

RETURN WITHIN 2 WEEKS TO:
CITY OF COLORADO SPRINGS
STORM WATER & SUBDIVISION
101 W. COSTILLA, SUITE 113
COLORADO SPRINGS, CO 80903
(719) 578-6212

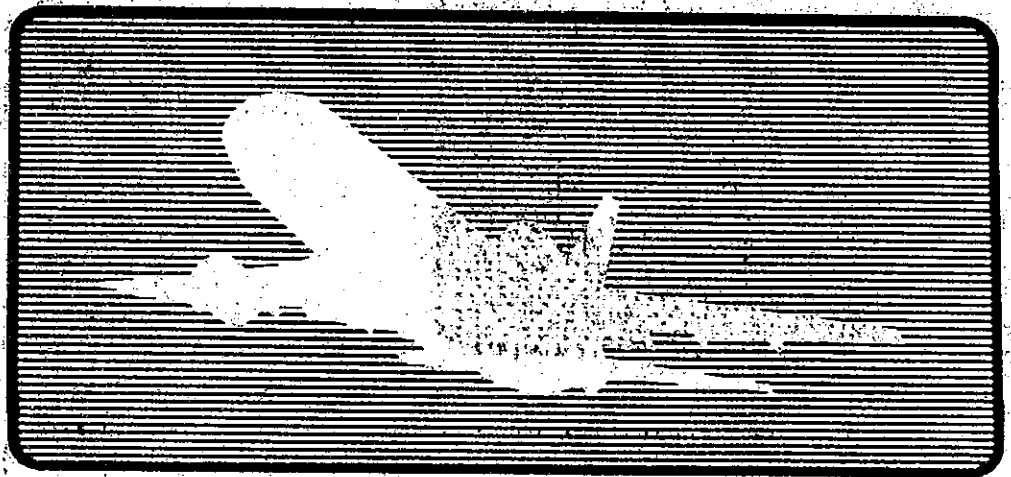
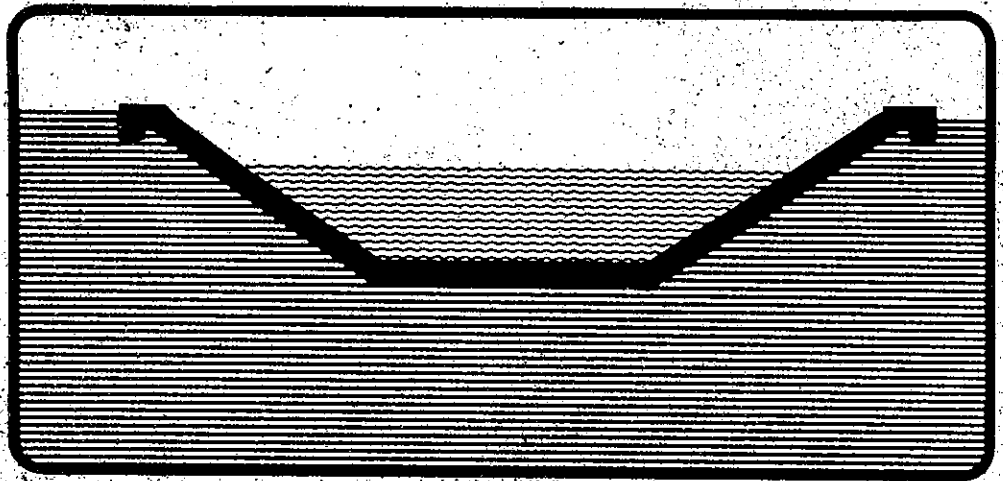
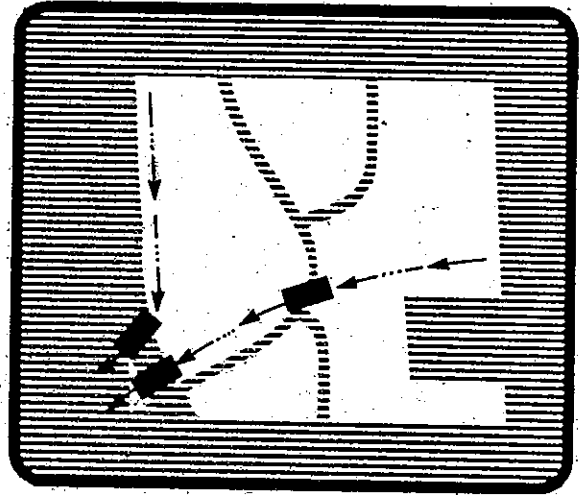
RETURN TO:
Land Development
101 West Costilla, Suite 122
Colorado Springs, CO 80903

*Return to
Eric New.
105. W Costilla
C.S. Colorado
578-6564*

Peterson Field Drainage Basin Master Plan Update

City of Colorado Springs, Co.

August 1984



URS

Approved by City Council
December 11, 1984

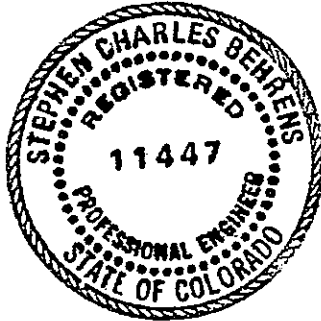
PETERSON FIELD DRAINAGE MASTER PLAN
COLORADO SPRINGS, COLORADO
SEPTEMBER 28, 1984

PREPARED BY:

URS/NES 911 South 8th Street
Colorado Springs, Colorado 80906
(303) 471-0073

C E R T I F I C A T I O N

I, Stephen C. Behrens, a Registered Engineer in the State of Colorado, hereby certify that the attached Drainage Study for the Peterson Field Drainage Basin was prepared under my direction and supervision and is correct to the best of my knowledge and belief. I further certify that said Drainage Study is in accordance with all City of Colorado Springs Ordinances, Specifications, and Criteria.




Stephen C. Behrens, P.E.

A P P R O V A L

The City of Colorado Springs City Council and Department of Public Works do hereby approve the contents of the attached Peterson Field Drainage Study. The Study shall be used as a guide for development of all drainage facilities within the study area.

Department of Public Works
(SEE ALSO ATTACHED MINUTES
OF THE CITY OF COLORADO
SPRINGS DRAINAGE BOARD)

(SEE ATTACHED RESOLUTION)
City Council

Haynes
Raider
Hauk

CITY OF COLORADO SPRINGS

December 13, 1984

TO: Bob Gordon
✓ DeWitt Miller
Jim Phillips
Jim Ringe
Larry Schenk
Chief Smith
Chief Stratton
Jim Wilson
Jim Colvin
Bob Parker
Johnnie Rogers
Larry Allison
Sterling Campbell
Ann Altier
Pauline Knopp
Bud Owsley
Dick Zickefoose
Bob Wilder
Jim Alice Scott
Rolf Philipsen
Dave Nickerson

FROM: City Manager

SUBJECT: Council Actions of December 11, 1984

At its regular meeting of December 11, 1984, City Council took the following actions with regard to contracts, agreements, ordinances and other fiscal matters.

PARK AND RECREATION

- 1) Approved a resolution accepting gifts to the Park and Recreation Department and expressing gratitude to the donors for their generous gifts.
- 2) Approved 1985 Budgeted and approved annual Contracts for the Park and Recreation Department sundry services.

RECEIVED
PUBLIC WORKS
COLORADO SPRINGS, COLO

DEC 17 1984

AM 7 8 9 10 11 12 1 2 3 4 5 6 PM

Page Four

UTILITIES (Cont'd.)

- 10) Tabled until the first meeting in January a request for water and wastewater service to Lots 1 - 6, Block 2 and Lot 23, Park Vista Addition by John R. Manus on behalf of Jon R. Staples.

PUBLIC WORKS

- ✓ 1) Tabled approval of Dry Creek Drainage Basin Master Study and establishment of a new drainage fee for the Dry Creek Drainage Basin equal to \$6,364.00 per acre.
- ✓ 2) Approved Peterson Field Drainage Basin Master Plan Update and establishment of a new drainage fee in the amount of \$3,612.00 per acre for a new bridge fee in the amount of \$209.00 per acre.
- 3) See Park and Recreation No. 4.
- 4) Approved award of contract in the amount of \$2,353,974.00 to Schmidt-Tiago Construction Company for 1985 asphaltic materials, with permission to extend the contract amount to the budgeted amount of \$2,505,000.00.
- 5) See Utilities No. 10.
- 6) Authorized the proper City officials to enter into contracts with MRC and the Health Association of the Pikes Peak Region for transportation of the handicapped for 1985.
- 7) See Attorney No. 1 and 2.
- ✓ 8) Approved expenditure of \$90,000.00 from Projects to be Determined Fund for engineering services for Centennial Boulevard - Fillmore to Fontanero.

POLICE

- 1) Approved Ordinance No. 84-310 on second reading amending the Code of the City of Colorado Springs 1980, as amended, relating to contributions to the Police and Fire Pension Funds.
- 2) Approved request by Silver Key Senior Services of donating the van frequently used by Silver Key as an extension of its contract for services.

CITY OF COLORADO SPRINGS

The "America the Beautiful" City

DEPARTMENT OF PUBLIC WORKS

CITY ENGINEERING DIVISION (303) 578-6606

30 S. NEVADA SUITE 403 P.O. BOX 1575

COLORADO SPRINGS, COLORADO 80901

M I N U T E S

COLORADO SPRINGS/EL PASO COUNTY DRAINAGE BOARD

of November 15, 1984

The Colorado Springs/El Paso County Drainage Board met at 2:00 P.M. on Thursday, November 15, 1984 in the City Council Chambers, City Administration Building, 30 S. Nevada Avenue.

Members Present

William Weber, Chairman
Leigh Whitehead
Richard Dailey
George Jury
Mike Mallon

Members Absent

Rick Brown
Fred Gibson

Others Present

DeWitt Miller, Dir Public Works
Gary Haynes, City Engineer
Jack Smith, Asst City Attorney
Chris Smith, Subdivision Admin
Ken Jorgensen
Roger Sams
Laurence Schenk
Others

The meeting was called to order at 2:00 P.M.

Item 1

Approval of the minutes of the October 18, 1984 Board Meeting. (The minutes were previously mailed.) The motion to accept the minutes was made by Mr. Jury. Mr. Whitehead seconded the motion and the motion was passed with a unanimous vote.

Items 2, 3 and 4

Items 2, 3 and 4 were acted upon by the Board with one motion. The items were treated as Consent Items.

A motion was made by Mr. Jury to accept the City Engineer's recommendations on Items 2, 3 and 4 (see Drainage Board Agenda, November 15th). The motion was seconded by Mr. Dailey. The motion passed with a unanimous vote.

Item 5

Request for credits for construction of drainage facilities within the Spring Creek Drainage Basin, Greystone Subdivision, Fountain and Academy Associates, Developer.

After review of the item by the City Engineer, the Board heard a motion by Mr. Whitehead to approve the staff's recommendation (see Drainage Board Agenda, November 15th). Mr. Mallon seconded the motion. The vote was unanimous in favor of the motion.

Item 6

Request for cash reimbursement for construction of drainage facilities within the Cottonwood Creek Drainage Basin, Dublin Business Park Subdivision Filing No. 1, Gibraltar Development Corporation, Developer.

The item was reviewed by the City Engineer. The Board heard a motion by Mr. Dailey to accept the staff's recommendation (see Drainage Board Agenda, November 15th). The motion received a second by Mr. Whitehead. The motion passed with a unanimous vote.

Item 7

Establishment of drainage and bridge fees for the Peterson Field Drainage Basin.

The City Engineer presented the Board with the revised proposed basin fees. The proposed fee included the Basin Fund Balance as of September 1984, as well as the basin deficit per the Board's motion of October 18, 1984 (see Drainage Board Agenda, November 15th).

Mr. Miller stated that it was his opinion that the Board should rescind their previous action of the October 18, 1984 meeting. The Board was in agreement and heard a motion by Mr. Whitehead to rescind the Board action of October 18, 1984. The motion was seconded by Mr. Dailey. The vote was unanimous in favor of the motion.

During discussion of this item, Mr. Jury stated that he was in opposition to the new fee. Mr. Jury expressed concern that the new fee would have a negative impact on the potential for development of the unplatted acreage in the basin.

Mr. Whitehead also expressed Mr. Jury's concern but felt that the new fees established in conjunction with a basin restudy must address fund deficits to make the basin fund balance out at build out.

The Board heard a motion by Mr. Whitehead to approve the staff's recommendation that a drainage fee of \$3,612.00 per acre and a bridge fee of \$209.00 per acre be established for the Peterson Field Basin. The motion was seconded by Mr. Dailey. The vote was 4 - 1 in favor of the motion with Mr. Jury voting in opposition to the motion.

Item 8

Request by City Engineer to revise the cash reimbursement for construction of drainage facilities for Columbine Indust-Rail Center, Miscellaneous Drainage Basin, Columbine Industrail Development, Mr. Kenneth B. Jorgensen, Developer.

Mr. Whitehead excused himself for this item.



AN INTERNATIONAL PROFESSIONAL SERVICES ORGANIZATION

URS COMPANY

3955 EAST EXPOSITION AVENUE
DENVER, COLORADO 80209
TEL: (303) 744-1861

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SAN MATEO
SANTA BARBARA
SANTA FE
SEATTLE
TAMPA
WASHINGTON, D.C.

October 10, 1984

Mr. Gary Haynes, City Engineer
City of Colorado Springs, Colorado
30 South Nevada, Suite 402
P.O. Box 1575
Colorado Springs, Colorado 80901

Re: Peterson Field Drainage Basin
Master Plan Update

Dear Mr. Haynes:

As you are aware, URS has been retained by the Crestone Development Corporation of Colorado Springs to prepare update recommendations to the 1976 Peterson Field Drainage Masterplan to reflect existing and planned changes which have developed over the last several years.

On August 23, 1984 URS met with the Airport Advisory Commission and received the Commission's approval to abandon the 1976 masterplanned storm water detention area proposed immediately east of planned Powers Boulevard. The Commission's approval was granted based on the following information:

- a) The existing two large storm water detention ponds within Peterson Field reduce the future fully developed peak 100-year storm runoff west of Powers Boulevard to a level below that proposed in the 1976 Masterplan.
- b) The masterplanned storm drainage facilities identified in the 1984 update are adequate to convey future fully developed 100-year peak flood flows without having to provide additional storm water detention within Peterson Field proper.
- c) Airport operators are solely responsible for the construction of any and all drainage storm drainage improvements required within Peterson Field proper.

The report includes a basin description, hydrology, hydraulics, design criteria, and a cost estimate for the remaining improvements for the basin. The report utilizes information obtained from previous studies for the Peterson Field drainage basin. A map has been prepared as a Master Drainage Plan showing existing and proposed improvements for the basin.



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Mr. Gary Haynes
October 10, 1984
Page 2

The study has been prepared as a Master Plan guide for coordinated drainage facility construction as development occurs in the study area. The recommended improvements are often general in nature as to size and location. The intent of the preliminary facility design has been to include enough construction costs in the basin fee to insure a fund for reimbursement that will theoretically "zero out" after all facilities are in place. The recommendations included herein should therefore be used as a guide in planning future development in Peterson Field Drainage Basin.

Very truly yours,

URS COMPANY

A handwritten signature in cursive script that reads "Stephen C. Behrens".

Stephen C. Behrens, P.E.
Vice President

SCB/pk

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PETERSON FIELD DRAINAGE MASTER PLAN
SEPTEMBER 28, 1984

1. PURPOSE AND SCOPE

URS was retained by the Crestone Development Corporation of Colorado Springs, Colorado to update recommendations to the 1976 Peterson Field Drainage Master Plan to reflect existing and planned changes which have occurred over the last several years.

These existing and planned changes include the following:

- Relocated Fountain Boulevard
- Planned Powers Boulevard
- Existing Peterson Field storm water detention ponds #1 and #2
- Local storm drainage improvements within Peterson Field
- Projected land use changes.

The purpose of this study is to define the general nature and location of improvements required to meet present (1984) City drainage design criteria. The scope of this study excludes establishing the exact design of required drainage improvements.

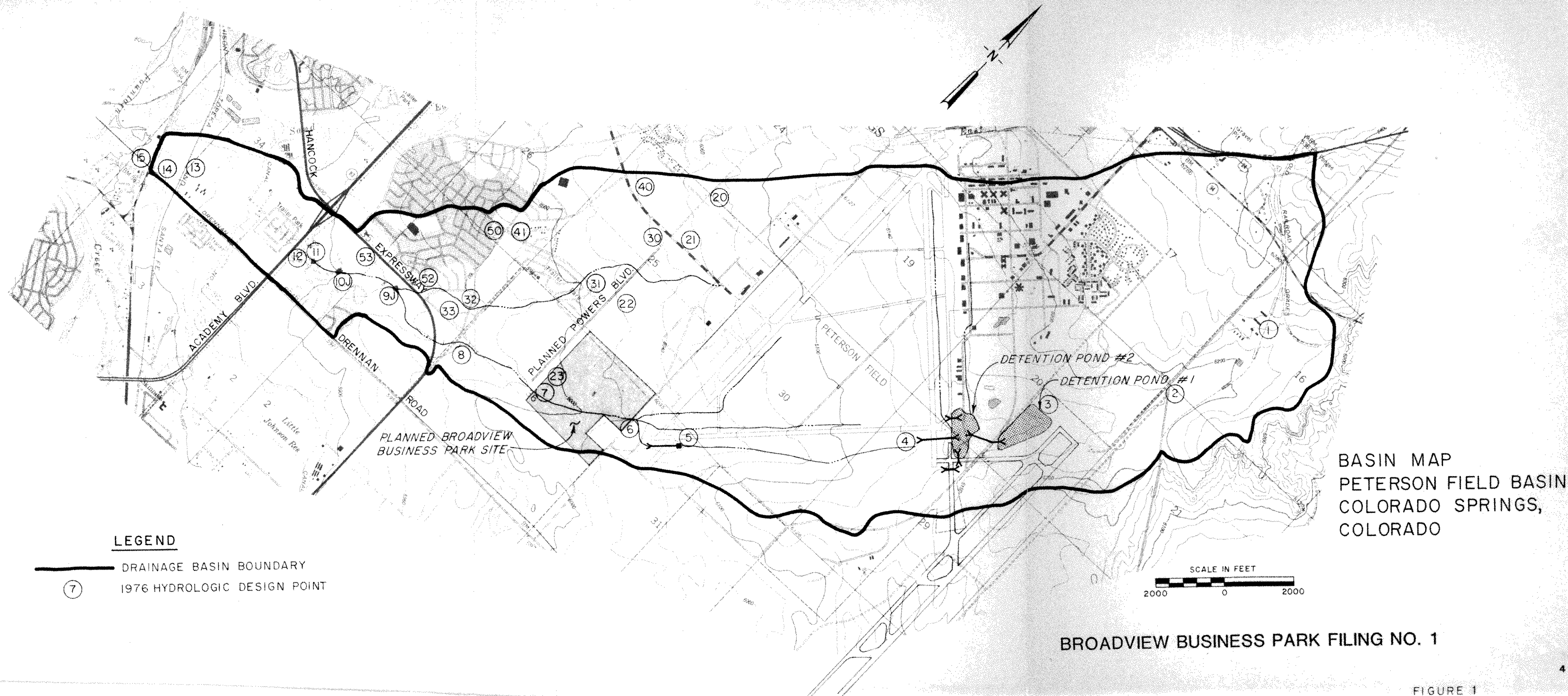
This study specifically examines the following two drainage concerns within the Peterson Field Basin:

- (1) the hydrologic impact of existing Peterson Field storm water detention ponds #1 and #2 on future fully developed 100-year flood flows and;
- (2) the potential benefits and drawbacks associated with locating additional storm water detention facilities within Peterson Field proper.

2. BASIN DESCRIPTION

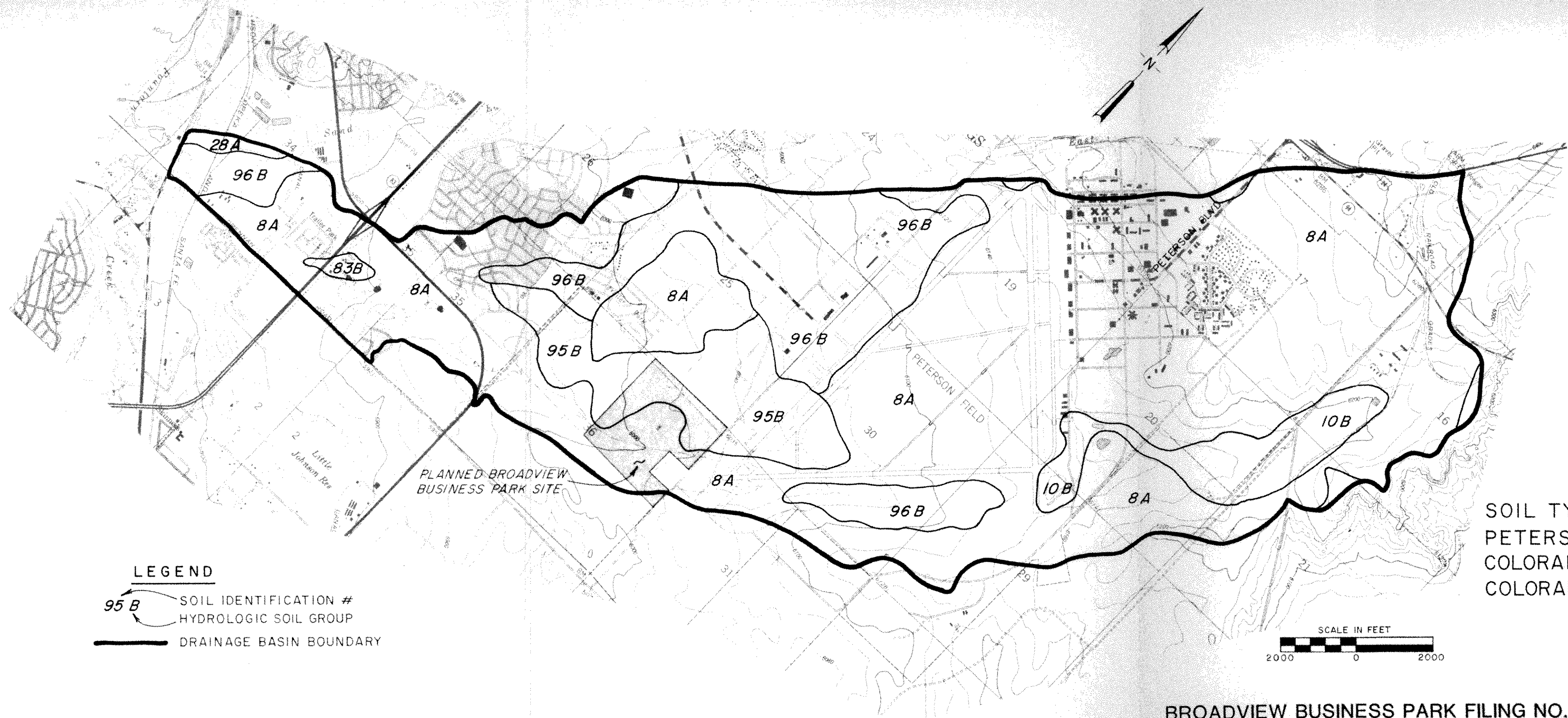
The Project Study Area encompasses that portion of Peterson Field Drainage Basin located east of planned Powers Boulevard as shown on Figure 1. Features of interest within the Study Area include planned Powers Boulevard, planned Hancock Expressway, Fountain Boulevard, Peterson Field, Colorado Highway 94, and U.S. Highway 24. The central portion of the Study Area is within the City of Colorado Springs, Colorado. The eastern and western portions of the Study Area are within unincorporated El Paso County.

Peterson Field Basin outfalls to Sand Creek which in turn outfalls to Fountain Creek. Sand Creek Basin is a major drainage planning basin located north of the Peterson Field Basin. Chandelle and Windmill Gulch basins are major drainageway planning basins located south of the Peterson Field Basin. Peterson Field Basin encompasses a total of approximately 8.6 square miles above Fountain Creek of which the Project Study Area encompasses a total of approximately 7.2 square miles. Peterson Field proper occupies approximately 3.9 square miles of the Project Study Area. Peterson Field Basin has a total length of approximately nine miles of which approximately six miles are within the Project Study Area. Elevations within



BASIN MAP
PETERSON FIELD BASIN
COLORADO SPRINGS,
COLORADO

BROADVIEW BUSINESS PARK FILING NO. 1



SOIL TYPES
PETERSON FIELD BASIN
COLORADO SPRINGS,
COLORADO

BROADVIEW BUSINESS PARK FILING NO. 1

SOURCE: SOIL SURVEY OF EL PASO COUNTY AREA, COLORADO
SOIL CONSERVATION SERVICE JUNE, 1981

Peterson Field Basin are approximately 5750 at Fountain Creek, 5990 at planned Powers Boulevard, and 6440 at the upper end of the Basin.

Basin soil and land use characteristics directly affect the relationship between rainfall and runoff within a basin. The U.S. Soil Conservation Service classifies soils into four hydrologic groups (A, B, C and D) according to a soil's runoff potential. Group A soils exhibit high infiltration rates when thoroughly wetted and are considered to have low runoff potential. Group B soils exhibit moderate infiltration rates when thoroughly wetted. Group C soils exhibit slow infiltration rates when thoroughly wetted. Group D soils exhibit very slow infiltration rates when thoroughly wetted and are considered to have high runoff potential.

Soil types within the Peterson Field Basin are listed in Table 1 and delineated in Figure 2. The Peterson Field Basin encompasses approximately 2.5 square miles of group 'B' hydrologic soils and the remainder are group 'A' soils. Most of the soils in the Peterson Field Basin have a high infiltration rate, are excessively drained, and are easily erodible. Reservoir embankments, dikes and levees constructed of Peterson Field Basin soils may be subject to piping and seepage. Water storage reservoirs constructed in Peterson Field Basin soils may experience

excessive seepage. Group 'A' hydrologic soils in the Peterson Field Basin are expected to have relatively low potential for frost action. Group 'B' hydrologic soils in the Peterson Field Basin are expected to have moderate potential for frost action.

TABLE 1
SOIL TYPES
PETERSON FIELD BASIN
COLORADO SPRINGS, COLORADO

Soil Identification		Slope	Hydrologic
Number	Soil Name	%	Soil Group
8	Blakeland Sandy Loam	1-9	A
10	Blendon Sandy Loam	0-3	B
28	Ellicott Loamy Coarse Sand	0-5	A
83	Stapleton Sandy Loam	3-8	B
95	Truckton Sandy Loam	1-9	B
96	Truckton Sandy Loam	0-3	B

Source: Soil Survey of El Paso County Area Colorado
U.S. Soil Conservation Service
June 1981

3. PREVIOUS REPORTS

Drainage master planning within the Peterson Field Basin has been ongoing since 1965. The following three drainage basin master planning study revisions and updates have been completed for the Peterson Field Basin:

Peterson Field Master Drainage Report, 1965
Karcich and Weber Inc.

Peterson Field Master Drainage Report, 1974
NHPQ Engineers, Inc.

Peterson Field Master Drainage Report, 1976
Department of Public Works, City of Colorado Springs.

In addition the following localized storm drainage planning, design and construction efforts have been undertaken within the Peterson Field Basin:

Peterson Field Report 1973
North-South Runway and Facilities West
R. Keith Hook and Associates.

Colorado Springs Municipal Airport
Runway 17L - 35R and Associated Taxiways
Grading and Drainage Project
Drainage Report, October, 1984, HNTB.

Previous drainage master planning efforts did not identify the consequences or implications of sub-basin diversion of storm runoff within the basin.

The 1976 Peterson Field Storm Drainage Master Plan Report recommended construction of two storm water detention ponds within the Peterson Field basin. A 115 acre foot capacity storm water detention pond was recommended east of planned Powers Boulevard (within the planned Broadview Business Park site) together with a 118 acre-foot capacity storm water detention pond recommended near the eastern boundary of Peterson Field proper.

Existing Peterson Field storm water detention ponds #1 and #2 are located near the eastern boundary of Peterson Field proper. These ponds were constructed in conjunction with Runway 17L - 35R and associated taxiways. Material excavated during construction of these ponds was used to construct runway 17L - 35R. Peterson Field storm water detention ponds #1 and #2 are twice as large as the masterplanned storm water detention facilities recommended in the 1976 Drainage Master Plan Report, having the capacity to store approximately 262 and 228 acre-feet of storm runoff respectively with three feet of freeboard.

Peterson Field storm water detention ponds #1 and #2 were designed to reduce the 100-year future fully developed peak flood flow from approximately 5,700 cfs (extrapolated) to approximately 130 cfs based on a total drainage area of 2,066 acres (3.23 square miles); a runoff

curve number of 90 (indicative of future fully developed conditions); and a 100-year 24 hour rainfall depth of 4.6 inches.

Storm runoff from a 1,372 acre area within Peterson Field combines with the outflow release from existing detention pond #1 and #2 before entering the planned Broadview Business park site from the east. The 1973 Peterson Field Drainage Report prepared by R. Keith Hook and Associates encompasses this 1,372 acre area. The 1973 report was reviewed and found to be satisfactory although it is based upon a presently outdated criteria of a 50-year storm yielding two inches in one hour and if implemented would result in the sub-basin diversion of storm runoff from an area encompassing approximately 73 acres to the east side of the planned Broadview Business Park site. It is our understanding that the personnel of the Colorado Springs Municipal Air Field use the 1973 Peterson Field Drainage Report as a guide to future air field storm drainage improvements. Sub-basin delineations and alphabetic identifiers used in the 1973 Peterson Field Drainage Report are shown in Figure 3. These sub-basin delineations and identifiers were used in the present study for clarity, consistency, and ease of comparison.

Powers Boulevard is a planned north-south major arterial roadway located approximately a quarter mile west of Peterson Field. Storm runoff from a 460 acre area east of Powers Boulevard historically flowed southwest across the planned alignment of Powers Boulevard. Approximately 85 acres of this 460 acre area are within the Broadview Business Park site. Previous studies (NHPQ 1974, City of Colorado Springs 1976) recommended that storm runoff from this 460 acre area be conveyed south along planned Powers Boulevard to the main channel. This sub-basin diversion was recommended to limit design storm runoff in an existing secondary channel west of Powers Boulevard to an acceptable level. This planned sub-basin diversion increases the quantity of offsite storm runoff entering the Broadview Business Park site from the north and increases the size and associated cost of required drainage facilities within the Broadview site. The impact of the planned sub-basin diversion on the Broadview site is mitigated to a certain extent by Peterson Field detention ponds #1 and #2 which reduce peak storm runoff entering the Broadview site from the east. The 1974 Report prepared by NHPQ assumed this sub-basin diversion would be accomplished by means of a closed conduit along Powers Boulevard whereas the 1976 Report prepared by the City assumed the construction of an open channel.

Preliminary design plans have been prepared for Powers Boulevard. These preliminary design plans do not incorporate facilities to accomplish the planned sub-basin diversion of storm runoff along Powers Boulevard.

Storm runoff released at the western property line of the planned Broadview Business Park site is comprised of storm runoff from Peterson Field and a 580 acre area located between Peterson Field and planned Powers Boulevard. Approximately 80% of this 580 acre area (460 acres) is associated with the planned sub-basin diversion of storm runoff along planned Powers Boulevard.

The 1974 Report by NHPQ recommended that storm runoff from the area located northeast at Chelton and Astrozon be diverted southwards along Chelton by means of an 84 inch diameter rcp conduit to reduce peak storm runoff in an existing downstream secondary channel. The 1976 Report by the City did not incorporate this recommendation.

4. EXISTING DRAINAGE FACILITIES

Main channel and secondary drainage facilities recommended in the 1976 Drainage Masterplan, or their equivalents, have been constructed to date with the following exceptions:

Main Channel

- 550 feet west of Hancock Expressway to Design Point 8
- Crossing at Hancock Expressway (Design Point 8)
- Hancock Expressway to planned Powers Boulevard (Design Point 7)
- Design Point 7 to Design Point 6
- Design Point 6 to Design Point 5
- Design Point 5 to Design Point 4
- Design Point 3 to Design Point 2
- Design Point 2 to Design Point 1.

Secondary Facilities

- 550 feet south of Fountain Boulevard to Design Point 40
- Design Point 20 - Design Point 21
- Design Point 21 - Design Point 22
- Design Point 22 - Design Point 23
- Design point 30 - Design Point 31
- Crossing at Hancock Expressway (Design Point 33).

Existing main channel improvements between the basin outfall and the west side of Hancock Expressway are adequate to convey presently anticipated future fully developed design flood flows.

5.0 BASIN HYDROLOGIC AND HYDRAULIC ANALYSIS

5.1 METHODOLOGY

The modified SCS method of determining peak flood flows was used to estimate future fully developed peak flood flows for the 5-year and 100-year storm events.

Drainage basins, sub-basin areas, and future fully developed runoff curve numbers for the area below Peterson Field storm water detention ponds #1 and #2 were obtained from the 1973, 1974 and 1976 Drainage Masterplanning Reports.

Time of concentration was estimated as the sum of overland flow time and channel flow time.

Overland flow time was estimated using the following equation:

$$T_o = \frac{11.9 \times L(mi)^3}{H (FT)^{0.385}} \text{ where } T_o = \text{overland flow time in hours}$$

L = overland flow path length in miles
 H = elevation difference in feet.

Channel or conduit flow time was determined as the length of channel or conduit flow path divided by average flow velocity of seven feet per second.

24-hour rainfall depths of 2.7 and 4.6 inches were used for the 5-year and 100-year storm events respectively.

Peterson Field storm water detention ponds #1 and #2 were designed to release at a peak rate of 130 cfs during the 100-year storm event.

5.2 EXISTING STORM WATER DETENTION HYDROLOGY

Peak 100-year design point, future fully developed flood flows downstream of existing storm water detention ponds #1 and #2 are presented in Table 2 and Table 3. The 100-year peak design point flow rates presented in Table 2 and Table 3 are based on a 130 cfs 100-year release rate from detention ponds #1 and #2.

URS NO. 4125 DATE 7/16/84
CLIENT: CRESTONE DEVELOPMENT CORPORATION

T A B L E 2
AIRPORT PEAK FLOOD FLOWS
PETERSON FIELD BASIN
COLORADO SPRINGS, COLORADO

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
DESIGN DRAINAGE POINT AREA (ACRES)	RUNOFF CURVE NUMBER, CN	DIRECT RUNOFF 24-HOUR STORM 5-YEAR 2.7 IN.	100-YEAR 4.6 IN.	SUB-BASIN ELEVATIONS MAX. MIN.	ΔH (FT)	SUB-BASIN LENGTH (FT)	SLOPE S ₀ %	OVERLAND FLOW TIME T _O (HRS)	CHANNEL FLOW TIME T _C (HRS)	24-HR. CSM IN	Q ₁₀₀ (CFS)	Q ₅ (CFS)	Q ₁₀₀ (CFS)	Q ₅ (CFS)	Q ₁₀₀ (CFS)	NOTES
1	188.0	69	0.52	1.67	6168 6052	116	9,600	1.21	0.83	NA	0.830	440	67	216	B	
2	40.0	69	0.52	1.67	6168 6112	56	3,750	1.49	0.37	NA	0.370	650	21	68	D	
3	252.0	70	0.56	1.75	6112 6084	28	2,320	1.21	---	0.0921	0.922	410	90	283	B,D,H	
4	276.0	70	0.56	1.75	6084 6056	28	2,150	1.30	---	0.0853	1.007	370	89	280	B,D,H,N	
5	425.0	69	0.52	1.67	6158 6054	104	7,850	1.32	---	0.3150	1.322	325	112	361	A	
6	740.0	70	0.56	1.75	6056 6036	20	2,300	0.87	---	0.0913	1.413	310	201	627	B,D,H,N,A,S	
7	34.0	69	0.52	1.67	6170 6140	30	2,300	1.30	0.27	NA	0.270	740	20	66	E	
8	34.0	100	2.70	4.60	6140 6110	30	2,200	1.36	0.25	NA	0.250	760	109	186	U,V,W	
9	97.0	73	0.68	1.97	6146 6110	36	2,080	1.73	---	0.0825	0.353	660	68	197	E,T,U,V,W	
10	20.0	98	2.47	4.46	6110 6064	46	3,300	1.39	0.34	NA	0.340	670	52	94	A ₁	
11	150.0	77	0.87	2.29	6110 6074	36	2,300	1.57	---	0.0913	0.431	605	123	325	E,T,U,V,W,A ₁ ,I	
12	164.0	77	0.87	2.29	6074 6060	14	1,220	1.15	---	0.0484	0.479	580	129	340	E,T,U,V,W,A ₁ ,I,F ₁	
13	178.0	76	0.82	2.21	6060 6054	6	960	0.63	---	0.0381	0.518	560	128	344	E,T,U,V,W,A ₁ ,I,F ₁ ,L	
14	952.0	70	0.56	1.75	6062 6058	4	600	0.67	---	0.0238	1.477	305	255	794	(6)+(13)+Q	
15	8.4	100	2.70	4.60	6058 6052	6	650	0.92	0.12	NA	0.120	950	34	57	E ₁	
16	16.9	100	2.70	4.60	6052 6038	14	1,220	1.15	---	0.0484	0.168	870	62	105	E ₁ , G ₁	
17	988.8	72	0.64	1.89	6038 6024	14	2,800	0.50	---	0.0476	1.525	295	292	862	(14)+(16)+I ₁	
18	INFLOW TO PETERSON FIELD STORM WATER DETENTION RESERVOIRS															
19	RELEASE FROM PETERSON FIELD DETENTION RESERVOIR NO. 2															
20	369.0	93	1.97	3.81	6126 6040	86	7,100	1.21	0.66	NA	0.66	495	562	1217*	C ₁	
21	378.4	93	1.97	3.81	6040 6034	6	1,450	0.41	---	0.0575	0.718	475	553	1200*	C ₁ + K ₁	
22	1371.8	78	0.92	2.38	6034 6024	10	725	1.38	---	0.0400	1.525	295	582	1635*	(17) + C ₁ +K ₁ +J ₁	
23	460.0	96	2.26	4.13	6150 5992	158	12,600	1.25	1.009	NA	1.009	380	617	1128	---	
24	1951.8	84	1.28	2.91	6024 5992	32	2,640	1.21	---	0.105	1.630	280	1093	2615*	---	
---	1491.8	80	1.03	2.55	---	---	---	---	---	---	1.630	280	672	1794*	---	

COLUMN 1: URS 1984.
COLUMNS 2 AND 3: R. KEITH HOOK 1973.
COLUMN 11: T_O (HR) = $\frac{(11.9 \times L(mi))}{H (FT)}$ 3, 0.385

COLUMN 12: CHANNEL FLOW TIME BASED ON VAVE = 7 FT/SEC.

*INCLUDES 130 CFS 100-YEAR RELEASE FROM PETERSON FIELD STORM WATER DETENTION PONDS #1 AND #2.

TABLE 3

BASIN PEAK FLOOD FLOWS
PETERSON FIELD BASIN
COLORADO SPRINGS, COLORADO

1	2	3	4	5
		DRAINAGE AREA (SQUARE MILES)		100-YEAR FUTURE FULLY DEVELOPED FLOOD FLOW (CFS)
	LOCATION	DIRECT	TOTAL	
2	MARKSHEFFEL ROAD	0.68	0.68	1,240
3		1.65	1.65	2,540
4		3.23	3.23	5,300
4		3.23	3.23	130
5		0.58	3.81	1,220
6		2.15	5.38	1,635
7	POWERS BOULEVARD	2.32	5.55	1,800
8	HANCOCK EXPRESSWAY	3.21	6.44	2,694
9J		3.76	6.99	3,155
10J		4.39	7.62	3,741
11	COLONY HILLS CIRCLE	4.50	7.73	3,753
12	ACADEMY BOULEVARD	4.66	7.89	3,753
13	AT & SF RAILROAD	4.86	8.09	3,873
14	LAS VEGAS STREET	4.93	8.16	3,880
15	OUTFALL TO SAND CREEK	4.96	8.20	3,900
21		0.282	0.282	273
22		0.561	0.561	900
23		0.72	0.72	1,130
31		0.089	0.089	105*
32		0.402	0.402	740
33		0.471	0.471	850
40		0.083	0.083	86*
41		0.338	0.338	550
53		0.520	0.520	830

* Denote 50-year flow

6 DESIGN CRITERIA

Present (1984) City of Colorado Springs drainage design criteria were employed in preparing this 1984 Basin Master Plan Update Report. These criteria require storm drainage improvements to accommodate the 5-year storm event provided the 100-year peak flood flow does not exceed 500 cfs and the 100-year storm event if the 100-year peak flood flow exceeds 500-cfs. Drainage design standards and criteria reduce but do not eliminate all flood risks. Storm events larger than the 100-year event can and do occur.

Drainage improvements recommended in the 1976 Master Drainage Report cannot convey the 1976 design flows in accordance with present (1984) drainage design criteria due to increased freeboard requirements, average channel flow velocities well in excess of 20-feet per second, inadequate thickness of concrete lining and excessively steep (1 to 1) channel side slopes.

Colorado Springs drainage design criteria have become more sophisticated and conservative since completion of the 1976 Peterson Field Master Drainage Report. Present (1984) City of Colorado Springs drainage design criteria used in this study are presented in Appendix A.

7. MASTER PLAN RECOMMENDATIONS

Elements of the recommended drainage Master Plan are shown on the attached drawing and are listed in Table 4.

Peterson Field storm water detention ponds #1 and #2 have approximately twice the storage capacity of the detention ponds recommended in the 1976 Master Drainage Report.

These existing detention ponds result in future fully developed peak flood flow less than or equal to the peak flood flows estimated in the 1976 Basin Master Drainage Report. The existing major drainageway improvements between the basin outfall and the west side of Hancock Expressway are adequate to convey presently anticipated future fully developed design flood flows.

Concrete channels are recommended to provide durable improvements which minimize the area within the basin committed to drainage improvements. These channels were sized based on a maximum allowable average flow velocity of twenty feet per second with freeboard of at least 25 percent of design depth of flow. Drop structures will probably be required in most master planned channels to limit average flow velocities to twenty feet per second. The location and height of these drop structures are to be determined during final design.

Required secondary drainage improvements within Peterson Field proper are presented in the 1973 Peterson Field Drainage Report prepared by R. Keith Hook and Associates. Construction of drainage facilities within Peterson Field proper is the sole responsibility of the Airport.

Drainage facilities should be provided along the west side of Peterson Field to intercept and convey storm runoff to the main stem. These drainage improvements are the sole responsibility of the Airport.

The proposed secondary channel along the east side of planned Powers Boulevard is to be constructed within the 210 foot wide roadway right-of-way.

Storm runoff intercepted by the proposed channel along the east side of planned Powers Boulevard should join the main stem west of planned Powers Boulevard; that is separate crossing should be provided under planned Powers Boulevard for storm runoff intercepted along the east side of Powers Boulevard due to the uncertainties and possible adverse effects of combining high velocity flows of the same order of magnitude of near right angles.

Guardrail is recommended along planned Powers Boulevard and Hancock Expressway in conjunction with the planned major and secondary channels along these roadways.

Maintenance access to all drainage facilities is required. A 12 foot wide maintenance access road is required along all channels unless located adjacent to and parallel to roadways. Planned channels along Hancock Expressway (extended) and planned Powers Boulevard do not require a 12 foot maintenance access road as they can be accessed from the adjacent roadways.

Because all of the concrete lined channels proposed herein are supercritical, planned roadway crossing should be carefully designed to assure that backwater associated with such a constriction does not result in upstream flow depths greater than critical depth which would result in a hydraulic jump.

A storm water detention facility is not required within the planned Broadview Business Park Site because the existing Peterson Field storm water detention ponds #1 and #2 have twice the storage capacity of the master planned storm water detention ponds recommended in the 1976 report. Our analysis indicates that the 100-year future fully developed peak flood flow on the east side of Powers Boulevard (given the existing Peterson Field storm water detention ponds #1 and #2) (2615 cfs) is less than the 1976 master planned 100-year peak flow rate (3590 cfs).

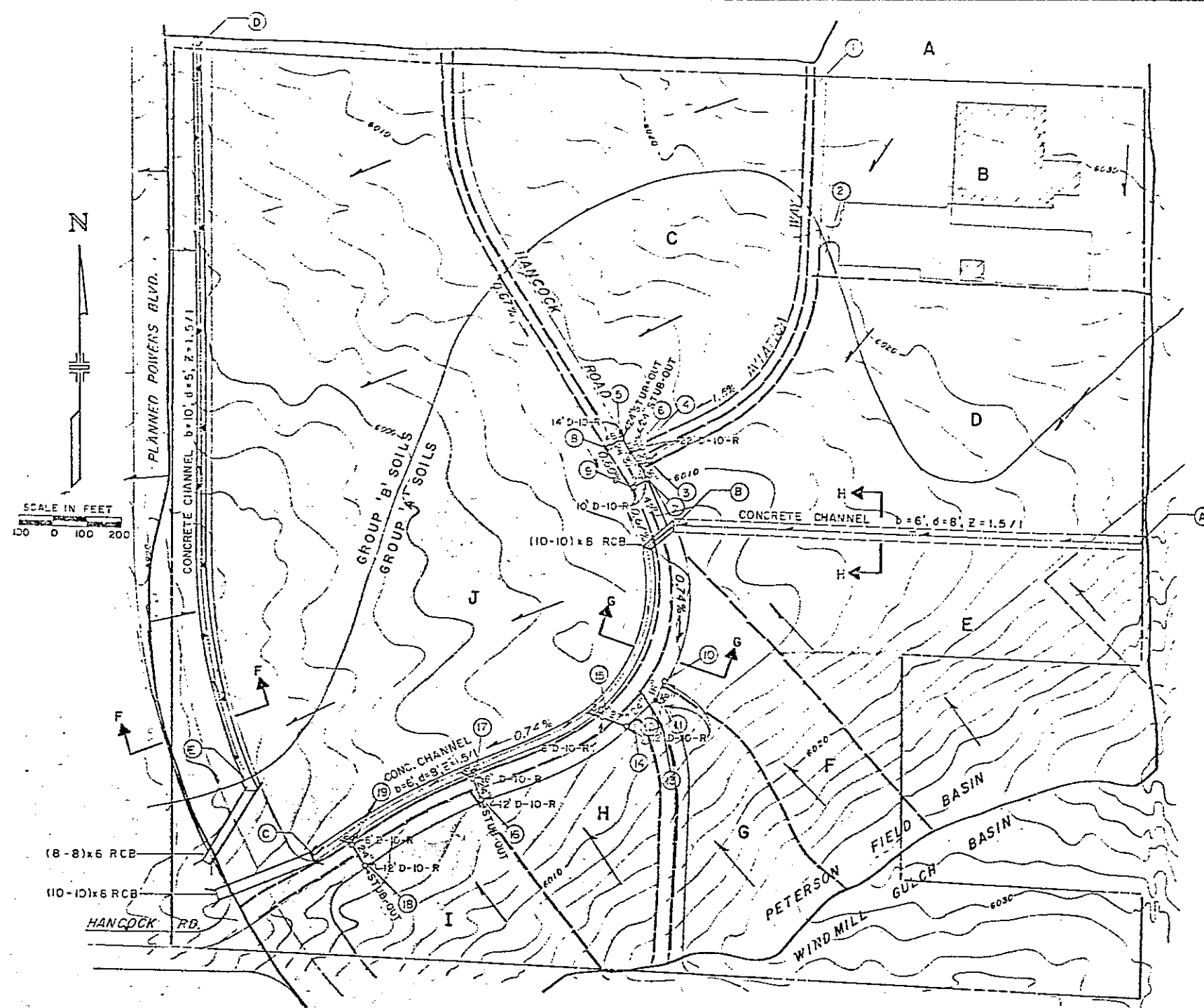
Additional major detention facilities within Peterson Field to reduce the cost of required drainage improvements west of Peterson Field are economically unwarranted (Appendix B for information).

On August 23, 1984, URS met with the Airport Advisory Commission and received the Commission's approval to abandon the 1976 master planned storm water detention area proposed immediately east of planned Powers Boulevard. The Commission's approval was granted based on the following information:

- (a) Existing Peterson Field Detention Ponds #1 and #2 reduce the future fully developed peak 100-year storm runoff west of Powers Boulevard to a level below that proposed in the 1976 Report.
- (b) The storm drainage facilities identified in the drainage Master Plan are adequate to convey future fully developed 100-year peak flood flows without having to provide additional storm water detention within Peterson Field proper.
- (c) Airport operators are solely responsible for the construction of any and all drainage storm drainage improvements required within Peterson Field proper.

No additional major storm water detention facilities are required or recommended within Peterson Field Basin as part of this Basin Master Plan Report.

Presently anticipated reimbursable storm drainage improvements within the planned Broadview Business Park site are shown in Figure 4. Drainage facilities in addition to those specifically identified in this Drainage Master Plan will be required in conjunction with future development of the basin. These additional non-specified drainage facilities will consist of minor drainage facilities such as inlets, manholes, storm sewer conduits and small open channels. Actual costs for these additional drainage facilities cannot be estimated without detailed site specific development plans. A line item cost allowance was however included in the Drainage Master Plan cost estimate for these additional non-specified drainage facilities. The magnitude of this line item cost allowance was estimated based on consideration of projected land use, topography and associated design storm runoff.



Drainage improvement costs within Peterson Field proper were not included in determining basin fee; therefore, any increases or decreases in drainage facility costs within the air field will not affect the basin fee.

8. ESTIMATED MASTER PLAN COSTS

1984 Master Plan Costs were estimated using the unit construction costs presented in Table 5. Estimated 1984 Master Plan Costs are presented in Table 4. Each of the estimated line item costs presented in Table 4 has been multiplied by a factor of 1.15 to provide a 15 percent allowance for engineering and contingency. Table 4 includes reimbursable storm drainage improvement costs associated with planned Broadview Business Park in addition to guardrail costs along Hancock Boulevard (extended) between Chelton and planned Airport Road, along planned Powers Boulevard between Hancock and 500 feet south of Fountain Boulevard. A detailed summary of reimbursable storm drainage improvement costs associated with planned Broadview Business Park is presented in Table 6.

TABLE 4 - RECOMMENDED MASTER PLAN
PETERSON FIELD BASIN
Colorado Springs, Colorado
ESTIMATED CONCEPTIONAL DESIGN IMPROVEMENT COSTS

URS

1	2	3	4	5	6	7	8
REACH OR DESIGN POINT	DESIGN DIS- CHARGE (cfs)	LENGTH (feet)	SLOPE (%)	IMPROVEMENT Trapezoidal Conc Channel b x d x L RCB (w-w) x d x L	ESTIMATED 1984 CONSTRUCTION COSTS ***		
					AIRPORT (\$)	DRAINAGE FEE (\$)	BRIDGE FEE (\$)
		80	1.00	60" DIA RCP AT HWY 94		11,600	
1-2	1240	3670	1.10	8 x 5.5 x 3600		322,100	
	1240	120		12 x 6 RCB x 120	MARKSHEFFEL RD.		92,600
2-3	2540	3400	0.80	22 x 5.5 x 3400	438,000		
3-4	3250 *			CONSTRUCTED			
4-5	1220	7300	1.20	7 x 6 x 7300	669,700		
5	1220	650	1.00	(8-8) x 6 x 650 RCB	464,400		
5-6	1220	1275	0.80	9 x 6 x 1275	124,100		
6-6	1800	1450	1.20	6 x 8 x 1450		158,300	
6'	1800	120	1.00	(10-10) x 8 x 120 RCB	BROADVIEW BUS. PARK	133,400	
6'-7	1800	1200	1.20	6 x 8 x 1200		131,000	
		1200		GUARDRAIL (TYPE 3)		35,200	
				SEE TABLE 7	BROADVIEW BUS. PARK	123,300	
7	1130	320	1.00	(8-8) x 6 x 320 RCB	POWERS BLVD.		211,300
7	1800	300	1.00	(10-10) x 8 x 300 RCB	POWERS BLVD.		276,700
7-8	2700	2700	1.60	14 x 8 x 2700		355,500	
		2700		GUARDRAIL (TYPE 3)		79,200	
		2700	1.00	(12-12) x 8 x 140 RCB	HANCOCK EXPRESSWAY		175,500
		2700	1.00	(12-12) x 8 x 140 RCB	HANCOCK EXPRESSWAY		175,500
8-9J	3160	1000	0.90	18 x 8 x 1000		142,900	
20-21	273 **	1430	1.30	4 x 3.5 x 1430		82,900	
21-22	900	2700	1.10	7 x 5 x 2700		220,300	
		2450	1.10	4 x 3.5 x 2450		142,000	
		2700		GUARDRAIL (TYPE 3)		79,200	
22'	900	80	1.00	12 x 5 x 80 RCB	ASTROZON BLVD.		54,100
22-23	1130	3600	1.00	10 x 5 x 3600		324,100	
		3600		GUARDRAIL (TYPE 3)		105,600	
30-31	105 **	2000	1.30	3 x 3 x 2000		100,200	
33	850	140	1.00	10 x 5 x 140 RCB	HANCOCK EXPRESSWAY		87,100
		110	1.00	8 x 6 x 110		8,300	
40-41	550	600	1.40	6 x 4 x 600		41,200	
NON-SPECIFIED DRAINAGE IMPROVEMENTS					326,732	473,268	
SUBTOTAL						3,069,568	
COST TO PREPARE THIS MASTER PLAN						27,200	
REIMBURSIBLE DRAINAGE COSTS OWED AS OF SEPT. 1984						1,722,728	
BASIN FUND BALANCE AS OF SEPT. 1984						(88,288)	
TOTAL ESTIMATED COSTS					\$2,022,932	\$4,731,208	\$1,072,800

* 1976 Master Drainage Report

** 50-year Design Criteria

TABLE 5
1984 UNIT CONSTRUCTION COSTS
PETERSON FIELD BASIN
CITY OF COLORADO SPRINGS, COLORADO

<u>Description</u>	<u>Unit Construction Cost</u>
Excavation	\$ 1.50/CY
Embankment (C.I.P.)	\$ 2.50/CY
Structure Excavation	\$ 9.00/CY
Structure Backfill	\$ 12.00/CY
Structure Concrete	\$ 200.00/CY
Reinforcing Steel	\$ 0.50/lb
72" Chain Link Security	
Fence	\$ 6.50/SY LF?
Concrete Channel	\$ 22.00/SY
(inc. channel excav.)	
Guardrail (Type 3)	\$ 25.50/L.F.

TABLE 6

REIMBURSABLE LOCAL STORM DRAINAGE IMPROVEMENTS

PLANNED BROADVIEW BUSINESS PARK

COLORADO SPRINGS, COLORADO

(1) DESCRIPTION	(2) QUANTITY	(3) UNIT COST	(4) UNIT COST
6' D-10-R	3 ea	\$ 1,800	\$ 5,400
10' D-10-R	2 ea	2,700	5,400
12' D-10-R	5 ea	3,000	15,000
14' D-10-R	2 ea	3,500	7,000
22' D-10-R	2 ea	5,500	11,000
5' DIA MH	3 ea	2,000	6,000
18" Ø RCP	44+60 = 104 LF	38/LF	4,000
24" Ø RCP	134+300 = 434 LF	51/LF	22,100
27" Ø RCP	___ 140 = 140 LF	57/LF	8,000
30" Ø RCP	70+28 = 98 LF	63/LF	6,200
36" Ø RCP	60+-- = 60 LF	76/LF	4,600
42" Ø RCP	--- 140 = 140 LF	89/LF	<u>12,500</u>

SUB TOTAL \$107,200

15% ENGINEERING AND CONTINGENCY 16,100

TOTAL 123,300

*How did it get
from 100K to 110K?*

9. BASIN FEE DETERMINATIONS

9.1 DRAINAGE FEE

The total cost of master planned storm drainage improvements used in computing the recommended revised drainage fee did not include drainage improvements within Peterson Field proper nor was this area included in determining the unplatted developable acreage within the basin. All drainage improvements within Peterson Field proper are to be funded solely by the Airport.

As of September 1984 reimbursable drainage improvement costs owed to developers and the City of Colorado Springs, Colorado, minus basin fund balance, totaled \$1,634,440 according to records obtained from the City of Colorado Springs Department of Public Works.

Presently there are approximately 1310 acres of unplatted developable acreage within the basin as estimated from the El Paso County Assessors Maps. The recommended revised drainage fee presented herein was computed by dividing the sum of estimated costs to complete the master planned storm drainage system (\$3,069,600) plus the net reimbursable drainage costs within the basin to date

(\$1,634,440) plus the estimated cost to prepare this 1984 Drainage Master Plan Update Report (\$27,200) by the total estimated unplatted developable acreage within the basin.

Estimated cost to complete master planned storm drainage improvements \$3,069,600

Net reimbursable storm drainage costs to date			
			+\$1,634,440
Cost to prepare this 1984 Master Plan		+\$	27,200
	TOTAL	=	\$4,731,208
Number of developable acres in the basin			1,310
Peterson Field Drainage Fee =		\$	3,612/acre

9.2 BRIDGE FEE

The City has designated Marksheffel Road, planned Powers Boulevard, Hancock Expressway, and Astrozon Boulevard (extended) as arterial roadways subject to the City's Arterial Roadway Bridge Ordinance. Under this ordinance the City is obligated to pay for that portion of arterial roadway bridge/structure greater than 68 feet as measured perpendicular to roadway centerline. In addition, the City is obligated to contribute to the Basin Bridge Fund in direct proportion to the ratio of presently developed acreage to total acreage within the basin. Computations associated with determining the recommended revised Bridge Fee are presented in Table 7 together with the estimated City/Developer cost splits for each remaining arterial roadway crossing.

URS NO. 4125 DATE 9/11/84
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TABLE 7 - BRIDGE FEE COMPUTATIONS
PETERSON FIELD BASIN
COLORADO SPRINGS, COLORADO

1	2	3	4	5	6	7	8	9	10
DESIGN POINT	LOCATION	RECOMMENDED IMPROVEMENT (W-W) XDXL	1984 COST INCLUDING 15% ENGINEERING & CONTINGENCY	CULVERT SKEW ANGLE	LENGTH GREATER THAN 68 FT.	PERCENT GREATER THAN 68 FT.	CITY PARTICIPATION FOR LENGTH GREATER THAN 68 FT.	BRIDGE FEE	
								CITY	DEVELOPER
2	MARKSHEFFEL RD.	12X6X120 RCB	\$ 92,600	45	24	20.0	18,500	33,500	40,600
7	POWERS BLVD.	(8-8)X6X320 RCB	211,300	45	223	69.7	147,300	29,000	135,000
7	POWERS BLVD.	(10-10)X8X300 RCB	276,700	90	232	77.3	213,900	28,400	34,400
8	HANCOCK EXP.	(12-12)X8X140 RCB	175,500	90	72	51.4	90,200	38,600	46,700
7-8	HANCOCK EXP.	(12-12)X8X140 RCB	175,500	45	44	31.3	54,900	54,600	66,000
22	ASTROZON BLVD.	(12X5)X80 RCB	54,100	90	12	15.0	8,100	20,800	25,200
33	HANCOCK EXP.	10X5X140 RCB	<u>87,100</u>	66	66	47.1	<u>41,000</u>	<u>20,900</u>	<u>25,200</u>
<u>TOTALS</u>			1,072,800				573,900	225,800	273,100

NOTES:

- COLUMN 9 = (COLUMN 4 - COLUMN 8) $\left[\frac{\text{PRESENTLY DEVELOPED AREA}}{\text{TOTAL BASIN AREA EXCLUSIVE OF PETERSON FIELD}} \right]$

$\left[\frac{\text{PRESENTLY DEVELOPED AREA}}{\text{TOTAL BASIN AREA EXCLUSIVE OF PETERSON FIELD}} \right] = \frac{1082}{2392} = 0.452$
- COLUMN 10 = (COLUMN 4 - COLUMN 8) - COLUMN 9
- BASIN BRIDGE FEE = $\frac{1,072,800 - 573,900}{2392} = \$209/\text{ACRE.}$

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APPENDIX A: DESIGN CRITERIA

A.1 CONCRETE LINED CHANNELS

Maximum flow velocity of 20 feet per second or special construction details

Freeboard = 25% normal depth of flow or 1 foot, whichever is greater

Provide two foot lip above concrete lining

n concrete = 0.015

Channel side slopes of 1 to 1 (1.5 to 1 preferred)

6" thick concrete bottom if channel bottom width is greater than 6 feet wide

4" thick concrete side slopes for average velocity less than 20 ft/sec

3 foot deep cut off walls at 200 foot intervals along channel

Doweled expansion joints every 100 feet

Contraction joints on 10 foot centers

12 foot wide maintenance access road.

A.2 REINFORCED CONCRETE BOX CULVERTS

Reinforced Concrete Box (RCB) culverts are presented herein for all drainageway crossings. The merits of bridge type alternates should be considered at each crossing during final design.

The concrete lined channels proposed herein are supercritical having design Froude Numbers characteristically on the order of 2.0. Theoretically no backwater is produced by a constriction or obstruction in a supercritical channel. Constrictions and obstructions in a supercritical channel, however, typically result in the water surface "humping up" immediately above and within the constricted section. Backwater height due to constriction in a supercritical channel is directly proportional to normal depth of flow. Constricted or obstructed roadway crossings on supercritical channels should be carefully designed to assure that culvert backwater does not result in an upstream depth of flow greater than critical depth which could result in a hydraulic jump with possible spilling of storm runoff from the channel. Ample vertical clearance or freeboard should be provided at all supercritical roadway crossings due to the hazards associated with the inadvertent formation of a hydraulic jump.

Backwater caused by a multi-cell concrete box culvert (constriction and obstruction of the flow) on a high velocity, supercritical trapezoidal concrete lined channel cannot be readily determined by theory. Experimental data for these conditions are scarce. It seems reasonable, from theory, to expect the water surface elevation immediately upstream of the culvert web walls to rise due to stagnation of the flow. The leading edges of culvert web walls should be shaped to minimize the extent of stagnation. Such shaping is especially important on high velocity channels due to the potentially large increase in stage between normal water surface elevation and the energy guideline.

Similarly, the design and construction of expansion and contraction joints and the adequate placement and spacing of weep holes are important in a high velocity concrete lined channel due to the possibility of stagnation of the flow at offset joints and the possible formation of unacceptable uplift pressures beneath the concrete lining which, if not relieved, can lead to failure of the concrete lining.

Hydraulic losses associated with high velocity, supercritical multi-cell concrete box culverts are thought to be largely comprised of pier or web wall losses caused by stagnation and separation of the flow at the culvert

web walls. Expansion and contraction losses are thought to be relatively minor in comparison because extremely large changes in flow velocity between the concrete lined channel and the proposed box culverts are not expected.

A.3 STORM WATER DETENTION

Potential benefits associated with storm water detention include the following:

- Reduction in size and corresponding cost of required downstream drainage improvements.

- Reduced drainageway maintenance costs.

- Borrow material available for construction.

Potential disadvantages associated with storm water detention include the following:

- Detention pond operation and maintenance costs.

- Long lead time if review by the State Engineer's Office is required.

- Liability for flood damages in the event of embankment failure due to negligence.

- Increased potential hazards to aircraft operation.

Colorado State Law (CRS 37-87-105) requires review and approval by the State Engineer of all dam and reservoir plans involving the following:

- A reservoir storing more than 100 acre-feet of water above the natural ground surface.

A dam having a high water surface area in excess of 20 acres.

A dam having a height greater than ten feet above the natural ground surface.

We presently understand the concerns of municipal air field personnel regarding the construction of storm water detention on air field property to be as follows:

Who pays for construction of storm water detention facilities.

Who pays for operation and maintenance of storm water detention facilities.

Who accepts potential liability for damages associated with potential hazards to aircraft operation.

Much of the land at the municipal air field was acquired using funds from the Aviation User Trust Fund which stipulates that land be used for aviation purposes.

We are given to understand that all construction activities within the safety area of an active runway (250' from centerline) are strictly controlled and that there may be limitations associated with operation of high profile construction equipment such as cranes and backhoes outside the safety area. Operational restrictions on high profile construction equipment must be identified on a case by case basis.

APPENDIX B: ADDITIONAL DETENTION ANALYSIS
FOR INFORMATION ONLY

Potential advantages and disadvantages of additional storm water detention facilities within Peterson Field were investigated during development of the drainage master plan. Storm water detention is economically justified if the associated reduction in size and cost of downstream drainage and bridge improvements exceeds the cost of constructing and maintaining the detention facility.

Detailed reservoir routing calculations were not performed due to the conceptual and exploratory nature of this analysis. The U.S. Soil Conservation Service's Chart Method of evaluating the impact of detention storage on peak flow rates was used to estimate peak flow rates for several storage volumes. Estimated 100-year design point peak flood flow rates for 1 to 150 acre-feet of additional detention storage volume within Peterson Field are presented in Table B-1 in addition to peak flood flow rates obtained from the 1974 and 1976 Reports for comparison.

URS NO. 4125 DATE 8/6/84
CLIENT: CRESTONE DEVELOPMENT CORPORATION

TABLE B-1
PEAK FLOOD FLOWS WITH ADDITIONAL DETENTION
PETERSON FIELD BASIN
COLORADO SPRINGS, COLORADO

1	2	3	4	5	6*	7**	8***	9***	10***	11***
100-YEAR FUTURE, FULLY DEVELOPED FLOOD FLOWS (CFS)										
CORRESPONDING DESIGN POINTS		LENGTH BETWEEN DESIGN POINTS (FEET)	DRAINAGE AREA (ACRES)	COMPOSITE RUNOFF CURVE NUMBER, CN	1974 REPORT	1976 REPORT	1984 STUDY			
					300 ACRE FEET PROPOSED	232 ACRE FEET PROPOSED	MASTER PLAN	ALTERNATIVE 1 PROPOSED	ALTERNATIVE 2 PROPOSED	ALTERNATIVE 3 PROPOSED
FIGURE 1	FIGURE 2						ACRE FEET EXISTING 456 ADDITIONAL 0 456	ACRE FEET EXISTING 456 ADDITIONAL 50 506	ACRE FEET EXISTING 456 ADDITIONAL 100 556	ACRE FEET EXISTING 456 ADDITIONAL 150 606
1974	1984									
1976										
1984										
5	20	NA	369	93	578	2390	1220	330	30	NA
6	22	NA	1372	78	1999	3090	1635	1290	700	326
23	23	NA	460	96	1242	1100	1130	1130	1130	1130
7E	24E	2265	1492	80	NA	NA	1800	1630	880	500
8	-	2750	2064	85	2183	3590	2694	2497	1907	1533
9	-	1740	2410	86	2374	3660	3155	2958	2368	1994
10	0	1890	2810	88	NA	4080	3741	3544	2954	2580
11	-	1460	2877	88	NA	4113	3753	3556	2966	2592

*PETERSON FIELD DRAINAGE BASIN MASTER PLAN NIPQ 1974.
**PETERSON FIELD MASTER DRAINAGE REPORT, CITY OF COLORADO SPRINGS, 1976.
***URS 1984.

B-2 and B-3 together with estimated 1984 facility costs. Estimated line item costs presented in Tables B-2 and B-3 include a 15 percent allowance for engineering and contingency. Estimated 1984 drainage and bridge improvement costs for an additional 50 acre-feet and 100 acre-feet of detention storage within Peterson Field are summarized in Table B-4. Estimated 1984 costs for no additional detention storage and estimated costs from the 1976 Report updated to 1984 using a factor of 1.66 are presented in Table B-4 for comparison. An additional 50 acre-feet detention facility within Peterson Field would reduce downstream drainage and bridge improvement costs by \$77,900.

The best hydrologic locations for providing additional storm water detention facilities within Peterson Field are at or near the outfalls of intensively developed sub-basins. Potential detention facility sites within Peterson Field meeting these requirements are located immediately east of the planned Broadview Business Park site (Area Q, Figure 3) and east of runway 17-35 (Design Point 20, Figure 3). The Airport Advisory

TABLE B-2 - 50 ACRE-FEET ADDITIONAL DETENTION ALTERNATIVE
PETERSON FIELD ALTERNATIVE BASIN
Colorado Springs, Colorado
ESTIMATED CONCEPTUAL DESIGN IMPROVEMENT COSTS

URS

1	2	3	4	5	6	7	8
REACH OR DESIGN POINT	DESIGN DIS- CHARGE (cfs)	LENGTH (feet)	SLOPE (%)	IMPROVEMENT Trapezoidal Conc Channel b x d x L RCB (W-W) x d x L	ESTIMATED 1984 CONSTRUCTION COSTS ***		
					AIRPORT (\$)	DRAINAGE FEE (\$)	BRIDGE FEE (\$)
1-2	1240	80 3670	1.00	60" DIA RCP AT HWY 94 8 x 5.5 x 3600		11,600 322,100	
2-3	2540	120 3400	0.80	12 x 6 RCB x 120 22 x 5.5 x 3400	MARKSHEFFEL RD. 438,000		92,600
3-4	3250			CONSTRUCTED			
4-5	1220	7300	1.20	7 x 6 x 7300	669,700		
5	330	650	1.00	2-48" DIA RCP x 650 50 ACRE-FT. DETENTION	150,700		
5-6	330	1275	0.80	4 x 4 x 1275	80,400		
6-6	1430	1450	1.20	4 x 8 x 1450		150,200	
6'	1430	120	1.00	(8-8) x 8 x 120	BROADVIEW BUS. PARK	116,000	
6'-7	1630	1200	1.20	6 x 8 x 1200		131,000	
		1200		GUARDRAIL (TYPE 3) SEE TABLE 7		35,200	
7	1130	320	1.00	(8-8) x 6 x 320 RCB	BROADVIEW BUS. PARK POWERS BLVD.	123,300	211,300
7	1630	300	1.00	(8-8) x 8 x 300 RCB	POWERS BLVD.		245,000
7-8	2500	2700	1.60	12 x 8 x 2700		340,400	
		2700		GUARDRAIL (TYPE 3)		79,200	
	2500	140	1.00	(12-12) x 8 x 140 RCB	HANCOCK EXPRESSWAY		175,500
	2500	140	1.00	(12-12) x 8 x 140 RCB	HANCOCK EXPRESSWAY		175,500
8-9J	2960	1000	0.90	16 x 8 x 1000		137,300	
20-21	273 **	1430	1.30	4 x 3.5 x 1430		82,900	
21-22	900	2700	1.10	7 x 5 x 2700		220,300	
		2450	1.10	4 x 3.5 x 2450		142,000	
		2700		GUARDRAIL (TYPE 3)		79,200	
22'	900	80	1.00	12 x 5 x 80 RCB	ASTROZON BLVD.		54,100
22-23	1130	3600	1.00	10 x 5 x 3600		324,100	
		3600		GUARDRAIL (TYPE 3)		105,600	
30-31	105 **	2000	1.30	3 x 3 x 2000		100,200	
33	850	140	1.00	10 x 5 x 140 RCB	HANCOCK EXPRESSWAY		87,100
		110	1.00	8 x 6 x 110		8,300	
40-41	550	600	1.40	6 x 4 x 600		41,200	
NON-SPECIFIED DRAINAGE IMPROVEMENTS					326,732	473,268	
SUBTOTAL						3,025,368	
COST TO PREPARE THIS MASTER PLAN						27,200	
REIMBURSIBLE DRAINAGE COSTS OWED AS OF SEPT. 1984						1,722,728	
BASIN FUND BALANCE AS OF SEPT. 1984						(88,288)	
TOTAL ESTIMATED COSTS					\$1,665,532	\$4,685,008	\$1,041,100

* 1976 Master Drainage Report

** 50-year Design Criteria

*** Line Item Costs Include 15% Engineering and Contingency

TABLE B-3 - 100 ACRE FEET ADDITIONAL DETENTION ALTERNATIVE
PETERSON FIELD ALTERNATIVE BASIN
Colorado Springs, Colorado
ESTIMATED CONCEPTIONAL DESIGN IMPROVEMENT COSTS

URS

1	2	3	4	5	6	7	8
REACH OR DESIGN POINT	DESIGN DIS- CHARGE (cfs)	LENGTH (feet)	SLOPE (%)	IMPROVEMENT Trapezoidal Conc Channel b x d x L RCB (w-w) x d x L	ESTIMATED 1984 CONSTRUCTION COSTS ***		
					AIRPORT (\$)	DRAINAGE FEE (\$)	BRIDGE FEE (\$)
		80	1.00	60" DIA RCP AT HWY 94		11,600	
1-2	1240	3670	1.10	8 x 5.5 x 3670		322,100	
	1240	120		12 x 6 RCB x 120	MARKSHEFFEL RD.		92,600
2-3	2540	3400	0.80	22 x 5.5 x 3400	438,000		
3-4	3250 *			CONSTRUCTED			
4-5	1220	7300	1.20	7 x 6 x 7300	669,700		
5	330	650	1.00	NO IMPROVEMENT REQUIRED			
				100 ACRE-FT. DETENTION			
5-6	30	1275	0.80	NO IMPROVEMENT REQUIRED			
6-6'	790	1450	1.20	4 x 6 x 1400		116,600	
6'	790	120	1.00	12 x 6 x 120 RCB	BROADVIEW BUS. PARK	69,600	
6'-7	880	1200	1.20	4 x 6 x 1200		100,000	
		1200		GUARDRAIL (TYPE 3)		35,200	
				SEE TABLE 7	BROADVIEW BUS. PARK	123,300	
7	1130	320	1.00	(8-8) x 6 x 320 RCB	POWERS BLVD.		211,300
7	880	300	1.00	12 x 6 x 7 x 300 RCB	POWERS BLVD.		229,400
7-8	1907	2700	1.60	7 x 8 x 2700		302,400	
		2700		GUARDRAIL (TYPE 3)		79,200	
	1907	140	1.00	(10-10) x 8 x 140 RCB	HANCOCK EXPRESSWAY		147,800
	1970	140	1.00	(10-10) x 8 x 140 RCB	HANCOCK EXPRESSWAY		147,800
8-9J	2368	1000	0.90	11 x 8 x 1000		123,300	
20-21	273 **	1430	1.30	4 x 3.5 x 1430		82,900	
21-22	900	2700	1.10	7 x 5 x 2700		220,300	
		2450	1.00	4 x 3.5 x 2450		142,000	
		2700		GUARDRAIL (TYPE 3)		79,200	
22	900	80	1.00	12 x 5 x 80 RCB	ASTROZON BLVD.		54,100
22-23	1128	3600	1.00	10 x 5 x 3600		324,100	
		3600		GUARDRAIL (TYPE 3)		105,600	
30-31	105 **	2000	1.30	3 x 3 x 2000		100,200	
33	850	140	1.00	10 x 5' x 140 RCB	HANCOCK EXPRESSWAY		87,100
		110	1.00	8 x 6 x 110		8,300	
40-41	550	600	1.40	6 x 4 x 600		41,200	
NON-SPECIFIED DRAINAGE IMPROVEMENTS					326,732	473,268	
SUBTOTAL						2,860,368	
COST TO PREPARE THIS MASTER PLAN						27,200	
REIMBURSIBLE DRAINAGE FEES OWED AS OF SEPT. 1984						1,722,728	
BASIN FUND BALANCE AS OF SEPT. 1984						188,288	
TOTAL ESTIMATED COSTS					\$1,434,432	\$4,522,000	\$970,100

* 1976 Master Drainage Report

** 50-year Design Criteria

*** Line Item Costs include 15% Engineering and Contingency

URS NO. 4125 DATE 9/11/84

CLIENT: CRESTONE DEVELOPMENT CORPORATION

T A B L E B-4
SUMMARY OF ESTIMATED COSTS WITH ADDITIONAL DETENTION
PETERSON FIELD BASIN
COLORADO SPRINGS, COLORADO

1	2	3	4	5	6	7	8	9
ESTIMATED IMPROVEMENT COSTS BY FUNDING SOURCES								
SOURCE	COST DATUM	ADDITIONAL DETENTION VOLUME AC-FT	CITY	AIRPORT	DRAINAGE FEE**	BRIDGE FEE	DRAINAGE FEE & BRIDGE FEE**	TOTAL ESTIMATED COSTS**
1976 Master Drainage Report	1976	NA	126,500	995,700	2,320,100	350,000	2,670,100	3,792,300
	1984*	NA	210,100	1,653,000	3,851,000	581,000	4,432,000	6,295,100
1984 Drainage Update	1984	0	0	2,022,932	4,731,208	1,072,800	5,804,008	7,826,940
	1984	50	0	1,665,532	4,685,008	1,041,100	5,726,108	7,391,640
	1984	100	0	1,434,432	4,522,008	970,100	5,492,108	6,926,540

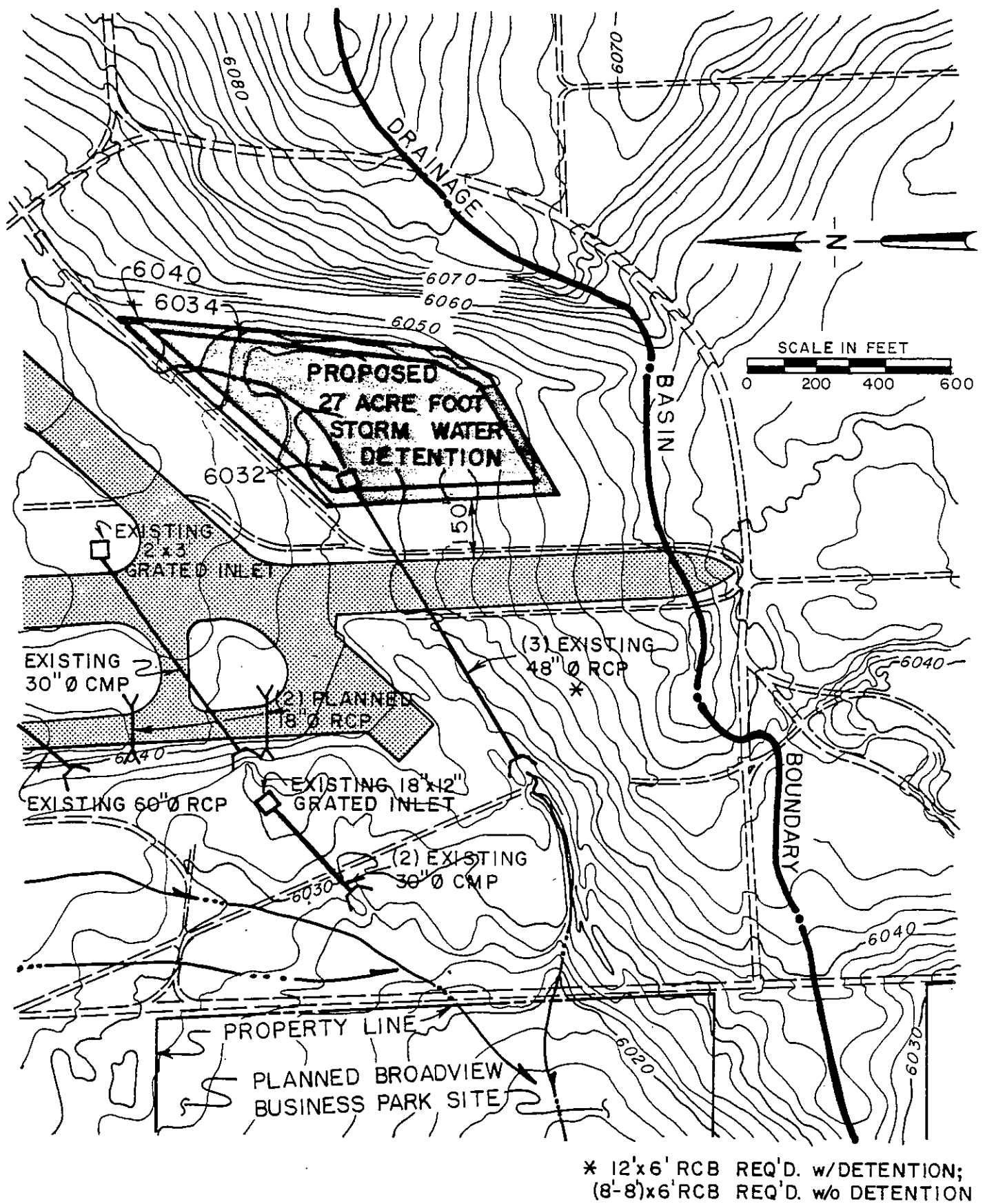
*1984 Cost = 1.66 x 1976 Cost.

**All estimates exclude the cost of storm water detention.

Includes net reimbursible drainage cost of \$1,634,440 as of September 1984.

Commission has indicated that Area Q shown on Figure 3 is planned for future air field facility expansion and is not available as a detention site. The Airport Advisory Commission, however, indicated that the potential detention facility site located east of runway 17-35 (Design Point 20, Figure 3) may be compatible with planned future airport operations. The configuration and topography of the area in the vicinity of Design Point 20, however, are such that the estimated cost to construct a detention facility of sufficient size to significantly reduce the cost of required drainage improvements west of Peterson Field (50 to 100 acre-feet) exceed potential downstream cost savings.

A 27 acre-foot storm water detention facility at Design Point 20 Figure 3 could reduce the size and associated cost of the master planned major drainageway crossing under runway 17-35 from an (8-8)x6 RCB to a 12x6 RBC with an associated cost savings of approximately \$94,000. Construction of a 27 acre-foot detention facility at this location would require approximately 94,000 cubic yards of excavation over an 11-acre area as shown in Figure B-1. Construction of such a detention facility can be economically justified only if a large source of



**27 ACRE-FOOT STORM WATER DETENTION FACILITY
PETERSON FIELD BASIN
COLORADO SPRINGS, COLORADO**

FIGURE B-1

borrow material (94,000 cubic yards) is required in conjunction with the planned relocation of the municipal air terminal and the 11 acre site is available at no cost. All drainage improvement costs within Peterson Field are the sole responsibility of the Airport. Construction of this 27 acre-foot detention facility as part of the planned relocation of the municipal terminal is left to the discretion of the Airport and is not part of the drainage Master Plan.

APPENDIX C: DRAINAGEWAY CROSSINGS

Estimated quantities and costs for both Master planned and Alternative drainageway crossings are presented in Table C-1. Estimated costs presented in Table C-1 exclude engineering and contingency.

URS NO. 4125 DATE 9/11/84
CLIENT: CRESTONE DEVELOPMENT CORPORATION

TABLE C-1
DRAINAGEWAY CROSSINGS
PETERSON FIELD BASIN
COLORADO SPRINGS, COLORADO

1	2	3	4	5	6	7	8	9	10	11	12
LOCATION	QDES (CFS)	IMPROVEMENT	CONCRETE (CY)			STEEL (LB)			STRUCTURE EXCAVATION (CY)	STRUCTURE BACKFILL (CY)	ESTIMATED 1984 CONSTRUCTION COST**
			BARREL	WING WALLS	TOTAL	BARREL	WING WALLS	TOTAL			
MARKSHEFFEL RD.*	1,240	12X6X120 RCB	207.04	53.18	260.22 \$ 52,000	22,314	3,255	25,569 12,800	1,340 12,100	300 3,600	\$ 80,500
BROADVIEW BUS. PK.*	1,800	(10-10)X8X120	291.6	70.70	362.30 \$ 72,600	32,314	5,690	38,000 19,000	2,050 18,500	491 5,900	\$116,000
BROADVIEW BUS. PK.	1,430	(8-8)X8X120	259.10	70.70	329.90 \$ 66,000	25,850	5,690	3,154 15,800	1,700 15,300	320 3,800	\$100,900
BROADVIEW BUS. PK.	790	12X6X120	186.40	7.20	194 \$ 38,800	17,500	3,200	20,520 10,300	950 8,600	229 2,800	\$ 60,500
POWERS BLVD.*	1,130	(8-8)X6X320	564.70	49.22	613.90 \$ 122,800	61,769	3,014	64,783 32,400	2,380 21,400	594 7,100	\$183,700
POWERS BLVD.*	1,800	(10-10)X8X300	719.50	70.70	790.30 \$ 158,200	78,250	5,690	83,940 42,000	3,840 34,600	698 8,400	\$243,200
POWERS BLVD.	1,630	(10-10)X8X300	640.80	70.70	711.50 \$ 142,400	62,930	5,690	68,620 34,300	3,175 28,600	649 7,800	\$213,100
POWERS BLVD.	880	12X6X300	461.40	49.20	510.60 \$ 102,200	42,220	3,020	45,240 22,600	1,854 16,700	483 58,000	\$199,500
ASTROZON BLVD.*	900	12X5X80	119.90	40.40	160.30 \$ 32,200	11,512	2,245	13,757 6,900	646 5,900	156 2,000	\$ 47,000
HANCOCK EXPRESS*	2,700	(12-12)X8X140	422.70	70.70	493.40 \$ 98,800	43,590	5,690	49,280 24,600	2,594 23,400	486 5,800	\$152,600
HANCOCK EXPRESS	1,900	(10-10)X8X140	338.80	70.70	409.50 \$ 82,000	37,450	5,690	43,140 21,600	2,250 20,300	379 4,600	\$128,500
HANCOCK EXPRESS	850	10X5X140	183.00	40.00	223 \$ 44,600	18,500	2,220	20,720 10,400	884 8,000	320 3,800	\$ 66,800

*MASTER PLAN IMPROVEMENT, ALL OTHER STRUCTURES SHOWN HEREIN ARE ASSOCIATED WITH ALTERNATIVES.

**EXCLUDES ENGINEERING AND CONTINGENCY.

DRAINAGE FEE EXCLUSIVE OF AREA IN COUNTY
FOR INFORMATION ONLY

The total land area in the Peterson Field Drainage Basin is not all contained within the City of Colorado Springs. Therefore, as a supplement to the Master Plan Update, a drainage fee can be computed using only the unplatted developable acreage within both the City of Colorado Springs and the drainage basin. This area is equal to 664 acres exclusive of the airport. The total estimated cost of improvements also is reduced by the cost of improvements outside the city limits. These costs are \$11,600 for the 60 inch RCP at Highway 94, \$322,100 for the concrete-lined channel from design point 1 to 2, and \$233,400 in non-specified improvements. Therefore, the total estimated cost of future improvements plus reimbursable drainage costs within the basin to date plus the estimated cost to prepare the 1984 Drainage Master Plan Update Report is \$4,164,108.

Peterson Field Drainage Fee = $\frac{\$4,164,108}{664 \text{ acres}}$ = \$6,271.25/acre