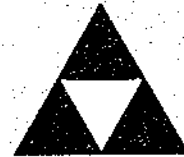


**ORCHARD AVENUE
DRAINAGE BASIN PLANNING STUDY
FOR
CANON CITY, COLORADO**

PREPARED BY:

**GRAEF, ANHALT, SCHLOEMER
& ASSOCIATES INC.
102 EAST PIKES PEAK AVENUE
SUITE 305
COLORADO SPRINGS, CO 80903**

November, 1994
Job No. 94121001.drn



**GRAEF
ANHALT
SCHLOEMER**
and ASSOCIATES

ENGINEERS & SCIENTISTS

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I. INTRODUCTION

A. Contract Authorization

This Orchard Avenue Drainage Basin Planning Study was authorized under the terms of an agreement between the City of Canon City and Graef Anhalt Schloemer and Associates, Inc. This study covers drainage development alternatives within the Orchard Avenue Drainage Basin.

B. Purpose and Scope of Work

The purpose of this study is to develop the most feasible drainage plans for the Orchard Avenue Drainage Basin. The detailed scope of services is as follows:

I. Orchard Avenue Drainage Basin as a whole

- A. Review previous studies, maps and other available information.
- B. Provide additional analysis and/or data which is critical to the project and not currently available, in order to accomplish II.

II. Conceptual Master Plan for Basin

- A. Recommend improvements for the basin.
- B. Prioritize the improvements.
- C. Provide a planning level cost estimate for each improvement.

C. Previous Drainage Reports

There have been two previous drainage studies performed within the Orchard Avenue Drainage Basin. The following is a summary of those reports:

"Preliminary Plan of a Storm Water Management Policy for the Four Major Drainage Basins located in the Northern Portions of Canon City, Colorado" By Great Divide Engineering and Surveying, 1986.

"Report on Storm Drainage Facilities for the City of Canon City, Colorado" By M & I, Inc., 1974.

D. Agency Jurisdictions

The City of Canon City has jurisdiction over the proposed drainage criteria and design requirements. Any proposed improvements or changes to the existing canals within the basins will need to be approved by one of the following canal boards:

- Fruitland Ditch
- Hydraulic Ditch
- Oil Creek Ditch

The US Army Corps of Engineers will have review approval for any work which disturbs existing wetland areas or for any modifications to the Arkansas River.

E. Drainage Criteria

The drainage criteria used in this study was obtained from the City of Canon City. Flow calculations are determined from the TR-20 Computer Program for Project Formulation Hydrology developed by the Soil Conservation Service. The charts used in determining input for the program are contained in the Appendix of this report.

F. Mapping

The Canon City, Colorado, 1:24,000 topographic quadrangle maps prepared by the U.S. Geological Survey were used as the basin map for this project. These maps use 20 feet contour intervals and was photo revised in 1976. The maps were used for the general purposes of basin boundary delineation and for the establishment of principal tributary regions and subbasins within these regions. Recent road additions were added to the maps to reflect current conditions.

The mapping was supplemented with 2 ft contour, 100 ft scale mapping of a portion of the drainage basin. These maps were produced in 1979 by Ponderosa Engineering and used to better delineate the drainage in undeveloped areas.

G. 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.

Aerial photography, taken in March 1994, was utilized to identify current land uses and drainage patterns throughout the Orchard Avenue Drainage Basin.

H. Environmental Considerations

Currently no significant environmentally sensitive areas exist in the basin except for an area adjacent to the Arkansas River. This area will be in its natural state. Any modifications to this area will be designed in such a manner as to create no adverse affects on the wetland area.

II. PROJECT DESCRIPTION

A. Basin Description and Location

The Orchard Avenue Drainage Basin encompasses the central portion of Canon City. It runs from the northeast Canon Basin on the west to the Abbey Drainage Basin on the east and from the Four Mile Creek Drainage Basin on the north and the Arkansas River in the south. It is situated in Township 18S, Range 70W of the 6th PM, Fremont County, Colorado. The basin contains approximately 3.14 Square Miles. A majority of the lands are currently platted, but not yet developed.

The runoff from this basin flows in a southerly direction and crosses U.S. Highway 50 (US 50) in culverts which empties into roadside ditches. The topography varies from mild slope of 1 % in the lower portion of the basin to 3% to 5% in the central portion of the basin. The vegetation consists primarily of native rangeland grasses with some trees and wetland vegetation along portions of the main channel.

B. Major Drainageways and Facilities

The Orchard Avenue Drainage Basin currently has no direct outlet channel which carries the runoff to the Arkansas River. The northern reaches of the basin flow through ranches and newly developed areas and into the existing Hydraulic Ditch (canal) which traverses across the entire basin. The upper channels vary from broad swales with heavy vegetation to well defined channels and roadside ditches with relatively sparse vegetation.

In addition to the Hydraulic Ditch (canal) there are two other canals which also traverse the entire basin. The northern-most canal which crosses the central part of the basin is a relatively small canal known as the Fruitland Ditch. As stated above, the Hydraulic Ditch, which is designed to transport approximately 96 cubic feet per second (CFS), crosses the basin south of Pear Street. The third canal known as the Oil Creek Ditch crosses the basin between US 50 and Arkansas River. Although most basin run-off is tributary to these canals, their capacities are such that larger storm flows will inundate the canals allowing water to flow over the existing canals.

The western portion of the Orchard Avenue Drainage Basin traverses through a broad channel which has its origins in an undeveloped rangeland area which currently contains the Police Firing Range. This upper reach of the basin contains several small natural swales which combine into a single, broad swale as it nears High Street. The channel crosses under High Street through a 50"x 31" corrugated metal pipe (CMP) and continues flowing south where it is joined by two other northerly channels which also crosses High Street via a 30" CMP and a 29"x 18" CMP. These channels cross over the Fruitland Ditch syphon approximately 800 feet north of South Street. The combined flow from approximately 550 acres continues flowing under South Street in a 60" CMP. From South Street to Central Avenue the drainage course is a defined channel which narrows to approximately 4 feet wide prior to crossing Central Avenue through a 48" CMP. The reach between Central Avenue and Pear Street is a mere roadside ditch which is directed into 2-30" CMP's. From this point the flow is directed into the Hydraulic Ditch approximately 600 feet south of Pear Street.

The central subbasins are also drained by natural swales in the upper reaches of the subbasins. As these channels approach developed areas, the broad swales narrow into extremely small developed channels. The reach between Central Avenue and Pear Street must snake between existing houses in a small concrete channel while making two 90 degree bends. The flow from this channel is also intercepted by the Hydraulic Ditch.

The easternmost subbasins flow through natural swales and roadside ditches, crossing Central Avenue and Pear Street in 18" CMP's. This flow appears to turn eastward and flow into the Abbey Channel.

The area south of the Hydraulic Ditch is drained by several north/south streets which all flow to US 50. This major roadway currently acts as a dam causing the storm flow to pond along the roadway until it sheet flows across the pavement. The storm flows which cross the highway and the Denver & Rio Grande Western Railroad continues south along several streets. The street flow is then intercepted by the Oil Creek Ditch. Once that canal overflows, the stormwater will continue as sheet flow into the Arkansas River.

The undersized culverts and lack of defined storm system to carry flow directly to the Arkansas River has added to the threat of frequent, shallow flooding to the residential neighborhoods north of US 50. The Hydraulic Ditch which is approximately 12 feet wide with an average slope of about 0.1% is quickly overwhelmed by most stormflows again directing flows toward the residential streets.

C. Existing Surface Water Improvements

The only significant surface water impoundment is located adjacent to the Arkansas River between 19th Street and Cottonwood Avenue. The existing wetland pond is an old river ox bow formed when the Arkansas River was channeled several years ago. The current ponding area covers approximately 8 acres with direct flow into the river.

III. HYDROLOGIC EVALUATION

A. Basin Hydrology

The hydrologic model used to determine peak flows and volumes throughout the Orchard Avenue Drainage Basin was the TR-20 Computer Program for Project Formulation Hydrology developed by the Soil Conservation Service.

The overall basin was divided into tributary basins and then into smaller subbasins. The subbasins were then numbered 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 considerations.

Peak flows for the 100-year, 50-year and 25-year, 24-hour storms, were calculated and evaluated.

B. Time of Concentration

The time of concentration (Tc) 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 subbasins and added to the initial overland flow time 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 shorter time of concentration.

C. Rainfall

Rainfall amounts for the Orchard Avenue Basin were determined from the National Oceanic and Atmospheric Administration Atlas 2, Precipitation-Frequency Atlas of the Western United States, Volume III- Colorado, 1973.

Precipitation for the 100-year 50-year and 25-year, 24-hour storms were 3.4, 3.05 and 2.75 inches, respectively.

D. Land use

Existing land uses in the Orchard Avenue drainage basin were determined by examining current development plans supplemented with field reconnaissance. Currently most of the development is occurring in the western and southern portion of the basin with the eastern and northern areas remaining in their natural state.

Proposed land use for the area was determined through examination of current development plans and through discussions with Fremont County Planning Department officials and Canon City officials. For design purposes undeveloped areas were assumed to be fully developed using projected densities. 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 is derived from the "Soil Survey of Fremont County Area, Colorado", currently being completed by the USDA Soil Conservation Service. Of the eight soils classifications found within the Orchard Avenue drainage basin, three belong to Hydrologic Soil Group C, and five belong to the Hydrologic Soil Group D (see the Soils Map for location). The following is a table of the soils located within the basin:

TABLE 2
SOILS CLASSIFICATIONS

<u>S.C.S Soils</u> <u>Map Numbering</u>	<u>Soil Classification</u>	<u>Hydrologic</u> <u>Soil Group</u>
58	Limon	C
59	Limon	D
60	Limon	D
61	Limon	C
62	Limon	C
63	Limon	D
71	Midway	D
92	Riverwash	D

F. Runoff Curve Numbers

Runoff Curve Numbers (CN's) were determined for the basin by utilizing soils and land use information described in previous sections. Curve numbers for the undeveloped portions of the basin were prepared based on projected land densities with some agricultural land remaining in its existing rangeland conditions.

IV. HYDRAULIC DESIGN EVALUATION

A. Existing Structure Evaluation

Only the existing structures which transport flows out of major subbasins have been examined in this report. These structures vary from a 12" CMP to 60" CMP. An allowable headwater of 6" below the edge of pavement was utilized to calculate maximum culvert capacities. The existing capacities of these structures were estimated using, primarily, inlet control analysis.

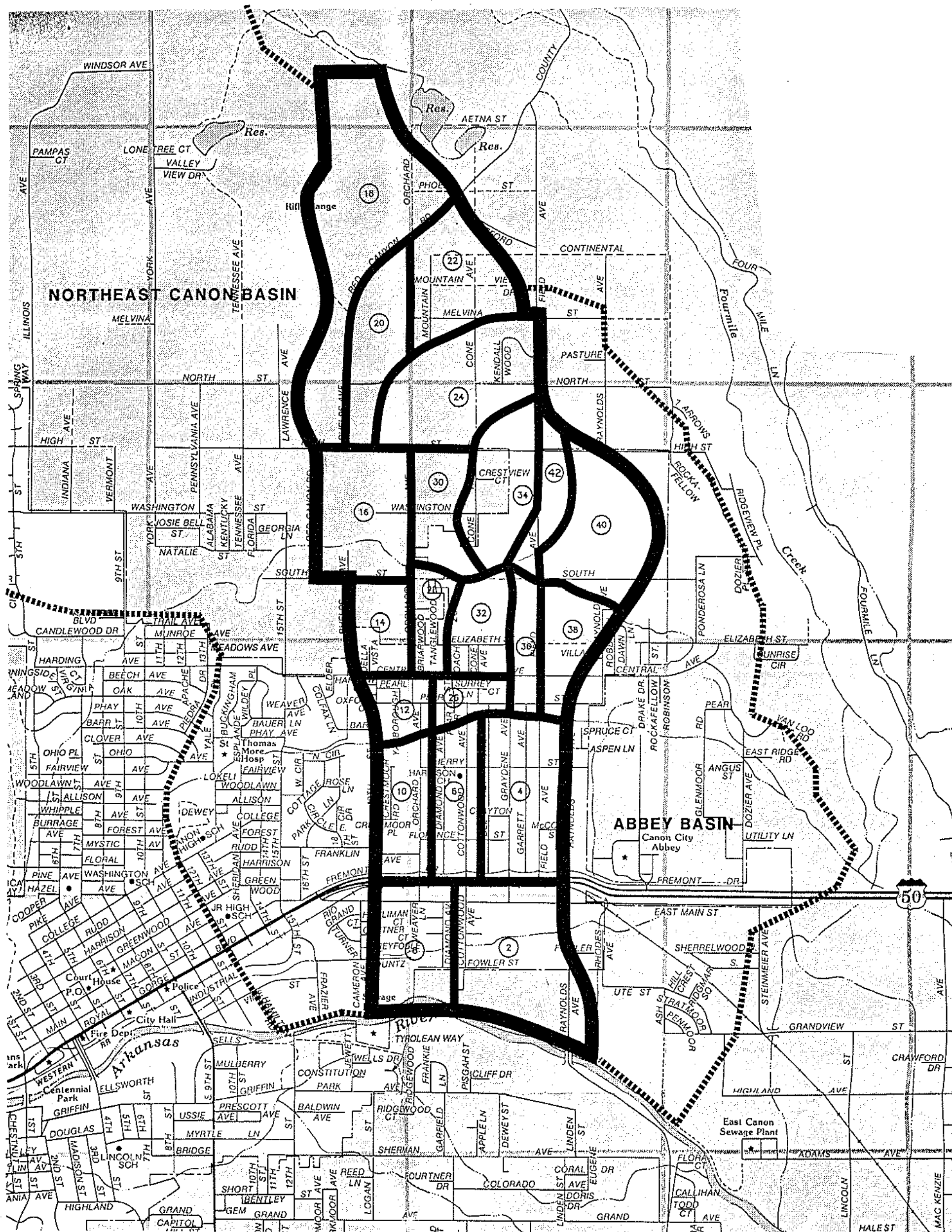
The analysis revealed that a portion of the existing structures throughout the basin are unable to effectively handle the existing 25 year, 24-hour storm without overflowing the roadways. An existing structure evaluation chart was developed to summarize these findings and is included at the end of this section.

B. Existing Drainageway Evaluation

As outlined in the Major Drainageway and Facilities section, most of the major drainage ways within the Orchard Avenue drainage basin are natural, unimproved channels. In the upper reaches of the basin, the channels are typically wide, grassed swales with little or no signs of erosion. The existing capacities of major channel reaches within the basin were estimated using normal depth flow analysis.

C. Environmental Inventory

The only significant environmentally sensitive area within the Orchard Avenue Basin is the wetland pond adjacent to the Arkansas River as described in the Existing Surface Water Improvements Section.



**ORCHARD AVE. DRAINAGE
BASIN PLANNING STUDY**

BASIN MAP

DESIGNED BY:
MAB

DRAWN BY:
JJW

CHECKED BY:
JRW

DATE:
12/2/94

FILE NO:
941210

PREPARED BY:

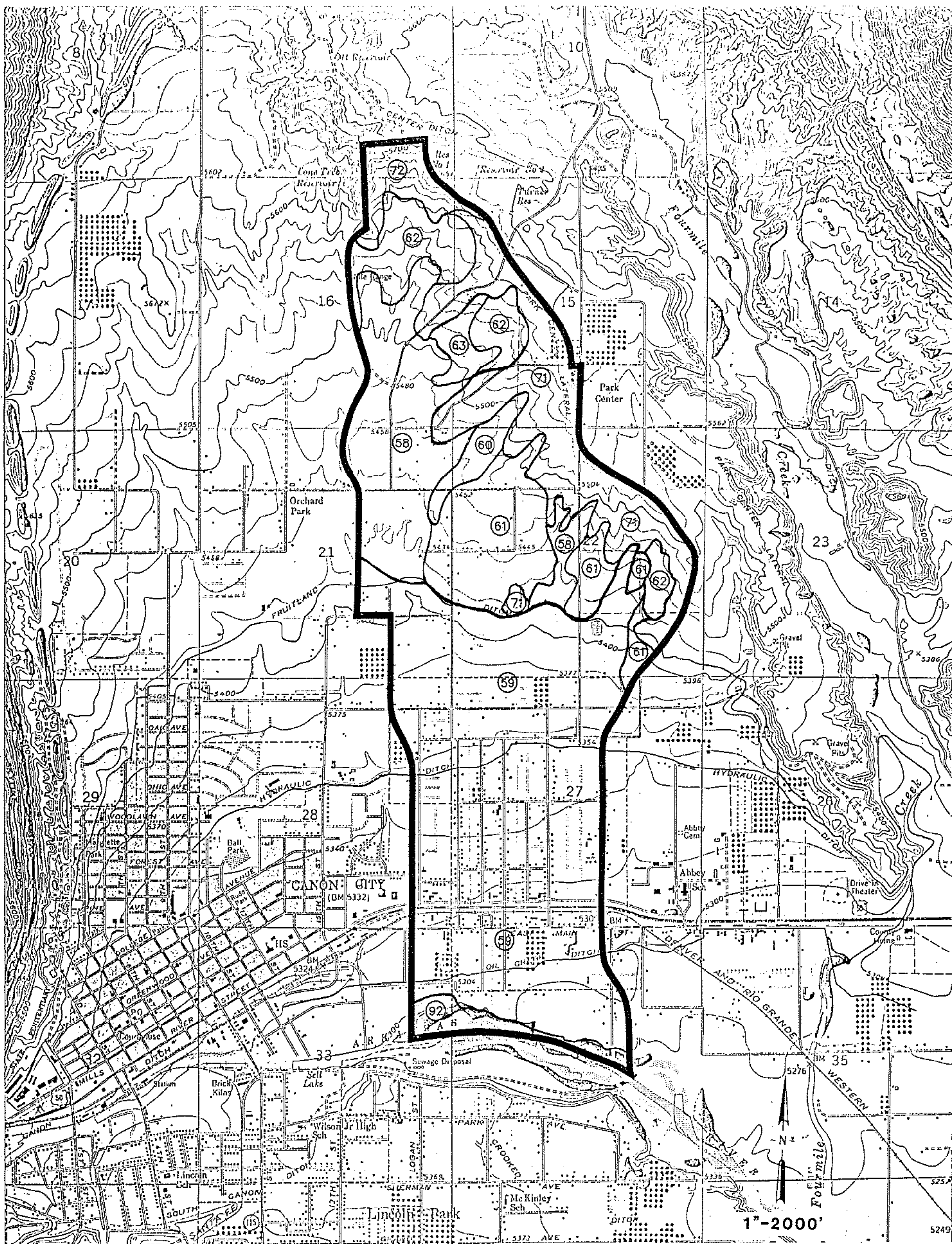


**GRAEF
ANHALT
SCHLOEMER**

and ASSOCIATES

ENGINEERS & SCIENTISTS

102 E. Pikes Peak Ave., Suite 305
Colorado Springs, CO. 80903
(719) 634-6902 TEL.
(719) 634-0660 FAX



SOIL NO. HYDROLOGIC GROUP

58	C
59	D
60	D
61	C
62	C
63	D
71	D
72	D
92	D

ORCHARD AVE. DRAINAGE
BASIN PLANNING STUDY

SOILS MAP

DESIGNED BY:
MAB

DRAWN BY:
JJW

CHECKED BY:
JRW

DATE:
7/20/94

FILE NO:
941210

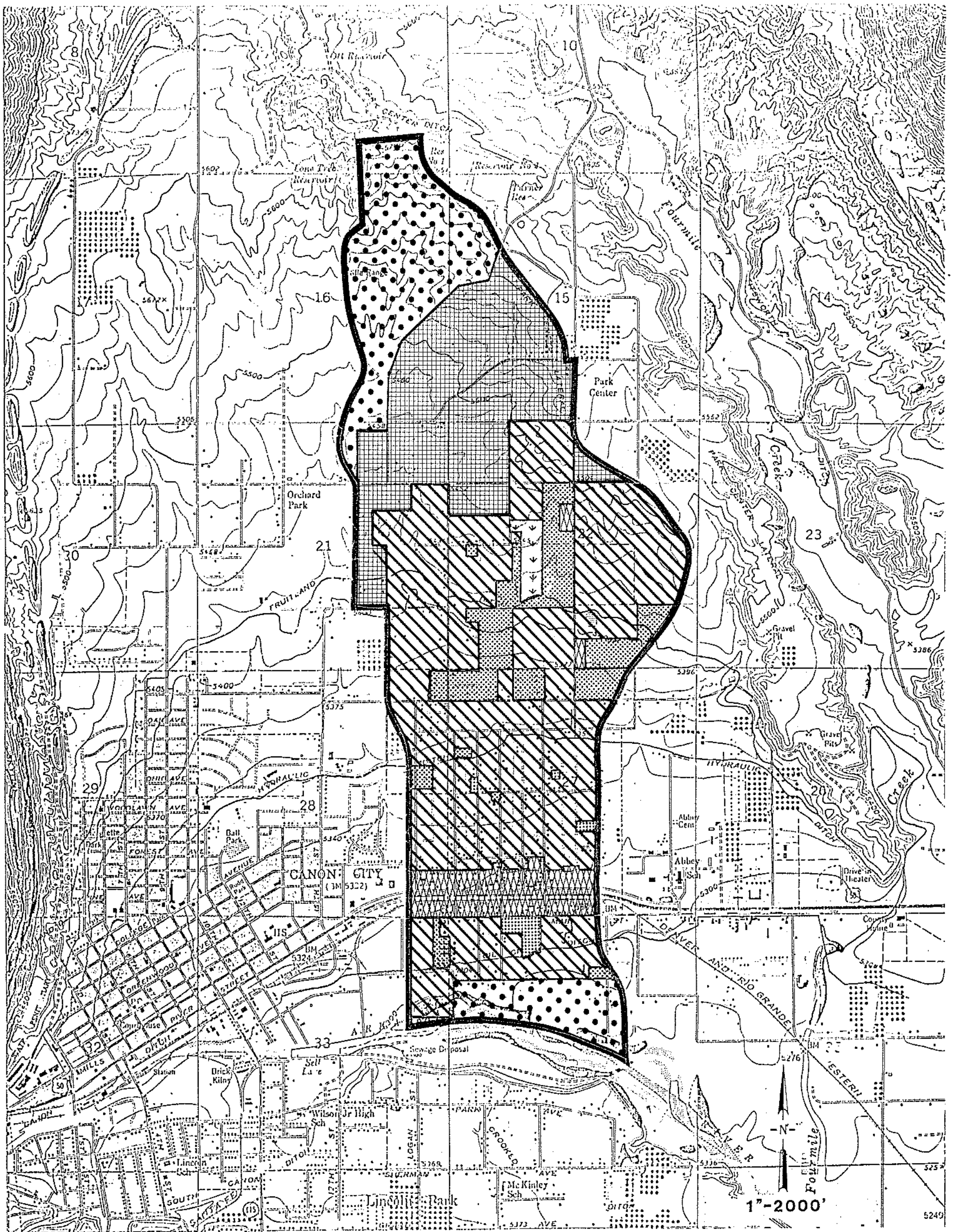
PREPARED BY:



**GRAEF
ANHALT
SCHLOEMER**
and ASSOCIATES

ENGINEERS & SCIENTISTS

102 E. Pikes Peak Ave., Suite 305
Colorado Springs, CO. 80903
(719) 634-6902 TEL.
(719) 634-0660 FAX



LEGEND

	AGRICULTURAL		LIGHT INDUSTRIAL
	ESTATE > 1 AC LOTS		COMMERCIAL
	SINGLE FAM < 6 DU/AC		PARK
	MULTI-FAM		

ORCHARD AVE. DRAINAGE
BASIN PLANNING STUDY

LAND USE MAP

DESIGNED BY:
MAB

DRAWN BY:
JJW

CHECKED BY:
JRW

DATE:
7/20/94

FILE NO:
941210

PREPARED BY:



**GRAEF
ANHALT
SCHLOEMER**

and ASSOCIATES
ENGINEERS & SCIENTISTS

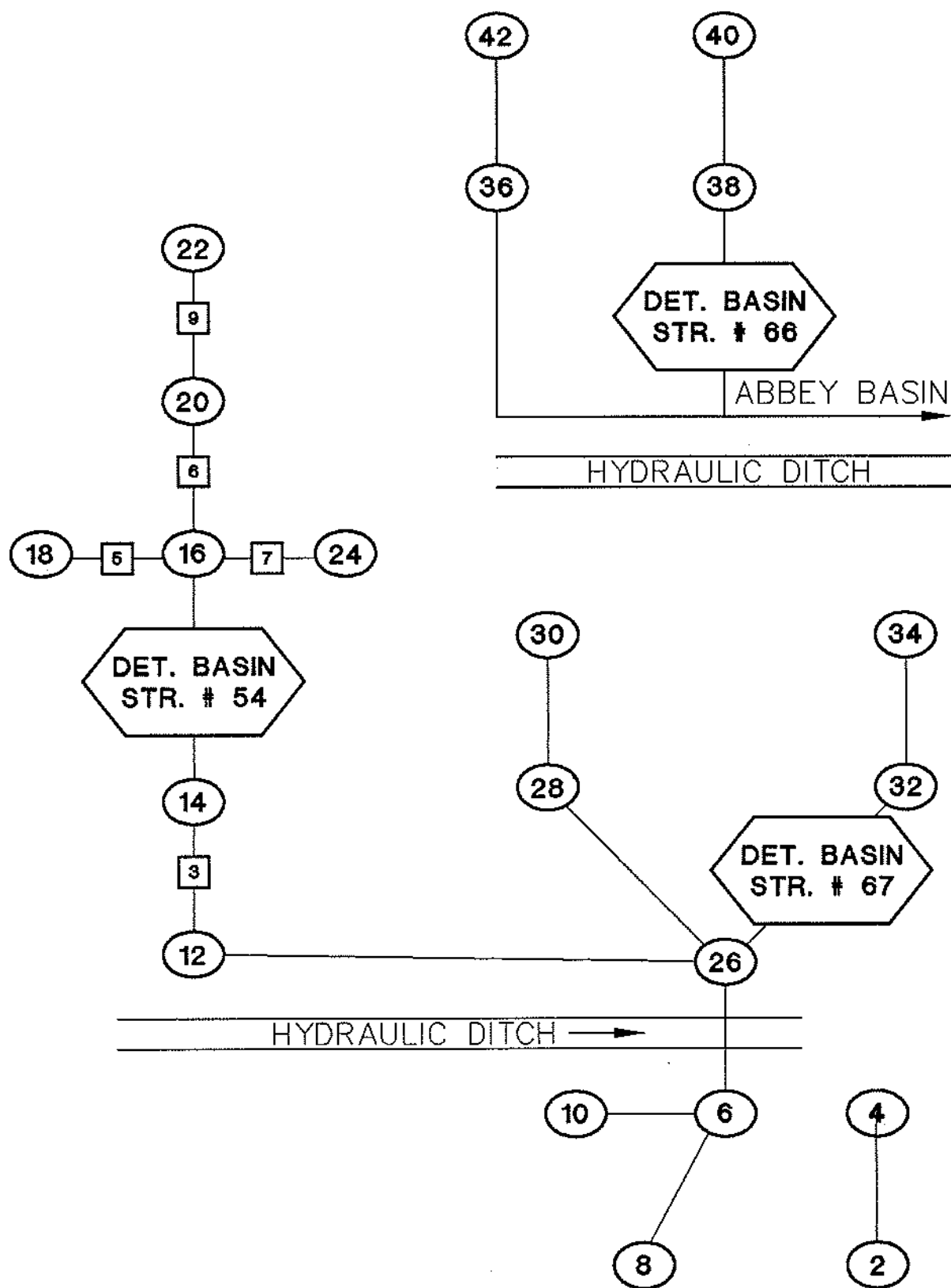
102 E. Pike Peak Ave., Suite 305
Colorado Springs, CO. 80903
(719) 634-6902 TEL.
(719) 634-7560 FAX

ORCHARD AVENUE BASIN
CN CALCULATION

BASIN #	AREA(SM)	LAND USE CN						SOIL TYPE %		EXIST CN	DEV CN	BASIN #
		AGRICULT %	ESTATE %	SING FAM %	MULT-FA %	INDUST %	COMM %	PARK %	% C D			
2	0.271	84 45		87 35	92 10		95 10			100	86.95	2
4	0.226			87 80	92 5		95 15			100	88.45	4
6	0.110			87 80	92 5		95 15			100	88.45	6
8	0.165	84 20		87 60	92 10		95 10			100	87.70	8
10	0.126			87 75	92 10		95 15			100	88.70	10
12	0.068			87 100						100	87.00	12
14	0.092			87 90	92 10					100	87.50	14
16	0.188		79 25	83 50					70	30	83.00	16
18	0.427	79 60	79 10	87 25					70	30	80.50	18
20	0.127	84 30							80	20	80.25	20
22	0.121		79 75						50	50	81.00	22
24	0.222		84 25									
			79 60						50	50	81.00	22
			84 40									
24	0.222		79 25	83 10					25	75	83.10	24
			84 50	87 15								
26	0.063			87 90	92 10					100	87.50	26
28	0.093			87 60	92 40					100	89.00	28
30	0.109		79 25	83 65	90 10				100		82.70	30
32	0.157			87 50	92 50					100	89.50	32
34	0.152			87 20	90 30		94 10	74 25	70	30	84.75	34
				83 15								
36	0.062			87 90	92 10					100	87.50	36
38	0.100			83 10	90 20		95 10		30	70	89.50	38
				87 30	92 30							
40	0.188			83 40	92 10				30	70	85.90	40
				87 50								
42	0.075			87 35	90 20		94 15	74 10	70	30	82.40	42
				83 15								

ORCHARD AVENUE BASIN
TIME OF CONCENTRATION AND CN CALCULATIONS
PROPOSED CONDITIONS

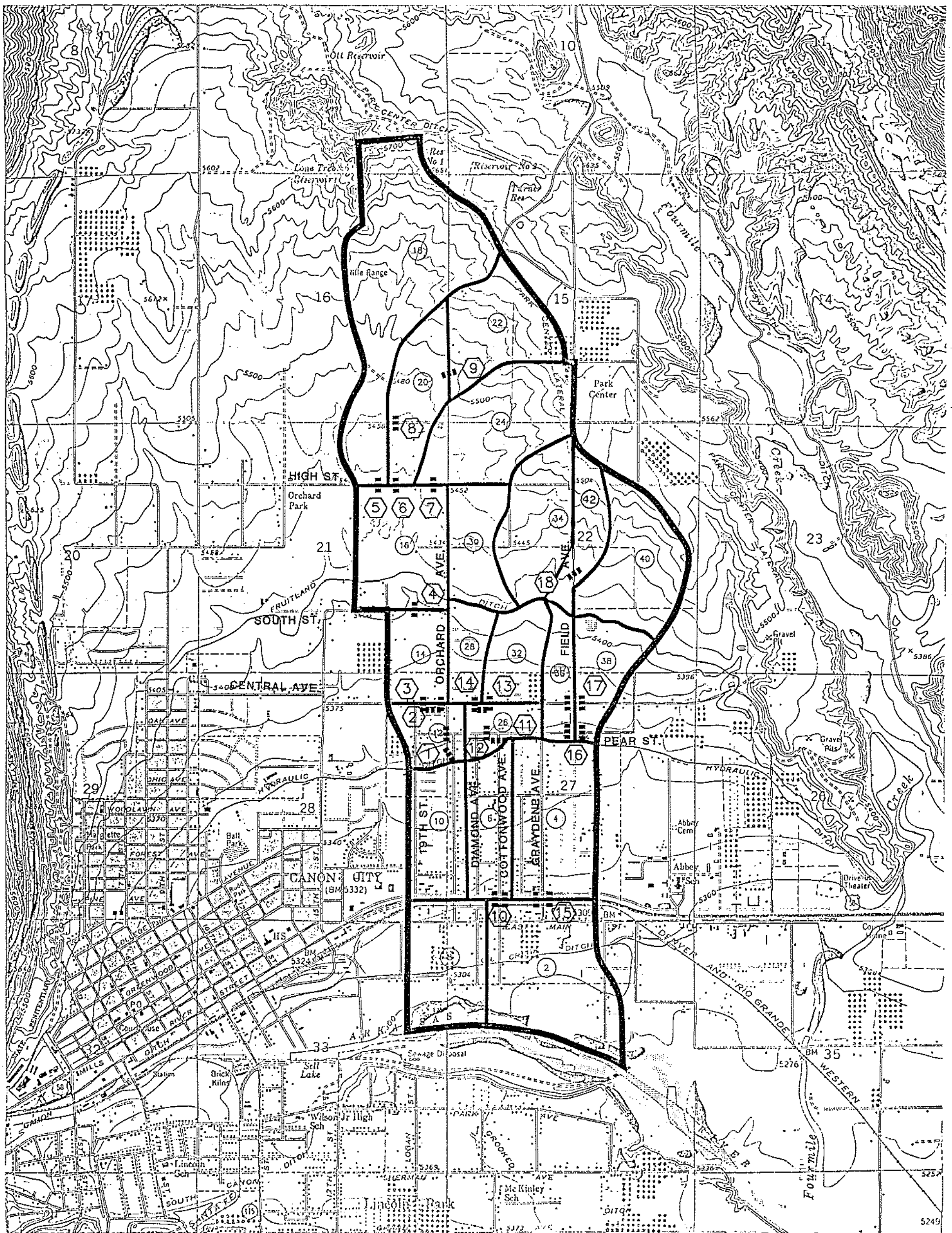
AREA DESIG.	C10 (10 yr)	L (ft)	Initial Tci Slope (%)	ti (min)	L (ft)	Travel Time Slope (%)	V (fps)	Tt (min)	TC (min)	TC (hr)	EXIST CN	DEV CN	AREA DESIG.
2	0.60	300	1.33	14.74	3300	1.33	7.50	7.33	22.07	0.368	86.2	86.95	2
4	0.60	300	0.95	16.47	3500	0.95	7.00	8.33	24.80	0.413	88.15	88.45	4
6	0.60	300	0.99	16.25	3200	0.99	7.10	7.51	23.76	0.396	88.45	88.45	6
8	0.60	300	1.33	14.74	2700	1.33	7.50	6.00	20.74	0.346	86.2	87.7	8
10	0.60	300	1.13	15.55	3000	1.13	7.40	6.76	22.31	0.372	88.7	88.7	10
12	0.60	300	1.00	16.19	1000	1.00	3.50	4.76	20.96	0.349	86.25	87	12
14	0.60	300	1.74	13.49	2000	1.74	5.00	6.67	20.16	0.336	84.75	87.5	14
16	0.40	300	0.90	23.47	2600	0.90	4.60	9.42	32.90	0.548	81.7	83	16
18	0.30	300	4.70	15.55	7100	4.70	5.60	21.13	36.68	0.611	80.5	80.5	18
20	0.40	300	2.88	15.99	3900	2.88	4.40	14.77	30.76	0.513	80	80.25	20
22	0.40	300	4.58	13.72	2100	4.58	5.40	6.48	20.20	0.337	81.25	81.25	22
24	0.40	300	3.78	14.62	3400	3.78	4.60	12.32	26.94	0.449	82.75	83.1	24
26	0.60	300	0.89	16.83	600	0.89	3.20	3.13	19.95	0.333	87.1	87.5	26
28	0.60	300	1.91	13.08	1900	1.91	5.70	5.56	18.64	0.311	86.4	89	28
30	0.40	300	2.89	15.97	2400	2.89	5.40	7.41	23.38	0.390	79	82.7	30
32	0.60	300	1.92	13.06	2200	1.92	6.90	5.31	18.37	0.306	84.95	89.5	32
34	0.60	300	4.46	9.89	3200	4.46	5.10	10.46	20.35	0.339	79.85	84.75	34
36	0.60	300	2.15	12.58	2300	2.15	5.60	6.85	19.42	0.324	84.6	87.5	36
38	0.60	300	1.83	13.27	2700	1.83	4.00	11.25	24.52	0.409	82.95	89.5	38
40	0.60	300	3.65	10.56	3100	3.65	5.50	9.39	19.96	0.333	82.5	85.9	40
42	0.60	300	4.46	9.89	3200	4.46	5.50	9.70	19.58	0.326	79.85	82.5	42



ORCHARD AVE.
DRAINAGE BASIN
TR-20 FLOW DIAGRAM
FUTURE CONDITIONS

ORCHARD AVENUE BASIN
SUMMARY OF DISCHARGES

AREA DESI	SUBBASIN FLOW			ACCUMULATED FLOW			DETAINED FLOWS			AREA DESIG
	100 YR FLOW	50 YR FLOW	25 YR FLOW	100 YR FLOW	50 YR FLOW	25 YR FLOW	100 YR FLOW	50 YR FLOW	25 YR FLOW	
2	442	375	319	1920	1648	1395	775	656	556	2
4	375	320	274							4
6	185	158	135	1179	996	843	1180	1000	848	6
8	286	244	208	1259	981	760	1464	1242	1054	8
10	223	191	163	1148	907	699				10
12	115	97	83	1078	851	665	302	255	214	12
14	160	136	117	1047	827	647	278	188	144	14
16	206	170	141	1011	817	661	270	181	137	16
18	381	310	252							18
20	125	102	83	278	229	186				20
22	159	131	108							22
24	275	228	189							24
26	109	93	80	995	839	709	776	654	550	26
28	176	151	130	288	242	203				28
30	142	118	98							30
32	299	262	226	497	420	356	141	102	88	32
34	231	194	163							34
36	109	93	79							36
38	174	150	129	462	394	333	117	95	83	38
40	306	258	218							40
42	105	87	72							42



STRUC NO.	STRUCTURE SIZE	STRUC NO.	STRUCTURE SIZE	STRUC NO.	STRUCTURE SIZE
1	43"X27" CMP	7	29"X18" CMP	14	12" CMP
2	2-30" CMP	8	43"X27" CMP	15	2-12" CMP
3A	48" CMP	9	18" CMP	16A	18" CMP
3B	29"X18" CMP	10	2-12" CMP	16B	18" CMP
3C	36"X22" CMP	11	15" CMP	17A	29"X18" CMP
4	60" CMP	12	18" CMP	17B	29"X18" CMP
5	50"X31" CMP	13	18" CMP	18	22"X13" CMP
6	30" CMP				

ORCHARD AVE. DRAINAGE BASIN PLANNING STUDY	
EXISTING STRUCTURES	
DESIGNED BY: MAB	DRAWN BY: JJW
CHECKED BY: JRW	DATE: 12/2/94
FILE NO: 941210	

PREPARED BY:

GRAEF ANHALT SCHLOEMER
and ASSOCIATES
ENGINEERS & SCIENTISTS

102 E. Pikes Peak Ave., Suite 305
Colorado Springs, CO. 80903
(719) 634-6902 TEL.
(719) 634-0660 FAX

ORCHARD AVENUE BASIN
STRUCTURE EVALUATION

STRUCT NO.	LOCATION	UNDETAINED/DETAINED FLOWS			EXIST. CULVERT SIZE	CAPACITY(cfs)	PROPOSED CULVERT SIZE	COST	REMARKS
100 YR(cfs)	50 YR(cfs)	25 YR(cfs)							
1	ORCHARD DR	1078/302	851/255	665/214	43"X27" CMP	55	60" RCP	----	STM SEWER
2	PEAR ST	1078/302	851/255	665/214	2-30" CMP	75	----	---	LOCAL FLOWS
3A	CENTRAL AVE	1047/278	827/188	647/144	48" CMP	100	----	---	REMOVE
3B					29"X18" CMP	25			LOCAL FLOWS
3C					36"X22" CMP	37			LOCAL FLOWS
4	SOUTH ST	1011/270	817/181	660/137	60" CMP	160	8'X5'BOX CULV	\$22,500	
5	HIGH ST	381/381	310/310	252/252	2-50"X31" CMP	140	10'X5'BOX CUL	\$30,000	
6	HIGH ST	278/278	228/228	186/186	30" CMP	30	6'X5'BOX CULV	\$19,500	
7	HIGH ST	275/275	228/228	189/189	29"X18" CMP	16	6'X5'BOX CULV	\$19,500	
8	NORTH ST	230/230	195/195	160/160	43"X27" CMP	35	2-54" CMP	\$13,500	
9	MOUNTAIN AVE	159/159	131/131	108/108	18" CMP	10	2-42" CMP	\$10,500	
10	SH 50	1179/—	907/—	843/—	2-12" CMP	11	2-72" RCP		STM SEWER
11	COTTONWOOD	995/486	839/410	709/346	15" CMP	12	----		LOCAL FLOWS
12	PEAR ST	995/486	839/410	709/346	18" CMP	10	---		LOCAL FLOWS
13	CENTRAL AVE	600/200	506/146	428/104	18" CMP	12	54" RCP		STM SEWER
14	CENTRAL AVE	288/288	242/242	203/203	12" CMP	6	54" RCP		STM SEWER
15	SH 50	373/373	320/320	274/274	2-12" CMP	20	72" RCP	\$160,000	
16A	PEAR ST	214/214	180/180	151/151	18" CMP	12	2-42" CMP	\$10,500	
16B	PEAR ST	467/121	397/97	337/83	18" CMP	10	----		FLOW DIVERT
17A	CENTRAL AVE	185/185	156/156	131/131	29"X18" CMP	24	2-36" CMP	\$6,800	
17B	CENTRAL AVE	450/121	380/97	350/83	29"X18" CMP	20	---		FLOW DIVERT
18	FIELD AVE	197/197	175/175	151/151	22"X13" CMP	10	54" CMP	\$9,000	

V. ALTERNATE DRAINAGE SYSTEMS

A. Alternate Development Policies

The Alternative Drainage systems were developed in a cooperative effort with input from the City of Canon City, the Fremont County Sanitation District, the Hydraulic Ditch Company, and the local residents. Several additional variations on the presented alternates were also examined but are not included in this report.

B. Alternate 1

This alternate investigates the existing flow conditions through the project area. It assumes that the Hydraulic Ditch is completely filled with stormwater and stormflows from the north would continue flowing across the canal. Based on this assumption nearly 1100 CFS would flow south between 19th Street and Diamond Avenue while approximately 1000 CFS would flow between Cottonwood Avenue and Field Avenue. The flow from the area east of Field Avenue would continue easterly toward the Abbey Basin.

The next assumption made is that the two (2) southerly flows will continue across SH 50 and the railroad and eventually empty into the Arkansas River. The total flow amounts that would reach the river would be 1259 CFS and 19570 CFS.

C. Alternate 2

Because of the lack of downstream facilities, detention facilities have been planned from the upper portion of the basin. A 41 acre foot detention basin is proposed for the area north of South Street to intercept the western portion of this basin. An improved channel is proposed from High Street to South Street on both sides of the detention basin with a new culvert under South Street. The channel reach from South Street to Central Avenue need only minimal improvements. A new 54" RCP trunk storm sewer is proposed from Central Avenue to SH 50 along Orchard Ave. This system would only handle about a 10-year storm flow with the remainder of the flow confined to the north - south residential streets. From SH 50 to East Main Street a larger 72" RCP storm sewer to intercept the total 100-year flow. The remainder of this portion of the system would be built as an open channel to the Arkansas River.

The central area of the basin currently drains through an undersized concrete channel through a residential area. An existing detention basin north of Elizabeth Street will be enlarged to an 18 acre foot basin. An improved channel will be built from the basin to Central Avenue. A 60" RCP storm sewer is proposed to intercept the flow along Central Avenue thereby relieving the undersize concrete channel. The proposed storm sewer will turn south along Stage Coach Avenue and then east to Cottonwood Avenue. From this point a 66" RCP storm sewer will carry most of the flow south to SH 50. A larger 78" RCP storm sewer will be needed to intercept the 100-year flow at SH 50 and transport it to a point below Fowler Street where an open channel will carry the flow to the Arkansas River.

The eastern portion of the drainage basin, along Field Avenue, will drain into a new 16 acre - feet detention basin. This flow will then be transported to the Abbey Channel once the flow peak has been decreased by 75%.

The estimated cost of Alternate 2 is \$3,221,000.00. This cost does not include land or easement purchase costs and is based on 1994 dollars.

D. Alternate 3

This alternative contains the same detention alternatives as Alternate 2 as well as the same improvements north of the Hydraulic Ditch.

This alternative differs with Alternate 2 in that all flows north of the Hydraulic Ditch will be intercepted by a concrete open channel which would be constructed in the current canal location. The existing canal flows would be enclosed within a 72" RCP. This concrete channel would vary in size from 8 feet to 15 feet and transport this flow directly to the Abbey Channel. This increase in flow in the Abbey Channel would need to be detained within a new detention basin within the Abbey Channel.

Since all flows north of the existing Hydraulic Ditch would be intercepted, only the area south of the canal would flow to SH 50. This flow could be intercepted by a 66" RCP storm sewer and transported to the Arkansas River.

The cost for this Alternate 3 is \$4,695,000.00

E. Alternate 4

This alternative is also the same as Alternate 2 for the western drainage basin north of Pear Street. Once the flow reaches Pear Street from the western and central portion of the drainage basin, a 60" RCP storm sewer will transport flows to Diamond Avenue. For the central basin the proposed storm sewer along Central Avenue will continue west past Stage Coach Avenue and then turn south through an easement within an undeveloped area until it reaches a junction box at Pear Street. From Pear Street south to SH 50 a 72" RCP storm sewer would be built to intercept about 60% of the flow. The remainder of the 100-year flow would be contained within improved street sections down Orchard Avenue, Diamond Avenue and Cottonwood Avenue to SH 50. The total 100-year flow would be intercepted by a 10 x 5 foot box culvert and transported to the Arkansas river.

The flow from the eastern portion of the basin would continue flowing toward the Abbey Drainage Basin.

The estimated cost for Alternate 4 is \$2,918,000.00.

F. Alternate 5

The improvements in this alternative are the same as those outlined in Alternate 3 except that the flow would be intercepted by a system along Central Avenue instead of the Hydraulic Ditch. The new Central Avenue trunk sewer would begin as a 60" RCP and increase in size to a 12 x 5 foot box culvert when it outfalls into the Abbey Channel.

The cost for this Alternate 5 is \$3,281,000.00.

G. Summary of Alternatives

Several factors were used to evaluate the alternatives, these included: Cost, constructability, citizen feedback, and city input. As a result of the numerous meetings held with public and private individuals Alternate 4 was selected as the preferred alternative. It was also recommended that Alternate 4 be modified to include the 16 acre - feet detention basin along Field Drive to reduce flows into the Abbey Channel.

Alternate 4 will require the disruption to only one residential street for construction. It also crosses SH 50 and the railroad in one location. A further reason for choosing this alternative is that the Fremont County Sanitary District can coordinate the construction of a new trunk sewer such that the new sanitary laterals would be placed below the proposed 72" RCP storm sewer invert.

VI. PRELIMINARY DESIGN

A. General

Based on the results of the alternatives evaluation and comments from the public meetings and the City, the concepts from the chosen alternative were developed into preliminary designs. Each major system in the Orchard Avenue drainage basin is delineated on the conceptual plans contained in Appendix B 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 Estimate of Probable Construction Costs, that does not preclude the use of other design materials or design schemes that will serve the intended purpose as well as or better than those presented herein both hydraulically and environmentally. 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 Canon City Engineering Department and other affected agencies.

VII. WATER QUALITY

A. General

Concern regarding storm water quality has been growing through the past decade. Recently the Environmental Protection Agency (EPA) has been working on regulations for monitoring and the use of best management practices to control stormwater. The actual design for any necessary control facilities will vary according to the type of pollutants present.

Pollutants enter stormwater in many ways, among which are the following:

1. Pollutants are absorbed as the raindrops pass through the atmosphere.
2. Pollutants are washed off the paved and unpaved surfaces by stormwater runoff.
3. Pollutants that have accumulated since the last storm in sewers, ditches, and channels are picked up by the stormwater.

B. Treatments

Most of the pollutants expected to reach the main stem of the channel should be of the suspended solid variety. However, it may be necessary to sample and analyze the stormwater to determine the exact control measures to implement.

Dry basins should be designed in areas where the main pollutants are suspended solids which simply settle out in the basin when the channel velocity drops. However, if dissolved solids, nitrates and nitrites, and soluble phosphorus are present, a wet pond will need to be constructed to reduce these pollutants.

VIII. ECONOMIC ANALYSIS

A. General

The economic analysis of the channel improvements listed in this study was derived from current construction prices for materials and labor in the Canon City, Fremont County area. In addition, the 1993 edition of the Colorado Department of Highways "Cost Data" was utilized. Estimated probable construction costs were determined for each channel reach for the selected alternative utilizing the protection scheme delineated in the Alternate Drainage Systems section and on the Conceptual Plans located in Appendix B.

The following Table 9, Unit Construction Costs, lists the specific unit costs used in determining the estimated probable construction costs:

**TABLE 9
UNIT CONSTRUCTION COSTS**

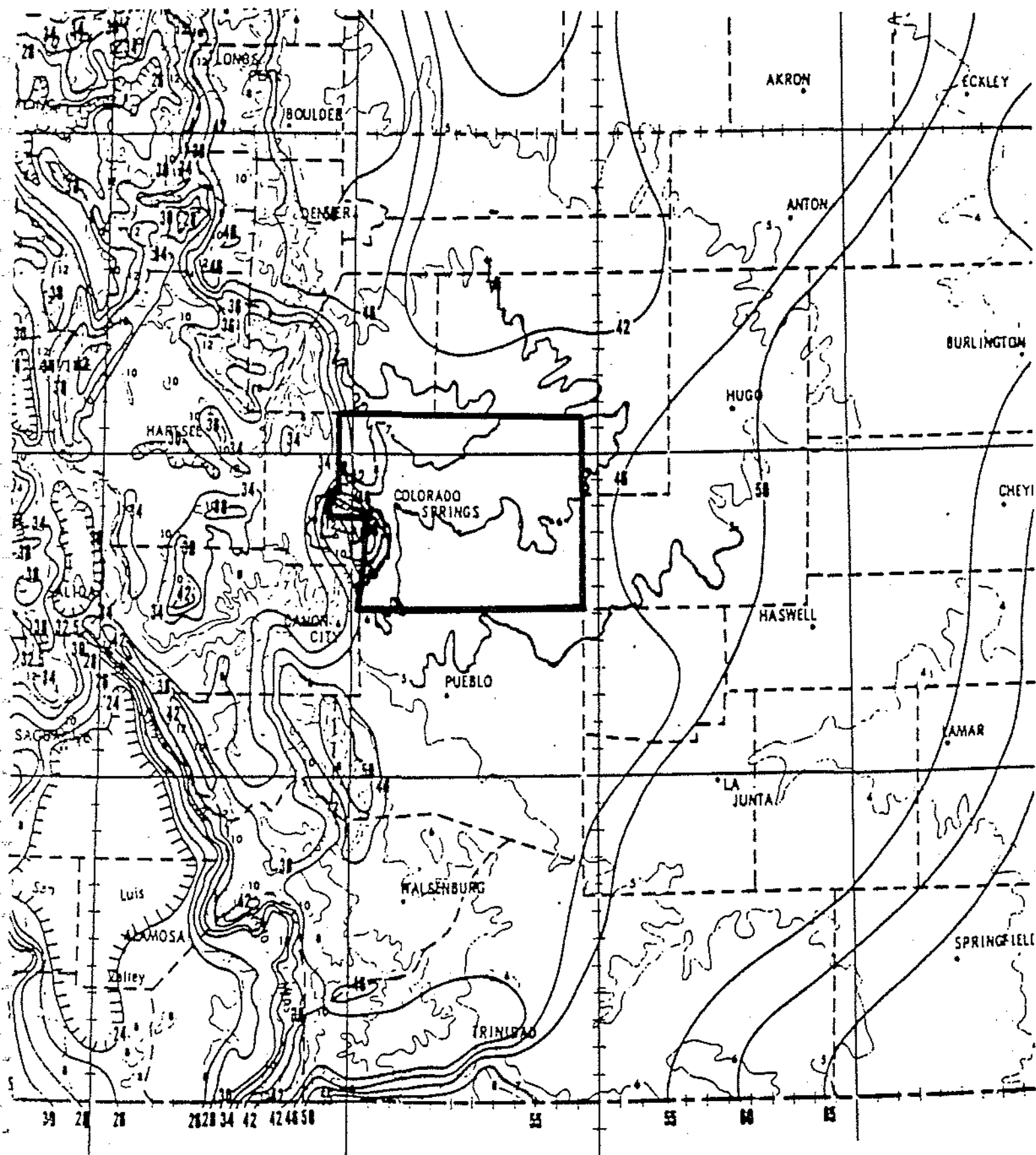
<u>Item Description</u>	<u>Unit</u>	<u>Estimated Unit Cost</u>
Gabion Baskets	CY	\$85.00
Rip Rap	CY	\$35.00
Heavy Rip Rap	CY	\$45.00
Granular bedding materials	CY	\$20.00
Reinforced concrete	CY	\$265.00
Concrete channel lining	CY	\$180.00
Structural backfill	CY	\$8.00
Structural excavation	CY	\$5.00
Unclassified excavation and embankment	CY	\$2.50
Seeding (native)	Acre	\$1000.00
48" RCP	LF	\$75.00
54" RCP	LF	\$90.00
60" RCP	LF	\$120.00
66" RCP	LF	\$150.00
72" RCP	LF	\$170.00
78" RCP	LF	\$200.00
72" RCP (Jacked)	LF	\$650.00
42" CMP (pipe and installation)	LF	\$60.00
54" CMP (pipe and installation)	LF	\$70.00
6' X 5' Box culvert	LF	\$260.00
8' X 5' Box culvert	LF	\$300.00
10' X 5' Box culvert	LF	\$400.00
12' X 5' Box culvert	LF	\$525.00
15' X 6' Box culvert	LF	\$600.00

NOTE: Pipe and culvert costs do not include utility relocation costs.

B. Preliminary Estimate of Probable Construction Costs

As previously stated, the proposed improvements are illustrated on the alternate conceptual plans that are included in Appendix B. Conceptual construction costs were estimated for each alternate based on the unit construction costs provided in this section and are also in Appendix B. Preliminary construction costs for the selected alternate are provided in Appendix C.

APPENDIX A
Design Charts

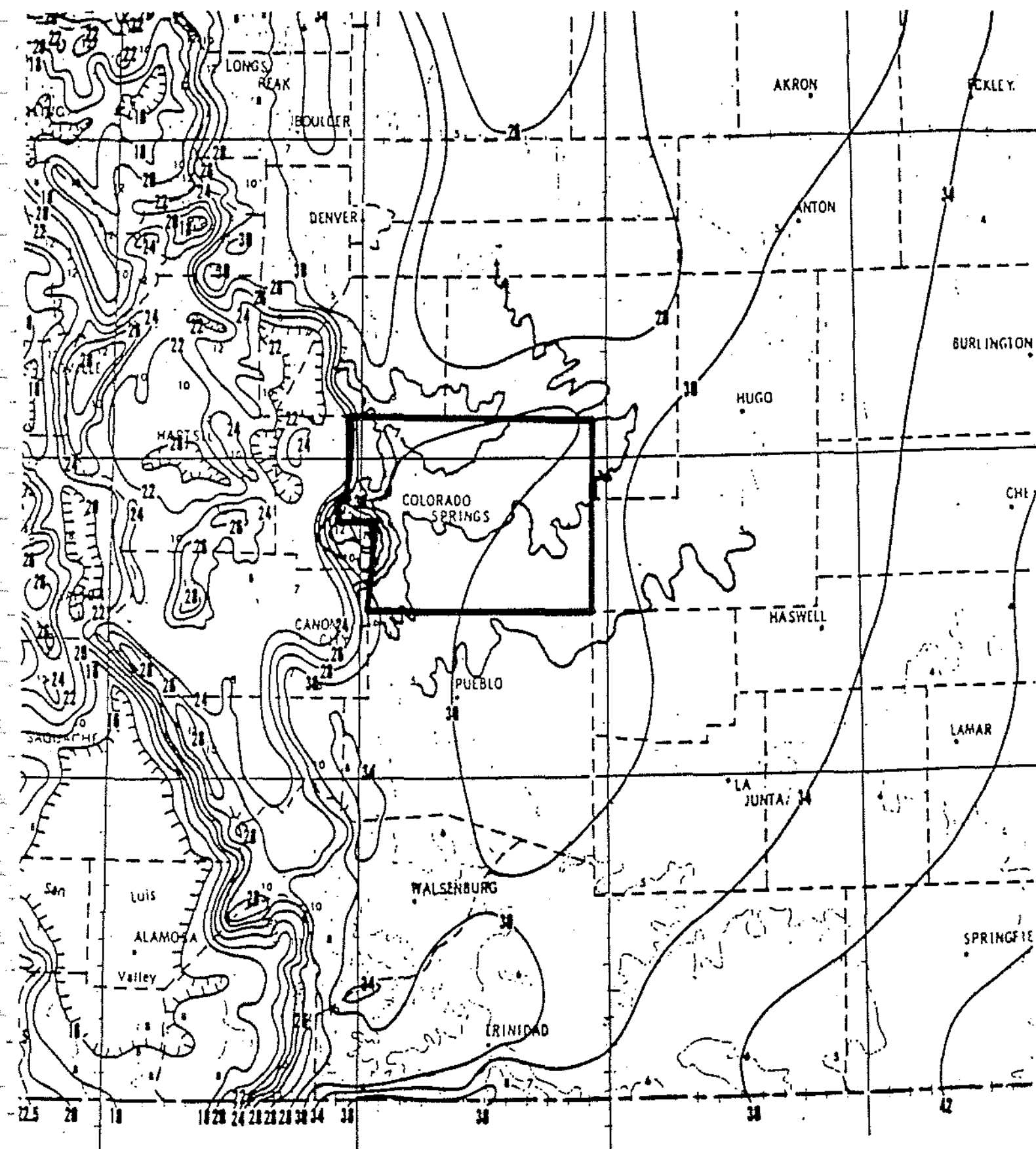


NOAA ATLAS 2, Volume III

Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology

Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

ISOPLUVIALS OF 100-YR 24-HR PRECIPITATION
IN TENTHS OF AN INCH

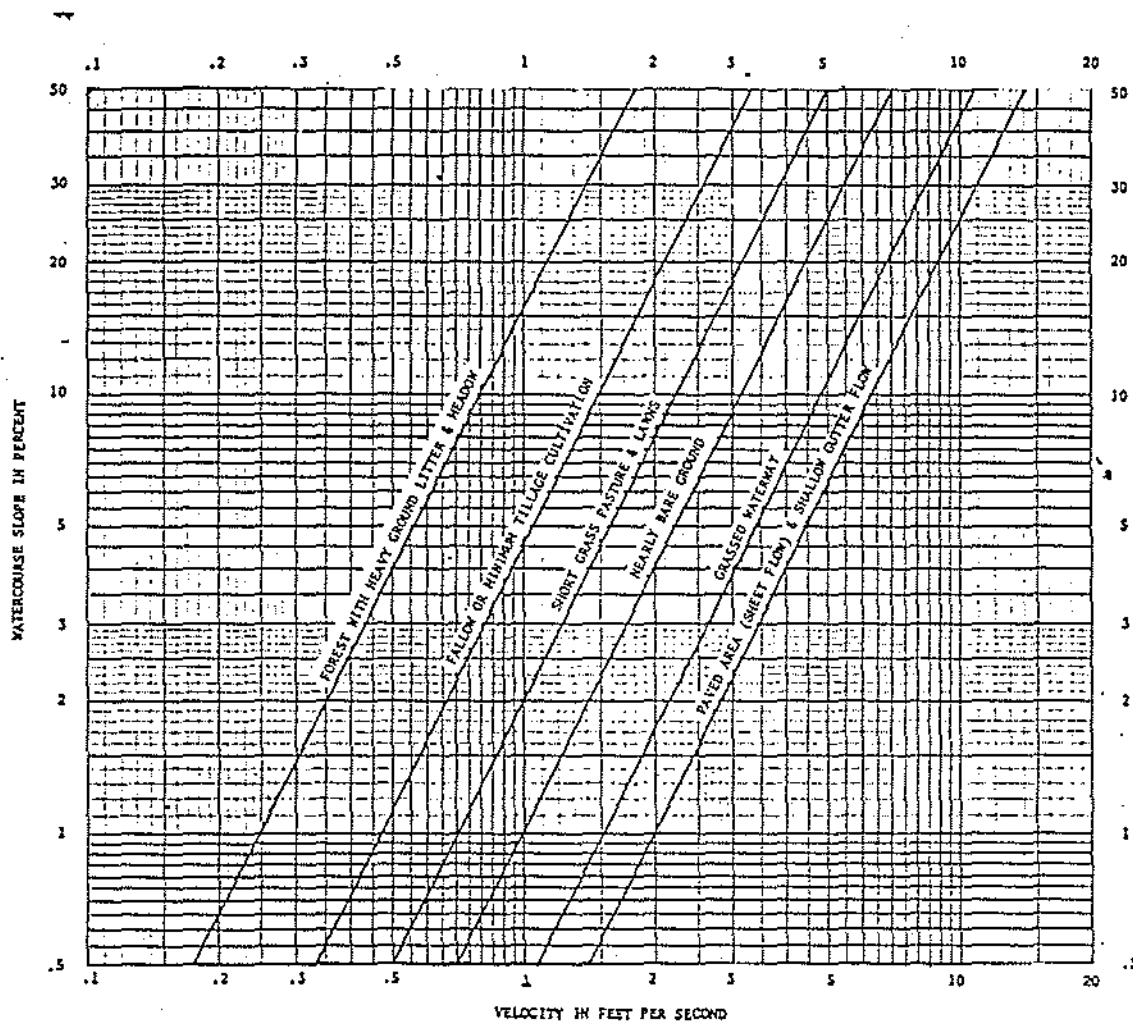


NOAA ATLAS 2, Volume III

Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology

Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

ISOPLUVIALS OF 10-YR 24-HR PRECIPITATION
IN TENTHS OF AN INCH



--Average velocities for estimating travel time for overland flow.

FIGURE 4

TABLE 5-5
 RUNOFF CURVE NUMBERS
 FOR HYDROLOGIC SOIL-COVER COMPLEXES
 URBAN AND SUBURBAN CONDITIONS 1/
 (For Antecedent Moisture Condition II)
 (From: U.S. Department of Agriculture,
 Soil Conservation Service, 1977)

NOTE: THIS TABLE TO
 BE USED FOR 24-HOUR
 STORM ONLY.

Land Use	Hydrologic Soil Group			
	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
Open spaces, lawns, parks, golf courses, cemeteries, etc.				
Good condition: grass cover on 75% or more of the area	39*	61	74	80
Fair condition: grass cover on 50% to 75% of the area	49*	69	79	84
Commercial and business areas (85% impervious)	89*	92	94	95
Industrial districts 72% impervious)	81*	88	91	93
Residential: <u>2/</u>				
<u>Acres per Dwelling Unit</u>	<u>Average % impervious^{3/}</u>			
1/8 acre or less	65	77*	85	90
1/4 acre	38	61*	75	83
1/3 acre	30	57*	72	81
1/2 acre	25	54*	70	80
1 acre	20	51*	68	79
Paved parking lots, roofs, driveways, etc.	98	98	98	98
Streets and roads:				
paved with curbs and storm sewers	98	98	98	98
gravel	76*	85	89	91
dirt	72*	82	87	89

1/ For a more detailed description of agricultural land use curve numbers, refer to in the National Engineering Handbook (U.S. Dept. of Agriculture, Soil Conservation Service, 1972).

2/ Curve numbers are computed assuming the runoff from the house and driveway is directed towards the street with a minimum of roof water directed to lawns where additional infiltration could occur.

3/ The remaining pervious areas (lawn) are considered to be in good pasture condition for these curve numbers.

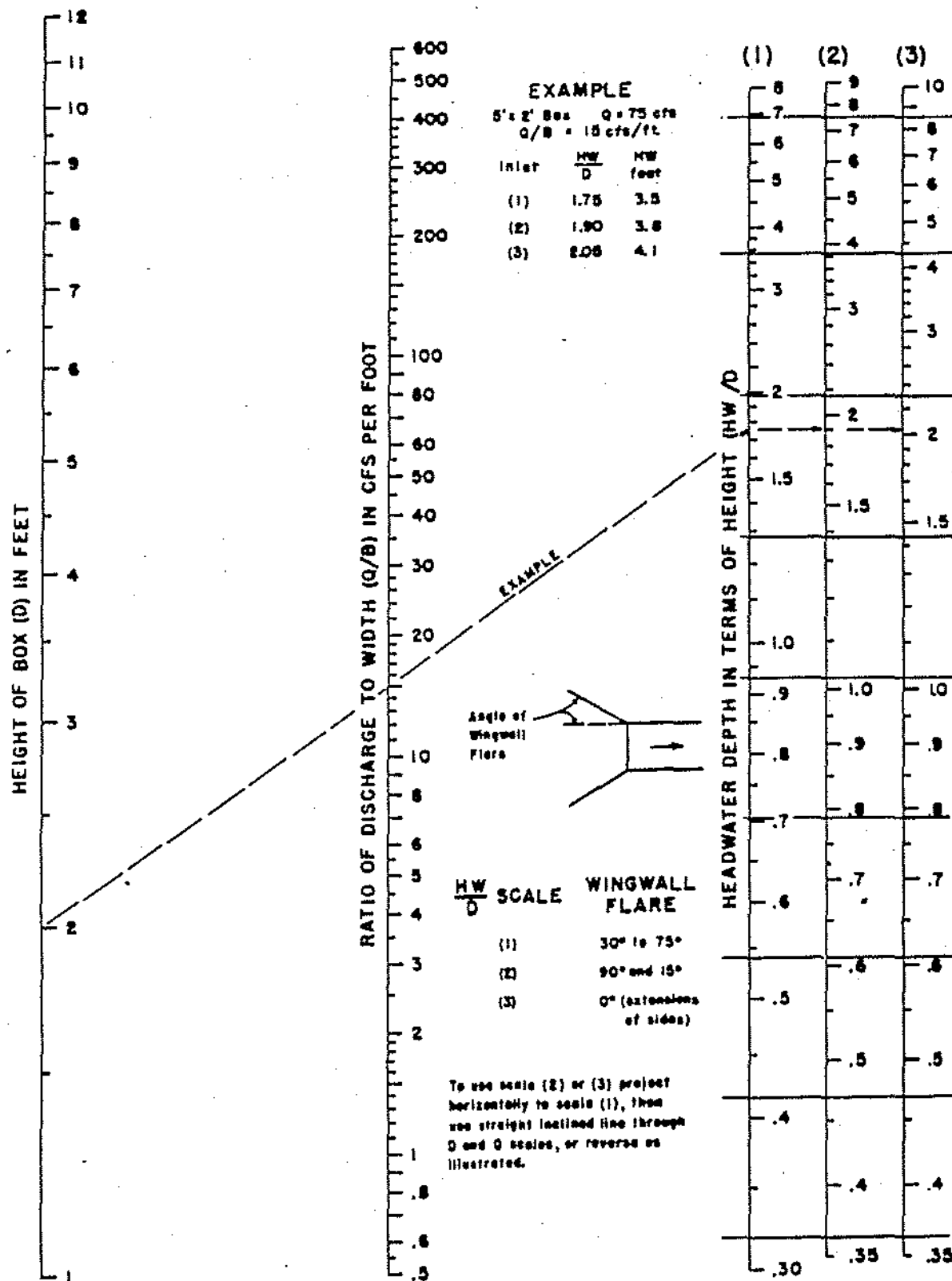
* Not to be used wherever overlot grading or filling is to occur.

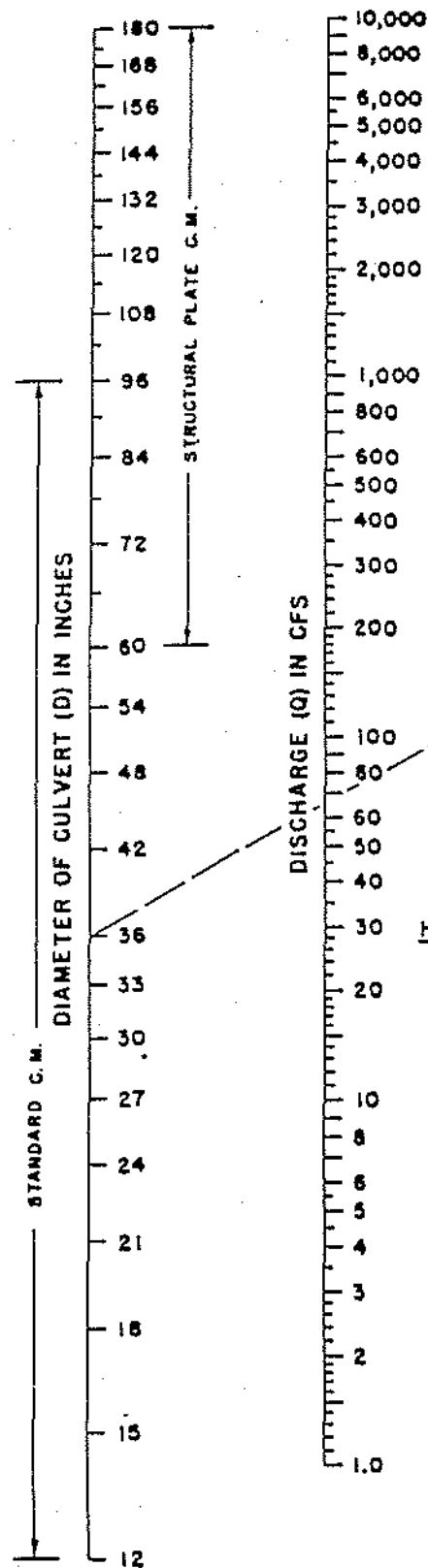
TABLE 5-4
 RUNOFF CURVE NUMBERS FOR HYDROLOGIC
 SOIL-COVER COMPLEXES--RURAL CONDITIONS
 (Antecedent Moisture Condition II, and $I_a = 0.2 S$)
 (From: U.S. Dept. of Agriculture,
 Soil Conservation Service, 1977)

NOTE: THIS TABLE TO
 BE USED FOR 24-HOUR
 STORM ONLY.

Land Use	Cover Treatment or Practice	Hydrologic Condition	Runoff curve number by Hydrologic soil group			
			A	B	C	D
Fallow	Straight Row	----	77	86	91	94
Row crops	Straight Row	Poor	72	81	88	91
	Straight Row	Good	67	78	85	89
	Contoured	Poor	70	79	84	88
	Contoured	Good	65	75	82	86
	Cont. and terraced	Poor	66	74	80	82
	Cont. and terraced	Good	62	71	78	81
Small grain	Straight Row	Poor	65	76	84	88
		Good	63	75	83	87
	Contoured	Poor	63	74	82	85
		Good	61	73	81	84
	Cont. and terraced	Poor	61	72	79	82
		Good	59	70	78	81
Close-seeded legumes <u>1/</u> or rotation meadow	Straight Row	Poor	66	77	85	89
	Straight Row	Good	58	72	81	85
	Contoured	Poor	64	75	83	85
	Contoured	Good	55	69	78	83
	Cont. and terraced	Poor	63	73	80	83
	Cont. and terraced	Good	51	67	76	80
Pasture or range		Poor	68	79	86	89
		Fair	49	<u>69</u>	79	84
		Good	39	<u>61</u>	74	80
	Contoured	Poor	47	<u>67</u>	81	88
	Contoured	Fair	25	59	75	83
	Contoured	Good	6	35	70	79
Meadow		Good	30	58	71	78
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77
Farmsteads		----	59	74	82	86
Roads (dirt) <u>2/</u> (hard surface) <u>2/</u>		----	72	82	87	89
		----	74	84	90	92

1/ Close-drilled or broadcast
2/ Including right-of-way





EXAMPLE

D = 36 inches (3.0 feet)
Q = 66 cfs

	$\frac{HW}{D}$	HW (feet)
(1)	1.8	5.4
(2)	2.1	6.3
(3)	2.2	6.6

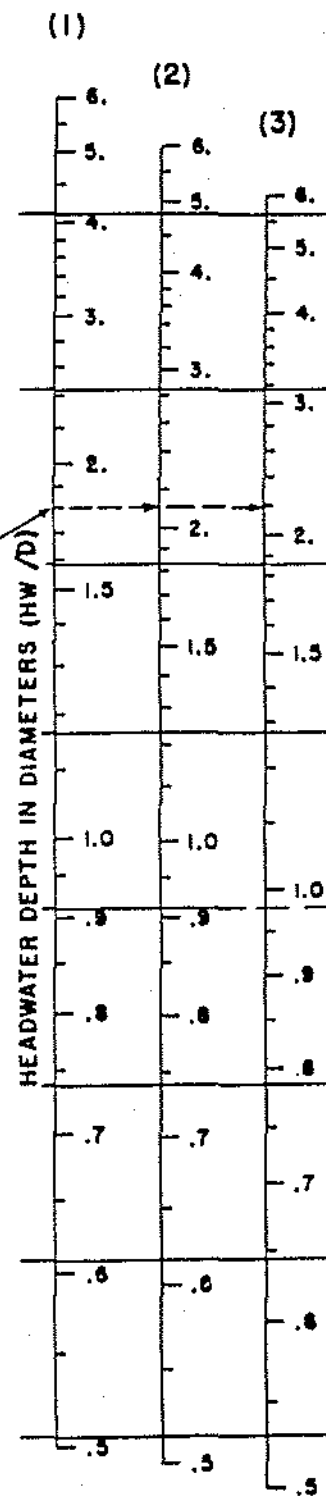
^{HW}D in feet

$\frac{HW}{D}$ SCALE

ENTRANCE TYPE

- (1) Headwall
- (2) Mitered to conform to slope
- (3) Projecting

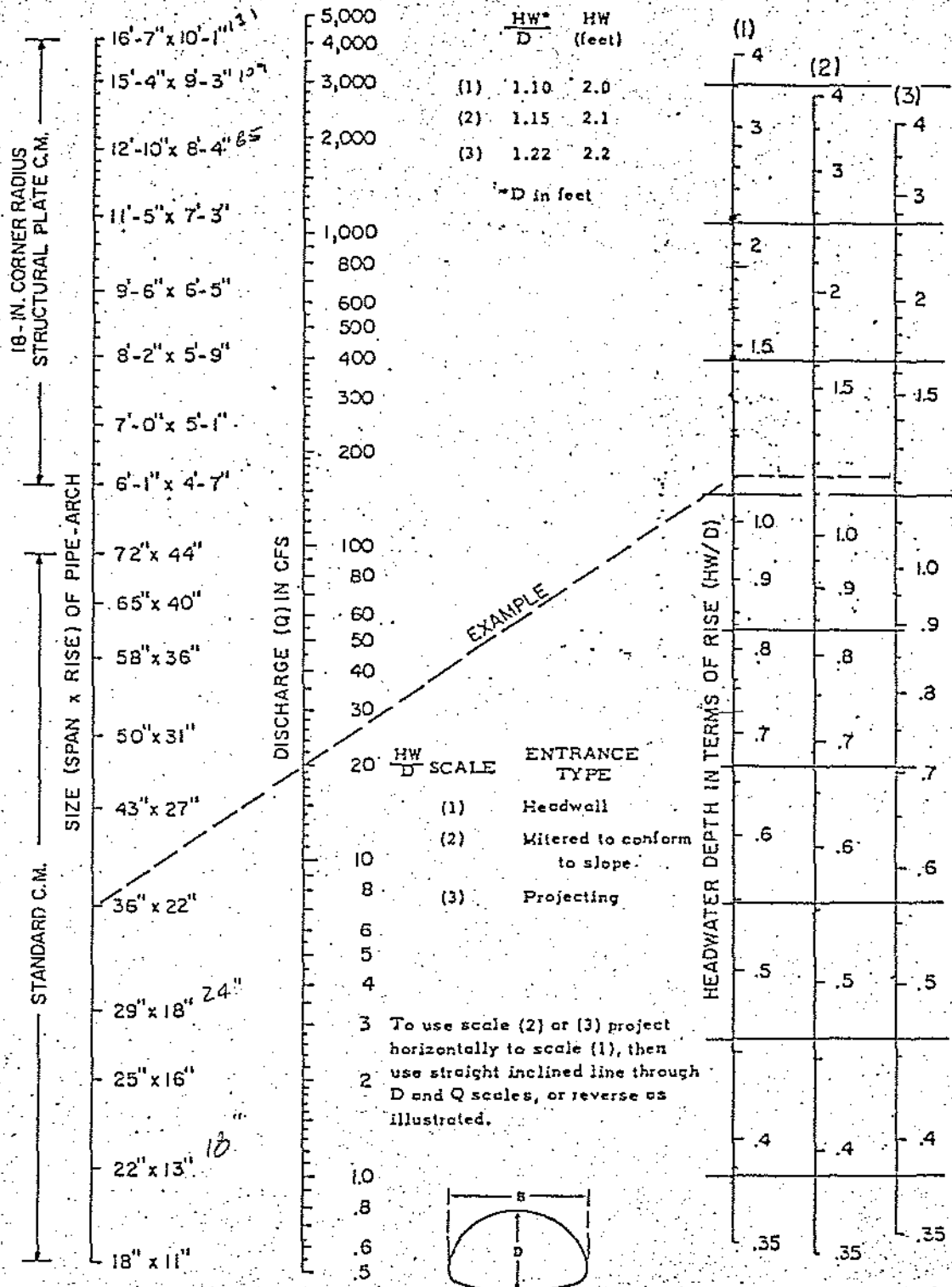
To use scale (2) or (3) project horizontally to scale (1), then use straight inclined line through Q and Q scales, or reverse as illustrated.



HEADWATER DEPTH FOR
C. M. PIPE CULVERTS
WITH INLET CONTROL

EXAMPLE

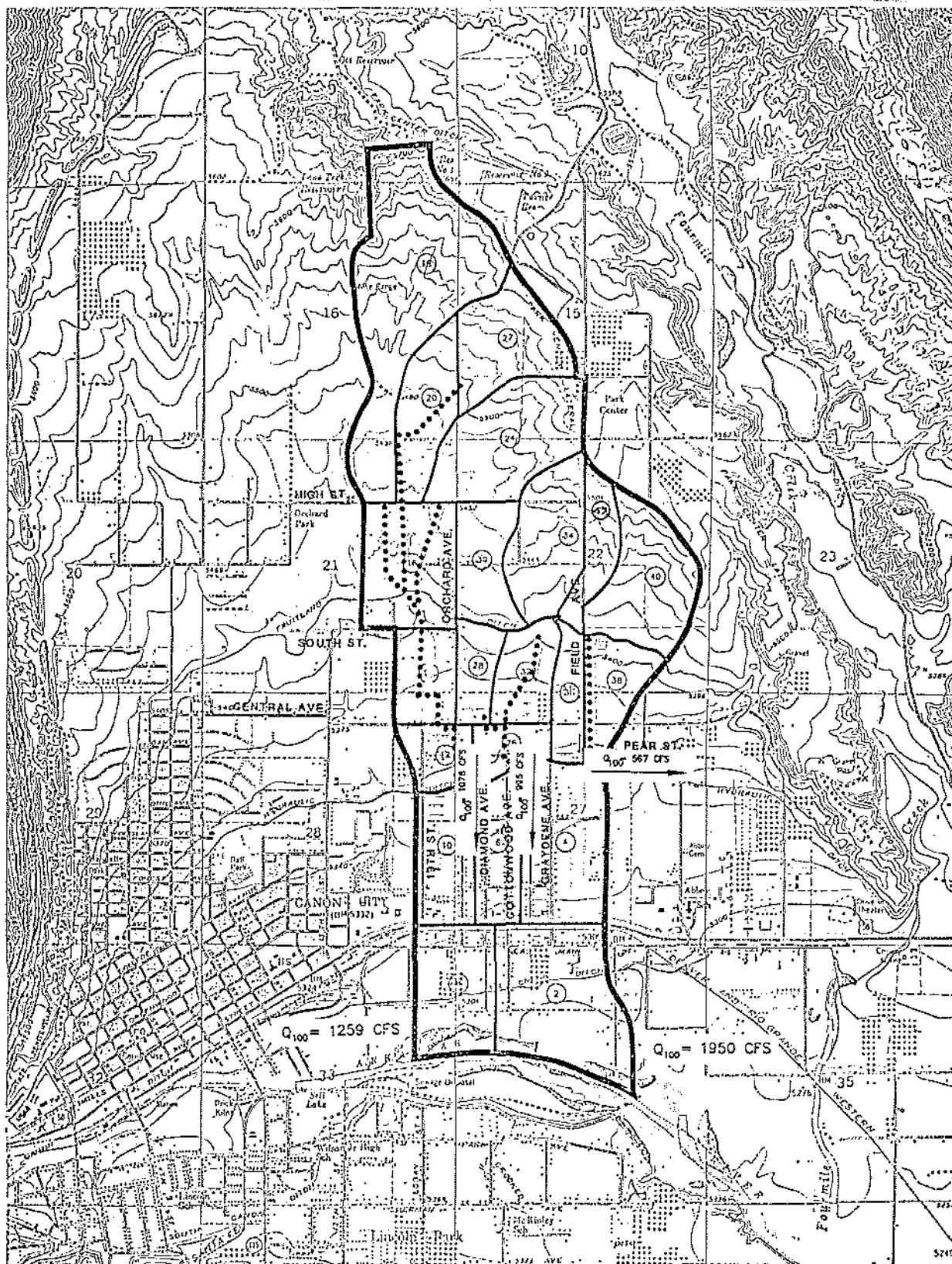
Size: 36" x 22"
Q = 20 cfs



HEADWATER DEPTH FOR CM PIPE-ARCH CULVERTS WITH INLET CONTROL

APPENDIX B

Alternate Conceptual Plans



EXISTING CONDITIONS

ORCHARD AVE. DRAINAGE
BASIN PLANNING STUDY

ALTERNATE 1

DESIGNED BY:
MAB

DRAWN BY:
JJW

CHECKED BY:
JRW

DATE:
12/2/94

FILE NO:
941210

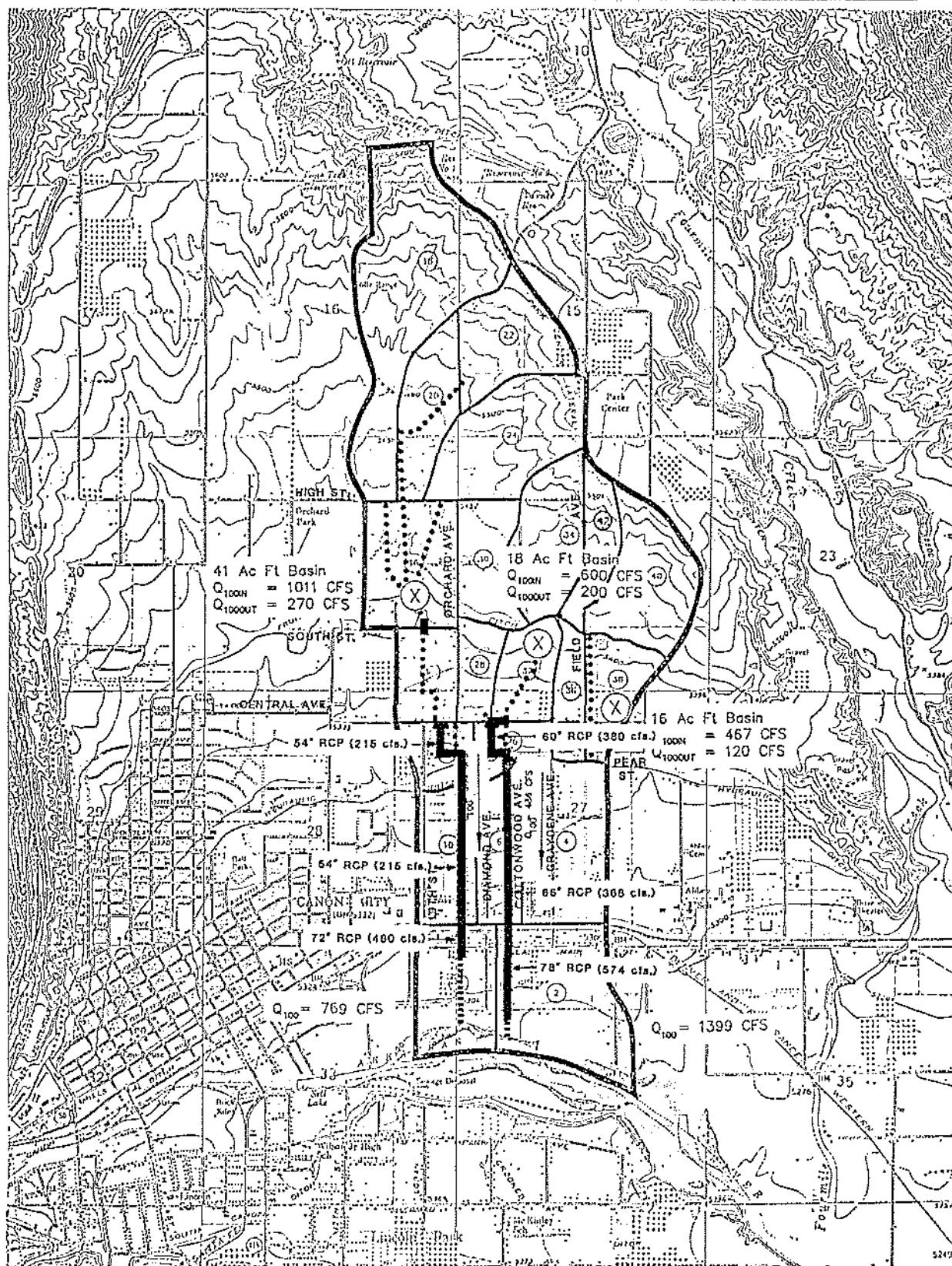
PREPARED BY:



**GRAEF
ANHALT
SCHLOEMER**

and ASSOCIATES

ENGINEERS & SCIENTISTS
102 E. Pikes Peak Ave., Suite 305
Colorado Springs, CO. 80903
(719) 634-6862 TEL.
(719) 634-0660 FAX



ORCHARD AVE. DRAINAGE
BASIN PLANNING STUDY

ALTERNATE 2

DESIGNED BY:
MAB

DRAWN BY:
JJW

CHECKED BY:
JRW

DATE:
12/2/94

FILE NO:
941210

PREPARED BY:



**GRAEF
ANHALT
SCHLOEMER**

and ASSOCIATES

ENGINEERS & SCIENTISTS

102 E. Pikes Peak Ave., Suite 305

Colorado Springs, CO. 80903

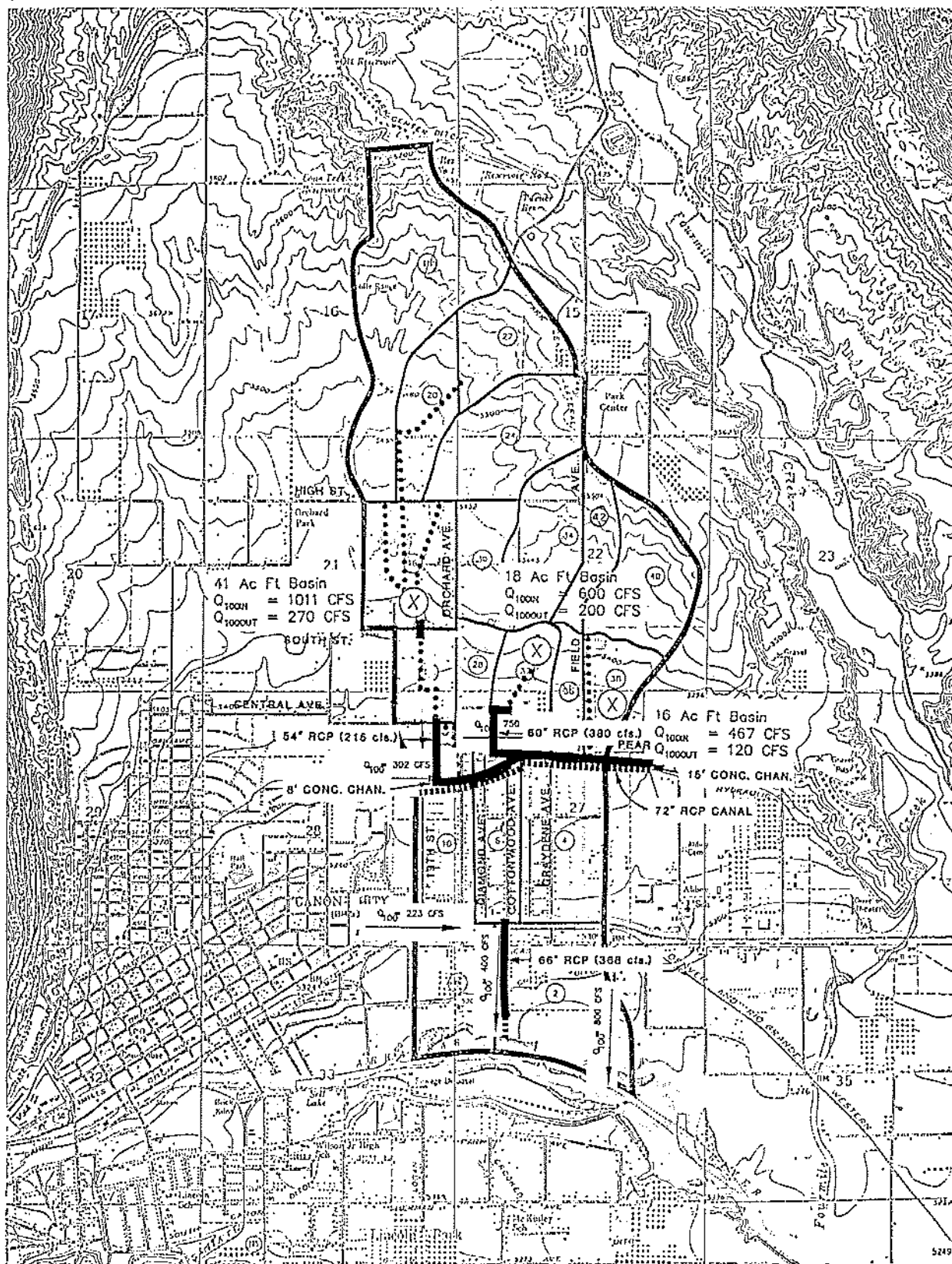
(719) 634-6902 TEL.

(719) 634-0660 FAX

ORCHARD AVENUE DRAINAGE STUDY

Alternative 2

<u>Location</u>	<u>Improvement Description</u>	<u>Estimated Probable Construction Cost</u>
<u>Orchard Ave. Trunk</u>		
Arkansas River to SH 50	6 Ft. Riprap Channel. 72" RCP Storm Sewer	\$351,000
SH 50 to Hydraulic Ditch	54" RCP Storm Sewer	\$440,000
Hydraulic Ditch to Central Ave.	54" RCP Storm Sewer	\$169,000
Central Ave to South St.	Reconstruct Channel. Add Riprap at Bends	\$96,000
South St. to High St.	8'x5' Box Culvert 6Ft. Wide Channel 41 Ac. Ft. Det Basin	\$380,000
<u>Cottonwood Ave Trunk</u>		
Arkansas River to SH 50	8 Ft. Riprap Channel 78" RCP Storm Sewer	\$650,000
SH 50 to Hydraulic Ditch	66" RCP Storm Sewer	\$582,000
Hydraulic Ditch to Central Ave.	60" RCP Storm Sewer	\$150,000
Central Ave North	54" RCP Storm Sewer 4 Ft. Wide Channel 18 Ac. Ft. Det Basin	\$228,000
<u>Field Ave Trunk</u>		
Hydraulic Ditch North	16 Ac. Ft. Det Basin	\$175,000
	TOTAL	\$3,221,000



ORCHARD AVE. DRAINAGE
BASIN PLANNING STUDY

ALTERNATE 3

DESIGNED BY:
MAB

DRAWN BY:
JJW

CHECKED BY:
JRW

DATE:
12/2/94

FILE NO:
841210

PREPARED BY:



**GRAEF
ANHALT
SCHLOEMER**

and ASSOCIATES

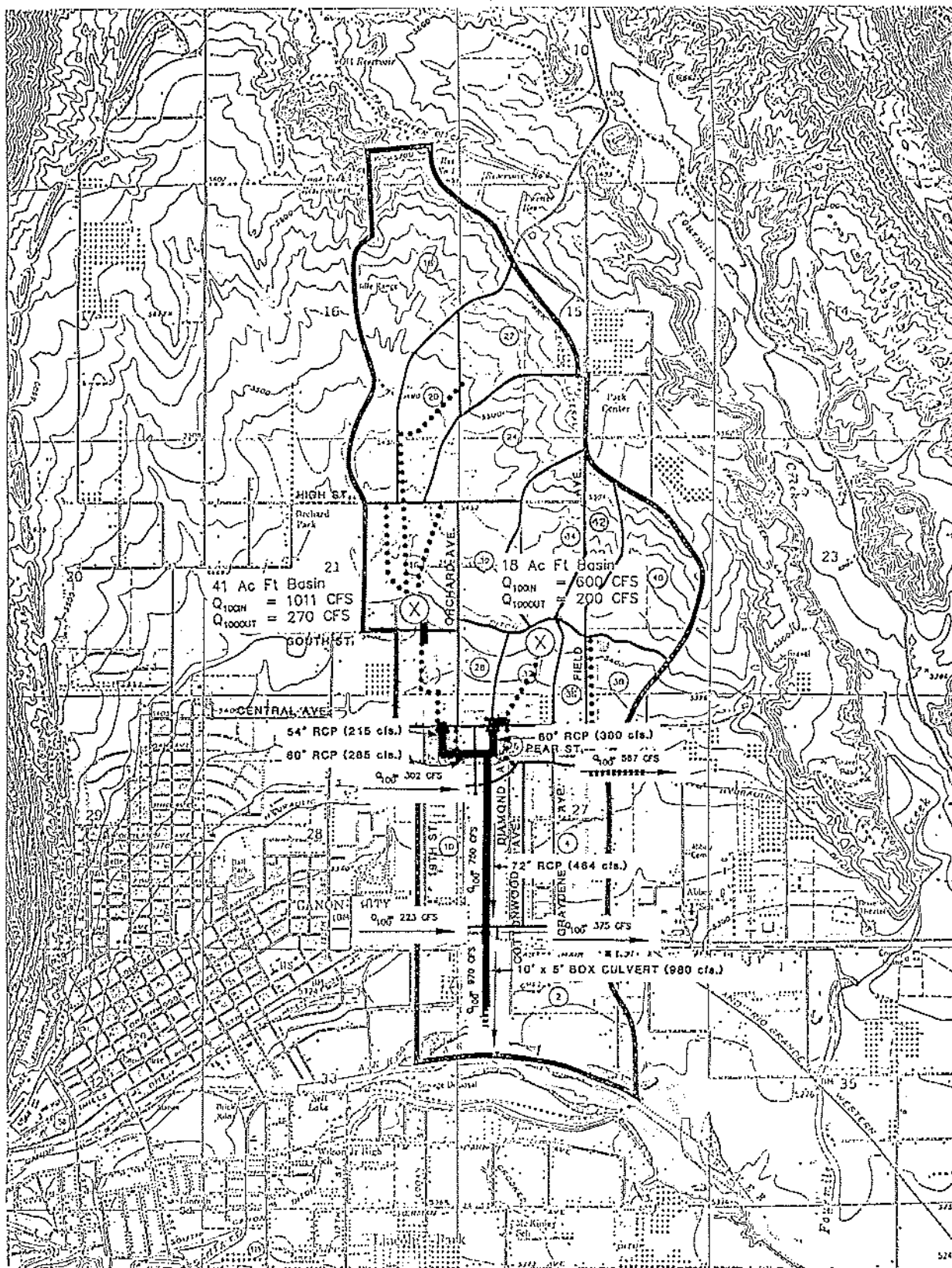
ENGINEERS & SCIENTISTS

102 E. Pikes Peak Ave., Suite 305
Colorado Springs, CO. 80903
(719)834-8902 TEL.
(719)834-0860 FAX

ORCHARD AVENUE DRAINAGE STUDY

Alternative 3

<u>Location</u>	<u>Improvement Description</u>	<u>Estimated Probable Construction Cost</u>
<u>Arkansas River Outfall</u>		
Arkansas River to SH 50	8 Ft. Riprap Channel 66" RCP Storm Sewer	\$445,000
<u>Hydraulic Ditch</u>		
19th St. to Cottonwood Ave.	72" RCP Canal Enclosure 8 Ft. Conc Channel 3-8'x5' Box Culvert	\$856,000
Cottonwood Ave to Abbey Channel	72" RCP Canal Enclosure 15 Ft. Conc Channel 6-15'x6' Box Culvert	\$2,196,000
<u>Orchard Ave. Trunk</u>		
Hydraulic Ditch to Central Ave.	54" RCP Storm Sewer	\$169,000
Central Ave to South St.	Reconstruct 5 Ft. Channel Add Riprap at Bends	\$96,000
South St. to High St.	8'x5' Box Culvert 6 Ft. Wide Channel 41 Ac Ft. Det Basin	\$380,000
<u>Cottonwood Ave. Trunk</u>		
Hydraulic Ditch to Central Ave.	60" RCP Storm Sewer	\$150,000
Central Ave. North	54" RCP Storm Sewer 4 Ft. Wide Channel 18 Ac. Ft. Det Basin	\$228,000
<u>Field Ave. Trunk</u>		
Hydraulic Ditch North	16 Ac. Ft. Det Basin	\$175,000
	TOTAL	<u>\$4,695,000</u>



ORCHARD AVE. DRAINAGE
BASIN PLANNING STUDY

ALTERNATE 4

DESIGNED BY:
MAB

DRAWN BY:
JJW

CHECKED BY:
JRW

DATE:
12/2/94

FILE NO:
841210

PREPARED BY:



GRAEF
ANHALT
SCHLOEMER

and ASSOCIATES

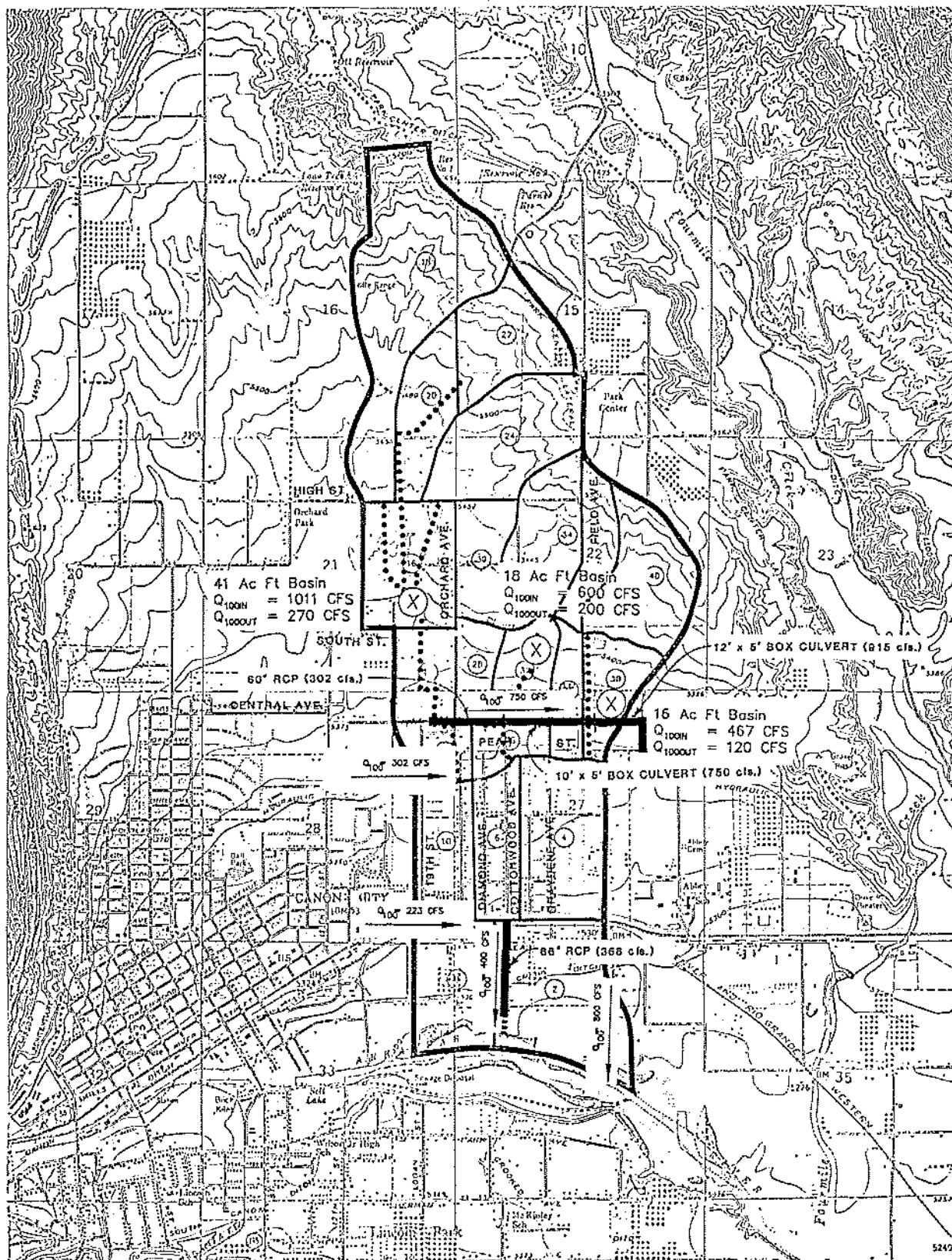
ENGINEERS & SCIENTISTS

102 E. Pikes Peak Ave., Suite 305
Colorado Springs, CO. 80903
(719) 634-6802 TEL.
(719) 634-0660 FAX

ORCHARD AVENUE DRAINAGE STUDY

Alternative 4

<u>Location</u>	<u>Improvement Description</u>	<u>Estimated Probable Construction Cost</u>
<u>Diamond Ave. Trunk</u> Arkansas River to SH 50	12 Ft. Riprap Channel 10'x5' Box Culvert	\$1,096,000
SH 50 to Hydraulic Ditch	72" RCP Storm Sewer	\$736,000
Hydraulic Ditch to Central Ave.	60" RCP Storm Sewer	\$150,000
Central Ave. North	54" RCP Storm Sewer 4 Ft. Wide Channel 18 Ac. Ft. Det Basin	\$228,000
<u>Orchard Ave. Trunk</u> Diamond Ave to Orchard Ave. at Pear St.	60" RCP Storm Sewer	\$75,000
Pear St to Central Ave.	54" RCP Storm Sewer	\$112,000
Central Ave. South St.	Reconstruct 5' Channel Add Riprap at Bends	\$96,000
South St. to High St	8'x5' Box Culvert 6 Ft. Wide Channel 41 Ac. Ft. Det Basin	\$380,000
<u>Field Ave. Trunk</u> Hydraulic Ditch North	12 Ft. Wide Channel	<u>\$45,000</u>
TOTAL		<u>\$2,918,000</u>



ORCHARD AVE. DRAINAGE
BASIN PLANNING STUDY

ALTERNATE 5

DESIGNED BY:
MAB

DRAWN BY:
JJW

CHECKED BY:
JRW

DATE:
12/2/94

FILE NO:
041210

PREPARED BY:



**GRAEF
ANHALT
SCHLOEMER**

and ASSOCIATES

ENGINEERS & SCIENTISTS
102 E. Pikes Peak Ave., Suite 305
Colorado Springs, CO. 80903
(719)834-6902 TEL
(719)834-0860 FAX

ORCHARD AVENUE DRAINAGE STUDY

Alternative 5

<u>Location</u>	<u>Improvement Description</u>	<u>Estimated Probable Construction Cost</u>
<u>Arkansas River Outfall</u> Arkansas River to SH 50	8 Ft. Riprap Channel 66" RCP Storm Sewer	\$445,000
<u>Central Ave. Trunk</u> Orchard Channel to Stage Coach Road	60" RCP Storm Sewer	\$235,000
Stage Coach Road to Field Drive	10' x 5' Box Culvert 18 Ac. Ft. Det. Basin	\$1,100,000
Field Drive to Abbey Channel	12' x 5' Box Culvert	\$850,000
<u>Orchard Ave. Trunk</u> Central Ave to South Street	Reconstruct 5 Ft. Channel Add Riprap at Bends	\$96,000
South Street to High Street	8' x 5' Box Culvert 6 Ft. Wide Channel 41 Ac. Ft. Det. Basin	\$380,000
<u>Field Ave. Trunk</u> Hydraulic Ditch North	16 Ac. Ft. Det Basin	<u>\$175,000</u>
	TOTAL	\$3,281,000

APPENDIX C

Preliminary Construction Costs

PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST SUMMARY

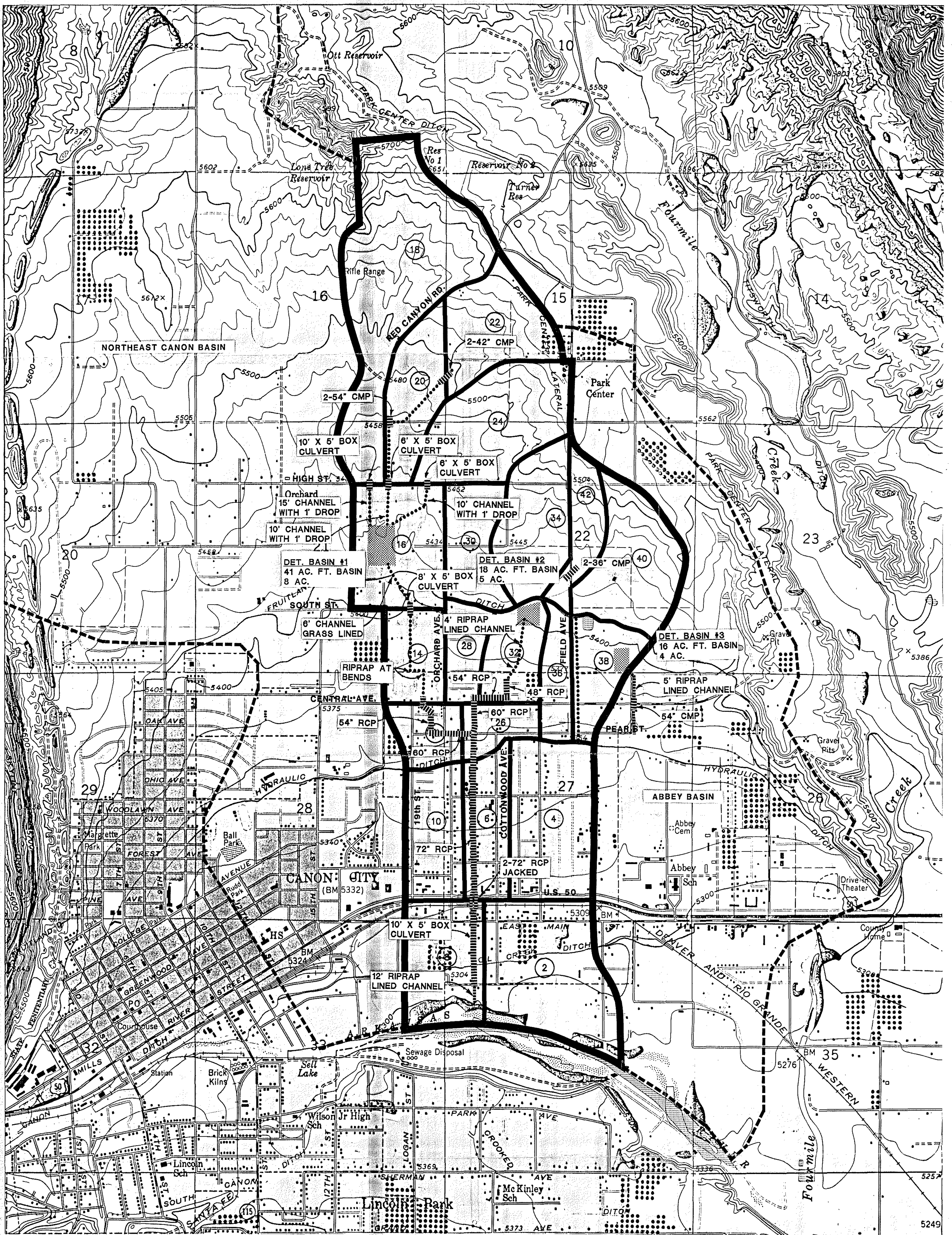
<u>Location</u>	<u>Improvement Description</u>	<u>Estimated Probable Construction Cost</u>
<u>Arkansas River Outfall to Pear Street</u>		
Outfall to Fowler St.	12' Wide Riprap Channel	\$31,000
Fowler St. to D&RGW RR	10' x 5' Box Culvert Oil Creek Canal Crossing	\$915,000
D&RGW RR to SH50	2-72" RCP Storm Sewer (Jacked), Junc. Box	\$200,000
SH50 to Pear St.	72" RCP Storm Sewer, Hydraulic Ditch Crossing, Junction Box.	\$751,000
		<hr/> \$1,897,000
<u>Pear Street to South Street (West Trunk)</u>		
Pear St. West to Yarbough St.	60" RCP Storm Sewer	\$120,000
Yarbough St. North to Central Ave.	54" RCP Storm Sewer	\$90,000
Central Ave. to South St.	Reconstruct 5 Ft. Channel, Add Riprap at Bends.	\$96,000
South St.	8'x5' Box Culvert	\$22,500
		<hr/> \$328,500

PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST SUMMARY

<u>Location</u>	<u>Improvement Description</u>	<u>Estimated Probable Construction Cost</u>
<u>South Street to Mountain Ave.</u>		
South St. to Det. Basin # 1	6 Ft. Wide Channel	\$13,750
Det. Basin # 1	41 Ac.Ft. Basin Improvements	\$286,400
Det Basin # 1 to High St. (West of Red Canyon Rd.)	15' Wide Channel W/1 Drop Structures	\$22,500
Det Basin # 1 to High St. (East of Red Canyon Rd.)	10' Wide Channel W/1 Drop Structures	\$15,000
Det Basin # 1 to High St. (West of Orchard Ave.)	10' Wide Channel W/1 Drop Structures	\$15,000
High St. (West of Red Canyon Rd.)	10' x 5' BC	\$30,000
High St. (East of Red Canyon Rd.)	6' x 5' BC	\$19,500
High St. (West of Orchard Ave.)	6' x 5' BC	\$19,500
North St.	2-54" CMP	\$13,500
Mountain Ave	2-42" CMP	\$10,500
		<hr/> \$445,650

PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST SUMMARY

<u>Location</u>	<u>Improvement Description</u>	<u>Estimated Probable Construction Cost</u>
<u>Pear Street to Detention Basin No. 2</u>		
Pear St. to Central Ave.	60" RCP Storm Sewer	\$97,500
Central Ave to Cone Ave.	54" RCP Storm Sewer	\$74,250
Cone Ave. to Elizabeth Ave.	48" RCP Storm Sewer	\$60,950
Elizabeth Ave. to Detention Basin No. 2	4 Ft. Channel Riprap Lined	\$39,000
Detention Basin No. 2		\$102,700
		<hr/> \$374,400
<u>Field Avenue Trunk</u>		
Hydraulic Ditch North to Det. Basin No. 3	5 Ft. Channel Riprap Lined	\$100,000
Det. Basin No. 3	16 Ac. Ft. Basin Improvements	\$110,000
		<hr/> \$210,000
TOTAL		\$3,255,550



ORCHARD AVE. DRAINAGE

BASIN PLANNING STUDY

BASIN IMPROVEMENTS MAP

DESIGNED BY:

MAB

DRAWN BY:

JJW

CHECKED BY:

JRW

DATE:

12/2/94

FILE NO:

941210

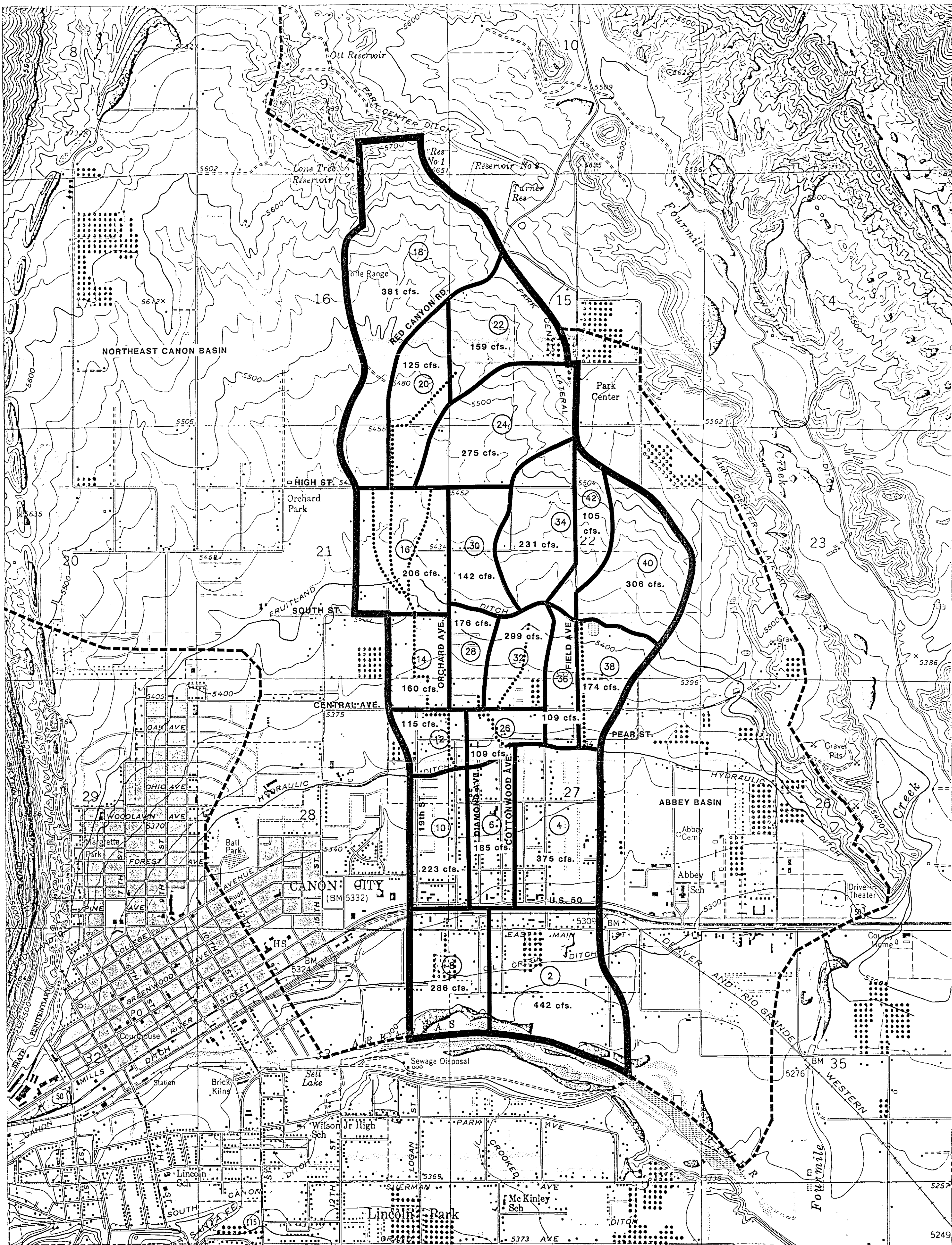
PREPARED BY:



**GRAEF
ANHALT
SCHLOEMER**

and ASSOCIATES
ENGINEERS & SCIENTISTS

102 E. Pikes Peak Ave., Suite 305
Colorado Springs, CO. 80903
(719)634-6902 TEL.
(719)634-0660 FAX



**ORCHARD AVE. DRAINAGE
BASIN PLANNING STUDY**

BASIN DISCHARGE MAP

DESIGNED BY:
MAB

DRAWN BY:
JJW

CHECKED BY:
JRW

DATE:
12/2/94

FILE NO:
941210

PREPARED BY:



**GRAEF
ANHALT
SCHLOEMER**

and ASSOCIATES
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Colorado Springs, CO. 80903
(719)634-6902 TEL.
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