRAPH AT	2	1709.	.48	314.	314.	314.	.00		
HYDROGRAPH AT	3	678.	.35	90.	90.	90.	.00		
3 COMBINED AT		3224.	.55	875.	875.	875.	.00		
ROUTED TO		3218.	.62	873.	873.	873.	.00	99.08	.62
HYDROGRAPH AT	4	823.	.32	98.	98.	98.	.00		
2 COMBINED AT		3522.	.58	971.	971.	971.	.00		
ROUTED TO		3473.	.73	967.	967.	967.	.00	98.57	.73
HYDROGRAPH AT	5	1316.	.38	189.	189.	189.	.00		
2 COMBINED AT		3947.	.70	1156.	1156.	1156.	.00		
ROUTED TO		3908.	.85	1145.	1145.	1145.	.00	99.72	.85
HYDROGRAPH AT	6	455.	.45	79.	79.	79.	.00		
2 COMBINED AT		4080.	.83	1223.	1223.	1223.	.00		
HYDROGRAPH AT	7	1869.	.60	428.	428.	428.	.00		
2 COMBINED AT		5413.	.78	1652.	1652.	1652.	.00		
ROUTED TO		5286.	1.17	1562.	1562.	1562.	.00	98.51	1.17
HYDROGRAPH AT	8	1639.	.63	394.	394.	394.	.00		
2 COMBINED AT		5945.	1.15	1956.	1956.	1956.	.00		
HYDROGRAPH AT	9	551.	.37	77.	77.	77.	.00		
2 COMBINED AT		5982.	1.15	2033.	2033.	2033.	.00		

*** NORMAL END OF HEC-1 ***

88021B.H1I

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ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

ID        GREEN VALLEY DRAINAGEWAY    #88021
ID        NORMAL DEPTH ROUTING
ID        FILE : 88021B.H1I
IT      1                   200
IO      5

KK      1
KM        INFLOW HYDROGRAPH FOR BASIN: 1
QI      0.      11.      22.      33.      44.      69.      97.     124.     151.     182.
QI    214.     246.     278.     313.     349.     386.     422.     464.     509.     554.
QI    599.     645.     691.     737.     783.     832.     887.     942.     997.    1055.
QI   1127.    1198.    1269.    1339.    1405.    1470.    1535.    1601.    1650.    1700.
QI   1749.    1804.    1774.    1741.    1707.    1674.    1637.    1600.    1563.    1525.
QI   1489.    1452.    1416.    1379.    1344.    1310.    1276.    1242.    1208.    1176.
QI   1143.    1111.    1081.    1055.    1029.    1003.     977.     949.     921.     894.
QI    866.     841.     815.     790.     764.     742.     719.     696.     673.     652.
QI    630.     609.     587.     568.     550.     532.     514.     496.     478.     460.
QI    442.     427.     413.     400.     386.     372.     359.     345.     332.     320.
QI    310.     301.     291.     282.     272.     263.     253.     244.     237.     229.
QI    222.     214.     207.     200.     192.     185.     179.     174.     169.     163.
QI    158.     153.     148.     142.     138.     135.     132.     129.     126.     123.
QI    119.     116.     113.     110.     107.     103.     100.      97.      94.      91.
QI     88.      86.      84.      82.      80.      77.      75.      73.      71.      69.
QI     67.      65.      63.      61.      59.      57.      54.      53.      52.      51.
QI     50.      49.      48.      47.      46.      44.      43.      42.      41.      40.
QI     39.      38.      37.      36.      35.      34.      33.      32.      31.      30.
QI     30.      29.      28.      27.      26.      25.      24.      23.      23.      22.
QI     21.      21.      20.      20.      19.      19.      19.      18.      18.      17.
QI     17.      16.      16.      16.      15.      15.      14.      14.      14.      14.
QI     14.      13.      13.      13.      13.      13.      13.      12.      12.      12.
QI     12.      12.      12.      11.      11.      11.      11.      11.      10.      10.
QI     10.      10.      10.      10.       9.       9.       9.       9.       9.       9.
QI      8.       8.       8.       8.       8.       7.       7.       7.       7.       7.
QI      7.       6.       6.       6.       6.       6.       6.       5.       5.       5.
QI      5.       5.       5.       4.       4.       4.       4.       4.       3.       3.
QI      3.       3.       3.       3.       2.       2.       2.       2.       2.       2.
QI      1.       1.       1.       1.       1.       0.       0.       0.       0.

KK      2
KM        INFLOW HYDROGRAPH FOR BASIN: 2
QI      0.      15.      30.      47.      84.     121.     159.     202.     246.     291.
QI    340.     390.     445.     506.     567.     629.     691.     753.     824.     898.
QI    973.    1065.    1161.    1257.    1346.    1435.    1521.    1588.    1655.    1709.
QI   1655.    1610.    1563.    1513.    1462.    1412.    1363.    1314.    1266.    1220.
QI   1174.    1129.    1085.    1041.    1004.     969.     934.     897.     860.     822.
QI    788.     754.     720.     689.     658.     628.     599.     569.     542.     518.
QI    494.     469.     445.     421.     400.     382.     363.     345.     327.     308.
QI    295.     282.     269.     256.     244.     231.     221.     211.     201.     191.
QI    181.     172.     165.     158.     150.     143.     136.     131.     126.     122.
QI    118.     114.     109.     105.     101.      96.      92.      88.      84.      81.
QI     78.      75.      72.      69.      67.      64.      61.      58.      55.      53.
QI     50.      49.      47.      46.      45.      43.      42.      40.      39.      37.
QI     36.      34.      33.      32.      31.      29.      28.      27.      26.      25.
QI     23.      22.      21.      20.      20.      19.      18.      18.      17.      17.
QI     16.      15.      15.      14.      14.      13.      13.      13.      13.      12.
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LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 54         QI     12.     12.     12.     12.     11.     11.     11.     11.     10.     10.
 55         QI     10.     10.      9.      9.      9.      9.      8.      8.      8.      8.
 56         QI      8.      7.      7.      7.      7.      6.      6.      6.      6.      5.
 57         QI      5.      5.      5.      4.      4.      4.      4.      3.      3.      3.
 58         QI      3.      3.      2.      2.      2.      2.      1.      1.      1.      1.
 59         QI      0.      0.

 60         KK       3
 61         KM        INFLOW HYDROGRAPH FOR BASIN: 3
 62         QI      0.      8.     16.     36.     56.     80.    103.    130.    157.    189.
 63         QI    223.    257.    291.    330.    370.    418.    471.    522.    571.    615.
 64         QI    652.    678.    646.    620.    592.    564.    537.    510.    485.    459.
 65         QI    435.    411.    391.    372.    351.    331.    311.    292.    275.    258.
 66         QI    241.    225.    211.    198.    184.    171.    159.    149.    138.    128.
 67         QI    119.    112.    105.     98.     91.     86.     80.     75.     69.     65.
 68         QI     61.     57.     53.     51.     48.     46.     44.     41.     39.     36.
 69         QI     34.     32.     31.     29.     28.     26.     24.     23.     21.     20.
 70         QI     19.     18.     18.     17.     16.     15.     14.     14.     13.     12.
 71         QI     12.     11.     10.     10.      9.      8.      8.      8.      7.      7.
 72         QI      7.      6.      6.      6.      5.      5.      5.      5.      5.      5.
 73         QI      5.      4.      4.      4.      4.      4.      4.      4.      4.      3.
 74         QI      3.      3.      3.      3.      3.      3.      2.      2.      2.      2.
 75         QI      2.      2.      2.      2.      1.      1.      1.      1.      1.      1.
 76         QI      1.      1.      0.      0.      0.

 77         KK
 78         KM        COMBINING RUNOFF FROM BASINS #1 - #3
 79         HC       3

 80         KK
 81         KM        ROUTING RUNOFF #1 - #3 THROUGH BASIN #4
 82         RS       7    FLOW      -1       0
 83         RC   0.055   0.045   0.055    4000   0.020
 84         RX       0      80     150     188     238     276     376     426
 85         RY     120     110     100      95      95     100     110     120

 86         KK       4
 87         KM        INFLOW HYDROGRAPH FOR BASIN: 4
 88         QI      0.     11.     24.     51.     80.    112.    146.    182.    224.    269.
 89         QI    315.    361.    414.    469.    539.    610.    676.    738.    788.    823.
 90         QI    780.    744.    707.    670.    634.    599.    564.    531.    499.    472.
 91         QI    446.    419.    391.    366.    341.    318.    296.    274.    255.    237.
 92         QI    219.    201.    187.    173.    159.    146.    137.    127.    118.    109.
 93         QI    102.     94.     87.     81.     75.     70.     65.     61.     58.     55.
 94         QI     52.     49.     45.     42.     39.     37.     35.     33.     31.     29.
 95         QI     27.     25.     24.     23.     21.     20.     19.     18.     17.     16.
 96         QI     15.     14.     13.     13.     12.     11.     10.      9.      9.      9.
 97         QI      8.      8.      7.      7.      6.      6.      6.      6.      6.      6.
 98         QI      5.      5.      5.      5.      5.      5.      4.      4.      4.      4.
 99         QI      4.      4.      3.      3.      3.      3.      3.      2.      2.      2.
100         QI      2.      2.      2.      1.      1.      1.      1.      1.      1.      0.
101         QI      0.
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LINE	ID	1	2	3	4	5	6	7	8	9	10
102	KK										
103	KM	COMBINING OUTFLOW FROM 4 AND HYDROGRAPH 4									
104	HC	2									
105	KK										
106	KM	ROUTE COMBINED FLOW FROM #4 THROUGH BASIN #5									
107	RS	11	FLOW	-1	0						
108	RC	0.055	0.045	0.055	6500	0.020					
109	RX	0	100	150	188	263	300	350	450		
110	RY	120	110	100	95	95	100	110	120		
111	KK	5									
112	KM	INFLOW HYDROGRAPH FOR BASIN: 5									
113	QI	0.	15.	29.	60.	96.	136.	179.	223.	271.	320.
114	QI	380.	440.	501.	563.	630.	703.	782.	876.	971.	1058.
115	QI	1146.	1217.	1283.	1316.	1249.	1204.	1154.	1104.	1056.	1007.
116	QI	961.	915.	871.	827.	786.	752.	717.	680.	644.	609.
117	QI	575.	543.	512.	482.	454.	425.	401.	377.	353.	329.
118	QI	308.	290.	272.	254.	236.	223.	210.	198.	185.	174.
119	QI	164.	154.	144.	134.	127.	120.	113.	106.	101.	96.
120	QI	92.	88.	84.	79.	75.	71.	67.	63.	60.	58.
121	QI	55.	52.	49.	46.	44.	41.	39.	37.	36.	34.
122	QI	33.	31.	30.	29.	27.	26.	25.	23.	22.	21.
123	QI	20.	19.	18.	16.	15.	15.	14.	14.	13.	13.
124	QI	12.	11.	11.	10.	10.	10.	10.	9.	9.	9.
125	QI	9.	9.	8.	8.	8.	8.	7.	7.	7.	7.
126	QI	6.	6.	6.	6.	5.	5.	5.	5.	5.	4.
127	QI	4.	4.	4.	3.	3.	3.	3.	2.	2.	2.
128	QI	2.	2.	1.	1.	1.	1.	0.	0.		
129	KK										
130	KM	COMBINE OUTFLOW FROM #5 WITH HYDROGRAPH #5									
131	HC	2									
132	KK	BASIN									
133	KM	ROUTING OUTFLOW FROM BASIN 5 THROUGH DET. BASIN									
134	RS	1	STOR	-1	0						
135	SV	0	0.38	32.6	167.4	199	246.6	306.9	363		
136	SQ	0	0	0	0	0	493	3449	8874		
137	SE	28.5	30	40	50	51.3	53	55	56.7		
138	KK										
139	KM	ROUTE OUTFLOW FROM BASIN THROUGH BASIN #6									
140	RS	21	FLOW	-1	0						
141	RC	0.055	0.045	0.055	5600	0.0089					
142	RX	0	100	150	188	263	300	350	450		
143	RY	120	110	100	95	95	100	110	120		
144	KK	6									
145	KM	INFLOW HYDROGRAPH FOR BASIN: 6									
146	QI	0.	4.	8.	15.	25.	35.	47.	59.	72.	85.
147	QI	99.	114.	131.	149.	166.	184.	202.	222.	243.	265.
148	QI	292.	319.	346.	371.	396.	417.	436.	455.	442.	429.
149	QI	416.	402.	387.	373.	359.	345.	332.	319.	306.	294.

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 150      QI    281.    270.    260.    250.    239.    229.    218.    209.    199.    189.
 151      QI    181.    172.    163.    155.    147.    140.    133.    126.    119.    112.
 152      QI    107.    101.     96.     91.     86.     81.     77.     73.     70.     66.
 153      QI     63.     60.     57.     54.     51.     48.     46.     44.     42.     40.
 154      QI     38.     35.     34.     33.     32.     31.     29.     28.     27.     26.
 155      QI     24.     23.     22.     21.     21.     20.     19.     18.     17.     17.
 156      QI     16.     15.     14.     13.     13.     13.     12.     12.     11.     11.
 157      QI     11.     10.     10.      9.      9.      9.      8.      8.      8.      7.
 158      QI      7.      7.      6.      6.      6.      5.      5.      5.      5.      5.
 159      QI      4.      4.      4.      4.      4.      4.      4.      4.      3.      3.
 160      QI      3.      3.      3.      3.      3.      3.      3.      3.      3.      3.
 161      QI      3.      3.      2.      2.      2.      2.      2.      2.      2.      2.
 162      QI      2.      2.      2.      2.      2.      2.      2.      1.      1.      1.
 163      QI      1.      1.      1.      1.      1.      1.      1.      1.      1.      1.
 164      QI      1.      1.      0.      0.      0.      0.      0.      0.      0.      0.

 165      KK
 166      KM          COMBINE OUTFLOW FROM 6 WITH WITH HYDROGRAPH 6
 167      HC

 168      KK         7
 169      KM          INFLOW HYDROGRAPH FOR BASIN: 7
 170      QI      0.     13.     26.     39.     60.     92.    124.    156.    193.    231.
 171      QI    269.    308.    351.    394.    437.    486.    540.    593.    647.    701.
 172      QI    756.    810.    869.    934.    999.   1064.   1144.   1228.   1312.   1395.
 173      QI   1472.   1550.   1627.   1693.   1752.   1810.   1869.   1830.   1790.   1751.
 174      QI   1709.   1665.   1621.   1577.   1534.   1491.   1447.   1405.   1364.   1324.
 175      QI   1283.   1244.   1206.   1167.   1129.   1098.   1068.   1037.   1006.    973.
 176      QI    940.    907.    877.    847.    817.    787.    760.    733.    706.    680.
 177      QI    655.    629.    604.    582.    561.    540.    519.    497.    476.    455.
 178      QI    438.    421.    405.    389.    373.    357.    341.    328.    317.    306.
 179      QI    294.    283.    272.    261.    251.    242.    233.    224.    215.    207.
 180      QI    198.    189.    183.    177.    171.    164.    158.    152.    146.    142.
 181      QI    138.    134.    131.    127.    123.    119.    116.    112.    108.    104.
 182      QI    101.     97.     93.     90.     88.     85.     83.     80.     78.     75.
 183      QI     73.     70.     68.     65.     63.     61.     58.     56.     55.     53.
 184      QI     52.     51.     49.     48.     47.     45.     44.     43.     42.     40.
 185      QI     39.     38.     37.     36.     34.     33.     32.     31.     30.     29.
 186      QI     28.     27.     26.     25.     24.     23.     22.     22.     21.     21.
 187      QI     20.     20.     19.     19.     18.     18.     17.     17.     16.     15.
 188      QI     15.     15.     15.     14.     14.     14.     14.     13.     13.     13.
 189      QI     13.     13.     12.     12.     12.     12.     12.     11.     11.     11.
 190      QI     11.     11.     10.     10.     10.     10.     10.      9.      9.      9.
 191      QI      9.      9.      8.      8.      8.      8.      7.      7.      7.      7.
 192      QI      7.      6.      6.      6.      6.      6.      5.      5.      5.      5.
 193      QI      5.      4.      4.      4.      4.      4.      3.      3.      3.      3.
 194      QI      2.      2.      2.      2.      2.      1.      1.      1.      1.      1.
 195      QI      0.      0.      0.

 196      KK
 197      KM          COMBINE OUTFLOW 6 WITH HYDRO 7
 198      HC
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LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 199        KK
 200        KM          ROUTE COMBINATION THROUGH BASIN #8
 201        RS      42    FLOW      -1       0
 202        RC   0.055   0.045   0.055   18920  0.0216
 203        RX       0     100     150     188     308     346     396     496
 204        RY     120     110     100      95      95     100     110     120

 205        KK       8
 206        KM          INFLOW HYDROGRAPH FOR BASIN: 8
 207        QI      0.     11.     22.     33.     47.     74.    101.    128.    157.    188.
 208        QI    220.    251.    286.    322.    358.    394.    438.    482.    527.    572.
 209        QI    617.    663.    708.    757.    811.    865.    919.    982.   1052.   1122.
 210        QI   1193.   1259.   1323.   1388.   1453.   1502.   1551.   1600.   1639.   1599.
 211        QI   1567.   1534.   1499.   1462.   1425.   1388.   1352.   1316.   1280.   1244.
 212        QI   1210.   1176.   1142.   1109.   1077.   1045.   1012.    982.    957.    931.
 213        QI    906.    879.    852.    824.    797.    771.    746.    721.    696.    673.
 214        QI    651.    628.    606.    585.    563.    542.    522.    505.    487.    469.
 215        QI    451.    433.    416.    398.    384.    370.    357.    343.    330.    317.
 216        QI    303.    291.    281.    272.    263.    253.    244.    235.    226.    218.
 217        QI    210.    203.    195.    188.    181.    173.    166.    161.    156.    151.
 218        QI    146.    140.    135.    130.    126.    123.    120.    117.    113.    110.
 219        QI    107.    104.    101.     98.     95.     91.     88.     85.     82.     79.
 220        QI     77.     75.     73.     71.     69.     67.     65.     63.     61.     59.
 221        QI     57.     55.     53.     50.     49.     48.     47.     46.     44.     43.
 222        QI     42.     41.     40.     39.     38.     37.     36.     35.     34.     33.
 223        QI     32.     31.     30.     29.     28.     27.     27.     26.     25.     24.
 224        QI     23.     22.     21.     20.     20.     19.     19.     18.     18.     17.
 225        QI     17.     17.     16.     16.     15.     15.     14.     14.     14.     13.
 226        QI     13.     13.     13.     12.     12.     12.     12.     12.     12.     11.
 227        QI     11.     11.     11.     11.     11.     10.     10.     10.     10.     10.
 228        QI      9.      9.      9.      9.      9.      9.      8.      8.      8.      8.
 229        QI      8.      8.      7.      7.      7.      7.      7.      7.      6.      6.
 230        QI      6.      6.      6.      5.      5.      5.      5.      5.      5.      4.
 231        QI      4.      4.      4.      4.      4.      3.      3.      3.      3.      3.
 232        QI      3.      2.      2.      2.      2.      2.      1.      1.      1.      1.
 233        QI      1.      1.      0.      0.      0.      0.

 234        KK
 235        KM         COMBINE OUTFLOW FROM #8 WITH HYDROGRAPH #8
 236        HC       2

 237        KK       9
 238        KM         INFLOW HYDROGRAPH FOR BASIN: 9
 239        QI      0.      6.     13.     26.     42.     59.     78.     97.    118.    140.
 240        QI    166.    192.    218.    245.    276.    307.    345.    385.    425.    462.
 241        QI    497.    525.    551.    530.    511.    490.    468.    447.    426.    406.
 242        QI    387.    367.    349.    331.    316.    301.    285.    269.    254.    240.
 243        QI    226.    213.    200.    188.    176.    166.    155.    145.    135.    126.
 244        QI    119.    111.    103.     96.     91.     85.     80.     75.     70.     66.
 245        QI     62.     58.     54.     51.     48.     45.     42.     41.     39.     37.
 246        QI     35.     33.     31.     30.     28.     26.     25.     24.     23.     22.
 247        QI     20.     19.     18.     17.     16.     15.     15.     14.     14.     13.
 248        QI     12.     12.     11.     11.     10.     10.      9.      8.      8.      7.
 249        QI      7.      7.      6.      6.      6.      6.      5.      5.      5.      5.
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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 250          QI      4.      4.      4.      4.      4.      4.      4.      4.      4.      3.
 251          QI      3.      3.      3.      3.      3.      3.      3.      3.      3.      2.
 252          QI      2.      2.      2.      2.      2.      2.      2.      2.      2.      1.
 253          QI      1.      1.      1.      1.      1.      1.      1.      1.      1.      0.
 254          QI      0.      0.      0.      0.

 255          KK
 256          KM        COMBINE OUTFLOW #8 AND HYDROGRAPH #9
 257          HC
 258          ZZ
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FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985

U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616

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                    GREEN VALLEY DRAINAGEWAY    #88021
                    NORMAL DEPTH ROUTING
                    FILE : 88021B.H1I

  5 IO        OUTPUT CONTROL VARIABLES
                    IPRNT          5  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

    IT        HYDROGRAPH TIME DATA
                    NMIN           1  MINUTES IN COMPUTATION INTERVAL
                    IDATE      1   0  STARTING DATE
                    ITIME       0000  STARTING TIME
                    NQ           200  NUMBER OF HYDROGRAPH ORDINATES
                    NDDATE     1   0  ENDING DATE
                    NDTIME      0319  ENDING TIME

              COMPUTATION INTERVAL     .02 HOURS
                   TOTAL TIME BASE    3.32 HOURS

        ENGLISH UNITS

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN     8870. TO   172622.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN     7098. TO   176538.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN     2721. TO   117766.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN     6361. TO   231088.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	1	1804.	.68	470.	470.	470.	.00		
HYDROGRAPH AT	2	1709.	.48	314.	314.	314.	.00		
HYDROGRAPH AT	3	678.	.35	90.	90.	90.	.00		
3 COMBINED AT		3224.	.55	875.	875.	875.	.00		
ROUTED TO		3218.	.62	873.	873.	873.	.00	99.08	.62
HYDROGRAPH AT	4	823.	.32	98.	98.	98.	.00		
2 COMBINED AT		3522.	.58	971.	971.	971.	.00		
ROUTED TO		3473.	.73	967.	967.	967.	.00	98.57	.73
HYDROGRAPH AT	5	1316.	.38	189.	189.	189.	.00		
2 COMBINED AT		3947.	.70	1156.	1156.	1156.	.00		
ROUTED TO	BASIN	825.	1.65	332.	332.	332.	.00	53.22	1.65
ROUTED TO		815.	1.90	287.	287.	287.	.00	96.93	1.90
HYDROGRAPH AT	6	455.	.45	79.	79.	79.	.00		
2 COMBINED AT		824.	1.90	365.	365.	365.	.00		
HYDROGRAPH AT	7	1869.	.60	428.	428.	428.	.00		
2 COMBINED AT		2201.	.60	794.	794.	794.	.00		
ROUTED TO		2001.	1.10	658.	658.	658.	.00	96.95	1.10
HYDROGRAPH AT	8	1639.	.63	394.	394.	394.	.00		
2 COMBINED AT		2769.	1.08	1052.	1052.	1052.	.00		
HYDROGRAPH AT	9	551.	.37	77.	77.	77.	.00		
2 COMBINED AT		2814.	1.08	1129.	1129.	1129.	.00		

*** NORMAL END OF HEC-1 ***

88021C.H1I

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LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1            ID        GREEN VALLEY DRAINAGEWAY    #88021
  2            ID        NORMAL DEPTH ROUTING
  3            ID        FILE : 88021C.H1I
  4            IT       1                   200
  5            IO       5

  6            KK       1
  7            KM        INFLOW HYDROGRAPH FOR BASIN: 1
  8            QI      0.     11.     22.     33.     44.     69.     97.    124.    151.    182.
  9            QI    214.    246.    278.    313.    349.    386.    422.    464.    509.    554.
 10            QI    599.    645.    691.    737.    783.    832.    887.    942.    997.   1055.
 11            QI   1127.   1198.   1269.   1339.   1405.   1470.   1535.   1601.   1650.   1700.
 12            QI   1749.   1804.   1774.   1741.   1707.   1674.   1637.   1600.   1563.   1525.
 13            QI   1489.   1452.   1416.   1379.   1344.   1310.   1276.   1242.   1208.   1176.
 14            QI   1143.   1111.   1081.   1055.   1029.   1003.    977.    949.    921.    894.
 15            QI    866.    841.    815.    790.    764.    742.    719.    696.    673.    652.
 16            QI    630.    609.    587.    568.    550.    532.    514.    496.    478.    460.
 17            QI    442.    427.    413.    400.    386.    372.    359.    345.    332.    320.
 18            QI    310.    301.    291.    282.    272.    263.    253.    244.    237.    229.
 19            QI    222.    214.    207.    200.    192.    185.    179.    174.    169.    163.
 20            QI    158.    153.    148.    142.    138.    135.    132.    129.    126.    123.
 21            QI    119.    116.    113.    110.    107.    103.    100.     97.     94.     91.
 22            QI     88.     86.     84.     82.     80.     77.     75.     73.     71.     69.
 23            QI     67.     65.     63.     61.     59.     57.     54.     53.     52.     51.
 24            QI     50.     49.     48.     47.     46.     44.     43.     42.     41.     40.
 25            QI     39.     38.     37.     36.     35.     34.     33.     32.     31.     30.
 26            QI     30.     29.     28.     27.     26.     25.     24.     23.     23.     22.
 27            QI     21.     21.     20.     20.     19.     19.     19.     18.     18.     17.
 28            QI     17.     16.     16.     16.     15.     15.     14.     14.     14.     14.
 29            QI     14.     13.     13.     13.     13.     13.     13.     12.     12.     12.
 30            QI     12.     12.     12.     11.     11.     11.     11.     11.     10.     10.
 31            QI     10.     10.     10.     10.      9.      9.      9.      9.      9.      9.
 32            QI      8.      8.      8.      8.      8.      7.      7.      7.      7.      7.
 33            QI      7.      6.      6.      6.      6.      6.      6.      5.      5.      5.
 34            QI      5.      5.      5.      4.      4.      4.      4.      4.      3.      3.
 35            QI      3.      3.      3.      3.      2.      2.      2.      2.      2.      2.
 36            QI      1.      1.      1.      1.      1.      0.      0.      0.      0.

 37            KK       2
 38            KM        INFLOW HYDROGRAPH FOR BASIN: 2
 39            QI      0.     15.     30.     47.     84.    121.    159.    202.    246.    291.
 40            QI    340.    390.    445.    506.    567.    629.    691.    753.    824.    898.
 41            QI    973.   1065.   1161.   1257.   1346.   1435.   1521.   1588.   1655.   1709.
 42            QI   1655.   1610.   1563.   1513.   1462.   1412.   1363.   1314.   1266.   1220.
 43            QI   1174.   1129.   1085.   1041.   1004.    969.    934.    897.    860.    822.
 44            QI    788.    754.    720.    689.    658.    628.    599.    569.    542.    518.
 45            QI    494.    469.    445.    421.    400.    382.    363.    345.    327.    308.
 46            QI    295.    282.    269.    256.    244.    231.    221.    211.    201.    191.
 47            QI    181.    172.    165.    158.    150.    143.    136.    131.    126.    122.
 48            QI    118.    114.    109.    105.    101.     96.     92.     88.     84.     81.
 49            QI     78.     75.     72.     69.     67.     64.     61.     58.     55.     53.
 50            QI     50.     49.     47.     46.     45.     43.     42.     40.     39.     37.
 51            QI     36.     34.     33.     32.     31.     29.     28.     27.     26.     25.
 52            QI     23.     22.     21.     20.     20.     19.     18.     18.     17.     17.
 53            QI     16.     15.     15.     14.     14.     13.     13.     13.     13.     12.
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LINE	ID	1	2	3	4	5	6	7	8	9	10
54	QI	12.	12.	12.	12.	11.	11.	11.	11.	10.	10.
55	QI	10.	10.	9.	9.	9.	9.	8.	8.	8.	8.
56	QI	8.	7.	7.	7.	7.	6.	6.	6.	6.	5.
57	QI	5.	5.	5.	4.	4.	4.	4.	3.	3.	3.
58	QI	3.	3.	2.	2.	2.	2.	1.	1.	1.	1.
59	QI	0.	0.								
60	KK	3									
61	KM	INFLOW HYDROGRAPH FOR BASIN: 3									
62	QI	0.	8.	16.	36.	56.	80.	103.	130.	157.	189.
63	QI	223.	257.	291.	330.	370.	418.	471.	522.	571.	615.
64	QI	652.	678.	646.	620.	592.	564.	537.	510.	485.	459.
65	QI	435.	411.	391.	372.	351.	331.	311.	292.	275.	258.
66	QI	241.	225.	211.	198.	184.	171.	159.	149.	138.	128.
67	QI	119.	112.	105.	98.	91.	86.	80.	75.	69.	65.
68	QI	61.	57.	53.	51.	48.	46.	44.	41.	39.	36.
69	QI	34.	32.	31.	29.	28.	26.	24.	23.	21.	20.
70	QI	19.	18.	18.	17.	16.	15.	14.	14.	13.	12.
71	QI	12.	11.	10.	10.	9.	8.	8.	8.	7.	7.
72	QI	7.	6.	6.	6.	5.	5.	5.	5.	5.	5.
73	QI	5.	4.	4.	4.	4.	4.	4.	4.	4.	3.
74	QI	3.	3.	3.	3.	3.	3.	2.	2.	2.	2.
75	QI	2.	2.	2.	2.	1.	1.	1.	1.	1.	1.
76	QI	1.	1.	0.	0.	0.					
77	KK										
78	KM	COMBINING RUNOFF FROM BASINS #1 - #3									
79	HC	3									
80	KK										
81	KM	ROUTING RUNOFF #1 - #3 THROUGH BASIN #4									
82	RS	7	FLOW	-1	0						
83	RC	0.055	0.045	0.055	4000	0.020					
84	RX	0	80	150	188	238	276	376	426		
85	RY	120	110	100	95	95	100	110	120		
86	KK	4									
87	KM	INFLOW HYDROGRAPH FOR BASIN: 4									
88	QI	0.	11.	24.	51.	80.	112.	146.	182.	224.	269.
89	QI	315.	361.	414.	469.	539.	610.	676.	738.	788.	823.
90	QI	780.	744.	707.	670.	634.	599.	564.	531.	499.	472.
91	QI	446.	419.	391.	366.	341.	318.	296.	274.	255.	237.
92	QI	219.	201.	187.	173.	159.	146.	137.	127.	118.	109.
93	QI	102.	94.	87.	81.	75.	70.	65.	61.	58.	55.
94	QI	52.	49.	45.	42.	39.	37.	35.	33.	31.	29.
95	QI	27.	25.	24.	23.	21.	20.	19.	18.	17.	16.
96	QI	15.	14.	13.	13.	12.	11.	10.	9.	9.	9.
97	QI	8.	8.	7.	7.	6.	6.	6.	6.	6.	6.
98	QI	5.	5.	5.	5.	5.	5.	4.	4.	4.	4.
99	QI	4.	4.	3.	3.	3.	3.	3.	2.	2.	2.
100	QI	2.	2.	2.	1.	1.	1.	1.	1.	1.	0.
101	QI	0.									

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LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 102       KK
 103       KM      COMBINING OUTFLOW FROM 4 AND HYDROGRAPH 4
 104       HC       2

 105       KK
 106       KM      ROUTE COMBINED FLOW FROM #4 THROUGH BASIN #5
 107       RS      11    FLOW      -1       0
 108       RC   0.055   0.045   0.055    6500   0.020
 109       RX       0     100     150     188     263     300     350     450
 110       RY     120     110     100      95      95     100     110     120

 111       KK       5
 112       KM      INFLOW HYDROGRAPH FOR BASIN: 5
 113       QI      0.     15.     29.     60.     96.    136.    179.    223.    271.    320.
 114       QI    380.    440.    501.    563.    630.    703.    782.    876.    971.   1058.
 115       QI   1146.   1217.   1283.   1316.   1249.   1204.   1154.   1104.   1056.   1007.
 116       QI    961.    915.    871.    827.    786.    752.    717.    680.    644.    609.
 117       QI    575.    543.    512.    482.    454.    425.    401.    377.    353.    329.
 118       QI    308.    290.    272.    254.    236.    223.    210.    198.    185.    174.
 119       QI    164.    154.    144.    134.    127.    120.    113.    106.    101.     96.
 120       QI     92.     88.     84.     79.     75.     71.     67.     63.     60.     58.
 121       QI     55.     52.     49.     46.     44.     41.     39.     37.     36.     34.
 122       QI     33.     31.     30.     29.     27.     26.     25.     23.     22.     21.
 123       QI     20.     19.     18.     16.     15.     15.     14.     14.     13.     13.
 124       QI     12.     11.     11.     10.     10.     10.     10.      9.      9.      9.
 125       QI      9.      9.      8.      8.      8.      8.      7.      7.      7.      7.
 126       QI      6.      6.      6.      6.      5.      5.      5.      5.      5.      4.
 127       QI      4.      4.      4.      3.      3.      3.      3.      2.      2.      2.
 128       QI      2.      2.      1.      1.      1.      1.      0.      0.

 129       KK
 130       KM      COMBINE OUTFLOW FROM #5 WITH HYDROGRAPH #5
 131       HC       2

 132       KK   BASIN
 133       KM      ROUTING OUTFLOW FROM BASIN 5 THROUGH DET. BASIN
 134       RS       1    STOR      -1       0
 135       SV       0    47.6   107.9     164
 136       SQ       0     493    3449    8874
 137       SE    51.3      53      55    56.7

 138       KK
 139       KM      ROUTE OUTFLOW FROM BASIN THROUGH BASIN #6
 140       RS      14    FLOW      -1       0
 141       RC   0.055   0.045   0.055    5600  0.0089
 142       RX       0     100     150     188     263     300     350     450
 143       RY     120     110     100      95      95     100     110     120

 144       KK       6
 145       KM      INFLOW HYDROGRAPH FOR BASIN: 6
 146       QI      0.      4.      8.     15.     25.     35.     47.     59.     72.     85.
 147       QI     99.    114.    131.    149.    166.    184.    202.    222.    243.    265.
 148       QI    292.    319.    346.    371.    396.    417.    436.    455.    442.    429.
 149       QI    416.    402.    387.    373.    359.    345.    332.    319.    306.    294.
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LINE	ID	1	2	3	4	5	6	7	8	9	10
150	QI	281.	270.	260.	250.	239.	229.	218.	209.	199.	189.
151	QI	181.	172.	163.	155.	147.	140.	133.	126.	119.	112.
152	QI	107.	101.	96.	91.	86.	81.	77.	73.	70.	66.
153	QI	63.	60.	57.	54.	51.	48.	46.	44.	42.	40.
154	QI	38.	35.	34.	33.	32.	31.	29.	28.	27.	26.
155	QI	24.	23.	22.	21.	21.	20.	19.	18.	17.	17.
156	QI	16.	15.	14.	13.	13.	13.	12.	12.	11.	11.
157	QI	11.	10.	10.	9.	9.	9.	8.	8.	8.	7.
158	QI	7.	7.	6.	6.	6.	5.	5.	5.	5.	5.
159	QI	4.	4.	4.	4.	4.	4.	4.	4.	3.	3.
160	QI	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
161	QI	3.	3.	2.	2.	2.	2.	2.	2.	2.	2.
162	QI	2.	2.	2.	2.	2.	2.	2.	1.	1.	1.
163	QI	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
164	QI	1.	1.	0.	0.	0.	0.	0.	0.	0.	0.
165	KK										
166	KM	COMBINE OUTFLOW FROM 6 WITH WITH HYDROGRAPH 6									
167	HC										
168	KK	7									
169	KM	INFLOW HYDROGRAPH FOR BASIN: 7									
170	QI	0.	13.	26.	39.	60.	92.	124.	156.	193.	231.
171	QI	269.	308.	351.	394.	437.	486.	540.	593.	647.	701.
172	QI	756.	810.	869.	934.	999.	1064.	1144.	1228.	1312.	1395.
173	QI	1472.	1550.	1627.	1693.	1752.	1810.	1869.	1830.	1790.	1751.
174	QI	1709.	1665.	1621.	1577.	1534.	1491.	1447.	1405.	1364.	1324.
175	QI	1283.	1244.	1206.	1167.	1129.	1098.	1068.	1037.	1006.	973.
176	QI	940.	907.	877.	847.	817.	787.	760.	733.	706.	680.
177	QI	655.	629.	604.	582.	561.	540.	519.	497.	476.	455.
178	QI	438.	421.	405.	389.	373.	357.	341.	328.	317.	306.
179	QI	294.	283.	272.	261.	251.	242.	233.	224.	215.	207.
180	QI	198.	189.	183.	177.	171.	164.	158.	152.	146.	142.
181	QI	138.	134.	131.	127.	123.	119.	116.	112.	108.	104.
182	QI	101.	97.	93.	90.	88.	85.	83.	80.	78.	75.
183	QI	73.	70.	68.	65.	63.	61.	58.	56.	55.	53.
184	QI	52.	51.	49.	48.	47.	45.	44.	43.	42.	40.
185	QI	39.	38.	37.	36.	34.	33.	32.	31.	30.	29.
186	QI	28.	27.	26.	25.	24.	23.	22.	22.	21.	21.
187	QI	20.	20.	19.	19.	18.	18.	17.	17.	16.	15.
188	QI	15.	15.	15.	14.	14.	14.	14.	13.	13.	13.
189	QI	13.	13.	12.	12.	12.	12.	12.	11.	11.	11.
190	QI	11.	11.	10.	10.	10.	10.	10.	9.	9.	9.
191	QI	9.	9.	8.	8.	8.	8.	7.	7.	7.	7.
192	QI	7.	6.	6.	6.	6.	6.	5.	5.	5.	5.
193	QI	5.	4.	4.	4.	4.	4.	3.	3.	3.	3.
194	QI	2.	2.	2.	2.	2.	1.	1.	1.	1.	1.
195	QI	0.	0.	0.							
196	KK										
197	KM	COMBINE OUTFLOW 6 WITH HYDRO 7									
198	HC										

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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 199          KK
 200          KM        ROUTE COMBINATION THROUGH BASIN #8
 201          RS      35    FLOW      -1       0
 202          RC   0.055   0.045   0.055   18750  0.0214
 203          RX       0     100     150     188     308     346     396     496
 204          RY     120     110     100      95      95     100     110     120

 205          KK       8
 206          KM        INFLOW HYDROGRAPH FOR BASIN: 8
 207          QI      0.     11.     22.     33.     47.     74.    101.    128.    157.    188.
 208          QI    220.    251.    286.    322.    358.    394.    438.    482.    527.    572.
 209          QI    617.    663.    708.    757.    811.    865.    919.    982.   1052.   1122.
 210          QI   1193.   1259.   1323.   1388.   1453.   1502.   1551.   1600.   1639.   1599.
 211          QI   1567.   1534.   1499.   1462.   1425.   1388.   1352.   1316.   1280.   1244.
 212          QI   1210.   1176.   1142.   1109.   1077.   1045.   1012.    982.    957.    931.
 213          QI    906.    879.    852.    824.    797.    771.    746.    721.    696.    673.
 214          QI    651.    628.    606.    585.    563.    542.    522.    505.    487.    469.
 215          QI    451.    433.    416.    398.    384.    370.    357.    343.    330.    317.
 216          QI    303.    291.    281.    272.    263.    253.    244.    235.    226.    218.
 217          QI    210.    203.    195.    188.    181.    173.    166.    161.    156.    151.
 218          QI    146.    140.    135.    130.    126.    123.    120.    117.    113.    110.
 219          QI    107.    104.    101.     98.     95.     91.     88.     85.     82.     79.
 220          QI     77.     75.     73.     71.     69.     67.     65.     63.     61.     59.
 221          QI     57.     55.     53.     50.     49.     48.     47.     46.     44.     43.
 222          QI     42.     41.     40.     39.     38.     37.     36.     35.     34.     33.
 223          QI     32.     31.     30.     29.     28.     27.     27.     26.     25.     24.
 224          QI     23.     22.     21.     20.     20.     19.     19.     18.     18.     17.
 225          QI     17.     17.     16.     16.     15.     15.     14.     14.     14.     13.
 226          QI     13.     13.     13.     12.     12.     12.     12.     12.     12.     11.
 227          QI     11.     11.     11.     11.     11.     10.     10.     10.     10.     10.
 228          QI      9.      9.      9.      9.      9.      9.      8.      8.      8.      8.
 229          QI      8.      8.      7.      7.      7.      7.      7.      7.      6.      6.
 230          QI      6.      6.      6.      5.      5.      5.      5.      5.      5.      4.
 231          QI      4.      4.      4.      4.      4.      3.      3.      3.      3.      3.
 232          QI      3.      2.      2.      2.      2.      2.      1.      1.      1.      1.
 233          QI      1.      1.      0.      0.      0.      0.

 234          KK
 235          KM        COMBINE OUTFLOW FROM #8 WITH HYDROGRAPH #8
 236          HC       2

 237          KK       9
 238          KM        INFLOW HYDROGRAPH FOR BASIN: 9
 239          QI      0.      6.     13.     26.     42.     59.     78.     97.    118.    140.
 240          QI    166.    192.    218.    245.    276.    307.    345.    385.    425.    462.
 241          QI    497.    525.    551.    530.    511.    490.    468.    447.    426.    406.
 242          QI    387.    367.    349.    331.    316.    301.    285.    269.    254.    240.
 243          QI    226.    213.    200.    188.    176.    166.    155.    145.    135.    126.
 244          QI    119.    111.    103.     96.     91.     85.     80.     75.     70.     66.
 245          QI     62.     58.     54.     51.     48.     45.     42.     41.     39.     37.
 246          QI     35.     33.     31.     30.     28.     26.     25.     24.     23.     22.
 247          QI     20.     19.     18.     17.     16.     15.     15.     14.     14.     13.
 248          QI     12.     12.     11.     11.     10.     10.      9.      8.      8.      7.
 249          QI      7.      7.      6.      6.      6.      6.      5.      5.      5.      5.
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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 250          QI       4.      4.      4.      4.      4.      4.      4.      4.      4.      3.
 251          QI       3.      3.      3.      3.      3.      3.      3.      3.      3.      2.
 252          QI       2.      2.      2.      2.      2.      2.      2.      2.      2.      1.
 253          QI       1.      1.      1.      1.      1.      1.      1.      1.      1.      0.
 254          QI       0.      0.      0.      0.

 255          KK
 256          KM          COMBINE OUTFLOW #8 AND HYDROGRAPH #9
 257          HC
 258          ZZ
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                                   ****
              FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985
U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616
                                   ****



                   GREEN VALLEY DRAINAGEWAY    #88021
                   NORMAL DEPTH ROUTING
                   FILE : 88021C.H1I

 5 IO        OUTPUT CONTROL VARIABLES
                  IPRNT          5  PRINT CONTROL
                  IPLOT          0  PLOT CONTROL
                  QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT        HYDROGRAPH TIME DATA
                   NMIN          1  MINUTES IN COMPUTATION INTERVAL
                  IDATE      1   0  STARTING DATE
                  ITIME       0000  STARTING TIME
                     NQ        200  NUMBER OF HYDROGRAPH ORDINATES
                 NDDATE      1   0  ENDING DATE
                 NDTIME       0319  ENDING TIME

              COMPUTATION INTERVAL     .02 HOURS
                   TOTAL TIME BASE    3.32 HOURS

       ENGLISH UNITS

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN      8870. TO    172622.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN      7098. TO    176538.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN      4735. TO    117766.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN     10745. TO    230016.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)
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RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	1	1804.	.68	470.	470.	470.	.00		
HYDROGRAPH AT	2	1709.	.48	314.	314.	314.	.00		
HYDROGRAPH AT	3	678.	.35	90.	90.	90.	.00		
3 COMBINED AT		3224.	.55	875.	875.	875.	.00		
ROUTED TO		3218.	.62	873.	873.	873.	.00	99.08	.62
HYDROGRAPH AT	4	823.	.32	98.	98.	98.	.00		
2 COMBINED AT		3522.	.58	971.	971.	971.	.00		
ROUTED TO		3473.	.73	967.	967.	967.	.00	98.57	.73
HYDROGRAPH AT	5	1316.	.38	189.	189.	189.	.00		
2 COMBINED AT		3947.	.70	1156.	1156.	1156.	.00		
ROUTED TO	BASIN	2995.	1.00	1055.	1055.	1055.	.00	54.69	1.00
ROUTED TO		2978.	1.15	1010.	1010.	1010.	.00	99.12	1.15
HYDROGRAPH AT	6	455.	.45	79.	79.	79.	.00		
2 COMBINED AT		3048.	1.13	1088.	1088.	1088.	.00		
HYDROGRAPH AT	7	1869.	.60	428.	428.	428.	.00		
2 COMBINED AT		3812.	1.07	1516.	1516.	1516.	.00		
ROUTED TO		3738.	1.45	1375.	1375.	1375.	.00	97.89	1.45
HYDROGRAPH AT	8	1639.	.63	394.	394.	394.	.00		
2 COMBINED AT		4087.	1.43	1769.	1769.	1769.	.00		
HYDROGRAPH AT	9	551.	.37	77.	77.	77.	.00		
2 COMBINED AT		4102.	1.43	1846.	1846.	1846.	.00		

*** NORMAL END OF HEC-1 ***

APPENDIX C

INPUT/OUTPUT FOR EXISTING CONDITIONS HEC-2 MODEL

THIS RUN EXECUTED 01/01/80 00:02:34

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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
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EXISTING
(88021.H2I)

T1 GREEN VALLEY DRAINAGEWAY #9
T2 FILE NAME: 88021.H2I
T3 CMG DRAINAGE ENG. JOB# 88021

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	1.	2.	0.	1.	.026000	.00	.0	0.	2965.000	.000

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

J3 VARIABLE CODES FOR SUMMARY PRINTOUT

38.000	13.000	14.000	15.000	1.000	42.000	26.000	4.000	8.000	25.000
39.000	53.000	54.000	.000	.000	.000	.000	.000	.000	.000

NC	.050	.050	.030	.100	.300	.000	.000	.000	.000	.000
QT	1.000	4102.000	.000	.000	.000	.000	.000	.000	.000	.000
X1	14.000	10.000	1104.000	1158.000	200.000	200.000	200.000	.000	.000	.000
GR	2967.500	1000.000	2967.000	1065.000	2966.000	1077.500	2965.000	1104.000	2962.000	1113.000
GR	2960.000	1115.000	2960.000	1135.000	2965.000	1158.000	2966.000	1170.000	2969.000	1190.000
X1	13.000	14.000	1173.500	1212.500	200.000	200.000	200.000	.000	.000	.000
GR	2962.000	1000.000	2961.000	1104.000	2961.000	1136.000	2961.500	1150.000	2961.000	1167.500
GR	2960.000	1173.500	2955.000	1186.500	2953.000	1189.500	2953.000	1202.500	2954.000	1205.000
GR	2955.000	1212.500	2960.000	1222.500	2961.000	1224.000	2962.000	1227.500	.000	.000
X1	12.000	14.000	1218.000	1259.500	200.000	200.000	200.000	.000	.000	.000
GR	2957.000	1000.000	2956.000	1022.500	2955.000	1062.500	2954.000	1212.500	2953.000	1218.000
GR	2950.000	1228.000	2946.000	1233.000	2946.000	1248.000	2948.000	1255.500	2950.000	1259.500
GR	2954.000	1292.500	2955.000	1302.500	2956.000	1342.500	2957.000	1355.500	.000	.000
X1	11.000	14.000	1230.000	1268.500	200.000	200.000	200.000	.000	.000	.000
GR	2951.000	1000.000	2950.000	1077.500	2949.000	1143.500	2948.000	1170.000	2948.000	1207.500
GR	2947.000	1218.500	2945.000	1230.000	2942.000	1234.500	2942.000	1262.000	2946.000	1268.500
GR	2948.000	1277.500	2949.000	1281.000	2950.000	1289.000	2951.000	1402.500	.000	.000

X1	10.000	13.000	1155.000	1202.000	200.000	200.000	200.000	.000	.000	.000
GR	2945.000	1000.000	2944.000	1120.000	2943.000	1148.500	2940.000	1155.000	2936.500	1170.000
GR	2936.500	1199.000	2940.000	1202.000	2943.000	1205.000	2944.000	1227.500	2943.000	1260.000
GR	2942.500	1322.500	2943.000	1367.500	2945.000	1382.500	.000	.000	.000	.000
X1	9.000	10.000	1058.800	1104.500	200.000	200.000	200.000	.000	.000	.000
GR	2940.000	1000.000	2939.000	1022.500	2938.000	1039.500	2937.000	1058.800	2931.000	1063.000
GR	2931.000	1097.000	2935.000	1104.500	2935.000	1159.000	2938.000	1190.000	2939.000	1222.500
X1	8.000	10.000	1116.500	1170.000	220.000	190.000	200.000	.000	.000	.000
GR	2933.000	1000.000	2932.000	1107.500	2928.000	1116.500	2927.000	1122.500	2927.000	1155.000
GR	2930.000	1170.000	2930.600	1201.500	2930.600	1225.000	2936.000	1255.000	2933.000	1282.500
X1	7.000	13.000	1196.000	1251.000	200.000	200.000	200.000	.000	.000	.000
GR	2929.000	1000.000	2928.000	1130.000	2928.200	1167.500	2928.000	1186.500	2925.000	1196.000
GR	2922.000	1201.000	2922.000	1221.000	2924.000	1235.000	2925.000	1251.000	2927.000	1258.500
GR	2928.000	1294.500	2929.000	1316.000	2930.000	1356.000	.000	.000	.000	.000
NC	.080	.050	.030	.100	.300	.000	.000	.000	.000	.000
X1	6.000	17.000	1230.000	1295.000	200.000	200.000	200.000	.000	.000	.000
GR	2924.000	1000.000	2923.200	1035.000	2923.800	1065.000	2923.000	1077.500	2922.700	1120.000
GR	2923.000	1150.000	2923.000	1207.500	2922.000	1230.000	2918.000	1240.000	2918.000	1275.000
GR	2923.000	1286.000	2924.000	1295.000	2924.000	1314.000	2923.000	1320.000	2923.000	1345.000
GR	2925.000	1365.000	2930.000	1384.000	.000	.000	.000	.000	.000	.000
X1	5.000	11.000	1320.000	1394.000	100.000	100.000	100.000	.000	.000	.000
GR	2918.000	1000.000	2917.000	1092.500	2916.000	1185.000	2916.000	1280.000	2916.800	1300.000
GR	2916.000	1320.000	2913.000	1332.500	2913.000	1362.500	2914.000	1375.000	2917.000	1394.000
GR	2917.300	1415.000	.000	.000	.000	.000	.000	.000	.000	.000
X1	4.000	11.000	1272.500	1385.000	100.000	100.000	100.000	.000	.000	.000
GR	2915.000	1000.000	2914.500	1035.000	2914.000	1145.000	2914.000	1200.000	2915.000	1240.000
GR	2915.000	1272.500	2911.000	1302.500	2911.000	1346.000	2912.000	1370.000	2915.000	1385.000
GR	2916.000	1400.000	.000	.000	.000	.000	.000	.000	.000	.000
X1	3.000	6.000	1041.500	1092.500	125.000	125.000	125.000	.000	.000	.000
X3	10.000	.000	.000	.000	.000	.000	.000	2911.520	2911.520	.000
GR	2912.000	1000.000	2911.980	1041.500	2900.940	1041.500	2901.060	1092.500	2912.100	1092.500
GR	2913.000	1099.000	.000	.000	.000	.000	.000	.000	.000	.000
SB	1.250	1.600	2.600	.000	51.000	3.000	480.000	.000	2901.000	2899.780
X1	2.000	7.000	1035.000	1086.000	85.000	85.000	85.000	.000	.000	.000
X2	.000	.000	1.000	2911.060	2911.980	.000	.000	.000	.000	.000
X3	10.000	.000	.000	.000	.000	.000	.000	2911.520	2911.520	.000
BT	5.000	1035.000	2911.980	.000	1047.500	2912.010	.000	1060.500	2912.040	.000
BT	1072.500	2912.070	.000	1086.000	2912.100	.000	.000	.000	.000	.000
GR	2911.000	1000.000	2910.000	1025.000	2910.760	1035.000	2899.610	1035.000	2899.610	1086.000
GR	2910.900	1086.000	2911.000	1093.500	.000	.000	.000	.000	.000	.000

X1	1.000	5.000	1063.000	1145.000	.000	.000	.000	.000	.000	.000
GR	2908.000	1000.000	2905.000	1063.000	2899.000	1075.000	2899.000	1145.000	2909.000	1165.000
EJ	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

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 14.000

14.00	5.57	2965.57	2967.76	2965.00	2971.45	5.87	.00	.00	2965.00
4102.	9.	4089.	4.	4.	210.	2.	0.	0.	2965.00
.00	2.10	19.48	2.09	.050	.030	.050	.000	2960.00	1088.83
.026460	0.	0.	0.	0	14	4	.00	76.04	1164.87

FLOW DISTRIBUTION FOR SECNO= 14.00 CWSEL= 2965.57

STA=	1089.	1104.	1158.	1165.
PER Q=	.2	99.7	.1	
AREA=	4.3	209.9	2.0	
VEL=	2.1	19.5	2.1	

*SECNO 13.000

3301 HV CHANGED MORE THAN HVINS

13.00	6.67	2959.67	2962.60	.00	2966.39	6.72	4.97	.08	2960.00
4102.	0.	3940.	162.	0.	186.	22.	1.	0.	2955.00
.00	.00	21.17	7.43	.050	.030	.050	.000	2953.00	1174.37
.023414	200.	200.	200.	7	18	0	.00	47.46	1221.83

FLOW DISTRIBUTION FOR SECNO= 13.00 CWSEL= 2959.67

STA=	1174.	1213.	1222.
PER Q=	96.1	3.9	
AREA=	186.1	21.8	
VEL=	21.2	7.4	

*SECNO 12.000

3301 HV CHANGED MORE THAN HVINS

12.00	6.07	2952.07	2955.45	.00	2960.58	8.51	5.63	.18	2953.00
4102.	0.	4002.	100.	0.	169.	18.	2.	1.	2950.00
.01	.00	23.68	5.62	.050	.030	.050	.000	2946.00	1221.09
.034421	200.	200.	200.	8	11	0	.00	55.52	1276.61

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

FLOW DISTRIBUTION FOR SECNO= 12.00 CWSEL= 2952.07

STA=	1221.	1260.	1277.
PER Q=	97.6	2.4	
AREA=	169.0	17.7	
VEL=	23.7	5.6	

*SECNO 11.000

3301 HV CHANGED MORE THAN HVINS

11.00	5.35	2947.35	2950.03	.00	2954.35	7.00	5.78	.45	2945.00
4102.	88.	3999.	14.	16.	186.	4.	3.	1.	2946.00
.01	5.46	21.48	3.53	.050	.030	.050	.000	2942.00	1214.67
.024636	200.	200.	200.	7	11	0	.00	59.90	1274.57

FLOW DISTRIBUTION FOR SECNO= 11.00 CWSEL= 2947.35

STA=	1215.	1219.	1230.	1269.	1275.
PER Q=	.0	2.1	97.5	.4	
AREA=	.7	15.5	186.2	4.1	
VEL=	1.5	5.6	21.5	3.5	

*SECNO 10.000

10.00	4.64	2941.14	2944.31	.00	2948.62	7.48	5.68	.05	2940.00
4102.	5.	4095.	2.	1.	186.	1.	4.	1.	2940.00
.01	3.48	21.97	2.95	.050	.030	.050	.000	2936.50	1152.54
.033115	200.	200.	200.	8	17	0	.00	50.60	1203.14

FLOW DISTRIBUTION FOR SECNO= 10.00 CWSEL= 2941.14

STA=	1153.	1155.	1202.	1203.
PER Q=	.1	99.8	.0	
AREA=	1.4	186.4	.6	
VEL=	3.5	22.0	2.9	

*SECNO 9.000

3301 HV CHANGED MORE THAN HVINS

9.00	4.73	2935.73	2937.72	.00	2942.17	6.44	6.13	.31	2937.00
4102.	0.	3932.	170.	0.	189.	43.	5.	1.	2935.00
.01	.00	20.78	3.98	.050	.030	.050	.000	2931.00	1059.69
.028467	200.	200.	200.	6	11	0	.00	106.88	1166.57

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

FLOW DISTRIBUTION FOR SECNO= 9.00 CWSEL= 2935.73

STA=	1060.	1105.	1159.	1167.
PER Q=	95.9	4.0	.2	
AREA=	189.2	39.9	2.8	
VEL=	20.8	4.1	2.6	

*SECNO 8.000

3301 HV CHANGED MORE THAN HVINS

8.00	4.27	2931.27	2933.12	.00	2936.48	5.21	5.32	.37	2928.00
4102.	73.	3832.	197.	12.	203.	47.	6.	2.	2930.00
.02	6.13	18.92	4.18	.050	.030	.050	.000	2927.00	1109.16
.024947	200.	200.	200.	6	11	0	.00	119.52	1228.68

FLOW DISTRIBUTION FOR SECNO= 8.00 CWSEL= 2931.27

STA=	1109.	1117.	1170.	1202.	1225.	1229.
PER Q=	1.8	93.4	3.4	1.4	.1	
AREA=	12.0	202.6	30.3	15.6	1.2	
VEL=	6.1	18.9	4.6	3.6	2.2	

*SECNO 7.000

3301 HV CHANGED MORE THAN HVINS

7.00	5.28	2927.28	2929.28	.00	2931.97	4.69	4.35	.16	2925.00
4102.	36.	4019.	47.	8.	229.	11.	7.	2.	2925.00
.02	4.35	17.54	4.28	.050	.030	.050	.000	2922.00	1188.77
.019174	220.	200.	190.	5	14	0	.00	79.93	1268.70

FLOW DISTRIBUTION FOR SECNO= 7.00 CWSEL= 2927.28

STA=	1189.	1196.	1251.	1259.	1269.
PER Q=	.9	98.0	1.1	.0	
AREA=	8.3	229.1	9.6	1.4	
VEL=	4.4	17.5	4.7	1.1	

CCHV= .100 CEHV= .300

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 6.000

3265 DIVIDED FLOW

6.00	4.90	2922.90	2924.59	.00	2927.91	5.00	4.03	.03	2922.00
4102.	17.	4085.	0.	14.	227.	0.	8.	3.	2924.00
.02	1.24	17.99	.00	.080	.030	.050	.000	2918.00	1091.37
.021196	200.	200.	200.	5	8	0	.00	124.93	1285.78

FLOW DISTRIBUTION FOR SECNO= 6.00 CWSEL= 2922.90

STA=	1091.	1120.	1140.	1230.	1295.
PER Q=	.0	.0	.4	99.6	
AREA=	2.9	2.0	9.2	227.0	
VEL=	.6	.6	1.6	18.0	

*SECNO 5.000

3265 DIVIDED FLOW

3301 HV CHANGED MORE THAN HVINS

5.00	3.67	2916.67	2918.17	.00	2922.18	5.51	5.67	.05	2916.00
4102.	236.	3866.	0.	95.	199.	0.	9.	4.	2917.00
.03	2.48	19.40	.00	.080	.030	.050	.000	2913.00	1123.26
.039854	200.	200.	200.	6	8	0	.00	262.01	1391.89

FLOW DISTRIBUTION FOR SECNO= 5.00 CWSEL= 2916.67

STA=	1123.	1185.	1280.	1297.	1320.	1394.
PER Q=	.9	4.4	.2	.2	94.2	
AREA=	20.6	63.4	5.6	5.6	199.2	
VEL=	1.8	2.8	1.8	1.8	19.4	

*SECNO 4.000

3265 DIVIDED FLOW

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

3301 HV CHANGED MORE THAN HVINS

4.00	3.18	2914.18	2915.50	.00	2918.19	4.01	3.54	.45	2915.00
4102.	15.	4087.	0.	16.	254.	0.	10.	4.	2915.00
.03	.98	16.10	.00	.080	.030	.050	.000	2911.00	1102.30
.031660	100.	100.	100.	5	11	0	.00	207.89	1380.97

FLOW DISTRIBUTION FOR SECNO= 4.00 CWSEL= 2914.18

STA=	1102.	1145.	1200.	1208.	1385.
PER Q=	.1	.3	.0	99.6	
AREA=	4.1	10.7	.8	253.9	
VEL=	.7	1.1	.7	16.1	

*SECNO 3.000

3301 HV CHANGED MORE THAN HVINS

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA= 2911.52 ELREA= 2911.52

3.00	3.37	2904.31	2906.84	.00	2913.50	9.19	4.18	.52	2911.98
4102.	0.	4102.	0.	0.	169.	0.	10.	5.	2912.10
.03	.00	24.33	.00	.080	.030	.050	.000	2900.94	1041.50
.057629	100.	100.	100.	7	14	0	.00	51.00	1092.50

FLOW DISTRIBUTION FOR SECNO= 3.00 CWSEL= 2904.31

STA=	1042.	1093.
PER Q=	100.0	
AREA=	168.6	
VEL=	24.3	

SPECIAL BRIDGE

SB XK	XKOR	COFQ	RDLEN	BWC	BWP	BAREA	SS	ELCHU	ELCHD
1.25	1.60	2.60	.00	51.00	3.00	480.00	.00	2901.00	2899.78

*SECNO 2.000

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

3301 HV CHANGED MORE THAN HVINS

CLASS C LOW FLOW

3420 BRIDGE W.S.= 2904.25 BRIDGE VELOCITY=, 22.13 CALCULATED CHANNEL AREA=, 156.

EGPRS	EGLWC	H3	QWEIR	QLOW	BAREA	TRAPEZOID AREA	ELLC	ELTRD
.00	2910.55	.00	0.	4102.	480.	483.	2911.06	2911.98

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA= 2911.52 ELREA= 2911.52

2.00	3.73	2903.34	.00	.00	2910.55	7.20	2.95	.00	2910.76
4102.	0.	4102.	0.	0.	190.	0.	11.	5.	2910.90
.03	.00	21.54	.00	.000	.030	.000	.000	2899.61	1035.00
.039153	125.	125.	125.	0	0	0	.00	51.00	1086.00

FLOW DISTRIBUTION FOR SECNO= 2.00 CWSEL= 2903.34

STA=	1035. 1086.
PER Q=	100.0
AREA=	190.5
VEL=	21.5

*SECNO 1.000

3301 HV CHANGED MORE THAN HVINS

1.00	3.12	2902.12	2903.57	.00	2906.93	4.80	2.90	.72	2905.00
4102.	0.	4039.	63.	0.	228.	10.	11.	5.	2899.00
.03	.00	17.71	6.43	.080	.030	.050	.000	2899.00	1068.76
.030010	85.	85.	85.	6	11	0	.00	82.48	1151.24

FLOW DISTRIBUTION FOR SECNO= 1.00 CWSEL= 2902.12

STA=	1069.	1145.	1151.
PER Q=	98.5	1.5	
AREA=	228.1	9.7	
VEL=	17.7	6.4	

THIS RUN EXECUTED 01/01/80 00:05:32

****
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
****

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

CMG DRAINAGE ENG. JOB# 8

SUMMARY PRINTOUT

SECNO	QLOB	QCH	QROB	CWSEL	ELMIN	VCH	TOPWID	DEPTH	AREA	XLCH	SSTA	ENDST
14.000	9.11	4088.76	4.12	2965.57	2960.00	19.48	76.04	5.57	216.23	.00	1088.83	1164.87
13.000	.00	3940.36	161.64	2959.67	2953.00	21.17	47.46	6.67	207.87	200.00	1174.37	1221.83
12.000	.00	4002.25	99.75	2952.07	2946.00	23.68	55.52	6.07	186.74	200.00	1221.09	1276.61
11.000	88.41	3999.14	14.45	2947.35	2942.00	21.48	59.90	5.35	206.44	200.00	1214.67	1274.57
10.000	4.87	4095.22	1.90	2941.14	2936.50	21.97	50.60	4.64	188.48	200.00	1152.54	1203.14
9.000	.00	3932.18	169.82	2935.73	2931.00	20.78	106.88	4.73	231.95	200.00	1059.69	1166.57
8.000	73.36	3831.61	197.02	2931.27	2927.00	18.92	119.52	4.27	261.64	200.00	1109.16	1228.68
7.000	35.95	4018.73	47.32	2927.28	2922.00	17.54	79.93	5.28	248.40	200.00	1188.77	1268.70
6.000	17.45	4084.55	.00	2922.90	2918.00	17.99	124.93	4.90	241.12	200.00	1091.37	1285.78
5.000	236.21	3865.79	.00	2916.67	2913.00	19.40	262.01	3.67	294.40	200.00	1123.26	1391.89
4.000	15.24	4086.75	.00	2914.18	2911.00	16.10	207.89	3.18	269.47	100.00	1102.30	1380.97
3.000	.00	4102.00	.00	2904.31	2900.94	24.33	51.00	3.37	168.60	100.00	1041.50	1092.50
2.000	.00	4102.00	.00	2903.34	2899.61	21.54	51.00	3.73	190.45	125.00	1035.00	1086.00
1.000	.00	4039.41	62.59	2902.12	2899.00	17.71	82.48	3.12	237.88	85.00	1068.76	1151.24

APPENDIX D

SUPPORTING CALCULATIONS FOR QUANTITATIVE GEOMORPHIC ANALYSIS INCLUDING OUTPUT FOR EQUILIBRIUM SLOPE ANALYSIS

Scour Depth and Scour Width Calculations for Existing Condition

$$D_s = Y\left[\frac{.0686\,V_m^{0.8}}{Y_m^{0.4}\,S^{0.3}} - 1\right] + \left[\frac{V_m}{8.5}\right]^2$$

D_s = Depth of scour (ft)
Y = Depth of flow = 4.94 ft
Y_m = Hydraulic depth = 3.87 ft
V_m = Mean channel velocity = 20 ft/s
S = Channel slope = .025 ft/ft

D_s = 1.69' + 5.54' = **7.23'**

$$W_s = \frac{.035\,Q}{Y_m^{1.5}\,S^{0.38}} - T$$

W_s = Width of scour (ft)
Y_m = Hydraulic depth = 3.87 ft
S = Channel slope = .0233 ft/ft
T = " topwidth = 50 ft
Q = " discharge = 4000 cfs

W_s = 76.7 − 50 = **26.7 ft**

at bend:

$$W_s = \left[\frac{.088\,Q\left(\frac{\sin^2\left(\frac{\alpha}{2}\right)}{\cos\alpha}\right)^{0.25}}{Y_m^{1.5}\,S^{0.38}}\right] - T$$

for $\alpha = 40°$, W_s = **70.6 ft**

DERIVATION OF EQUATION USED IN EQUILIBRIUM SLOPE PROGRAM:

SIMPLIFICATION OF ENGELUND - HANSEN FORMULA

FROM "SEDIMENTATION ENGINEERING" ASCE, 1977
EQN. 2.234e PAGE 208:

$$g_s = .05\,\gamma_s V^2 \left[\frac{d_{50}}{g\left(\frac{\gamma_s}{\gamma}-1\right)}\right]^{1/2} \left[\frac{\tau_o}{(\gamma_s-\gamma)\,d_{50}}\right]^{3/2}$$

$$= \frac{.05\,\gamma_s V^2}{d_{50}} \left[\frac{1}{g\left(\frac{\gamma_s}{\gamma}-1\right)}\right]^{1/2} \left[\frac{\tau_o}{(\gamma_s-\gamma)}\right]^{3/2}$$

FOR $\tau_o = \gamma R S = \gamma D S$
AND $G_s = \frac{\gamma_s}{\gamma_w} = \frac{\gamma_s}{\gamma}$

$$g_s = \frac{.05\,\gamma_s V^2}{d_{50}} \left[\frac{1}{g(G_s-1)}\right]^{1/2} \left[\frac{DS}{(G_s-1)}\right]^{3/2}$$

$$= \frac{.05\,\gamma_s V^2 (DS)^{3/2}}{g^{1/2}\,(G_s-1)^2}\,\frac{1}{d_{50}}$$

ASSUMING EFFECTIVE CHANNEL WIDTH = A/D AND CONVERTING FROM lb/s/FT TO CFS:

$$Q_s = \frac{.05\,\gamma_s V^2 (DS)^{3/2}}{g^{1/2}\,(G_s-1)^2\,d_{50}} \left(\frac{A}{D}\right)\left(\frac{1}{\gamma_s}\right)$$

$$= \frac{.05\,V^2 D^{1/2} S^{3/2} A}{g^{1/2}\,(G_s-1)^2\,d_{50}} \qquad \text{BUT } Q = VA \text{ SO;}$$

$$= \frac{.05}{g^{1/2}\,(G_s-1)^2}\;\frac{Q V D^{1/2} S^{3/2}}{d_{50}}$$

FOR $g = 32.2$ FT/s, $G_s = 2.64$ AND d_{50} IN (mm):

$$Q_s = \frac{Q V D^{1/2} S^{3/2}}{d_{50}}$$

SOLUTION PROCEDURE FOR EQUILIBRIUM SLOPE ANALYSIS

1. For given cross-section, Q (dominant discharge) and n (manning's roughness) assume a value of S (slope) and solve for D (depth) using Manning's equation:

$$Q = \frac{1.486\ Rh^{2/3}\ S^{1/2}}{n}\ A$$

2. Knowing Q, V, D, and S (assumed) from step (1) above determine Qs (sediment transport rate) from simplified Engelund-Hansen equation:

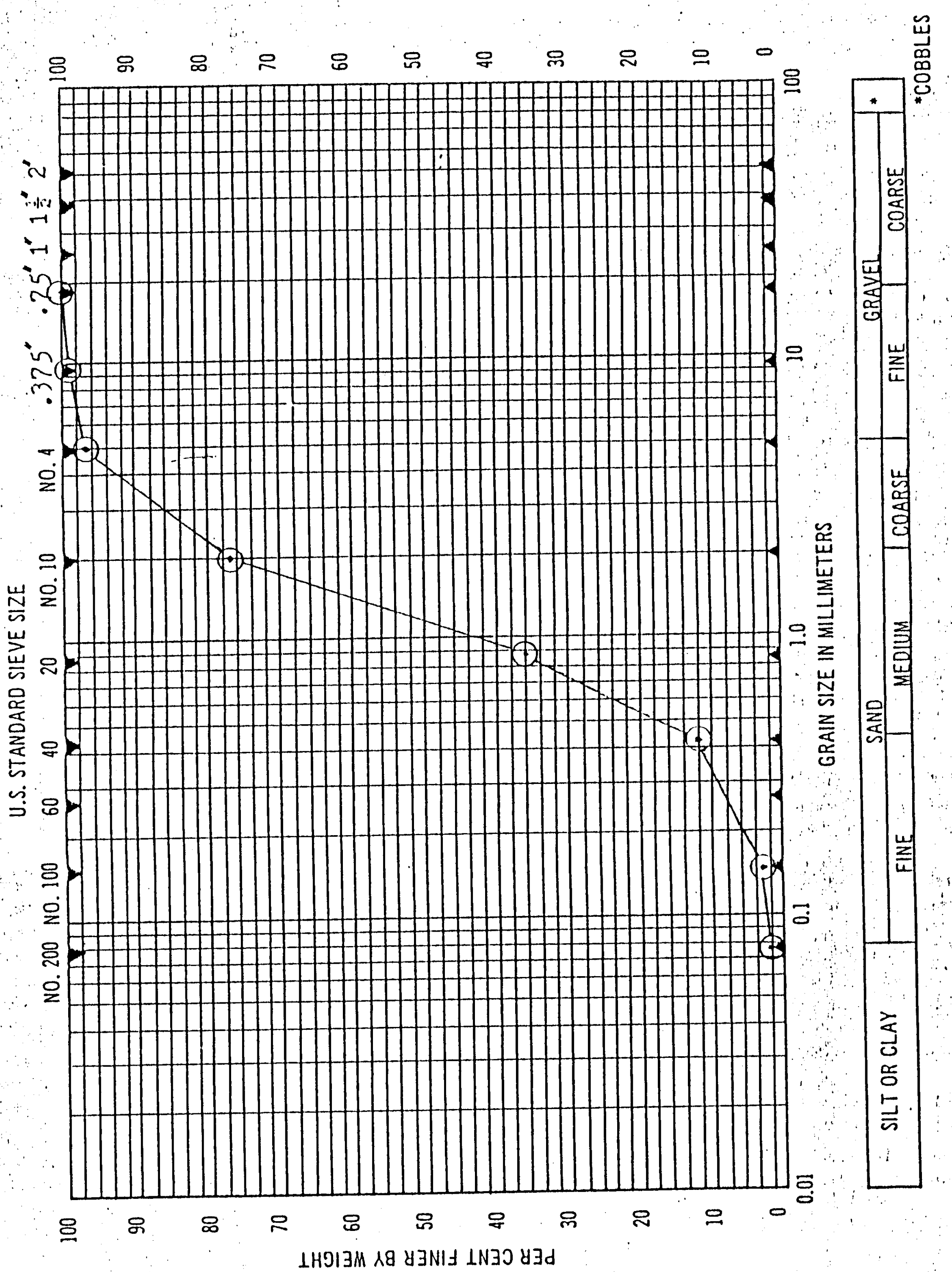
$$Qs = \frac{Q\ V\ D^{1/2}\ S^{3/2}}{d_{50}}$$

3. Compare value of Qs computed in step (2) above with known sediment transport supply rate Qsp. If Qs and Qsp do not agree adjust the assumed value of S and repeat steps (1) through (3) until Qs and Qsp agree. The equilibrium slope is the value of S such that Qs and Qsp agree.

GRAIN-SIZE DISTRIBUTION
(UNIFIED SOIL CLASSIFICATION SYSTEM)

JOB NO. 88-293F BY JMM DATE 6/28/88

KEY	BORING	DEPTH	ELEV.	SOIL CLASSIFICATION
⊙	#1	:BED		Brown SAND with trace gravel and silt
				PI = NP USCS(SW)



desert earth engineering

GYD #9 88021

SIZE FRACTIONS AND GEOMETRIC MEANS FOR SEDIMENT INPUT TO EQUILIBRIUM SLOPE ANALYSIS PROGRAM

SIEVE #	SIEVE SIZE (MM)	GEOMETRIC MEAN (MM)	% WITHIN SIZE FRATION
.75"	18.892		
		13.467	1
.375"	9.446		
		6.732	2
4	4.760		
		3.085	20
10	2.000		
		1.297	41
20	0.841		
		0.594	24
40	0.420		
		0.250	9
100	0.149		
		0.105	3
200	0.074		

Use of Size Fraction and Geometric Mean Data by Program

SEDIMENT TRANSPORT RATE IS COMPUTED FOR EACH SIZE FRACTION I.E.:

$$Q_s = \frac{(F_1)QVD^{1/2}S^{3/2}}{d_{50_1}} + \frac{(F_2)QVD^{1/2}S^{3/2}}{d_{50_2}} + \cdots + \frac{(F_n)QVD^{1/2}S^{3/2}}{d_{50_n}}$$

OR

$$Q_s = QVD^{1/2}S^{3/2}\left[\frac{F_1}{d_{50_1}} + \frac{F_2}{d_{50_2}} + \cdots + \frac{F_n}{d_{50_n}}\right]$$

∴ EFFECTIVE d_{50} FOR ENTIRE SAMPLE IS:

$$d_{50_{eff}} = \frac{1}{\frac{F_1}{d_{50_1}} + \frac{F_2}{d_{50_2}} + \cdots + \frac{F_n}{d_{50_n}}}$$

FOR THIS PROJECT:

$$d_{50\,eff} = \frac{1}{\frac{.01}{13.467} + \frac{.02}{6.732} + \frac{.20}{3.085} + \frac{.41}{1.297} + \frac{.24}{.594} + \frac{.09}{.250} + \frac{.03}{.105}}$$

$$d_{50\,eff} = 0.697$$

SAMPLE INPUT CROSS-SECTION FOR EQUILIBRIUM SLOPE PROGRAM WITH INPUT LEGEND

A SAMPLE INPUT FILE TO PROGRAM EQSLP IS SHOWN BELOW. THE INPUT FILE IS FOR A SINGLE CROSS-SECTION:

```
                                        COLUMN #
              1       2       3       4       5       6       7       8       9      10
LINE #

  1     GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS
  2     14
  3        .050    .030    .050   .0235     104     158    1644       1      10
  4           0       7       0       1       0
  5       0.105   0.250   0.594   1.297   3.085   6.732  13.467
  6       0.030   0.090   0.240   0.410   0.200   0.020   0.010
  7        2962
  8      2967.5     0.0  2967.0    65.0  2966.0    77.5  2965.0   104.0  2962.0   113.0
  9      2960.0   115.0  2960.0   135.0  2965.0   158.0  2966.0   170.0  2969.0   190.0
```

LINE #	COLUMN #	VARIABLE
1-2	1-10	TITLE CARDS
3	1-3	MANNING'S n VALUES FOR LEFT OVERBANK, CHANNEL AND RIGHT OVERBANK
3	4	ASSUMED VALUE OF SLOPE FOR STARTING COMPUTATIONS
3	5 & 6	LEFT AND RIGHT BANK STATIONS
3	7	WATER DISCHARGE
3	8	NUMBER OF WATER PROFILES
3	9	NUMBER OF POINTS IN CROSS-SECTION
4	1	UPSTREAM SUPPLY RATE FOR SEDIMENT TRANSPORT (Qsp) (If = -1 then the cross-section under analysis represents the supply reach and the computed value of Qsp is the supply rate) (If = 0 then Qsp = the value computed for cross-section where Qsp input as -1)
4	2	NUMBER OF SIZE FRACTIONS IN GRAIN SIZE DISTRIBUTION
4	3	USE LEFT OVERBANK IN SEDIMENT TRANSPORT RATE COMPUTATIONS? (1=YES, 0=NO)
4	4	USE CHANNEL IN SEDIMENT TRANSPORT RATE COMPUTATIONS? (1=YES, 0=NO)
4	5	USE RIGHT OVERBANK IN SEDIMENT TRANSPORT RATE COMPUTATIONS? (1=YES, 0=NO)
5	1-10	GEOMETRIC MEANS OF SEDIMENT SIZE FRACTIONS
6	1-10	SIZE FRACTIONS FOR GEOMETRIC MEANS
7	1	ASSUMED VALUE OF WSEL FOR STARTING COMPUTATIONS
8-9	1-10	X-SECTION DATA (ELEV., STA., PAIRS)

```
UPSTREAM SUPPLY
    .050    .030    .050   .0235       0     100    1644       1       4
      -1       7       0       1       0
   0.105   0.250   0.594   1.297   3.085   6.732  13.467
   0.030   0.090   0.240   0.410   0.200   0.020   0.010
      .5
       5       0       0       0       0     100       5     100
GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS
14
    .050    .030    .050   .0235     104     158    1644       1      10
       0       7       0       1       0
   0.105   0.250   0.594   1.297   3.085   6.732  13.467
   0.030   0.090   0.240   0.410   0.200   0.020   0.010
    2962
  2967.5     0.0  2967.0    65.0  2966.0    77.5  2965.0   104.0  2962.0   113.0
  2960.0   115.0  2960.0   135.0  2965.0   158.0  2966.0   170.0  2969.0   190.0
GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS
13
    .050    .030    .050   .0235  1173.5  1212.5    1644       1      14
       0       7       0       1       0
   0.105   0.250   0.594   1.297   3.085   6.732  13.467
   0.030   0.090   0.240   0.410   0.200   0.020   0.010
    2960
  2962.0 1000.00 2961.00 1104.00 2961.00 1136.00 2961.50 1150.00 2961.00 1167.50
  2960.0 1173.50 2955.00 1186.50 2953.00 1189.50 2953.00 1202.50 2954.00 1205.00
  2955.0 1212.50 2960.00 1222.50 2961.00 1224.00 2962.00 1227.50
GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS
12
    .050    .030    .050   .0235  1218.0  1259.5    1644       1      14
       0       7       0       1       0
   0.105   0.250   0.594   1.297   3.085   6.732  13.467
   0.030   0.090   0.240   0.410   0.200   0.020   0.010
    2953
  2957.0 1000.00 2956.00 1022.50 2955.00 1062.50 2954.00 1212.50 2953.00 1218.00
  2950.0 1228.00 2946.00 1233.00 2946.00 1248.00 2948.00 1255.50 2950.00 1259.50
  2954.0 1292.50 2955.00 1302.50 2956.00 1342.50 2957.00 1355.50
GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS
11
    .050    .030    .050   .0235     230   268.5    1644       1      14
       0       7       0       1       0
   0.105   0.250   0.594   1.297   3.085   6.732  13.467
   0.030   0.090   0.240   0.410   0.200   0.020   0.010
    2945
  2951.0     0.0  2950.0    77.5  2949.0   143.5  2948.0   170.0  2948.0   207.5
  2947.0   218.5  2945.0   230.0  2942.0   234.5  2942.0   262.0  2946.0   268.5
  2948.0   277.5  2949.0   281.0  2950.0   289.0  2951.0   402.5
GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS
10
    .050    .030    .050   .0235    1155    1202    1644       1      13
       0       7       0       1       0
   0.105   0.250   0.594   1.297   3.085   6.732  13.467
   0.030   0.090   0.240   0.410   0.200   0.020   0.010
    2945
  2945.0 1000.00 2944.00 1120.00 2943.00 1148.50 2940.00 1155.00 2936.50 1170.00
  2936.5 1199.00 2940.00 1202.00 2943.00 1205.00 2944.00 1227.50 2943.00 1260.00
  2942.5 1322.50 2943.00 1367.50 2945.00 1382.50
GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS
 9
    .050    .030    .050   .0235    58.8   104.5    1644       1      10
       0       7       0       1       0
   0.105   0.250   0.594   1.297   3.085   6.732  13.467
   0.030   0.090   0.240   0.410   0.200   0.020   0.010
    2937
  2940.0     0.0  2939.0    22.5  2938.0    39.5  2937.0    58.8  2931.0    63.0
  2931.0    97.0  2935.0   104.5  2935.0   159.0  2938.0   190.0  2939.0   222.5
```

INPUT FOR PROGRAM EQSLP

```
    .050    .030    .050   .0235  1116.5  1170.0    1644       1      10
       0       7       0       1       0
   0.105   0.250   0.594   1.297   3.085   6.732  13.467
   0.030   0.090   0.240   0.410   0.200   0.020   0.010
    2930
  2933.0 1000.00 2932.00 1107.50 2928.00 1116.50 2927.00 1122.50 2927.00 1155.00
  2930.0 1170.00 2930.60 1201.50 2930.60 1225.00 2936.00 1255.00 2933.00 1282.50
GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS
 7
    .050    .030    .050   .0235  1196.0  1251.0    1644       1      13
       0       7       0       1       0
   0.105   0.250   0.594   1.297   3.085   6.732  13.467
   0.030   0.090   0.240   0.410   0.200   0.020   0.010
    2925
  2929.0 1000.00 2928.00 1130.00 2928.20 1167.50 2928.00 1186.50 2925.00 1196.00
  2922.0 1201.00 2922.00 1221.00 2924.00 1235.00 2925.00 1251.00 2927.00 1258.50
  2928.0 1294.50 2929.00 1316.00 2930.00 1356.00
GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS
 6
    .050    .030    .050   .0235     230     295    1644       1      17
       0       7       0       1       0
   0.105   0.250   0.594   1.297   3.085   6.732  13.467
   0.030   0.090   0.240   0.410   0.200   0.020   0.010
    2922
  2924.0    0.00 2923.20   35.00 2923.80   65.00 2923.00   77.50 2922.70  120.00
  2923.0  150.00 2923.00  207.50 2922.00  230.00 2918.00  240.00 2918.00  275.00
  2923.0  286.00 2924.00  295.00 2924.00  314.00 2923.00  320.00 2923.00  345.00
  2925.0  365.00 2930.00  384.00
GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS
 5
    .050    .030    .050   .0235    1320    1394    1644       1      11
       0       7       0       1       0
   0.105   0.250   0.594   1.297   3.085   6.732  13.467
   0.030   0.090   0.240   0.410   0.200   0.020   0.010
    2916
  2918.0 1000.00 2917.00 1092.50 2916.00 1185.00 2916.00 1280.00 2916.80 1300.00
  2916.0 1320.00 2913.00 1332.50 2913.00 1362.50 2914.00 1375.00 2917.00 1394.00
  2917.3 1415.00
GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS
 4
    .050    .030    .050   .0235  1272.5    1385    1644       1      11
       0       7       0       1       0
   0.105   0.250   0.594   1.297   3.085   6.732  13.467
   0.030   0.090   0.240   0.410   0.200   0.020   0.010
    2915
  2915.0 1000.00 2914.50 1035.00 2914.00 1145.00 2914.00 1200.00 2915.00 1240.00
  2915.0 1272.50 2911.00 1302.50 2911.00 1346.00 2912.00 1370.00 2915.00 1385.00
  2916.0 1400.00
```

GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS

CROSS-SECTION - UPSTREAM SUPPLY

QS	EQUILIBRIUM SLOPE	NLOB	NC	NROB
109.75	.0235	.050	.030	.050

HYDRAULIC DATA

CWSEL-	1.61	DEPTH-	1.61	QLOB-	0.	VLOB-	.00
Q-	1641.	AREA-	160.8	QCH-	1641.	VCH-	10.21
ELMIN-	.00	TOPWID-	100.0	QROB-	0.	VROB-	.00

GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS

CROSS-SECTION - 14

QS	EQUILIBRIUM SLOPE	NLOB	NC	NROB
109.75	.0153	.050	.030	.050

HYDRAULIC DATA

CWSEL-	2964.14	DEPTH-	4.14	QLOB-	0.	VLOB-	.00
Q-	1637.	AREA-	135.5	QCH-	1637.	VCH-	12.08
ELMIN-	2960.00	TOPWID-	47.5	QROB-	0.	VROB-	.00

GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS

CROSS-SECTION - 13

QS	EQUILIBRIUM SLOPE	NLOB	NC	NROB
109.74	.0138	.050	.030	.050

HYDRAULIC DATA

CWSEL-	2957.82	DEPTH-	4.82	QLOB-	0.	VLOB-	.00
Q-	1635.	AREA-	128.1	QCH-	1603.	VCH-	13.34
ELMIN-	2953.00	TOPWID-	39.0	QROB-	32.	VROB-	4.08

GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS

CROSS-SECTION - 12

QS	EQUILIBRIUM SLOPE	NLOB	NC	NROB
109.75	.0138	.050	.030	.050

HYDRAULIC DATA

CWSEL-	2950.84	DEPTH-	4.84	QLOB-	0.	VLOB-	.00
Q-	1636.	AREA-	126.9	QCH-	1630.	VCH-	13.15
ELMIN-	2946.00	TOPWID-	41.2	QROB-	6.	VROB-	1.94

GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS

CROSS-SECTION - 11

QS	EQUILIBRIUM SLOPE	NLOB	NC	NROB
109.75	.0151	.050	.030	.050

HYDRAULIC DATA

CWSEL-	2945.77	DEPTH-	3.77	QLOB-	3.	VLOB-	1.91
Q-	1636.	AREA-	127.2	QCH-	1633.	VCH-	13.02
ELMIN-	2942.00	TOPWID-	42.6	QROB-	0.	VROB-	.00

GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS

CROSS-SECTION - 10

QS	EQUILIBRIUM SLOPE	NLOB	NC	NROB
109.75	.0161	.050	.030	.050

HYDRAULIC DATA

CWSEL-	2940.01	DEPTH-	3.51	QLOB-	0.	VLOB-	.07
Q-	1633.	AREA-	133.3	QCH-	1633.	VCH-	12.25
ELMIN-	2936.50	TOPWID-	47.0	QROB-	0.	VROB-	.06

GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS

CROSS-SECTION - 9

QS	EQUILIBRIUM SLOPE	NLOB	NC	NROB
109.75	.0159	.050	.030	.050

HYDRAULIC DATA

CWSEL-	2934.39	DEPTH-	3.39	QLOB-	0.	VLOB-	.00
Q-	1640.	AREA-	130.0	QCH-	1640.	VCH-	12.62
ELMIN-	2931.00	TOPWID-	42.7	QROB-	0.	VROB-	.00

GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS

CROSS-SECTION - 8

QS	EQUILIBRIUM SLOPE	NLOB	NC	NROB
109.75	.0173	.050	.030	.050

HYDRAULIC DATA

CWSEL-	2930.00	DEPTH-	3.00	QLOB-	16.	VLOB-	3.68
Q-	1636.	AREA-	139.3	QCH-	1619.	VCH-	12.01
ELMIN-	2927.00	TOPWID-	58.0	QROB-	0.	VROB-	.00

GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS

CROSS-SECTION - 7

QS	EQUILIBRIUM SLOPE	NLOB	NC	NROB
109.75	.0164	.050	.030	.050

HYDRAULIC DATA

CWSEL-	2925.66	DEPTH-	3.66	QLOB-	1.	VLOB-	1.77
Q-	1638.	AREA-	141.5	QCH-	1635.	VCH-	11.68
ELMIN-	2922.00	TOPWID-	59.6	QROB-	1.	VROB-	1.78

GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS

CROSS-SECTION - 6

QS	EQUILIBRIUM SLOPE	NLOB	NC	NROB
109.75	.0167	.050	.030	.050

HYDRAULIC DATA

CWSEL-	2921.17	DEPTH-	3.17	QLOB-	0.	VLOB-	.00
Q-	1640.	AREA-	134.6	QCH-	1640.	VCH-	12.18
ELMIN-	2918.00	TOPWID-	49.9	QROB-	0.	VROB-	.00

GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS

CROSS-SECTION - 5

QS	EQUILIBRIUM SLOPE	NLOB	NC	NROB
109.75	.0182	.050	.030	.050

HYDRAULIC DATA

CWSEL-	2915.90	DEPTH-	2.90	QLOB-	0.	VLOB-	.00
Q-	1635.	AREA-	145.9	QCH-	1635.	VCH-	11.21
ELMIN-	2913.00	TOPWID-	66.6	QROB-	0.	VROB-	.00

GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS

CROSS-SECTION - 4

QS	EQUILIBRIUM SLOPE	NLOB	NC	NROB
109.75	.0209	.050	.030	.050

HYDRAULIC DATA

CWSEL-	2913.20	DEPTH-	2.20	QLOB-	0.	VLOB-	.00
Q-	1645.	AREA-	158.1	QCH-	1645.	VCH-	10.40
ELMIN-	2911.00	TOPWID-	90.0	QROB-	0.	VROB-	.00

APPENDIX E

SUPPORTING CALCULATIONS FOR PROPOSED IMPROVEMENTS

MANNINGS RATING FOR TRAPEZOIDAL CHANNEL

PROJECT NAME: GREEN VALLEY DRAINAGEWAY #9

PROJECT LOCATION: DESIGN CROSS-SECTION, STATION 0+00 TO 7+00

Q	BW	S	Z	n	D
4102.00	38.00	.0307	1.00	.0300	4.55

V	A	WP	Rh	TW	Dh
21.17	193.66	50.87	3.81	47.10	4.11

F#	Hv	Hsp	Dc
1.84	6.96	11.51	6.69

Q = DISHARGE (CFS)
BW = BOTTOM WIDTH (FT)
S = SLOPE (FT/FT)
Z = SIDE SLOPE
n = ROUGHNESS COEFFICIENT
D = DEPTH (FT)
V = VELOCITY (FT/S)
A = AREA (SQ. FT.)
WP = WETTED PERIMETER (FT)
Rh = HYDRAULIC RADIUS (FT)
TW = TOPWIDTH (FT)
Dh = HYDRAULIC DEPTH (FT)
F# = FROUDE NUMBER
Hv = VELOCITY HEAD (FT)
Hsp = SPECIFIC HEAD (FT)
Dc = CRITICAL DEPTH (FT)

FREEBOARD = $\frac{Hsp}{6} = \frac{11.51}{6} = 1.92'$

REQD. CHANNEL DEPTH = $4.55' + 1.92' = 6.47'$

$$D_s = D\left[\left(\frac{.0686\,V^{0.8}}{D_h^{0.4}\,S^{0.3}}\right) - 1\right] + \left(\frac{V}{8.5}\right)^2 = 7.45'$$

MANNINGS RATING FOR TRAPEZOIDAL CHANNEL

PROJECT NAME: GREEN VALLEY DRAINAGEWAY #9

PROJECT LOCATION: DESIGN CROSS-SECTION, STATION 7+00 TO 20+33

Q	BW	S	Z	n	D
4102.00	50.00	.0240	1.00	.0300	4.16

V	A	WP	Rh	TW	Dh
18.20	225.42	61.77	3.65	58.32	3.86

F#	Hv	Hsp	Dc
1.63	5.14	9.30	5.69

Q = DISHARGE (CFS)
BW = BOTTOM WIDTH (FT)
S = SLOPE (FT/FT)
Z = SIDE SLOPE
n = ROUGHNESS COEFFICIENT
D = DEPTH (FT)
V = VELOCITY (FT/S)
A = AREA (SQ. FT.)
WP = WETTED PERIMETER (FT)
Rh = HYDRAULIC RADIUS (FT)
TW = TOPWIDTH (FT)
Dh = HYDRAULIC DEPTH (FT)
F# = FROUDE NUMBER
Hv = VELOCITY HEAD (FT)
Hsp = SPECIFIC HEAD (FT)
Dc = CRITICAL DEPTH (FT)

REQD FREEBOARD $= \frac{Hsp}{6} = \underline{1.55'}$

REQD CHANNEL DEPTH $= 4.16' + 1.55'$
$= \underline{5.71}$ FT

SUPERELEVATION, $\frac{\Delta y}{2}$, FOR $Rc/Tw = 5$

$$\frac{\Delta y}{2} = \frac{V^2}{g\,5} = 1.0 \text{ FT}$$

$$Ds' = D\left[\left(\frac{0.0686\,V^{0.8}}{Dh^{0.4}\,S^{0.3}}\right) - 1\right] + \left(\frac{V}{8.5}\right)^2 = \underline{5.61} \text{ FT}$$

$$\text{FOR } \alpha = 25°;\ Ds = D\left[\frac{.143\,V^{0.8}}{Dh^{0.4}\,S^{0.3}}\left(\frac{\sin^2 \alpha}{\cos \alpha}\right)^{0.2} - 1\right] + \left(\frac{V}{8.5}\right)^2$$

$= \underline{6.40}$ FT

MANNINGS RATING FOR TRAPEZOIDAL CHANNEL

PROJECT NAME: GREEN VALLEY DRAINAGEWAY #9

PROJECT LOCATION: DESIGN CROSS-SECTION, STATION 7+00 TO 20+33
ALTERNATIVE PROFILE

Q	BW	S	Z	n	D
4102.00	50.00	.0255	1.00	.0300	4.09

V	A	WP	Rh	TW	Dh
18.56	221.06	61.56	3.59	58.17	3.80

F#	Hv	Hsp	Dc
1.68	5.35	9.43	5.69

Q = DISHARGE (CFS)
BW = BOTTOM WIDTH (FT)
S = SLOPE (FT/FT)
Z = SIDE SLOPE
n = ROUGHNESS COEFFICIENT
D = DEPTH (FT)
V = VELOCITY (FT/S)
A = AREA (SQ. FT.)
WP = WETTED PERIMETER (FT)
Rh = HYDRAULIC RADIUS (FT)
TW = TOPWIDTH (FT)
Dh = HYDRAULIC DEPTH (FT)
F# = FROUDE NUMBER
Hv = VELOCITY HEAD (FT)
Hsp = SPECIFIC HEAD (FT)
Dc = CRITICAL DEPTH (FT)

FREEBOARD $= \frac{Hsp}{6} = \frac{9.43}{6} = 1.57'$

REQ. CHANNEL DEPTH $= 4.09' + 1.57' = 5.66'$

$$Ds = D\left[\left(\frac{.0686\, V^{0.8}}{Dh^{0.4}\, S^{0.3}}\right) - 1\right] + \left(\frac{V}{8.5}\right)^2 = 5.80$$

DETERMINATION OF TRANSITION LENGTH

FROM 38' BW TO 50' BW

$$L_T = \frac{\Delta W}{2 \tan \theta}$$

WHERE: L_T = TRANSITION LENGTH (FT)
ΔW = CHANGE IN CHANNEL WIDTH (FT)

AND $\tan \theta = \left(\frac{1}{3.375 \, \mathbb{F}} \right)$

$\mathbb{F}$ = FROUDE # OF UPSTREAM FLOW
= 1.84

$$\tan \theta = \left(\frac{1}{3.375 (1.84)} \right) = 0.161$$

$$L_T = \frac{12}{2 (.161)} = 37 \text{ FT}$$

USE 40 FOOT TRANSITION

GRADE CONTROL DESIGN

S_D = DESIGN SLOPE = .0240 (D/S REACH)
= .0307 (U/S REACH)

S_S = STABLE SLOPE = .0181 (D/S REACH)
= .0163 (U/S REACH)

H_d = DESIGN DROP = 2 FT.

L_R = GRADE CONTROL SPACING = $\dfrac{H_d}{S_D - S_S}$

= 340 FT (D/S REACH)
= 140 FT (U/S REACH)

D_{CW} = DEPTH OF CUTOFF WALL = $.06\,q + 3H_d - \dfrac{L_R}{100} + 1.25$

$= .06(76) + 3(2) - \dfrac{340}{100} + 1.25$

= 8.4' FOR D/S REACH, USE <u>8.5 FT</u>

$= .06(96) + 3(2) - \dfrac{140}{100} + 1.25$

= 11.6' FOR U/S REACH, USE <u>11.5 FT</u>

DETERMINATION OF POTENTIAL ADDITIONAL SCOUR ALONG SOUTH BANK @ SECTION 4 DUE TO PHASE I IMPROVEMENTS TO NORTH BANK

$$W_s = \frac{.035\ Q}{Y_m^{1.5}\ S^{0.38}} - T$$

W_s = WIDTH OF SCOUR (FT)
Y_m = HYDRAULIC DEPTH (FT)
S = CHANNEL SLOPE (FT)
T = " TOPWIDTH (FT)
Q = " DISCHARGE (FT)

FOR EXISTING CONDITIONS:

Y_m = 2.09 FT
S = .024 FT/FT
T = 74 FT
Q = 3866 CFS

$\therefore W_s$ = 53 FT ASSUME $\frac{53}{2}$ = 27 FT PER BANK

FOR PHASE I CONDITIONS:

Y_m = 2.95 FT
S = .024 FT/FT
T = 73 FT
Q = 4102 CFS

$\therefore W_s$ = 44 FT

$\Delta W_s = 44' - 27' = \underline{\underline{17'}}$

GVD #9

88021

COST INFO FOR RAIL BANK PROTECTION

DETAIL A2 SIMILIAR TO ADOT STANDARD C-17.10, TYPE 2

FROM ADOT CONTRACTS & SPECS (JOHN STERNER, 255-7221)

1984 PROJECT, 2200 LINEAL FT OF TYPE 2 RAIL BANK PROTECTION

3 BIDS ($/FT) 90, 112, 135

USE HIGH VALUE ($135/FT) TO ACCOUNT FOR INFLATION

```
GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS
UPSTREAM SUPPLY
    .050    .030    .050   .0235       0     100    1644       1       4
      -1       7       0       1       0
   0.105   0.250   0.594   1.297   3.085   6.732  13.467
   0.030   0.090   0.240   0.410   0.200   0.020   0.010
      .5
       5       0       0       0       0     100       5     100
GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS
DESIGN SECTION WITH 50' BOTTOM WIDTH
    .030    .030    .030   .0233       0      70    1644       1       4
       0       7       0       1       0
   0.105   0.250   0.594   1.297   3.085   6.732  13.467
   0.030   0.090   0.240   0.410   0.200   0.020   0.010
       5
      10       0       0      10       0      60      10      70
GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS
DESIGN SECTION WITH 38' BOTTOM WIDTH
    .030    .030    .030   .0233       0      58    1644       1       4
       0       7       0       1       0
   0.105   0.250   0.594   1.297   3.085   6.732  13.467
   0.030   0.090   0.240   0.410   0.200   0.020   0.010
       5
      10       0       0      10       0      48      10      58
```

INPUT FOR PROGRAM EQSLP

(SEE LEGEND IN APPENDIX D FOR DESCRIPTION OF INPUT)

GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS

CROSS-SECTION - UPSTREAM SUPPLY

QS	SLOPE	NLOB	NC	NROB
109.75	.0235	.050	.030	.050

HYDRAULIC DATA

CWSEL-	1.61	DEPTH-	1.61	QLOB-	0.	VLOB-	.00
Q-	1641.	AREA-	160.8	QCH-	1641.	VCH-	10.21
ELMIN-	.00	TOPWID-	100.0	QROB-	0.	VROB-	.00

GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS

CROSS-SECTION - DESIGN SECTION WITH 50' BOTTOM WIDTH

QS	EQUILIBRIUM SLOPE	NLOB	NC	NROB
109.74	.0181	.030	.030	.030

HYDRAULIC DATA

CWSEL-	2.60	DEPTH-	2.60	QLOB-	0.	VLOB-	.00
Q-	1631.	AREA-	136.9	QCH-	1631.	VCH-	11.91
ELMIN-	.00	TOPWID-	55.2	QROB-	0.	VROB-	.00

GREEN VALLEY DRAIANGEWAY #9, EQUILIBRIUM SLOPE ANALYSIS

CROSS-SECTION - DESIGN SECTION WITH 38' BOTTOM WIDTH

QS	EQUILIBRIUM SLOPE	NLOB	NC	NROB
109.75	.0163	.030	.030	.030

HYDRAULIC DATA

CWSEL-	3.18	DEPTH-	3.18	QLOB-	0.	VLOB-	.00
Q-	1640.	AREA-	130.9	QCH-	1640.	VCH-	12.53
ELMIN-	.00	TOPWID-	44.4	QROB-	0.	VROB-	.00

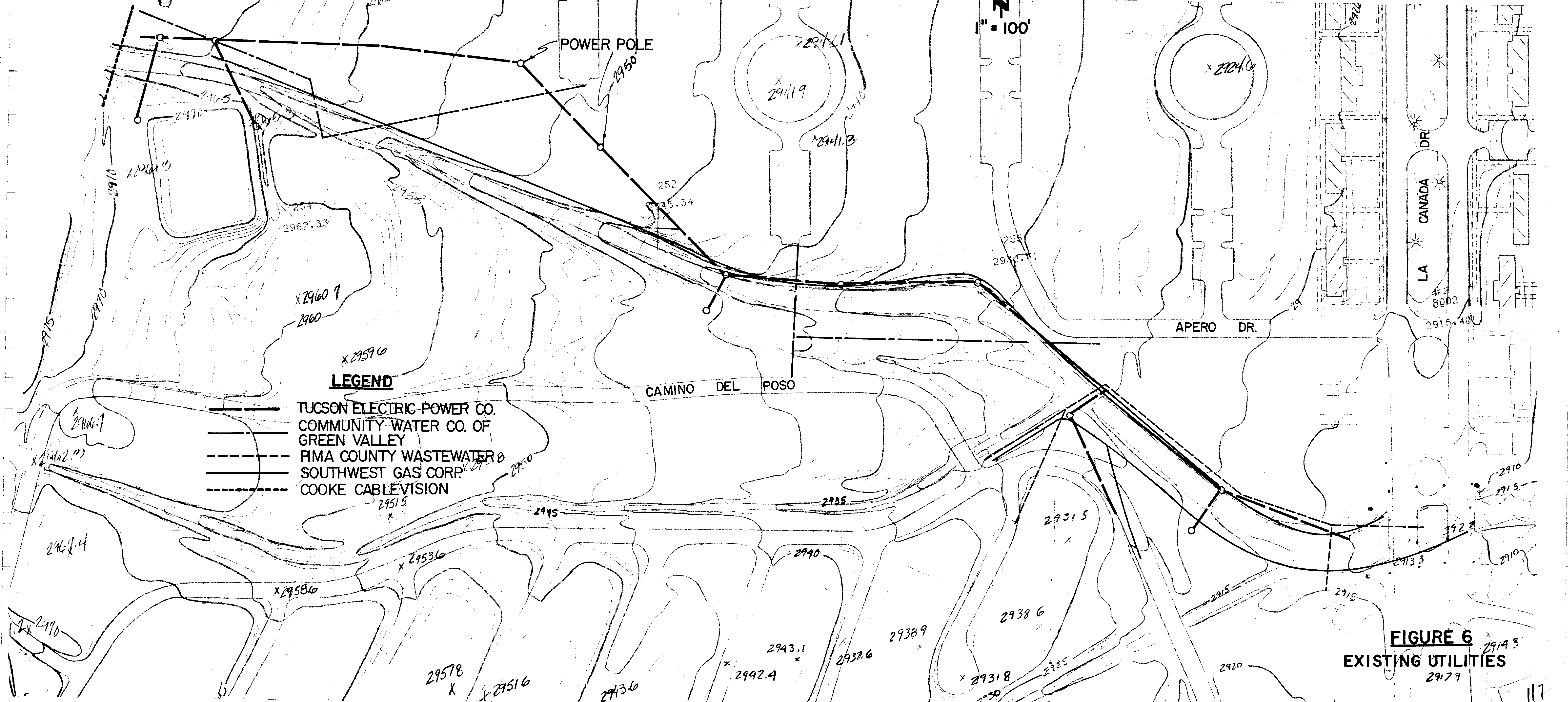


FIGURE 6
EXISTING UTILITIES

FIGURE 2
BASIN BOUNDARY MAP
FOR HEC-I MODEL

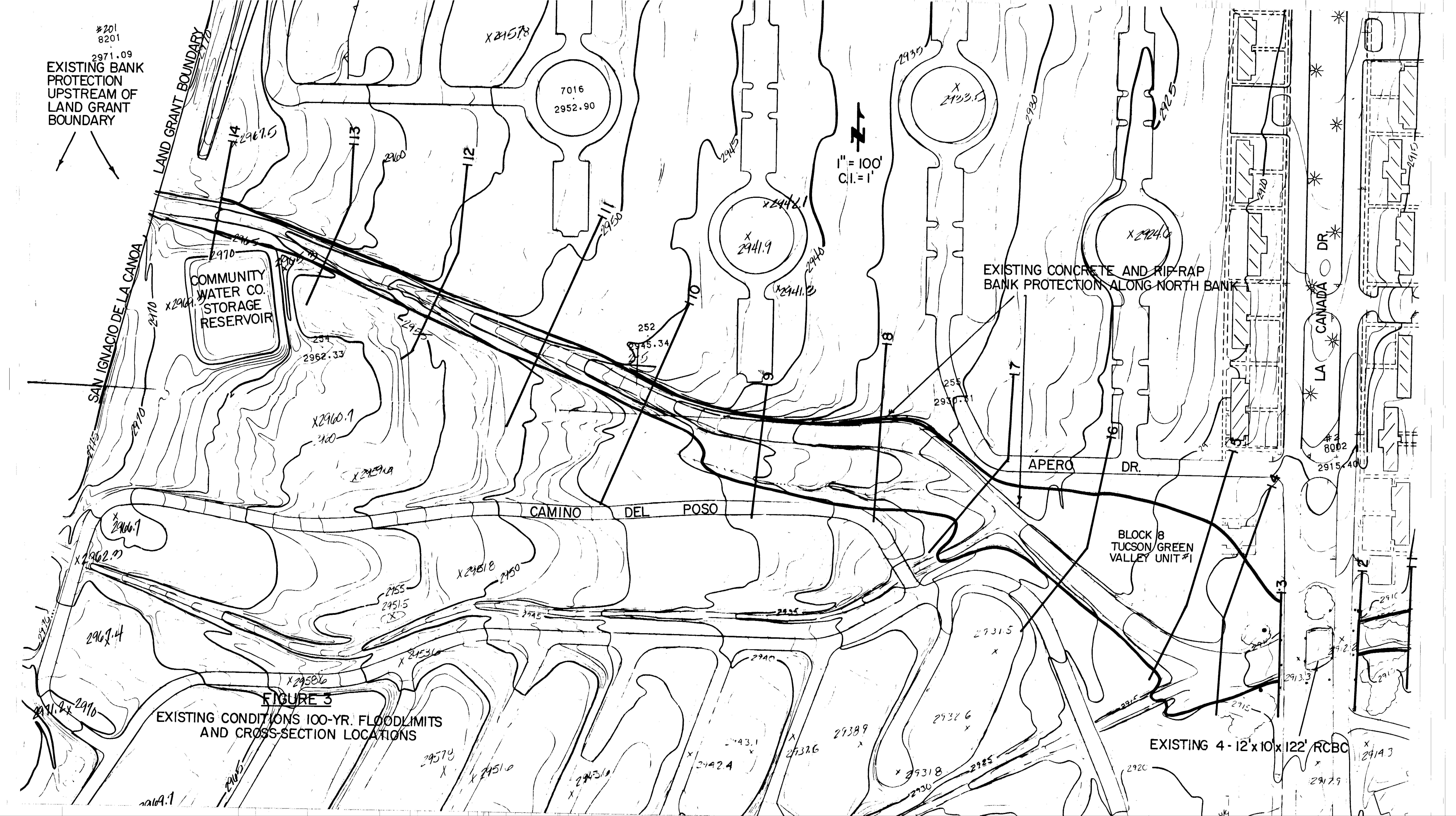
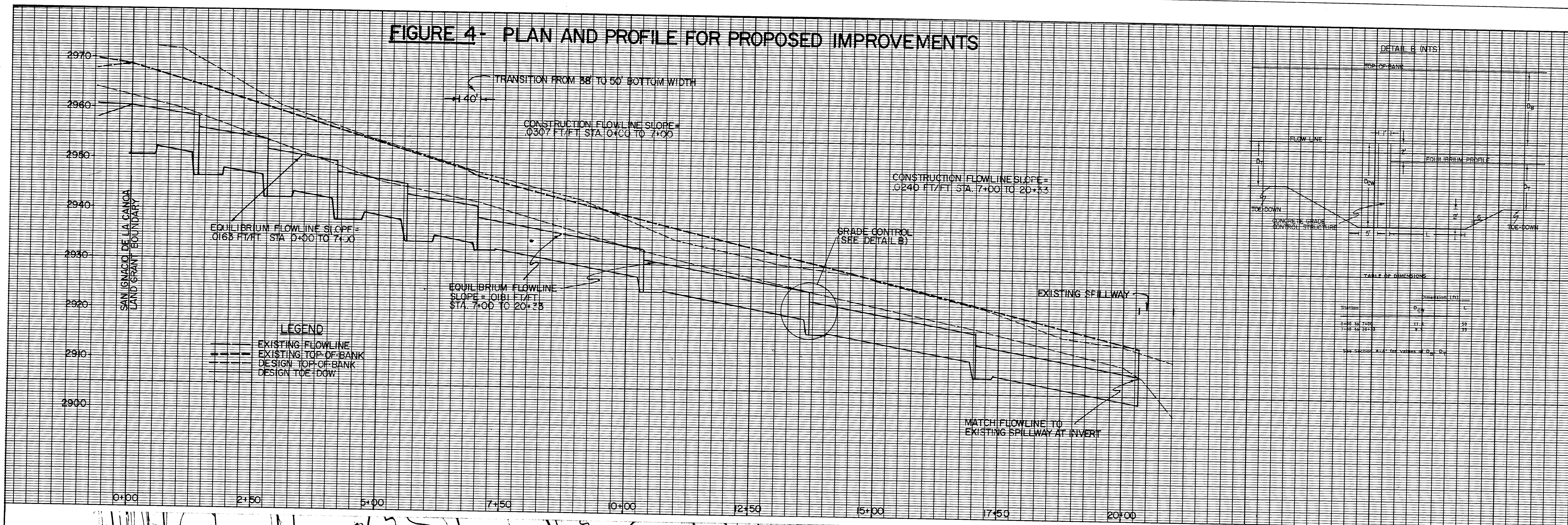
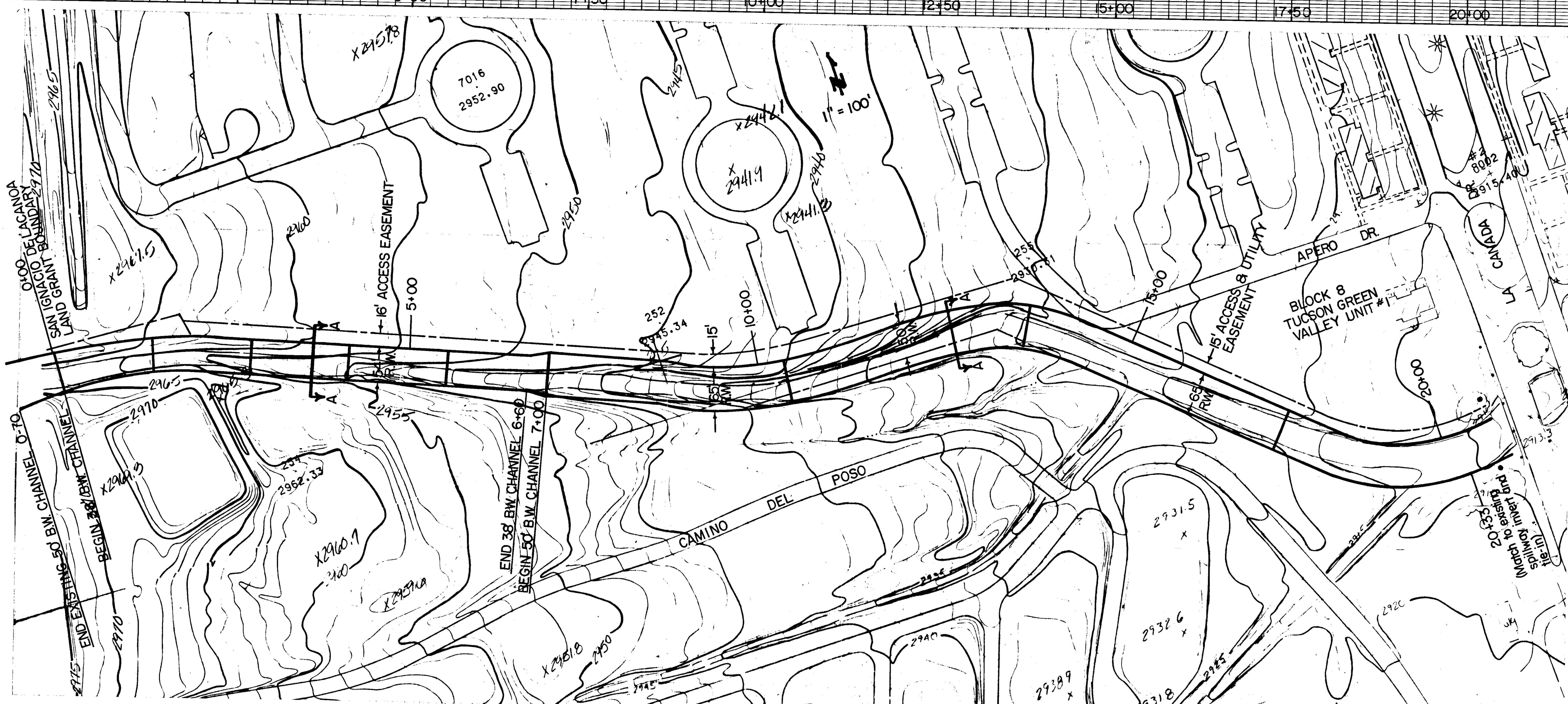


FIGURE 3

EXISTING CONDITIONS 100-YR. FLOODLIMITS AND CROSS-SECTION LOCATIONS

FIGURE 4- PLAN AND PROFILE FOR PROPOSED IMPROVEMENTS





SECTION A-A

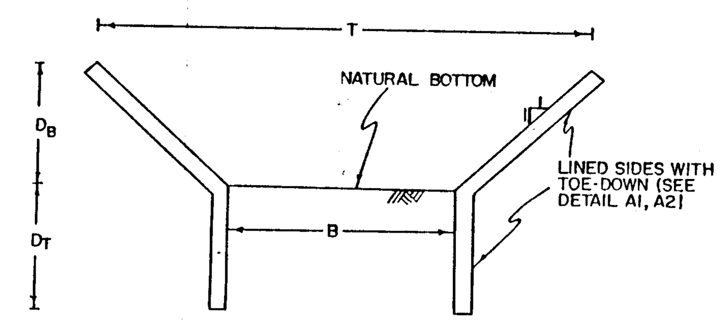
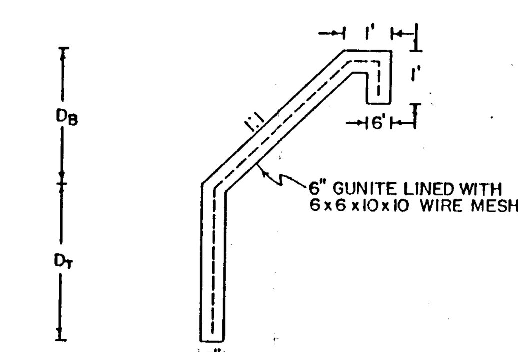


TABLE OF DIMENSIONS

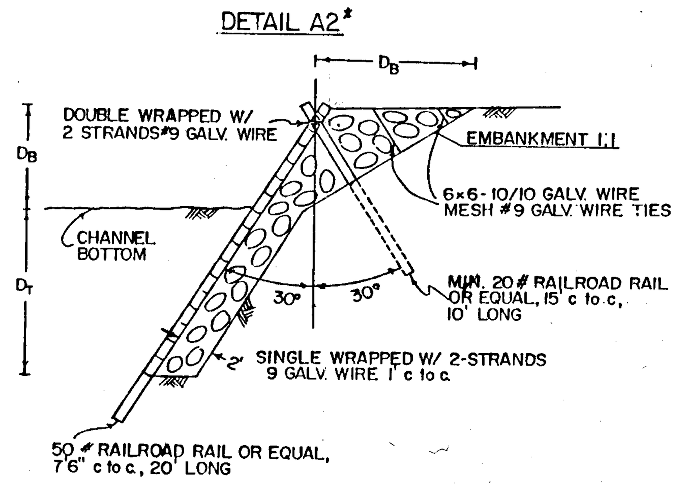
Station	Dimension (ft) B	T	D_B	D_T*
0+00 to 7+00	38	51.0	6.50	7.50
7+00 to 20+33**	50	61.5	5.75	5.75

*Measured from equilibrium flowline.
**Increase D_B and D_T one foot along outer bank through curved reaches.

DETAIL A1*



DETAIL A2*



*DETAILS A1 AND A2 SHOW ALTERNATIVE BANK LININGS

SECTIONS AND DETAILS ARE NTS

SCALES	HORZ. 1" = 100'	SHEET 1 OF 1
	VERT. 1" = 10'	

NO	REVISION	DESCRIPTION	DIV/SECT ENGR.	DATE

DESIGNED
DRAWN
CHECKED
PROJ ENGR
DATE

CMG DRAINAGE ENGINEERING, INC.
P.O. BOX 1425 TUCSON, ARIZONA 85702 (602) 882-4244