Vol. 1

BLACK FOREST DRAINAGE BASIN PLANNING STUDY

Prepared for:

El Paso County
Department of Public Works

May 1989

WILSON &COMPANY

EXECUTIVE SUMMARY

This is a summary of the results of the Black Forest Drainage Basin Planning Study in El Paso County, Colorado. The study covered all aspects of drainage basin planning in this 3.88 square mile basin. A number of drainage improvement alternatives were examined ad discussed at several public meetings held during the course of this study. Preliminary design plans were developed for the selected alternative.

The final design flows used for sizing the drainage facilities and improvements in the basin were developed using the SCS TR-20 computer program for project formulation hydrology. Peak flows for the 100-year and 10-year 24-hour storms in addition to the 100-year and 10-year 2-hour storms were examined and the highest peak was utilized for design purposes. The following information is a summary of the recommendations and subsequent costs of the proposed improvements.

A more detailed explanation of the items listed in this summary section can be found in the body of this report.

IMPROVEMENT COSTS SUMMARY

Location	Cost
South Tributary	$ 192,481.00
Middle Tributary	225,687.00
Main Tributary	1,834,024.00
Pauma Valley Tributary	263,138.00
Chaparrel Hills Tributary	12,474.00
TOTAL DRAINAGE IMPROVEMENT COSTS	$2,527,804.00
TOTAL BRIDGE COST	$ 358,050.00
TOTAL DETENTION LAND COST	$ 84,000.00

Fees

Drainage Basin Fee	$4,305.00
Bridge Fee	$ 598.00
Detention Land Fee	$ 140.00

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I. INTRODUCTION

A. Authorization

This Drainage Basin Planning Study was authorized under the terms of an agreement between the El Paso County Department of Public Works and Wilson & Company. This study covers drainage development alternatives within the Black Forest Drainage Basin.

B. Purpose and Scope of Work

The purpose of this study is to develop the most feasible drainage and flood control plans for the Black Forest Drainage Basin. The detailed scope of services is as follows:

1. Meet initially and bi-weekly or when requested by the County to:

    a. Insure compliance with the services required by this agreement.
    b. Obtain existing data and general information from participating entities.
    c. Solicit desires of participating entities and other interested agencies or groups in order to develop alternate plans.
    d. Procure current information relative to development plans in the basin.
    e. Procure information relative to right-of-way limitations and potential hazards due to flooding.
    f. Avoid duplication of effort whenever possible by utilizing existing information available from other agencies.
    g. Present findings of study segments and to acquire input from COUNTY and interested agencies and individuals.

2. Contact effected cities, individuals and agencies who have pertinent knowledge and an interest in the study area.

3. Utilize the City of Colorado Springs/El Paso County Drainage Criteria Manual as well as criteria requirements and policies of other applicable State or Federal agencies.

4. Perform a hydrologic study of the area for the 10 and the 100-year recurrence intervals under existing and future basin conditions.

5. Perform hydraulic calculations for the conceptual design of the outfall drainageway system.

6. Develop profile information from the contour maps and land field reconnaissance.

7. Develop and evaluate several improvement alternatives and provide information to arrive at a selected alternative.

8. Evaluate operations and maintenance aspects of the alternative improvements.

9. Identify known wetland areas and other environmentally sensitive areas relative to stormwater facility preliminary design.

10. Provide specific detention requirements such as maximum allowable discharge, minimum volume, and surface area of each facility.

11. Prepare a written report detailing the items which were examined in the course of the study.

C. Previous Drainage Reports

There have been numerous private drainage studies of areas performed within the Black Forest Drainage Basin. However, to date no comprehensive drainage study of the basin has been completed. The previous reports were completed using a number of different methods and under different criteria. It is the intent of this Drainage Basin Planning Study to utilize as much of the information contained in these studies as feasible. The following is a synopsis of those reports:

"Kingswood Drainage Report" by Colorado Engineers, Inc., 1972.

Area: Kingswood Subdivision - 160 Acres
Method: Burkli-Ziegler Formula
Criteria: 50-year storm, 3"/hr

"Drainage Report for Donala Subdivision No. 1" by H.J. Kraettli & Sons, 1972

Area: Donala Subdivision No. 1 - 412 Acres
Method: SCS method
Criteria: 50-year storm, 2"/hr (1-hr duration)

"Drainage Report for Donala Subdivision No. 2" by H.J. Kraettli & Sons, 1972

Area: Donala Suvdivision No. 2 - 229 Acres
Method: SCS method
Criteria: 50-year storm, 2"/hr (1-hr duration)

"Drainage Report for Donala Subdivision No. 3" by H.J. Kraettli & Sons, 1972

Area: Donala Subdivision No. 3 - 321 Acres
Method: SCS method
Criteria: 50-year storm, 2"/hr (1-hr duration)

"Drainage Report for Gleneagle Filing No. 1" by Leigh Whitehead & Assoc., 1983

Area: Gleneagle Filing No. 1 (Replat of a part of Donala Sub. No. 3) - 62 Acres
Method: Modified SCS method
Criteria: 5-year and 100-year storm, 2.6" and 4.2"/hr (24-hr duration)

"Drainage Report for Gleneagle Filing No. 2" by Leigh Whitehead & Assoc., 1984

Area: Gleneagle Filing No. 2 (Replat of a part of Donala Sub. No. 3) - 21.3 Acres
Method: Modified SCS method
Criteria: 5-year and 100-year storm, 2.6" and 4.2"/hr (24-hr duration)

"Drainage Report for Gleneagle Filing No. 3" by Costin Engineering Co., 1985

Area: Gleneagle Filing No. 3 - 13.2 Acres
Method: Modified SCS method
Criteria: 5-year and 100-year storm, 2.6" and 4.4"/hr (24-hr duration)

"Drainage Report for Gleneagle Filing No. 4" by Costin Engineering Co., 1986

Area: Gleneagle Filing No. 4 - 40 Acres
Method: Modified SCS method
Criteria: 5-year and 100-year storm, 2.6" and 4.4"/hr (24-hr duration)

"Drainage Plan for Academy Village" by Denver Engineering Corp., 1985

Area: Academy Village - 31.8 Acres
Method: Rational method (>20 ac.), SCS method (<20 ac.)
Criteria: 5-year and 100-year storm, 2.6" and 4.4"/hr (24-hr duration)

"Drainage Report for Academy View Filing No. 1" by Costin Engineering Co., 1986

Area: Academy View Filing No. 1
Method: SCS method
Criteria: 5-year and 100-year storm, 2.6" and 4.4"/hr (24-hr duration)

"Drainage Study for the Shoppe in the Glen" by Greiner Engineering, Inc., 1986

Area: The Shoppe in the Glen - 12.4 Acres
Method: Rational method
Criteria: 5-year and 100-year storm

"Drainage Report for Gleneagle-North Detention Pond" by Costin Engineering Co., 1988

Area: Gleneagle-North Detention Pond
Method: Army Corps of Engineers HEC-1 Program
Criteria: 10-year and 100-year storm

Although some information concerning changes in historic flow paths and proposed development densities is very useful, the flow information derived in the aforementioned reports may no longer be valid due to recent changes in the drainage criteria. Also, to date no floodplain study has been undertaken by FEMA within the project boundaries.

D. Mapping

The Monument, Colorado 1:24,000 topographic quadrangle map prepared by the U.S. Geological Survey was used as a based map for this project. The map uses 20' contours and was photorevised in 1986 from aerial photographs taken in 1984. This map was used for the general purposes of basin boundary delineation and for the establishment of principal tributary regions and subbasins within these regions.

The mapping for the floodplain and channel improvement plans was developed utilizing both new and existing mapping. The existing mapping was provided by El Paso County and is a combination of several base maps done by local developers over the past several years. The existing aerial mapping was not based on a USGS benchmark and had to be mechanically revised to match the new aerial mapping, which was tied into the USGS benchmark. This mapping was developed at a 1"=200' scale with 2 foot contour intervals.

E. Field Reconnaissance

Field reconnaissance of the basin was performed in order to supplement existing roadway and site development plans, and existing drainage reports. Culvert locations, sizes and depths were field checked and subbasin flow patterns were analyzed. In addition, existing as well as potential problem areas were noted for a more in-depth evaluation.

The field investigation information was utilized to develop existing land use conditions and also to evaluate future detention facility sites.

II. PROJECT DESCRIPTION, LOCATION AND DRAINAGE

A. Basin Description and Location

The Black Forest Drainage Basin is located 15 miles north of downtown Colorado Springs in northwestern El Paso County. It is situated in Townships 11 and 12 south, Range 67 west of the 6th P.M., El Paso County, Colorado. The basin contains 3.79 square miles (±), with the majority being platted but yet undeveloped land. The basin is bounded on the west by Monument Creek, on the south and east by the Smith Creek Drainage Basin and on the north by the Jackson Creek Drainage Basin. The basin crosses I-25 between the north entrance of the U.S. Air Force Acedemy and Baptist Road.

The runoff from the Black Forest Drainage Basin flows in a southwesterly direction, crosses I-25 through approximately six (6) culverts and continues across the Air Force Academy land into Monument Creek. The topography varies with moderate slopes of approximately 6% to 8% in the upper basin and gentler 2% to 4% slopes in the lower part of the basin. The vegetation also varies with trees covering about a quarter of the upper basin and native pasture grasses covering the remainder of the undeveloped land.

Most of the existing channels are little more than natural valleys and swales which are dry except for during rainfall events, although the primary channel through the basin, which begins at the northern most reach of the basin, is very well defined with year-round flow through about 50% of its reach.

B. Major Drainageways and Facilities

The Black Forest Drainage Basin is composed of several tributary basins. Of the six (6) tributaries which cross I-25, only three (3) are large enough to be considered major drainageways. The southernmost drainageway drains approximately 140 acres, 64 acres of which were diverted out of the Black Forest Basin with the construction of Gleneagle Drive. This existing drainageway is presently comprised of a broad grassed swale with no visual evidence of erosion, and crosses I-25 through a 6 ft. x 6 ft. box culvert.

The second largest tributary comprises approximately 385 acres and drains much of the Gleneagle golf course. This drainageway, like the one a thousand feet south, is also a broad grassed swale which crosses under I-25 through a 6 ft. x 7 ft. box culvert. This drainageway does have the Donala Wastewater Treatment Plant in its path which will require some special considerations.

The third and largest tributary is the main channel of the Black Forest Drainage Basin. Approximately 1325 acres are tributary to the double 10 ft. x 10 ft. box culvert which crosses under I-25. The existing drainageway is a well defined channel approximately 20 feet wide and 10 feet deep. The channel begins in the upper reaches of the basin as broad grassed swales, which combine flows from north of Baptist Road with flow from east of Gleneagle Drive. The two subtributaries join together west of Gleneagle Drive just south of Jessie Drive. The drainageway cross section varies from Gleneagle Drive to I-25. In some areas severe erosion is evident, while in other areas stable vegetation-covered banks exist.

All of the basin is tributary to Monument Creek which is located about 1200 feet west of I-25. Monument Creek is a wide, natural stream which is located entirely within the boundaries of the US Air Force Academy. Flows from the Black Forest Drainage Basin are routed to Monument Creek. Since developed flows will be kept to existing levels there should be no detrimental effects on the existing channel.

C. Existing Surface Water Impoundments

The Black Forest Drainage Basin is typical of most of the rangeland areas along the front range with regards to existing stock ponds. Several ponds can be found along the main channel reach, including a couple of ponds located near the Baptist Assembly. Most of these ponds were only used to store water for livestock, and are inundated by major storm events.

During the course of the Gleneagle development, several detention/retention ponds were constructed. Two (2) of the retention ponds currently function as stormwater control facilities and as golf course amenities. These two ponds are located along the middle tributary, and only have about 70 acres draining to them. A third, dry pond is located on the same tributary just upstream of the wastewater treatment plant. Since no outlet pipe exists, the pond must first fill with stormwater before any is released. Once the storm passes, the stormwater remaining in the pond infiltrates into the sandy soil.

There have been two (2) ponds constructed along the main tributary. One of the ponds, which was built on the main channel about 4100 feet downstream of Gleneagle Drive, is relatively small and appears to have been built more to retard sediment than to detain stormwater flow. The second pond, located east of Gleneagle Drive, is known as Jake's Lake East. This facility has 365 acres tributary to it, and was specifically designed as an irrigation water source for the golf course.

An additional pond is under construction along the main tributary, approximately 3700 feet downstream of Gleneagle Drive. This pond will be used primarily for stormwater control and can detain 36 acre-feet of water at its maximum depth.

III. HYDROLOGIC EVALUATION

A. Basin Hydrology

The hydrologic model used to determine peak flows and volumes throughout the Black Forest Drainage Basin was the TR-20 computer program for Project Formulation Hydrology developed by the Soil Conservation Service. The TR-20 program is in compliance with the City/County Drainage Criteria Manual for computing flows for areas larger than 100 acres.

The overall basin was divided into tributary basins and then into smaller subbasins. The subbasins have a maximum size of 100 acres. The subbasins were then numbered with even numbers and design points designated with letters (See the Basin Discharge Map in the back pocket of this report). The subbasins were chosen with respect to the natural topography, roadway crossings and development changes. The subbasins were then field verified and modified where necessary. Peak flows for these subbasins were then calculated for existing as well as fully developed conditions.

According to present criteria, peak flows for the 100 year and 10 year 24-hour storms, as well as the 100 year and 10 year 2-hour storms, must be calculated. The storm which produced the highest peak values was then used to evaluate existing and future drainageways and other stormwater facilities.

B. Time of Concentration

The time of concentration (T_C) used in the TR-20 calculations was determined by first calculating an initial overland flow time from the subbasin boundary to the naturally occurring swales and channels. Then a travel time was calculated in these natural swales to the bottom of the subbasin and added to the initial time of concentration to determine the overall time of concentration for existing conditions. For future developed conditions the channel travel times were adjusted to reflect improved conditions and therefore a quicker time of concentration.

C. Rainfall

Rainfall amounts for the Black Forest Basin were determined from the National Oceanic and Atmospheric Administration Atlas 2, Volume III, as detailed in the City/County Drainage Criteria Manual, Figures 5-4a through 5-4e.

Precipitation for the 100 year, 24-hour and the 10 year, 24-hour storm were 4.6 inches and 3.0 inches, respectively. The precipitation amounts for the 100 year, 2-hour and the 10 year, 2-hour storms were calculated by the procedures as outlined in the criteria manual. The amounts for the 2-hour storms were based on a 1-hour rainfall of 2.84 inches for the 100-year storm and 1.97 inches for the 10-year storm. The calculated amount for the 100-year 2-hour rainfall is 1.156 x 2.84 = 3.28 inches. The calculated amount for the 10-year 2-hour rainfall is 1.157 x 1.97 = 2.28 inches.

The Type IIA rainfall distribution curves used for the 24-hour storm were developed by the National Weather Service and are in conformance with the criteria manual, Table 5-3. The distribution curve used for the 2-hour storm is similar to that used by the Colorado Unit Hydrograph Procedure. The cumulative rainfall event percentages are shown in the following table:

TABLE 1

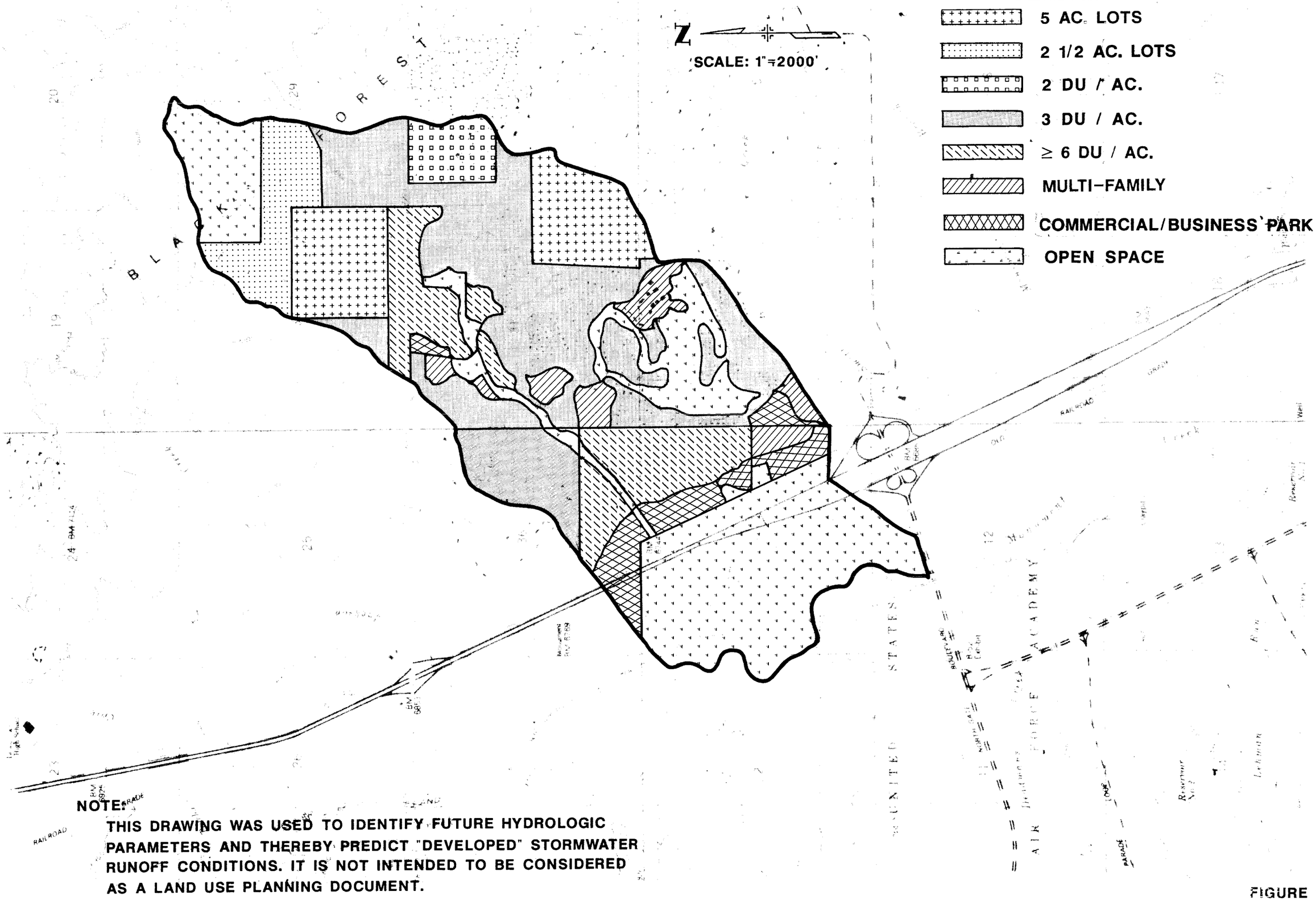
2-HOUR RAINFALL DISTRIBUTION

TIME (MIN)	10-YEAR STORM RAINFALL DIST. (%)*	10-YEAR STORM ACCUM. DIST. (%)*	10-YEAR STORM CUMULATIVE RAINFALL (%)	100-YEAR STORM RAINFALL DIST. (%)*	100-YEAR STORM ACCUM. DIST. (%)*	100-YEAR STORM CUMULATIVE RAINFALL (%)
5	2	2	0.0173	1	1	0.0087
10	3.7	5.7	0.0493	3	4	0.0346
15	8.2	13.9	0.1201	4.6	8.6	0.0744
20	15	28.9	0.2498	8	16.6	0.1436
25	25	53.9	0.4659	14	30.6	0.2647
30	12	65.9	0.5696	25	55.6	0.4810
35	5.6	71.5	0.6180	14	69.6	0.6021
40	4.3	75.8	0.6551	8	77.6	0.6713
45	3.8	79.6	0.6880	6.2	83.8	0.7249
50	3.2	82.8	0.7156	5	88.8	0.7682
55	3.2	86	0.7433	4	92.8	0.8028
60	3.2	89.2	0.7710	4	96.8	0.8374
65	3.2	92.4	0.7986	4	100.8	0.8720
70	3.2	95.6	0.8263	2	102.8	0.8893
75	3.2	98.8	0.8539	2	104.8	0.9066
80	2.5	101.3	0.8755	1.2	106	0.9170
85	1.9	103.2	0.8920	1.2	107.2	0.9273
90	1.9	105.1	0.9084	1.2	108.4	0.9377
95	1.9	107	0.9248	1.2	109.6	0.9481
100	1.9	108.9	0.9412	1.2	110.8	0.9585
105	1.9	110.8	0.9576	1.2	112	0.9689
110	1.9	112.7	0.9741	1.2	113.2	0.9792
115	1.7	114.4	0.9888	1.2	114.4	0.9896
120	1.3	115.7	1.0000	1.2	115.6	1.0000
	115.7			115.6		

* % OF 1-HOUR RAINFALL

D. Land Use

Existing land uses in the Black Forest Drainage Basin were determined by examining current development plans supplemented with field reconnaissance. Currently most of the development is occurring in the central portion of the basin with the outlying areas remaining in their natural state or partially developed into 5 acre lot subdivisions. Presently, most of the interior of the basin is platted, however, only about 30% of the basin is fully developed.



NOTE:

THIS DRAWING WAS USED TO IDENTIFY FUTURE HYDROLOGIC PARAMETERS AND THEREBY PREDICT "DEVELOPED" STORMWATER RUNOFF CONDITIONS. IT IS NOT INTENDED TO BE CONSIDERED AS A LAND USE PLANNING DOCUMENT.

FIGURE 1

REVISION

WILSON & COMPANY
ENGINEERS & ARCHITECTS
COLORADO SPRINGS COLORADO

BLACK FOREST
DRAINAGE BASIN PLANNING STUDY
LAND USE MAP

DESIGN	
DRAWN	
DATE	
FILE NO.	
SHEET NO.	9

WILSON & COMPANY

Proposed land use for the area was determined through examination of current development plans and through discussions with El Paso County Land Use officials. The properties currently owned by the Baptist Assembly and the U.S. Air Force Academy were assumed to remain in their natural state. All other undeveloped areas were assumed to be fully developed using projected densities. In addition, on the recommendation of El Paso County officials, some of the 5 acre lot subdivisions were assumed to have been replatted at a higher density to reflect possible ultimate conditions in the area. The land use map is a composite of this land use information. There is not a time frame or date associated with this ultimate projected land use.

E. Soil Characteristics

The soils information contained in this report were derived from the "Soil Survey of El Paso County Area, Colorado" published by the USDA Soil Conservation Service in 1981. Of the eight (8) soils groups found within the Black Forest Drainage Basin five (5) belong to soils group B and, two (2) belong to soils group C, and one (1) belongs to both soils group B and D (See the soil map exhibit for location). The following is a table of the soils located within the basin:

TABLE 2

S.C.S. Soils Map Number	Soil Type	Hydrologic Group
1	Alamosa Loam	C
14	Brussett Loam	B
41	Kettle Gravelly Loamy Sand	B
42	Kettle-Rock Outcrop Complex	B/D (Rock)
45	Kutch Clam Loam	C
68	Peyton-Pring Complex	B
71	Pring Coarse Sandy Loam	B
92/93	Tomah-Crowfoot Loamy Sands	B

Although the Kettle-Rock Outcrop is found within this basin, most of the complex is within hydrologic group B. Very little rock outcroppings are visable in the area. Only a 10% quantity of type D soils was used in the computations of Soils Map Number 41.

F. Curve Numbers

Curve numbers (CN's) were determined for the basin by utilizing soils and land use information. Curve numbers for existing conditions were developed by examining existing development densities for the currently developing properties. Curve numbers for the undeveloped portions of the basin were developed for a range land condition. According to the El Paso County office of the Soil Conservation Service, most of the range land in the basin is in good to fair condition. Curve numbers for developed conditions were calculated based on the projected land use information found on the land use map.

N

SCALE: 1"=2000'

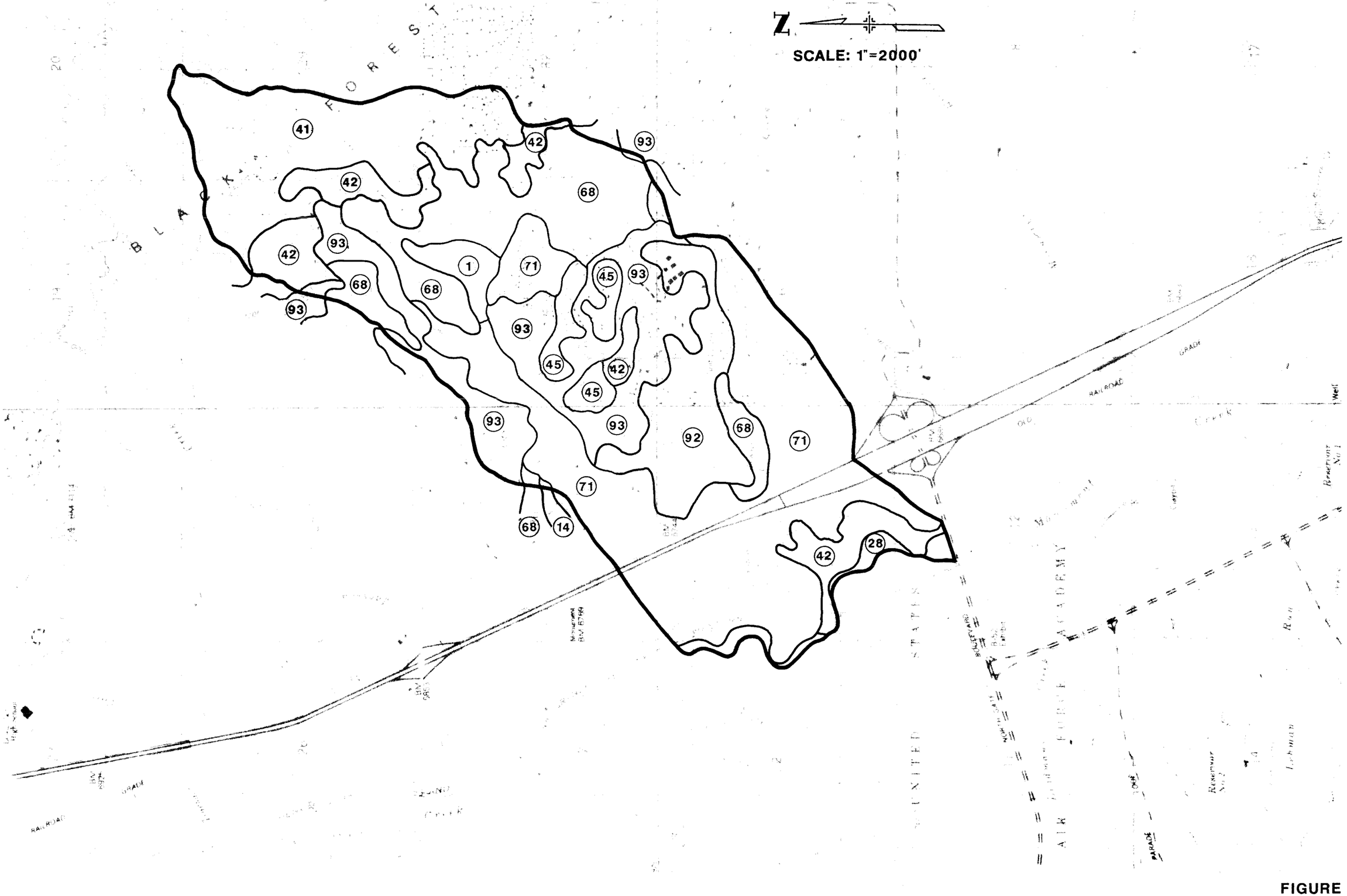


FIGURE 2

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ENGINEERS & ARCHITECTS
COLORADO SPRINGS COLORADO

REVISION

BLACK FOREST
DRAINAGE BASIN PLANNING STUDY
SOILS MAP

DESIGN	
DRAWN	
DATE	
FILE NO.	
SHEET NO.	11

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TABLE 3

BLACK FOREST STUDY
EXISTING CONDITIONS

AREA NAME	TOTAL AREA (ACRES)	TOTAL AREA (SQ.MI.)	SOIL TYPE B	CN (II)	CN (III)	SOIL TYPE C	CN (II)	CN (III)	SOIL TYPE D	CN (II)	CN (III)	TOTAL CN (II)	TOTAL CN (III)	AREA NAME
2	45.948	0.072	44.566	65.0	81.0				1.382	82.0	92.0	65.5	81.3	2
4	59.684	0.093	57.297	65.0	81.0				2.387	82.0	92.0	65.7	81.4	4
6	21.513	0.034	21.513	79.0	91.0							79.0	91.0	6
7	40.863	0.064	40.863	65.0	81.0							78.5	89.0	7
8	79.566	0.124	79.566	65.0	81.0							65.0	81.0	8
10	49.731	0.078	49.731	68.5	83.5							68.5	83.5	10
11	14.080	0.022	14.080	68.5	83.5							68.5	83.5	11
12	76.936	0.120	74.443	65.0	81.0				2.493	82.0	92.0	65.6	81.4	12
14	8.889	0.014	8.889	79.0	91.0							79.0	91.0	14
16	16.169	0.025	16.169	65.0	81.0							65.0	81.0	16
17	38.200	0.060	38.200	64.0	79.5							64.0	79.5	17
18	34.835	0.054	34.835	65.0	81.0							65.0	81.0	18
19	20.224	0.032	20.224	65.0	81.0							65.0	81.0	19
20	50.813	0.079	50.813	67.5	82.3							67.5	82.3	20
22	76.727	0.120	76.727	67.5	82.8							67.5	82.8	22
24	60.693	0.095	90.537	63.5	80.0							63.5	80.0	24
25	29.844	0.046	29.844	63.5	80.0							63.5	80.0	25
26	70.546	0.110	70.546	71.8	85.0							71.8	85.0	26
28	91.381	0.143	90.480	65.0	81.0				0.901	82.0	92.0	65.2	81.1	28
30	46.644	0.073	46.644	65.0	81.0							65.0	81.0	30
32	31.716	0.050	31.716	65.0	81.0							65.0	81.0	32
33	7.724	0.012	7.724	61.0	78.0							61.0	78.0	33
34	120.819	0.189	120.819	65.0	81.0							65.0	81.0	34
36	33.542	0.052	33.542	65.0	81.0							65.0	81.0	36
37	9.479	0.015	9.479	65.0	81.0							65.0	81.0	37
38	21.180	0.033	21.180	65.0	81.0							65.0	81.0	38
39	21.050	0.033	21.050	65.0	81.0							65.0	81.0	39
40	41.387	0.065	41.387	61.0	78.0							61.0	78.0	40
42	58.717	0.092	47.229	61.0	78.0	10.261	74.0	87.0	1.227	80.0	91.0	63.7	79.8	42
44	60.847	0.095	39.230	67.5	82.8	17.764	78.1	90.4	3.853	83.5	92.8	71.6	85.7	44
46	8.067	0.013	3.356	69.3	84.0	4.711	79.3	91.0				75.1	88.1	46
47	18.825	0.029	6.428	67.5	82.8	12.397	78.1	90.4				77.9	92.0	47
48	86.503	0.135	86.503	66.1	81.8							66.1	81.8	48
50	49.950	0.078	32.032	67.1	82.5	17.918	77.9	90.2				71.0	85.3	50
52	14.979	0.023	14.979	61.0	78.0							61.0	78.0	52
54	39.345	0.061	26.891	61.0	78.0	12.454	74.0	87.0				65.1	80.8	54
56	47.191	0.074	40.703	68.5	82.0	6.488	78.8	90.8				69.9	83.2	56
58	57.926	0.091	57.926	63.0	79.5							63.0	79.5	58
60	40.819	0.064	40.369	65.0	81.0				0.45	81.0	92.0	65.2	81.1	60
62	25.299	0.040	10.967	70.5	84.5	14.332	76.5	91.3				73.9	88.4	62
64	47.210	0.074	47.210	70.3	84.8							70.3	84.8	64
66	108.499	0.170	105.360	68.6	83.6	3.139	79.0	89.5				68.9	83.8	66
68	60.148	0.094	54.128	65.9	81.9	5.554	76.5	89.5	0.466	82.7	92.6	67.0	82.7	68
70	24.891	0.039	11.797	66.5	82.0	12.776	77.5	90.0	0.318	82.4	92.4	72.3	86.2	70
72	71.161	0.111	66.154	65.5	81.5	2.843	76.5	89.5	2.164	81.0	92.5	66.4	82.2	72
73	27.900	0.044	27.900	66.0	82.0							66.0	82.0	73
74	34.386	0.054	34.386	69.5	84.0							69.5	84.0	74
76	4.108	0.006	4.108	70.0	85.0							70.0	85.0	76
78	27.102	0.042	27.102	65.0	81.0							65.0	81.0	78
80	35.273	0.055	35.273	65.0	81.0							65.0	81.0	80
82	58.550	0.091	57.453	65.5	81.5				1.097	81.0	92.5	65.8	81.7	82
84	47.310	0.074	43.324	66.0	81.5				3.986	83.0	92.5	67.4	82.4	84
86	63.720	0.100	63.187	66.0	82.0				0.533	83.0	93.0	66.1	82.1	86
88	73.178	0.114	71.786	66.0	82.0				1.392	83.0	93.0	66.3	82.2	88
90	88.545	0.138	88.545	66.0	82.0							66.0	82.0	90

TABLE 4

BLACK FOREST STUDY
FUTURE CONDITIONS

AREA NAME	TOTAL AREA (ACRES)	TOTAL AREA (SQ.MI.)	SOIL TYPE B	CN (II)	CN (III)	SOIL TYPE C	CN (II)	CN (III)	SOIL TYPE D	CN (II)	CN (III)	TOTAL CN (II)	TOTAL CN (III)	AREA NAME
2	45.948	0.072	44.566	65.0	81.0				1.382	82.0	92.0	65.5	81.3	2
4	59.684	0.093	57.297	65.0	81.0				2.387	82.0	92.0	65.7	81.4	4
6	21.513	0.034	21.513	79.0	91.0							79.0	91.0	6
7	40.863	0.064	40.863	78.5	89.0							78.5	89.0	7
8	29.702	0.046	29.702	90.0	96.0							90.0	96.0	8
10	49.731	0.078	49.731	76.0	88.3							76.0	88.3	10
11	14.080	0.022	14.080	76.0	88.3							76.0	88.3	11
12	76.936	0.120	74.443	65.0	81.0				2.493	82.0	92.0	65.6	81.4	12
14	8.889	0.014	8.889	79.0	91.0							79.0	91.0	14
16	16.169	0.025	16.169	71.8	85.0							71.8	85.0	16
17	38.200	0.060	38.200	75.8	87.4							75.8	87.4	17
18	34.835	0.054	34.835	81.2	91.6							81.2	91.6	18
19	20.224	0.032	20.224	84.8	93.4							84.8	93.4	19
20	50.813	0.079	50.813	76.8	89.0							76.8	89.0	20
22	76.727	0.120	76.727	65.7	76.5							65.7	76.5	22
24	60.693	0.095	60.693	64.3	80.4							64.3	80.4	24
25	29.844	0.046	29.844	64.3	80.4							64.3	80.4	25
26	70.546	0.110	70.546	71.8	85.3							71.8	85.3	26
28	91.381	0.143	91.381	65.0	81.0				0.901	82.0	92.0	65.0	81.0	28
30	46.644	0.073	46.644	65.0	81.0							65.0	81.0	30
32	31.716	0.050	31.716	78.5	89.0							78.5	89.0	32
33	7.724	0.012	7.724	92.0	97.0							92.0	97.0	33
34	120.819	0.189	120.819	79.1	89.8							79.1	89.8	34
36	33.542	0.052	33.542	65.0	81.0							65.0	81.0	36
37	9.479	0.015	9.479	81.2	90.6							81.2	90.6	37
38	21.180	0.033	21.180	83.6	92.8							83.6	92.8	38
39	21.050	0.033	21.050	73.1	85.8							73.1	85.8	39
40	41.387	0.065	41.387	82.3	92.0							82.3	92.0	40
42	58.717	0.092	47.229	80.1	90.6	10.261	86.2	94.5	1.227	89.5	96.0	81.4	91.4	42
44	42.022	0.066	32.802	69.2	84.0	5.367	79.2	91.0	3.853	84.4	93.2	71.9	85.7	44
46	8.067	0.013	3.356	72.0	86.0	4.711	81.0	92.0				77.3	89.5	46
47	18.825	0.029	6.428	72.0	70.3	12.397	81.0	88.1				77.9	82.0	47
48	86.503	0.135	86.503	67.1	82.5							67.1	82.5	48
50	49.950	0.078	32.032	71.7	85.8	17.918	80.8	91.9				75.0	88.8	50
52	14.979	0.023	14.979	77.8	89.5							77.8	89.5	52
54	39.345	0.061	26.891	73.8	86.9	12.454	82.2	92.5				76.5	88.7	54
56	47.191	0.074	40.703	73.3	86.7	6.488	81.8	92.4				74.5	87.5	56
58	57.926	0.091	57.926	76.6	88.4							76.6	88.4	58
60	40.819	0.064	40.369	76.5	88.0				0.45	82.0	92.0	76.6	88.0	60
62	25.299	0.040	10.967	79.2	89.7	14.332	85.4	94.1				82.7	92.2	62
64	47.210	0.074	47.210	71.7	85.8							71.7	85.8	64
66	108.499	0.170	105.360	71.3	85.7	3.139	80.7	92.0				71.6	85.9	66
68	60.148	0.094	54.128	72.3	86.1	5.554	76.5	89.5	0.466	93.0	98.0	72.8	86.5	68
70	24.891	0.039	11.797	81.4	91.1	12.776	86.8	94.9	0.318	92.0	98.0	84.3	93.1	70
72	71.161	0.111	66.154	81.3	89.8	2.843	86.8	94.9	2.164	90.0	96.0	81.8	90.2	72
73	27.900	0.044	27.900	72.0	86.0							72.0	86.0	73
74	34.386	0.054	34.386	89.2	95.6							89.2	95.6	74
76	4.108	0.006	4.108	75.6	87.6							75.6	87.6	76
78	27.102	0.042	27.102	84.6	92.9							84.6	92.9	78
80	35.273	0.055	35.273	75.4	87.3							75.4	87.3	80
82	58.550	0.091	57.453	68.8	83.8				1.097	82.5	93.3	69.1	84.0	82
84	47.310	0.074	43.324	65.5	81.5				3.986	82.5	92.5	66.9	82.4	84
86	63.720	0.100	63.187	66.0	82.0				0.533	83.0	93.0	66.1	82.1	86
88	73.178	0.114	71.786	66.0	82.0				1.392	83.0	93.0	66.3	82.2	88
90	88.545	0.138	88.545	66.0	82.0							66.0	82.0	90

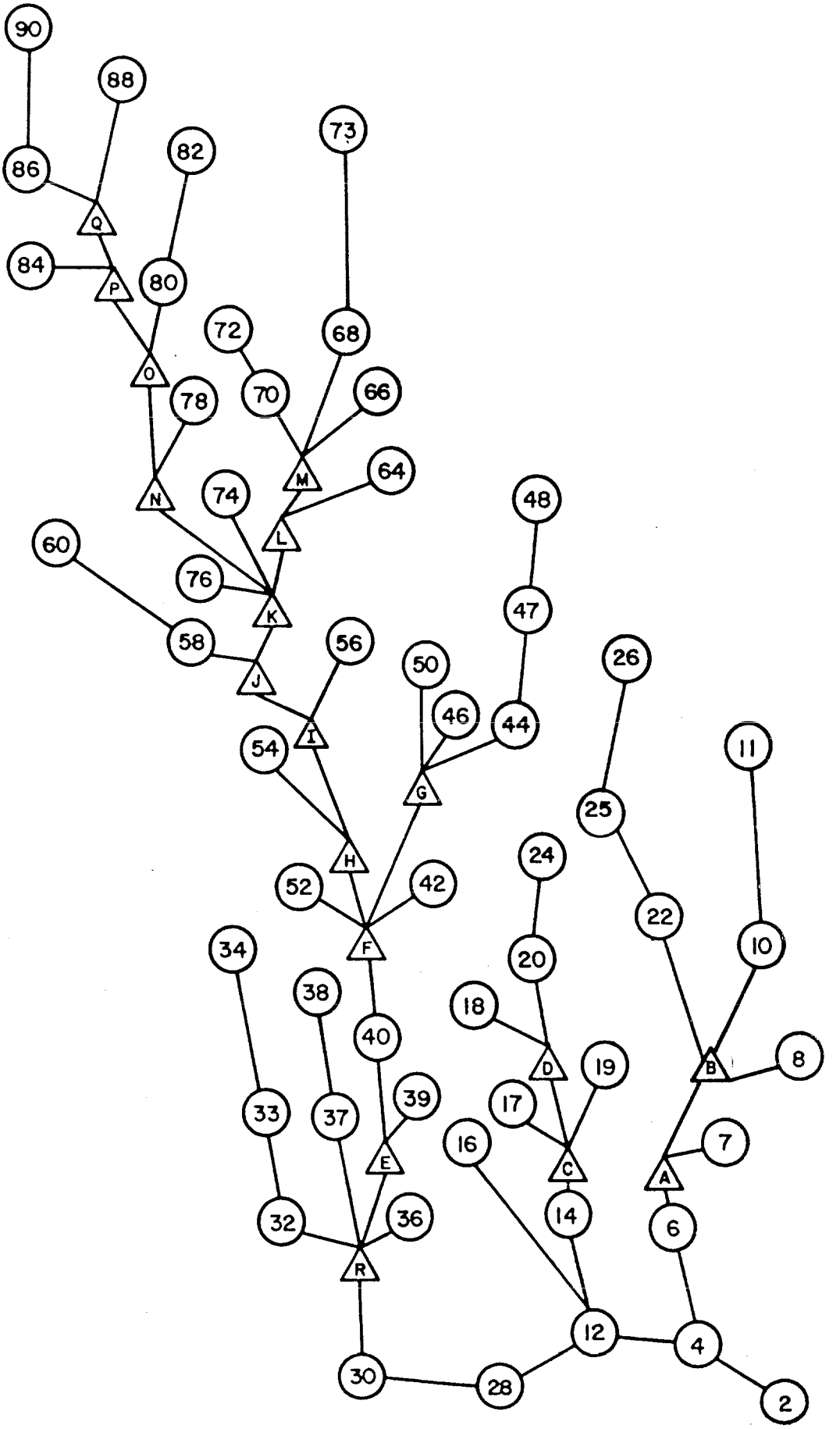

FIGURE 3
TR-20 FLOW DIAGRAM
EXISTING CONDITIONS

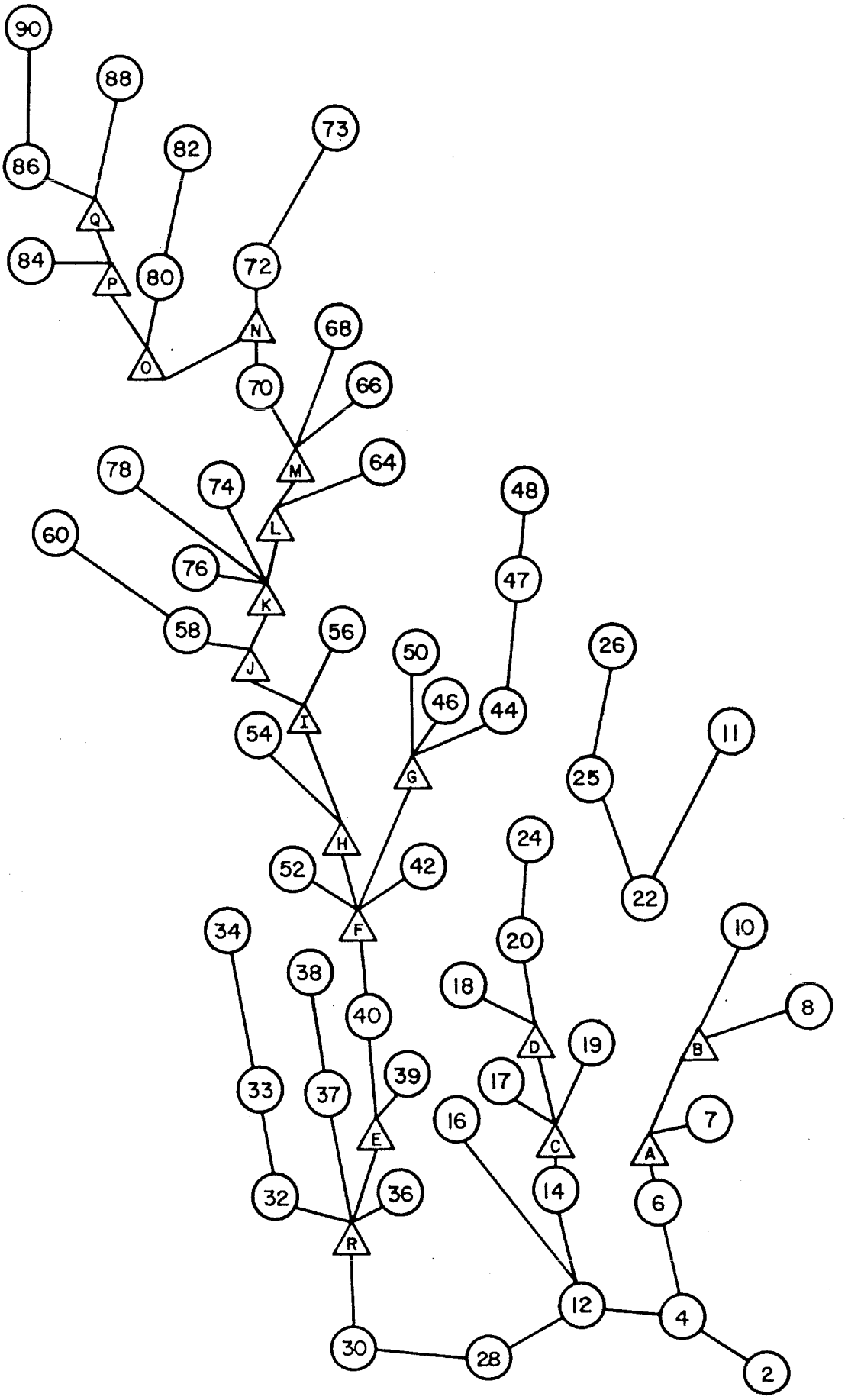

FIGURE 4
TR-20 FLOW DIAGRAM
FUTURE CONDITIONS

TABLE 5

SUMMARY OF DISCHARGES

Subbasin No.	Existing Conditions Peak Flows (CFS) 24-Hour 100-Yr	24-Hour 10-Yr	2-Hour 100-Yr	2-Hour 10-Yr	Future Conditions Peak Flows (CFS) 24-Hour 100-Yr	24-Hour 10-Yr	2-Hour 100-Yr	2-Hour 10-Yr
2	80	25	65	30	80	25	50	30
4	95	30	85	40	95	30	85	40
6	55	25	45	25	55	25	45	25
7	75	25	95	55	120	55	100	55
8	100	50	45	20	150	85	100	70
10	75	25	70	35	135	60	105	60
11	30	10	25	10	40	20	30	15
12	110	35	100	50	110	35	100	50
14	25	10	20	10	25	10	20	10
16	25	5	20	10	40	15	30	15
17	55	15	45	20	100	40	80	45
18	55	15	50	25	115	55	90	50
19	35	10	30	15	80	40	60	35
20	85	30	70	35	145	65	110	60
22	90	30	90	45	80	25	60	25
24	80	20	75	35	85	25	75	35
25	45	15	40	20	45	15	40	20
26	140	55	120	60	145	55	115	60
28	120	35	115	55	120	35	115	55
30	70	20	65	30	70	20	65	30
32	40	15	40	20	90	40	65	35
33	10	5	10	5	40	25	25	20
34	155	45	150	70	360	165	265	150
36	50	15	45	20	50	15	45	20
37	15	5	15	5	35	15	25	15
38	35	10	30	15	80	40	60	35
39	35	10	30	15	55	25	40	20
40	45	10	50	20	150	75	110	65
42	80	20	70	35	200	100	150	85
44	95	35	75	40	95	40	75	40
46	20	10	15	10	20	10	15	10
47	60	30	30	15	60	30	30	15
48	150	45	125	60	155	50	130	65
50	105	40	85	45	125	55	100	55
52	15	5	15	5	45	20	35	20
54	60	20	55	25	115	50	85	50
56	100	35	75	40	130	60	105	55
58	85	25	75	35	170	80	130	70
60	70	20	60	30	125	55	90	50
62	70	30	55	30	90	45	70	40
64	110	40	90	45	115	45	90	50
66	215	75	180	90	270	110	220	115
68	150	50	90	45	230	95	185	95

SUMMARY OF DISCHARGES (Cont.)

Subbasin No.	Existing Conditions Peak Flows (CFS) 24-Hour 100-Yr	24-Hour 10-Yr	2-Hour 100-Yr	2-Hour 10-Yr	Future Conditions Peak Flows (CFS) 24-Hour 100-Yr	24-Hour 10-Yr	2-Hour 100-Yr	2-Hour 10-Yr
70	60	25	50	25	95	50	70	45
72	130	45	110	55	270	135	185	110
73	--	--	--	--	80	35	60	30
74	70	25	55	30	155	90	110	70
76	10	5	10	5	10	5	10	5
78	45	15	40	20	105	55	75	45
80	55	15	50	25	100	45	75	40
82	105	35	90	40	130	50	110	55
84	95	35	75	35	95	35	80	40
86	115	40	100	45	115	40	100	50
88	125	40	110	55	125	40	110	50
90	160	55	135	65	160	55	135	65

TABLE 6

SUMMARY OF DISCHARGES

Design Point	Existing Conditions Peak Flows (CFS) 24-Hour 100-Yr	24-Hour 10-Yr	2-Hour 100-Yr	2-Hour 10-Yr	Future Conditions Peak Flows (CFS) 24-Hour 100-Yr	24-Hour 10-Yr	2-Hour 100-Yr	2-Hour 10-Yr
A	315	85	250	125	350	165	290	150
B	240	70	200	100	265	115	195	100
C	290	65	280	120	300	135	135	80
D	260	55	240	105	365	155	290	160
E	2090	620	1355	645	1900	360	1455	610
F	1990	610	1320	650	1825	355	1345	565
G	390	155	325	160	435	165	320	145
H	1510	490	930	455	1655	790	1225	740
I	1445	470	880	435	1540	740	1135	690
J	1350	430	805	395	1410	685	1035	570
K	1235	395	690	340	1135	580	900	540
L	630	225	535	260	860	385	690	375
M	455	155	400	195	665	290	53	285
N	625	170	530	245	815	280	705	330
O	590	150	500	230	590	150	530	240
P	510	135	435	190	520	135	425	190
Q	390	115	340	160	390	116	330	160
R	2140	655	1460	710	2010	960	1600	715

IV. HYDRAULIC DESIGN EVALUATION

A. Existing Drainageway Evaluation

As outlined in the Master Drainageway and Facilities Section, most of the major drainageways within the Black Forest Drainage Basin are natural, unimproved channels. The channel in the upper reaches of most of the basin are wide grassed swales with little or no signs of erosion. The only channel which exhibits signs of erosion is the main tributary channel. Even in this channel, where flows exceed 2000 CFS in some areas, erosion is only evident along a portion of the channel reach and at culvert outlets.

An evaluation chart was developed for the major existing channel in the basin. The following is a list of abbreviations used in the chart:

D.P. A - Design Point A as shown on the basin discharge map
b - Channel bottom width
z - The reciprocal of the channel side slope (i.e. 2H to 1V slope, z=2)
Q_{100} - Peak stormwater flow for a 100-year storm
S - Channel slope
D_n - Normal Depth
V_n - Velocity in the channel for normal depth
L - Length of the channel

The evaluation chart was developed using existing conditions as observed in the field. Peak flows were determined using the results of the Hydrologic Design Evaluation. The 24-hour, 100 year storm peak was used since it produced the highest storm peaks for existing conditions in most instances. For actual design it may be necessary to use the Rational Method for subbasins whose area is less than 100 acres.

B. Existing Structure Evaluation

Only the existing structures which transport flows out of major subbasins have been examined in this report. These structures vary from 18" CSP's to a double 10' x 10' box culvert. The culverts were analyzed using the guidelines presented in the City/County Drainage Criteria Manual. An allowable headwater of 6" below the edge of pavement was utilized to calculate maximum culvert capacities.

The analysis revealed that a large number of the existing structures throughout the basin are unable to effectively handle the existing 100 year, 2-hour storm without overflowing the roadways. An existing structure evaluation chart was developed to summarize these findings.

C. Wetland Identification

Wetlands and other environmentally significant areas were identified during the course of this study, see the Wetlands Map Exhibit. Since environmental concerns were identified as an integral part of the design criteria, the development of regional detention alternatives was performed to lessen the impact of development on the environment. Detention basin locations were evaluated not only for site constructability but also for their affect on wetlands and riparian areas.

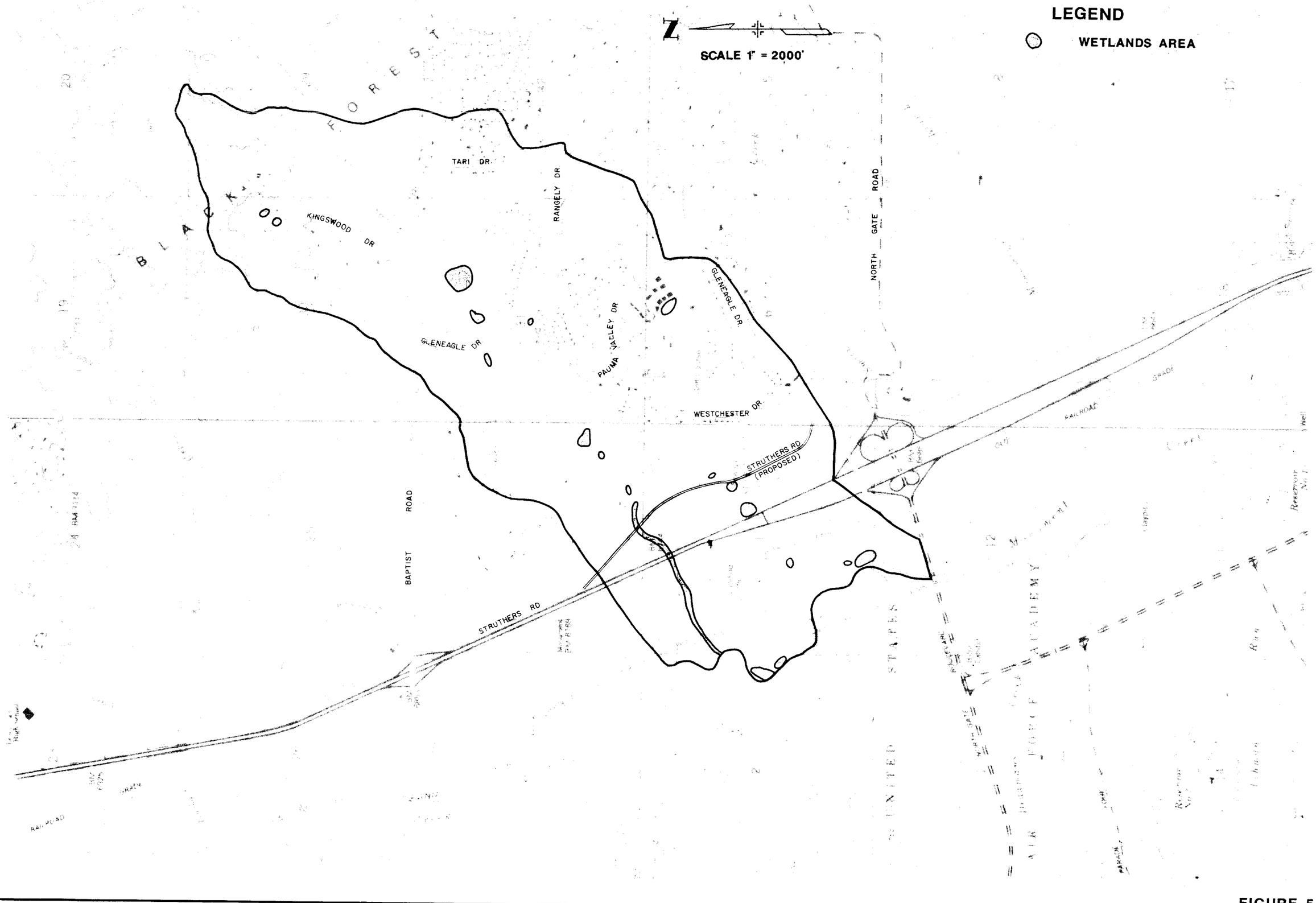

FIGURE 5

WILSON & COMPANY
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COLORADO SPRINGS COLORADO

REVISION

BLACK FOREST
DRAINAGE BASIN PLANNING STUDY
WETLANDS MAP

DESIGN	
DRAWN	
DATE	
FILE NO.	
SHEET NO.	20

WILSON & COMPANY

The wetland areas shown on the wetlands map exhibit were located based on information provided by the U.S. Fish and Wildlife agency, from aerial photography and also from field observations. The wetland locations shown on this map are general in nature and will require future study and delineation at the time of construction plan development in order to obtain a Section 404 permit from the Corps of Engineers.

D. Floodplain Delineation

Hydraulic calculations were performed along the major flow routes to determine the extent of the existing floodplain in the area. These water surface profiles and boundaries were delineated using the U.S. Army Corps of Engineers HEC-2 Water Surface Profile Program. Since there has not been a Flood Insurance Study performed by the Federal Emergency Management Agency (FEMA), channel cross section and length information was obtained from the aerial mapping done in conjunction with this project as well as from mapping provided by El Paso County. Channel roughness coefficients were determined from aerial photographs and from field reconnaissance. The existing 100-year floodplain is delineated on the preliminary plans contained in this study. The HEC-2 input and output are presented in the Technical Addendum of this study which is available for review at the El Paso County Department of Public Works. The following is a table of the existing 100-year flow elevations.

TABLE 7

HEC-2 STATION	CHANNEL STATION	100-YEAR FLOW ELEVATION
Middle Tributary:		
11	0+60	6724.8
12	5+60	6735.3
13	9+30	6746.6
14	13+50	6760.3
15	18+00	6765.8
16	26+00	6794.6
17	28+00	6802.7
18	28+60	6807.6
Main Tributary:		
50	2+00	6657.1
52	13+80	6697.8
54	25+20	6719.0
56	25+80	6724.4
58.1	26+00	6725.1
58.2	27+50	6725.7
60	29+50	6728.3
62	40+40	6758.5
64	48+50	6784.1
65	51+00	6790.2
66	54+80	6801.9

HEC-2 STATION	CHANNEL STATION	100-YEAR FLOW ELEVATION
Main Tributary (Cont.):		
68	56+60	6801.9
69	65+00	6834.0
70	68+00	6846.5
71	76+00	6857.2
72	84+00	6877.5
73	91+60	6912.6
74	100+00	6945.4
76	102+80	6961.6
78.1	103+10	6964.2
78.2	104+00	6964.8
80	105+20	6963.6
82	108+60	6978.9
84	115+60	7006.8
86	122+80	7036.5
88	129+20	7057.0
104	138+50	7079.2
106	151+20	7128.9
108	155+10	7144.3
110	159+10	7160.2
Pauma Valley Tributary:		
200	7+30	6821.8
202	12+60	6838.8
204	18+70	6858.9
206	20+20	6868.0
208	21+20	6870.0

TABLE 8

MAJOR DRAINAGEWAY EVALUATION CHART
EXISTING CONDITIONS

CHANNEL LOCATION	CHANNEL DESCRIPTION	Q_{100} (CFS)	S (%)	D_n (Ft.)	V_n (Ft.)	L (Ft.)
South Tributary I-25 (D.P. A) to Gleneagle Dr.	Grassed Swale, b=3ft,z=10	315	3.0	1.75	7.1	1800
Middle Tributary I-25 (D.P. D) to exist. Detention Basin (D.P. D)	Wide grassed swale w/wetlands Vegetation, b=20ft,z=15	290	2.8	1.25	5.5	1250
Exist. Detention Basin (D.P. D) to Winchester Dr.	Grassed swale, b=10ft, z=10	260	3.2	1.5	7.2	1500
Main Tributary I-25 (D.P. E) to Struthers Ranch Stock Pond	Wide vegetated channel, b=35ft, z=4, some side slope erosion	2090	3.0	3.4	14.0	1400
Struthers Ranch Stock Pond to Exist. Detention Pond at Gleneagle Dr. (D.P. F)	Grassed channel between stock ponds, b=50ft,z=10	2090	2.7	2.7	11.1	1400
Exist. Dentention Pond (D.P. F) to future detention pond (D.P. H)	Partially vegetated channel, b=35ft,z=6	1510	4.5	2.4	14.7	800
Exist. Detention Pond (D.P. F) to Palm Springs Dr. culverts (D.P. G)	Grassed channel, b=10ft,z=6	390	3.3	2.3	9.9	2100
Future Detention Pond (D.P. H) to Wuthering Heights Dr. channel (D.P. I)	Narrow unvegetated channel, b=10ft,z=1, significant side slope erosion	1445	2.4	5.9	17.8	1580
Wuthering Heights Dr. channel (D.P. I) to Baptist Rd. channel (D.P. J)	Narrow unvegetated channel, b=10ft,z=1, significant side slope erosion	1350	3.9	5.1	21.0	540

CHANNEL LOCATION	CHANNEL DESCRIPTION	Q_{100} (CFS)	S (%)	D_n (Ft.)	V_n (Ft.)	L (Ft.)
Baptist Rd. channel (D.P. J) to Gleneagle Dr. (D.P. K)	Grass channel (except near Gleneagle Dr.) b=50ft,z=4	1235	3.5	2.0	11.6	1200
Gleneagle Dr. (D.P. K) to Jake's Lake East (D.P. L)	Concrete channel, b=6ft, z=1	630	3.8	2.8	28.5	250
Jake's Lake East (D.P. L) to Grassed confluence area (D.P. M)	Grassed swale, b=10ft,z=10	455	4.4	1.9	9.8	900
Grassed confluence area (D.P. M) to Baptist Rd.	Riprap lined channel, b=2ft,z=2 for 400 ft, wide grass swale, b=150ft,z=10 for 1000 ft	140 140	2.8 4.0	2.6 0.3	7.6 3.5	400 1000
Gleneagle Dr. (D.P. K) to Baptist Rd. (D.P. N)	Concrete lined channel, b=0ft,z=2	625	4.3	3.5	27.8	1325
Baptist Rd. (D.P. N) to Castlegate Ct. (D.P. O)	Grassed swale, b=10ft,z=6	590	4.5	2.3	13.5	1400
Castlegate Ct. (D.P. O) to (D.P. P)	Grassed swale, b=30ft,z=10	510	4.0	1.5	10.7	1450
(D.P. P) to Celtic Ct. (D.P. Q)	Grassed swale, b=5ft,z=6	390	5.0	1.8	11.5	400

TABLE 9

EXISTING STRUCTURE EVALUATION CHART

STRUC. NO.	SUBBASIN NO.	SIZE/DESCRIPTION	LOCATION	MAX CAPACITY (CFS)	EXIST Q_{100} (CFS)	REMARKS
1	6	6'x6' RC Box Culvert	I-25 SB Lanes, Approx 2000 ft N. of USAFA Entrance	550	315	Adequate
2	7	6'x6' RC Box Culvert	I-25 NB Lanes, Approx 2500 ft N. of USAFA Entrance	630	315	Adequate
3	14	6'x7' RC Box Culvert	I-25 SB Lanes, Approx 3500 ft N. of USAGA Entrance	680	290	Adequate
5	16	36" CSP	I-25, Approx 3900 ft N. of USAFA Entrance	60	25	Adequate
4	17	6'x7' RC Box Culvert	I-25 NB Lanes, Approx 3500 ft N. of USAFA Entrance	665	290	Adequate
6	22	24" CSP	Winchester Dr., Approx 1150 ft N. of Gleneagle Drive	16	90	Inadequate
7	24	33" CSP	Winchester Dr., Approx 2050 ft N. of Gleneagle Drive	45	115	Inadequate
8	26	2-18" CSP	Mission Hills Way, Approx 1500 ft W. of Gleneagle Dr.	24	140	Inadequate
9	39	DBL 10'x10' RC Box Culvert	I-25, Approx 5600 ft N. of USAFA Entrance	3700	2090	Adequate
10	37	48" CSP	I-25, Approx 6100 ft N. of USAFA Entrance	100	50	Adequate
11	33	3.5'x2' RC Box Culvert	I-25, Approx 6800 ft N. of USAFA Entrance	60	160	Inadequate

STRUC. NO.	SUBBASIN NO.	SIZE/DESCRIPTION	LOCATION	MAX CAPACITY (CFS)	EXIST Q_{100} (CFS)	REMARKS
13	44	42" CSP	Pauma Valley Dr., Approx 100 ft S. of Palm Springs Dr.	90	300	Inadequate
14	46	42"x27" CSP	Pauma Valley Dr., S. side of Palm Springs Dr.	60	20	Adequate
15	48	33" CSP	Gleneagle Dr., Approx 100 ft N. of Palm Springs Way	45	150	Inadequate
16A	50	42"x27" CSP	Wuthering Heights Dr., N. side of Palm Springs Dr.	56	105	Inadequate
16B	50	30" CSP	Wuthering Heights De., Approx 100 ft N. of Palm Springs Dr.	45		
18	60	24" CSP	Baptist Rd., Approx 250 ft W. of Gleneagle Dr.	28	70	Inadequate
19	62	4'x6' RC Box Culvert	Gleneagle Dr., Approx 550 ft S. of Jessie Dr.	750	610	Adequate
21	72	54" CSP	Baptist Rd., Approx 300 ft E. of Kingwood Dr.	140	130	Adequate if headwall added
22A	74	48" RCP	Gleneagle Dr., Approx 500 ft S. of Jessie Dr.	130	70	Adequate
23	78	48" CSP	Baptist Rd., W. side of Gleneagle Dr.	130	625	Inadequate
24	80	2-24" CSP	Castlegate Ct., Approx 200 ft W. of Kingswood Dr.	23	590	Inadequate

STRUC. NO.	SUBBASIN NO.	SIZE/DESCRIPTION	LOCATION	MAX CAPACITY (CFS)	EXIST Q_{100} (CFS)	REMARKS
25	82	24" CSP	Kingswood Dr., Approx 900 ft N. of Castlegate Ct.	9	105	Inadequate
26	84	24" CSP	Celtic Ct., Approx 700 ft W. of Kingswood Dr.	28	95	Inadequate
27	86	36" CSP	Celtic Ct., Approx 350 ft W. of Kingswood Dr.	45	390	Inadequate
28	88	24" CSP	Kingswood Dr., Approx 300 ft N. of Celtic Ct.	8	125	Inadequate

V. ALTERNATIVE DRAINAGE SYSTEMS

A. Alternative Development Policies

The policies for the development of alternative stormwater systems were compiled from a number of sources. The main source for the policies was the City/County Drainage Criteria Manual. In addition, an Initial Study Conference, held on July 8, 1988, was a source for a number of recommendations. Some of the following policies were utilized in developing the drainage systems:

1. Develop detention/retention basin scenarios to reduce projected future flow to historic levels prior to the USAFA boundary.

2. Consult with County officials, governmental agencies and concerned citizens to delineate concerns.

3. Develop facilities compatible with projected land uses.

4. Develop conceptual costs of the possible alternatives for comparison.

5. Avoid significant environmental impacts, if possible.

6. Incorporate nonstructural means of erosion protection where technically feasible.

Based on the above mentioned criteria a number of detention alternatives were developed. Those alternatives are presented in this section. The size and outflow amounts from these basins were dependent on the amount of projected inflow and the location within the drainage basin. In some cases it was necessary to reduce flows below historic levels based on existing outflow constraints. Channel evaluations were, in general, not greatly affected by the detention basin scenarios. Costs for the detention alternatives do not include channel improvements which may be required throughout the Black Forest Drainage Basin since those costs are similar in all of the alternatives. For those few channels which were affected by the alternatives, a cost and channel description was added to the detention basin analysis. The plan layouts and evaluation table for each alternate are contained in Appendix A of this report.

B. Alternative 1

This alternative examines the use of detention in the upper portion of the basin. Detention Basin N is situated on the main channel, which begins near the Baptist Center. Basin N is a 2.3 acre facility which reduces the peak flow prior to it flowing through the existing concrete channel along Gleneagle Dr. Detention Basin L examines the feasibility of retrofiting Jake's Lake East into a regional detention facility. Under this alternative, developed flows would be routed under Baptist Rd. through an enlarged culvert and then across Jessie Dr. in an enlarged culvert. In addition to enlarging pipes, additional protection would be needed in this channel reach. In order to utilize Jake's Lake East a large culvert would have to be added and used as a primary spillway. The lake level would have to be lowered to provide storage and adjustments made to the irrigation piping.

From the juncture of the flows from the two facilities just west of Gleneagle Dr. the flow continues southwest to Detention Basin H, a 2.6 acre facility which is presently under construction. This facility will lower the channel flows to below historic levels. From this point the flow continues toward I-25.

Detention Basin 11 is needed to reduce developed flows to a level small enough to pass through the 3.5'x2' box culvert under I-25. This facility would cover 2.2 acres of land and would need a separate embankment since state regulations do not permit detention basin embankments within their right of way.

The southern part of the basin flow which passes under I-25 in the middle tributary in the vicinity of the sewage treatment plant, will also require additional detention. An existing retention facility is located along Mission Hill Way and is designated as Basin 8. This existing pond discharges across the golf course and eventually crosses Westchester Dr. In this alternative a detention basin is proposed north of proposed Struthers Rd. This 2.1 acre facility would detain the flows from the proposed developments south of Westchester Dr. Under this scenario a large culvert would be needed at the Westchester Dr. crossing of this channel and also a slightly smaller culvert would be needed at the other tributary crossing of Westchester Dr.

The total cost for constructing these facilities is $588,000.

C. Alternative 2

This alternative contains many of the same conceptual detention facilities as Alternative 1. However, in lieu of Basin L, Jake's Lake East, Basin N is enlarged to 3.5 acres and all of the flows north of Baptist Rd. are diverted to this facility. This will require placing a culvert under Kingswood Dr. and constructing an improved channel to carry these diverted flows. By combining these flows and holding back the peak, the released flows are reduced to such an amount that the area tributary to Jake's Lake East can release developed flow into the lake without overloading the facility.

From this point the flows will travel through Basin H which is under construction. Basin F was added to the tributary channel from Pauma Valley Dr. in order to permit the elimination of Basin 11. By reducing the peak at the 1.7 acre detention facility at Basin F, developed flows from the Chaparral Hills area can be diverted along I-25 into the double 10'x10' box culvert without producing peak flows above historic levels.

The detention basin scheme for the middle tributary is similar to Alternative 1 with Basin's 8 & C in the same locations. Basin 22 was added to lower the flows crossing Westchester Dr. in the southern culvert. Also, the upgrading of the existing irrigation lake to permit detention will also permit additional flows from Gleneagle Dr. to be diverted along Huntington Beach Dr. and into the lake. The addition of an outlet pipe and a slight lowering of the lake level would provide the needed storage volume. The estimated cost for this alternative is $441,500.

D. Alternative 3

This alternative contains the most detention facilities of all the alternatives. Detention Basins N & 21 are used to detain the flows north of Baptist Rd. The reduced flows from Basin 21 permit the existing Baptist Rd. culvert and the Jessie Dr. storm sewer system to remain intact. Also the wetlands area between Jessie Dr. and Jake's Lake East would be impacted to a lesser degree under this alternative.

Further downstream Basins H & F were included as in Alternative 2. In addition, Basin 44, a 0.25 acre basin, was added to help alleviate some of the flooding problems along Pauma Valley Dr. Under this alternative the flow from the Chapparal Hills area is again diverted to the double 10'x10' box culvert under I-25.

The middle tributary scheme is the same as in Alternative 2 except that detention Basin C is eliminated and Basin D is added. Basin D is located just east of Westchester Dr. and is designed to reduce the flows so that the existing Westchester Dr. culvert can remain. The 1.6 acre facility will require the expansion of an existing golf course water hazard and the construction of an embankment west of Westchester Dr. A cost of $496,500 is estimated for this scenario.

E. Alternative 4

The scheme illustrated in this alternative uses diversions to eliminate the need for extra detention basins. Basin 21 is enlarged to a 4.4 acre facility and flows north of Castlegate Ct. are diverted across Kingswood Dr. and into the facility. Flows at the existing Baptist Rd. crossing near Gleneagle Dr. would be permitted to continue without being detained.

Further downstream Basin H will reduce channel flows to historic levels and Basin 44 was utilized for local flow reductions. However, Basin F was eliminated and Basin 11 reinstated. It was found that to be able to release at historic levels at the USAFA boundary either Basin F or Basin 11 are required.

The middle tributary alternative eliminates the modifications to the existing irrigation lake, instead a diversion channel, with culverts crossing the fairways, would be constructed across the golf course to transport the flows to an expanded Basin D. The estimated cost for these facilities is $458,500.

F. Alternative 5

This alternative contains a combination of some of the other alternatives. The main tributary scheme is the same as Alternative 4 with a 4.4 acre facility at Basin 21, the existing facility at Basin F and the 0.25 acre facility at Basin 44. Also, as delineated in Alternative 4, Basin 11 is used to reduce the peak from the Chapparal Hills area.

The middle tributary scheme utilizes the existing pond at Basin 8 but requires the enlargement of Basin 22 to provide the needed storage volume, due to a diversion of flows from Basin 8. Through an upgrade to the existing irrigation

flow diversion ditch, the 100-year stormwater can also be directed into the existing lake. Basin 22 work will require the addition of an outlet pipe and the raising of the dam embankment to provide additional storage above the pond depth required for irrigation storage. In addition, an outlet channel across the golf course would also be needed to direct the flows to the southern Westchester Drive culvert.

Although the flows across Westchester Drive will be reduced under this scenario, it will still be necessary to upsize the existing 24" culverts. However, through the use of detention in the upper part of the basin, flows in the lower part of the basin will not have to be detained in order to keep developed flows below historic levels in the South Tributary. Flows in the Middle Tributary will still have to be detained by a small amount in Basin C. The cost for this alternative is estimated at $418,500.

G. Alternative Evaluation

Evaluations of the alternatives were based on a number of factors including: cost, constructability, land use, land acquisition, impact on existing utilities, wetlands and riparian considerations and impacts on existing culverts. After evaluating the merits and drawbacks of each alternative a rating of 1 through 5 was assigned to the alternatives.

H. Alternative Selection

The results of the alternatives evaluation were presented at a public meeting held on September 30, 1988. As a result of the comments and conclusions reached at this meeting, Alternative 5 was selected as the preferred alternative.

TABLE 10

COMPARISON OF ALTERNATIVES

ALTERNATIVE	COST	OPERATIONS & MAINTENANCE	WETLANDS & RIPARIAN CONSIDERATIONS	OTHER FACTORS	RATING
1	$588,000	Less number of basins to maintain	May require low flow channel through wetlands north of Gleneagle Dr.	Would require the replacement of most culverts	5
2	$441,500	Same as Alt. 1	Diversion channel along I-25 may affect existing wetlands	Would have less of an impact on existing development	2
3	$496,500	Most number of basins to maintain	Same as Alt. 2	Same as Alt. 2	4
4	$458,500	Least number of lakes to maintain	Has little effect on wetlands	Would have most impact on existing development	3
5	$418,500	Same as Alt. 1	Has least effect on wetlands	Would make optimum use of existing facilities	1

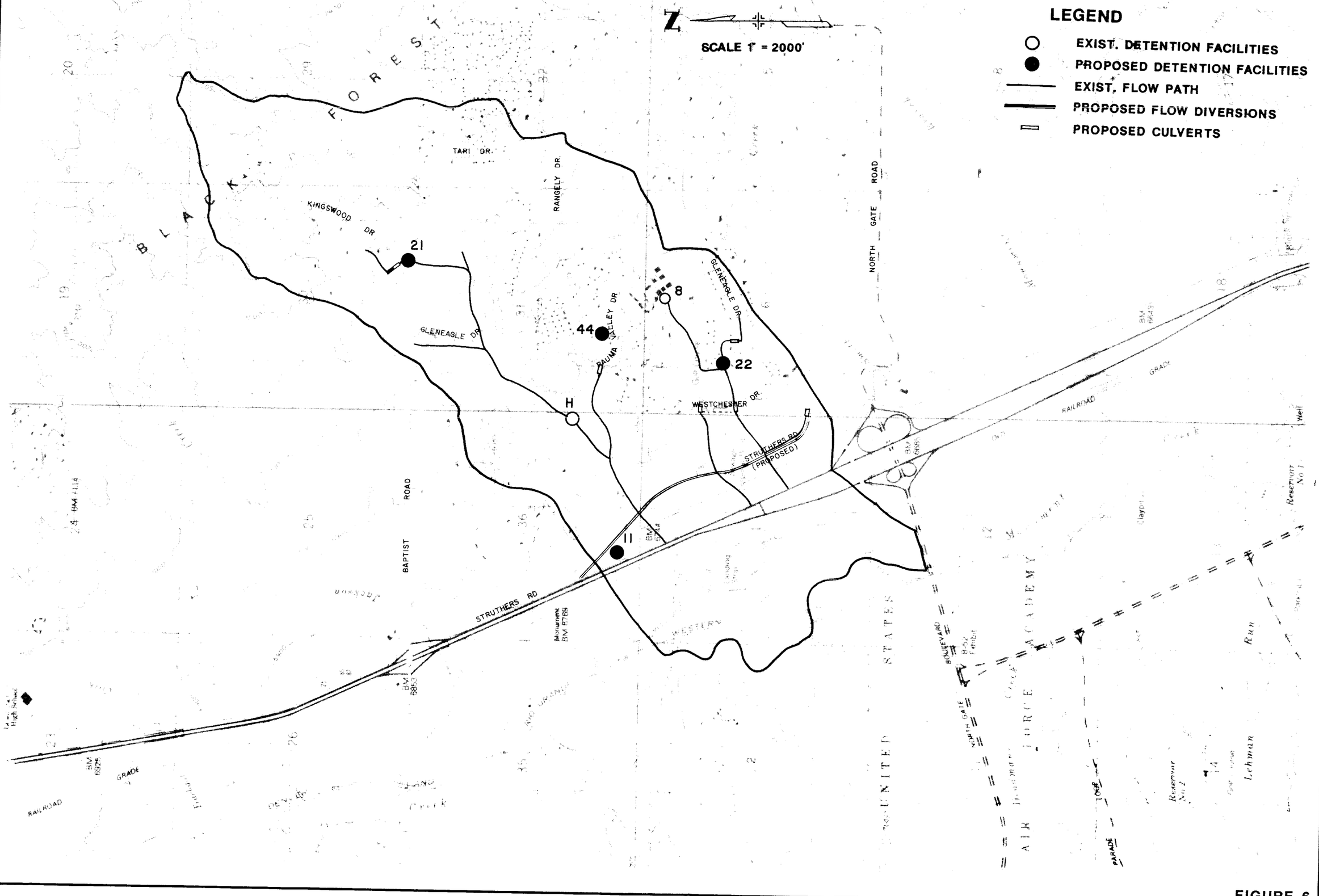


FIGURE 6

WILSON & COMPANY
ENGINEERS & ARCHITECTS
COLORADO SPRINGS COLORADO

REVISION

BLACK FOREST
DRAINAGE BASIN PLANNING STUDY
REGIONAL DETENTION ALTERNATIVE #5

DESIGN	
DRAWN	
DATE	
FILE NO.	
SHEET NO.	33

WILSON & COMPANY

ALTERNATIVE 5

LOCATION	DESCRIPTION	COST	EXIST Q (CFS)	INFLOW CFS	OUTFLOW CFS	CONSTRUCTABILITY	LAND USE	LAND ACQUISITION	IMPACT ON EXIST UTILITIES	WETLAND & RIPARIAN CONSIDERATIONS	IMPACTS ON EXISTING CULVERTS
Basin 21	4.4 Ac w/54" outlet	$130,000	150	910	150	Some earthwork rq'd, fits into exist terrain	Multi-use dry basin	Acquisition of ROW rq'd for all facilities within private property	None	No wetlands or habitats affected	None
Basin H	2.6 Ac w/2-36" outlet & 25' weir	0	1290	1620	1270	Under construction	Multi-use dry basin	Same as Basin 21	None	Landscaping planned to promote habitats	None
Basin 44	0.25 Ac w/24" outlet	50,000	150	155	120	Same as Basin 21	Golf course facility	Same as Basin 21	None	Same as Basin 21	Would require drive culvert sizes in Pauma Valley Dr.
Basin 11	2.2 Ac w/3.5'x2' outlet	70,000	224	390	70	Basin would need embankment beyond I-25 ROW	Multi-use dry basin	Same as Basin 21	None	Would temporarily disturb habitats	None
Basin 8	2.3 Ac w/2-18" outlet	0	140	150	25	Existing	Multi-use lake	None	None	None	None
Basin C	2.1 Ac w/48" outlet	70,000	200	330	100	Same as Basin 21	Multi-use dry basin	Same as Basin 21	None	Same as Basin 21	None
Basin 22	2.7 Ac w/36" outlet & 20' weir	10,000	80	105	22	Minor retrofit of existing lake	Multi-use lake	None	May affect existing irri-gation stor:ge	None	None
		$330,000									

ADDITIONAL COSTS

14'x6' Box Culv @ Kingswood Dr.	35,000
400'b=10' Riprap diversion channel from Castlegate Ct.	26,000
8'x4' Box Culv @ Pauma Valley Dr.	17,500
36" Culv @ Gleneagle Dr. & Huntington Beach Dr.	10,000
6'x4' Culv @ Westchester Dr.	30,000
TOTAL	$448,500

TABLE 11

VI. PRELIMINARY DESIGN

A. General

Based on the results of the alternatives evaluation and comments from the public meetings and the County the concepts from the chosen alternative were developed into preliminary designs. Each major system in the Black Forest Drainage Basin is delineated on the Preliminary Plans contained in the Appendix of this report with the associated costs for the facilities included in a summary table in the Economic Analysis section.

Although specific types of erosion protection and drop structures are delineated on the preliminary plans, that does not preclude the use of other design materials or design schemes that will serve the intended purpose as good as or better than those presented herein. The designs presented in this study represent one method of stabilizing the channel. Other methods of stabilization are permitted as long as they meet with the approval of the El Paso County Department of Public Works. It must also be noted, however, that any additional costs for an alternate protection system, above those costs listed in this study, must be borne solely by the person developing the channel.

B. South Tributary

This drainage system is presented on Sheet No. 1 of the preliminary design plan/profile sheets. The outfall for this drainage system is an existing 6' x 6' box culvert under I-25. Improvements to this tributary begin at the USAFA property line within the boundaries of the proposed Academy Village Development. Some revisions to the Academy Village development plan will be necessary due to proposed improvements upstream, in addition to improvements required along Gleneagle Drive to correct previous basin diversions.

A 6' x 3' culvert crossing at future Struthers Road and Gleneagle Drive is needed to correct a diversion which is presently overloading several culverts under the I-25 ramps. This culvert would be constructed utilizing County funds. By redirecting the flows into the grass lined channel along future Struthers Road the historic drainage path can be reestablished. These higher flows will require upsizing of the proposed roadside ditch to a 3.5 feet deep grass-lined channel.

The proposed grass-lined channel on the north side of Academy Village can be decreased in size from a depth of 3.4 ft. to a depth of 2.5 feet due to the upgrading of the existing Gleneagle lake facility. In addition, due to the upgrading of the lake into a detention facility the existing small detention facility at the Shoppe in the Glen can be eliminated. Also the proposed Academy Village detention facilities do not appear to be necessary.

The proposed 42" RCP crossing of future Struthers Road shown on the Academy Village development plan should be revised to a 8' x 4' box culvert and a riprap channel installed to the USAFA property line.

The northern channel along the Academy Village property line will connect into a new storm sewer across Westchester Drive and then continues through a series of channels and culverts across the existing golf course. The system eventually connects into the existing irrigation lake. Improvements to the lake, such as an outlet facility and higher embankment, will permit the lake to be utilized as a 6.5 ac. ft. stormwater detention facility. An existing grass lined channel which proceeds northerly from the lake will also require lowering to assure adequate capacity.

A culvert crossing at Gleneagle Drive and Huntington Beach Drive should be installed to reduce the flows along Gleneagle Drive. This minor diversion can then be directed into the detention facility and released at a below historic rate. The cost of this diversion in addition to the enlarging of the culvert within the Westchester Drive right of way would be paid for by County funds.

C. Middle Tributary

This drainage system is also presented on Sheet No. 1 of the preliminary design plan/profile sheets. The outfall for this drainage system is an existing 6' x 7' box culvert under I-25. Some historic flows within this subbasin have been diverted by the Gleneagle golf course into their existing lake which will be releasing detained flows into the South Tributary. However, even with this flow diversion some detention will be needed in this tributary to keep developed flows to historic levels as mandated by the U.S. Air Force Academy.

The recommended site for this detention facility is along the east side of future Struthers Road at the site of an existing depression. The detention basin size would be relatively small, encompassing only one acre of land with a volume of 4.7 ac. ft. This facility would serve as a regional basin for the lands below Westchester Drive, however, the proposed facility is no larger than would have been required to reduce the developed flows from the proposed site to existing levels.

For the regional detention facility to function properly it will be necessary to revise the Academy View development plan to bring flows into the facility. These flows, plus the developed site flows and some flows from east of Westchester will then be released at the mandated rate across future Struthers Road. These flows should be contained within a riprap channel until the channel widens at the USAFA property line.

The Westchester Drive culvert will have to be upgraded into a larger storm sewer to accommodate future flows tributary to the area. The part of the storm sewer within the road right of way would be included in the County's capital improvements budget.

D. Main Tributary

This drainage channel, known as Jake's Creek, is shown on the preliminary design plan/profile sheets beginning on Sheet No. 2 and continuing through Sheet No. 4.

The outfall for this channel is a double 10' x 10' box culvert under I-25. As in the channels improvement, work for the channel begins at the USAFA property line. These improvements consist of a widening of the existing channel and adding riprap to the channel side slopes from the property line to the future Struthers Road culvert crossing. This 320 FT^2 facility is the only proposed drainage crossing which falls under the drainage criteria designation of a bridge.

Proceeding easterly from the culvert, a channel with riprap side slopes is again utilized along with several drop structures. At this point a grouted riprap channel is used as an emergency spillway for an existing pond. In order to preserve the wetland areas in this as well as other ponds, a series of overflow channels were designed to carry the major 100-year flows around these facilities. The low flow channels will also be preserved.

Once beyond the existing ponds, located on the Struther's Ranch property, Jake's Creek encounters a large pond embankment. This pond only has a 12" RCP riser as the principal spillway therefore the majority of the flows must exit via the emergency spillway located on the eastern side of the pond. This existing riprap channel will require upgrading to accommodate the large flows which will still flow out of the recently completed 32 ac. ft. detention facility just upstream.

Detention facility H will require the installation of a trickle channel in the pond bottom in addition to the construction of several drop structures leading into the pond. Beyond the limits of the pond the channel will need to be relocated away from the existing high banks, straightened and lined with riprap to prevent erosion. The channel can then continue northerly along its present alignment to an area where several drop structures must be constructed through a steep channel section. Just upstream of this area the channel widens into a broad grassed channel. A buried riprap side slope is recommended in this existing stable channel area to preserve the existing wetlands.

The channel then continues northeasterly until it reaches Gleneagle Drive where several flow tributaries join the main channel. Due to the large amount of flows crossing Gleneagle drive from Jake's Lake and because of the height of the drop from the existing culvert to the channel bottom it is recommended that a baffle chute drop structure be constructed similar to the existing baffle chute drop out of Jake's Lake.

The channel area between Jake's Lake and Holbein Drive consists of an existing grassed wetlands area and does not require channel improvements except for the steep channel section just upstream of the lake. Because of the width of the grassed area and the subsequent shallow depth of flow in the area, no damage is anticipated even in areas where the proposed lots encroach slightly on the area.

The proposed improvements begin again just south of Baptist Road with the construction of a new culvert across Baptist Road which will act as the principal spillway for the proposed 28 ac. ft. detention facility. The addition of a riser box on the inlet end of the existing 54" culvert will permit the culvert

to be utilized as an emergency spillway. Flows into this facility will come from several directions. Future development east of Kingswood Drive will cause the diversion of some stormwaters along Baptist Road. To avoid erosion it will be necessary to construct a riprap channel along Baptist Road and into the new facility.

In addition to the Baptist Road channel, flow will enter the detention facility from Castlegate Court. This will require the construction of a culvert under Kingswood Drive and a riprap channel to divert the stormwater flows into the facility. No channel protection is recommended in the existing channel north of Kingswood Drive at this time due to the large 5 acre lots in the area. However, the existing floodplain area should be preserved and grade control structures added to stabilize the channel.

E. Pauma Valley Tributary

This channel is a tributary of Jake's Creek and joins the main channel just above the Struther's Ranch ponds. The design recommendations for this tributary are presented on the preliminary design plan/profile Sheet No. 5. Riprap side slope improvements to this channel begin at Jake's Creek and continue easterly to an existing desiltation pond located due south of the new main channel detention pond. This section of the channel also contains several drop structures which were placed to follow the existing channel profile.

The area upstream of the existing desilitation pond is a very broad possible wetland area. With flow depths of less than a foot in this channel section it is recommended that the existing channel floodplain area be preserved with only grade control structures added to the existing channel. As the channel approaches Pauma Valley it begins to narrow and therefore requires riprap lining to prevent erosion. A new box culvert will be required under Pauma Valley Drive to replace the existing 42" and 42" x 27" culverts. This crossing would be installed by the County.

The existing ditch along Pauma Valley Drive should be deepened and riprap lined due to the large amount of flows along the roadway. However, even with the installation of 60" x 38" culverts under the existing driveways some overflow can be expected to occur in the area. The new ditch section should be placed along Pauma Valley Drive to a point where an existing 42" x 27" drive culvert outlets. A 3.8 ac. ft. detention facility is proposed in this area on the existing golf course property. This facility will be used to reduce the flow volumes onto Pauma Valley Drive by 40% and also lessen the potential for flooding to the existing structure which the flow now passes by.

The cost for constructing the ditch improvements would be shared by the developers and the County. The developer's portion of the ditch improvements would begin at the new box culvert and continue approximately 450 feet upstream to a point where the existing ditch ties into the Pauma Valley Drive right of way. From this point to the existing 42" x 27" CSP the County would bear the cost of the improvements.

F. Chaparrel Hills Tributary

This channel is located north of Jake's Creek along I-25 and is presently a small grass lined swale which does not require any improvements. However, if increased development occurs in this subbasin it is estimated that a 15 ac. ft. detention facility would be needed to mitigate the storm flows prior to their reaching the small culvert under I-25. This basin should be placed east of future Struthers Road with a 54" RCP culvert placed under the road.

If the existing 5 acre lot subdivision remains, the detention facility would not be required.

VII. ECONOMIC ANALYSIS

A. General

The economic analysis of the channel improvements listed in this study were derived from current construction prices for materials and labor in the Colorado Springs, El Paso County area. In addition, the 1987 edition of the Colorado Department of Highways "Cost Data" was utilized. Costs were determined for each channel reach for the selected alternative utilizing the protection scheme delineated in the Alternative Drainage Systems section and on the preliminary plans located in the back of this study. The following table, Unit Construction Costs, lists the specific unit prices used in determining the channel protection construction costs:

TABLE 12

UNIT CONSTRUCTION COSTS

Item Description	Unit	Estimated Unit Price
Rock Riprap	C.Y.	$ 35.00
Grouted Rock Riprap	C.Y.	50.00
Granular Filter Material	C.Y.	12.00
Class 6 Gravel (Maintenance Rd)	C.Y.	20.00
Reinforced Concrete	C.Y.	250.00
Non-Reinforced Concrete	C.Y.	150.00
Dam Embankment	C.Y.	5.00
Excavation and Embankment	C.Y.	1.50
Seeding (Native)	Acre	750.00
Sod	S.Y.	5.00
24" RCP	L.F.	35.00
36" RCP	L.F.	50.00
42" RCP	L.F.	60.00
48" RCP	L.F.	75.00
54" RCP	L.F.	90.00
60" x 38" RCEP	L.F.	110.00
6' x 3' Concrete Box Culvert	L.F.	210.00
6' x 4' Concrete Box Culvert	L.F.	225.00
8' x 4' Concrete Box Culvert	L.F.	350.00
8' x 8' Concrete Box Culvert	L.F.	430.00
40' x 8' Concrete Box Culvert	L.F.	2,000.00
Inlets	Each	3,000.00
Land Acquisition	Acre	14,000.00
3' Drop Structures (b=20')	Each	10,000.00
4' Drop Structures (b=20')	Each	12,000.00
4' Drop Structures (b=40')	Each	20,000.00
8' Baffle Chute Drop	Each	30,000.00
Grade Control Structures	Each	1,500.00
Energy Dissipator	Each	2,000.00

Note: Pipe and culvert costs do not include pavement replacement costs or utility relocation costs.

B. Improvement Cost Estimates

As previously stated, the improvements which these costs are based on are contained in the Appendix of this report on the Preliminary Design Plan/Profile sheets. Preliminary costs were calculated for each item based on the unit construction costs provided in this section. Typical channel details can also be found in the Appendix of this report.

The costs within this report are divided into Basin costs which are shared equally throughout the unplatted lands and County costs which are items which the County will pay for through their capital improvements budget. The County will participate in correcting existing problems so as not to overburden the developers. These projects will be scheduled when the funds become available. The following tables are a summary of those preliminary costs.

TABLE 13

PRELIMINARY COST SUMMARY

Channel Location	Improvement Description	Unit	Unit Price	Quantity	Estimated Cost Basin	Estimated Cost County
South Tributary						
USAFA to future Struthers Road	Riprap channel b=8', z=2.5, D=4'	L.F.	$ 85.00	350	$ 29,750.00	$
	8' x 4' BC	L.F.	350.00	120	42,000.00	
	36" RCP	L.F.	50.00	75	3,750.00	
Future Struthers Road to Gleneagle Drive	Grass lined channel b=4', z=4, D=3.5'	L.F.	20.00	1375	27,500.00	
	6' x 3' BC	L.F.	210.00	60		12,600.00
Future Struthers Road to Westchester Drive	Grass lined channel b=4', z=4, D=2.5'	L.F.	17.50	950	16,625.00	
	Grass lined channel b=4', z=4, D=2.5'	L.F.	17.50	250	4,375.00	
Westchester Drive to Detention Basin 22	36" RCP	L.F.	50.00	245		12,250.00
	36" RCP	L.F.	50.00	50		2,500.00
	Inlets	Each	3,000.00	2		6,000.00
	Riprap channel b=3', z=2.5, D=2.3'	L.F.	50.00	100	5,000.00	
	Sod lined channel b=3', z=4, D=2.3'	L.F.	20.00	170	3,400.00	

PRELIMINARY COST SUMMARY

Channel Location	Improvement Description	Unit	Unit Price	Quantity	Estimated Cost Basin	Estimated Cost County
South Tributary (Cont.)						
Westchester Drive to Detention Basin 22	36" RCP	L.F.	$ 50.00	75	$ 3,750.00	$
	Sod lined channel b=3', z=4, D=2.3'	L.F.	20.00	75	1,500.00	
	Energy Dissipator	Each	2,000.00	1	2,000.00	
	36" RCP	L.F.	50.00	120	6,000.00	
	Detention Basin 22	L.S.	10,000.00	1	10,000.00	
	Sod lined channel b=3', z=4, D=2.3'	L.F.	20.00	460	9,200.00	
	Riprap Channel b=3', z=4, D=2.5'	L.F.	20.00	40	800.00	
	36" RCP	L.F.	50.00	20	1,000.00	
Gleneagle Drive	36" RCP	L.F.	50.00	60		3,000.00
	36" RCP	L.F.	50.00	25		1,250.00
	36" RCP	L.F.	50.00	25		1,250.00
	36" RCP	L.F.	50.00	10		500.00
	48" RCP	L.F.	75.00	60		4,500.00
	Construction Cost				$166,650.00	$43,850.00

PRELIMINARY COST SUMMARY

Channel Location	Improvement Description	Unit	Unit Price	Quantity	Estimated Cost Basin	Estimated Cost County
Middle Tributary						
	Riprap channel b=8', z=2.5, D=3.6'	L.F.	$ 70.00	350	$ 24,500.00	$
	8' x 4' BC	L.F.	350.00	155	54,250.00	
	48" RCP	L.F.	75.00	60	4,500.00	
	Detention Basin C	L.S.	34,000.00	1	34,000.00	
	54" RCP	L.F.	90.00	60	5,400.00	
	Riprap channel b=4', z=2.5, D=3.0'	L.F.	55.00	1250	68,750.00	
	54" RCP	L.F.	90.00	110		9,900.00
	54" RCP	L.F.	90.00	50		4,500.00
	Inlets	Each	3,000.00	2		6,000.00
	42" RCP	L.F.	60.00	120		7,200.00
	Riprap channel b=3', z=2.5, D=2.3'	L.F.	50.00	80	4,000.00	
		Construction Cost			$195,400.00	$27,600.00

PRELIMINARY COST SUMMARY

Channel Location	Improvement Description	Unit	Unit Price	Quantity	Estimated Cost Basin	Estimated Cost County
Main Tributary						
USAFA to Pauma Valley Tributary	Partial lined riprap channel b=40', z=2.5, D=4.6'	L.F.	$ 170.00	355	$ 60,350.00	$
	40' x 8' BC (Bridge)	L.F.	2,000.00	155	(310,000.00)	
	Partial lined riprap channel b=40', z=2.5, D=4.6'	L.F.	170.00	170	28,900.00	
	4' Drop structure b=40'	Each	20,000.00	2	40,000.00	
	Riprap channel b=40', z=2.5, D=4.25'	L.F.	360.00	300	108,000.00	
	Partial lined riprap channel b=40', z=2.5, D=4.5'	L.F.	165.00	280	46,200.00	
	4' Drop structure b=40'	Each	20,000.00	1	20,000.00	
	Partial lined riprap channel b=40', z=2.5, D=4.5'	L.F.	165.00	230	37,950.00	
	Partial lined riprap channel b=40', z=2.5, D=4.5'	L.F.	165.00	265	43,725.00	
	4' Drop structure b=40'	Each	20,000.00	1	20,000.00	
	Partial lined riprap channel b=40', z=2.5, D=4.8'	L.F.	175.00	110	19,250.00	
	4' Drop structure b=40'	Each	20,000.00	1	20,000.00	

PRELIMINARY COST SUMMARY

Channel Location	Improvement Description	Unit	Unit Price	Quantity	Estimated Cost Basin	Estimated Cost County
Main Tributary (Cont.)						
Pauma Valley Tributary to Detention Basin H	Riprap channel b=20', z=2.5, D=5.5'	L.F.	$ 160.00	320	$ 51,200.00	$
	Grouted riprap channel b=20', z=2.5, D=4.4'	L.F.	250.00	370	92,500.00	
	4' Drop structure b=20'	Each	12,000.00	1	12,000.00	
	Detention Basin H	L.S.	96,016.00	1	20,000.00*	
Detention Basin H to Gleneagle Drive	Riprap channel b=20', z=2.5, D=5.6'	L.F.	250.00	650	162,500.00	
	4' Drop structure b=20'	Each	12,000.00	2	24,000.00	
	Riprap channel b=20', z=2.5, D=5.4'	L.F.	235.00	500	117,500.00	
	Riprap channel b=20', z=2.5, D=5.1'	L.F.	220.00	380	83,600.00	
	Riprap channel b=20', z=2.5, D=4.5'	L.F.	270.00	120	32,400.00	
	4' Drop structure b=20'	Each	12,000.00	2	24,000.00	
	Riprap channel b=20' to 60', z=2.5, D=4.0'	L.F.	195.00	145	28,275.00	

* $20,000 for future pond construction.

PRELIMINARY COST SUMMARY

Channel Location	Improvement Description	Unit	Unit Price	Quantity	Estimated Cost Basin	Estimated Cost County
Main Tributary (Cont.)						
	Partial lined riprap channel b=60', z=2.5, D=3.5'	L.F.	$ 100.00	855	$ 85,500.00	$
	Grade control structures	Each	1,500.00	3	4,500.00	
	Partial lined riprap channel b=60' to 20', z=2.5, D=4.3'	L.F.	125.00	175	21,875.00	
	Riprap channel b=20', z=2.5, D=4.9'	L.F.	145.00	135	19,575.00	
	Baffle Chute Energy Dissipator	Each	30,000.00	1	30,000.00	
	Concrete channel b=0, z=2.5, D=3.3'	L.F.	70.00	1100	77,000.00	
Gleneagle Drive to Detention Basin 21	Riprap channel b=8', z=2.5, D=4.5'	L.F.	75.00	230	17,250.00	
	48" RCP	L.F.	95.00	150	14,250.00	
	Detention Basin 21	L.S.	135,000.00	1	135,000.00	
Detention Basin 21 along Baptist Road	Riprap channel b=8', z=2.5, D=3.5'	L.F.	60.00	1000	60,000.00	
Detention Basin 21 to Castlegate Ct.	8' x 8' BC	L.F.	430.00	50		21,500.00
	Riprap channel b=8', z=2.5, D=4.7'	L.F.	80.00	300	24,000.00	
	Grade control structures	Each	1,500.00	4	6,000.00	
At Celtic Ct.	Riprap outlet protection	L.F.	30.00	20	600.00	
		Construction Cost			$1,587,900.00	$21,500.00
		Bridge Cost			310,000.00	

PRELIMINARY COST SUMMARY

Channel Location	Improvement Description	Unit	Unit Price	Quantity	Estimated Cost Basin	Estimated Cost County
Pauma Valley Tributary						
Main Channel to Pauma Valley Drive	Partial lined riprap channel b=20', z=2.5, D=2.5'	L.F.	$ 60.00	410	$ 24,600.00	$
	Partial lined riprap channel b=20', z=2.5, D=3.4'	L.F.	60.00	730	43,800.00	
	3' Drop structures b=20'	Each	9,000.00	4	36,000.00	
	Partial lined buried riprap channel b=60' to 20', z=4, D=2.5'	L.F.	70.00	50	3,500.00	
	Grade control structure	Each	2,500.00	1	2,500.00	
	Riprap channel b=20', z=2.5, D=2.8'	L.F.	120.00	75	9,000.00	
	Riprap channel b=20' to 100', z=2.5, D=2.8'	L.F.	250.00	50	12,500.00	
Pauma Valley Drive to Detention Basin 44	6' x 4' Concrete Box Culvert	L.F.	225.00	90		20,250.00
	Riprap channel b=2', z=2.5, D=4.0'	L.F.	65.00	450	29,250.00	
	Riprap channel b=2', z=2.5, D=4.0'	L.F.	65.00	410		26,650.00

PRELIMINARY COST SUMMARY

Channel Location	Improvement Description	Unit	Unit Price	Quantity	Estimated Cost Basin	Estimated Cost County
Pauma Valley Tributary (Cont.)						
	4' Drop structure b=4'	Each	$ 2,000.00	1	$ 2,000.00	$
	60" x 38" RCEP	L.F.	110.00	75		8,250.00
	Riprap channel b=2', z=2.5, D=3.8'	L.F.	65.00	220		15,400.00
	24" RCP	L.F.	35.00	225	7,875.00	
	Riprap channel b=5', z=2.5, D=3.2'	L.F.	90.00	200	18,000.00	
	Detention Basin 44	L.S.	38,800.00	1	38,800.00	
		Construction Cost			$227,825.00	$70,550.00

PRELIMINARY COST SUMMARY

Channel Location	Improvement Description	Unit	Unit Price	Quantity	Estimated Cost Basin	Estimated Cost County
Chaparrel Hills Tributary						
	54" RCP	L.F.	$ 90.00	120	$ 10,800.00	$
	Detention Basin 11	L.S.	55,000.00	1	55,000.00*	

* Detention Basin 11 costs (both land and construction) are not charged to the entire Black Forest Drainage Basin. These costs would be charged to the area within Chaparrel Hills Subdivision should a replat occur and a higher land use density be constructed.

TABLE 14

DETENTION LAND COST

Location	Unit	Unit Price	Quantity	Cost
South Tributary Detention Basin 22	Acre	$14,000.00	---	$ 0.00
Middle Tributary Detention Basin C	Acre	14,000.00	1.0	14,000.00
Main Tributary Detention Basin H	Acre	14,000.00	---	0.00
Detention Basin 21	Acre	14,000.00	5.0	70,000.00
Pauma Valley Tributary Detention Basin 44	Acre	14,000.00	---	0.00
				$ 84,000.00

$14,000 per acre for detention land cost is based on the 1989 park land reimbursement paid by the City of Colorado Springs.

TABLE 15

SUMMARY OF COSTS

Location	Estimated Cost Basin	Estimated Cost County
South Tributary	$ 166,650.00	$ 43,850.00
Middle Tributary	195,400.00	27,600.00
Main Tributary	1,587,900.00	21,500.00
Pauma Valley Tributary	227,825.00	70,550.00
Chaparrel Hills Tributary	10,800.00	0.00
Construction Cost	$2,188,575.00	$ 163,500.00
Contingencies (5% of Const. Cost)	109,429.00	8,175.00
Engineering (10% of Const. Cost & Cont.)	229,800.00	17,168.00
Total Construction Cost	$2,527,804.00	$ 188,843.00
Study Cost	50,900.00	
TOTAL IMPROVEMENT COSTS	$2,578,704.00	

Bridge Costs

Middle Tributary	
Construction Cost	$ 310,000.00
Contingencies (5% of Constr. Cost)	15,500.00
Engineering (10% of Constr. Cost & Contingencies)	32,550.00
TOTAL BRIDGE COST	$ 358,050.00

C. Drainage Basin Fee Calculations

As prescribed by the City/County Drainage Criteria Manual Drainage Basin Fees have been determined for the Black Forest Drainage Basin. This fee has been calculated by dividing the total costs of all major improvements within the drainage basin by the total acres of developable acreage within the basin. Major improvements are defined as those facilities which have approximately 100 acres tributary to them. The recommended drainage fee is computed as follows:

Area

Total Developable Land - 599 Acres

Fees

$$\text{Drainage Fee} = \frac{\$2,578,704}{599} = \$4,305/\text{Acre}$$

$$\text{Bridge Fee} = \frac{\$358,050}{599} = \$598/\text{Acre}$$

$$\text{Detention Land Fee} = \frac{\$\ 84,000}{599} = \$140/\text{Acre}$$

The acreage included in the Total Developable Land figure of 599 acres was derived based on an estimate of unplatted land within the basin (exclusive of land not expected to develop) as well as previously platted land within the basin considered to have the potential to re-develop to a higher density than existing. Unplatted land not included in this 599 acres (i.e. land not expected to develop) includes the U.S. Air Force Academy and portions of Baptist Assembly. Previously platted land considered subject to replatting includes portions of the Kingswood Subdivision immediately adjacent to Baptist Road near Gleneagle Drive. Under current County regulations, land to be replatted is subject to a pro rata portion of the Drainage Basin Fee in effect at the time of replat based on the percentage of increase in density above that as originally platted. Accordingly, a portion of the Kingswood acreage considered subject to replat has been included in the Total Developable Land figure.

VIII. MAINTENANCE REQUIREMENTS

A. Access

Maintenance access must be provided along all major drainageways. The typical channel sections developed for this study all contain a 12 foot maintenance road adjacent to the channels. The specific location of the maintenance road should be determined at the time of final plan design since adjustment to the location of the maintenance road may have to be made due to field conditions. In addition, in some instances it may be necessary to construct ramps down into the channel for proper access.

B. Right-of-Way

El Paso County shall maintain major drainageways and detention facilities within the basin which have been designed and constructed according to applicable County standards, approved and accepted by the County, and properly dedicated free of encumbrance to El Paso County. For major drainageways this right-of-way dedication shall include the limits of the channel side slopes subjected to the 100-year flow and an additional freeboard depth, plus any maintenance road area. For detention facilities this right-of-way shall include the entire basin area in addition to an appropriate maintenance road which will provide proper access and run around the entire facility.

C. Costs

The costs for maintaining these accepted public channels and detention facilities shall be borne by El Paso County unless other specific arrangements acceptable to the County are made prior to final platting. Should the owner of the property on which the facility is located wish to maintain the facility to a level greater than required by El Paso County, that additional cost shall be paid by that owner.

APPENDIX A

BLACK FOREST DRAINAGE BASIN PLANNING STUDY

PUBLIC MEETING MINUTES

On Friday, September 30, 1988 at 9:00 a.m., a public meeting was held at the El Paso County Department of Public Works offices to discuss the Black Forest Drainage Basin Planning Study. An evaluation of proposed alternative stormwater management facilities was made available for public review and distributed to governmental agencies and major property holders within the basin. Those choosing to attend were:

NAME	ORGANIZATION	PHONE
Mike Bartusek	Wilson & Company	520-5800
Steven Watt	Wilson & Company	520-5800
Carl M. Bennett	Black Forest BACC	488-3750
Dan Bunting	Regional Floodplain Admin.	578-6230
Anita Culp	Corps of Engineers	543-9459
Bruce Goforth	Colo. Div. of Wildlife	473-2945
Howard Cloud	Academy Village	481-4404
Phil Olsen	Gleneagle Assoc.	488-2866
Mike Koken	Gleneagle Assoc.	488-2333
Roy Cammack	SCS	473-7104
Chuck Brown	Academy View/Hadjis	635-7660
James Perry	Academy View/Hadjis	635-7660
Alan B. Morrice	EPC DPW	520-6460

The meeting was opened by Mr. Alan Morrice who welcomed those in attendance and solicited comments and recommendations. Mr. Steve Watt then gave a short description of the general project approach, the data collection (mapping), the evaluation of existing systems (for existing and projected land use), and the development and evaluation of alternatives. Mr. Watt then stated that the meeting was a starting point for selecting an alternative. He also described how the four alternatives were structured to evaluate sub-systems and isolate elements.

Mr. Mike Bartusek then proceeded to give a general discussion of the basin and its tributaries and sub-basins. Mr. Bartusek then described the process which was used to develop the projected land use map, including the utilization of proposed development plans and discussions with the El Paso County Land Use Department and Department of Public Works officials. He also mentioned that the projected land use contained some areas of redevelopment (i.e., existing 5 acre lots redeveloped into multi-family housing along Baptist Rd.). Mr. Phil Olsen strongly objected to this type of approach. He stated that in his opinion the development projected for the Kingswood area would never happen. In addition, he disagreed with the Filing #4 area of the Gleneagle Development being shown as a multi-family area. He stated that the area contained single family homes with a density of 3.4 D.U./Ac. Mr. Bartusek pointed out that according to the drainage report developed and submitted to the County by Gleneagle for the Filing #4 area the lots were an average of 6000 square feet in size. Further, it was noted that the multi-family lable only indicated use of a higher curve number for the area. At this point Mr. Morrice stated that the land use plan could be updated and requested suggestions. Mr. Olsen said that as far as he

was concerned the only variable in that area was the 40 acre parcel east of the Gleneagle Development and the area north and east of existing Baptist Rd. Mr. Morrice then said that the intent of the Land Use Map was to show the potential ultimate development along Baptist Rd. which commonly occurs along a major arterial.

At this point Mr. Bartusek began discussion on the detention alternatives which had been distributed the previous week and made available for public review. He opened the discussion by presenting a fifth alternative which was the optimum combination of the other four alternatives. Alternative #5 was chosen based on hydraulic, land use, environmental and cost considerations. Mr. Bartusek divided the basin into three subsystems and described the process which was used to evaluate the different detention basin locations.

Mr. Bartusek then went on to describe subsystem #1 which encompassed the area upstream of Gleneagle Drive near Baptist Road. The following is a summary of the findings:

Basin L (Jake's Lake East) - This basin was discarded early due to its small size, the amount of work necessary to retrofit it, and the impacts on the upstream culverts at Baptist Road and Jessie Drive and the wetlands south of Jessie Drive.

Basin N & Basin 21 Combination - Utilizing these two basins worked hydraulically, however the cost of two separate basins is greater than one large basin.

Basin N with Diversion from the area east of Kingswood Drive - This basin functioned properly hydraulically, however the topography is steeper than the Basin 21 site. In addition, if Gleneagle Drive were to be extended across Baptist Road in the future it would interfere with the detention basin.

Basin 21 with Diversion from the area north of Castlegate Court - This was the recommended basin for this subsystem. It satisfied the hydraulic considerations as well as the topographic considerations. In addition, the cost of this basin alternative would be lower since the 1000 foot channel from Castlegate Court to Baptist Raod would no longer be needed.

Mr. Olsen questioned whether the Basin 21 alternative would require improvements within the wetlands area south of Jessie Drive. Mr. Bartusek stated that since flows out of the detention basin would be kept to historic levels no improvements should be required.

Subsystem #2, which encompasses the area downstream of subsystem #1 and also the Chaparral Hills area, was discussed by Mr. bartusek as follows:

Basin H - This is a detention facility presently under construction and was therefore considered in all evaluations of this subsystem.

Basin 44 - This relatively small basin was recommended to help alleviate existing flooding problems along Pauma Valley Drive. It would need to be constructed on existing golf course property.

Basin F - This facility would only be needed if flows from the Chaparral Hills area were diverted to the existing double 10' x 10' box culvert under I-25. Since the costs of Basin 11 and Basin F were similar and also because of the costs and problems of building a diversion on U.S. Air Force Academy property, this basin was eliminated.

Basin 11 - This site was chosen because the construction of this facility would be triggered solely by development of the tributary area and therefore would not impact the remainder of the basin.

Mr. Morrice mentioned that there were existing wetlands just downstream of Basin H. Mr. Bartusek added that these were actually check dams which were built to control erosion which have promoted wetland growth in the area.

Mr. Olsen then questioned whether Basin 44 was the same facility that Mr. Morrice had discussed with Gleneagle previously. Mr. Morrice responded that it was the same facility. Mr. Olsen then asked if some channel improvements would still be reuqired along Pauma Valley Drive if Basin 44 was built. Mr. Bartusek answered that although some improvements would be required, they would be less than if no detention was used.

Subsystem #3 examines the southern area of the basin. The following descriptions of the subsystem was presented by Mr. Bartusek:

Basin 8 - This is an existing lake which is used for irrigation storage and for stormwater management by the Gleneagle Development. No improvements were recommended to this facility since it reduced the 100-year storm peak from about 150 CFS to 25 CFS.

Basin D - This facility would require the expansion of an existing water hazard into a major facility. This expansion would require the purchase of two existing single family lots. Because of the impact on the area and the cost of purchasing these lots this alternative was rejected.

Basin C - This basin would replace the existing facility which was built just upstream of the sewage disposal ponds. The new facility would be located on the eastern side of proposed Struthers Road and would be located primarily within the existing floodplain. It would be a 15 acre-foot facility and cover about 2 acres.

Basin 22 with Diversion from Gleneagle Drive - This facility is presently an irrigation lake which has no outlet works. Very little modification to this lake would be required to have it function as a detention facility. The addition of an outlet culvert and an improved swale across the golf course would be needed. In addition to the lake modifications, it was recommended that a culvert be placed across Gleneagle Drive at Huntington Beach Drive to divert some of the flows off of Gleneagle Drive into the lake. This would help alleviate some of the flooding which currently occurs along Gleneagle Drive.

Mr. Olsen informed us that Gleneagle had constructed a diversion channel between Basin 8 and Basin 22 which lowers the amount of flow which reaches the northern culvert on Westchester Drive. Mr. Morrice said that he had concerns regarding the diversion since the intent of the alternative was to bring the major flow to Basin C and if that major flow bypasses Basin C then major problems could result. Phil Olsen stated that since Basin 8 and Basin 22 were Gleneagle's primary source of irrigation for the golf course that further discussions with the owner, James Barrish, would be necessary.

The next subject discussed was the conceptual channelization recommendations for the existing streams. Three improved channel types were presented. A narrow channel with protected side slopes for the 100-year storm, a wider channel with a 10-year channel with protected side slopes and a grassed overbank area for the 100-year flows, and a very wide, shallow channel with protected side slopes and a trickle channel for daily flows.

Riprap protection was shown on the exhibits, however, any type of approved materials could be used. A question was raised by Ms. Anita Culp concerning the use of trickle channels through wetlands. She felt that putting a trickle channel through a wetland would pull the water out of the surrounding ground and dry up the wetlands. When a specific area was discussed which had a channel bottom slope of 3.5%, Mr. Bruce Goforth recommended adding small drop structures and reworking the wetland area.

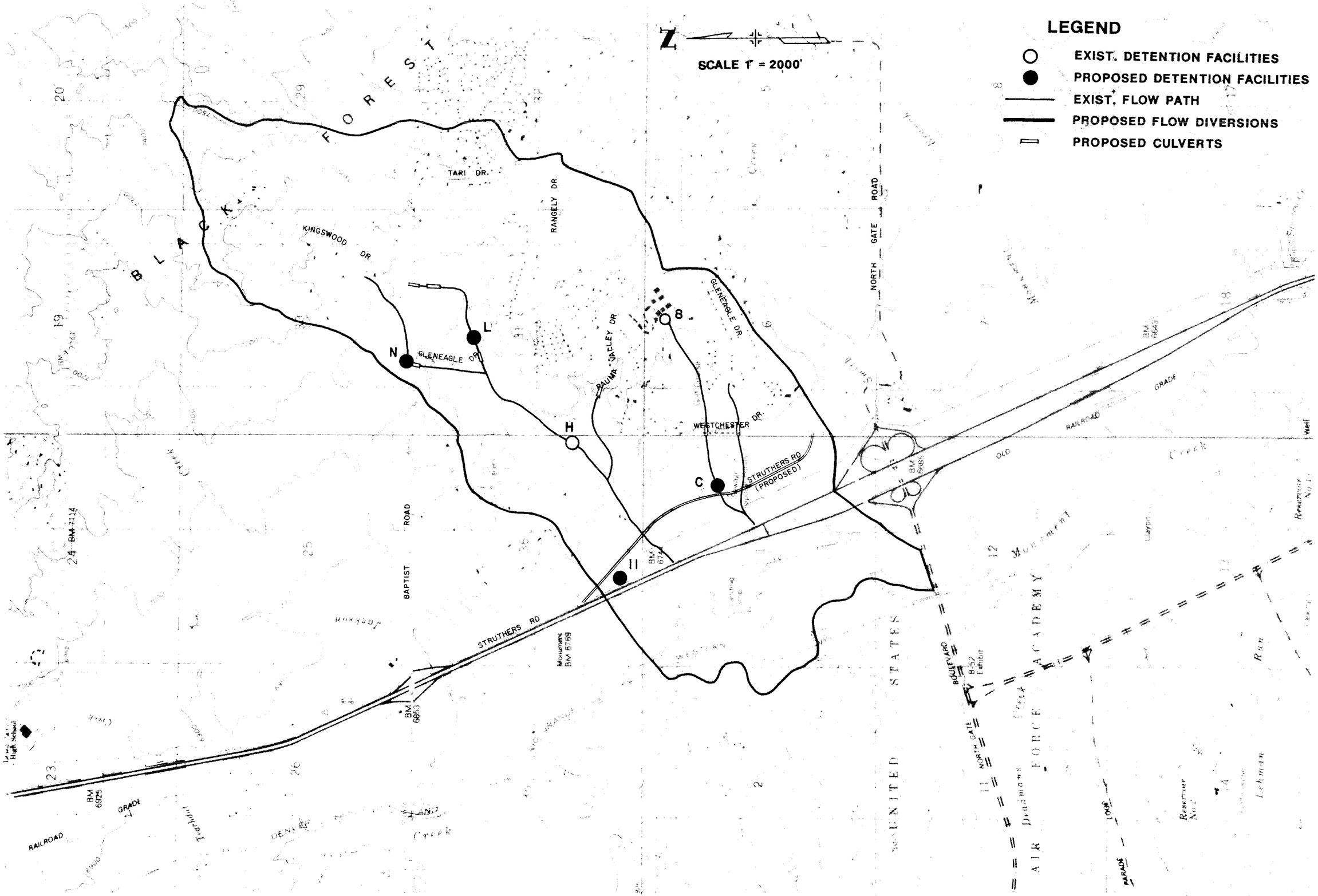
Mr. Olsen was upset that only the typical types of channel sections were shown. He felt that natural channels should be used along parts of the channel. Mr. Watt pointed out that the county's main responsibility was for the protection of its citizens and therefore some type of protection may be needed along the stream. Mr. Bartusek emphasized that if an area could be left natural it would be. Ms. Culp recommended using smaller 2 foot drop structures to lower grades. Mr. Olsen stated that between Gleneagle Drive and Basin H there is 100 feet of vertical drop within 3000 feet and he saw no way of doing what Ms. Culp recommended. Mr. Bartusek said that the 3000 foot reach needs to be broken into smaller reaches since the channel changes so much within that area.

Ms. Culp asked if the county would allow trees to be planted within the channel overbank areas as shown on the exhibit. Mr. Morrice stated that the county would consider some vegetation within the shallow flow areas and channel banks. However, they would not allow large trees to be planted which may be uprooted and block downstream culverts. Mr. Morrice indicated that the exhibit was presented to show the county's willingness to entertain different approaches to stormwater management. Ms. Culp and Mr. Goforth applauded Mr. Morrice's willingness to examine different types of channel sections to obtain the same end result of a stable channel. However, they felt that it was important that a paper trail be left so that others in the future will understand the intent of the report and not use rigid channel sections automatically. Mr. Bartusek stated that a section would be placed in the report concerning this issue so that it will be clearly understood that innovative ideas are encouraged.

Mr. Olsen questioned the detention costs which were presented in the alternatives. He felt that they were too low. Mr. Morrice pointed out that they were for comparison purposes only and the more detailed cost estimated will be presented with the preliminary design. Mr. Olsen was also concerned about funding. He felt that Gleneagle would end up paying for everything since no one

else was doing any work. Mr. Morrice said that the funding issue has not been looked at yet.

Mr. Morrice then closed the meeting by asking whether there were any major objections to the County pursuing Alternative #5 as the selected alternative. Hearing no objections, Mr. Morrice thanked those in attendance and mentioned that copies of Alternative #5 would be sent along with the meeting minutes for additional comments. He also mentioned that minor modifications to the selected alternative may occur during the Preliminary Design Phase and that those changes would be included in the copies of the Report which will be sent out for review.



WILSON & COMPANY
ENGINEERS & ARCHITECTS
COLORADO SPRINGS COLORADO

REVISION

BLACK FOREST
DRAINAGE BASIN PLANNING STUDY
REGIONAL DETENTION ALTERNATIVE #1

DESIGN	
DRAWN	
DATE	
FILE NO.	
SHEET NO.	1

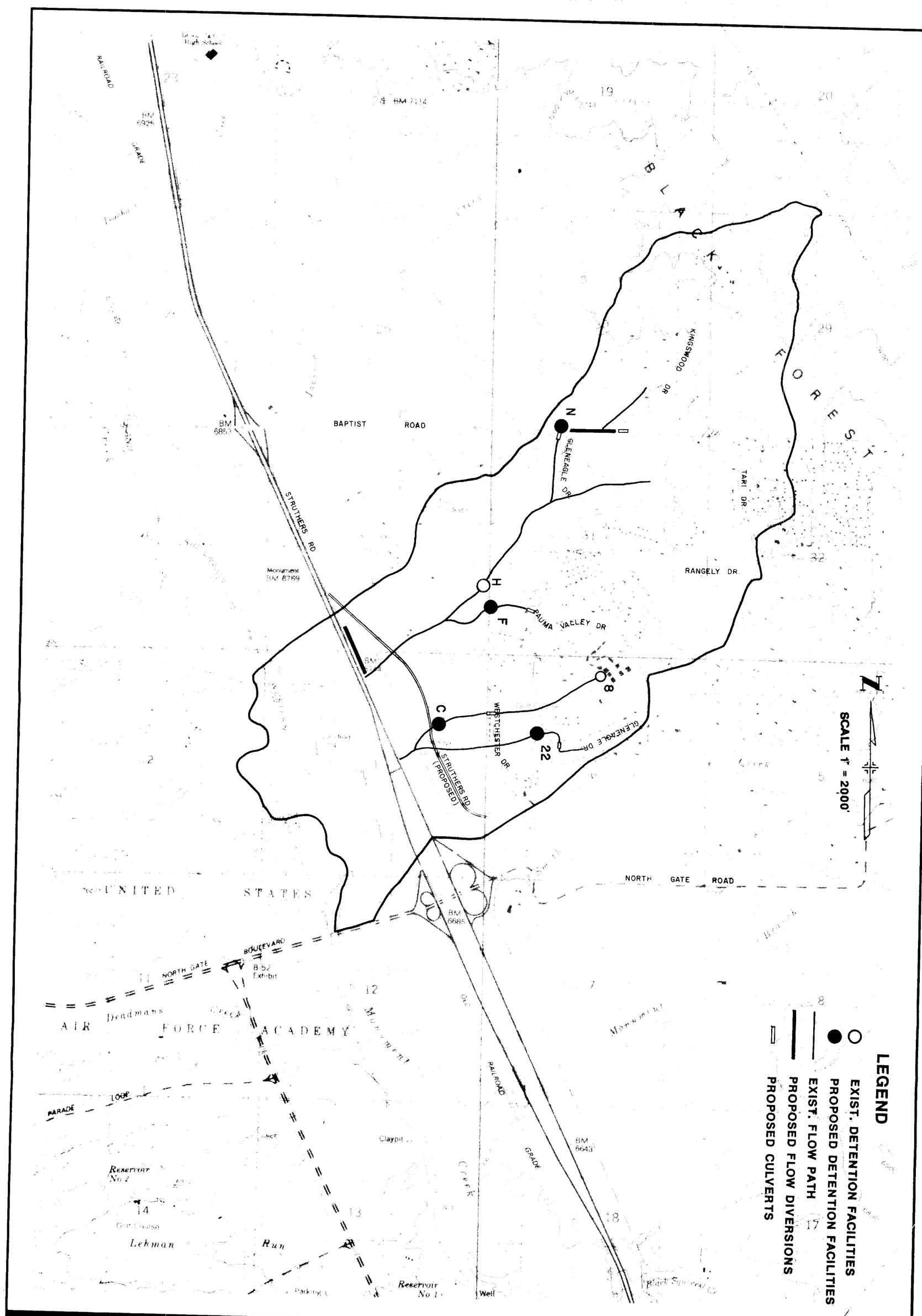
WILSON & COMPANY

ALTERNATIVE 1

LOCATION	DESCRIPTION	COST	EXIST Q (CFS)	INFLOW CFS	OUTFLOW CFS	CONSTRUCTABILITY	LAND USE	LAND ACQUISITION	IMPACT ON EXIST UTILITIES	WETLAND & RIPARIAN CONSIDERATIONS	IMPACTS ON EXISTING CULVERTS
Basin N	2.3 Ac w/72" outlet	$100,000	630	650	200	Some earthwork rq'd, fits into exist terrain	Multi-use dry basin	Acquisition of ROW rq'd for all facilities within private property	None	No wetlands or habitats affected	Existing 48" culvert needs to be upsized to 72"
Basin L	0.75 Ac w/72" outlet & 20' weir	60,000	710	980	950	Requires major retrofit of existing lake	Multi-use lake	Same as Basin N	May require lowering of existing irrigation line	Would disturb existing wetlands	Would require upsizing of existing culvert at Gleneagle Dr.
Basin H	2.6 Ac w/2-36" outlet & 25' weir	0	1290	1660	1220	Under construction	Multi-use dry basin	Same as Basin N	None	Landscaping planned to promote habitats	None
Basin 11	2.2 Ac w/3.5'x2' outlet	70,000	224	390	70	Basin would need embankment beyond I-25 ROW	Multi-use dry basin	Same as Basin N	None	Would temporarily disturb habitats	None
Basin 8	2.3 Ac w/2-18" outlet	0	140	150	25	Existing	Multi-use lake	None	None	None	None
Basin C	2.1 Ac w/48" outlet	70,000	200	330	100	Same as Basin N	Multi-use dry basin	Same as Basin N	None	Same as Basin N	None
		$300,000									

ADDITIONAL COSTS

72" Culv @ Baptist Rd.	10,000
12'x4' Box Culv @ Baptist Rd.	37,500
12'x4' Box Culv @ Jessie Dr.	85,000
Channel Improvements-Jessir Dr. to Jakes Lake	70,000
72" Culv @ Gleneagle Dr.	13,000
10'x4' Box Culv @ Pauma Valley Dr.	22,500
6'x4' Box Culv @ Westchester Dr.	30,000
4'x4' Box Culv @ Westchester Dr.	20,000
TOTAL	$588,000



WILSON & COMPANY

DESIGN
DRAWN
DATE
FILE NO.
SHEET NO. 2

BLACK FOREST
DRAINAGE BASIN PLANNING STUDY
REGIONAL DETENTION ALTERNATIVE #2

WILSON & COMPANY
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COLORADO SPRINGS COLORADO

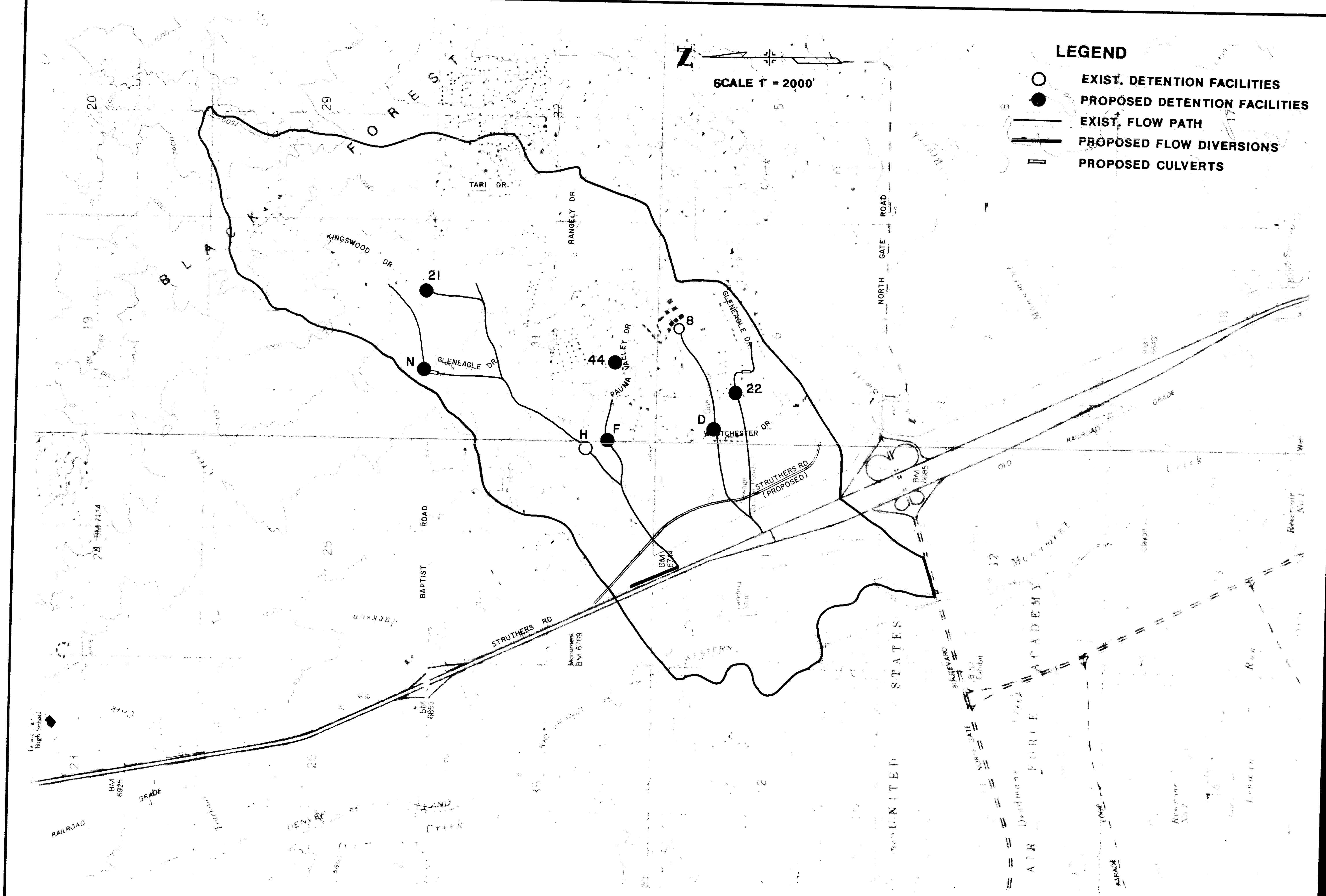
REVISION

ALTERNATIVE 2

LOCATION	DESCRIPTION	COST	EXIST Q (CFS)	INFLOW CFS	OUTFLOW CFS	CONSTRUCTABILITY	LAND USE	LAND ACQUISITION	IMPACT ON EXIST UTILITIES	WETLAND & RIPARIAN CONSIDERATIONS	IMPACTS ON EXISTING CULVERTS
Basin N	3.5 Ac w/72" outlet	$120,000	630	910	200	Some earthwork rq'd, fits into exist terrain	Multi-use dry basin	Acquisition of ROW rq'd for all facilities within private property	None	No wetlands or habitats affected	Existing 48" culvert needs to be upsized to 72"
Basin H	2.6 Ac w/2-36" outlet & 25' weir	0	1290	1520	1170	Under construction	Multi-use dry basin	Same as Basin N	None	Landscaping planned to promote habitats	None
Basin F	1.7 Ac w/46" outlet & 20' weir	70,000	540	612	340	Same as Basin N	Multi-use dry basin	Same as Basin N	None	Would temporarily disturb habitats	None
Basin 8	2.3 Ac w/2-18" outlet	0	140	150	25	Existing	Multi-use lake	None	None	None	None
Basin C	2.1 Ac w/48" outlet	70,000	200	330	100	Same as Basin N	Multi-use dry basin	Same as Basin N	None	Same as Basin N	None
Basin 22	2.7 Ac w/36" outlet & 20' weir	10,000	80	105	22	Minor retrofit of existing lake	Multi-use lake	None	May affect existing irrigation storage	None	None
		$270,000									

ADDITIONAL COSTS

72" Culv @ Baptist Rd.	10,000
8'x6' Box Culv @ Kingswood Dr.	25,000
500'b=5' Riprap diversion channel along Baptist Rd.	20,000
10'x4' Box Culv @ Pauma Valley Dr.	22,500
1200'b=5' Riprap diversion channel along I-25	54,000
36" Culv @ Gleneagle Dr. & Huntington Beach Dr.	10,000
6'x4' Culv @ Westchester Dr.	30,000
TOTAL	$441,500



BLACK FOREST DRAINAGE BASIN PLANNING STUDY

REGIONAL DETENTION ALTERNATIVE #3

WILSON & COMPANY
ENGINEERS & ARCHITECTS
COLORADO SPRINGS COLORADO

REVISION

DESIGN	
DRAWN	
DATE	
FILE NO.	
SHEET NO.	3

WILSON & COMPANY

ALTERNATIVE 3

LOCATION	DESCRIPTION	COST	EXIST Q (CFS)	INFLOW CFS	OUTFLOW CFS	CONSTRUCTABILITY	LAND USE	LAND ACQUISITION	IMPACT ON EXIST UTILITIES	WETLAND & RIPARIAN CONSIDERATIONS	IMPACTS ON EXISTING CULVERTS
Basin N	2.3 Ac w/72" outlet	$100,000	630	650	200	Some earthwork rq'd, fits into exist terrain	Multi-use dry basin	Acquisition of ROW rq'd for all facilities within private property	None	No wetlands or habitats affected	Existing 48" culvert needs to be upsized to 72"
Basin 21	2.7 Ac w/54" outlet	90,000	150	350	70	Same as Basin N	Multi-use dry basin	Same as Basin N	None	Same as Basin N	None
Basin H	2.6 Ac w/2-36" outlet & 25' weir	0	1290	1570	1170	Under construction	Multi-use dry basin	Same as Basin N	None	Landscaping planned to promote habitats	None
Basin 44	0.25 Ac w/24" outlet	50,000	150	155	120	Same as Basin N	Golf course facility	Same as Basin N	None	Same as Basin N	Would require drive culvert sizes in Pauma Valley Dr.
Basin F	1.7 Ac w/46" outlet & 20' weir	70,000	540	580	300	Same as Basin N	Multi-use dry basin	Same as Basin N	None	Would temporarily disturb habitats	None
Basin 8	2.3 Ac w/2-18" outlet	0	140	150	25	Existing	Multi-use lake	None	None	None	None
Basin 22	2.7 Ac w/36" outlet & 20' weir	10,000	80	100	22	Minor retrofit of existing lake	Multi-use lake	None	May affect existing irrigation storage	None	None
Basin D	1.6 Ac w/30" outlet	85,000	120	130	30	Expansion of existing pond would require excavation & embankment work	Multi-use lake	Would require purchase of exist. platted lot & golf course	None	Would temporarily disturb habitats	Would permit existing Westchester culvert to remain
		$405,000									

ADDITIONAL COSTS

72" Culv @ Baptist Rd.	10,000
8'x4' Box Culv @ Pauma Valley Dr.	17,500
1200'b=5' Riprap diversion channel along I-25	54,000
36" Culv @ Gleneagle Dr. & Huntington Beach Dr.	10,000
TOTAL	$496,500

SCALE 1" = 2000'

LEGEND

- EXIST. DETENTION FACILITIES
- PROPOSED DETENTION FACILITIES
- EXIST. FLOW PATH
- PROPOSED FLOW DIVERSIONS
- PROPOSED CULVERTS

BLACK FOREST

TARI DR.

KINGSWOOD DR

RANGELY DR

GLENEAGLE DR

PAUMA VALLEY DR

GLENEARLE DR

WESTCHESTER DR

NORTH GATE ROAD

STRUTHERS RD (PROPOSED)

STRUTHERS RD

BAPTIST ROAD

RAILROAD GRADE

BOULEVARD

NORTH GATE

UNITED STATES AIR FORCE ACADEMY

Jacks Run

Lehman Run

Reservoir No 1

Reservoir No 2

Golf Course

Monument BM 6769

BM 6925

BM 6853

BM 6844

21

44

8

H

D

WILSON & COMPANY
ENGINEERS & ARCHITECTS
COLORADO SPRINGS COLORADO

REVISION

BLACK FOREST
DRAINAGE BASIN PLANNING STUDY
REGIONAL DETENTION ALTERNATIVE #4

DESIGN	
DRAWN	
DATE	
FILE NO.	
SHEET NO.	4

WILSON & COMPANY

ALTERNATIVE 4

LOCATION	DESCRIPTION	COST	EXIST Q (CFS)	INFLOW CFS	OUTFLOW CFS	CONSTRUCTABILITY	LAND USE	LAND ACQUISITION	IMPACT ON EXIST UTILITIES	WETLAND & RIPARIAN CONSIDERATIONS	IMPACTS ON EXISTING CULVERTS
Basin 21	4.4 Ac w/54" outlet	$130,000	150	910	150	Some earthwork rq'd, fits into exist terrain	Multi-use dry basin	Acquisition of ROW rq'd for all facilities within private property	None	No wetlands or habitats affected	None
Basin H	2.6 Ac w/2-36" outlet & 25' weir	0	1290	1620	1270	Under construction	Multi-use dry basin	Same as Basin 21	None	Landscaping planned to promote habitats	None
Basin 44	0.25 Ac w/24" outlet	50,000	150	155	120	Same as Basin 21	Golf course facility	Same as Basin 21	None	Same as Basin 21	Would require drive culvert sizes in Pauma Valley Dr.
Basin 11	2.2 Ac w/3.5'x2' outlet	70,000	224	390	70	Basin would need embankment beyond I-25 ROW	Multi-use dry basin	Same as Basin 21	None	Would temporarily disturb habitats	None
Basin 8	2.3 Ac w/2-18" outlet	0	140	150	25	Existing	Multi-use lake	None	None	None	None
Basin D	1.6 Ac w/30" outlet	100,000	120	180	50	Expansion of existing pond would require excavation & embankment work	Multi-use lake	Would require purchase of exist. platted lot & golf course	None	Would temporarily disturb habitats	Would permit existing Westchester culvert to remain
		$350,000									

ADDITIONAL COSTS

14'x6' Box Culv @ Kingswood Dr.	35,000
400'b=10' Riprap diversion channel from Castlegate Ct.	26,000
8'x4' Box Culv @ Pauma Valley Dr.	17,500
36" Culv @ Gleneagle Dr. & Huntington Beach Dr.	10,000
600' Swale and culvert combination from existing lake to Basin D	20,000
TOTAL	$458,500

APPENDIX B

THIS DRAWING IS A MASTER PLANNING SHEET REPRESENTING PRELIMINARY AND CONCEPTUAL ENGINEERING. IT SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES

Future Struthers Road

60 LF - 48" RCP @ 1.0% For Future Drive Crossing

350 LF - Rip Rap Channel, b = 8' Q100 = 300 cfs, V = 9.4 fps Flow d = 2.6', Z = 2.5 Chan D = 3.6', Type L Rock

1250 LF - Rip Rap Channel, b = 4' Q100 = 90 cfs, V = 7.0 fps Flow d = 1.6', Z = 2.6 Chan D = 3.0', Type L Rock

160 LF - 54" RCP @ 1.0%

120 LF 42" RCP @ 5.3%

80 LF - Rip Rap Channel, b = 3' Q100 = 60 cfs V = 9.1 fps Flow d = 1.1', Z = 2.5 Chan D = 2.5' Type L Rock

40 LF - Rip Rap Channel, b = 3' Q100 = 50 cfs, V = 4.8 fps Flow d = 1.3', Z = 4 Chan D = 2.5'

460 LF - Sod Lined Channel, b = 3' Q100 = 50 cfs, V = 6.0 fps Flow d = 1.1', Z = 4 Chan D = 2.3'

Property Line USAFA

Danala WWTP

Exist 100 Year Floodplain

Exist 6'x7' BC

180 LF - 8'x4' BC @ 1.4%

Detention Basin C
Q100 In = 365 cfs
Q100 Out = 270 cfs
Vol = 4.7 Ac Ft
Area = 1.0 Ac.

60 LF - 54" RCP @ 3.52% For Future Drive Crossing

170' LF Sod Lined Channel, b = 3'

Exist Pond To Be Preserved

100 LF - Rip Rap Channel, b = 3' Type L Rock

110 LF - 36" RCP @ 4.5%

10 LF Rip Rap Protection

145 LF - 36" RCP @ 1.0%

40 LF - 36" RCP @ 1.0%

WESTCHESTER DR.

75 LF Sod Lined Channel, b = 3' Q100 = 40 cfs, V = 8.9 fps Flow = 1.1, Z = 4 Chan D = 2.3

10 LF 36" RCP @ 2.4%

10 LF 36" RCP @ 2.4%

Detention Basin 22
Q100 In = 152 cfs
Q100 Out = 98 cfs
Vol = 6.5 Ac. FT.
Area = 2.5 Ac.

WS Elev 6818.0

Energy Dissipator

Low-Flow Crossing

75 LF - 36" RCP @ 1.6%

120 LF - 36" RCP @ 2.5%

90 LF - 36" RCP @ 3.6%

HUNTINGTON BEACH DR.

GLENEAGLE DR.

Trash Rack & Anti Vortex Device

60 LF - 48" RCP @ 1.0%

10 LF - 36" RCP @ 1.0%

25 LF - 36" RCP @ 1.0%

26 LF - 36" RCP @ 1.0%

60 LF - 36" RCP @ 1.0%

80' Emergency Spillway Elev. 6821.0 w/ Concrete Slope Protection

250 LF Grass Lined Channel, b = 4' Q100 = 100 cfs, V = 4.9 fps Flow d = 1.3', Z = 4 Chan D = 2.5'

Sta 49+80 Tie Into 950 LF Academy Village Grass Lined Channel, b = 4' Q100 = 50 cfs, V = 3.7 fps Flow d = 1.4', Z = 4 Chan D = 2.5

Future Struthers Rd.

60 LF - 6'x3' BC

75 LF - 36" RCP @ 1.0%

100 LF - 8'x4' BC @ 1.0%

20 LF Rip Rap Protection

R=100'

Place Erosion Ditch Checks @ 160' Spacing Along Channel

1375 LF Academy Village Grass Lined Channel, b = 4' Q100 = 140 cfs, V = 4.6 fps Flow d = 2.3', Z = 4 Chan D = 3.6'

350 LF - Rip Rap Channel, b = 8' Q100 = 300 cfs, V = 7.6 fps Flow d = 2.7', Z = 2.5 Chan D = 4.0, Type L Rock

Flow To 6'x6' BC @ I-25

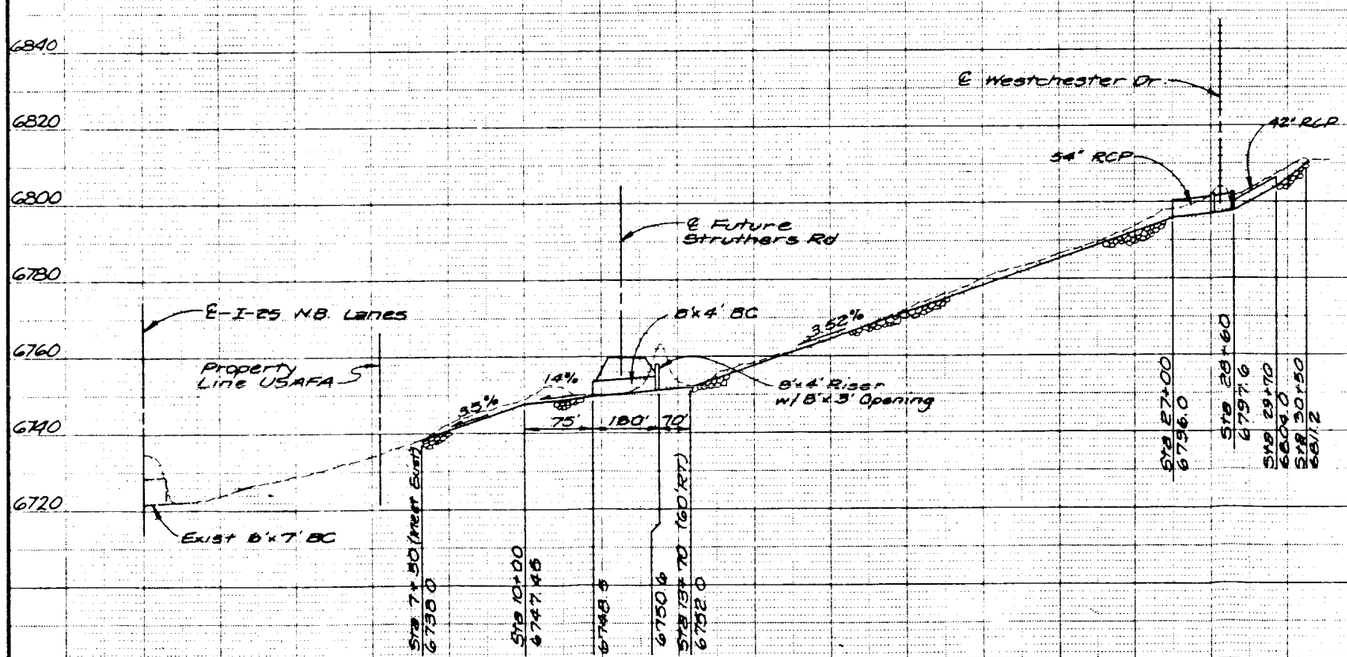
I-25 N.B.

N

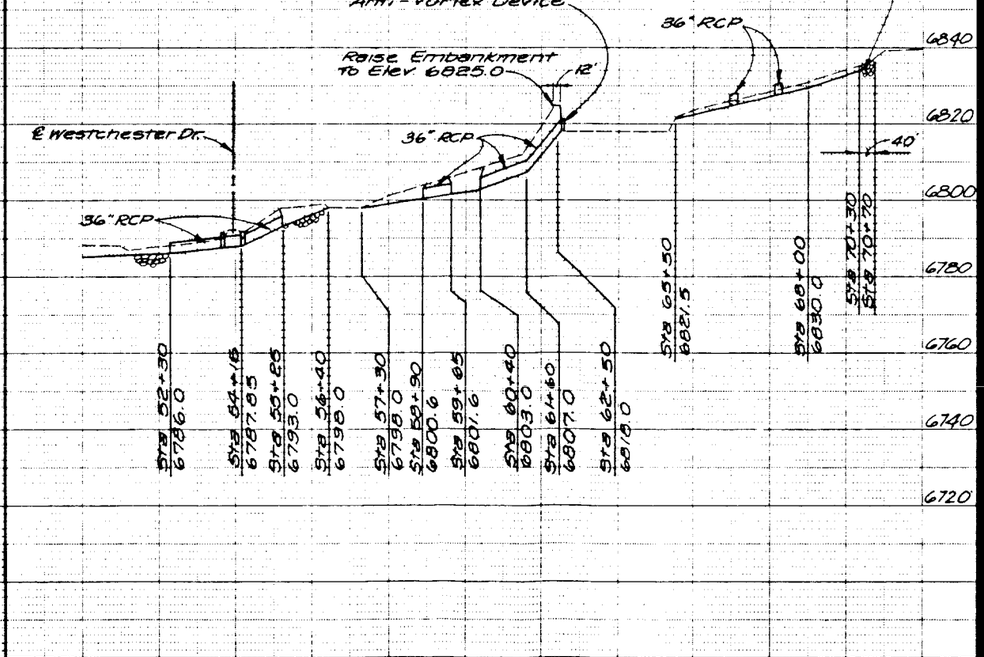
0 200 400 600

SCALE IN FEET

MIDDLE TRIBUTARY



SOUTH TRIBUTARY



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ENGINEERS & ARCHITECTS
COLORADO SPRINGS COLORADO

REVISION	DATE	BY

BLACK FOREST
DRAINAGE BASIN PLANNING STUDY
PRELIMINARY DESIGN
PLAN / PROFILE SHEET
WESTCHESTER CHANNEL B
STA 0+00 TO STA 30+00 & STA 50+00 TO STA 72+00

DESIGN	MAB
DRAWN	W&C
DATE	
FILE NO.	88-889
SHEET NO.	1

THIS DRAWING IS A MASTER PLANNING SHEET REPRESENTING PRELIMINARY AND CONCEPTUAL ENGINEERING. IT SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES

355 LF - Channel
w/ Rip Rap Side
Slopes, b = 40'
Q100 = 1825 cfs, V = 12.5 fps
Flow d = 3.1', Z = 2.5
Chan D = 4.6', Type H Rock

170 LF - Channel
w/ Rip Rap Side
Slopes, b = 40'
Q100 = 1825 cfs, V = 12.5 fps
Flow d = 3.1', Z = 2.5
Chan D = 4.6', Type H Rock

Low Flow Channels
& Ponding Areas
To Be Preserved

265 LF - Channel
w/ Rip Rap Side
Slopes, b = 40'
Q100 = 1745 cfs, V = 12.0 fps
Flow d = 3.1', Z = 2.5
Chan D = 4.5', Type H Rock

230 LF - Channel
W/ Rip Rap Side
Slopes, b = 40'
Q100 = 1745 cfs, V = 12.4 fps
Flow d = 3.0', Z = 2.5
Chan D = 4.5', Type H Rock

Property Line
USAFA

Exist 100 Year
Floodplain

Monument
Creek

I-25 S.B.
I-25 N.B.

R=150'
R=250'

155 LF - 40'x 8'
BC @ 27%

Exist 18" CSP

Place Type L Rip Rap
Along Dam Face

Exist 12" CSP

Exist RCP

MATCH LINE STA 56+30
SEE SHEET NO. 3

280 LF - Channel
W/ Rip Rap Side
Slopes, b = 40'
Q100 = 1825 cfs, V = 12.2 fps
Flow d = 3.1', Z = 2.5
Chan D = 4.5', Type H Rock

110 LF - Channel
W/ Rip Rap Side
Slopes, b = 40'
Q100 = 1745 cfs, V = 10.5 fps
Flow d = 3.4', Z = 2.5
Chan D = 4.8', Type L Rock

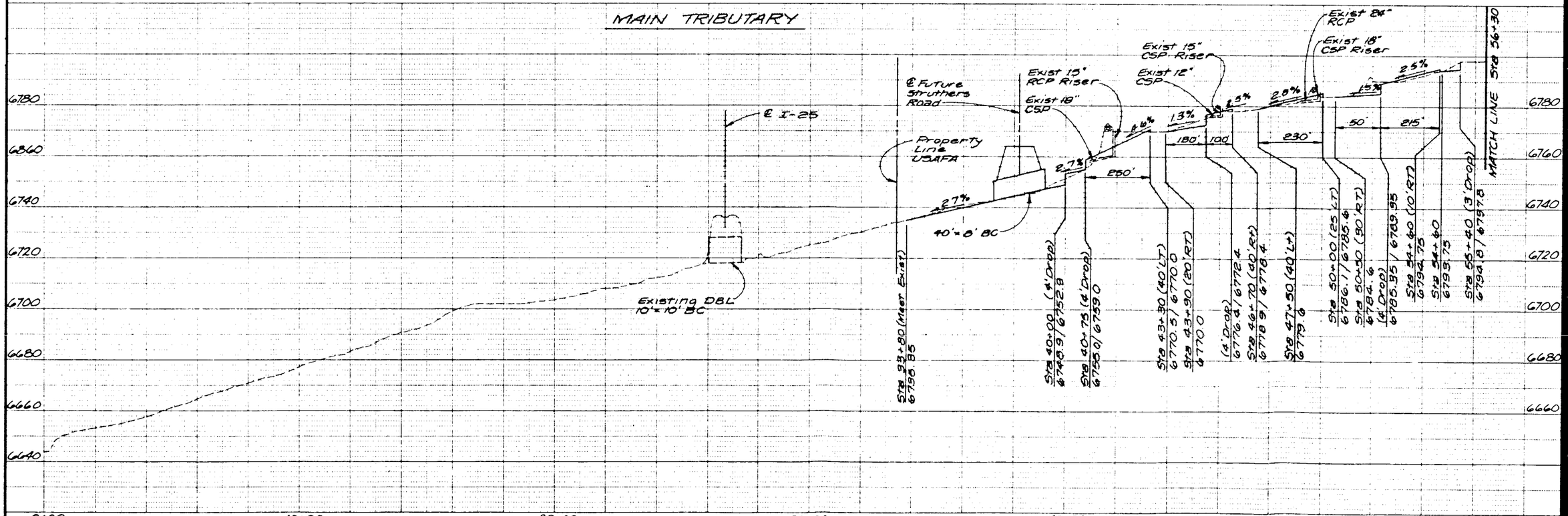
300 LF - Rip Rap
Channel, b = 40'
Q100 = 1825 cfs, V = 14.2 fps
Flow d = 2.75', Z = 2.5
Chan D = 4.25',
Type VH Rock

Future
Struthers
Road

N

0 200 400 600
SCALE IN FEET

MAIN TRIBUTARY



WILSON & COMPANY
ENGINEERS & ARCHITECTS
COLORADO SPRINGS, COLORADO

BLACK FOREST
DRAINAGE BASIN PLANNING STUDY
PRELIMINARY DESIGN
PLAN / PROFILE SHEET
JAKES CHANNEL
STA 0+00 TO STA 58+30

DESIGN	MAB
DRAWN	W&C
DATE	
FILE NO.	88-809
SHEET NO.	2

BY	DATE	REVISION

THIS DRAWING IS A MASTER PLANNING SHEET REPRESENTING PRELIMINARY AND CONCEPTUAL ENGINEERING. IT SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES

MATCH LINE Sta 56+30 See Sht. No 2

320 L.F. Rip Rap Channel b=20' Q100=1320 cfs, V=10.3 fps Flow d=4.1', Z=2.5 Chan D=5.5' Type M Rock

Exist. 18" RCP

Exist. 2-36" RCP

Detention Facility #H Q100 In=1655 cfs Q100 Out=1320 cfs Vol.=32 Ac FT Area=9.5 Ac

400 L.F. Low Flow Channel W/ Concrete Bottom b=5' and Boulder Sides Chan D=2'

500 L.F. Rip Rap Channel b=20' Q100=1590 cfs, V=13.4 fps Flow d=3.85', Z=2.5 Chan D=5.6', Type H Rock

120 L.F. Rip Rap Channel b=20' Q100=1135 cfs, V=13.8 fps Flow d=3.0', Z=2.5 Chan D=4.5', Type VH Rock

145 L.F. Rip Rap Channel Transition b From 20' to 60' Sta 91+00 to Sta 91+45

200 L.F. - Concrete Lined Channel b=0 Q100=105 cfs, V=17.4 fps Flow d=1.75', Z=2 Chan D=3.3'

900 L.F. - Concrete Lined Channel b=0 Q100=105 cfs, V=17.4 fps Flow d=1.75', Z=2 Chan D=3.3'

370 L.F. Grouted Rip Rap Channel b=20' Q100=1300 cfs, V=17.6 fps Flow d=2.8', Z=2.5 Chan D=4.9' Type N Rock (See Profile Below) Rip Rap Dike

For Channel Information See Sheet No. 5

650 L.F. Rip Rap Channel b=20' Q100=1590 cfs, V=12.2 fps Flow d=4.1', Z=2.5 Chan D=5.6' Type H Rock

385 L.F. Rip Rap Channel b=20' Q100=1410 cfs V=13.9 fps Flow d=3.6', Z=2.5 Chan D=5.1 Type H Rock

Grade Control Structures

Exist Concrete Channel b=0 Chan D=3.0', Z=2

Exist 6'x4' BC

Exist 100 Year Floodplain

855 L.F. Channel W/ Buried Rip Rap Side Slopes b=60' Q100=1135 cfs, V=7.5 fps Flow d=2.2', Z=2.5 Chan D=3.5' Type L Rock

175 LF Channel W/ Rip Rap Side Slopes Transition b From 60' to 20' Sta 100+25 to Sta 102+00

135' LF Rip Rap Lined Channel b=20', S=1.5% Q100=870 cfs, V=8.6 Flow d=3.5', Z=2.5 Chan D=4.9' Type M Rock

PAUMA VALLEY DR.

WUTHERING HEIGHTS DR.

GLENEAGLE DR.

BAPTIST RD.

MATCH LINE Sta 103+30 See Sheet No 4

MATCH LINE See Sheet No 4

0 200 400 600 SCALE IN FEET

MAIN TRIBUTARY

Sta 65+00 (5' RT) 6832.0

Sta 59+00 6801.8 (4' Drop) 6805.1 / 6801.1

6.3%

10' 300'

SIDE CHANNEL PROFILE

MATCH LINE STA 56+30

Sta 56+60 6799.0

Sta 59+00 (See Side Channel Profile) 6804.0

Sta 59+80 (See Side Channel Profile) 6808.8

1.9%

Exist Detention Facility "H"

Exist 2-36" RCP

Exist 12" RCP Riser

Exist 18" RCP

Exist Temporary Maintenance Rd.

Exist 2-84" CSP

2.5%

6.3%

3.9%

3.5%

4.6%

Sta 69+25 6832.25

Sta 73+75 6839.5

Sta 74+50 6839.35

Sta 75+00 (Grade) 6840.6 / 6839.6

Sta 76+10 (4' Drop) 6847.60 / 6835.60

Sta 81+00 6863.0

Sta 86+00 6880.1

Sta 89+80 (4' Drop) 6893.8 / 6897.8

Sta 90+10 (4' Drop) 6898.2 / 6903.2

Sta 92+45 6914.0

Sta 95+00 (Grade Control Structure) 6924.0

Sta 97+35 (Grade Control Structure)

Sta 97+80 (Grade Control Structure)

Sta 103+10 12' Baffle Chute Drop Structure

MATCH LINE Sta 103+30

Exist 6'x4' BC

6840 6820 6800 6880 6860 6840 6820 6800 6960 6940 6920 6900 6880 6860 6840 6820 6800

56+00 60+00 70+00 80+00 90+00 100+00

REVISION	DATE	BY

WILSON & COMPANY
ENGINEERS & ARCHITECTS
COLORADO SPRINGS COLORADO

BLACK FOREST DRAINAGE BASIN PLANNING STUDY

PRELIMINARY DESIGN
PLAN / PROFILE SHEET
JAKES CHANNEL
STA 56+30 TO STA 103+30

DESIGN	MAB
DRAWN	W&C
DATE	
FILE NO.	88-809
SHEET NO.	3

THIS DRAWING IS A MASTER PLANNING SHEET REPRESENTING PRELIMINARY AND CONCEPTUAL ENGINEERING. IT SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES

MATCH LINE STA 103+30 SEE SHEET NO. 3

Exist 6'x4' BC

230 LF Rip Rap
Channel b = 8'
Q100 = 670 cfs, V = 13.0 fps
Flow d = 2.9', Z = 2.5
Chan D = 4.5' Type H Rock

Exist Baffle Chute Energy Dissipater

Limits of Exist & Proposed Lots

GLENEAGLE DR.

Jakes Lake East

HOLBROOK ST.

Preserve Exist Channel
Sta 110+00 to Sta 126+00
b Varies 50' to 150'
Q100 = 670 cfs, V = 7.4 fps
Flow d = 1.4', Z = 10

MATCH LINE, SEE SHEET NO. 3

650 LF - Low Flow Channel w/ Concrete Bottom b = 5' Chan D = 2'

BAPTIST RD.

HOLBEIN DR.

Proposed 48" RCP @ 0.8%

Exist Rip Rap Channel

DESTREE DR.

Exist 48" RCP

Exist 54" CSP (See Emergency Spillway Detail)

1100 LF Rip Rap
Channel b = 8'
Q100 = 350 cfs, V = 13.75 fps
S = 9.0%, Z = 2.5
Flow d = 2.0'
Chan D = 3.5', Type H Rock

Exist 100 Year Floodplain

300 LF Rip Rap
Channel b = 8'
Q100 = 590 cfs, V = 11.0 fps
Flow d = 3.3', Z = 2.5
Chan D = 4.7' Type H Rock

LEGATE CT.

CELTIC CT.

Grade Control Structures

Exist 36" CSP

20 LF Rip Rap Protection

Grade Control Structures

6'x8'x50' BC @ 12.2%

KINGSWOOD DR.

Preserve Exist Channel
Sta 139+00 to Sta 156+00
b Varies 20' to 50'
Q100 = 590 cfs, V = 9.0 fps
Flow d = 1.8, Z = 10

Detention Basin #1
Q100 In = 81.7 cfs
Q100 Out = 14.5 cfs
Vol. = 28 Ac FT
Area = 3.5 Ac

300 LF - Low Flow Channel w/ Concrete Bottom b = 5' Chan D = 2

N

0 200 400 600
SCALE IN FEET

WILSON & COMPANY
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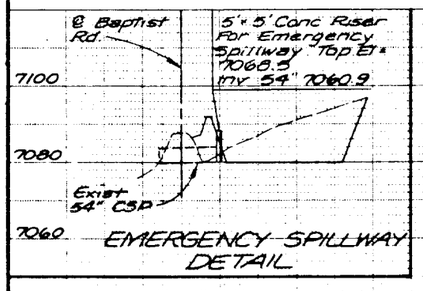
COLORADO SPRINGS COLORADO

REVISION	DATE	BY

BLACK FOREST
DRAINAGE BASIN PLANNING STUDY
PRELIMINARY DESIGN
PLAN / PROFILE SHEET
JAKES CHANNEL
STA 103+30 TO STA 159+00

DESIGN	MAB
DRAWN	W&C
DATE	
FILE NO.	88-809
SHEET NO.	4

EMERGENCY SPILLWAY DETAIL



MAIN TRIBUTARY

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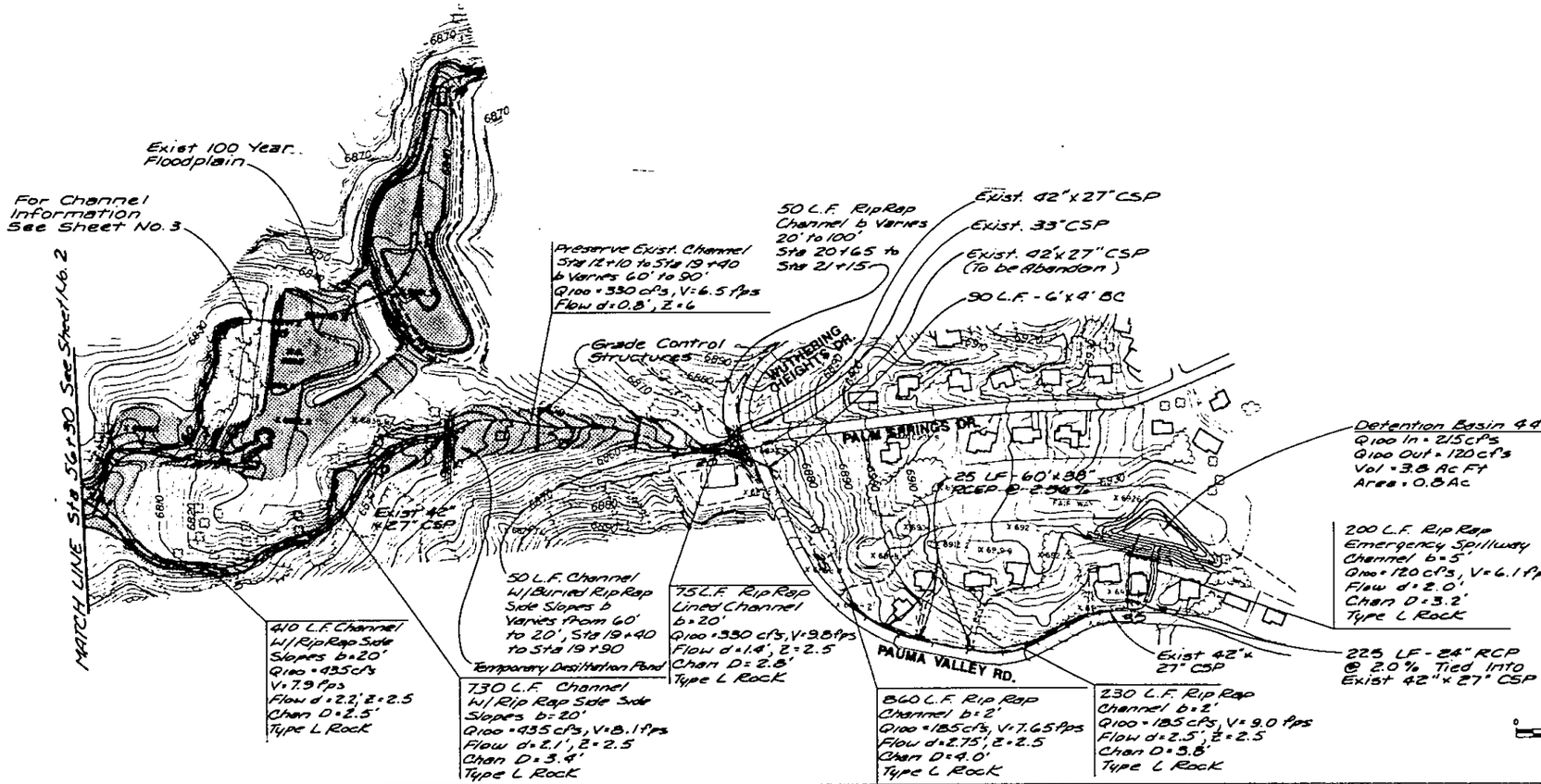
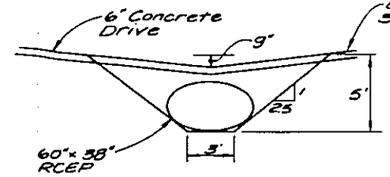
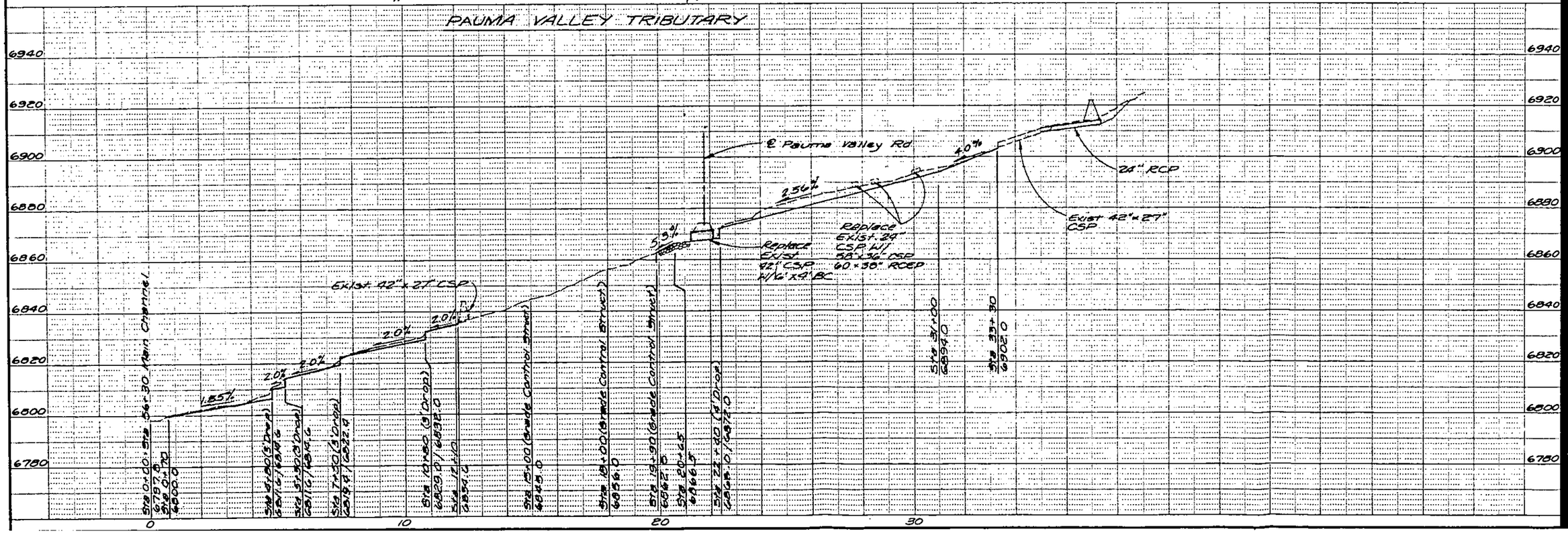




DRIVEWAY TYPICAL



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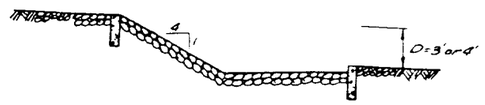
COLORADO SPRINGS COLORADO

BLACK FOREST
DRAINAGE BASIN PLANNING STUDY
PRELIMINARY DESIGN
PLAN / PROFILE SHEET
PAUMA VALLEY CHANNEL
STA 0+00 TO STA 37+00

DESIGN	MAB
DRAWN	W&C
DATE	
FILE NO.	88-809
SHEET NO.	5

REVISION	DATE	BY

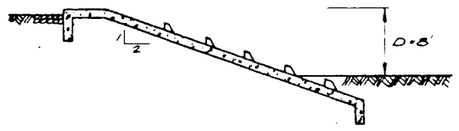


GROUTED RIP RAP SLOPED DROP STRUCTURE

For Details See City of Colorado Springs/El Paso County Drainage Criteria Manual Fig. 10-15c

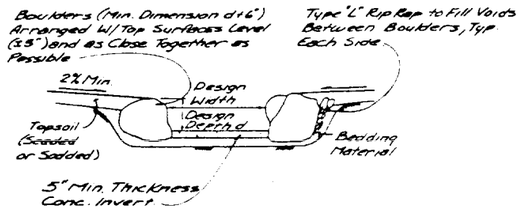
VERTICAL DROP WITH PRESHAPED RIP RAP BASIN

For Details See City of Colorado Springs/El Paso County Drainage Criteria Manual Fig. 10-10a



BAFFLE CHUTE DROP

For Details See City of Colorado Springs/El Paso County Drainage Criteria Manual Fig. 10-13b



TYPICAL LOW-FLOW CHANNEL WITH BOULDER EDGES AND CONCRETE INVERT

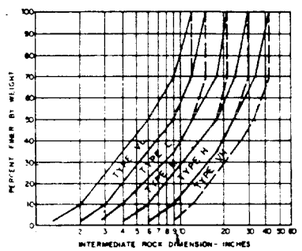
RIPRAP REQUIREMENTS FOR CHANNEL LININGS **

$V_s^{0.17}/(S_s-1)^{0.64}$, (ft^3/sec)	Rock Type ***
3.4 to 3.2	VL
3.3 to 3.9	L
4.0 to 4.5	M
4.6 to 5.5	H
5.6 to 6.4	VH

* Use S_s = 2.5 unless the source of rock and its densities are known at the time of design.

** Table valid only for Froude number of 0.8 or less and side slopes no steeper than 2h:1v.

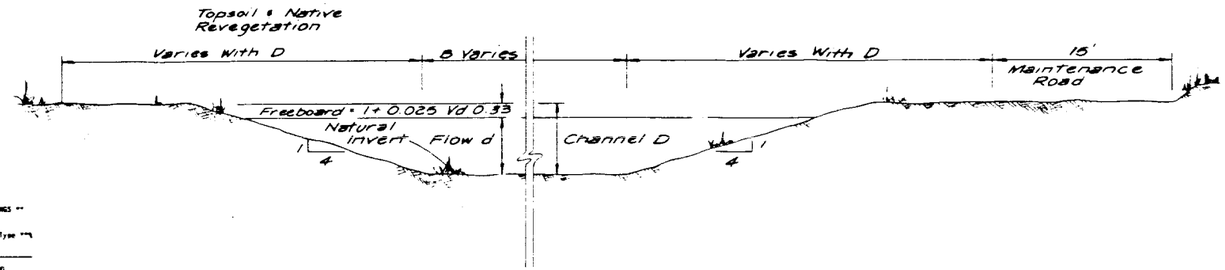
*** Type VL and L riprap shall be buried after placement to reduce vandalism
SMP slope mattress with toe protection may be substituted for Type VL or L riprap
G12 gabion with toe protection may be substituted for Type M and Type H riprap.



Gradation of Ordinary Rip Rap

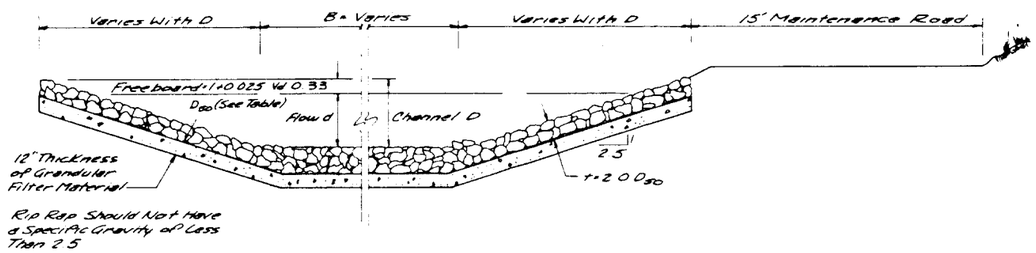
NOTES:

1. All Final Design and Construction shall be to Current City of Colorado Springs and El Paso County Standards and Specifications.
2. Final Channel Sizing, Transitions, and Superelevations are Subject to Detailed Drainage Reports of the Subject Area.
3. This Detail was used for Cost Estimating Purposes for this Master Plan only.
4. Topsoil and Revegetation above Rip Rap Assumed to be Non-Reimbursable.



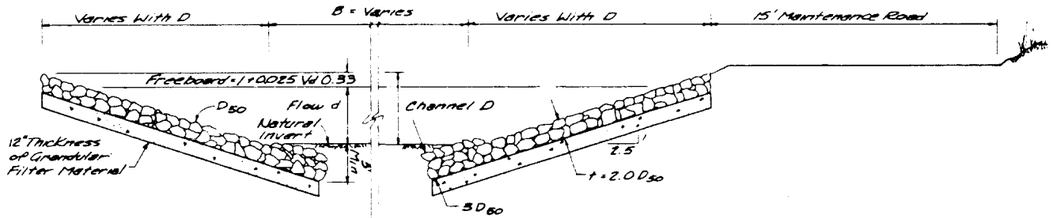
TYPICAL GRASS OR SOD LINED CHANNEL SECTION

NTS



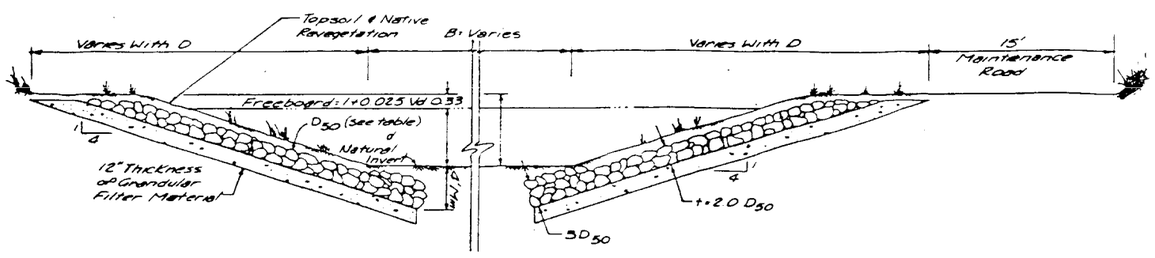
TYPICAL FULLY LINED RIP RAP CHANNEL SECTION

NTS



TYPICAL PARTIALLY LINED RIP RAP CHANNEL SECTION

NTS



TYPICAL PARTIALLY LINED BURIED RIP RAP CHANNEL SECTION

NTS

WILSON & COMPANY
ENGINEERS & ARCHITECTS
COLORADO SPRINGS COLORADO

BY | DATE | REVISION

BLACK FOREST
DRAINAGE BASIN PLANNING STUDY

TYPICAL CHANNEL SECTIONS & DROP STRUCTURE DETAILS

DESIGN	MAB
DRAWN	W&C
DATE	
FILE NO.	88-809
SHEET NO.	6