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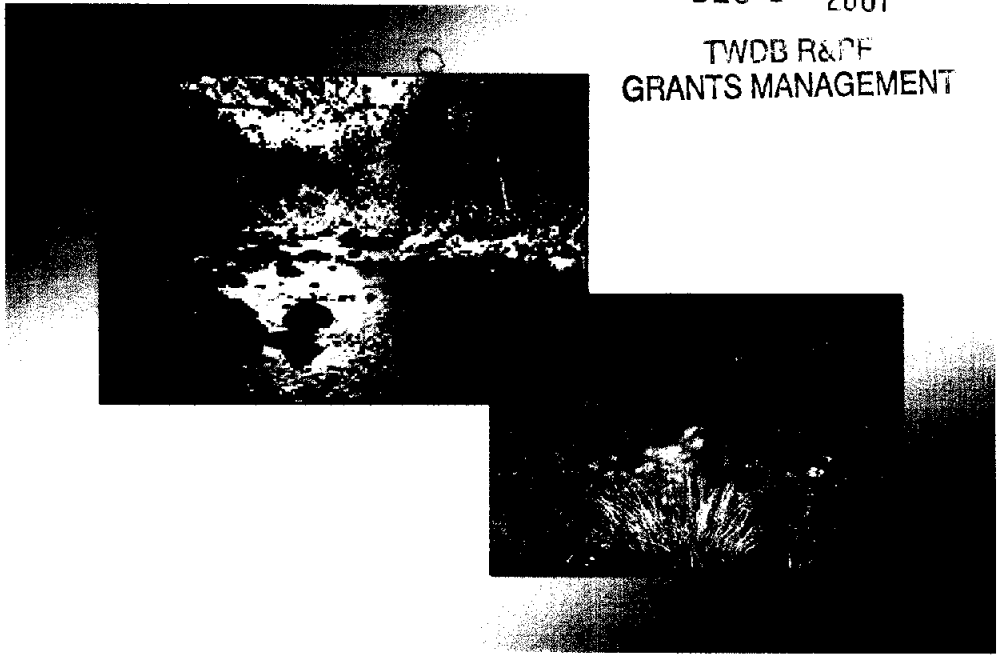
Final

**WOODCREEK MASTER DRAINAGE PLAN
Improvements to Hog Creek**

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City of Woodcreek, Texas



November 2001

Project No. 2000-33

Esney Consultants Inc.



**WOODCREEK MASTER DRAINAGE PLAN
Improvements to Hog Creek**

Prepared for:

City of Woodcreek
17 Wildwood Circle
Woodcreek, Texas 78676

Prepared by:

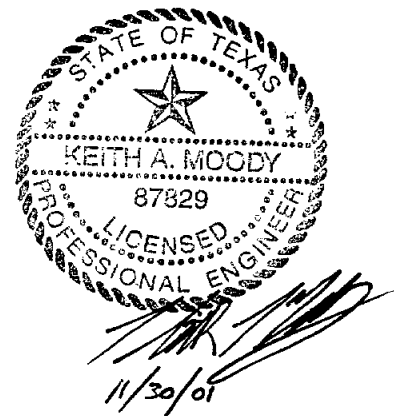
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1.0 INTRODUCTION

The City of Woodcreek currently comprises 586 housing units (single- and multi-family) and 346 vacant building lots spread over 686 acres. Woodcreek is bisected by a mile-long stretch of Hog Creek. Hog Creek originates about one mile northeast of Woodcreek in an unincorporated area of Hays County. It drains from the northeast to the southwest and empties into an amenity lake contained by a concrete covered dam which feeds into Cypress Creek.

The flow of water through Hog Creek is obstructed, causing a serious threat of flooding to area homes in heavy rains. Concrete culverts, built over 20 years ago, are placed too high to be effective, and the openings are too small to move water through the creek in high water periods. There is also a series of low concrete dams along Hog Creek originally built to create holding ponds, which further impede the flow of water. During years of normal rainfall, the creek stays almost full. Regular monthly rains of two inches or more send the water over the creek's banks into adjacent streets and yards.

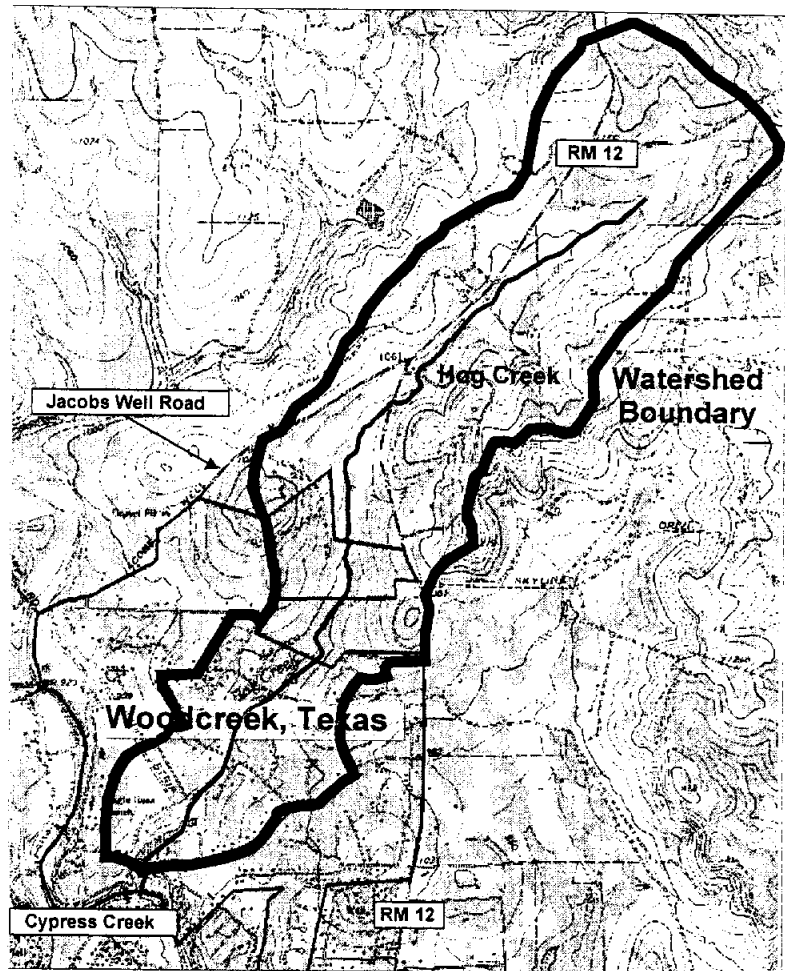


Figure 1 Site Location and Drainage Area Map

1.1 PURPOSE OF THIS REPORT

The purpose of this report is to identify and quantify the current flood conditions along Hog Creek, and prepare a cost effective plan to relieve flood prone areas along the creek. This report includes hydrologic analyses to estimate flow rates, hydraulic analyses to determine the water surface elevations, a cursory environmental survey of the area, preliminary construction cost estimates, and a recommended implementation plan.

This report does not include the evaluation of flooding in upland areas or local drainage ways including site grading, roadside ditches, etc.

A draft of this report was submitted to the Texas Water Development Board on August 17, 2001 and comments were received on November 27, 2001. The response to these comments can be found in *Appendix D* of this report.

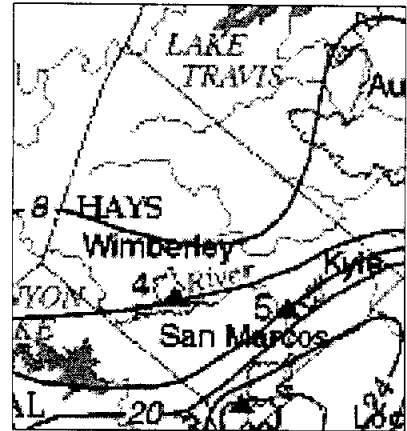
1.2 SPONSORS

Project sponsors include: City of Woodcreek, Hays County, Texas Water Development Board and Guadalupe Blanco River Authority. These sponsors contributed both financial and technical resources to development of this drainage plan.

1.3 HISTORICAL FLOODING

Historically, the City of Woodcreek has been subjected to extensive flooding from frequent four-inch or greater rain storms. Homes built just after the subdivision opened in the early 1970s were built before floodplain and flood way boundaries were defined. Although the City of Woodcreek does not allow construction in the floodplain now, there are many existing homes at risk of damage by high waters because of their low elevations.

During the heavy rains of June 1997 and October 1998, there was extensive street flooding and water damage to homes along the creek extending also into adjacent neighborhoods. A buildup of debris in the creek bed compounded by the ineffectiveness of the culverts and dams to keep the water moving caused the runoff to flood streets and homes. Access for most residents was completely blocked for the major part of the day during the October 1998 flooding. For the study area, the two-day rainfall totals for the June 1997 storm ranged from 3 to 4 inches, and the rainfall totals for the October 1998 storm range from 8 to 12 inches (Figure 2).



During the October 1998 storm event, Hog Creek was producing runoff depths over two feet deep across Brookhollow Drive, resulting in serious water damage to several nearby homes. Runoff was extensive on numerous city streets, with approximately one foot of water covering major routes and causing damage to streets and landscaping, washing away asphalt and lawns. Although no estimates of repair costs were accumulated, six homes suffered damage necessitating structural and/or interior repairs.



Figure 3 Photograph

The amount of runoff into Hog Creek has increased in volume during heavy rains since the surge in development upstream of a residential subdivision (Mountain Crest) in the unincorporated area of Hays County. Hog Creek is a deeply carved dry creek bed in this subdivision with occasional seepage from springs. There was no flooding of streets or homes in Mountain Crest during the heavy rains of 1997 and 1998. However, the runoff from the higher elevations in Mountain Crest resulted in

increased flow into the lower extension of Hog Creek across the Woodcreek community.

The city can only expect flooding to become more extensive due to the rapid rate of new home construction in the drainage area to the north. We can expect more frequent occurrences of flooding with less and less pervious soil remaining to absorb the water of even routine storms.

2.0 HYDROLOGIC ANALYSIS

2.1 METHOD OF ANALYSIS

Version 2.0.0 of the HEC-HMS computer program developed by the Hydrologic Engineering Center of the U. S. Army Corps of Engineers (USACE) is used in this analysis to estimate peak flow rates along Hog Creek. Peak flow rates are computed along the watercourse for the 10-year, 50-year, 100-year and 500-year frequency storm events. This section describes the input parameters used in this study and summarizes the results of the hydrologic analysis. Excerpts from the HEC-HMS model input and output are included in Appendix B.

2.2 PRECIPITATION

The design storms used in this analysis include a balanced rainfall distribution for a 24-hour duration. The precipitation depths for each design storm are taken from NOAA Technical Memorandum NWS Hydro-35 and Rainfall Frequency Atlas of the United States, Technical Paper 40 (TP 40).

Table 1 Precipitation Depths

Duration	Frequency				
	10-Year	50-Year	100-Year	500-Year	
5-min	0.64	0.80	0.88	1.04	HYDRO-35
15-min	1.40	1.75	1.90	2.15	
60-min	2.95	3.89	4.20	5.20	
2-hrs	3.60	4.75	5.40	6.50	TP 40
3-hrs	4.00	5.25	6.00	7.25	
6-hrs	4.80	6.50	7.20	8.80	
12-hrs	5.75	7.80	8.80	10.80	
24-hrs	6.75	8.90	10.00	12.30	

2.2.1 Drainage Area

The Hog Creek watershed is delineated using USGS 7 ½ minute quadrangle maps, and is subdivided into 2 subwatersheds: A and B (Exhibit 1). Subarea A extends to Mountain Crest Drive and includes a drainage area of 743.7 acres (1.162 square miles). Subarea B includes a drainage area of 336.6 acres (0.526 square miles). Subarea B extends to the #10 Tee box located near the upper end of a large amenity lake located near the end of the “landing strip.”

2.2.2 Infiltration Losses

The U.S. Department of Agriculture Natural Resource Conservation Service (NRCS, formerly the Soil Conservation Service) has developed a rainfall runoff index, the runoff curve number (CN), which takes into account such factors as soil characteristics, land use/land condition, and antecedent soil moisture to derive a generalized rainfall runoff relationship for a given area. A

description of these components and the equation for calculating runoff depth from rainfall are provided below.

The NRCS classifies soils into four hydrologic soil groups: A, B, C and D. These groups indicate the runoff potential of a soil, ranging from a low runoff potential (group A) to a high runoff potential (group D). Based on the information provided in the Soil Surveys of Hays County, C and D soil groups are predominant throughout this study area. C soils within the study area primarily include Bolar (BrB) and Brackett (BtD and BtG), while D soils primarily include Anhalt (AnB) and Comfort (CrD). Exhibit 2 provided in Appendix A includes a soils map of the area.

The NRCS provides runoff curve numbers for three Antecedent Moisture Conditions (AMC): I, II and III. AMC I represents dry soil conditions and AMC III represents saturated soil conditions. AMC II, which represents average soil moisture conditions, is assumed for this analysis. Runoff curve numbers vary from 0 to 100, with the smaller values representing lower runoff potential and the larger values representing higher runoff potential. A CN value of 75 approximately represents runoff potential for the soil types within the study area. Impervious cover values are entered separately from CN values into HEC-HMS model. It is assumed that 100% runoff is generated from impervious areas, while runoff from pervious areas is estimated using the selected CN value and the following equations:

$$Q = (P - 0.2 \times S)^2 / (P + 0.8 \times S) \quad \text{Equation 1}$$

and

$$CN = 1000 / (10 + S) \quad \text{Equation 2}$$

where:

- Q = depth of runoff (in),
- P = depth of precipitation (in),
- S = potential maximum retention after runoff begins, and
- CN = runoff curve number.

2.2.3 Unit Hydrograph Method

A rainfall/runoff transformation is required to convert rainfall excess (total rainfall minus infiltration losses) into runoff from a particular subarea. The NRCS unit hydrograph option in HEC-HMS is used in this analysis to generate runoff hydrographs for each defined subarea within the Hog Creek watershed. This method requires only one input parameter, lag time (T_{LAG}).

The dimensionless unit hydrograph developed by the NRCS (Figure 4) was developed by Victor Mockus and presented in National Engineering Handbook, Section 4, Hydrology, published by the U. S. Natural Resource Conservation Service. The dimensionless unit hydrograph has its ordinate values expressed in a dimension less ratio q/q_p and its abscissa values as t/T_p . This unit

hydrograph has a point of inflection approximately 1.7 times the time to peak (T_p), and the time-to-peak 0.2 of the time-of-base (T_b) (NRCS, 1985).

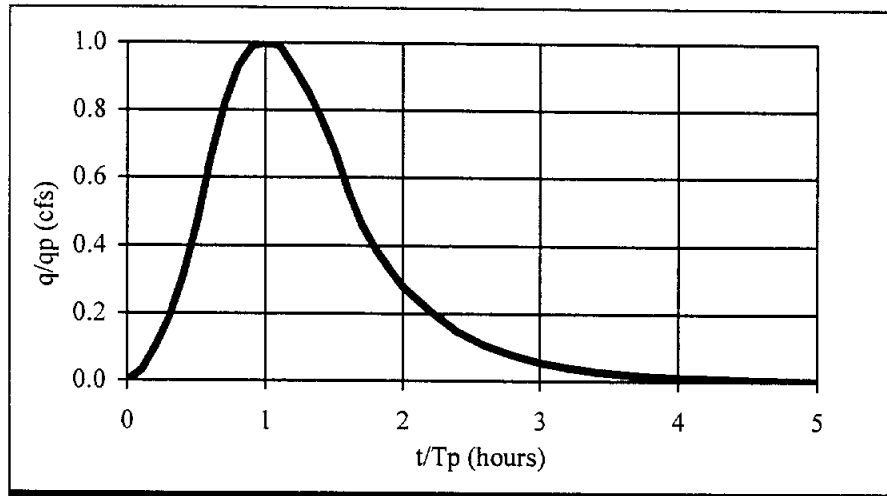


Figure 4 NRCS Unit Graph

Input data for this method consists of a single parameter, T_{LAG} , which is equal to the time (hours) between the center of mass of rainfall excess and the peak of the unit hydrograph. (NRCS, 1985)

The time to peak is computed using the following equation:

$$T_{PEAK} = \Delta t/2 + T_{LAG} \quad \text{Equation 3}$$

where:

- T_{PEAK} = time to peak of the unitgraph (hrs)
- Δt = computation interval / duration of unit excess (hrs)
- T_{LAG} = watershed lag (hrs)

The peak flow rate of the unitgraph is computed using the following equation:

$$qp = 484A/T_{PEAK} \quad \text{Equation 4}$$

where:

- qp = peak flow rate of the unitgraph (cfs/in)
- A = watershed area (sq mi)

2.2.4 Time of Concentration and Lag Time Computation

The NRCS method assumes that the lag time of a watershed is 60% of the watershed's time of concentration. The time of concentration is the time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed (NRCS, 1985). It may be estimated by calculating and summing the travel time for each sub-reach defined by the

flow type: sheet flow, shallow concentrated flow, roadway and storm sewers and channelized flow. The methods prescribed in the NRCS' Technical Release 55 (TR55) are used to determine the time of concentrations for each flow segment in this analysis. The watershed parameter worksheet used to calculate time of concentration and lag time for each subarea is presented in Appendices B. A detailed discussion of the methods used to estimate travel times for each typical flow segment is presented below.

• **Sheet Flow (< 300 feet)**

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact, drag over the plane surface, obstacles such as litter, crop ridges, and rocks, and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. For sheet flow less than 300 feet, travel time is computed as follows:

$$T_t = (0.007 \times (n \times L)^{0.8}) / (P_2^{0.5} \times s^{0.4}) \tag{Equation 5}$$

where

- T_t = travel time (hr),
- n = Manning's roughness coefficient,
- L = flow length (ft),
- P₂ = 2-year, 24-hour rainfall (in), and
- s = slope of hydraulic grade line (land slope, ft/ft).

• **Shallow Concentrated Flow**

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from the following figure (Figure 5) in which average velocity is a function of watercourse slope and type of channel.

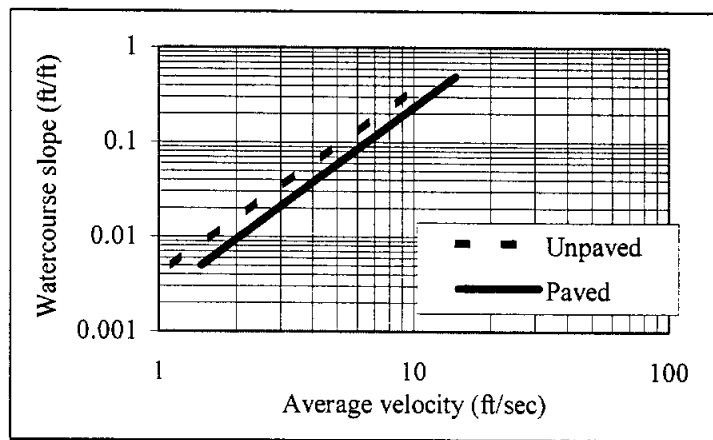


Figure 5 Average Velocities for Estimating Travel Time in Shallow Concentrated Flow Segments

After determining the average velocity, the following equation is used to compute travel time:

$$T_t = L / (3600 \times V) \tag{Equation 6}$$

Where;

- Tt = travel time (hr),
- L = flow length (ft),
- V = average velocity (ft/s), and
- 3600 = conversion factor from seconds to hours.

• Open Channel Flow

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation. Both open channel and closed conduit systems can be included.

Manning's equation is

$$V = 1.49 \times r^{2/3} \times s^{0.5} / n \quad \text{Equation 7}$$

where

- V = average velocity (ft/sec),
- r = hydraulic radius (ft) and is equal to a/p_w ,
- a = cross sectional flow area (ft²),
- p_w = wetted perimeter (ft),
- s = slope of the hydraulic grade line (channel slope, ft/ft), and
- n = Manning's roughness coefficient for open channel flow.

After determining the average velocity, equation 6 is used to compute travel time.

2.3 HYDROGRAPH ROUTING

The Kinematic Wave method of stream flow routing is used in this analysis to modify hydrographs to reflect the effects of translation and attenuation within a channel reach. The required input for this method includes: channel length (6,200 feet), channel slope (1.25%), Manning's roughness coefficient (0.04), channel bottom width (40 feet) and a representative channel side slope (10:1).

2.4 RESULTS

Tables 2 and 3 present the results of this hydrologic analysis for the existing conditions and the future full development conditions of the watershed. The existing conditions 100-year computed peak flow rate at Mountain Crest Drive (subarea A) is 2,708 cfs. The combined 100-year existing conditions flow near the project outfall (#10 Tee box) is 3,840 cfs. The corresponding

future 100-year computed peak flow rates at Mountain Crest Drive and the project outfall are 3,072 cfs and 4,376 cfs, respectively.

Table 2 Existing Conditions Computed Peak flow Rates

	Drainage Area (sq mi)	Computed Peak Flow Rates (cfs)				Flow Location
		10-Year	50-Year	100-Year	500-Year	
Subbasin A	1.162	1,635	2,402	2,708	3,458	Mountain Crest Drive
Subbasin B	0.526	912	2,384	1,477	1,857	
Total	1.688	2,293	3,394	3,840	4,938	Outfall near #10 Tee

Table 3 Future Conditions Computed Peak flow Rates

	Drainage Area (sq mi)	Computed Peak Flow Rates (cfs)				Flow Location
		10-Year	50-Year	100-Year	500-Year	
Subbasin A	1.162	2,004	2,777	3,072	3,819	Mountain Crest Drive
Subbasin B	0.526	1,072	1,472	1,626	1,998	
Total	1.688	2,826	3,947	4,376	5,466	Outfall near #10 Tee

Complete rainfall (depth and distribution) and peak flow rate information was not available for calibration in this study. However, the results of the analysis were reviewed by representatives of the Guadalupe-Blanco River Authority (GBRA), and compared with the values computed using the USGS regional regression equations published in WRIR 96-4307. The upper and lower confidence limits (67%) of the equations were computed to estimate a correlation and/or statistical expectation. The results are as follows for the 100 year design storm:

HEC-HMS 100-yr Design Storm: **4376 cfs**

100-yr regression equation upper limit: 5529 cfs

100-yr regression equation: 2731 cfs

100-yr regression equation lower limit: 1349 cfs

3.0 HYDRAULIC ANALYSIS

3.1 METHOD OF ANALYSIS

Version 2.2 (September 1998) of the HEC-RAS computer program developed by the Hydrologic Engineering Center (HEC) of the US Army Corps of Engineers is used in this analysis to compute water surface elevations along the existing channel reach. Water surface elevations are computed for the 10-year, 50-year, 100-year and 500-year frequency storm events. HEC-RAS model output is included in Appendix C. The following sections describe the primary model input parameters and the results of the analysis.

3.1.1 Starting Condition

The starting condition for the downstream boundary condition is set at critical depth for all profiles.

3.1.2 Peak Flow Rates

The computed peak flow rates presented in the previous section are used in this analysis to estimate the 10-year, 50-year, 100-year and 500-year water surface elevations along the creek.

3.1.3 Channel Geometry

Channel cross section data used in the model is based on field survey data collected along the creek specifically for this project. Survey data is tied to FEMA benchmarks and includes each culvert crossing, significant hydraulic features and representative channel sections.

3.1.4 Manning Roughness Coefficients

For open channel flow, the HEC-RAS computer program computes water surface elevations for each cross-section based on the energy equation and the standard step method. Typically, Manning's equation is used by the program to estimate head losses from one cross-section to the next. Channel roughness coefficients typically range from approximately 0.035 to 0.040 for grass lined channels, may increase to about 0.06 to 0.08 for poorly maintained channels with high weeds and small trees.

3.2 RESULTS

Tables 4 and 5 present the computed water surface elevations from the hydraulic analysis of the existing and future development conditions of the watershed, respectively. Exhibit 3a illustrates the current floodplain delineation along Hog Creek published by FEMA, and Exhibit 3b illustrates the floodplain delineations for the "revised" existing and future conditions of Hog Creek without improvements. Exhibit 4a and 4b illustrate the stream profiles for the "revised" existing and future conditions of the watershed, respectively.

Table 4 Existing Conditions Computed Water Surface Elevations

Station (feet)	500-Year		100-Year		50-Year		10-Year		Description	
	Flow Rate (cfs)	CWSEL (feet)	Flow Rate (cfs)	CWSEL (feet)	Flow Rate (cfs)	CWSEL (feet)	Flow Rate (cfs)	CWSEL (feet)		
10+00	4,938	943.50	3,840	943.28	3,394	943.12	2,293	942.47	near outfall (#10 Tee)	
10+67	4,938	944.56	3,840	944.22	3,394	944.07	2,293	943.69		
11+18	4,938	944.96	3,840	944.68	3,394	944.56	2,293	944.12		
11+19	4,938	945.91	3,840	945.60	3,394	945.46	2,293	945.09		
18+19	4,444	953.02	3,463	952.57	3,063	952.36	2,074	951.77		
18+84	4,444	953.53	3,463	952.90	3,063	952.90	2,074	952.90		
19+09										Brookhollow Dr.
19+34	4,444	955.43	3,463	955.11	3,063	954.96	2,074	954.57		
19+91	4,444	955.38	3,463	955.00	3,063	954.71	2,074	954.49		
20+92	4,444	953.62	3,463	955.55	3,063	955.49	2,074	954.90		
21+02	4,444	955.68	3,463	955.38	3,063	955.06	2,074	954.56		
22+26	4,444	956.80	3,463	956.33	3,063	956.14	2,074	955.38		
33+12	4,198	969.96	3,274	969.35	2,898	969.04	1,964	968.19		
33+35	4,198	970.70	3,274	970.15	2,898	969.87	1,964	969.03	Brookmeadow Dr.	
33+43										
33+72	4,198	971.48	3,274	970.95	2,898	970.75	1,964	970.15		
34+44	4,198	970.22	3,274	969.55	2,898	970.62	1,964	970.17		
34+84	4,198	972.05	3,274	971.53	2,898	971.29	1,964	970.58		
34+95									driveway	
35+05	4,198	973.02	3,274	972.51	2,898	972.28	1,964	971.62		
36+81	4,198	975.39	3,274	974.83	2,898	974.58	1,964	973.90	Brookside Dr.	
36+96										
37+11	4,198	976.43	3,274	975.98	2,898	975.76	1,964	975.13		
37+41	4,198	976.47	3,274	976.06	2,898	975.85	1,964	975.24		
40+20	4,198	978.59	3,274	978.12	2,898	977.92	1,964	977.43		
40+48	4,198	979.19	3,274	978.71	2,898	978.48	1,964	977.76		
57+37	4,198	1,003.14	3,274	1,002.08	2,898	1,001.61	1,964	1,000.25		
57+68							Culvert		Mountain Crest Dr.	
57+98	4,198	1,007.26	3,274	1,006.45	2,898	1,006.19	1,964	1,005.51		
58+27	3,458	1,007.32	2,708	1,006.49	2,401	1,006.23	1,635	1,006.02		

Table 5 Future Conditions Computed Water Surface Elevations

Station (feet)	500-Year		100-Year		50-Year		10-Year		Description	
	Flow Rate (cfs)	CWSEL (feet)	Flow Rate (cfs)	CWSEL (feet)	Flow Rate (cfs)	CWSEL (feet)	Flow Rate (cfs)	CWSEL (feet)		
10+00	5,466	943.70	4,376	943.42	3,947	943.31	2,826	942.88	near outfall (#10 Tee)	
10+67	5,466	944.73	4,376	944.39	3,947	944.26	2,826	943.82		
11+18	5,466	945.86	4,376	945.51	3,947	945.36	2,826	944.97		
11+19	5,466	946.05	4,376	945.76	3,947	945.63	2,826	945.28		
18+19	4,917	953.20	3,941	952.80	3,557	952.61	2,552	952.07		
18+84	4,917	953.83	3,941	953.19	3,557	952.94	2,552	952.90		
19+09										Brookhollow Dr.
19+34	4,917	955.58	3,941	955.27	3,557	955.14	2,552	954.77		
19+91	4,917	955.50	3,941	955.18	3,557	955.03	2,552	954.60		
20+92	4,917	955.91	3,941	955.68	3,557	955.58	2,552	955.22		
21+02	4,917	956.68	3,941	956.66	3,557	955.45	2,552	954.77		
22+26	4,917	958.39	3,941	956.50	3,557	956.36	2,552	955.78		
33+12	4,643	970.17	3,724	969.65	3,362	969.41	2,415	968.60		
33+35	4,643	970.93	3,724	970.43	3,362	970.21	2,415	969.46		
33+43									Brookmeadow Dr.	
33+72	4,643	971.60	3,724	971.20	3,362	971.01	2,415	970.44		
34+44	4,643	971.02	3,724	970.88	3,362	970.79	2,415	970.41		
34+84	4,643	972.27	3,724	971.80	3,362	971.59	2,415	970.94		
34+95									driveway	
35+05	4,643	973.23	3,724	972.76	3,362	972.56	2,415	971.96		
36+81	4,643	975.64	3,724	975.11	3,362	974.88	2,415	974.25		
36+96									Brookside Dr.	
37+11	4,643	976.67	3,724	976.17	3,362	976.04	2,415	975.46		
37+41	4,643	976.68	3,724	976.23	3,362	976.11	2,415	975.56		
40+20	4,643	979.60	3,724	978.93	3,362	978.67	2,415	977.92		
40+48	4,643	980.43	3,724	979.59	3,362	979.28	2,415	978.21		
57+37	4,643	1,003.63	3,724	1,002.60	3,362	1,002.18	2,415	1,000.94		
57+68									Mountain Crest Dr.	
57+98	4,643	1,004.23	3,724	1,006.82	3,362	1,006.52	2,415	1,005.20		
58+27	3,819	1,008.31	3,072	1,006.87	2,777	1,006.57	2,004	1,006.04		

4.0 PROPOSED IMPROVEMENTS

The proposed improvements to Hog Creek include four (4) primary components: a bridge upgrade at Brookhollow Drive, channel improvements downstream of Brookhollow Drive to outfall at the amenity lake, a roadside ditch along Cypress Point Road and the adoption of watershed management practices. The following sections describe these recommendations.

4.1 BRIDGE UPGRADE AT BROOKHOLLOW

The proposed low water crossing at Brookhollow Drive should be upgraded to include an all weather bridge crossing. The proposed bridge opening developed in this study includes a bottom width of 70 feet, and a top width of 120 feet. The depth of the proposed bridge opening is 5.0 feet. The road surface would be raised approximately 1.0 foot.

This all weather crossing is required at this location to provide connectivity for emergency vehicles during storm events.

4.2 CHANNEL IMPROVEMENTS DOWNSTREAM OF BROOKHOLLOW DRIVE

The channel downstream of Brookhollow Drive should be improved to include a bottom width of 40 feet, 3:1 side slopes (horizontal : vertical) and a channel slope of 1.0% (ft/ft). The proposed channel will lie within the channel bed of the existing waterway, and should only have minimal conflicts with existing trees. The downstream end of the channel improvement will begin at the upper edge of the existing amenity lake, just east of the #10 Tee box. The existing top of bank of the amenity lake will serve as the starting flowline of the proposed channel, and preserve this rock outcrop feature and provide erosion control at the proposed channel outfall.

4.3 ROADSIDE DITCH AT CYPRESS POINT ROAD

A roadside ditch extending from Hog Creek west of the #10 Tee box along Cypress Point Road is proposed to divert drainage from the landing strip and Doolittle Drive to the amenity lake. There is currently no defined outfall to the amenity lake for these areas. The roadside ditch will include a 'V' shape with 3:1 side slopes and a varying depth of 2.0 to 4.0 feet. This roadside ditch will include the replacement of two (2) driveway crossings.

4.4 WATERSHED MANAGEMENT

Watershed management will include the improvements described above; however, in order to be effective in the long term, it will also be necessary to regulate future development in the floodplain in accordance with the National Flood Insurance Program (NFIP) and perform routine maintenance on Hog Creek to preserve flood conveyance.

4.4.1 Permitting and Regulatory Compliance

The NFIP is a Federal program enabling property owners in participating communities to purchase insurance protection against losses from flooding. Participation in the NFIP is based on an agreement between local communities and the Federal Government, which enables flood insurance to the citizens of the community, provided the community adopts and enforces a floodplain management ordinance.

At a minimum, the City of Woodcreek should formally adopt and enforce the criteria established by the NFIP for regulating development in the floodplain. In order to effectively regulate development in the Hog Creek floodplain, a request for Letter of Map Revision (LOMR) should be submitted to the Federal Emergency Management Agency (FEMA) to better define the limits of the floodplain and floodway defined on FEMA's Flood Insurance Rate Maps (FIRM).

4.4.2 Maintenance

Creek maintenance is an important means of ensuring continued, adequate conveyance. Specifically in the heavily wooded areas upstream of Brookhollow Drive, dead trees and limbs, and debris should be removed routinely. Maintenance may also include mowing as needed throughout the year.

In addition, the rock wall guard rail located at Brookmeadow Drive impedes the flow of the creek and should be removed. A more compatible guard rail system can be installed if necessary for safety considerations.

5.0 IMPLEMENTATION PLAN

5.1 REGULATORY COMPLIANCE

Prior to commencement of construction, it will be necessary to submit the project and appropriate permit applications to regulatory agencies. A detailed review and acquisition of the necessary permits for the construction of these project(s) exceeds the scope of this contract. However, a partial list and brief discussion of permits is included in the following subsections. This following list of agencies and corresponding permit activities is intended to be general in nature, and is not intended to represent an exhaustive search of this issue.

5.1.1 Federal Emergency Management Agency (FEMA)

The Nation Flood Insurance Act of 1968 was enacted by Title XIII of the Housing and Urban Development Act of 1968 (Public Law 90-448, August 1, 1968) to provide previously unavailable flood insurance protection to property owners in flood prone areas. The Federal Emergency Management Agency (FEMA) administers the National Flood Insurance Program (NFIP), however, if a local community elects to participate in the NFIP, the local government is primarily responsible for enforcement. Participating communities are typically covered by flood insurance studies (FIS) which define water surface profiles and flood plain boundaries through their communities.

Hog Creek, a tributary to Cypress Creek, is a studied stream in the current Hays County Flood Insurance Study (FIS) dated February 18, 1998. The approximate limits of the 100-year floodplain boundary (Zone A) is illustrated on Flood Insurance Rate Map (FIRM) Panel No. 48209C0094 E.

The results of the existing conditions analysis presented in this study may be submitted to FEMA in order to obtain a revision to the current FIRM. This requires a formal submittal to FEMA in the form of a request for a letter of map revision (LOMR). The proposed improvements included in this study may be submitted to FEMA with the appropriate fee in the form of a conditional letter of map revision (CLOMR). The purpose of a CLOMR is to gain assurance from FEMA that the proposed improvements will be effective in reducing the limits of the 100-year floodplain as described in this study. Formal submittals to FEMA in the form of a LOMR or CLOMR request exceeds the scope of this project.

5.1.2 U. S. Army Corps of Engineers (USACOE)

Pursuant to Section 404 of the Clean Water Act and the Rules and Regulations promulgated thereunder by the United States Environmental Protection Agency (EPA) and the United States Army Corps of Engineers (USACE), the filling or excavation of waters of the United States, including wetlands, with dredged or fill material, requires the issuance of a permit from the USACE (33 CFR Parts 320-330). For purposes of administering the Section 404 permit program, the USACE defines wetlands as follows:

Those areas that are inundated or saturated by surface or groundwater at a

frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas. (33 CFR 328.3)

The Corps of Engineers Wetlands Delineation Manual (Technical Report Y-87-1), issued by the USACE, in 1987, states that wetlands must possess three essential characteristics. These characteristics include, under normal circumstances: 1) the presence of hydrophytic (water-loving) vegetation, 2) hydric soils, and 3) wetland hydrology. If all three of these criteria are present on a particular property in areas larger than one-third acre in size, then a permit (general permit or nationwide permit) must be issued by the USACE in order to fill all or a portion of those areas.

All property owners within the United States and its territories must adhere to the provisions of the Clean Water Act. If any contemplated activity might impact waters of the United States, including adjacent or isolated wetlands. If jurisdictional wetlands are found to exist, then any activity which would involve filling, excavating, or dredging these wetlands would require the issuance of a permit.

Section 404 (b)(1) guidelines (40 CFR Part 230), established by the U. S. Environmental Protection Agency, constitute the substantive environmental criteria used in the evaluating activities regulated under Section 404 of the Clear Water Act. The purpose of these guidelines is to restore and maintain the chemical physical and biological integrity of waters of the United states through the control of discharge of dredged or fill material.

5.1.3 U. S. Environmental Protection Agency (EPA)

The Federal Clean Water Act of 1972 established several programs designed to protect and enhance the quality of the Nation's surface water. One of these programs, the National Pollutant Discharge Elimination Systems (NPDES) regulates construction activities disturbing more than five (5) acres of land. Any proposed project that involves clearing, grading, or excavating will be covered under the NPDES Storm Water Permit for Construction Activities as long as the project complies with the Storm Water Pollution Prevention Plan (SWPPP) and all other conditions associated with the NPDES storm water construction permit.

A Notice of Intent (NOI) must be filed with the U. S. Environmental Protection Agency at least 48 hours in advance of construction activities. Changes to the timing of the notification should be tracked to ensure that construction delays do not result from inadequate advance notification.

5.1.4 U. S. Fish and Wildlife Service (USFWS)

The U. S. Fish and Wildlife Service (USFWS), in the Department of the Interior, and the National Marine Fisheries Service (NMFS), in the Department of Commerce, share responsibility for administration of the Endangered Species Act (ESA). Generally the USFWS is responsible for terrestrial and freshwater species and migratory birds, while the NMFS deals with those species occurring in marine environments and anadromous fish.

Section 9 of the ESA prohibits take of federally listed endangered or threatened species without appropriate authorization. Take is defined in the ESA, in part as “killing, harming, or harassment” of a federally listed species, while incidental take is take that is “incidental to, and not the purpose of, otherwise lawful activities”.

Section 10 of the ESA provides a means for non-Federal projects resulting in take of listed species to be permitted subject to carefully prescribed conditions. Application for an incidental take permit is subject to a number of requirements, including preparation of a Habitat Conservation Plan by the applicant. In processing an incidental take permit application, the USFWS must comply with appropriate environmental laws, including the National Environmental Policy Act. Review of the application under Section 7 of the ESA is also required to ensure that permit issuance is not likely to jeopardize listed species. Section 10 issuance criteria require the USFWS to issue an incidental take permit if, after opportunity for public comment, it finds that:

1. the taking will be incidental;
2. the applicant will, to the maximum extent practicable, minimizing and mitigate the impacts of the taking;
3. the applicant will ensure that adequate funding and means to deal with unforeseen circumstances will be provided;
4. the taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild; and
5. the applicant will ensure that other measures that the USFWS may require as being necessary or appropriate will be provided.

The U. S. Fish and Wildlife Service should be contacted to determine the potential occurrence of and consequent impacts to any federal threatened and endangered species. In addition, the Corps of Engineers will require USFWS review of the project to ensure the project is in compliance with the Endangered Species Act prior to the issuance of a Section 404 permit.

5.1.5 Texas Natural Resource Conservation Commission (TNRCC)

The Texas Natural Resource Conservation Commission (TNRCC) has regulatory authority over: dam safety, the Edwards Aquifer, water rights, Texas Pollutant Discharge System and Section 404(b)(1) guidelines for specification of disposal sites for dredged or fill material. The following sections briefly describe these regulations.

- **Edwards Aquifer Rules**

The Edwards Rules (30 TAC Chapter 213) regulate activities having the potential for polluting the Edwards Aquifer and associated surface waters. The goals of the rules are the protection of existing and potential uses of groundwater and the maintenance of Texas Surface Water Quality Standards. The activities addressed are those that pose a threat to water quality in the recharge and transition zones. The rules apply in the Edwards Aquifer recharge, transition, and

contributing zones. The limits of this project(s) lie within the Edwards Aquifer contributing zone, and will require compliance with the Edwards Rules published June 1, 1999.

Construction of any regulated activity will require the submission of an application to, and the approval of the TNRCC. Each application is required to include the following:

1. Name of the development;
 2. A narrative description of the location of the project;
 3. A technical report (includes information prepared for NPDES SWPPP, description of permanent BMP's, measures to control stream bank erosion, method of wastewater disposal from the site, measures that will be used to contain any spill of static hydrocarbons or hazardous substances such as on a roadway or from a pipeline or temporary aboveground storage tank and indicate placement of permanent aboveground storage tank facilities (§213.24)); and
 4. Any additional information needed by the executive director for plan approval.
- Texas Pollutant Discharge Elimination System (TPDES)

On September 14, 1998, the U.S. Environmental Protection Agency (EPA) authorized Texas to implement its Texas Pollutant Discharge Elimination System (TPDES) program. TPDES is the state program to carry out the National Pollutant Discharge Elimination System (NPDES), a federal regulatory program to control discharges of pollutants to surface waters of the United States. The Texas Natural Resource Conservation Commission (TNRCC) will regulate the program. However, under terms of NPDES authorization, the EPA will retain administration of all EPA-issued storm water general permits until the existing permits expire. The expiration date for existing construction permits is July 7, 2003.

- Section 401 Water Quality Certification

Any activity requiring authorization under Section 404 of the Clean Water Act will also require a Section 401 water quality certification from the TNRCC. In Texas, these regulations are administered by the TNRCC.

- Texas Historical Commission

The Division of Antiquities Protection of the Texas Historical Commission coordinates the program by identifying and protecting important archeological and historic sites that may be threatened by public construction projects. This department coordinates the nomination of numerous sites as State Archeological Landmarks or for listing in the National Register of Historic Places. Designation is often sought by interested parties as the most effective way to protect archeological sites threatened by new development or vandalism. Applicable rules are found in the Texas Administrative Code, Title 13-Cultural Resources, Part II-Texas Historical Commission, Chapters 24-28.

The Corps of Engineers will require that the State Historical Preservation Officer (SHPO) review the project to ensure the project is in compliance with the National Historic Act prior to issuance of a Section 404 permit.

5.2 ENVIRONMENTAL INVENTORY

The environmental issues of this report have been developed by reference to existing information in published reports, maps, aerial photography, unpublished documents and communications from government agencies, individuals, and private organizations. These issues have been summarized to provide a general review level of the flora and fauna in the immediate area of Woodcreek beginning at the 10th tee box on the Woodcreek Golf Course and proceeding in a northerly direction to the water gap, an area outside the Woodcreek city limits. Generally, this discussion presents a cursory, screening level perspective on the environmental issues which may affect the study area.

Important species may be considered the local dominant (most abundant) species, species having some economic or recreational importance, those exhibiting disproportionate habitat impacts (habitat formers) as well as species listed, or proposed for listing, by either the State of Texas or the federal government (protected species) or Texas Organization for Endangered Species (TOES). There are numerous unlisted species, which are still of concern (due to their rarity, restricted distribution direct exploitation, or habitat vulnerability) yet have not been included in the following discussions. Typically, the level of detail required to obtain the distribution and life history of these species, so as to produce a substantive evaluation, would be beyond the scope of this screening level survey.

5.2.1 Environmental Setting

Woodcreek is located about 12 miles northeast of Canyon Reservoir in Hays county on the Edwards Plateau. Woodcreek is located in a valley of the Blanco River at about 800 to 900 ft-msl. Land use in Woodcreek is rural residential, suburban residential and recreational. Most of the surrounding land use is rangeland, which is typical for the region.

5.2.2 Tree Survey

In order to establish a typical distribution of native tree species, a representative section of Hog Creek beginning at Brookhollow Drive and continuing to Brookmeadow Drive in the City of Woodcreek was surveyed. The following types, and quantities of trees were located immediately adjacent to the creek.

Table 6 Representative Tree Survey

Name	Qty
Live Oak	10
Hackberry	1
Cedar Elm	50
Sycamore	13
Mountain Juniper	100
Willow	1
Red Oak	1
Bald Cypress	1

Sample taken between Brookhollow Dr. and Brookmeadow Dr.

5.2.3 Wetlands Inventory

Developed areas around Woodcreek total 99 percent, primarily residential, with about 1 percent wetland area adjacent to the creek. Based on the information provided on the U. S. Fish and Wildlife Service (USFWS) Inventory Maps dated 1992 (based on 7 ½ minute USGS Quadrangle, Driftwood, Texas), the study area includes two (2) primary areas: Hog Creek and the amenity lake. The following table provides a breakdown of the wetland designations presented on the inventory map.

Table 7 Wetlands Inventory

Identified Feature	Symbol	System	Subsystem	Class	Subclass	Water Regime	Special Modifiers
Hog Creek	P FO 1 A	Palustrine	n/a	Forested	Broad-Leaved Deciduous	Temporarily Flooded	n/a
Amenity Lake	P UB H h	Palustrine	n/a	Unconsolidated Bottom	n/a	Permanently Flooded	diked/impounded

5.2.4 Wildlife Habitat

Important species known to occur in Hays County, and which may have habitat within the study area are listed in Table 8. Although the species listed in the table do not necessarily occur within Woodcreek proper, this is a comprehensive list of species and their preferred habitats that have the potential to be present, along with others known to Comal and Hays Counties.

Table 8 Important Species Having Habitat or Known to Occur

Common Name	Scientific Name	Summary of Habitat Preference	Listing Entity			Potential Occurrence In County
			USFWS1	TPWD1	TOES2,3	
American Peregrine Falcon	Falco peregrinus anatum	Open country: cliffs		E	E	Nesting/Migrant
Arctic Peregrine Falcon	Falco peregrinus tundrius	Open country: cliffs		T	T	Nesting/Migrant
Black-capped Vireo	Vireo atricapillus	Semi-open broad-leaved shrublands	E	E	T	Nesting/Migrant
Blanco Blind Salamander	Eurycea robusta	Troglobitic: Stream bed of the Blanco River		T	T	Resident
Blanco River Springs Salamander	Eurycea pterophila	Subaquatic: Springs and caves of the Blanco River				Resident
Blue Sucker	Cycoreus elongatus	Channels and flowing pools with exposed bedrock		T	WL	Resident
Bracted Twistflower	Streptanthus bracteatus	Endemic: Shallow clay soils over limestone; rocky slopes			E	Resident
Cagle's Map Turtle	Graptemys caglei	Waters of the Guadalupe River Basin	C		C	Resident
Canyon Mock-Orange	Philadelphus ernestii	Edwards Plateau			WL	Resident
Cascade Caverns Salamander	Eurycea latitans	Endemic: Subaquatic: Springs and caves		T	T	Resident
Cave Myotis Bat	Myotis velifer	Colonial & cave dwelling: hibernates in limestone caves of Edwards Plateau				Resident
Comal Blind Salamander	Eurycea tridentifera	Endemic: Semi-troglobitic: Springs and waters of caves		T	T	Resident
Comal Springs Dryopid Beetle	Stygoparnus comalensis	Cling to objects in streams: adults fly especially at night	E			Resident
Comal Springs Riffle Beetle	Heterelmis comalensis	Comal and San Marcos Springs	E			Resident
Comal Springs Salamander	Eurycea sp. 8	Endemic: Comal Springs				Resident
Dark Noseburn	Tragis nigricans	Deciduous woodlands, clay or clay loams, mesic canyons			WL	Resident
Edwards Aquifer Diving Beetle	Haideoporus texanus	Habitat poorly known: known from artesian well				Resident
Edwards Plateau Spring Salamander	Eurycea sp. 7	Troglobitic: Edwards Plateau				Resident
Flint's Net-Spinning Caddisfly	Cheumatopsyche flinti	"a spring"				Resident
Fountain Darter	Etheostoma fonticola	San Marcos and Comal rivers: springs and spring-fed streams	E	E	E	Resident
Golden-Cheeked Warbler	Dendroica chrysoparia	Woodlands with oaks and old juniper	E	E	E	Nesting/Migrant
Guadalupe Bass	Micropterus treculi	Streams of eastern Edwards Plateau			WL	Resident
Henslow's Sparrow	Ammodramus henslowii	Weedy fields or cut over areas: bare ground for running and walking				Nesting/Migrant
Hill Country Wild-Mercury	Argythamnia aphoroides	Shallow to moderately deep clays: live oak woodlands			WL	Resident
Horseshoe Lipooth	Polygyra hippocrepis	Steep, wooded hillsides of Land Park in New Braunfels				Resident
Keeled Earless Lizard	Holbrookia propinqua	Coastal dunes, barrier islands and sandy areas				Resident
Lindheimer's Tickseed	Desmodium lindheimeri	Presumably flowers in mid-summer			WL	Resident
Peck's Cave Amphipod	Stygobromus pecki	Underground in Edwards aquifer	E			Resident
Plains Spotted Skunk	Spilogale putorius interrupta	Catholic: Wooded, brushy areas and tallgrass prairies				Resident
San Marcos Gambusia (extirpated)	Gambusia georgei	Endemic: upper San Marcos River	E	E	E	Resident
San Marcos Saddle-case Caddisfly	Protoptila arca	Syrit: well-oxygenated warm water 1-2 m deep				Resident
San Marcos Salamander	Eurycea nana	Headwaters of the San Marcos River	T	T	T	Resident
Spot-tailed Earless Lizard	Holbrookia lacerata	Oak-juniper woodlands and mesquite-prickly pear				Resident
Texas Amorphia	Amorpha roemeriana					Resident
Texas Blind Salamander	Eurycea rathbuni	Troglobitic: Caverns along 6 mile stretch of San Marcos Springs Fault	E	E	T	Resident
Texas Garter Snake	Thamnophis sirtalis annexens	Varied, especially wet areas, bottomlands and pastures				Resident
Texas Horned Lizard	Phrynosoma cornutum	Varied, sparsely vegetated uplands		T	T	Resident
Texas Mock-Orange	Philadelphus texensis	Endemic: Limestone cliffs and boulders in mesic stream bottoms and canyons			WL	Resident
Texas Salamander	Eurycea neotenes	Edwards Aquifer creek gravel bottoms, emergent vegetation, underground & rock ledges				Resident
Texas Wild-Rice	Zizania texana	Upper 2.5 km of the San Marcos River	E	E	E	Resident
Wanock's Coral Root	Hexalectris wanockii	Oak-juniper woodlands in mountain canyons: terraces along creekbeds				Resident
Whooping Crane	Grus americana	Potential migrant	E	E	E	Migrant
Zone-tailed Hawk	Buteo albonotatus	Arid, open country including deciduous or pine-oak woodland: nests in various habitats and sites		T	T	Nesting/Migrant

1 Texas Parks and Wildlife Department. Unpublished 1999. September 1999. Data and map files of the Texas Biological and Conservation Data System maintained by TPWD Wildlife Diversity Branch, Resource Protection Division, Austin, Texas.

2 Texas Organization for Endangered Species (TOES). 1995. Endangered, threatened, and watch list of Texas vertebrates. TOES Publication 10. Austin, Texas. 22 pp.

3 Texas Organization for Endangered Species (TOES). 1993. Endangered, threatened, and watch list of Texas plants. TOES Publication 9. Austin, Texas. 32 pp.

4 Texas Organization for Endangered Species (TOES). 1988. Invertebrates of Special Concern. TOES Publication 7. Austin, Texas. 17 pp.

E = Endangered

T = Threatened

E/PT = Proposed Endangered or Threatened

C = Candidate Category, Substantial Information

WL = Conservation Watch List

Blank = Rare, but no regulatory listing status

5.3 CONSTRUCTION PHASING

The construction phasing of this project should generally move from downstream to upstream. The proposed roadside ditch improvement should be constructed first in order to provide immediate service of runoff areas in the west, and diversion of runoff of stormwater as the main channel is being constructed. Once the main channel has been improved, the proposed bridge at Brookhollow Drive can be constructed.

5.4 PRELIMINARY CONSTRUCTION COST ESTIMATE

Table 9 presents the preliminary construction cost estimates for the improvements described in this report. These preliminary estimates are for planning purposes only, and are only intended to provide an order of magnitude of the actual construction cost. Once detailed field survey information has been collected and construction plans have been prepared for these improvements, a better estimate of the construction costs can be more accurately estimated.

Table 9 Preliminary Construction Cost Estimate

Channel Improvement	Unit	Quantity	Unit Price	Cost
mobilization	LS	1	\$ 10,000.00	\$ 10,000.00
excavation	CY	8,000	\$ 10.00	\$ 80,000.00
demolition of check dam	EA	2	\$ 2,000.00	\$ 4,000.00
erosion/sedimentation controls	LS	1	\$ 6,000.00	\$ 6,000.00
contingency	25%			\$ 22,500.00
engineering and surveying	15%			\$ 16,875.00
Total				\$ 139,375.00
Roadside Ditch Improvement				
mobilization	LS	1	\$ 10,000.00	\$ 10,000.00
excavation	CY	1,500	\$ 10.00	\$ 15,000.00
driveway culvert replacements	EA	2	\$ 3,000.00	\$ 6,000.00
revegetation	AC	1	\$ 1,000.00	
outfall / transition stabilization	LS	1	\$ 2,000.00	
erosion/sedimentation control	LS	1	\$ 2,000.00	\$ 2,000.00
contingency	25%			\$ 5,750.00
engineering and surveying	15%			\$ 4,312.50
Total				\$ 43,062.50
Bridge at Brookhollow Dr.				
mobilization	LS	1	\$ 10,000.00	\$ 10,000.00
demolition	LS	1	\$ 10,000.00	\$ 10,000.00
structure	LS	1	\$ 240,000.00	\$ 240,000.00
utilities	LS	1	\$ 10,000.00	\$ 10,000.00
erosion/sedimentation control	LS	1	\$ 2,000.00	\$ 2,000.00
contingency	25%			\$ 52,400.00
engineering and surveying	15%			\$ 47,160.00
Total				\$ 371,560.00

APPENDIX A - EXHIBITS

Exhibit 1	Drainage Area Map
Exhibit 2	Soil Map
Exhibit 3a	Floodplain: FEMA
Exhibit 3b	Floodplain: Revised Existing and Future
Exhibit 4a	Stream Profiles: Existing Conditions
Exhibit 4b	Stream Profiles: Future Conditions
Exhibit 5	Improvement Plan

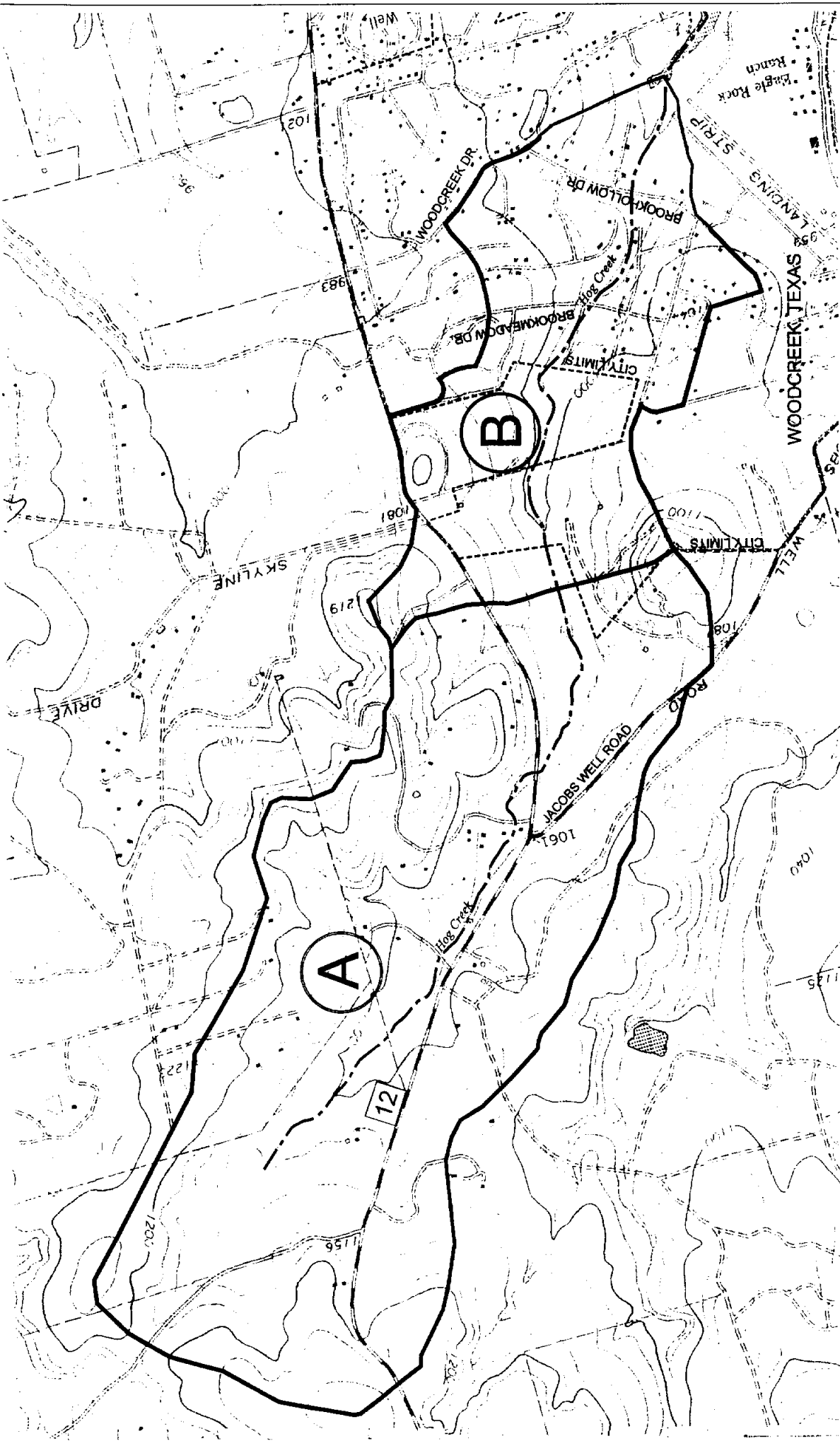


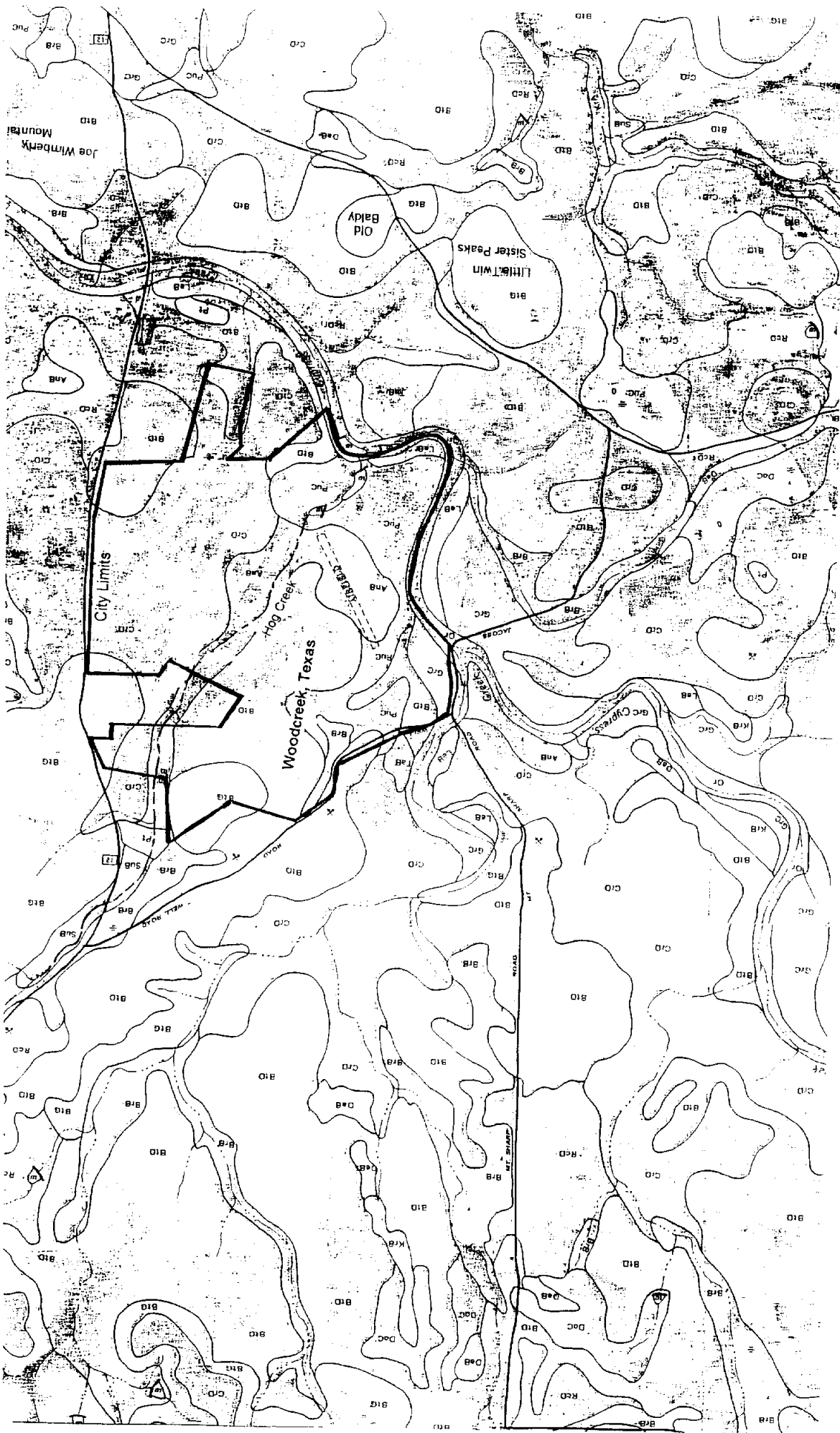
EXHIBIT 1
DRAINAGE AREA MAP
 WOODCREEK MASTER DRAINAGE PLAN

NOVEMBER, 2001

PROJECT NUMBER 200033

EC
 Espey Consultants, Inc.
 Environmental & Engineering Services





Espey Consultants, Inc.
 Environmental & Engineering Services

EXHIBIT 2
SOILS MAP
 WOODCREEK MASTER DRAINAGE PLAN

NOVEMBER 2001
 PROJECT NUMBER 2000-33

NATIONAL FLOOD INSURANCE PROGRAM

FIRM FLOOD INSURANCE RATE MAP

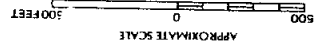
HAYS COUNTY, TEXAS AND INCORPORATED AREAS

(SEE MAP INDEX FOR PANELS NOT PRINTED)

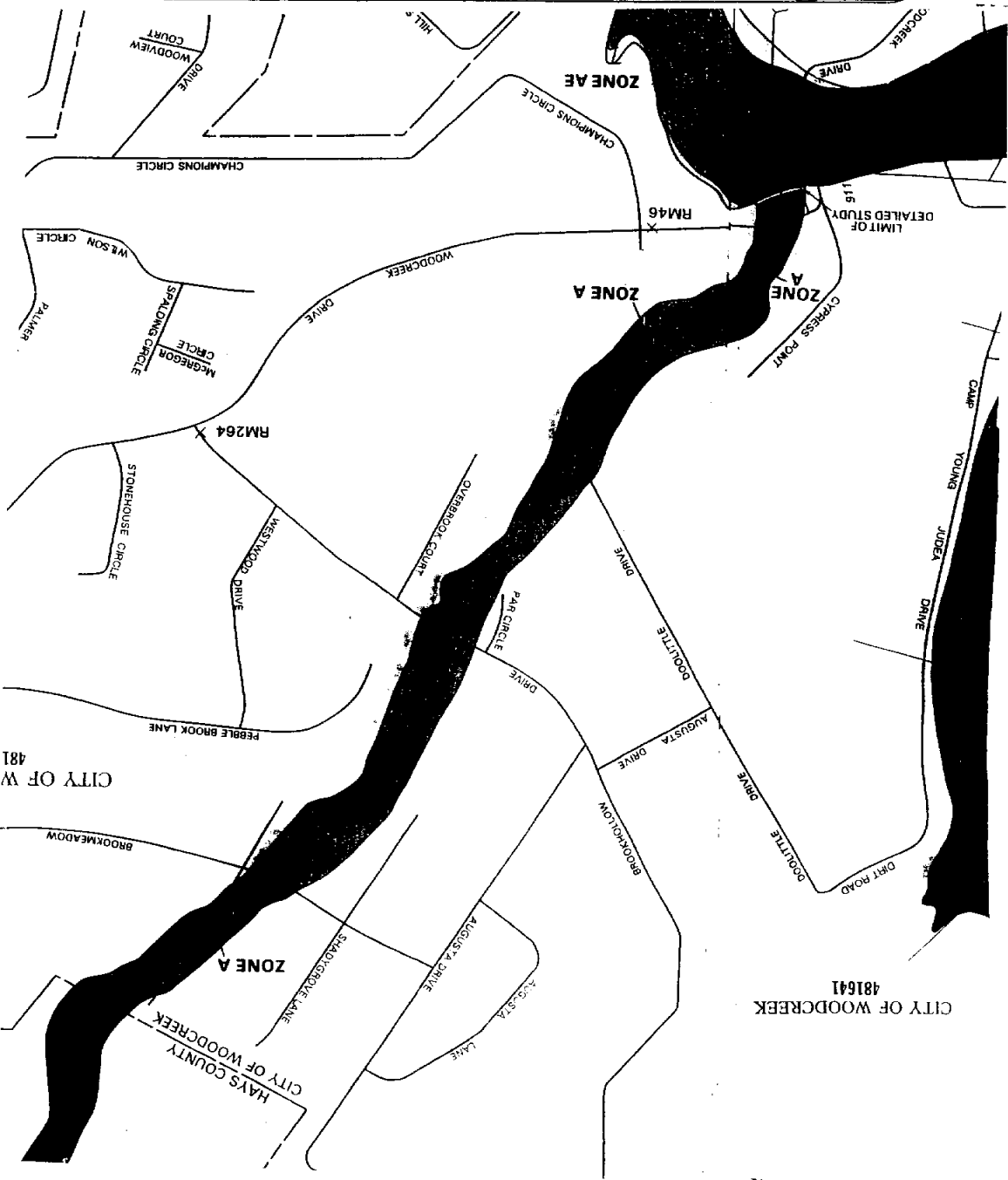
CONTAINS:

COMMUNITY	NUMBER	PANEL	SHEET
HAYS COUNTY	480321	0834	E
UNINCORPORATED AREAS	481641	0834	E
WOODCREEK, CITY OF			

MAP NUMBER
48209C0094 E
EFFECTIVE DATE:
FEBRUARY 18, 1998



Federal Emergency Management Agency

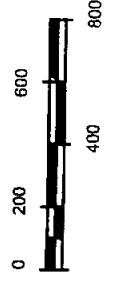
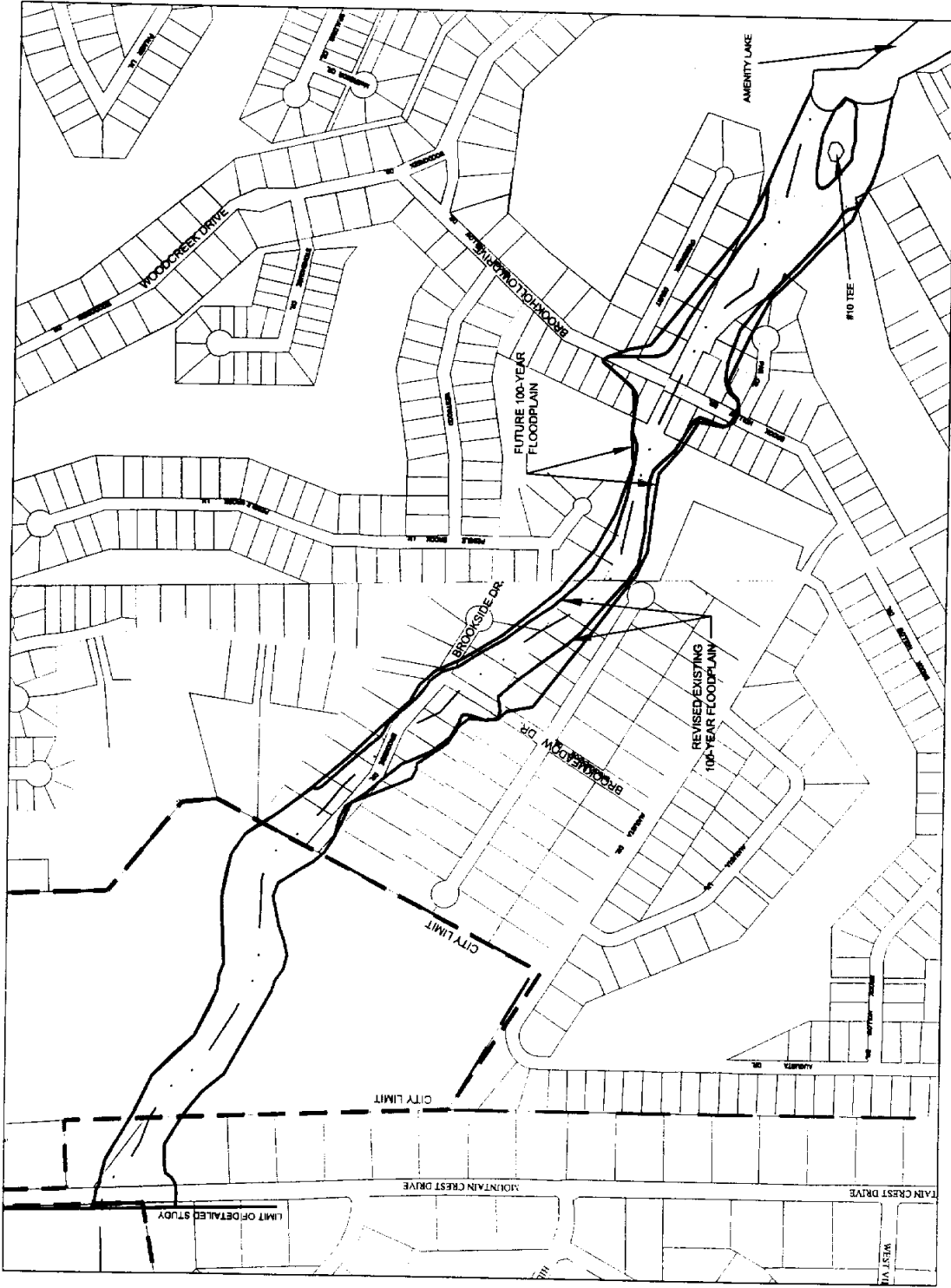


Note: Zone A floodplains indicate that no base flood elevations have been determined.

EC
Espey Consultants, Inc.
Environmental & Engineering Services

EXHIBIT 3a
FLOODPLAIN : FEMA
WOODCREEK MASTER DRAINAGE PLAN

NOVEMBER, 2001
PROJECT NUMBER 2000-33



Espey Consultants, Inc.
 Environmental & Engineering Services

EXHIBIT 3b
FLOODPLAIN: REVISED EXISTING & FUTURE
 WOODCREEK MASTER DRAINAGE PLAN
 NOVEMBER, 2001
 PROJECT NO. 2000-33

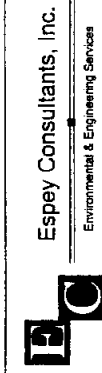
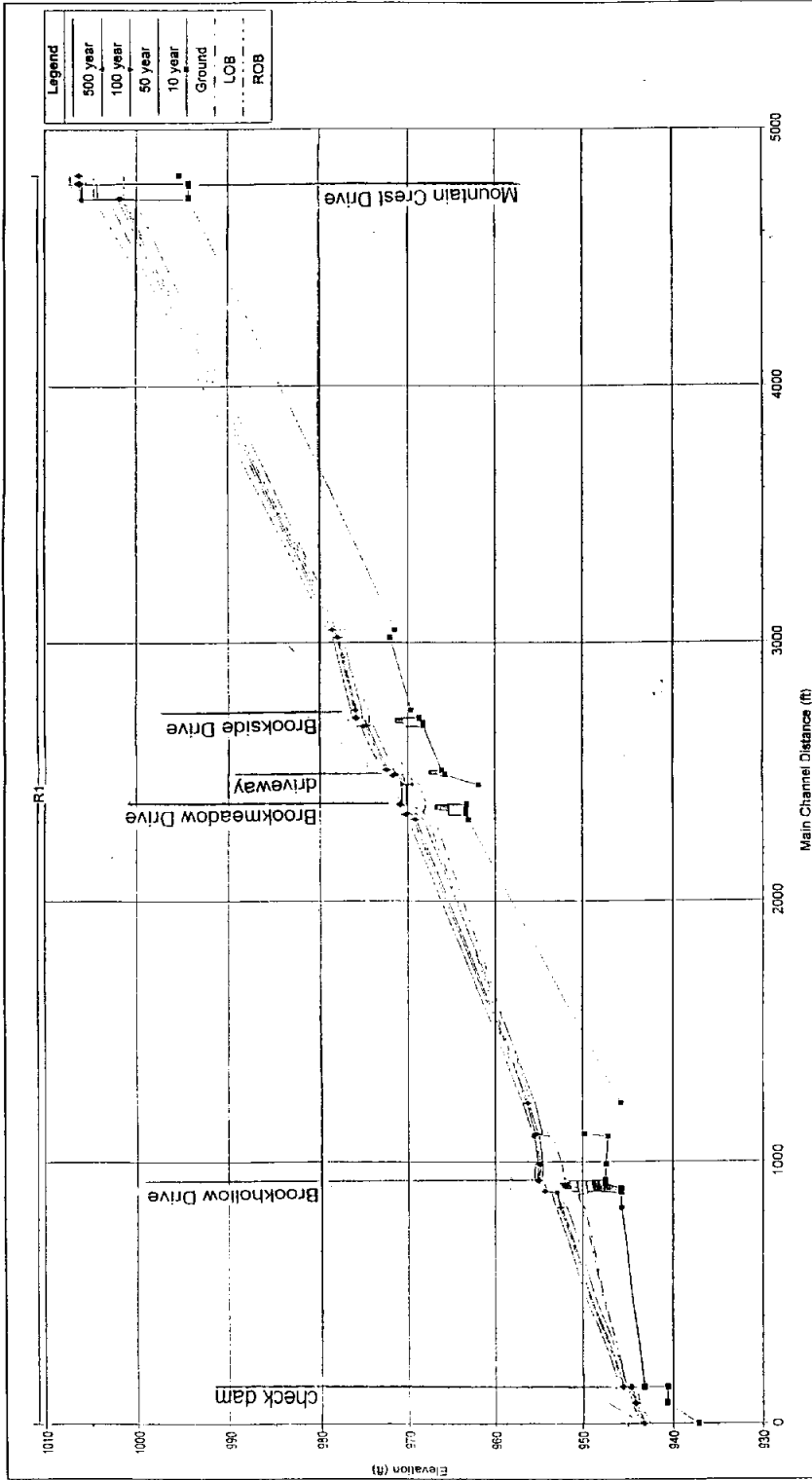
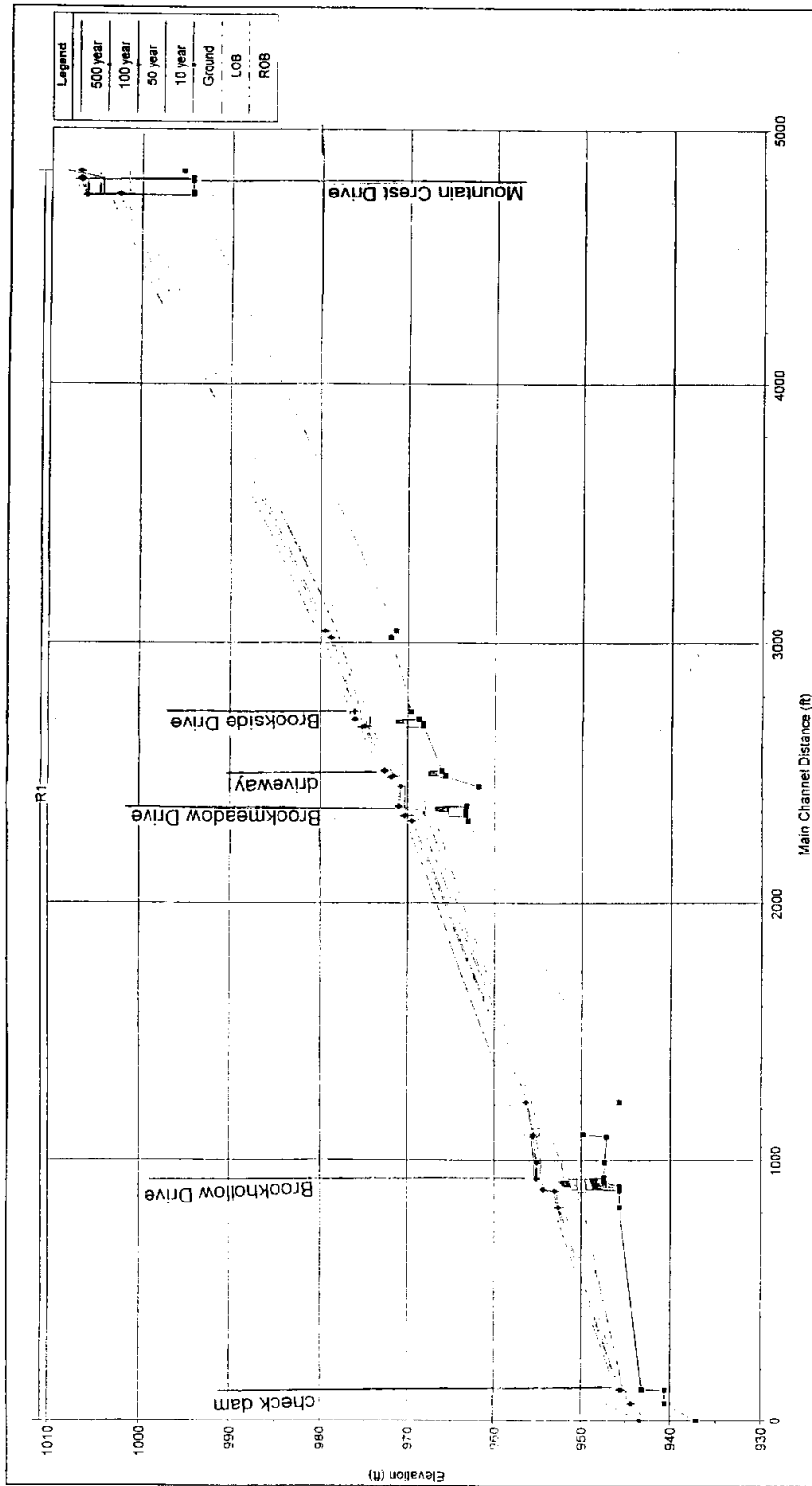


EXHIBIT 4a
STREAM PROFILES: REVISED EXISTING
CONDITIONS
 WOODCREEK MASTER DRAINAGE PLAN
 NOVEMBER, 2001 PROJECT NUMBER 2000-33



Note: Future watershed development conditions without channel improvements

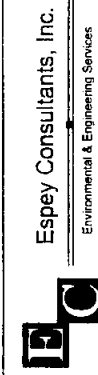
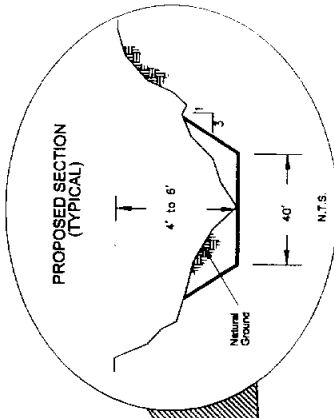
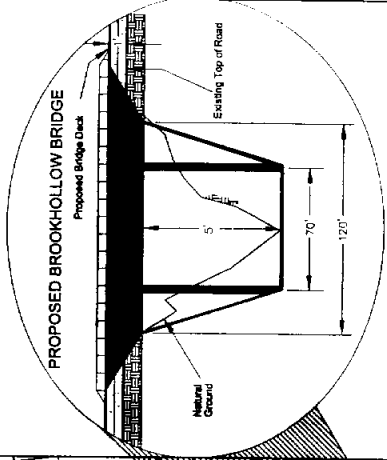


EXHIBIT 4b
STREAM PROFILES: FUTURE CONDITIONS
 WOODCREEK MASTER DRAINAGE PLAN
 NOVEMBER, 2001
 PROJECT NUMBER 2090-33



Espey Consultants, Inc.
Environmental & Engineering Services

EXHIBIT 5
HOG CREEK IMPROVEMENT PLAN
WOODCREEK MASTER DRAINAGE PLAN

NOVEMBER, 2001
PROJECT NO. 2000-33

APPENDIX B – HEC-HMS MODEL OUTPUT

Watershed Parameter Worksheet

Existing Conditions HOG_CREEK.HMS
 10-Year EX_10.LOG
 50-Year EX_50.LOG
 100-Year EX_100.LOG
 500-Year EX_500.LOG

Future Conditions HOG_CREEK.HMS
 10-Year ULT_10.LOG
 50-Year ULT_50.LOG
 100-Year ULT_100.LOG
 500-Year ULT_500.LOG

EXISTING CONDITION

TR-55 Method of Computing the Time of Concentration

			SUBAREA	
			A	B
Sheet Flow	variable	units		
Manning's roughness coef.	n	n/a	0.3	0.3
Flow Length	L	feet	200	200
2-year, 24-hour rainfall	P2	inches	4.1	4.1
Slope	s	ft/ft	0.0500	0.0500
Travel time (equation 3-3)	Tt	hours	0.303	0.303
Shallow Concentrated Flow		min.	18.2	18.2
Flow Length	L	feet	2,300	2,000
Slope	s	ft/ft	0.02	0.1200
Surface (1=paved or 2=unpaved)		n/a	2	2
Velocity (figure 3-1)	V	ft/sec	2.29	5.61
Travel time	Tt	hours	0.279	0.099
Manning's Equation		min.	16.7	5.9
Flow Length	L	feet	8,600	5,500
Slope	S	ft/ft	0.0125	0.0125
roughness	n	n/a	0.04	0.04
Open Channel				
Bottom Width	BW	feet	10	40
Side Slopes (H:1)	H	feet	6	10
Depth	d	feet	5	4
...or Closed Conduit				
Rise / Diameter	R / D	feet	0	0
Span (0 if circular)	S	feet	0	0
Cross-Sectional Area	X-A	feet ²	200.00	320.00
Flow Rate	Q	cfs	1659.57	2550.24
Velocity (figure 3-1)	V	ft/sec	8.30	7.97
Travel time	Tt	hours	0.288	0.192
Flow Length	L	feet	-	-
Slope	S	ft/ft	0.0210	0.0164
roughness	n	n/a	0.015	0.05
Open Channel				
Bottom Width	BW	feet	0	2
Side Slopes (H:1)	H	feet	0	7
Depth	d	feet	0	4
...or Closed Conduit				
Rise / Diameter	R / D	feet	2.5	0
Span (0 if circular)	S	feet	0	0
Cross-Sectional Area	X-A	feet ²	4.91	120.00
Flow Rate	Q	cfs	51.51	736.77
Velocity (figure 3-1)	V	ft/sec	10.49	6.14
Travel time	Tt	hours	-	-
Total Travel Time	TC	hours	0.870	0.594
	TC	min.	52.2	35.6
Lag Time	TL	hours	0.5219	0.3563
	TL	min.	31.3	21.4

Basin: Hog Creek - Existing

Description: Hog Creek Existing Conditions Model

Last Modified Date: 4 June 2001

Last Modified Time: 15:57:18

Version: 2.0.0

Unit System: English

Default DSS File Name: P:\active\2000-33 Woodcreek MP\Hec-hms\Hog_Creek\Hog_Creek.dss

End:

Junction: Landing Strip

Canvas X: 442.961

Canvas Y: 633.495

Label X: -37

Label Y: -38

End:

Reach: Reach-1

Canvas X: 442.961

Canvas Y: 633.495

From Canvas X: 515.777

From Canvas Y: 900.485

Label X: -61

Label Y: 0

Downstream: Landing Strip

Route: Kinematic Wave

Shape: Trapezoid

Length: 6200

Energy Slope: 0.0125

Width: 40

Side Slope: 10

Mannings n: 0.04

Number of Increments: 5

End:

Subbasin: Subbasin A

Description: Hog Creek Upper Watershed

Canvas X: 515.777

Canvas Y: 900.485

Label X: 13

Label Y: 27

Area: 1.162

Downstream: Reach-1

LossRate: SCS

Percent Impervious Area: 10

Curve Number: 75

Transform: SCS

Lag: 31.300000

Baseflow: Recession

End:

Subbasin: Subbasin B

Canvas X: 637.136

Canvas Y: 718.447
Label X: 16
Label Y: 0
Area: 0.526
Downstream: Landing Strip

LossRate: SCS
Percent Impervious Area: 15
Curve Number: 75

Transform: SCS
Lag: 21.400000

Baseflow: Recession

End:

Basin: Hog Creek - Ultimate
Description: Hog Creek Ultimate Conditions Model
Last Modified Date: 4 June 2001
Last Modified Time: 16:07:46
Version: 2.0.0
Unit System: English
Default DSS File Name: P:\active\2000-33 Woodcreek MP\Hec-
hms\Hog_Creek\Hog_Creek.dss
End:

Junction: Landing Strip
Canvas X: 442.961
Canvas Y: 633.495
Label X: -37
Label Y: -38
End:

Reach: Reach-1
Canvas X: 442.961
Canvas Y: 633.495
From Canvas X: 515.777
From Canvas Y: 900.485
Label X: -61
Label Y: 0
Downstream: Landing Strip

Route: Kinematic Wave
Shape: Trapezoid
Length: 6200
Energy Slope: 0.0125
Width: 40
Side Slope: 10
Mannings n: 0.04
Number of Increments: 5
End:

Subbasin: Subbasin A
Description: Hog Creek Upper Watershed
Canvas X: 515.777
Canvas Y: 900.485
Label X: 13
Label Y: 27
Area: 1.162
Downstream: Reach-1

LossRate: SCS
Percent Impervious Area: 50
Curve Number: 75

Transform: SCS
Lag: 29.200000

Baseflow: Recession
End:

Subbasin: Subbasin B
Canvas X: 637.136

Canvas Y: 718.447
Label X: 16
Label Y: 0
Area: 0.526
Downstream: Landing Strip

LossRate: SCS
Percent Impervious Area: 50
Curve Number: 75

Transform: SCS
Lag: 20.600000

Baseflow: Recession

End:

Precip: 10-Year
Last Modified Date: 4 June 2001
Last Modified Time: 16:31:12
Version: 2.0.0
Default DSS File Name: P:\active\2000-33 Woodcreek MP\Hec-
hms\Hog_Creek\Hog_Creek.dss
Unit System: English
Enable Evapotranspiration: No
Precipitation Method: Frequency Based Hypothetical
End:

Method Parameters: Frequency Based Hypothetical
Exceedence Frequency: 10
Single Hypothetical Storm Size: Yes
Convert to Annual Series: Yes
Storm Size: 1.69
Total Duration: 1440
Time Interval: 5
Percent of Duration Before Peak Rainfall: 50
Depth: 0.64
Depth: 1.4
Depth: 2.95
Depth: 3.6
Depth: 4
Depth: 4.8
Depth: 5.75
Depth: 6.75

End:

Subbasin: Subbasin A
End:

Subbasin: Subbasin B
End:

Precip: 50-Year
Last Modified Date: 23 March 2001
Last Modified Time: 08:56:49
Version: 2.0.0
Default DSS File Name: P:\active\2000-33 Woodcreek MP\Hec-
hms\Hog_Creek\Hog_Creek.dss
Unit System: English
Enable Evapotranspiration: No
Precipitation Method: Frequency Based Hypothetical
End:

Method Parameters: Frequency Based Hypothetical
Exceedence Frequency: 2
Single Hypothetical Storm Size: Yes
Convert to Annual Series: Yes
Storm Size: 1.69
Total Duration: 1440
Time Interval: 5
Percent of Duration Before Peak Rainfall: 50
Depth: 0.8
Depth: 1.75
Depth: 3.89
Depth: 4.75
Depth: 5.25
Depth: 6.5
Depth: 7.8
Depth: 8.9

End:

Subbasin: Subbasin A
End:

Subbasin: Subbasin B
End:

Precip: 100-Year
Last Modified Date: 4 June 2001
Last Modified Time: 16:08:15
Version: 2.0.0
Default DSS File Name: P:\active\2000-33 Woodcreek MP\Hec-
hms\Hog_Creek\Hog_Creek.dss
Unit System: English
Enable Evapotranspiration: No
Precipitation Method: Frequency Based Hypothetical
End:

Method Parameters: Frequency Based Hypothetical
Exceedence Frequency: 1
Single Hypothetical Storm Size: Yes
Convert to Annual Series: Yes
Storm Size: 1.69
Total Duration: 1440
Time Interval: 5
Percent of Duration Before Peak Rainfall: 50
Depth: 0.875
Depth: 1.9
Depth: 4.2
Depth: 5.4
Depth: 6
Depth: 7.2
Depth: 8.8
Depth: 10

End:

Subbasin: Subbasin A
End:

Subbasin: Subbasin B
End:

Precip: 500-Year
Last Modified Date: 4 June 2001
Last Modified Time: 16:15:13
Version: 2.0.0
Default DSS File Name: P:\active\2000-33 Woodcreek MP\Hec-
hms\Hog_Creek\Hog_Creek.dss
Unit System: English
Enable Evapotranspiration: No
Precipitation Method: Frequency Based Hypothetical
End:

Method Parameters: Frequency Based Hypothetical
Exceedence Frequency: 0.2
Single Hypothetical Storm Size: Yes
Convert to Annual Series: Yes
Storm Size: 1.69
Total Duration: 1440
Time Interval: 5
Percent of Duration Before Peak Rainfall: 50
Depth: 1.04
Depth: 2.15
Depth: 5.2
Depth: 6.5
Depth: 7.25
Depth: 8.8
Depth: 10.8
Depth: 12.3

End:

Subbasin: Subbasin A
End:

Subbasin: Subbasin B
End:

HMS * Summary of Results

Project : Hog Creek Run Name : Ex 10

Start of Run : 01Mar01 0600 Basin Model : Hog Creek - Existing
 End of Run : 02Mar01 1200 Met. Model : 10-Year
 Execution Time : 17Aug01 0955 Control Specs : Control 1

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Subbasin A	1635.1	01 Mar 01 1835	256.49	1.162
Reach-1	1628.7	01 Mar 01 1845	256.49	1.162
Subbasin B	912.33	01 Mar 01 1825	120.05	0.526
Landing Strip	2292.6	01 Mar 01 1840	376.54	1.688

HMS * Summary of Results

Project : Hog Creek Run Name : Ex 50

Start of Run : 01Mar01 0600 Basin Model : Hog Creek - Existing
 End of Run : 02Mar01 1200 Met. Model : 50-Year
 Execution Time : 17Aug01 0956 Control Specs : Control 1

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Subbasin A	2401.8	01 Mar 01 1835	380.89	1.162
Reach-1	2383.8	01 Mar 01 1845	380.91	1.162
Subbasin B	1316.7	01 Mar 01 1825	176.68	0.526
Landing Strip	3394.1	01 Mar 01 1835	557.59	1.688

HMS * Summary of Results

Project : Hog Creek Run Name : Ex 100

Start of Run : 01Mar01 0600 Basin Model : Hog Creek - Existing
 End of Run : 02Mar01 1200 Met. Model : 100-Year
 Execution Time : 17Aug01 0958 Control Specs : Control 1

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Subbasin A	2708.1	01 Mar 01 1835	444.25	1.162
Reach-1	2683.2	01 Mar 01 1845	444.26	1.162
Subbasin B	1476.8	01 Mar 01 1825	205.47	0.526
Landing Strip	3839.5	01 Mar 01 1835	649.73	1.688

HMS * Summary of Results

Project : Hog Creek Run Name : Ex 500

Start of Run : 01Mar01 0600 Basin Model : Hog Creek - Existing
 End of Run : 02Mar01 1200 Met. Model : 500-Year
 Execution Time : 17Aug01 0958 Control Specs : Control 1

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Subbasin A	3458.3	01 Mar 01 1835	578.94	1.162
Reach-1	3428.7	01 Mar 01 1840	579.15	1.162
Subbasin B	1856.5	01 Mar 01 1825	266.63	0.526
Landing Strip	4937.5	01 Mar 01 1835	845.78	1.688

HMS * Summary of Results

Project : Hog Creek Run Name : Ult 10

Start of Run : 01Mar01 0600 Basin Model : Hog Creek - Ultimate
 End of Run : 02Mar01 1200 Met. Model : 10-Year
 Execution Time : 17Aug01 0959 Control Specs : Control 1

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Subbasin A	2004.3	01 Mar 01 1835	326.14	1.162
Reach-1	1998.2	01 Mar 01 1840	326.26	1.162
Subbasin B	1071.5	01 Mar 01 1825	147.63	0.526
Landing Strip	2825.5	01 Mar 01 1835	473.89	1.688

HMS * Summary of Results

Project : Hog Creek Run Name : Ult 50

Start of Run : 01Mar01 0600 Basin Model : Hog Creek - Ultimate
 End of Run : 02Mar01 1200 Met. Model : 50-Year
 Execution Time : 17Aug01 0959 Control Specs : Control 1

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Subbasin A	2777.1	01 Mar 01 1835	456.19	1.162
Reach-1	2772.0	01 Mar 01 1840	456.27	1.162
Subbasin B	1472.4	01 Mar 01 1825	206.50	0.526
Landing Strip	3947.3	01 Mar 01 1835	662.77	1.688

HMS * Summary of Results

Project : Hog Creek Run Name : Ult 100

Start of Run : 01Mar01 0600 Basin Model : Hog Creek - Ultimate
 End of Run : 02Mar01 1200 Met. Model : 100-Year
 Execution Time : 17Aug01 0959 Control Specs : Control 1

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Subbasin A	3072.4	01 Mar 01 1835	521.62	1.162
Reach-1	3068.6	01 Mar 01 1840	521.79	1.162
Subbasin B	1625.8	01 Mar 01 1825	236.12	0.526
Landing Strip	4376.2	01 Mar 01 1835	757.91	1.688

HMS * Summary of Results

Project : Hog Creek Run Name : Ult 500

Start of Run : 01Mar01 0600 Basin Model : Hog Creek - Ultimate
 End of Run : 02Mar01 1200 Met. Model : 500-Year
 Execution Time : 17Aug01 1000 Control Specs : Control 1

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Subbasin A	3819.4	01 Mar 01 1835	659.65	1.162
Reach-1	3812.6	01 Mar 01 1840	659.95	1.162
Subbasin B	1997.9	01 Mar 01 1825	298.60	0.526
Landing Strip	5466.2	01 Mar 01 1835	958.56	1.688

HEC-RAS September 1998 Version 2.2
 U.S. Army Corp of Engineers
 Hydrologic Engineering Center
 609 Second Street, Suite D
 Davis, California 95616-4687
 (916) 756-1104

```

X  X  XXXXXX  XXXX  XXXX  XX  XXXX
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```

PROJECT DATA

Project Title: Hog Creek Existing
 Project File : HCexist.prj
 Run Date and Time: 8/8/01 4:46:52 PM

Project in English units

Project Description:
 Hog Creek Drainage Study

PLAN DATA

Plan Title: Hog Creek
 Plan File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Existing\HCexist.p01

Geometry Title: Hog Creek
 Geometry File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Existing\HCexist.g01

Flow Title : Flow Data
 Flow File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Existing\HCexist.f01

Plan Summary Information:

Number of: Cross Sections = 25 Multiple Openings = 0
 Culverts = 5 Inline Weirs = 0
 Bridges = 0

Computational Information

Water surface calculation tolerance = 0.01
 Critical depth calculation tolerance = 0.01
 Maximum number of iterations = 20
 Maximum difference tolerance = 0.3
 Flow tolerance factor = 0.001

Computation Options

Critical depth computed only where necessary
 Conveyance Calculation Method: At breaks in n values only
 Friction Slope Method: Average Conveyance
 Computational Flow Regime: Mixed Flow

FLOW DATA

Flow Title: Flow Data
 Flow File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Existing\HCexist.f01

Flow Data (cfs)

River	Reach	RS	PF 1	PF 2	PF 3	PF 4
Hog Creek	R1	5827	3458	2708	2401	1635
Hog Creek	R1	4084	4198	3274	2898	1964
Hog Creek	R1	2226	4444	3463	3063	2074
Hog Creek	R1	1119	4938	3840	3394	2293

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Hog Creek	R1	PF 1	Critical	Critical

GEOMETRY DATA

Geometry Title: Hog Creek
 Geometry File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Existing\HCexist.g01

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 5827

INPUT

Description:
 Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	1015.89	122	1014.43	139	1009.46	150	1004.71
163	995.35	175	996.26	187	998.87	207	1000.93
270	1001.42	303	1002.26	343	1003.08	376	1003.69
452	1006.34	496	1008.35	531	1009.41	416	1004.94

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	150	.04	270	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 150 270 29 29 29 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 5798

APPENDIX C – HEC-RAS MODEL OUTPUT

Existing Conditions HCEXIST.PRJ
Future Conditions (without improvements)..... HCDEVELOPED.PRJ
Future Conditions (with improvements)..... HCPROPOSED.PRJ

INPUT
 Description:
 Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	1015.89	122	1014.43	139	1009.46	150	1004.71	159	996.92
163	996.55	175	997.45	187	994.32	207	1000.93	241	1000.85
270	1001.42	303	1002.26	343	1003.08	378	1003.69	416	1004.94
452	1006.34	496	1008.35	531	1009.41				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	150	.04	270	.04

 Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

Left	Right	Lengths	Left Channel	Right	Coeff	Contr.	Expan.
150	270		61	61		.1	.3

 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	153	1010.4	193	531	1006

CULVERT RIVER: Hog Creek
 REACH: R1 RS: 5766

INPUT
 Description:
 Distance from Upstream XS = 10
 Deck/Roadway Width = 45
 Weir Coefficient = 2.6
 Bridge Deck/Roadway Skew =
 Upstream Deck/Roadway Coordinates
 num= 6

Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
122	1014.43				175	1007.64				207	1004.96			
241	1004.92				303	1004.92				416	1004.94			

Upstream Bridge Cross Section Data
 Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	1015.89	122	1014.43	139	1009.46	150	1004.71	159	996.92
163	996.55	175	997.45	187	994.32	207	1000.93	241	1000.85
270	1001.42	303	1002.26	343	1003.08	378	1003.69	416	1004.94
452	1006.34	496	1008.35	531	1009.41				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	150	.04	270	.04

 Bank Sta: Left Right Coeff Contr. Expan.

Left	Right	Coeff	Contr.	Expan.
150	270		.1	.3

 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	153	1010.4	193	531	1006

Downstream Deck/Roadway Coordinates
 num= 6

Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
122	1014.43				175	1007.64			
241	1004.92				303	1004.92			
					416	1004.94			

Downstream Bridge Cross Section Data
 Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	1015.89	122	1014.43	139	1009.46	150	1004.71	159	996.28
163	995.35	175	996.54	187	994.3	207	1000.93	241	1000.85
270	1001.42	303	1002.26	343	1003.08	378	1003.69	416	1004.94
452	1006.34	496	1008.35	531	1009.41				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	150	.04	270	.04

 Bank Sta: Left Right Coeff Contr. Expan.

Left	Right	Coeff	Contr.	Expan.
150	270		.1	.3

 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	153	1010.4	193	531	1006

Upstream Embankment side slope = 3 horiz. to 1.0 vertical
 Downstream Embankment side slope = 3 horiz. to 1.0 vertical
 Maximum allowable submergence for weir flow = .95
 Elevation at which weir flow begins =
 Energy head used in spillway design =
 Spillway height used in design =
 Weir crest shape = Broad Crested

Number of Culverts = 3

Culvert Name Shape Rise Span
 Culvert #1 Circular 10
 FHWA Chart # 2 - Corrugated Metal Pipe Culvert
 FHWA Scale # 3 - Pipe projecting from fill
 Solution Criteria = Highest U.S. EG
 Culvert Upstrm Dist Length n Value Entrance Loss Coef Exit Loss Coef

Upstrm Dist	Length	n Value	Entrance Loss Coef	Exit Loss Coef
5	60	.024	.5	1

 Upstream Elevation = 996.92
 Centerline Station = 159
 Downstream Elevation = 996.28
 Centerline Station = 159

Culvert Name Shape Rise Span
 Culvert #2 Circular 10
 FHWA Chart # 1 - Concrete Pipe Culvert
 FHWA Scale # 1 - Square edge entrance with headwall
 Solution Criteria = Highest U.S. EG
 Culvert Upstrm Dist Length n Value Entrance Loss Coef Exit Loss Coef

Upstrm Dist	Length	n Value	Entrance Loss Coef	Exit Loss Coef
5	60	.024	.5	1

 Upstream Elevation = 997.45
 Centerline Station = 175
 Downstream Elevation = 996.54
 Centerline Station = 175

Culvert Name Shape Rise Span
 Culvert #3 Circular 10
 FHWA Chart # 1 - Concrete Pipe Culvert

FHWA Scale # 1 - Square edge entrance with headwall
 Solution Criteria = Highest U.S. EG
 Culvert Upstrm Dist Length n Value Entrance Loss Coef Exit Loss Coef
 5 60 .024 .5 1
 Upstream Elevation = 994.32
 Centerline Station = 187
 Downstream Elevation = 994.3
 Centerline Station = 187

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 5737

INPUT

Description:
 Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	1015.89	122	1014.43	139	1009.46	150	1004.71	159	996.28
163	995.35	175	996.54	187	994.3	207	1000.93	241	1000.85
270	1001.42	303	1002.26	343	1003.09	378	1003.69	416	1004.94
452	1006.34	496	1008.35	531	1009.41				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	150	.04	270	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 150 270 1689 1689 1689 .1 .3
 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	153	1010.4	193	531	1006

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 4048

INPUT

Description:
 Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
90	980	135	977.42	155	977.13	166	973.67	170	972.76
172	971.92	176	971.47	180	971.78	184	972.59	199	974.7
209	978.13	248	979.93	290	980.47				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
90	.04	155	.04	209	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 155 209 28 28 28 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 4020

INPUT

Description:
 Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	981	129	978.08	153	976.4	175	973.06	179	972.06
186	972.02	195	973.29	212	976.6	225	978.3	267	980.4

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	129	.04	225	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 129 225 279 279 279 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 3741

INPUT

Description:
 Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980	145	974.75	157	971.82	163	971.04	191	971.18
197	969.69	200	969.62	203	969.87	207	971.13	219	971.52
226	972.31	242	973.04	257	974.4	342	977.01	590	980

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	145	.04	257	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 145 257 30 30 30 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 3711

INPUT

Description:
 Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980	176	974.75	206	971.42	225	971.69	235	968.72
238	968.72	248	971.58	290	973.04	305	974.4	590	980

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	176	.04	305	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 176 305 30 30 30 .1 .3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	232	971.6	241	590	971.6

CULVERT RIVER: Hog Creek
 REACH: R1 RS: 3696

INPUT

Description:
 Distance from Upstream XS = 4
 Deck/Roadway Width = 14
 Weir Coefficient = 2.6
 Bridge Deck/Roadway Skew =
 Upstream Deck/Roadway Coordinates

num= 2
 Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord
 225 971.69 248 971.58

Upstream Bridge Cross Section Data

Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980	176	974.75	206	971.42	225	971.69	235	968.72
238	968.72	248	971.58	290	973.04	305	974.4	590	960

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	176	.04	305	.04

Bank Sta: Left Right Coeff Contr. Expan.
 176 305 .1 .3
 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	232	971.6	241	590	971.6

Downstream Deck/Roadway Coordinates

num= 2
 Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord
 225 971.69 248 971.58

Downstream Bridge Cross Section Data

Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980	176	974.75	206	971.42	225	971.69	235	968.26
238	968.27	248	971.58	290	973.04	305	974.4	390	977.01

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	176	.04	305	.04

Bank Sta: Left Right Coeff Contr. Expan.
 176 305 .1 .3
 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	232	971.6	241	390	971.6

Upstream Embankment side slope = 3 horiz. to 1.0 vertical
 Downstream Embankment side slope = 3 horiz. to 1.0 vertical
 Maximum allowable submergence for weir flow = .95
 Elevation at which weir flow begins =
 Energy head used in spillway design =
 Spillway height used in design =
 Weir crest shape = Broad Crested

Number of Culverts = 1

Culvert Name Shape Rise Span
 Culvert #1 Circular 2
 FHNA Chart # 2 - Corrugated Metal Pipe Culvert
 FHNA Scale # 3 - Pipe projecting from fill
 Solution Criteria = Highest U.S. EG
 Culvert Upstrm Dist Length n Value Entrance Loss Coef Exit Loss Coef
 4 30 .024 .5 1

Number of Barrels = 2
 Upstream Elevation = 968.72
 Centerline Stations

Sta.	Sta.
235	238

 Downstream Elevation = 968.26
 Centerline Stations

Sta.	Sta.
235	238

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 3681

INPUT

Description:
 Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980	176	974.75	206	971.42	225	971.69	235	968.26
238	968.27	248	971.58	290	973.04	305	974.4	390	977.01

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	176	.04	305	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 176 305 176 176 176 .1 .3
 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	232	971.6	241	390	971.6

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 3505

INPUT

Description:
 Station Elevation Data num= 9

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980	232	970.05	236	969.87	261	968.32	275	968.09
288	966.15	315	968.68	339	970.06	539	977		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	232	.04	339	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 232 339 21 21 21 .1 .3
 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	284	967.7	292	539	968

CULVERT RIVER: Hog Creek
 REACH: R1 RS: 3495

INPUT

Description:
 Distance from Upstream XS = 5

```

Deck/Roadway Width      =      14
Weir Coefficient        =      2.6
Bridge Deck/Roadway Skew =
Upstream Deck/Roadway Coordinates
num=      3
Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
275 968.09                288 967.61                315 968.68

Upstream Bridge Cross Section Data
Station Elevation Data num=      9
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
100 980 232 970.05 236 969.87 261 968.32 275 968.09
288 966.15 315 968.68 339 970.06 539 977

Manning's n Values num=      3
Sta n Val Sta n Val Sta n Val
100 .04 232 .04 339 .04

Bank Sta: Left Right Coeff Contr. Expan.
232 339 .1 .3
Ineffective Flow num=      2
Sta L Sta R Elev Sta L Sta R Elev
100 284 967.7 292 539 968

Downstream Deck/Roadway Coordinates
num=      3
Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
275 968.09                288 967.61                315 968.68

Downstream Bridge Cross Section Data
Station Elevation Data num=      9
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
100 980 232 970.05 236 969.87 261 968.32 275 968.09
288 965.73 315 968.68 339 970.06 539 975

Manning's n Values num=      3
Sta n Val Sta n Val Sta n Val
100 .04 232 .04 339 .04

Bank Sta: Left Right Coeff Contr. Expan.
232 339 .1 .3
Ineffective Flow num=      2
Sta L Sta R Elev Sta L Sta R Elev
100 284 967.7 292 539 968

Upstream Embankment side slope =      3 horiz. to 1.0 vertical
Downstream Embankment side slope =      1 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =      .95
Elevation at which weir flow begins =
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape =      Broad Crested

Number of Culverts =      1

Culvert Name Shape Rise Span
Culvert #1 Circular .67
FHWA Chart # 1 - Concrete Pipe Culvert
FHWA Scale # 3 - Groove end entrance; pipe projecting from fill
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist Length n Value Entrance Loss Coef Exit Loss Coef
5 21 .013 .5 1

Number of Barrels =      2
Upstream Elevation =      966.15
Centerline Stations
Sta. Sta.
287 289
Downstream Elevation =      965.73
Centerline Stations
Sta. Sta.
287 289

CROSS SECTION RIVER: Hog Creek
REACH: R1 RS: 3484

INPUT
Description:
Station Elevation Data num=      9
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
100 980 232 970.05 236 969.87 261 968.32 275 968.09
288 965.73 315 968.68 339 970.06 539 975

Manning's n Values num=      3
Sta n Val Sta n Val Sta n Val
100 .04 232 .04 339 .04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
232 339 40 40 40 .1 .3
Ineffective Flow num=      2
Sta L Sta R Elev Sta L Sta R Elev
100 284 967.7 292 539 968

CROSS SECTION RIVER: Hog Creek
REACH: R1 RS: 3444

INPUT
Description:
Station Elevation Data num=      13
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
100 980 232 968.33 252 967.01 271 965.85 278 961.89
286 962.08 287 964.83 298 966.68 300 967.99 306 968.67
329 968.97 340 971.19 540 973

Manning's n Values num=      3
Sta n Val Sta n Val Sta n Val
100 .04 232 .04 306 .04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
232 306 72 72 72 .1 .3

CROSS SECTION RIVER: Hog Creek
REACH: R1 RS: 3372

INPUT

```

Description:
 Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980.02	124	977.45	158	972.83	184	970.89	244	966.41
273	965.6	278	963.56	281	963.24	287	966.15	322	967.9
452	970.32	490	971.6	590	976				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	184	.04	322	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 184 322 37 37 37 .1 .3
 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	275	966.91	284	590	966.91

CULVERT RIVER: Hog Creek
 REACH: R1 RS: 3343

INPUT
 Description:
 Distance from Upstream XS = 5
 Deck/Roadway Width = 16
 Weir Coefficient = 2.6
 Bridge Deck/Roadway Skew =
 Upstream Deck/Roadway Coordinates num= 6

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
184	970.89		250	966.93		296	966.91	
317	967.79		337	967.85		490	971.8	

Upstream Bridge Cross Section Data
 Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980.02	124	977.45	158	972.83	184	970.89	244	966.41
273	965.6	278	963.56	281	963.24	287	966.15	322	967.9
452	970.32	490	971.6	590	976				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	184	.04	322	.04

Bank Sta: Left Right Coeff Contr. Expan.
 184 322 .1 .3
 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	275	966.91	284	590	966.91

Downstream Deck/Roadway Coordinates num= 6

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
184	970.89		250	966.93		296	966.91	
317	967.79		337	967.85		490	971.8	

Downstream Bridge Cross Section Data
 Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980.02	124	977.45	158	972.83	184	970.89	239	968.24
250	966.42	274	965.97	290	963.37	303	963.37	317	967.35
337	968.09	490	971.6	590	976				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	239	.04	337	.04

Bank Sta: Left Right Coeff Contr. Expan.
 239 337 .1 .3
 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	291	966.91	301	590	966.91

Upstream Embankment side slope = 3 horiz. to 1.0 vertical
 Downstream Embankment side slope = 3 horiz. to 1.0 vertical
 Maximum allowable submergence for weir flow = .95
 Elevation at which weir flow begins =
 Energy head used in spillway design =
 Spillway height used in design =
 Weir crest shape = Broad Crested

Number of Culverts = 1

Culvert Name Shape Rise Span
 Culvert #1 Circular 2
 FHWA Chart # 2 - Corrugated Metal Pipe Culvert
 FHWA Scale # 3 - Pipe projecting from fill
 Solution Criteria = Highest U.S. EG
 Culvert Upstrm Dist Length n Value Entrance Loss Coef Exit Loss Coef
 5 37 .024 .5 1

Number of Barrels = 2
 Upstream Elevation = 963.24

Centerline Stations

Sta.	Sta.
278	281

Downstream Elevation = 963.37

Centerline Stations

Sta.	Sta.
293	298

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 3335

INPUT
 Description:
 Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980.02	124	977.45	158	972.83	184	970.89	239	968.24
250	966.42	274	965.97	290	963.37	303	963.37	317	967.35
337	968.09	490	971.6	590	976				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	239	.04	337	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 239 337 23 23 23 .1 .3
 Ineffective Flow num= 2
 Sta L Sta R Elev Sta L Sta R Elev
 100 291 966.91 301 590 966.91

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 3312

INPUT
 Description:
 Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
40	971	100	968.72	112	966.86	127	965.42	145	964.93
151	963.66	157	963.05	161	963.68	171	965.61	183	967.06
189	967.64	206	967.8	351	971.6				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
40	.04	112	.04	189	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 112 189 1086 1086 1086 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 2226

INPUT
 Description:
 Station Elevation Data num= 20

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	957.52	156	957.86	185	959.14	218	959.14	251	958.17
297	956.58	312	955.83	319	952.24	325	947.21	332	945.83
338	945.74	342	946.06	344	947.1	347	949.85	348	952.32
362	956.28	392	957.38	425	958.03	459	959.24	559	965.13

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	312	.04	362	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 312 362 124 124 124 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 2102

INPUT
 Description:
 Station Elevation Data num= 20

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
20	958	100	955.76	130	955.9	161	956.02	191	955.76
219	955.64	244	955.13	257	954.49	273	951.39	279	950.88
286	949.79	298	949.81	311	949.9	316	950.06	331	953.82
361	954.15	380	955.47	415	956.8	449	957.65	484	958.83

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
20	.04	257	.04	331	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 257 331 10 10 10 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 2092

INPUT
 Description:
 Station Elevation Data num= 21

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
20	958	100	955.76	130	955.9	161	956.02	191	955.76
219	955.64	244	955.13	259	954.06	272	951.02	274	949.55
280	948.74	286	947.63	297	947.33	306	947.18	314	949.38
331	953.46	362	954.15	381	955.47	416	956.8	450	957.65
485	958.83								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
20	.04	244	.04	331	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 244 331 101 101 101 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1991

INPUT
 Description:
 Station Elevation Data num= 17

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
56	956.66	98	954.83	186	954.17	300	954.6	303	953.52
321	953.58	335	952.97	339	949	342	947.81	367	947.39
370	949.38	372	951.15	382	952.31	403	952.14	433	953.16
459	954.27	491	956.57						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
56	.04	335	.04	382	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 335 382 57 57 57 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1934

INPUT
 Description:
 Station Elevation Data num= 20

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
56	956.66	98	954.83	143	953.73	186	953.02	300	952.77
320	952.45	341	951.83	344	950.96	346	949.09	353	947.55
361	947.45	373	948.73	376	948.43	380	952.09	396	952.19
419	952.47	471	954.05	543	955.33	588	956.58	634	958.58

Manning's n Values num= 3

Sta n Val Sta n Val Sta n Val
 56 .04 341 .04 380 .04
 Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 341 380 50 50 .1 .3
 Ineffective Flow num= 2
 Sta L Sta R Elev Sta L Sta R Elev
 56 347 952.85 363 634 952.9

CULVERT RIVER: Hog Creek
 REACH: R1 RS: 1909

INPUT

Description:
 Distance from Upstream XS = 13
 Deck/Roadway Width = 19
 Weir Coefficient = 2.6
 Bridge Deck/Roadway Skew =
 Upstream Deck/Roadway Coordinates
 num= 5
 Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord
 200 953.02 320 952.69 356 953.01
 396 952.69 471 954.05

Upstream Bridge Cross Section Data

Station Elevation Data num= 20
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 56 956.66 98 954.83 143 953.73 186 953.02 300 952.77
 320 952.45 341 951.83 344 950.96 346 949.09 353 947.55
 361 947.45 373 948.73 376 949.43 380 952.09 396 952.19
 419 952.47 471 954.05 543 955.33 588 956.58 634 958.58

Manning's n Values

num= 3
 Sta n Val Sta n Val Sta n Val
 56 .04 341 .04 380 .04

Bank Sta: Left Right Coeff Contr. Expan.
 341 380 .1 .3
 Ineffective Flow num= 2
 Sta L Sta R Elev Sta L Sta R Elev
 56 347 952.85 363 634 952.9

Downstream Deck/Roadway Coordinates

num= 7
 Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord
 192 953.02 300 952.45 338 952.13
 386 953.01 427 952.69 483 953.5
 573 955.33

Downstream Bridge Cross Section Data

Station Elevation Data num= 22
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 62 956.66 104 954.83 149 953.73 192 953.02 300 951.19
 322 950.66 338 949.45 351 950.43 361 949.16 373 947.62
 375 946.67 378 946.12 383 945.71 386 945.83 389 947.35
 398 947.87 407 950.55 427 950.8 454 951.38 483 951.78
 573 955.33 618 956.58

Manning's n Values

num= 3
 Sta n Val Sta n Val Sta n Val
 62 .04 351 .04 407 .04

Bank Sta: Left Right Coeff Contr. Expan.
 351 407 .1 .3
 Ineffective Flow num= 2
 Sta L Sta R Elev Sta L Sta R Elev
 62 373 952.8 393 618 952.9

Upstream Embankment side slope = 3 horiz. to 1.0 vertical
 Downstream Embankment side slope = 3 horiz. to 1.0 vertical
 Maximum allowable submergence for weir flow = .95
 Elevation at which weir flow begins =
 Energy head used in spillway design =
 Spillway height used in design =
 Weir crest shape = Broad Crested

Number of Culverts = 2

Culvert Name Shape Rise Span
 Culvert #2 Circular 2.5
 FHWA Chart # 2 - Corrugated Metal Pipe Culvert
 FHWA Scale # 3 - Pipe projecting from fill
 Solution Criteria = Highest U.S. EG
 Culvert Upstrm Dist Length n Value Entrance Loss Coef Exit Loss Coef
 3 41 .024 .5 1
 Upstream Elevation = 949.04
 Centerline Station = 349
 Downstream Elevation = 948.68
 Centerline Station = 375

Culvert Name Shape Rise Span
 Culvert #1 Circular 1
 FHWA Chart # 2 - Corrugated Metal Pipe Culvert
 FHWA Scale # 3 - Pipe projecting from fill
 Solution Criteria = Highest U.S. EG
 Culvert Upstrm Dist Length n Value Entrance Loss Coef Exit Loss Coef
 3 51 .024 .5 1
 Number of Barrels = 4
 Upstream Elevation = 949.62
 Centerline Stations
 Sta. Sta. Sta. Sta.
 351 353 355 360
 Downstream Elevation = 949.41
 Centerline Stations
 Sta. Sta. Sta. Sta.
 379 382 385 390

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1884

INPUT

Description:
 Station Elevation Data num= 22
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev

62	956.66	104	954.83	149	953.73	192	953.02	300	951.19
322	950.86	338	949.45	351	950.43	361	949.16	373	947.62
375	946.67	378	946.12	383	945.71	386	945.83	389	947.35
398	947.87	407	950.55	427	950.6	454	951.36	483	951.78
573	955.33	616	956.58						

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 62 .04 351 .04 407 .04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 351 407 65 65 65 .1 .3
 Ineffective Flow num= 2
 Sta L Sta R Elev Sta L Sta R Elev
 62 373 952.8 393 618 952.9

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1819

INPUT Description:
 Station Elevation Data num= 12
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 75 953.84 100 949.78 136 948.61 150 947.41 154 946.62
 162 945.69 166 945.83 170 947.53 185 949.78 215 950.07
 250 950.95 322 954.05

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 75 .04 100 .04 215 .04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 100 215 700 700 700 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1115

INPUT Description:
 Station Elevation Data num= 16
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 50 947 100 945.25 135 944.04 162 944.37 198 944.31
 234 944.54 251 944.02 270 943.64 295 943.34 323 943.31
 350 943.33 376 943.19 401 943.52 412 945.16 415 945.27
 445 947

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 50 .04 100 .04 412 .04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 100 412 1 1 1 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1118

INPUT Description:
 Station Elevation Data num= 20
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 100 945.25 135 944.04 162 944.37 198 944.31 234 944.54
 255 943.81 272 942.74 278 941.07 285 941.51 297 942.45
 298 943.2 334 943.31 359 942.97 367 941.75 376 941.21
 380 940.58 388 941.19 391 941.81 415 945.09 421 945.24

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 100 .04 100 .04 415 .04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 100 415 51 51 51 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1067

INPUT Description:
 Station Elevation Data num= 15
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 100 947.13 189 942 214 942.1 233 941.57 249 940.62
 272 941.85 296 942.92 321 943.08 338 942.34 358 942.57
 369 941.38 377 941.3 383 941.47 410 944.61 420 945.21

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 100 .04 100 .04 410 .04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 100 410 67 67 67 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1000

INPUT Description:
 Station Elevation Data num= 22
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 65 945.25 100 943.27 124 942.01 148 940.45 179 938.86
 184 939.55 189 938.82 200 939 202 937.17 212 937.73
 213 939.53 249 942.96 264 943.07 285 943.43 308 942.8
 345 941.53 362 942.16 376 942.23 386 942.28 420 942.25
 459 942.78 470 945.21

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 65 .04 100 .04 285 .04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 100 285 0 0 0 .1 .3

Profile Output Table - Standard Table 1

Reach	River Sta	Q Total (cfs)	Min Chl (ft)	El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
-------	-----------	---------------	--------------	---------	----------------	----------------	----------------	--------------------	-----------------	-------------------	----------------	--------------

R1	1819	2074.00	945.69	951.77	950.90	952.19	0.004724	5.39	418.96	181.15	0.54
R1	1119	4938.00	943.19	945.91	945.91	946.88	0.018158	7.91	632.16	344.95	0.99
R1	1119	3840.00	943.19	945.60	945.60	946.43	0.019623	7.34	526.28	330.55	1.00
R1	1119	3394.00	943.19	945.46	945.46	946.23	0.020363	7.06	481.84	324.32	1.00
R1	1119	2293.00	943.19	945.09	945.09	945.70	0.022635	6.28	365.40	306.96	1.01
R1	1118	4938.00	940.58	944.96	945.49	946.79	0.050395	10.85	455.09	305.58	1.57
R1	1118	3840.00	940.58	944.68	945.17	946.34	0.057438	10.34	371.27	295.47	1.63
R1	1118	3394.00	940.58	944.56	945.03	946.14	0.061009	10.08	336.61	291.19	1.65
R1	1118	2293.00	940.58	944.12	944.62	945.59	0.044967	9.74	235.51	170.41	1.46
R1	1067	4938.00	940.62	944.56	944.56	945.68	0.018371	8.49	581.35	264.89	1.01
R1	1067	3840.00	940.62	944.22	944.20	945.16	0.018191	7.76	494.80	256.27	0.98
R1	1067	3394.00	940.62	944.07	944.04	944.93	0.018277	7.44	455.97	252.31	0.98
R1	1067	2293.00	940.62	943.69	943.58	944.31	0.017052	6.33	362.12	242.46	0.91
R1	1000	4938.00	937.17	943.50	943.55	944.49	0.016066	8.56	658.34	366.41	0.96
R1	1000	3840.00	937.17	943.28	943.28	944.07	0.013566	7.63	576.53	346.75	0.87
R1	1000	3394.00	937.17	943.12	943.12	943.89	0.012781	7.42	525.26	328.78	0.85
R1	1000	2293.00	937.17	942.47	942.47	943.30	0.013140	7.40	338.13	247.60	0.85

HEC-RAS September 1998 Version 2.2
 U.S. Army Corp of Engineers
 Hydrologic Engineering Center
 609 Second Street, Suite D
 Davis, California 95616-4687
 (916) 756-1104

```

X   X   XXXXXX   XXXX   XXXX   XX   XXXX
X   X   X       X   X   X   X   X   X
X   X   X       X   X   Z   Z   X   X   X
XXXXXXXX XXXX   X       XXX XXXX XXXXXX XXXX
X   X   X       X       X   X   X   X   X
X   X   X       X   X   X   X   X   X   X
X   X   XXXXXX   XXXX   X   X   X   X   XXXX
    
```

PROJECT DATA

Project Title: Fully developed /Existing Hog Creek
 Project File : HCdeveloped.prj
 Run Date and Time: 8/8/01 5:17:56 PM

Project in English units

Project Description:
 Hog Creek Drainage Study

PLAN DATA

Plan Title: Plan 02
 Plan File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Develop\HCdeveloped.p02

Geometry Title: Hog Creek
 Geometry File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Develop\HCdeveloped.g01

Flow Title : Developed Flow Data
 Flow File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Develop\HCdeveloped.f02

Plan Summary Information:

Number of: Cross Sections = 25 Multiple Openings = 0
 Culverts = 5 Inline Weirs = 0
 Bridges = 0

Computational Information

Water surface calculation tolerance = 0.01
 Critical depth calculation tolerance = 0.01
 Maximum number of iterations = 20
 Maximum difference tolerance = 0.3
 Flow tolerance factor = 0.001

Computation Options

Critical depth computed only where necessary
 Conveyance Calculation Method: At breaks in n values only
 Friction Slope Method: Average Conveyance
 Computational Flow Regime: Subcritical Flow

FLOW DATA

Flow Title: Developed Flow Data
 Flow File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Develop\HCdeveloped.f02

Flow Data (cfs)

River	Reach	RS	PF 1	PF 2	PF 3	PF 4
Hog Creek	R1	5827	3819	3072	2777	2004
Hog Creek	R1	4084	4643	3724	3362	2415
Hog Creek	R1	2226	4917	3941	3557	2552
Hog Creek	R1	1119	5466	4376	3947	2826

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Hog Creek	R1	PF 1	Critical	Critical

GEOMETRY DATA

Geometry Title: Hog Creek
 Geometry File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Develop\HCdeveloped.g01

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 5827

INPUT

Description:

Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	1015.89	122	1014.43	139	1009.46	150	1004.71	159	998.37
163	995.35	175	996.26	187	998.87	207	1000.93	241	1000.85
270	1001.42	303	1002.26	343	1003.08	378	1003.69	416	1004.94
452	1006.34	496	1008.35	531	1009.41				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	150	.04	270	.04

Bank Sta: Left 150 Right 270 Lengths: Left Channel 29 Right Channel 29 Coeff Contr. .1 Expan. .3

CROSS SECTION RIVER: Hog Creek

REACH: R1 RS: 5798

INPUT

Description:

Station Elevation Data num= 18					
Sta	Elev	Sta	Elev	Sta	Elev
100	1015.89	122	1014.43	139	1009.46
163	996.55	175	997.45	187	994.32
270	1001.42	303	1002.26	343	1003.08
452	1006.34	496	1008.35	531	1009.41

Manning's n Values num= 3					
Sta	n Val	Sta	n Val	Sta	n Val
100	.04	150	.04	270	.04

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	150	270		61	61		.1	.3

Ineffective Flow num= 2					
Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	153	1010.4	193	531	1006

CULVERT RIVER: Hog Creek
REACH: R1 RS: 5768

INPUT

Description:

Distance from Upstream XS = 10
 Deck/Roadway Width = 45
 Weir Coefficient = 2.6
 Bridge Deck/Roadway Skew =

Upstream Deck/Roadway Coordinates num= 6									
Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
122	1014.43				175	1007.64			
241	1004.92				303	1004.92			
					416	1004.94			

Upstream Bridge Cross Section Data num= 18					
Sta	Elev	Sta	Elev	Sta	Elev
100	1015.89	122	1014.43	139	1009.46
163	996.55	175	997.45	187	994.32
270	1001.42	303	1002.26	343	1003.08
452	1006.34	496	1008.35	531	1009.41

Manning's n Values num= 3					
Sta	n Val	Sta	n Val	Sta	n Val
100	.04	150	.04	270	.04

Bank Sta:	Left	Right	Coeff	Contr.	Expan.
	150	270		.1	.3

Ineffective Flow num= 2					
Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	153	1010.4	193	531	1006

Downstream Deck/Roadway Coordinates num= 6									
Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
122	1014.43				175	1007.64			
241	1004.92				303	1004.92			
					416	1004.94			

Downstream Bridge Cross Section Data num= 18					
Sta	Elev	Sta	Elev	Sta	Elev
100	1015.89	122	1014.43	139	1009.46
163	995.35	175	996.54	187	994.3
270	1001.42	303	1002.26	343	1003.08
452	1006.34	496	1008.35	531	1009.41

Manning's n Values num= 3					
Sta	n Val	Sta	n Val	Sta	n Val
100	.04	150	.04	270	.04

Bank Sta:	Left	Right	Coeff	Contr.	Expan.
	150	270		.1	.3

Ineffective Flow num= 2					
Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	153	1010.4	193	531	1006

Upstream Embankment side slope = 3 horiz. to 1.0 vertical
 Downstream Embankment side slope = 3 horiz. to 1.0 vertical
 Maximum allowable submergence for weir flow = .95
 Elevation at which weir flow begins =
 Energy head used in spillway design =
 Spillway height used in design =
 Weir crest shape = Broad Crested

Number of Culverts = 3

Culvert Name Shape Rise Span
 Culvert #1 Circular 10
 FHWA Chart # 2 - Corrugated Metal Pipe Culvert
 FHWA Scale # 3 - Pipe projecting from fill
 Solution Criteria = Highest U.S. EG
 Culvert Upstrm Dist Length n Value Entrance Loss Coef Exit Loss Coef
 5 60 .024 .5 1
 Upstream Elevation = 996.92
 Centerline Station = 159
 Downstream Elevation = 996.28
 Centerline Station = 159

Culvert Name Shape Rise Span
 Culvert #2 Circular 10
 FHWA Chart # 1 - Concrete Pipe Culvert
 FHWA Scale # 1 - Square edge entrance with headwall
 Solution Criteria = Highest U.S. EG
 Culvert Upstrm Dist Length n Value Entrance Loss Coef Exit Loss Coef
 5 60 .024 .5 1
 Upstream Elevation = 997.45
 Centerline Station = 175
 Downstream Elevation = 996.54
 Centerline Station = 175

Culvert Name Shape Rise Span
 Culvert #3 Circular 10

FHWA Chart # 1 - Concrete Pipe Culvert
 FHWA Scale # 1 - Square edge entrance with headwall
 Solution Criteria = Highest U.S. EG
 Culvert Upstrm Dist Length n Value Entrance Loss Coef Exit Loss Coef
 5 60 .024 .5 1
 Upstream Elevation = 994.32
 Centerline Station = 187
 Downstream Elevation = 994.3
 Centerline Station = 187

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 5737

INPUT

Description:
 Station Elevation Data num= 19

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	1015.89	122	1014.43	139	1005.46	150	1004.71	159	996.28
163	995.35	175	996.54	187	994.3	207	1000.93	241	1000.85
270	1001.42	303	1002.26	343	1003.08	378	1003.69	416	1004.94
452	1006.34	496	1008.35	531	1009.41				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	150	.04	270	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 150 270 1689 1689 1689 .1 .3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	153	1010.4	193	531	1006

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 4048

INPUT

Description:
 Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
90	980	135	977.42	155	977.13	166	973.67	170	972.76
172	971.92	176	971.47	180	971.78	184	972.59	199	974.7
209	978.13	248	979.93	290	980.47				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
90	.04	155	.04	209	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 155 209 28 28 28 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 4020

INPUT

Description:
 Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	981	129	978.08	153	976.4	175	973.06	179	972.06
186	972.02	195	973.29	212	976.6	225	978.3	267	980.4

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	129	.04	225	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 129 225 279 279 279 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 3741

INPUT

Description:
 Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980	145	974.75	157	971.82	163	971.04	191	971.18
197	969.69	200	969.62	203	969.87	207	971.13	219	971.52
226	972.31	242	973.04	257	974.4	342	977.01	590	980

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	145	.04	257	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 145 257 30 30 30 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 3711

INPUT

Description:
 Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980	176	974.75	206	971.42	225	971.69	235	968.72
238	968.72	248	971.58	290	973.04	305	974.4	590	980

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	176	.04	305	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 176 305 30 30 30 .1 .3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	232	971.6	241	590	971.6

CULVERT RIVER: Hog Creek
 REACH: R1 RS: 3696

INPUT

Description:
 Distance from Upstream XS = 4
 Deck/Roadway Width = 14
 Weir Coefficient = 2.6
 Bridge Deck/Roadway Skew =

Upstream Deck/Roadway Coordinates

num= 2
 Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord
 225 971.69 248 971.58

Upstream Bridge Cross Section Data

Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980	176	974.75	206	971.42	225	971.69	235	968.72
238	968.72	248	971.58	290	973.04	305	974.4	590	980

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	176	.04	305	.04

Bank Sta: Left Right Coeff Contr. Expan.
 176 305 .1 .3
 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	232	971.6	241	590	971.6

Downstream Deck/Roadway Coordinates

num= 2
 Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord
 225 971.69 248 971.58

Downstream Bridge Cross Section Data

Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980	176	974.75	206	971.42	225	971.69	235	968.26
238	968.27	248	971.58	290	973.04	305	974.4	390	977.01

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	176	.04	305	.04

Bank Sta: Left Right Coeff Contr. Expan.
 176 305 .1 .3
 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	232	971.6	241	390	971.6

Upstream Embankment side slope = 3 horiz. to 1.0 vertical
 Downstream Embankment side slope = 3 horiz. to 1.0 vertical
 Maximum allowable submergence for weir flow = .95
 Elevation at which weir flow begins =
 Energy head used in spillway design =
 Spillway height used in design =
 Weir crest shape = Broad Crested

Number of Culverts = 1

Culvert Name Shape Rise Span
 Culvert #1 Circular 2
 FHWA Chart # 2 - Corrugated Metal Pipe Culvert
 FHWA Scale # 3 - Pipe projecting from fill
 Solution Criteria = Highest U.S. EG
 Culvert Upstrm Dist Length n Value Entrance Loss Coef Exit Loss Coef
 4 30 .024 .5 1

Number of Barrels = 2
 Upstream Elevation = 968.72
 Centerline Stations
 Sta. Sta.
 235 238
 Downstream Elevation = 968.26
 Centerline Stations
 Sta. Sta.
 235 238

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 3681

INPUT

Description:
 Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980	176	974.75	206	971.42	225	971.69	235	968.26
238	968.27	248	971.58	290	973.04	305	974.4	390	977.01

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	176	.04	305	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 176 305 176 176 .1 .3
 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	232	971.6	241	390	971.6

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 3505

INPUT

Description:
 Station Elevation Data num= 9

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980	232	970.05	236	969.87	261	968.32	275	968.09
288	966.15	315	968.68	339	970.06	539	977		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	232	.04	339	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 232 339 21 21 21 .1 .3
 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	284	967.7	292	539	968

CULVERT RIVER: Hog Creek
 REACH: R1 RS: 3495

INPUT

Description:

Distance from Upstream XS = 5
 Deck/Roadway Width = 14
 Weir Coefficient = 2.6
 Bridge Deck/Roadway Skew =
 Upstream Deck/Roadway Coordinates
 num= 3

Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
275	968.09				288	967.61				315	968.68			

Upstream Bridge Cross Section Data
 Station Elevation Data num= 9

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980	232	970.05	236	969.87	261	968.32	275	968.09
288	966.15	315	968.68	339	970.06	539	977		

Manning's n Values num= 3

Sta	n	Val	Sta	n	Val	Sta	n	Val
100	.04		232	.04		339	.04	

Bank Sta: Left Right Coeff Contr. Expan.
 232 339 .1 .3
 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	284	967.7	292	539	968

Downstream Deck/Roadway Coordinates
 num= 3

Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
275	968.09				288	967.61			
					315	968.68			

Downstream Bridge Cross Section Data
 Station Elevation Data num= 9

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980	232	970.05	236	969.87	261	968.32	275	968.09
288	965.73	315	968.68	339	970.06	539	975		

Manning's n Values num= 3

Sta	n	Val	Sta	n	Val	Sta	n	Val
100	.04		232	.04		339	.04	

Bank Sta: Left Right Coeff Contr. Expan.
 232 339 .1 .3
 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	284	967.7	292	539	968

Upstream Embankment side slope = 3 horiz. to 1.0 vertical
 Downstream Embankment side slope = 3 horiz. to 1.0 vertical
 Maximum allowable submergence for weir flow = .95
 Elevation at which weir flow begins =
 Energy head used in spillway design =
 Spillway height used in design =
 Weir crest shape = Broad Crested

Number of Culverts = 1

Culvert Name Shape Rise Span
 Culvert #1 Circular .87
 FHWA Chart # 1 - Concrete Pipe Culvert
 FHWA Scale # 3 - Groove end entrance; pipe projecting from fill
 Solution Criteria = Highest U.S. EG
 Culvert Upstrm Dist Length n Value Entrance Loss Coef Exit Loss Coef
 5 21 .013 .5 1

Number of Barrels = 2

Upstream Elevation = 966.15

Centerline Stations
 Sta. Sta.
 287 289

Downstream Elevation = 965.73

Centerline Stations
 Sta. Sta.
 287 289

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 3484

INPUT

Description:

Station Elevation Data num= 9

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980	232	970.05	236	969.87	261	968.32	275	968.09
288	965.73	315	968.68	339	970.06	539	975		

Manning's n Values num= 3

Sta	n	Val	Sta	n	Val	Sta	n	Val
100	.04		232	.04		339	.04	

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 232 339 40 40 40 .1 .3
 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	284	967.7	292	539	968

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 3444

INPUT

Description:

Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980	232	968.93	252	967.01	271	965.85	278	961.89
286	962.08	287	964.83	298	966.68	300	967.99	306	968.67
329	968.97	340	971.19	540	973				

Manning's n Values num= 3

Sta	n	Val	Sta	n	Val	Sta	n	Val
100	.04		232	.04		306	.04	

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 232 306 72 72 72 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 3372

INPUT
 Description:
 Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980.02	124	977.45	158	972.83	184	970.89	244	966.41
273	965.6	278	963.56	281	963.24	287	966.15	322	967.9
452	970.32	490	971.6	590	976				

 Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	184	.04	322	.04

 Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

Left	Right	Lengths	Left Channel	Right	Coeff	Contr.	Expan.
184	322		37	37		.1	.3

 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	275	966.91	284	590	966.91

 CULVERT RIVER: Hog Creek
 REACH: R1 RS: 3343

INPUT
 Description:
 Distance from Upstream XS = 5
 Deck/Roadway Width = 16
 Weir Coefficient = 2.6
 Bridge Deck/Roadway Skew =
 Upstream Deck/Roadway Coordinates
 num= 6

Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
184	970.89				250	966.93				296	966.91			
317	967.79				337	967.85				490	971.8			

Upstream Bridge Cross Section Data
 Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980.02	124	977.45	158	972.83	184	970.89	244	966.41
273	965.6	278	963.56	281	963.24	287	966.15	322	967.9
452	970.32	490	971.6	590	976				

 Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	184	.04	322	.04

 Bank Sta: Left Right Coeff Contr. Expan.

Left	Right	Coeff	Contr.	Expan.
184	322		.1	.3

 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	275	966.91	284	590	966.91

 Downstream Deck/Roadway Coordinates
 num= 6

Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
184	970.89				250	966.93				296	966.91			
317	967.79				337	967.85				490	971.8			

Downstream Bridge Cross Section Data
 Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980.02	124	977.45	158	972.83	184	970.89	239	968.24
250	966.42	274	965.97	290	963.37	303	963.37	317	967.35
337	968.09	490	971.6	590	976				

 Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	239	.04	337	.04

 Bank Sta: Left Right Coeff Contr. Expan.

Left	Right	Coeff	Contr.	Expan.
239	337		.1	.3

 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	291	966.91	301	590	966.91

 Upstream Embankment side slope = 3 horiz. to 1.0 vertical
 Downstream Embankment side slope = 3 horiz. to 1.0 vertical
 Maximum allowable submergence for weir flow = .95
 Elevation at which weir flow begins =
 Energy head used in spillway design =
 Spillway height used in design =
 Weir crest shape = Broad Crested

Number of Culverts = 1
 Culvert Name Shape Rise Span
 Culvert #1 Circular 2
 FHWA Chart # 2 - Corrugated Metal Pipe Culvert
 FHWA Scale # 3 - Pipe projecting from fill
 Solution Criteria = Highest U.S. EG
 Culvert Upstrm Dist Length n Value Entrance Loss Coef Exit Loss Coef

5	37	.024	.5	1
---	----	------	----	---

 Number of Barrels = 2
 Upstream Elevation = 963.24
 Centerline Stations

Sta.	Sta.
278	281

 Downstream Elevation = 963.37
 Centerline Stations

Sta.	Sta.
293	298

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 3335
 INPUT
 Description:
 Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980.02	124	977.45	158	972.83	184	970.89	239	968.24
250	966.42	274	965.97	290	963.37	303	963.37	317	967.35
337	968.09	490	971.6	590	976				

 Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	239	.04	337	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 239 337 23 23 .1 .3
 Ineffective Flow num= 2
 Sta L Sta R Elev Sta L Sta R Elev
 100 291 966.91 301 590 966.91

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 3312

INPUT

Description:
 Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
40	971	100	968.72	112	966.86	127	965.42	145	964.93
151	963.65	157	963.05	161	963.88	171	965.61	183	967.06
189	967.64	206	967.8	351	971.6				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
40	.04	112	.04	189	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 112 189 1086 1086 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 2226

INPUT

Description:
 Station Elevation Data num= 20

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	957.52	156	957.86	185	959.14	218	959.14	251	958.17
297	956.58	312	955.83	319	952.24	325	947.21	332	945.83
338	945.74	342	946.06	344	947.1	347	949.85	348	952.32
362	956.28	392	957.38	425	958.03	459	959.24	559	965.13

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	312	.04	362	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 312 362 124 124 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 2102

INPUT

Description:
 Station Elevation Data num= 20

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
20	959	100	955.76	130	955.9	161	956.02	191	955.76
219	955.64	244	955.13	257	954.49	273	951.39	279	950.88
286	949.79	298	949.81	311	949.9	316	950.06	331	953.82
361	954.15	380	955.47	415	956.8	449	957.65	484	958.83

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
20	.04	257	.04	331	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 257 331 10 10 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 2092

INPUT

Description:
 Station Elevation Data num= 21

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
20	958	100	955.76	130	955.9	161	956.02	191	955.76
219	955.64	244	955.13	259	954.06	272	951.02	274	949.55
280	948.74	286	947.63	297	947.33	306	947.18	314	949.38
331	953.46	362	954.15	381	955.47	416	956.8	450	957.65
485	958.93								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
20	.04	244	.04	331	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 244 331 101 101 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1991

INPUT

Description:
 Station Elevation Data num= 17

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
56	956.66	98	954.83	186	954.17	300	954.6	303	953.52
321	953.58	335	952.97	339	949	342	947.81	367	947.39
370	949.38	372	951.15	382	952.31	403	952.14	433	953.16
459	954.27	491	956.57						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
56	.04	335	.04	382	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 335 382 57 57 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1934

INPUT

Description:
 Station Elevation Data num= 20

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
56	956.66	98	954.83	143	953.73	186	953.02	200	952.77
320	952.45	341	951.83	344	950.96	346	949.09	353	947.55
361	947.45	373	948.73	376	949.43	380	952.09	396	952.19
419	952.47	471	954.05	543	955.33	588	956.58	634	958.58

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 56 .04 341 .04 380 .04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 341 380 50 50 50 .1 .3

Ineffective Flow num= 2
 Sta L Sta R Elev Sta L Sta R Elev
 56 347 952.85 363 634 952.9

CULVERT RIVER: Hog Creek
 REACH: R1 RS: 1909

INPUT

Description:
 Distance from Upstream XS = 13
 Deck/Roadway Width = 19
 Weir Coefficient = 2.6
 Bridge Deck/Roadway Skew =
 Upstream Deck/Roadway Coordinates
 num= 5
 Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord
 200 953.02 320 952.69 356 953.01
 396 952.69 471 954.05

Upstream Bridge Cross Section Data
 Station Elevation Data num= 20
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 56 956.66 98 954.83 143 953.73 186 953.02 300 952.77
 320 952.45 341 951.83 344 950.96 346 949.09 353 947.55
 361 947.45 373 948.73 376 949.43 380 952.09 396 952.19
 419 952.47 471 954.05 543 955.33 588 956.58 634 958.59

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 56 .04 341 .04 380 .04

Bank Sta: Left Right Coeff Contr. Expan.
 341 380 .1 .3

Ineffective Flow num= 2
 Sta L Sta R Elev Sta L Sta R Elev
 56 347 952.85 363 634 952.9

Downstream Deck/Roadway Coordinates
 num= 7
 Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord
 192 953.02 300 952.45 338 952.13
 386 953.01 427 952.69 483 953.5

Downstream Bridge Cross Section Data
 Station Elevation Data num= 22
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 62 956.66 104 954.83 149 953.73 192 953.02 300 951.19
 322 950.86 338 949.45 351 950.43 361 949.16 373 947.62
 375 946.67 378 946.12 383 945.71 386 945.83 389 947.35
 398 947.87 407 950.55 427 950.8 454 951.38 483 951.78
 573 953.33 618 956.58

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 62 .04 351 .04 407 .04

Bank Sta: Left Right Coeff Contr. Expan.
 351 407 .1 .3

Ineffective Flow num= 2
 Sta L Sta R Elev Sta L Sta R Elev
 62 373 952.9 393 618 952.9

Upstream Embankment side slope = 3 horiz. to 1.0 vertical
 Downstream Embankment side slope = 3 horiz. to 1.0 vertical
 Maximum allowable submergence for weir flow = .95
 Elevation at which weir flow begins =
 Energy head used in spillway design =
 Spillway height used in design =
 Weir crest shape = Broad Crested

Number of Culverts = 2

Culvert Name Shape Rise Span
 Culvert #2 Circular 2.5
 FHWA Chart # 2 - Corrugated Metal Pipe Culvert
 FHWA Scale # 3 - Pipe projecting from fill
 Solution Criteria = Highest U.S. EG
 Culvert Upstrm Dist Length n Value Entrance Loss Coef Exit Loss Coef
 3 41 .024 .5 1
 Upstream Elevation = 949.04
 Centerline Station = 349
 Downstream Elevation = 948.68
 Centerline Station = 375

Culvert Name Shape Rise Span
 Culvert #1 Circular 1
 FHWA Chart # 2 - Corrugated Metal Pipe Culvert
 FHWA Scale # 3 - Pipe projecting from fill
 Solution Criteria = Highest U.S. EG
 Culvert Upstrm Dist Length n Value Entrance Loss Coef Exit Loss Coef
 3 51 .024 .5 1

Number of Barrels = 4
 Upstream Elevation = 949.62
 Centerline Stations
 Sta. Sta. Sta. Sta.
 351 353 355 360
 Downstream Elevation = 949.41
 Centerline Stations
 Sta. Sta. Sta. Sta.
 379 382 385 390

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1884

INPUT

Description:
 Station Elevation Data num= 22

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
62	956.56	104	954.83	149	953.73	192	953.02	300	951.19
322	950.86	338	949.45	351	950.43	361	949.16	373	947.62
375	946.67	378	946.12	383	945.71	386	945.83	389	947.35
398	947.87	407	950.55	427	950.8	454	951.38	483	951.78
573	955.33	618	956.58						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
62	.04	351	.04	407	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

351	407	65	65	65	.1	.3
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Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
62	373	952.8	393	618	952.9

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1819

INPUT

Description: Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
75	953.84	100	949.78	136	948.61	150	947.41	154	946.62
162	945.69	166	945.83	170	947.53	185	949.78	215	950.07
250	950.95	322	954.05						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
75	.04	100	.04	215	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

100	215	700	700	700	.1	.3
-----	-----	-----	-----	-----	----	----

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1119

INPUT

Description: Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
50	947	100	945.25	135	944.04	162	944.37	198	944.31
234	944.54	251	944.02	270	943.64	295	943.34	323	943.31
350	943.33	376	943.19	401	943.52	412	945.16	415	945.27
445	947								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
50	.04	100	.04	412	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

100	412	1	1	1	.1	.3
-----	-----	---	---	---	----	----

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1118

INPUT

Description: Station Elevation Data num= 20

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	945.25	135	944.04	162	944.37	198	944.31	234	944.54
255	943.81	272	942.74	278	941.07	285	941.51	297	942.45
298	943.2	334	943.31	359	942.97	367	941.75	376	941.21
380	940.58	388	941.19	391	941.81	415	945.09	421	945.24

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	100	.04	415	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

100	415	51	51	51	.1	.3
-----	-----	----	----	----	----	----

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1067

INPUT

Description: Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	947.13	189	942	214	942.1	233	941.57	249	940.62
272	941.85	296	942.92	321	943.08	338	942.34	358	942.57
369	941.38	377	941.3	383	941.47	410	944.61	420	945.21

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	100	.04	410	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

100	410	67	67	67	.1	.3
-----	-----	----	----	----	----	----

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1000

INPUT

Description: Station Elevation Data num= 22

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
65	945.25	100	943.27	124	942.01	148	940.45	179	938.86
184	939.55	189	938.82	200	939	202	937.17	212	937.73
213	939.53	249	942.96	264	943.07	285	943.43	308	942.8
345	941.53	362	942.16	376	942.23	386	942.28	420	942.25
459	942.78	470	945.21						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
65	.04	100	.04	285	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

100	285	0	0	0	.1	.3
-----	-----	---	---	---	----	----

Profile Output Table - Standard Table 1

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Frcude # Chl
-------	-----------	---------	-----------	-----------	-----------	-----------	------------	----------	-----------	-----------	--------------

RI	1819	3557.00	945.69	952.61	951.79	953.27	0.005512	6.85	583.26	206.09	0.61
RI	1819	2552.00	945.69	952.07	951.21	952.58	0.004991	5.91	476.31	190.23	0.56
RI	1119	5466.00	943.19	946.05	946.05	947.08	0.017557	8.15	681.94	351.51	0.98
RI	1119	4376.00	943.19	945.76	945.76	946.65	0.018774	7.62	579.32	337.84	0.99
RI	1119	3947.00	943.19	945.63	945.63	946.48	0.019387	7.39	537.45	332.10	1.00
RI	1119	2826.00	943.19	945.28	945.28	945.97	0.021638	6.69	422.78	315.85	1.01
RI	1118	5466.00	940.58	945.86	945.64	946.71	0.012812	7.39	742.04	321.00	0.85
RI	1118	4376.00	940.58	945.51	945.35	946.26	0.014033	6.96	630.62	321.00	0.87
RI	1118	3947.00	940.58	945.36	945.20	946.08	0.014945	6.80	581.00	321.00	0.88
RI	1118	2826.00	940.58	944.97	944.83	945.56	0.016213	6.17	457.72	305.89	0.89
RI	1067	5466.00	940.62	944.73	944.73	945.91	0.017757	8.71	627.58	270.33	1.00
RI	1067	4376.00	940.62	944.39	944.39	945.42	0.018395	8.15	536.87	260.49	1.00
RI	1067	3947.00	940.62	944.26	944.23	945.21	0.018251	7.84	503.19	257.12	0.99
RI	1067	2826.00	940.62	943.82	943.82	944.62	0.020008	7.18	393.43	245.79	1.00
RI	1000	5466.00	937.17	943.70	943.70	944.67	0.014406	8.52	730.06	370.73	0.92
RI	1000	4376.00	937.17	943.42	943.42	944.28	0.014434	7.94	628.92	364.00	0.90
RI	1000	3947.00	937.17	943.31	943.31	944.11	0.013701	7.68	588.09	350.63	0.88
RI	1000	2826.00	937.17	942.88	942.88	943.62	0.011144	7.19	450.97	295.45	0.80

HEC-RAS September 1998 Version 2.2
 U.S. Army Corp of Engineers
 Hydrologic Engineering Center
 609 Second Street, Suite D
 Davis, California 95616-4687
 (916) 756-1104

```

X  X  XXXXXX  XXXX  XXXX  XX  XXXX
X  X  X      X  X      X  X  X  X
X  X  X      X  X      X  X  X  X
XXXXXX  XXXX  X      XXX  XXXX  XXXXXX  XXXX
X  X  X      X      X  X      X  X  X
X  X  X      X  X      X  X      X  X
X  X  XXXXXX  XXXX  X  X  X  X  XXXXX
    
```

PROJECT DATA

Project Title: Hog Creek Proposed
 Project File : HCProposed.prj
 Run Date and Time: 8/9/01 3:29:32 PM

Project in English units

Project Description:
 Hog Creek Drainage Study

PLAN DATA

Plan Title: Plan 24
 Plan File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Proposed\HCProposed.p24

Geometry Title: CI 1000-1934 & BH Bridge
 Geometry File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Proposed\HCProposed.g02

Flow Title : Developed Flow Data
 Flow File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Proposed\HCProposed.f04

Plan Summary Information:

Number of: Cross Sections = 25 Multiple Openings = 0
 Culverts = 4 Inline Weirs = 0
 Bridges = 1

Computational Information

Water surface calculation tolerance = 0.01
 Critical depth calculation tolerance = 0.01
 Maximum number of iterations = 20
 Maximum difference tolerance = 0.3
 Flow tolerance factor = 0.001

Computation Options

Critical depth computed only where necessary
 Conveyance Calculation Method: At breaks in n values only
 Friction Slope Method: Average Conveyance
 Computational Flow Regime: Subcritical Flow

FLOW DATA

Flow Title: Developed Flow Data
 Flow File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Proposed\HCProposed.f04

Flow Data (cfs)

River	Reach	RS	PF 1	PF 2	PF 3	PF 4
Hog Creek	R1	5827	3819	3072	2777	2004
Hog Creek	R1	4084	4643	3724	3362	2415
Hog Creek	R1	2226	4917	3941	3557	2552
Hog Creek	R1	1119	5466	4376	3947	2826

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Hog Creek	R1	PF 1	Critical	Critical

GEOMETRY DATA

Geometry Title: CI 1000-1934 & BH Bridge
 Geometry File : p:\active\2000-33 Woodcreek MP\HEC-RAS\Proposed\HCProposed.g02

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 5827

INPUT

Description:

Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	1015.89	122	1014.43	139	1009.46	150	1004.71
163	995.35	175	996.26	187	998.87	207	1000.93
270	1001.42	303	1002.26	343	1003.08	378	1003.69
452	1006.34	496	1008.35	531	1009.41	416	1004.94

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	150	.04	270	.04

Bank Sta: Left 150 Right 270 Lengths: Left Channel 29 Right 29 Coeff Contr. .1 Expan. .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 5798

INPUT
 Description:
 Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	1015.89	122	1014.43	139	1009.46	150	1004.71	159	996.92
163	996.55	175	997.45	187	994.32	207	1000.93	241	1000.85
270	1001.42	303	1002.26	343	1003.08	378	1003.69	416	1004.94
452	1006.34	496	1008.35	531	1009.41				

 Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	150	.04	270	.04

 Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 150 270 61 61 .1 .3
 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	153	1010.4	193	531	1006

CULVERT RIVER: Hog Creek
 REACH: R1 RS: 5768

INPUT
 Description:
 Distance from Upstream XS = 10
 Deck/Roadway Width = 45
 Weir Coefficient = 2.6
 Bridge Deck/Roadway Skew =
 Upstream Deck/Roadway Coordinates
 num= 6

Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
122	1014.43				175	1007.64				207	1004.96			
241	1004.92				303	1004.92				416	1004.94			

Upstream Bridge Cross Section Data
 Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	1015.89	122	1014.43	139	1009.46	150	1004.71	159	996.92
163	996.55	175	997.45	187	994.32	207	1000.93	241	1000.85
270	1001.42	303	1002.26	343	1003.08	378	1003.69	416	1004.94
452	1006.34	496	1008.35	531	1009.41				

 Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	150	.04	270	.04

 Bank Sta: Left Right Coeff Contr. Expan.
 150 270 .1 .3
 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	153	1010.4	193	531	1006

Downstream Deck/Roadway Coordinates
 num= 6

Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
122	1014.43				175	1007.64				207	1004.96			
241	1004.92				303	1004.92				416	1004.94			

Downstream Bridge Cross Section Data
 Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	1015.89	122	1014.43	139	1009.46	150	1004.71	159	996.28
163	995.35	175	996.54	187	994.3	207	1000.93	241	1000.85
270	1001.42	303	1002.26	343	1003.08	378	1003.69	416	1004.94
452	1006.34	496	1008.35	531	1009.41				

 Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	150	.04	270	.04

 Bank Sta: Left Right Coeff Contr. Expan.
 150 270 .1 .3
 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	153	1010.4	193	531	1006

Upstream Embankment side slope = 3 horiz. to 1.0 vertical
 Downstream Embankment side slope = 3 horiz. to 1.0 vertical
 Maximum allowable submergence for weir flow = .95
 Elevation at which weir flow begins =
 Energy head used in spillway design =
 Spillway height used in design =
 Weir crest shape = Broad Crested

Number of Culverts = 3

Culvert Name	Shape	Rise	Span
Culvert #1	Circular	10	

 FHWA Chart # 2 - Corrugated Metal Pipe Culvert
 FHWA Scale # 3 - Pipe projecting from fill
 Solution Criteria = Highest U.S. EG

Culvert Upstrm Dist	Length	n Value	Entrance Loss Coef	Exit Loss Coef
5	60	.024	.5	1

 Upstream Elevation = 996.92
 Centerline Station = 159
 Downstream Elevation = 996.28
 Centerline Station = 159

Culvert Name	Shape	Rise	Span
Culvert #2	Circular	10	

 FHWA Chart # 1 - Concrete Pipe Culvert
 FHWA Scale # 1 - Square edge entrance with headwall
 Solution Criteria = Highest U.S. EG

Culvert Upstrm Dist	Length	n Value	Entrance Loss Coef	Exit Loss Coef
5	60	.024	.5	1

 Upstream Elevation = 997.45
 Centerline Station = 175
 Downstream Elevation = 996.54
 Centerline Station = 175

Culvert Name	Shape	Rise	Span
Culvert #3	Circular	10	

 FHWA Chart # 1 - Concrete Pipe Culvert

FHWA Scale # 1 - Square edge entrance with headwall
 Solution Criteria = Highest U.S. EG
 Culvert Upstrm Dist Length n Value Entrance Loss Coef Exit Loss Coef
 5 60 .024 .5 1
 Upstream Elevation = 994.32
 Centerline Station = 187
 Downstream Elevation = 994.3
 Centerline Station = 187

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 5737

INPUT

Description:
 Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	1015.89	122	1014.43	139	1009.46	150	1004.71	159	996.28
163	995.35	175	996.54	187	994.3	207	1000.93	241	1000.85
270	1001.42	303	1002.26	343	1003.08	378	1003.69	416	1004.94
452	1006.34	496	1008.35	531	1009.41				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	150	.04	270	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 150 270 1689 1689 1689 .1 .3
 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	153	1010.4	193	531	1006

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 4048

INPUT

Description:
 Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
90	980	135	977.42	155	977.13	166	973.67	170	972.76
172	971.92	176	971.47	180	971.78	184	972.59	199	974.7
209	979.13	248	979.93	290	980.47				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
90	.04	155	.04	209	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 155 209 28 28 28 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 4020

INPUT

Description:
 Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	981	129	978.08	153	976.4	175	973.06	179	972.06
186	972.02	195	973.29	212	976.6	225	978.3	267	980.4

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	129	.04	225	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 129 225 279 279 279 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 3741

INPUT

Description:
 Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980	145	974.75	157	971.82	163	971.04	191	971.18
197	969.69	200	969.62	203	969.87	207	971.13	219	971.52
226	972.31	242	973.04	257	974.4	342	977.01	590	980

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	145	.04	257	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 145 257 30 30 30 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 3711

INPUT

Description:
 Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980	176	974.75	206	971.42	225	971.69	235	968.72
238	968.72	248	971.58	290	973.04	305	974.4	590	980

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	176	.04	305	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 176 305 30 30 30 .1 .3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	232	971.6	241	590	971.6

CULVERT RIVER: Hog Creek
 REACH: R1 RS: 3696

INPUT

Description:
 Distance from Upstream XS = 4
 Deck/Roadway Width = 14
 Weir Coefficient = 2.6
 Bridge Deck/Roadway Skew =
 Upstream Deck/Roadway Coordinates

```

num= 2
Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord
225 971.69 248 971.58

Upstream Bridge Cross Section Data
Station Elevation Data num= 10
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
100 980 176 974.75 206 971.42 225 971.69 235 968.72
238 968.72 248 971.58 290 973.04 305 974.4 390 977.01

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
100 .04 176 .04 305 .04

Bank Sta: Left Right Coeff Contr. Expan.
176 305 .1 .3
Ineffective Flow num= 2
Sta L Sta R Elev Sta L Sta R Elev
100 232 971.6 241 390 971.6

Downstream Deck/Roadway Coordinates
num= 2
Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord
225 971.69 248 971.58

Downstream Bridge Cross Section Data
Station Elevation Data num= 10
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
100 980 176 974.75 206 971.42 225 971.69 235 968.26
238 968.27 248 971.58 290 973.04 305 974.4 390 977.01

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
100 .04 176 .04 305 .04

Bank Sta: Left Right Coeff Contr. Expan.
176 305 .1 .3
Ineffective Flow num= 2
Sta L Sta R Elev Sta L Sta R Elev
100 232 971.6 241 390 971.6

Upstream Embankment side slope = 3 horiz. to 1.0 vertical
Downstream Embankment side slope = 3 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .95
Elevation at which weir flow begins =
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

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Number of Culverts = 1
Culvert Name Shape Rise Span
Culvert #1 Circular 2
FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 3 - Pipe projecting from fill
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist Length n Value Entrance Loss Coef Exit Loss Coef
4 30 .024 .5 1

Number of Barrels = 2
Upstream Elevation = 968.72
Centerline Stations
Sta. Sta.
235 238
Downstream Elevation = 968.26
Centerline Stations
Sta. Sta.
235 238

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CROSS SECTION RIVER: Hog Creek
REACH: R1 RS: 3681

INPUT
Description:
Station Elevation Data num= 10
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
100 980 176 974.75 206 971.42 225 971.69 235 968.26
238 968.27 248 971.58 290 973.04 305 974.4 390 977.01

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
100 .04 176 .04 305 .04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
176 305 176 176 .1 .3
Ineffective Flow num= 2
Sta L Sta R Elev Sta L Sta R Elev
100 232 971.6 241 390 971.6

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CROSS SECTION RIVER: Hog Creek
REACH: R1 RS: 3505

INPUT
Description:
Station Elevation Data num= 9
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
100 980 232 970.05 236 969.87 261 968.32 275 968.09
288 966.15 315 968.68 339 970.06 539 977

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
100 .04 232 .04 339 .04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
232 339 21 21 21 .1 .3
Ineffective Flow num= 2
Sta L Sta R Elev Sta L Sta R Elev
100 284 967.7 292 539 968

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CULVERT RIVER: Hog Creek
REACH: R1 RS: 3495

INPUT
Description:
Distance from Upstream XS = 5

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Deck/Roadway Width = 14
 Weir Coefficient = 2.6
 Bridge Deck/Roadway Skew =
 Upstream Deck/Roadway Coordinates
 num= 3
 Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord
 275 968.09 288 967.61 315 968.68

Upstream Bridge Cross Section Data
 Station Elevation Data num= 9
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 100 980 232 970.05 236 969.87 261 968.32 275 968.09
 288 966.15 315 968.68 339 970.06 539 977

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 100 .04 232 .04 339 .04

Bank Sta: Left Right Coeff Contr. Expan.
 232 339 .1 .3
 Ineffective Flow num= 2
 Sta L Sta R Elev Sta L Sta R Elev
 100 284 967.7 292 539 968

Downstream Deck/Roadway Coordinates
 num= 3
 Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord
 275 968.09 288 967.61 315 968.68

Downstream Bridge Cross Section Data
 Station Elevation Data num= 9
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 100 980 232 970.05 236 969.87 261 968.32 275 968.09
 288 965.73 315 968.68 339 970.06 539 975

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 100 .04 232 .04 339 .04

Bank Sta: Left Right Coeff Contr. Expan.
 232 339 .1 .3
 Ineffective Flow num= 2
 Sta L Sta R Elev Sta L Sta R Elev
 100 284 967.7 292 539 968

Upstream Embankment side slope = 3 horiz. to 1.0 vertical
 Downstream Embankment side slope = 3 horiz. to 1.0 vertical
 Maximum allowable submergence for weir flow = .95
 Elevation at which weir flow begins =
 Energy head used in spillway design =
 Spillway height used in design =
 Weir crest shape = Broad Crested

Number of Culverts = 1
 Culvert Name Shape Rise Span
 Culvert #1 Circular .67
 FHWA Chart # 1 - Concrete Pipe Culvert
 FHWA Scale # 3 - Groove end entrance; pipe projecting from fill
 Solution Criteria = Highest U.S. EG
 Culvert Upstrm Dist Length n Value Entrance Loss Coef Exit Loss Coef
 5 21 .013 .5 1

Number of Barrels = 2
 Upstream Elevation = 966.15
 Centerline Stations
 Sta. Sta.
 287 289
 Downstream Elevation = 965.73
 Centerline Stations
 Sta. Sta.
 287 289

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 3484

INPUT
 Description:
 Station Elevation Data num= 9
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 100 980 232 970.05 236 969.87 261 968.32 275 968.09
 288 965.73 315 968.68 339 970.06 539 975

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 100 .04 232 .04 339 .04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 232 339 40 40 .1 .3
 Ineffective Flow num= 2
 Sta L Sta R Elev Sta L Sta R Elev
 100 284 967.7 292 539 968

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 3444

INPUT
 Description:
 Station Elevation Data num= 13
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 100 980 232 968.93 252 967.01 271 965.85 278 961.89
 286 962.08 287 964.83 298 966.68 300 967.99 306 968.67
 329 968.97 340 971.19 540 973

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 100 .04 232 .04 306 .04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 232 306 72 72 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 3372

INPUT

Description:
 Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980.02	124	977.45	158	972.83	184	970.89	244	966.41
273	965.6	278	963.56	281	963.24	287	966.15	322	967.9
452	970.32	490	971.6	590	976				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	184	.04	322	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 184 322 37 37 37 .1 .3
 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	275	966.91	284	590	966.91

CULVERT RIVER: Hog Creek
 REACH: R1 RS: 3343

INPUT

Description:
 Distance from Upstream XS = 5
 Deck/Roadway Width = 16
 Weir Coefficient = 2.6
 Bridge Deck/Roadway Skew =
 Upstream Deck/Roadway Coordinates num= 6

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
184	970.89	250	966.93	296	966.91	490	971.8	
317	967.79	337	967.85					

Upstream Bridge Cross Section Data
 Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980.02	124	977.45	158	972.83	184	970.89	244	966.41
273	965.6	278	963.56	281	963.24	287	966.15	322	967.9
452	970.32	490	971.6	590	976				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	184	.04	322	.04

Bank Sta: Left Right Coeff Contr. Expan.
 184 322 .1 .3
 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	275	966.91	284	590	966.91

Downstream Deck/Roadway Coordinates num= 6

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
184	970.89	250	966.93	296	966.91	490	971.8	
317	967.79	337	967.85					

Downstream Bridge Cross Section Data
 Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980.02	124	977.45	158	972.83	184	970.89	239	968.24
250	966.42	274	965.97	290	963.37	303	963.37	317	967.35
337	968.09	490	971.6	590	976				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	239	.04	337	.04

Bank Sta: Left Right Coeff Contr. Expan.
 239 337 .1 .3
 Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
100	291	966.91	301	590	966.91

Upstream Embankment side slope = 3 horiz. to 1.0 vertical
 Downstream Embankment side slope = 3 horiz. to 1.0 vertical
 Maximum allowable submergence for weir flow = .95
 Elevation at which weir flow begins =
 Energy head used in spillway design =
 Spillway height used in design =
 Weir crest shape = Broad Crested

Number of Culverts = 1

Culvert Name Shape Rise Span
 Culvert #1 Circular 2
 FHWA Chart # 2 - Corrugated Metal Pipe Culvert
 FHWA Scale # 3 - Pipe projecting from fill
 Solution Criteria = Highest U.S. EG
 Culvert Upstrm Dist Length n Value Entrance Loss Coef Exit Loss Coef
 5 37 .024 .5 1

Number of Barrels = 2
 Upstream Elevation = 963.24

Centerline Stations

Sta.	Sta.
278	281

Downstream Elevation = 963.37
 Centerline Stations

Sta.	Sta.
293	298

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 3335

INPUT

Description:
 Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	980.02	124	977.45	158	972.83	184	970.89	239	968.24
250	966.42	274	965.97	290	963.37	303	963.37	317	967.35
337	968.09	490	971.6	590	976				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
100	.04	239	.04	337	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 239 337 23 23 23 .1 .3
 Ineffective Flow num= 2
 Sta L Sta R Elev Sta L Sta R Elev
 100 291 966.91 301 590 966.91

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 3312

INPUT

Description:

Station Elevation Data num= 13
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 40 971 100 968.72 112 966.86 127 965.42 145 964.93
 151 963.66 157 963.05 161 963.68 171 965.61 183 967.06
 189 967.64 206 967.8 351 971.6

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 40 .04 112 .04 189 .04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 112 189 1086 1086 1086 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 2226

INPUT

Description:

Station Elevation Data num= 20
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 100 957.52 156 957.86 185 959.14 218 959.14 251 958.17
 297 956.58 312 955.83 319 952.24 325 947.21 332 945.83
 338 945.74 342 946.06 344 947.1 347 949.85 348 952.32
 362 956.28 392 957.38 425 958.03 459 959.24 559 965.13

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 100 .04 312 .04 362 .04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 312 362 124 124 124 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 2102

INPUT

Description:

Station Elevation Data num= 20
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 20 958 100 955.76 130 955.9 161 956.02 191 955.76
 219 955.64 244 955.13 257 954.49 273 951.39 279 950.88
 286 949.79 298 949.81 311 949.9 316 950.06 331 953.82
 361 954.15 380 955.47 415 956.8 449 957.65 484 958.83

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 20 .04 257 .04 331 .04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 257 331 10 10 10 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 2092

INPUT

Description:

Station Elevation Data num= 21
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 20 958 100 955.76 130 955.9 161 956.02 191 955.76
 219 955.64 244 955.13 259 954.06 272 951.02 274 949.55
 280 948.74 286 947.63 297 947.33 306 947.18 314 949.38
 331 953.46 362 954.15 381 955.47 416 956.8 450 957.65
 485 958.83

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 20 .04 244 .04 331 .04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 244 331 101 101 101 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1991

INPUT

Description:

Station Elevation Data num= 17
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 56 956.66 98 954.83 186 954.17 300 954.6 303 953.52
 321 953.58 335 952.97 339 954.06 342 947.81 367 947.39
 370 949.38 372 951.15 382 952.31 403 952.14 433 953.16
 459 954.27 491 956.57

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val
 56 .04 335 .04 382 .04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 335 382 57 57 57 .1 .3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1934

INPUT

Description:

Station Elevation Data num= 13
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
 56 956.66 58 954.83 143 953.73 186 953.02 295 952.77
 315 946.34 385 946.34 403 952.21 419 952.47 471 954.05
 543 955.33 588 956.58 634 958.58

Manning's n Values num= 3
 Sta n Val Sta n Val Sta n Val

56 .04 295 .035 403 .04
 Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
 295 403 50 50 50 .1 .3
 Ineffective Flow num= 2
 Sta L Sta R Elev Sta L Sta R Elev
 56 300 954 400 634 954

BRIDGE RIVER: Hog Creek
 REACH: R1 RS: 1909

INPUT
 Description:
 Distance from Upstream XS = 13
 Deck/Roadway Width = 19
 Weir Coefficient = 2.6
 Bridge Deck/Roadway Skew =
 Upstream Deck/Roadway Coordinates
 num= 7

Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
98	954.83	951	143	954	951	200	954	951						
320	954	951	356	954	951	396	954	951						
471	954.05	951												

Upstream Bridge Cross Section Data
 Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
56	956.66	98	954.83	143	951.73	186	953.02
315	946.34	385	946.34	403	952.21	419	952.47
543	955.33	588	956.58	634	958.58	471	954.05

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
56	.04	295	.035	403	.04

Bank Sta: Left Right Coeff Contr. Expan.
 295 403 .1 .3
 Ineffective Flow num= 2
 Sta L Sta R Elev Sta L Sta R Elev
 56 300 954 400 634 954

Downstream Deck/Roadway Coordinates
 num= 9

Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
104	954.83	951	149	954	951	192	954	951						
300	954	951	338	954	951	386	954	951						
427	954	951	483	954	951	573	955.33	951						

Downstream Bridge Cross Section Data
 Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
62	956.66	104	954.83	149	953.73	192	953.02
322	950.86	333	949.45	344	945.84	414	945.84
454	951.38	483	951.78	573	955.33	618	956.58

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
62	.04	322	.035	429	.04

Bank Sta: Left Right Coeff Contr. Expan.
 322 429 .1 .3
 Ineffective Flow num= 2
 Sta L Sta R Elev Sta L Sta R Elev
 62 333 954 429 618 954

Upstream Embankment side slope = 3 horiz. to 1.0 vertical
 Downstream Embankment side slope = 3 horiz. to 1.0 vertical
 Maximum allowable submergence for weir flow = .95
 Elevation at which weir flow begins =
 Energy head used in spillway design =
 Spillway height used in design =
 Weir crest shape = Broad Crested

Number of Piers = 2

Pier Data
 Pier Station Upstream= 320 Downstream= 350
 Upstream num= 2

Width	Elev	Width	Elev
1	945	1	952

 Downstream num= 2

Width	Elev	Width	Elev
1	945	1	952

Pier Data
 Pier Station Upstream= 380 Downstream= 410
 Upstream num= 2

Width	Elev	Width	Elev
1	945	1	952

 Downstream num= 2

Width	Elev	Width	Elev
1	945	1	952

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data
 Energy
 Selected Low Flow Methods = Highest Energy Answer

High Flow Method
 Energy Only

Additional Bridge Parameters
 Add Friction component to Momentum
 Do not add Weight component to Momentum
 Class B flow critical depth computations use critical depth
 inside the bridge at the upstream end
 Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1884

INPUT
 Description:

Station Elevation Data num= 14									
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
62	956.66	104	954.83	149	953.73	192	953.02	300	951.19
322	950.86	333	949.45	344	945.84	414	945.84	429	950.76
454	951.38	483	951.78	573	955.33	618	956.58		

Manning's n Values num= 3									
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
62	.04	322	.035	429	.04				

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	322	429		65	65	65		.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
62	333	954	429	618	954

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1819

INPUT Description:

Station Elevation Data num= 9									
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
75	953.84	100	949.78	126.29	948.93	137.5	945.19	177.5	945.19
191.46	949.84	215	950.07	250	950.95	322	954.05		

Manning's n Values num= 5									
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
75	.04	100	.04	126.29	.035	191.46	.04	215	.04

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	100	215		700	760	700		.1	.3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1119

INPUT Description:

Station Elevation Data num= 17									
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
50	947	100	945.25	135	944.04	162	944.37	198	944.31
217.27	944.43	236	938.19	276	938.19	291.57	943.38	295	943.34
323	943.31	350	943.33	376	943.19	401	943.52	412	945.16
415	945.27	445	947						

Manning's n Values num= 5									
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
50	.04	100	.04	217.27	.035	291.57	.04	412	.04

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	100	412		1	1	1		.1	.3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1116

INPUT Description:

Station Elevation Data num= 18									
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	945.25	135	944.04	162	944.37	198	944.31	234	944.54
236.14	944.47	255	938.18	295	938.18	310.17	943.24	334	943.31
359	942.97	367	941.75	376	941.21	380	940.58	388	941.19
391	941.81	415	945.09	421	945.24				

Manning's n Values num= 5									
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
100	.04	100	.04	236.14	.035	310.17	.04	415	.04

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	100	415		51	51	51		.1	.3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1067

INPUT Description:

Station Elevation Data num= 16									
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
100	947.13	189	942	214	942.1	216.96	942.02	230	937.67
270	937.67	284.17	942.39	296	942.92	321	943.08	338	942.34
358	942.57	369	941.38	377	941.3	383	941.47	410	944.61
420	945.21								

Manning's n Values num= 5									
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
100	.04	100	.04	216.96	.035	284.17	.04	410	.04

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	100	410		67	67	67		.1	.3

CROSS SECTION RIVER: Hog Creek
 REACH: R1 RS: 1000

INPUT Description:

Station Elevation Data num= 19									
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
65	945.25	100	943.27	124	942.01	148	940.45	173.59	939.14
180	937	220	937	233.43	941.48	249	942.96	264	943.07
285	943.43	308	942.8	345	941.53	362	942.16	376	942.23
386	942.28	420	942.25	459	942.78	470	945.21		

Manning's n Values num= 5									
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
65	.04	100	.04	173.59	.035	233.43	.04	470	.04

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	100	470		0	0	0		.1	.3

Profile Output Table - Standard Table 1

Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude #	Chl
-------	-----------	---------------	----------------	----------------	----------------	----------------	--------------------	-----------------	-------------------	----------------	----------	-----

R1	1119	5466.00	938.19	944.93	944.93	946.03	0.007643	8.42	649.07	301.30	1.01
R1	1119	4376.00	938.19	944.62	944.62	945.58	0.006608	7.85	557.47	290.26	1.00
R1	1119	3947.00	938.19	944.45	944.45	945.39	0.006351	7.76	508.36	284.17	1.02
R1	1119	2826.00	938.19	943.71	943.71	944.69	0.006325	7.94	355.90	182.88	1.00
R1	1118	5466.00	938.18	944.74	944.74	945.85	0.007688	8.47	645.07	297.53	1.01
R1	1118	4376.00	938.18	944.33	944.33	945.38	0.007107	8.22	532.41	222.72	0.94
R1	1118	3947.00	938.18	943.78	943.78	945.07	0.009452	9.11	433.43	167.21	1.00
R1	1118	2826.00	938.18	943.06	943.06	944.25	0.009041	8.75	323.13	117.00	0.93
R1	1067	5466.00	937.67	943.90	943.90	945.15	0.009140	8.97	609.10	247.93	1.01
R1	1067	4376.00	937.67	943.52	943.52	944.64	0.008491	8.46	517.04	236.10	1.01
R1	1067	3947.00	937.67	943.37	943.37	944.42	0.008120	8.23	479.68	233.99	1.01
R1	1067	2826.00	937.67	942.80	942.80	943.77	0.007351	7.89	358.06	185.41	1.00
R1	1000	5466.00	937.00	943.30	943.30	944.30	0.008001	8.03	680.76	349.30	1.01
R1	1000	4376.00	937.00	942.92	942.92	943.88	0.007399	7.86	556.65	297.60	1.01
R1	1000	3947.00	937.00	942.77	942.77	943.69	0.006959	7.69	513.58	286.62	1.01
R1	1000	2826.00	937.00	941.72	941.72	943.02	0.009317	9.15	308.94	118.47	1.00

APPENDIX D – TWDB COMMENTS

TWDB Comments
Response to TWDB Comments

**TEXAS WATER DEVELOPMENT BOARD**

William B. Madden, *Chairman*
Jack Hunt, *Member*
Noé Fernández, *Member*

Craig D. Pedersen
Executive Administrator

Wales H. Madden, Jr., *Vice-Chairman*
William W. Meadows, *Member*
Kathleen Hartnett White, *Member*

September 21, 2001

The Honorable Ken Jacobs
Mayor, City of Woodcreek
P.O. box 1570
Wimberley, TX 78776

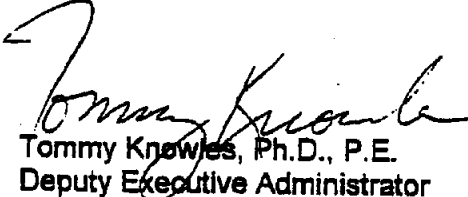
Re: Flood Protection Planning Grant Contract Between and the City of Woodcreek (City) and Texas Water Development Board (Board), TWDB Contract No. 2000-483-360, Draft Final Report

Dear Mayor Jacobs:

Staff members of the Texas Water Development Board have completed a review of the draft report under TWDB Contract No. 2000-483-360. As stated in the above referenced contract, the City will consider incorporating comments from the EXECUTIVE ADMINISTRATOR shown in Attachment 1, and other commentors on the draft final report into a final report. The City must include a copy of the EXECUTIVE ADMINISTRATOR's comments in the final report.

The Board looks forward to receiving one (1) electronic copy of the report with all appendices, one (1) unbound single-sided camera-ready original, and nine (9) bound double-sided copies of the final report on this planning project. Please contact Mr. Gilbert Ward at (512) 463-6418 if you have any questions about the Board's comments.

Sincerely,


Tommy Knowles, Ph.D., P.E.
Deputy Executive Administrator
Office of Planning

Cc: Gilbert R. Ward

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Provide leadership, technical services and financial assistance to support planning, conservation, and responsible development of water for Texas.

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ATTACHMENT 1
TEXAS WATER DEVELOPMENT BOARD
Contract No. 2000-483-360
Draft Woodcreek Master Drainage Plan,
Improvements to Hog Creek, City of Woodcreek, Texas"

1. In general, the study follows standard practice. However, the method used is dependent on the assumptions made by the evaluator. I did not see any indication that the study was calibrated with a known event to confirm the assumed basin and storm attributes used in the study or to develop any correlation with statistical expectation.

For example, a 100-yr frequency rainfall applied to a drainage basin does not necessarily correlate to a 100-year runoff event. Runoff is a function of precipitation depth minus losses. Losses can include consideration of soil moisture conditions that can vary regionally; dry, average, or saturated.

2. Loss models, such as the NRCS curve number (CN) procedure generally consider methods that typically yield "average" procedural conditions that do not necessary reflect actual climatic or regional conditions. Runoff can vary considerably as to where basin soil conditions statistically fall within the dry to saturated range. A 100-yr precipitation applied to a saturated basin could yield a 500-yr flood/ runoff event.

If a historical event were unavailable for calibration, at least some sensitivity analyses might have proven useful as a planning tool. Again, as an example, does the community wish to plan on a "statistical," or average, or do they wish to go conservative? Conservative may be "safe," but it also has serious political implication (land value/ tax base, etc.).

3. Basin response is also be a function of storm duration. The storm used for this project was a 24-hour event while the basin itself was quite small (under 2 square miles). A 24-hour event might (or might not) be overly conservative. I have seen studies where the use of the 24-hr duration, without calibration, yielded discharges two to three time greater than a statistical approach. If the study intended to target a statistical expectation, but without calibration who can tell what the this study actually tells? Again, however, we can return to the question as to what is the planning intention of the community.

4. An Application for Approval of Reclamation Project need not be filed with the Texas Natural Resource Conservation Commission for the referenced proposal. It was determined from our review that the proposed project, since it is in the City of Woodcreek, needs to be permitted by the City. The City of Woodcreek by virtue of its participation in the National Flood Insurance Program, and in accordance with Section 16.236 (d) (3&4) of the Texas Water Code, has approval authority for the project. If the City has not already done so, they should insure that the proposed construction is documented and permitted in accordance with their Flood Hazard Prevention Ordinance. This documentation should also be submitted by the City to the Federal Emergency Management Agency to obtain a Letter of Map Revision (LOMR) of Woodcreek's Flood Insurance Rate Map.

5. The technical content of the referenced report is based on acceptable hydrological and hydraulic methods and is complete. Therefore, the merits of the proposed project can be evaluated from the report.
6. The report describes the results of hydrologic and hydraulic analyzes completed in an effort to identify and quantify current flood conditions along Hog Creek. Preliminary construction cost estimates and a recommended implementation plan are also included in the report.
7. It appears that current, acceptable methodologies have been employed in the accumulation and presentation of data in this report. The recommended construction of main channel improvements and modification of bridges for flood control purposes are eligible for Board financing. The implementation plan and proposed construction phasing appear to be sound. The report would be appropriate for use in support of an application to the Board for financing the proposed improvements, however estimations of project costs should be refined before application submittal. All additional information required by Board rules, 31 TAC 363.401-404, and required to make legal findings required by Texas Water Code Chapter 17.771-776 would be required at the time of application. Flood control work is not eligible for the Board's pre-design funding option.
8. Water surface elevations are estimated in the report for the 10-year, 50-year, 100-year, and 500-year floods, however it is not apparent from the narrative what level of flood protection is provided by the recommended projects.



Espey Consultants, Inc.
Environmental & Engineering Services

November 30, 2001

Mr. Tommy Knowles, Ph.D., P.E.
Texas Water Development Board
1700 North Congress Avenue
Austin, Texas
78711-3231

Re: Response to TWDB Comments
Woodcreek Masterplan
EC Job#: 2000-33

Dear Dr. Knowles:

Please accept the following response to your comment letter dated September 21, 2001.

1. Complete rainfall (depth and distribution) and peak flow rate information was not available for calibration in this study. However, the results of the analysis were reviewed by representatives of the Guadalupe-Blanco River Authority (GBRA), and compared with the values computed using the USGS regional regression equations published in WRIR 96-4307. The upper and lower confidence limits (67%) of the equations were computed to estimate a correlation and/or statistical expectation. The results are as follows for the 100 year design storm:

HEC-HMS 100-yr Design Storm: **4376 cfs**

100-yr regression equation upper limit: 5529 cfs

100-yr regression equation: 2731 cfs

100-yr regression equation lower limit: 1349 cfs

2. Refer to comments and calculations presented in 1.
3. The 24-hour storm is used to conform to design criteria of the National Flood Insurance Program (NFIP) and is adequate for planning purposes and the purposes of updating FEMA's flood insurance rate maps (FIRM). In light of the comparison reported in 1, the estimate of the 100-year peak flow using the 24-hour design storm appears to lie within acceptable limits. Without statistical information for the watershed (recorded annual peak flow rates), a statistical approach is not available for use in this study.
4. Understood.
5. No action required.

6. No action required.
7. Understood.
8. The intended level of service of the recommended channel improvements lies between a 50-year and 100-year design storm for the existing flooding areas adjacent to lower Hog Creek. These areas have historically been flooded due to their proximity to the creek and the undersized road crossings that serve them. Therefore, due to the existing constraints (low slab elevations, shallow creek depth, limited creek right-of-way, etc.) this level of service is all that can be expected.

If you have any questions or require any additional information please do not hesitate to call Keith A. Moody, P.E. or myself at 512-326-5659.

Sincerely,


Brian K. Reis, P.E.

Managing Engineer

P:\active\2000-33 Woodcreek MP\letters\TWDB response.doc

