FOR INFO. ONLY
NOT FOR REVIEW
PRELIMINARY DESIGN

7/30/86

MASTER DRAINAGE STUDY

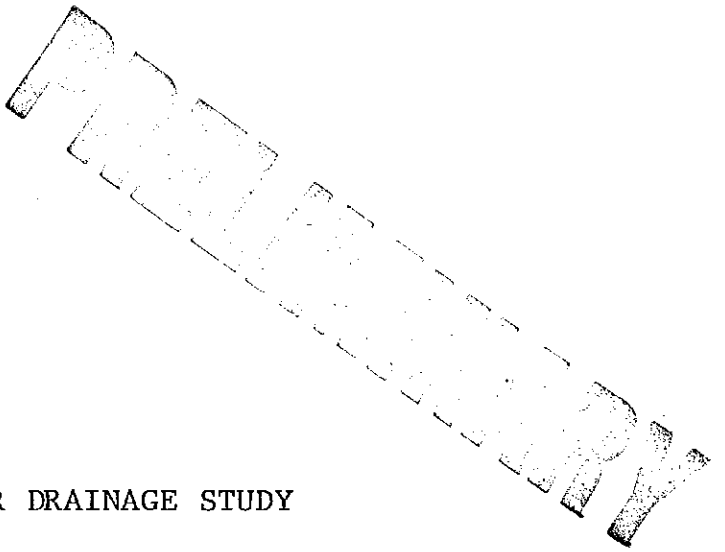
FOR

HIGH CHAPARRAL

JOB NO. 5178806

APRIL 1986

Greiner
Engineering



MASTER DRAINAGE STUDY

FOR

HIGH CHAPARRAL

JOB NO. 5178806

APRIL 1986

Prepared for:

M.L. Properties, Inc.
5085 List Drive
Colorado Springs, CO 80919
(303) 599-8999

Prepared by:

GREINER ENGINEERING SCIENCES, INC.
5373 North Union Blvd., Suite 200
Colorado Springs, CO 80918
(303) 593-0212

STATEMENTS

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the City for drainage reports, and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by the negligent acts, errors, or omissions on my part in preparing this report.

Kenneth C. Harrison 4/16/86
Kenneth C. Harrison, P.E.
GREINER ENGINEERING SCIENCES, INC.

The Developer and/or his representative has read and will comply with all the requirements specified in this drainage report and plan.

Authorized Representative
M.L. PROPERTIES, INC.
5085 List Drive
Colorado Springs, CO 80919

FLOODPLAIN STATEMENT

High Chaparral, in its entirety, is located outside the 100-year floodplain as indicated on the floodplain map published by FEMA.

Kenneth C. Harrison
Kenneth C. Harrison, P.E.

PRELIMINARY

TABLE OF CONTENTS

SUMMARY OF RESOURCES USED

1. "Master Drainage Plan and Preliminary Sand Creek Channel Design - the Colorado Springs Ranch", prepared by Simmons, Li & Associates, dated January 1985.

2. "Sand Creek Drainage Basin Study", prepared by United Western Planning and Engineering Company, dated October 1977.

3. Powers Boulevard Corridor - Preliminary Design, prepared by R. Keith Hook & Associates, dated June 1982.

4. Barnes Road P & P - Preliminary, prepared by Greiner Engineering Sciences, Inc.

5. "Procedures for Determining Peak Flows in Colorado", prepared by the Soil Conservation Service, U.S. Department of Agriculture, dated March 1984.

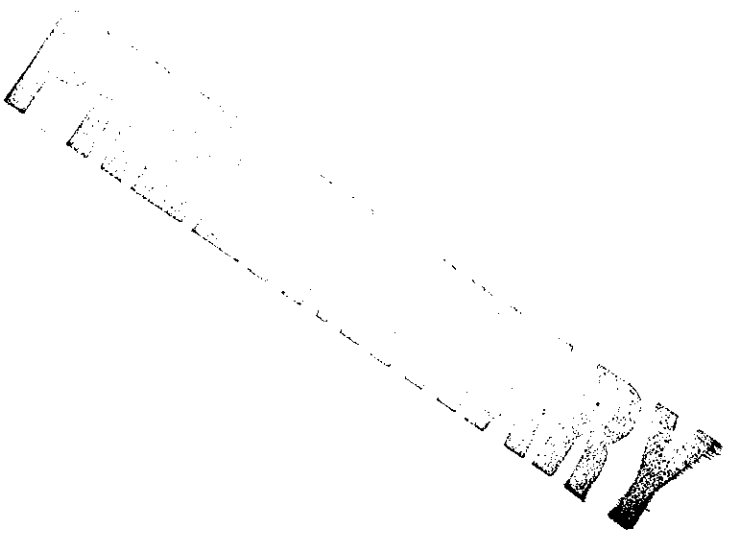
6. "Master Drainage Study for Stetson Hills", prepared by Greiner Engineering Sciences, Inc., dated April 1985 (filed September 1985).

7. Preliminary Drainage Plan and Study for Old Farm Heights, prepared by URS NES, dated March 27, 1985 (currently under review).

8. Drainage Report for Old Farm Subdivision Filing #4, prepared by H.J. Kraettli & Sons, Inc., dated November 15, 1978, approved November 29, 1978.

9. Old Farm Master Drainage Plan, prepared by H.J. Kraettli & Sons, dated August 9, 1978.

10. The Ridge Subdivision Drainage Report, prepared by R. Keith Hook & Associates, Inc., dated February 1973, approved March 1973.



Purpose of Study

The purpose of this study is to analyze the existing and future drainage patterns and characteristics within the High Chaparral development (the project) and to plan for the safe conveyance of storm runoff to the Sand Creek Drainageway. This study has been prepared in comformance with the drainage requirements for the City of Colorado Springs, Colorado. The specific scope of work includes the following tasks:

1. Describe the existing drainage characteristics on and offsite.

2. Determine the developed storm flow for the initial 5-year and the major 100-year storm as it effects this project.

3. Determine the size, type and location of drainage facilities required to safely handle the storm runoff.

4. Determine downstream effects.

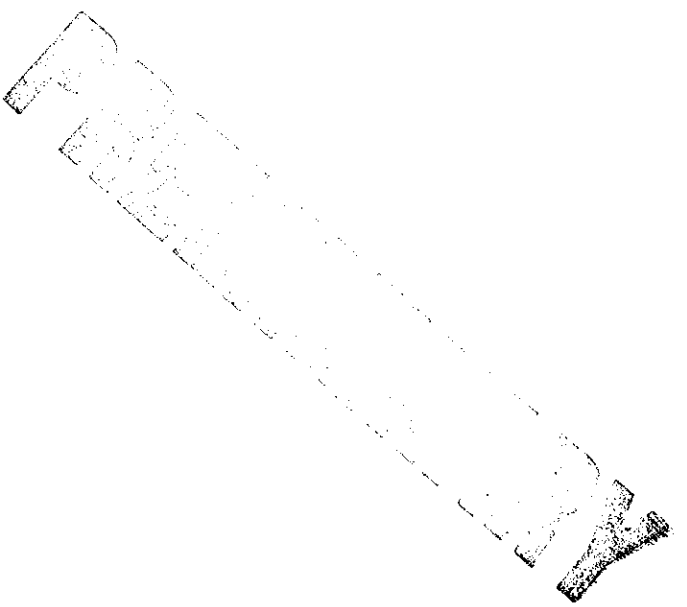
5 Present a preliminary construction costs summary.

Location and Description of the Study Area

High Chaparral is located in Sections 24 and 25, Township 13 South, Range 65 West of the Sixth Principal Meridian, City of Colorado Springs, El Paso County, Colorado. South of and adjacent to the project is Barnes Road which is presently a four lane street with open ditches. Barnes Road will ultimately be a six lane curb and gutter street. West of and adjacent to the project are The Ridge and Old Farm Subdivisions. Access from the west is provided through these subdivisions by two existing 36-foot wide residential type streets; High Chaparral Drive and Iron Horse Drive. North of and adjacent to the project is Templeton Heights Subdivision which is to be developed as Old Farm Heights. East of and adjacent to the project is Powers Boulevard. Presently, Powers Boulevard is a two lane, open ditch street with plans for becoming a major arterial eight lane street. Recent construction plans for Powers Boulevard indicate major vertical alignment changes throughout the length of the eastern boundary of the project. The Powers Boulevard construction plans were used in preparing the Overlot Grading Plan for the project, which is the basis for the drainage plan attached to this report. Elevations for the future vertical alignment of Powers Boulevard are also shown on the overall Drainage Plan.

High Chaparral is to be a multi-use type development with tracts zoned for single and multi-family, retail and office service centers, office/research and development complexes, and open/ preservation areas. Internally, the development will be serviced by Rio Vista Drive, Chaparral Drive and Iron Horse Drive. The major street, Rio Vista Drive, will be a sixty-foot wide curb and gutter street with two lanes north and southbound and one continuous center left turn lane. At the Barnes Road intersection, Rio Vista Drive will be eighty-four feet wide with two left turn lanes, two northbound lanes and two southbound lanes. Chaparral Drive will be a forty-foot wide curb and gutter street. Iron Horse Drive will be a thirty-six-foot wide curb and gutter street.

It is presently planned for the project to be constructed in two phases. Phase One will include the construction of Rio Vista Drive to a few feet north of Iron Horse Drive. Phase One will also include the construction of Chaparral Drive and Iron Horse Drive to the project's western property line. Phase Two will include the construction of the remaining portion of Rio Vista Drive to the north property line where it will tie into the Old Farm Heights Development. The location of this tie-in has been coordinated with URS Engineering, the firm that is currently preparing the development plans for Old Farm Heights.



Hydrologic Calculations

Basic Criteria - The basis of this report was the Storm Drainage Criteria published by the City of Colorado Springs.

As required by the City, the rainfall distribution was determined from a graph for 100-year, 6-hour, Type II A storm (Figure 5).

The modified SCS procedures were used for all hydrologic and drainage calculations. The precipitation values used were 3.5 inches for the 100-year, 6-hour storm and 2.1 inches for the 5-year, 6-hour storm.

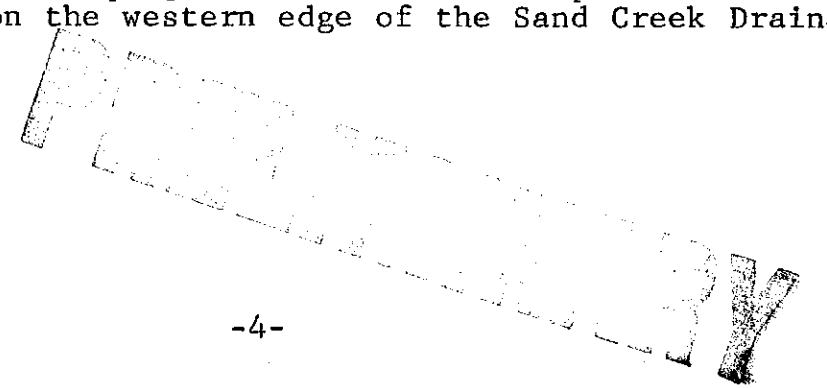
The base SCS Runoff Curve Numbers used for different land uses were determined from the table shown in Figure 3.

Time of Concentration - The initial time of concentration for single family development was assumed at ten minutes, whereas for multi-family and "commercial" type development, it was assumed at seven minutes. Then, channel time and street flow time were added. Times for street and channel flow are average times for the entire length being considered. Street flow time was derived from the SCS graph NEH-4 (Figure 6).

On-Site Storm Sewers - The on-site storm sewers were basically sized to accommodate a 5-year storm. The storm sewer system started where street/gutter capacity was reached as established by the City of Colorado Springs (Figure 7). The inlets were located and designed in accordance with the methods and requirements established by the City of Colorado Springs. (The subsequent sections of this report will describe exceptions to the above.)

100-Year Event - For the 100-year event, the maximum street capacity from right-of-way to right-of-way was calculated using Manning's Formula. Culverts located under Barnes Road and Powers Boulevard were sized for the 100-year storm as required by the City of Colorado Springs.

Offsite Flows - Storm flows from small Out-Parcels that drain into the development were calculated based on conservative assumptions regarding their future development. These assumptions are discussed in subsequent sections of this report. Other than flow from the Out-Parcels, there is very little offsite storm flow entering the project since the development is located high in elevation on the western edge of the Sand Creek Drainage Basin.

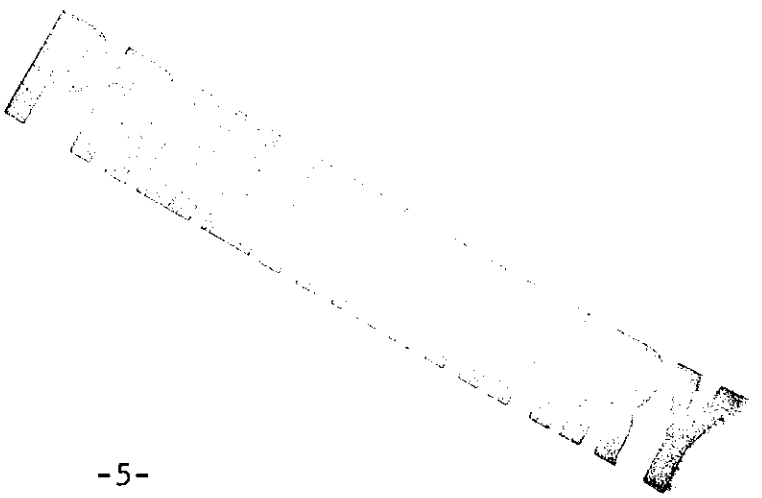


General Existing Drainage Characteristics

High Chaparral is located on the most westerly boundary of the Sand Creek Drainage Basin. Because of its location and high elevation, minimal offsite storm runoff drains into the project. Presently, the land is being used for five-acre homesites. The property is drained by two natural channels which both outfall offsite into Sand Creek. The southern two-thirds of the property drains via a natural channel from an elevation of 6,830 feet to a low point of 6,610 feet located at Barnes Road. The runoff then passes under Barnes Road through an existing twenty-four inch culvert; then it proceeds via a natural channel through private property to a sixty-six inch culvert under Powers Boulevard; then into an open ditch through the Colorado Springs Ranch project, eventually outfalling into Sand Creek. The northern one-third of the property drains via a natural channel from an elevation of 6,830 feet to a low point of elevation of 6,720 feet located at the northern property line. From there, the runoff proceeds downstream via a natural channel through the proposed Old Farm Heights Subdivision; then through a sixty-four inch culvert under Powers Boulevard; then in a natural channel through Stetson Hills Subdivision, eventually outfalling into the Sand Creek Drainage Channel.

There are no existing on-site drainage structures or facilities that need to be considered in this drainage study. Offsite structures include a twenty-four inch culvert under Barnes Road, a sixty-six inch culvert under Powers Boulevard, south of Barnes Road, and a sixty-four inch culvert under Powers Boulevard located north of the project.

The soils in the basin are identified by the Soil Conservation Service as Stapleton-Bernal sandy loams which belong to the B and C Hydrologic Groups. Runoff from these groups is medium with a rapid to medium permeability, with medium surface runoff. Average CN values were determined for each land use type (refer to the Attachment section of this report for CN calculations).



Proposed Drainage System - General

Basin A and B:

The natural channel and existing outfall will be filled in and abandoned. The storm runoff will be redirected via a system of curb and gutter streets, swales and storm sewers to the most southeasterly corner of the project. The runoff will then pass under Barnes Road/Powers Boulevard and outfall into a privately constructed and maintained ditch located in the M.L. Properties tracts. The runoff will then pass under Tutt Avenue and cross the Colorado Springs Ranch tract and eventually outfall into Sand Creek. All of the necessary letters from M.L. Properties and the Colorado Springs Ranch that state developed flows will be accepted will be required prior to platting. The total 5-year and 100-year storm runoff for Basin A and B at the outfall point are 173.2 cfs and 354.2 cfs, respectively.

Basin C and D:

The natural channel will be filled in and the storm runoff will be redirected via a system of curb and gutter streets, swales and storm sewers. Both basins will eventually outfall via a culvert located offsite under Powers Boulevard. The runoff will then enter a channel in the Stetson Hills Development and then discharge into Sand Creek.

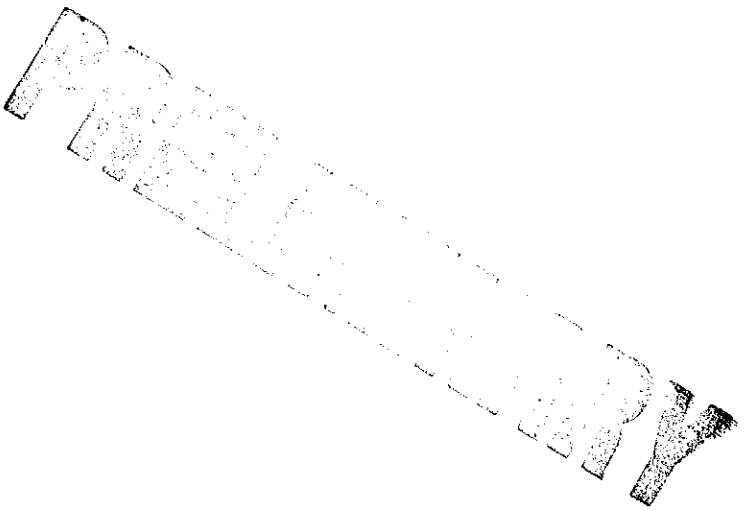
Basin C storm runoff will be collected in the storm sewer system to be located in Rio Vista as well as in the curb and gutter section of Rio Vista. This runoff will pass into the Old Farm Heights project where it will be collected and routed to the culvert located under Powers Boulevard. The design considerations for this outfall have been coordinated with the developers of Old Farm Heights. A letter stating that developed flow will be accepted into their project will be required prior to platting. A letter from the Stetson Hills Development will also be required for the same purpose. The total 5-year and 100-year storm runoffs for Basin C are 51.8 cfs and 107.8 cfs, respectively.

Basin D:

Basin D storm runoff will enter a swale located only on the westerly right-of-way line of Powers Boulevard. It will flow offsite into the Powers Boulevard culvert where it will follow the same path as described above. The total 5-year and 100-year storm runoffs for Basin D are 43.2 cfs and 86.6 cfs, respectively.

Basin E:

This basin consists of only a small area zoned primarily for open space and preservation areas with only a small amount of single family residential. This area drains into the Templeton Gap Basin. Due to the negligible amount of storm water runoff generated by Basin E, it was considered to have negligible downstream impact.



Proposed On-Site Drainage System

General - This study was prepared based on various conservative assumptions made with regard to the final drainage characteristics of the development. The Overlot Grading Plan is being used as the basis for the Drainage Plan attached at the back of this report. Final Grading Plans for individual parcels will be prepared as the individual parcels are platted. Listed below are the assumptions made for each sub-basin with regard to the final grading and drainage characteristics.

I. Basin A

A. Sub-Basin A-1:

This entire area will drain via a concrete lined swale to a culvert located under Rio Vista Drive (Design Point A-1). An easement for the swale will be required prior to platting and construction. A pipe may be substituted for the swale once outfall points of the individual surrounding parcels are determined. In order to accomplish the above, an easement will be required from the Out-Parcel in order to fill in the existing channel. The culvert under Rio Vista Drive will be sized for the 100-year storm event in order to reduce the 100-year storm flow at the Barnes Road/Rio Vista Drive intersection.

B. Sub-Basin A-2:

This basin consists only of Rio Vista Drive since the tracts on either side of the street do not drain into the street.

C. Sub-Basin A-3:

This basin will drain to a concrete lined swale located along the western right-of-way line of Powers Boulevard. An easement for the swale will be required prior to platting and construction. A pipe may be substituted for the swale once outfall points for the parcels contributory to the swale are determined. The runoff from this area will enter the storm sewer system at Design Point A-2.

D. Sub-Basin A-4:

This basin will drain to the proposed storm sewer located along the westerly right-of-way line of Powers Boulevard. The 5-year storm will be picked up by the storm sewer at various points along the length of the sewer. (Entry points will be determined as this area is platted.) The 100-year storm will be picked up by an area inlet located at Design Point A-3. The area inlet was sized with 50% blockage.

E. Sub-Basin A-5:

This basin will drain to Design Point A-3 via a series of curb & gutter parking lots located along the northern right-of-way line of Barnes Road. The storm runoff will enter the storm drain system via an area inlet located at Design Point A-3

F. Barnes Road:

No drainage other than street drainage will be allowed to enter the Barnes Road right-of-way. All sheet flow from adjacent tracts will be directed to the outfall point shown on the attached drainage plan via curb and gutter parking lots.

G. Alternate Analysis:

Several alternates were evaluated in order to determine the most cost effective method of directing the storm runoff to the outfall point. These analyses are included in subsequent sections of this report.

II. Basin B

A. Sub-Basin B-1:

The majority of this basin consists of Out-Parcels. Development density for each parcel was determined based on the most recent plans for these areas.

B. Sub-Basins B-2 through B-7:

Sub-Basins B-2, B-3, B-4, and B-5 include Out-Parcels for which development densities were assumed. Inlets were required at the locations shown on Chaparral Drive and Rio Vista Drive in order to reduce the 5-year storm flow in the gutters. The inlet located at Design Point B-5 is a sump which will reduce 100-year storm flow entering Barnes Road. The inlets located in Barnes Road were required in order to reduce the 100-year flow in the Barnes Road gutter.

II. Basin C

A. Sub-Basins C-1 and C-2:

These basins will drain directly into Rio Vista Drive. Inlets were located based on the allowable 5-year street capacities.

B. Sub-Basin C-3:

It was assumed that this basin would drain to Rio Vista Drive via a curb and gutter street entering the SFR site at Design Point C-3. In order to accommodate this, a storm sewer will be stubbed into this area and all downstream facilities sized accordingly. Additional public storm sewer facilities will probably be required in the SFR site, but the location and size will be determined as the SFR site is platted.

C. Sub-Basin C-4:

This basin will drain directly into Rio Vista Drive.

D. Sub-Basin C-5:

This basin consists only of Rio Vista Drive since the adjacent tracts slope away from the road. An inlet is not required since the street capacity was not exceeded.

IV. Basin D

A. Sub-Basin D-1:

This basin will drain to a concrete lined swale located along the western right-of-way line of Powers Boulevard. The storm runoff will outfall into the Old Farm Heights Subdivision at Design Point D-1. A storm sewer can be substituted for the concrete lined channel. Its size and location will depend upon how this area is platted and developed.

B. Sub-Basin D-2:

This basin will drain to a private swale located along the northerly property line of the project. It will outfall into the Old Farm Heights Subdivision at Design Point D-1.

V. Basin E

This basin consists of preservation areas, open spaces and a minimal amount of single family residential area. Areas E-1 and E-2 drain into the Old Farm development. This area was included in the Old Farm Master Drainage Study as a part of a 29.2 acre drainage sub-basin with an average CN value of 81. Area E-1 will be changed from agricultural land to an SFR lot. The increase in runoff from this change is insignificant. Area E-2 (open space only) will be developed as a park with only light recreation equipment. The planting of shrubs and grass will reduce the runoff rate from this area. The remainder of E-2 will remain a preservation area as described in the Old Farm Drainage Report. Area E-3 drains into The Ridge Subdivision and is so small that its impact as a single family lot is very minimal.

Proposed Offsite Drainage Considerations

I. Basins A and B Offsite

A. From Rio Vista/Barnes Road to Barnes Road/Powers Boulevard. Two alternates were analyzed regarding how to direct the storm flow from Rio Vista at Barnes Road to Barnes Road at Powers Boulevard drainage structure where it would pass under Barnes Road.

Alternate #1:

Intercept the 100-year flow at Rio Vista and transfer it to Powers Boulevard structure via a concrete lined channel and there pass under Barnes Road via a box culvert. The design of the box culvert was based on inlet control with a HW/D=1.2. Because of this criteria, a large box would be required in order to pass the storm flow under Barnes Road.

Alternate #2:

Intercept the 100-year flow at Rio Vista and at various points along the north side of Barnes Road and pipe it as shown in the drainage plan attached to the back of the report. This alternate proved more cost effective since it eliminated the need for the large box culvert under Barnes Road at Powers Boulevard.

(Refer to Alternate Analysis Section for backup.)

B. From Barnes Road/Powers Boulevard intersection to existing natural outfall point located on the east side of Powers Boulevard south of Barnes Road.

Alternate #1:

The storm runoff would outfall into a temporary rip-rap ditch located along the west side of Powers Boulevard. The water would then flow to the existing low point and into the existing 66 inch CMP located under Powers Boulevard. This pipe would have to be replaced with a much larger box culvert in order to accommodate the High Chaparral Development as well as the proposed development for the tract south of Barnes Road and west of Powers Boulevard. The box culvert would be constructed across the entire right-of-way of Powers Boulevard and the outfall into the existing channel located to the east of Powers Boulevard.

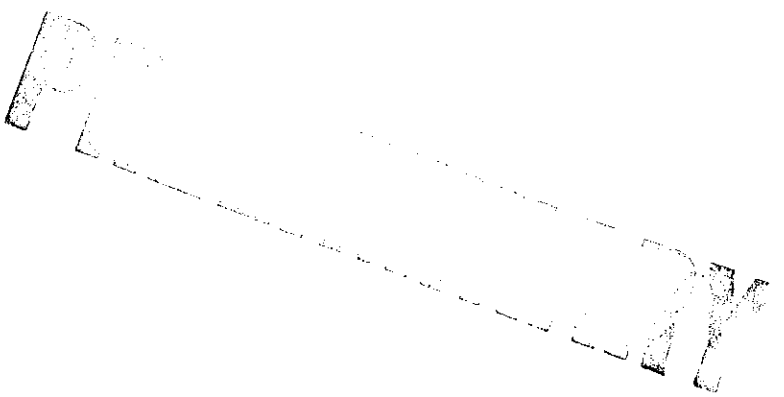
Alternate #2:

The storm runoff would outfall into a permanent concrete lined ditch located along the east side of Powers Boulevard where it would be carried to the natural outfall point east of Powers Boulevard. As a result of this change, the culvert under Powers Boulevard can be reduced substantially, thus resulting in a considerable savings (see Engineer's Cost Estimate and Alternate Analysis). M.L. Properties currently owns the tract that would be accepting the developed flow from High Chaparral. A letter would be obtained stating this fact.

II. Basins C and D Offsite

The runoff from Basin C will be contained in Rio Vista Drive and will flow offsite to a sump located at the natural low point in the Old Farm Heights Subdivision (see copy of Old Farm Heights Drainage Map). From here, the water will flow to the Powers Boulevard structure via a lined channel or a piped system. Depending upon whether or not the storm runoff is contained in a pipe or in a channel will determine the size of culvert required under Powers Boulevard. It is assumed at this time that this culvert will need to be replaced. Once under Powers Boulevard, the water will enter a channel to be constructed through the Stetson Hills Development. This channel has been sized to accept the developed flow from both the High Chaparral Development and from the Old Farm Heights Development. All of the downstream structures will have to be in place prior to allowing High Chaparral to discharge. Letters from the various property owners will be required prior to platting.

The assumptions used in the Stetson Hills Master Drainage Study were conservative (attached are copies of portions of that study).



Preliminary Engineer's Cost Estimate

The following Cost Estimate is a reflection of what is shown on the attached Drainage Plan. It also represents the lowest cost and therefore provides a basis for the Sand Creek Drainage Basin reimbursement program. Alternates were analyzed for several sections of the storm sewer system and will be described following this estimate.

Quantity Cost Estimate - Basin A

	Description	Quantity	Unit	Unit Price	Total
1.	42" RCP Culvert	1290	L.F.	$ 62.00	$ 79,980.00
2.	48" RCP	680	L.F.	78.00	53,040.00
3.	54" RCP	130	L.F.	100.00	13,000.00
4.	Manholes	2	EACH	1,500.00	3,000.00
5.	Inlets (D 10 R): 6'	2	EACH	2,000.00	4,000.00
6.	Area Sump	1	EACH	4,500.00	4,500.00
7.	42" Flared End Section	1	EACH	700.00	700.00
8.	42" Headwall and Wingwalls	1	EACH	1,100.00	1,100.00
	Swale "A"				
9.	Excavation	2,500	C.Y.	1.10	2,750.00
10.	Reinforced Concrete Channel Lining	280	C.Y.	250.00	70,000.00
	Swale "B"				
11.	Excavation	2,850	C.Y.	1.10	3,135.00
12.	Reinforced Concrete Channel Lining	320	C.Y.	250.00	80,000.00
	Subtotal				$315,205.00

Quantity Cost Estimate - Basin B

	Description	Quantity	Unit	Unit Price	Total
1.	18" RCP	720	L.F.	$ 24.00	$ 17,280.00
2.	24" RCP	95	L.F.	30.00	2,850.00
3.	30" RCP	330	L.F.	38.00	12,540.00
4.	36" RCP	200	L.F.	50.00	10,000.00
5.	42" RCP	880	L.F.	62.00	54,560.00
6.	72" RCP	330	L.F.	178.00	58,740.00

Basin B (cont.)

	Description	Quantity	Unit	Unit Price	Total
7.	Manholes	5	EACH	1,500.00	7,500.00
8.	Inlets (D 10 R):				
	6'	2	EACH	2,000.00	4,000.00
	8'	1	EACH	2,400.00	2,400.00
	14'	5	EACH	3,200.00	16,000.00
	22'	1	EACH	4,400.00	4,400.00
9.	Junction Box	1	EACH	5,000.00	5,000.00
10.	Outfall Headwall and Wingwalls for 72" Pipe	1	EACH	2,000.00	2,000.00
11.	36" x 18" - 45° Wye	1	EACH	550.00	550.00
12.	30" x 18" - 45° Wye	1	EACH	500.00	500.00
	Subtotal				$198,320.00

Quantity Cost Estimate - Basin C

	Description	Quantity	Unit	Unit Price	Total
1.	18" RCP	360	L.F.	$ 24.00	$ 8,640.00
2.	24" RCP	240	L.F.	30.00	7,200.00
3.	27" RCP	600	L.F.	34.00	20,400.00
4.	30" RCP	30	L.F.	38.00	1,140.00
5.	Standard Manholes	5	EACH	1,500.00	7,500.00
6.	Inlets (D 10 R):				
	14'	3	EACH	3,200.00	9,600.00
	Subtotal				$ 54,480.00

Quantity Cost Estimate - Basin D

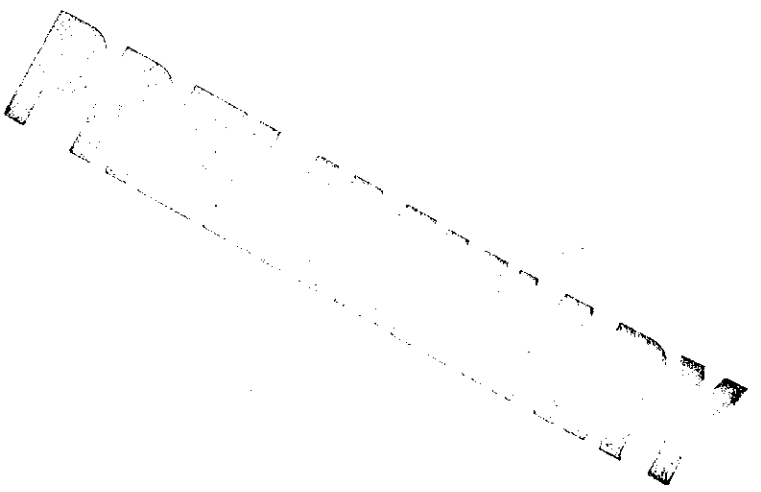
	Description	Quantity	Unit	Unit Price	Total
	Swale "C"				
1.	Excavation	3,250	C.Y.	$ 1.10	$ 3,575.00
2.	Reinforced Concrete Channel Lining	365	C.Y.	250.00	91,250.00
	Subtotal				$ 94,825.00

Construction Cost Summary

Basin A	$315,205.00
Basin B	198,320.00
Basin C	54,480.00
Basin D	94,825.00
Subtotal	662,830.00
15% Engineering	99,424.00
TOTAL REIMBURSIBLE	$762,254.00

Basin Fee Summary

Sand Creek Basin Area -- 117.1 Acres	
1986 Basin Fee @ $5,034.00/Acre	$589,481.40
1986 Bridge Fee @ $420.00/Acre	49,182.00
Subtotal	638,663.40
Templeton Gap Basin Area -- 12.4 Acres	
1986 Basin Fee @ $2,436.00/Acre	$ 30,206.40
1986 Bridge Fee @ $28.00/Acre	347.20
Subtotal	30,553.60
TOTAL BASIN FEES (Current)	$669,217.00



Engineer's Cost Estimate - Alternate Analyses

The following Cost Estimates were made in order to determine the most cost effective drainage system required to drain the High Chaparral Development.

Alternate Analysis No. 1

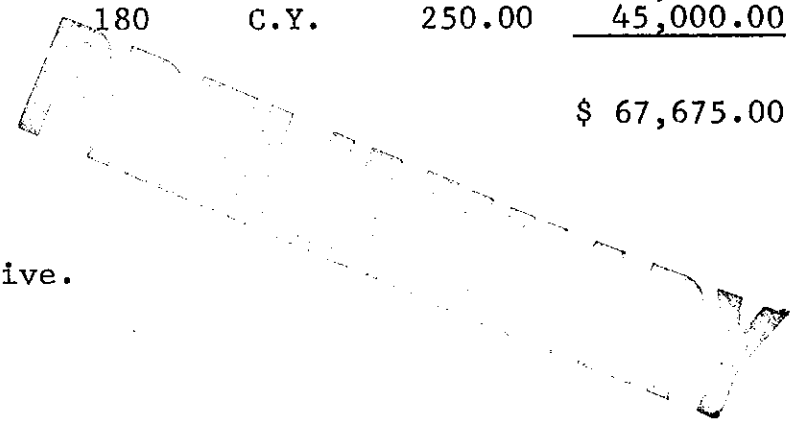
Location: Design Point A-1 to A-2:

	Description	Quantity	Unit	Unit Price	Total
Option #1 - Piped					
1.	Entrance Headwall and Wingwall	1	EACH	$1,300.00	$ 1,300.00
2.	42" RCP from Entrance to A-2	790	L.F.	62.00	48,980.00
3.	Manholes for 42" Pipe	2	EACH	1,500.00	3,000.00
4.	6' D 10 R Inlets on Rio Vista Drive	2	EACH	2,000.00	4,000.00
	Subtotal				$ 57,280.00

	Description	Quantity	Unit	Unit Price	Total
Option #2 - Channel					
1.	Entrance Headwall and Wingwall	1	EACH	$1,300.00	$ 1,300.00
2.	42" RCP from Entrance to Channel Outfall	230	L.F.	62.00	14,260.00
3.	Exit Headwall and and Wingwall	1	EACH	1,300.00	1,300.00
4.	6' D 10 R Inlets in Rio Vista Drive	2	EACH	2,000.00	4,000.00
5.	Channel Excavation	1650	C.Y.	1.10	1,815.00
6.	Reinforced Concrete Lining (4" Thick)	180	C.Y.	250.00	45,000.00
	Subtotal				$ 67,675.00

Summary

Option #1 is less expensive.



Alternate Analysis No. 2

Location: Design Point A-2 to A-3:

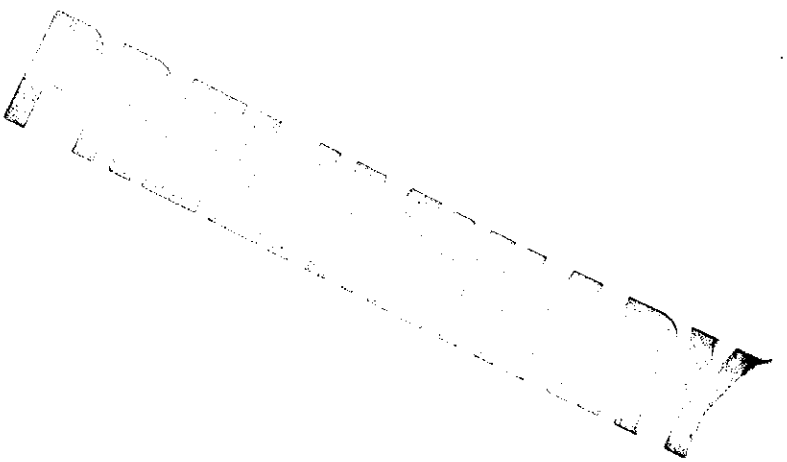
Description	Quantity	Unit	Unit Price	Total
Option #1 - Fully Enclosed Pipe				
1. Entrance Headwall at Point A-2	1	EACH	$1,300.00	$ 1,300.00
2. 42" RCP	500	L.F.	62.00	31,000.00
3. 48" RCP	680	L.F.	78.00	53,040.00
4. Area Inlet at Point A-3	1	EACH	3,000.00	3,000.00
5. Standard Manholes	4	EACH	1,500.00	6,000.00
Subtotal				$ 94,340.00

Description	Quantity	Unit	Unit Price	Total
Option #2 - Concrete Lined Ditch				
1. Channel Excavation	2800	C.Y.	$ 1.10	$ 3,080.00
2. Reinforced Concrete	465	C.Y.	250.00	116,250.00
Subtotal				$119,330.00

Note: The above does not include any drop structures or energy dissipation structures which may be required.

Summary

Option #1 is less expensive.



Alternate Analysis No. 3

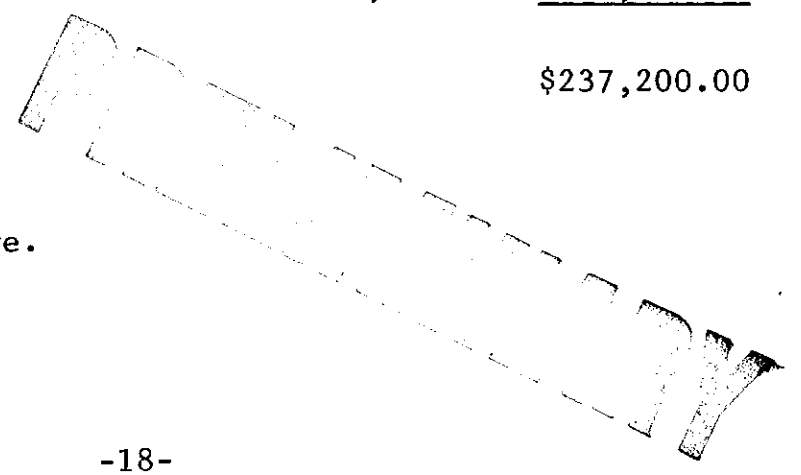
Location: From Point 5B to High Chaparral Outfall Located South of Barnes Road and East of Powers Boulevard.

	Description	Quantity	Unit	Unit Price	Total
Option #1 - Piped					
1.	18" RCP	310	L.F.	$ 24.00	$ 7,440.00
2.	36" RCP	250	L.F.	50.00	12,500.00
3.	42" RCP	890	L.F.	62.00	55,180.00
4.	54" RCP	130	L.F.	100.00	13,000.00
5.	72" RCP	300	L.F.	178.00	53,400.00
6.	Inlets (D 10 R):				
	14'	2	EACH	3,200.00	6,400.00
	6'	2	EACH	2,000.00	4,000.00
7.	Standard Manholes	3	EACH	1,500.00	4,500.00
8.	Junction Box (M.H. 9B)	1	EACH	5,000.00	5,000.00
9.	Outfall Headwall and Wingwall for 72" Pipe	1	EACH	2,000.00	2,000.00
	Subtotal				$163,420.00

	Description	Quantity	Unit	Unit Price	Total
Option #2 - Open Channel					
1.	18" RCP	100	L.F.	$ 24.00	$ 2,400.00
2.	36" RCP	90	L.F.	50.00	4,500.00
3.	Channel Excavation	3000	C.Y.	1.10	3,300.00
4.	Channel Lining - Reinforced Concrete	450	C.Y.	250.00	112,500.00
5.	Barnes Road Guardrail	900	L.F.	15.00	13,500.00
6.	Entrance Headwall and Wingwall for 8x6 RCB	1	EACH	2,500.00	2,500.00
7.	8' x 6' Box Culvert	400	L.F.	240.00	96,000.00
8.	Exit Headwall and Wingwall for 8x6 RCB	1	EACH	2,500.00	2,500.00
	Subtotal				$237,200.00

Summary

Option #1 is less expensive.



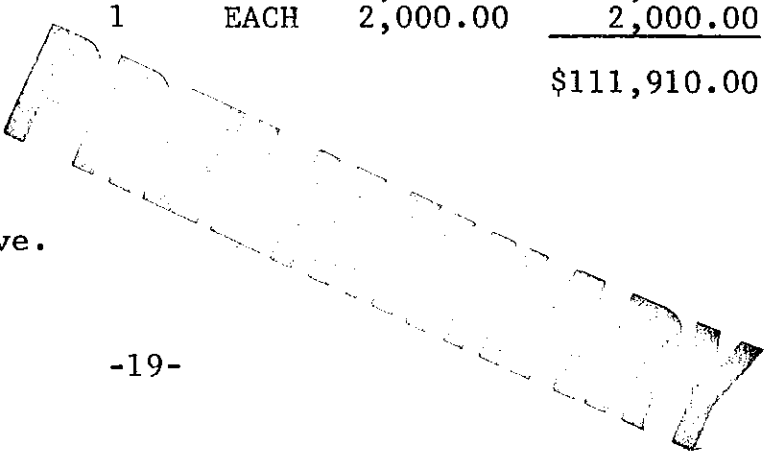
Alternate Analysis No. 4

The purpose of the following analysis is to determine the most cost effective method of draining both the High Chaparral Development and the tract to the south and west of Barnes Road and Powers Boulevard. (Refer to Alternate Analysis #4 - Appendix for calculations and maps.)

Location: Drainage Facilities for High Chaparral Outfall to the Natural Channel on the East Side of Powers Boulevard.

	Description	Quantity	Unit	Unit Price	Total
	Option #1 - Outfall South and West of Barnes Road and Powers Boulevard, Respectively				
1.	Channel Excavation	1200	C.Y.	$ 1.10	$ 1,320.00
2.	Reinforced Concrete Channel Lining	165	C.Y.	250.00	41,250.00
3.	Box Culvert Headwall and Wingwalls	2	EACH	2,700.00	5,400.00
4.	Box Culvert - Double 6 x 6	300	L.F.	360.00	108,000.00
5.	Guardrail on Powers Boulevard - Outfall on M.L.'s Property	400	L.F.	15.00	6,000.00
	Subtotal				$161,970.00

	Description	Quantity	Unit	Unit Price	Total
	Option #2 - Outfall South and East of Barnes Road and Powers Boulevard, Respectively				
1.	Channel Excavation	4100	C.Y.	$ 1.10	$ 4,510.00
2.	Concrete Channel Lining	200	C.Y.	250.00	50,000.00
3.	72" Pipe Under Powers Boulevard	300	L.F.	178.00	53,400.00
4.	Entrance Headwalls	1	EACH	2,000.00	2,000.00
5.	Exit Headwall	1	EACH	2,000.00	2,000.00
	Subtotal				$111,910.00



Summary

Option #2 is less expensive.

Conclusions and Recommendations

The purpose of this study was to analyze and size the major drainage facilities necessary for the development of High Chaparral. The results of this analysis are summarized on the Drainage Plan accompanying this report.

It is intended that this report be used as a basis for the design of drainage facilities within the individual parcels of High Chaparral and that the drainage pattern established herein not be altered without careful consideration of how it will effect the remainder of the system.

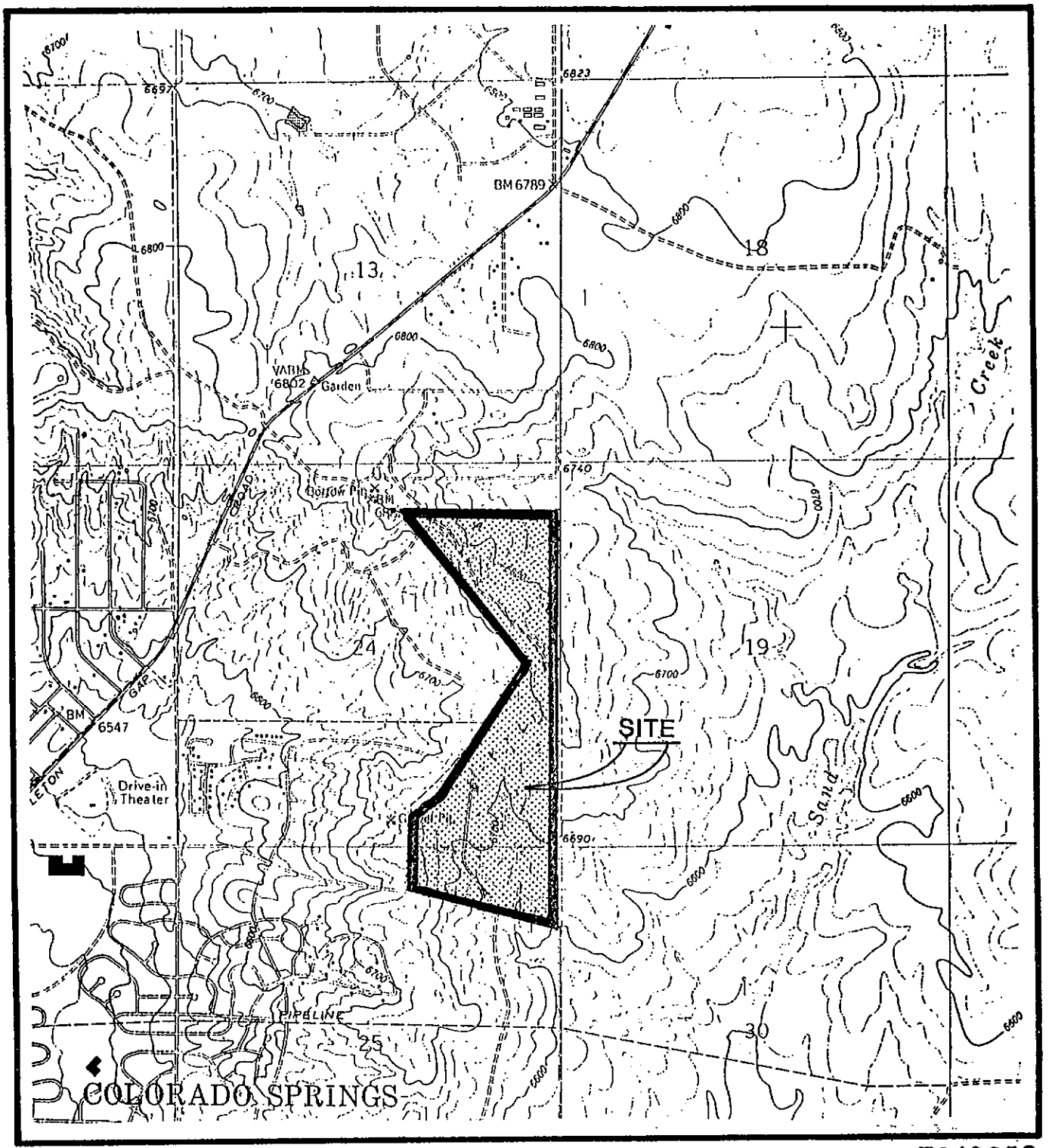
SUBMITTED FOR REVIEW AND APPROVAL:

Prepared By: Kenneth C. Harrison 4/16/86
KENNETH C. HARRISON, P.E.

Reviewed By: Barney J. Fix 4/16/86
BARNEY J. FIX, P.E.

PRELIMINARY

A P P E N D I X



VICINITY MAP

SCALE 1"=2000'

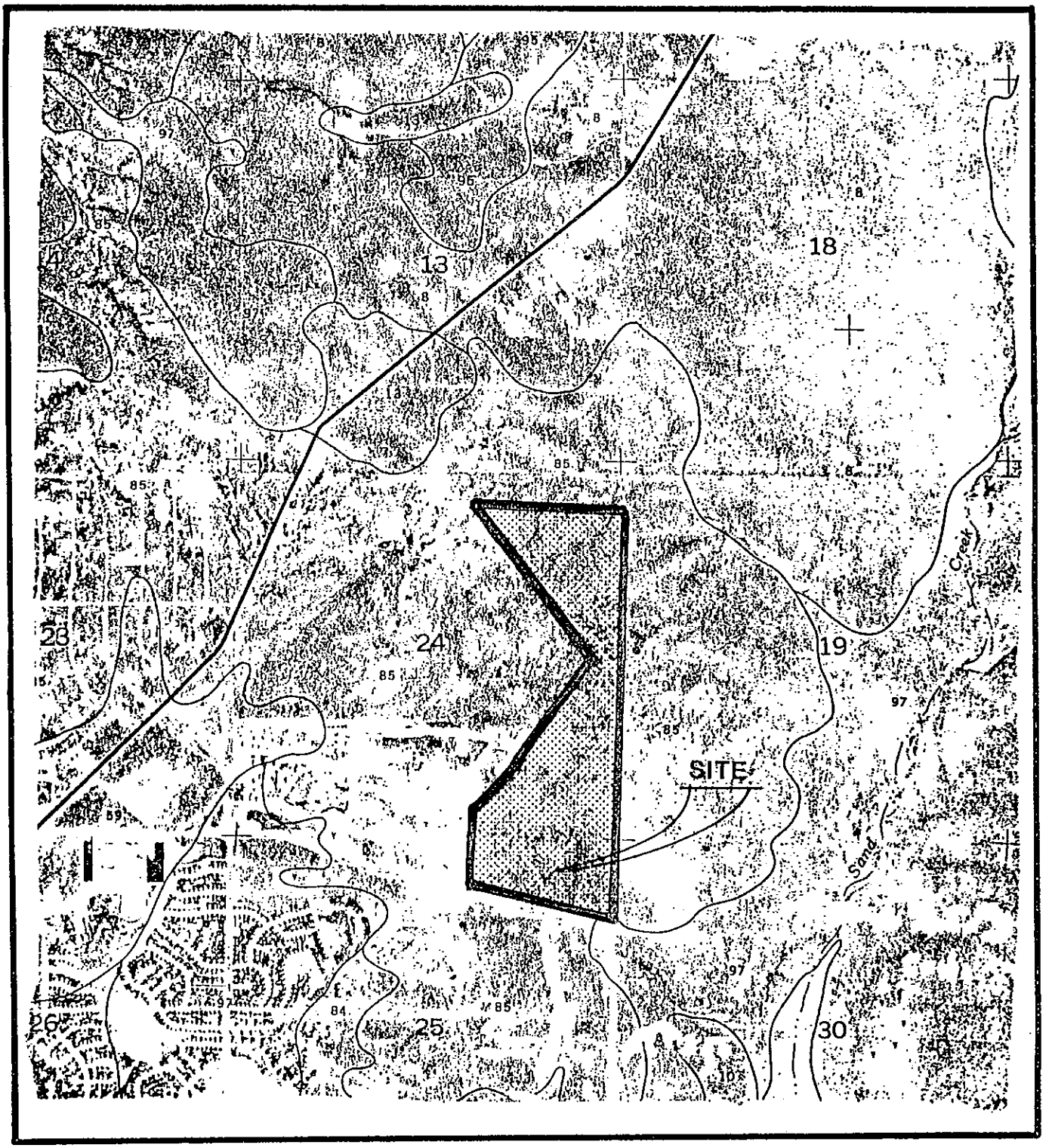
T24&25S

R66W

FALCON NW QUADRANGLE

GREINER ENGINEERING SCIENCES, INC.

FIGURE 1



SOILS MAP

SCALE 1"=2000'

TAKEN FROM SOILS CONS. SERVICE MAP

GREINER ENGINEERING SCIENCES, INC.

FIGURE 2

Table 2 - Runoff curve numbers for selected agricultural, suburban, and urban land use. (Antecedent moisture condition II, and $I_a = 0.2S$)

Land Use Description		Hydrologic Soil Group A	B	C	D
Cultivated land[1]:	without conservation treatment	72	81	88	91
	with conservation treatment	62	71	78	81
Pasture or range land:	Poor condition	68	79	86	89
	Good condition	39	61	74	80
Meadow:	Good condition	30	58	71	78
Wood or Forest land:	thin stand, poor cover, no mulch	45	66	77	83
	good cover[2]	25	55	70	77
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: [3]					
Average lot size	Average % Impervious[4]				
1/8 acre or less	65	77	85	90	92
1/5 acre	47	65	78	85	89
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
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 National Engineering Handbook, Section 4, Hydrology, Chapter 9, August 1972.

2. Good cover is protected from grazing and litter and brush cover soil.

FIGURE 3

Table 1 -- Determination of Runoff Depth in inches for selected CN's and rainfall amounts

Curve Number [1]	(P) Rainfall (Inches) 2.10	3.50
56	0.03	0.38
58	0.05	0.45
60	0.08	0.53
62	0.11	0.62
64	0.14	0.71
66	0.18	0.80
68	0.23	0.90
70	0.28	1.01
72	0.34	1.12
74	0.40	1.24
76	0.47	1.36
78	0.54	1.50
80	0.62	1.64
82	0.71	1.78
84	0.82	1.94
86	0.92	2.10
88	1.05	2.27
90	1.18	2.45
92	1.33	2.64
94	1.49	2.84
96	1.67	3.04
98	1.87	3.27

1/ To obtain runoff depths for CN's and other rainfall amounts not shown in this table, use arithmetic interpolation or:

$$Q = \frac{CN\ (P + 2)^2 - 400\ (P+2 - \frac{100}{CN})}{CN\ (P - 8) + 800}$$

FIGURE 4

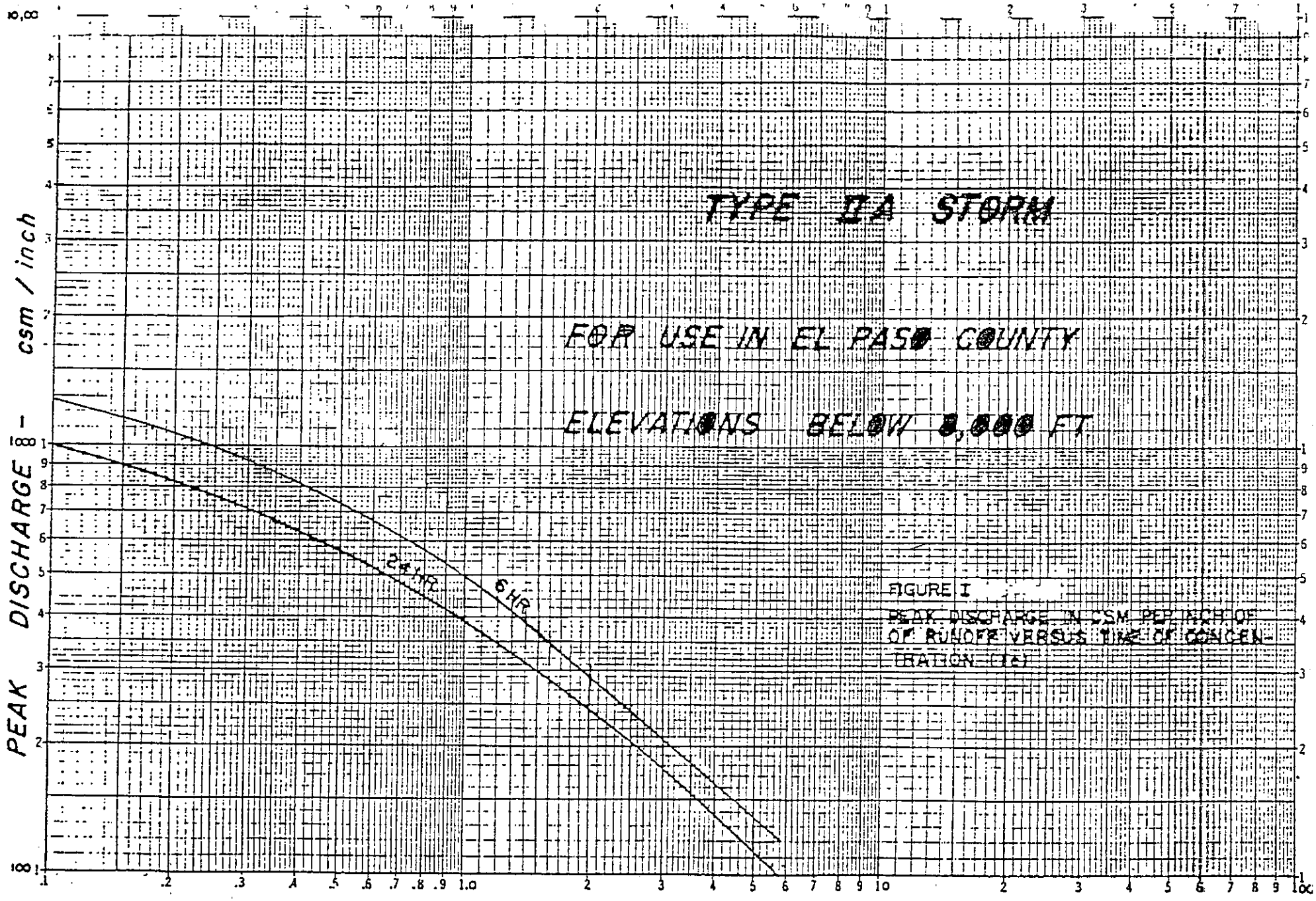
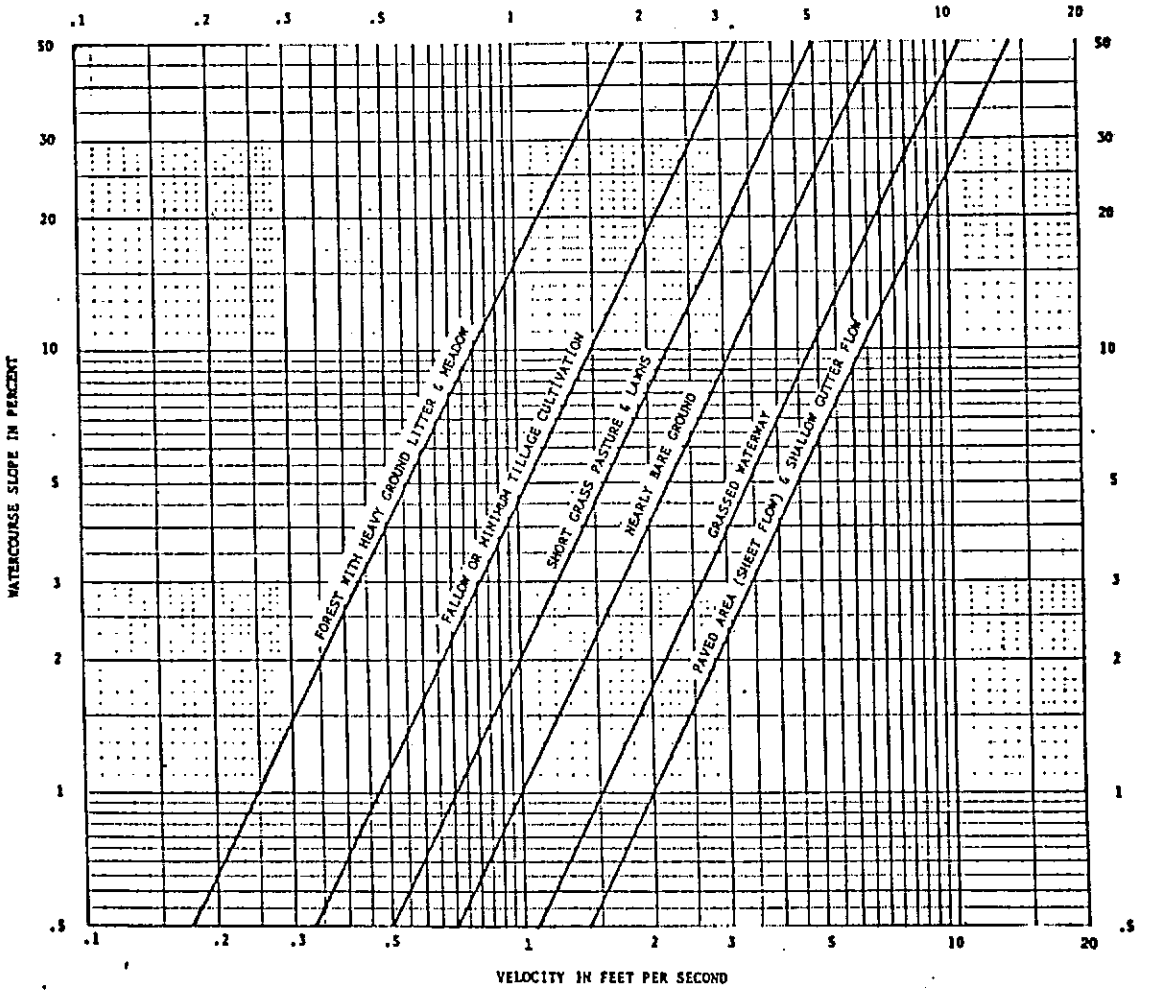


FIGURE I
PEAK DISCHARGE IN CSM PER INCH OF RUNOFF VERSUS TIME OF CONCENTRATION (Tc)

FIGURE 5



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

FROM S.C.S. TECHNICAL RELEASE No. 55

URBAN HYDROLOGY FOR SMALL WATERSHEDS

FIGURE 6

Table 5 Permissible Drainage Street Capacities with 8" Vertical Curbs *
8" Curb - Full Storm Water Capacity (with level curbs)

S %	34' Residential FPS	34' Residential CFS	36' Residential FPS	36' Residential CFS	40' Residential FPS	40' Residential CFS	34' One-Way Art. FPS	34' One-Way Art. CFS	60' & 76' Arterial FPS	60' & 76' Arterial CFS	S %
0.5	4.08	28.9	4.02	29.5	3.90	30.1		20.0		20.0	0.5
1.0	5.76	40.9	5.70	41.7	5.51	42.6		30.0		30.0	1.0
1.5	7.06	50.1	6.97	51.1	6.75	52.2	6.97	30.0	6.97	30.0	1.5
2.0	8.15	57.8	8.05	59.0	7.79	60.2	8.05	34.0	8.05	34.0	2.0
2.5	9.11	64.7	9.00	65.9	8.71	67.4	9.00	36.0	9.00	36.0	2.5
3.0	9.98	70.9	9.86	72.2	9.54	73.8	9.86	38.0	9.86	38.0	3.0
3.5	10.78	76.5	10.65	78.0	10.31	79.7	10.65	40.0	10.65	40.0	3.5
4.0	11.52	81.8	11.38	83.4	11.02	85.2	11.33	42.0	11.38	42.0	4.0
4.5	12.22	86.8	12.07	88.5	11.69	90.4	12.07	43.0	12.07	43.0	4.5
5.0	12.89	91.5	12.73	93.3	12.32	95.3	12.73	45.0	12.73	45.0	5.0
5.5	13.52	95.9	13.35	97.8	12.92	99.9	13.35	47.0	13.35	47.0	5.5
6.0	14.12	100.0	13.94	102.2	13.49	104.3	13.94	49.0	13.94	49.0	6.0

FIGURE 7

* Intermediate Values may be Obtained by Arithmetic Interpolation

CURB OPENING INLET CAPACITIES (cfs)

Table 6

NOTE: This chart reflects approx. 60% pickup of street flows

Opening Length (ft.)	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	22.0
Sump Capacity (cfs)	7.9	12.8	18.4	23.0	27.6	34.5	39.4	44.4	49.3	54.2
Street Slope %										
0.5	6.3	6.6	6.8	8.0	8.8	9.7	10.6	11.5	12.4	13.1
1.0	8.6	8.8	9.4	10.0	10.4	11.3	12.0	12.8	13.8	14.7
1.5	7.7	10.6	10.9	11.5	12.2	12.7	13.4	14.2	15.0	15.9
2.0	6.5	12.2	12.5	12.9	13.4	14.0	14.6	15.2	15.9	16.3
2.5	5.7	14.0	13.9	14.2	14.7	15.2	15.7	16.3	17.0	17.7
3.0	5.2	12.7	14.8	15.4	15.8	16.1	16.5	17.2	17.8	18.5
3.5	4.7	11.3	16.1	16.6	16.9	17.2	17.8	18.2	18.9	19.6
4.0	4.4	10.6	17.0	17.5	17.9	18.2	18.5	19.0	19.5	20.2
4.5	4.1	9.7	18.1	18.4	18.7	19.1	19.5	20.0	20.5	21.1
5.0	3.9	9.2	17.7	19.4	19.7	20.0	20.3	20.3	21.3	21.8
5.5	3.7	3.7	16.7	20.3	20.6	20.9	21.2	21.5	22.0	22.5
6.0	3.5	3.3	15.6	20.7	21.0	21.4	21.9	22.4	22.9	23.4
6.5	3.4	7.9	14.9	21.8	22.2	22.6	23.1	23.5	24.0	24.5
7.0	3.2	7.6	14.2	22.2	22.6	23.0	23.5	23.8	24.2	25.1
7.5	3.1	7.3	13.6	22.7	23.4	23.8	24.2	24.6	25.0	25.7
8.0	3.0	7.0	13.0	21.8	24.3	24.6	24.9	25.3	25.7	26.2
8.5	2.9	6.8	12.6	20.3	25.0	25.3	25.6	26.0	26.4	26.8
9.0	2.8	6.5	12.1	19.9	25.7	25.9	26.3	26.6	27.0	27.4
9.5	2.7	6.4	11.8	19.4	26.5	26.7	27.0	27.4	27.7	28.1
10.0	2.6	6.2	11.4	18.7	26.7	27.2	27.6	28.0	28.3	28.8

Revised: C.Aamold/5-16-74

FIGURE 8

BASIN SUMMARY CALCULATIONS

SUBDIVISION High Chaparral
LOCATION Colorado Springs
JOB NO. 5178806
DESIGN STORM 5 YR. RECURRENCE INTERVAL
MAJOR STORM 100 YR.
COMPUTATIONS BY K Harrison DATE 2/27/85
CHECKED BY _____ DATE _____

GREINER ENGINEERING SCIENCES, INC.
5373 N. UNION BOULEVARD
COLORADO SPRINGS, COLORADO
80918

RUNOFF COMPUTATIONS
(SCS METHOD)
$Q_p = (AQ)\, q$

Basin A

PAGE ____ OF ____

Area Designation	A (Acres) (Mi^2)	CN		Q in.	AQ $mi.^2$ -in.	ΣAQ $mi.^2$ -in.	t_c hr.	q csm / in.	Q p cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in.	Min. Slope %	Length ft.	VEL V fps	at (min)	
Design Pt A_1	23.1	83		0.77	.0278	.0278	.25	990	27.5								No runoff into street Pass under Rd Via Culvert
Area A1	.0361			1.86	.0671	.0671	"	"	66.5								
Design Pt A_1	3.3	98		1.87	.0096	—	0.25	990	9.5	34.0							Flow in Street
Area A-2	.0052			3.27	.0169	—	"	990	16.7	106							
Des. Pnt A_2	21.6	89		1.12	.0378	.0752	0.27	970	72.9								Flow Directed to Channel
Area A-3	.0338			2.36	.0797	.1637	"	970	158.8								
Des Pnt A_3	12.3	94		1.49	.0286	.1038	0.30	920	95.5								Flow Directed to Channel
Area A-4	.0192			2.84	.0546	.2183	"	"	200.8								
Des Pnt A_3	8.2	93		1.41	.0181	.1219	0.30	920	112.1								
Area A-5	.0128			2.74	.0351	.2534	"	"	233.1								

SUBDIVISION High Chaparral
LOCATION Col. Springs
JOB NO. 5178806
DESIGN STORM 5 YR. RECURRENCE INTERVAL
MAJOR STORM 100 YR.
COMPUTATIONS BY K. Harrison DATE 2/27/86
CHECKED BY _____ DATE _____

GREINER ENGINEERING SCIENCES, INC.
5373 N. UNION BOULEVARD
COLORADO SPRINGS, COLORADO
80918

RUNOFF COMPUTATIONS
(SCS METHOD)
$Qp = (AQ)\,q$

Basin "B"

PAGE ____ OF ____

Area Designation	A (Acres) (Mi^2)	CN		Q in.	AQ $mi.^2$ -in.	ΣAQ $mi.^2$ -in.	t_c hr.	q csm / in.	Q p cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in.	Min. Slope %	Length ft.	VEL V fps	at (min)	
Dsgn Pt B-1	23.3	89		1.12	.0408	.0408	.27	970	39.6								
Area B-1	0.0364			2.36	.0859	.0859	.27	970	83.3								
Dsgn Pt B-2	2.0	94		1.49	.0047	.0455	.29	940	42.8								
Area B-2	.0031			2.84	.0089	.0948	"	"	89.1								
Dsgn Pt B-3	3.6	94		1.49	.0084	—	.29	940	7.9								
Area B-3	.0056			2.84	.0160	—	"	"	15.6								
Dsgn Pt B4	2.8	94		1.49	.0065	.0604	.29	940	56.8								
Area B4	.0044			2.84	.0124	.1232	"	"	115.8								
Dsgn Pt B5	4.2	95		1.58	.0104	.0708	.32	900	63.7								
Area B5	.0066			2.94	.0193	.1425	"	"	128.2								
Dsgn Pt B6	1.0	98		1.87	.0029	.0737	.32	900	66.3								
Area B6	.0016			3.27	.0051	.1476	"	"	132.8								
Dsgn Pt B7	1.2	98		1.87	.0035	.0772	.35	870	67.2								
Area B7	.0019			3.27	.0061	.1537	"	"	133.7								

SUBDIVISION High Chaparral
LOCATION Colorado Springs
JOB NO. 5178806
DESIGN STORM 5 YR. RECURRENCE INTERVAL
MAJOR STORM 100 YR.
COMPUTATIONS BY K. Harrison DATE 2/27/85
CHECKED BY _____ DATE _____

GREINER ENGINEERING SCIENCES, INC.
5373 N. UNION BOULEVARD
COLORADO SPRINGS, COLORADO
80918

RUNOFF COMPUTATIONS
(SCS METHOD)
$Q_p = (AQ)\, q$

Basin A + B

PAGE ____ OF ____

Area Designation	A (Acres) (Mi^2)	CN		Q in.	AQ $mi.^2$ -in.	ΣAQ $mi.^2$ -in.	t_c hr.	q csm / in.	Q p cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in.	Min. Slope %	Length ft.	VEL V fps	at (min)	
ΣA	68.2	—				.1219	0.30	920	112.1								
	0.1070					.2534	0.30	"	233.1								
ΣB	38.1	—				.0772	0.35	870	67.2								
	.0595					.1537	"	"	133.7								
ΣA+B	106.3					0.1991	0.35	870	173.2								
	.1661					0.4071	0.35	870	354.2								

SUBDIVISION High Chaparral
LOCATION Col. Springs
JOB NO. 5170800
DESIGN STORM 5 YR. RECURRENCE INTERVAL
MAJOR STORM 100 YR.
COMPUTATIONS BY K. Harrison DATE 3/14/86
CHECKED BY _____ DATE _____

GREINER ENGINEERING SCIENCES, INC.
5373 N. UNION BOULEVARD
COLORADO SPRINGS, COLORADO
80918

RUNOFF COMPUTATIONS
(SCS METHOD)
$Q_p = (AQ)\, q$

Basin C

PAGE ____ OF ____

Area Designation	A (Acres) (Mi^2)	CN		Q in.	AQ $mi.^2$ -in.	ΣAQ $mi.^2$ -in.	t_c hr.	q csm / in.	Q p cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in.	Min. Slope %	Length ft.	VEL V fps	at (min)	
Dsgn Pnt C-1	7.3	93		1.41	.0161	.0161	.175	1100	17.7 cfs								
C-1	.0114			2.74	.0313	.0313	"	"	34.4 cfs								
Dsgn Pnt C-2	4.0	93		1.41	.0089	.0249	.21	1050	26.2 cfs								
C-2	.0063			2.74	.0171	.0484	"	"	50.8 cfs								
Dsgn Pnt C-3	11.6	86		0.92	.0167	.0416	.22	1025	42.6								
C-3	.0181			2.10	.0381	.0865	"	"	88.6								
Dsgn Pnt C-4	8.0	90		1.18	.0148	.0564	.30	920	51.8								
C-4	.0125			2.45	.0306	.1171	"	"	107.8								

SUBDIVISION High Chaparral
LOCATION Col Springs
JOB NO. 517806
DESIGN STORM 5 YR. RECURRENCE INTERVAL
MAJOR STORM 100 YR.
COMPUTATIONS BY K. Harrison DATE 3/17/86
CHECKED BY ____ DATE ____

GREINER ENGINEERING SCIENCES, INC.
5373 N. UNION BOULEVARD
COLORADO SPRINGS, COLORADO
80918

RUNOFF COMPUTATIONS
(SCS METHOD)
$Qp = (AQ)\, q$

Basin D

Area Designation	A (Acres) (Mi²)	CN		Q in.	AQ mi.² -in.	ΣAQ mi.² -in.	t_c hr.	q csm/in.	Q p cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in.	Min. Slope %	Length ft	VEL V fps	Δt (min)	
Des. Pnt. D-1	15.0	91		1.26	.0295	.0295	0.21	1050	31.0								
D-1	.0234			2.55	.0598	.0598	"	"	62.8								
Des. Pt. D-1	5.3	93		1.41	.0117	.0412	0.21	1050	43.2								
D-2	.0083			2.74	.0227	.0825	"		86.6								

BACKUP FOR HYDROLOGIC CALCULATIONS

Greiner Engineering

☐ DENVER, COLORADO
☒ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral - General
JOB NUMBER 5178806 SHEET 1 OF ____
CALCULATED BY K. Harrison DATE 5/30/85
CHECKED BY D.T DATE 7/29/85

CN Calculations

A. Hydrologic Soil Types - Stapleton - Bernal Sandy Loams

1. 40% Stapleton - Group B
2. 30% Bernal - Group C
3. 30% Included
   - Blakeland Sandy Loam - Group A
   - Louviers Silty Clay loam - Group D
   - Rock Outcrop - Group D
   - Truckton Sandy loam - Group B

Assume "Ave." hydrologic soil group for included soils as Group 'C'

Therefore the project site soils consists of the following hydrologic soil groups

Group "B" = 40%

Group "C" = 60%

Greiner Engineering

☐ DENVER, COLORADO
☒ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral - General
JOB NUMBER _____ SHEET 2 OF _____
CALCULATED BY _____ DATE _____
CHECKED BY DJT DATE 7/29/85

B Average CN for each land use Area.

1. Open Space, Preservation Area, & Park Area

Group "B" CN = 61

Group "C" CN = 74

Factored CN = $\frac{(40)61 + 60(74)}{100} \approx 69$

OPEN SPACE PRESERVATION PARK AREAS	=	69

2. Single Family (3-5 DU/Acre)

SF Group "B" CN = 78

SF Group "C" CN = 85

Factored "CN" = $\frac{40(78) + 60(85)}{100} \approx 82$

Single Family 3-5 DU/Acre	=	82

3. Single Family (8 DU/Acre)

Group "B" CN = 85

Group "C" CN = 90

Factored CN = $\frac{40(85) + 60(90)}{100}$ 88

Single Family 8/DU./Acre	=	88

4, Commercial to include
Off/ Research
Ret/office
Multi Family
Commercial

Group "B" CN = 92

Group "C" CN = 94

Factored "CN" = $\frac{40(92)+60(94)}{100} \approx 93$

Commercial =	93

5. Streets

Streets	98

BASIN A

Greiner Engineering

☐ DENVER, COLORADO
☐ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral
JOB NUMBER 578806 SHEET 1 OF
CALCULATED BY K. Harrison DATE 2/27/86
CHECKED BY DATE

Basin A

I Design Pnt. A.

A General

It is proposed to drain Area A-1 via a swale as shown on the drainage plan. This is based on the assumption that offsite grading and channel construction can be done within the Out Parcel. The runoff will then pass through under Rio Vista via a culvert and then will outfall into a small ditch located on the zoning boundary line. The water will then be discharged into a borrow ditch along the western Powers Blvd right of way. Inlets will be located on top of the pipe in order to alleviate street drainage problems.

B Area to be drained

	Acreage	CN
Single Family (3-5/Acre)	5.8	82
Single Family (8/Acre)	4.4	88
Parks	5.4	69
Single Family (Out Parcel) 8/Acre	5.0	88
Multi Family (" ") 10/Acre	2.5	93
	23.1	83 Ave CN

C. P_5 = 0.77 inches P_{100} = 1.86 inches

D time of Concentration

Initial =	10 min.
Overland flow (400L. F, 6%, 2.5fps	2.6
Ditch (1300ft, assumb 10fps)	2.2
Total	14.8 ∴ or .25

E q = 1990

F $Q_P = PAq$

$Q_{P_5} = 0.77\left(\frac{23.1}{640}\right)990 =$

$Q_{P_5} = 27.5$ cfs

$Q_{P_{100}} = 1.86\left(\frac{23.1}{640}\right)(990)$

$Q_{P_{100}} = 66.5$ cfs

Greiner Engineering

☐ DENVER, COLORADO
☒ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral
JOB NUMBER 5178806 SHEET 2 OF ____
CALCULATED BY K. Harrison DATE 2/27/85
CHECKED BY ____ DATE ____

II Design of Inlets over the culvert @ Design Pnt. A,

A General
Inlets will be located over the 48" pipe in order to pick up some of the street flows on Rio Vista

B Area to be drained

	Area	CN
Road (2400 L.F. 60 ft wide (each side)]	3.3	98

C. $P_5 = 1.87$ $P_{100} = 3.27$

D. t_c = use the same t_c as @ Pt A =
$t_c = .25$

E. $q = 990$

F. Flow @ Design Pt A - (on Street)
$Q_{P5} = 9.5$ cfs $Q_{P100} = 16.7$ cfs

G. Design Inlets
Design inlets to pickup only the 5yr storm; bypass the 100 yr.
Flow in each gutter = $9.5/2 \approx 5.0$ cfs
Assume 40% bypass
∴ Inlet sized @ $5.0/(60) = 8.3$ cfs
Street Slope = ≈ 3%
Inlet Size 6 ft
Q_{center} = 7.6 cfs

H. Inlet Calcs

	5yr	100 year
Flow in Gutters =	5.0 cfs	8.5 cfs
Q_{center} @ inlet =	-7.6	-7.6 cfs
Q_{bypass}	0	0.9 cfs

Greiner Engineering

☐ DENVER, COLORADO
☒ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral
JOB NUMBER 5178806 SHEET 3 OF ____
CALCULATED BY K. Harrison DATE 2/27/86
CHECKED BY ____ DATE ____

III Design Pt A-2

A. General

This point is located at the intersection of the ~~con~~ proposed east-west channel and the north-south channel located on the west side of Powers Blvd.

B. Area to be Drained

	Area	CN
Open Space	3.8	69
ORD	15.8	93
Powers Blvd (1700 L.F. @ 50 ft)	2.0	98
	21.6	89 CN AVE.

C. P_5 = 1.12 P_{100} = 2.36

D. Determine t_c

t_c @ Pt A_1 =	14.8 min.
Δt_c @ Pt A_2 =	1.2 min
(550 L.F. @ Ditch @ 8 fps)	
Total t_c	16 min = .27

E = q = 970

F. Flow @ Pt A_2

(See Calc Sheet)

Q_{P5} = 72.9 Q_{P100} = 158.8

This flow is in a ditch which will either be located in/with the Powers Blvd R.O.W. or inside an easement adjacent to the R.O.W.

Greiner Engineering

☐ DENVER, COLORADO
☒ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral
JOB NUMBER 5178896 SHEET 4 OF ____
CALCULATED BY K. Harrison DATE 2/27/86
CHECKED BY ____ DATE ____

IV Design Pnt A_3

A. General

The storm runoff will be carried to this point via a channel located along the western right of way line on Powers Blvd. The location of this ditch is not determined yet due to the preliminary ~~Sketch~~ design for Powers Blvd. It is assumed ~~that~~ the ditch will be located in an easement just west of the Powers Blvd R.O.W.

B Area to be drained

	Area	CN
ROSC	11.0	93
Powers Blvd (110 @ 50ft)	1.3	98
Total	12.3	94

C. P_5 = 1.49 P_{100} = 2.84

D t_c

t_c @ Pnt A_2 =	16 min	
A t_c @ Pnt A_3 (1200ft/channel @ 12fps)	1.7 min	
	17.7 min	or .30

E q = 9.29

F

Q_{P5yr} = 95.5 total or 37.2 off of Area A-4

Q_{P100yr} = 200.8 total or 71.6 off of Area A-4

V Design Pnt A_2

A General
Since the 100yr Capacity of Barnes Rd is so low the water coming off of Area A-5 needs to be intercepted prior to entering Barnes Rd. Due to the small area, this can be done with a concrete curb and gutter parking lot. The water will be directed to Pnt A-3 and will enter the storm sewer system via an area sump inlet.

B. Area to be drained

RDSC	8.2 Acres	93

C. $P_5 = 1.41$ $P_{100} = 2.74$

D t_c - Barnes Area A-4 $t_c = .30$ min

E $Q = 920$

F $Q_5 = 112.1$ $Q_{100} = 233.1$

G. The actual flows entering the area sump inlet is not dependent upon the t_c of .30 since the peak flow will enter the inlet earlier.
The t_c = .30 is to be used in order to size the pipe (downstream

Q_{enter} for $t_c = .30$ = 32.3 cfs

Q_{enter} for t_c = 10 min = 0.167 ~~45~~ $Q = 1150$

$$Q_{100} = P_{100} A Q$$
$$= 2.74 \left(\frac{8.2}{640}\right)(1150) = 40.4 \text{ cfs}$$

Greiner Engineering

☐ DENVER, COLORADO
☒ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

Alternate Analysis #1

PROJECT High Chaparral
JOB NUMBER 5178806 SHEET 1 OF
CALCULATED BY K. Harrison DATE 2/28/86
CHECKED BY DATE

II Design of Culvert under Rio Vista @ Pnt A,

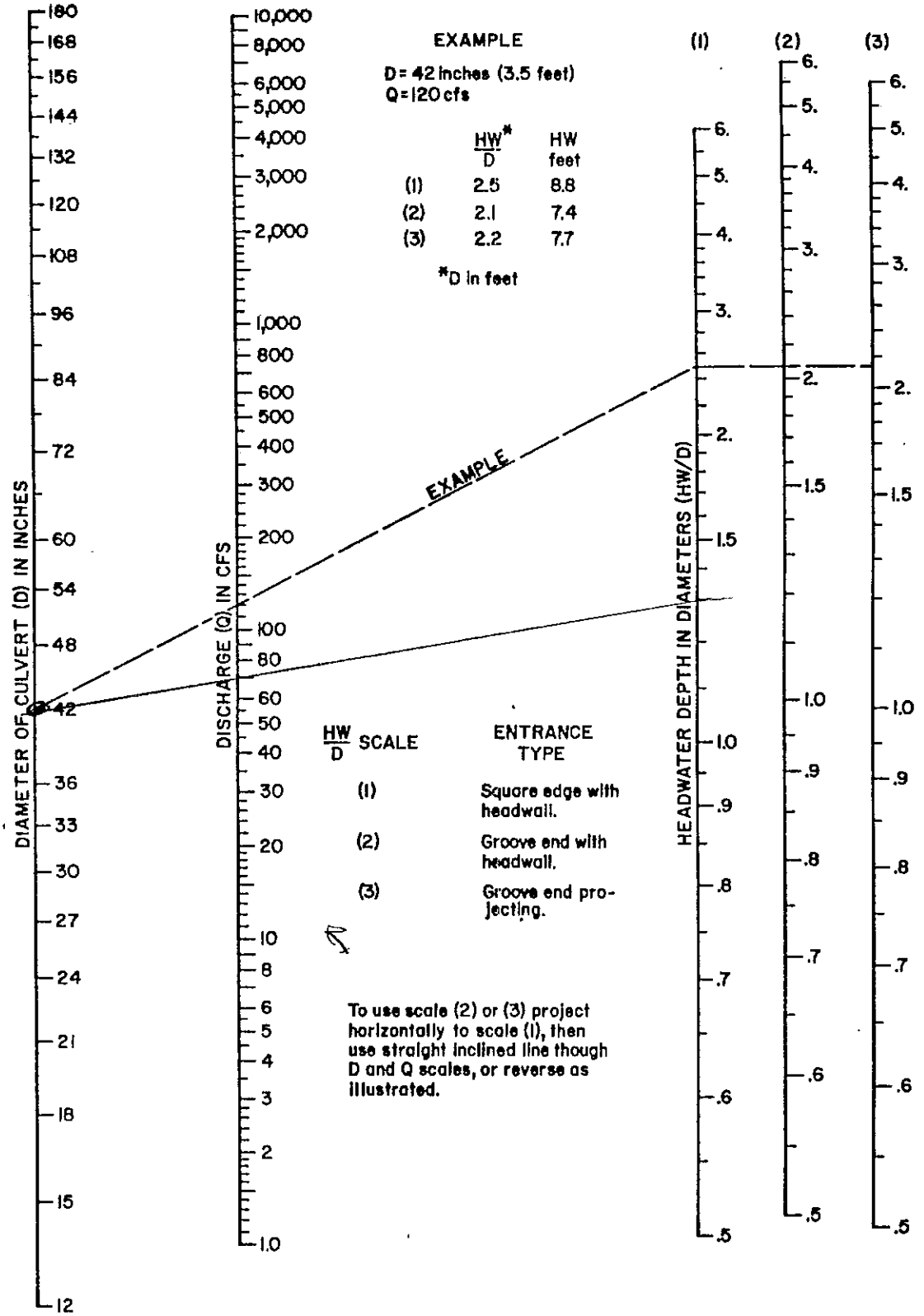
Assume Inlet Control

See following chart for prelim. design

Assume HW/D = 1.3

From the attached chart @ 42" should be sufficient to handle the flow

High Chaparral
5178806 301
K. Harrison 2/28/80



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

TEXAS HIGHWAY DEPARTMENT

Figure 8-14

Greiner Engineering

☐ DENVER, COLORADO
☐ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral
JOB NUMBER 5178806 SHEET 1 OF ____
CALCULATED BY K. Harrison DATE 2/28/86
CHECKED BY ____ DATE ____

Design of Swale "A"

I General

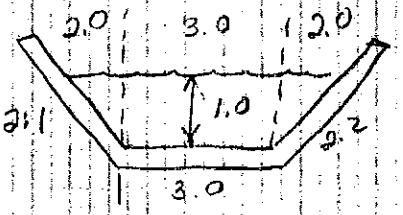
This ditch will be constructed from the Single Family site in area A-1 to design point A-1. Due to the steepness of the swale the ditch will have to be concrete lined. Possible drop structure may be required. An alternate pipe may be used more economically but its size and location will be determined once the various contributing areas are platted

II Design Considerations

A. Q outfall @ Pt A-1 = 66.5 cfs.
This is the 100yr. flow.

B. Slope of Ditch
High Pt = 6750 ±
Low Pt = 6670 ±
Difference 80 ft Length = 1300 L.F. Slope = 6.2%
N = .017

C. Trial Section



$A = \frac{1}{2}(1.0)(3+7) = 5$

$P = 3 + 2.2(2) = 7.4$

$R = .676$

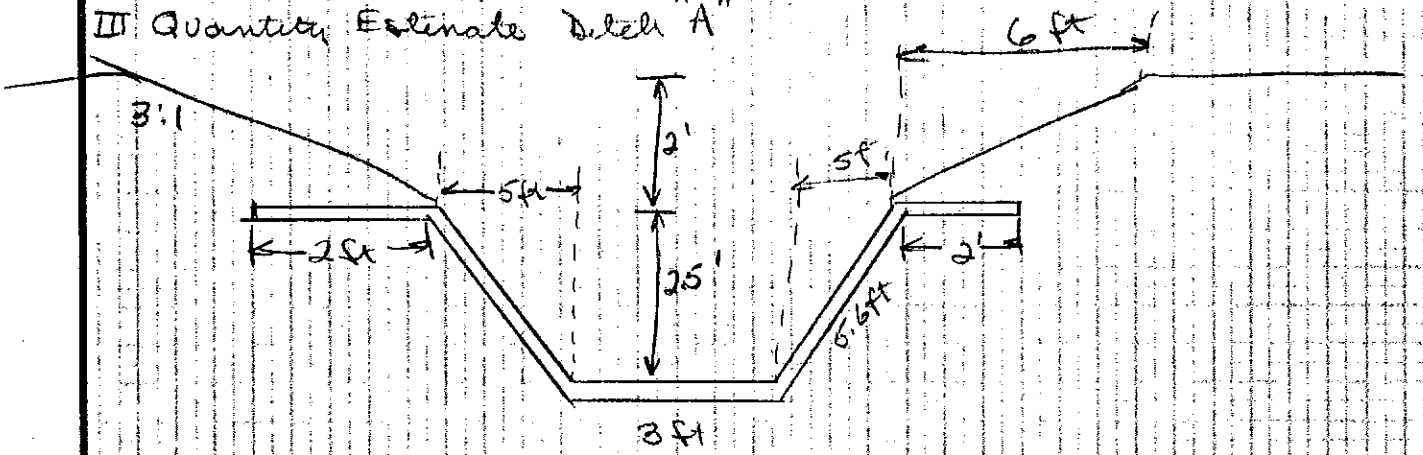
$Q = \frac{1.49}{.017}(5)(.676)^{2/3}(.062^{1/2}) = 84$ cfs

Greiner Engineering

☐ DENVER, COLORADO
☒ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral
JOB NUMBER 5178806 SHEET 2 OF ____
CALCULATED BY K. Harrison DATE 2/28/86
CHECKED BY ____ DATE ____

III Quantity Estimate Ditch "A"



Typical Section - Ditch A

Length = 1150 ft

Excavation =

$$\left[\tfrac{1}{2}(2.5)(3+13)+\tfrac{1}{2}(2)(13+25)\right]1150/27 = 2500 \text{ C.Y.}$$

Channel Lining (assume 4" thick)

$(18.2 \text{ ft})(1150)(.33)/27 = 255 \text{ C.Y.}$

10% for cutoff walls & misc. drops 25 C.Y.

Total 280 C.Y.

Greiner Engineering

☐ DENVER, COLORADO
☒ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral
JOB NUMBER 5178806 SHEET 1 OF ____
CALCULATED BY K. Harrison DATE 2/28/86
CHECKED BY ____ DATE ____

Design of Swale "B"

I General

This ditch will be constructed from the open space to design Pnt A_2. The ditch will be concrete lined. An alternate pipe may be more economical but its size and location will be determined when the contributory areas are platted. ~~Also~~

II Design Considerations

A Flow @ A_2 w/o flow from A_1 & A-2

Total @ A_2 =	158.8 (100yr - from Pg 3 - Area A calcs)
Q from A_1	- 66.5
Q from A_2 =	- 16.7
Q @ Pnt A_2	75.6 cfs

B Slope

$(6760 - 6672) / 1300 = 6.8\%$

C Trial Section

$A = \frac{1}{2}(1)(3+7) = 5$

$P = 3 + 2.2(2) = 7.4$

$R = 5/7.4 = .676$

$Q = \frac{1.49}{.017}(5)(.676)^{2/3}(.068)^{1/2} = 98$ cfs

Use same channel section as Swale A

III Quantity Estimate Swale "B"

Length = 1300 L.F. (Swale B) Length = 1150ft (Swale "A")

In order to calculate quantities, use proportions since Swale "A" has the same cross section but differs in length

Excavation

$$\frac{1300 \text{ L.F.}}{1150 \text{ L.F.}} (2500) = \approx 2850 \text{ C.Y.}$$

Lining

$$\frac{1300 \text{ L.F.}}{1150 \text{ L.F.}} (280) \approx 320 \text{ C.Y.}$$

BASIN B

Greiner Engineering

☐ DENVER, COLORADO
☐ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral
JOB NUMBER 5178806 SHEET 1 OF ____
CALCULATED BY K. Harrison DATE 2/27/86
CHECKED BY ____ DATE ____

Basin B

I Design Pt B,

A Area to be Drained

SFR (3-5/A)	5.8 Acres	82	
SFR (8/Acre)	10.0 Acres	88	
M.F (12-14/Acre)	7.3 Acres	93	
Rd (1500x20)	0.7 Acres	98	
	23.8 Acres	88.5	use 89 Ave

B P_5 = 1.12 P_{100} = 2.36

C. t_c

Init/bal =	10.0 min.
(Assumed interior Street 6%, 400 ft, 5 fps)	1.3 min.
Street - High Chap (1500 ft, 7%, 5 fps)	5.0 min.
Total t_c	16.3 or .27 hr.

D S = 970

E Q = PAS

$Q_5 = 1.12 \left(\frac{23.3}{640}\right)(970) = 39.6$

$Q_{100} = 2.36 \left(\frac{\ }{\ }\right)(\ ) = 83.3$

F Check Street Capacities

Street Slope = 5%

Street Cap 5yr = 98 cfs or 49 cfs each gutter

Street Cap 100yr = > 200 cfs

G. Design Inlet (Inlet #3)

Street Grade = 5%, Recessed type

Install 14' inlet one side

Q_{Retain} = 12.0 cfs

H. Inlet Summary

	5yr	100yr.
Flow @ Pnt B,	39.6	83.3
Q_{retain}	-12.0	-12.0
Q_{bypass}	27.6	71.3

The next design point was selected for the following reasons:

- The 5yr street capacity on Rio Vista (industrial type street; slope ± 4%) is 42cfs or 21cfs per gutter
- The 100yr. capacity on Rio Vista = 220cfs ±

Therefore another inlet will be required on High Chaparral Drive in order to reduce the cfs flow in the gutter before it reaches Rio Vista

II Design Pnt. B_2

A. General
The inlet will be located at the PCE of Chaparral Drive

B. Area to be drained

M.F Rd.	1.8 Acres	93
	0.2 Acres	98
	2.0 Acres	94 Ave.

C. $P_5 = 1.49$ $P_{100} = 2.84$

D. t_c

t_c @ Pnt B-1	16.3 min	
Δt_c @ Pnt B-2 (300 L.F @ 4%, 4fps)	1.3 min	
	17.6 min	.29 hr.

E. $I = 940$

F. Q_{P5} Total of Basin $= 42.8$ Q_{P100} (Total of Basin) $= 89.1$

G. Inlet Design - Street Slope 4%, Inlet 14', $Q_{enter} = 11$ cfs (Inlet #4)

	5 yr	100 yr
Total @ Pnt B_2	42.8	89.1
Previous pickup @ Inlet	-12.0	-12.0
Flow @ Pnt B_2	30.8 cfs	77.1 cfs
Inlet @ B_2 - Q_{enter} (Inlet #4)	-11.0	-11.0 cfs
Q_{bypass}	19.8 cfs	66.1 cfs

Greiner Engineering

Basin B

☐ DENVER, COLORADO
☒ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral
JOB NUMBER 5178806 SHEET 4 OF ____
CALCULATED BY K. Harrison DATE 2/27/86
CHECKED BY ____ DATE ____

- Once the flow from Chaparral Rd. enters Rio Vista several other sub-basins are affecting the flow in Rio Vista.
- Since the bypass at Inlet B-1 is about the inlet capacity in Rio Vista another inlet will be required on Rio Vista as soon as the water reaches the corner on Chaparral Rd.

The following calcs are required in order to size the inlet described above

III Design Pnt B_3

A General
Even though street capacity at this point is not reached, any flow (Q_5) at this point cannot enter Rio Vista due to the allowable inlet capacity in Rio Vista. Therefore an inlet shall be designed to pick up 100% of the 5 yr. flow at this point

B. Area to be drained

Road (Chaparral - 1700×20)	0.8 Acres	98
Multi Family	1.5 Acres	93
Multi Family (Old Parcel)	1.3 Acres	93
	3.6 Acres	94

C $P_5 = 1.49$ $P_{100} = 2.84$

D t_c - Same as Pnt $B_2 = .29$ hr

E. Total Q @ Pnt. B_2 =

$Q_{P5} = 7.9$ cfs $Q_{P100} = 15.0$

F. Inlet Design (Inlet #5)
Pick up 100%, assume 40% bypass = (7.9/.60) = 13.2 cfs
Street slope = 4%, Inlet size = 8 ft
$Q_{enter} = 17(.6) = 10.2$ cfs

Greiner Engineering

Basin B

☐ DENVER, COLORADO
☐ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral
JOB NUMBER 5170806 SHEET 6 OF ____
CALCULATED BY K. Harrison DATE 2/27/86
CHECKED BY ____ DATE ____

G. Inlet Flow Calcs (Inlet #5)

	5yr	100yr
Q @ Inlet	7.9	15.0
Q enter	-10.2	-10.2
Q bypass	0	4.8

Greiner Engineering

☐ DENVER, COLORADO
☐ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT Basin B High Chaparral
JOB NUMBER 5178806 SHEET 6 OF
CALCULATED BY K. Harrison DATE 2/27/86
CHECKED BY DATE

IV Design Pnt B_4

General

An inlet is required here in order to pickup the 5yr bypass flow coming off of Chaparral Road due to the 5yr street capacity in Rio Vista

A. Area to be drained (B-4)

Multi Family	1.0 Acre	93
Multi Family (Part Parcel)	1.3 Acre	93
Street (Rio Vista) (150 L.F @ 30' wide)	0.5 Acre	98
	2.8 Acre	94 Ave

B. $P_5 = 1.49$ $P_{100} = 2.84$

C. t_c Use Same @ Design Pnt B_2 = 17.6 min .29 hr

D. $Q = 940$

E. $Q_{r\ Total}$

$5_{yr} = 56.8$ 100_{yr} 115.8

F. Flow @ Inlet

	5yr	100yr	
Total	56.8	115.8	
B_1 Inlet	-12.0	-12.0	
B_2 Inlet	-11.0	-11.0	
B_3 Inlet	-7.9 (5yr @ inlet)	-10.2	* see calcs
A_1 bypass	+0	+1.0	
Flow @ B_4	25.9	83.6	

Greiner Engineering

Basin B

☐ DENVER, COLORADO
☐ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral
JOB NUMBER 5.78806 SHEET 17 OF ____
CALCULATED BY K. Harrison DATE 2/27/86
CHECKED BY ____ DATE ____

G. Design Inlet (Inlet #6)

Street Slope = 2.5%
Inlet Size 14'
Q_{enter} = 15.2 (.60) = 9.1 cfs

H. Bypass Calculations

	5yr	100yr
Flow @ B_4	25.9	82.6
Q_{enter}	- 9.1	- 9.1
Q_{bypass}	16.8	74.5

I Ck Street Capacities on Rio Vista (2.5% slope)

5yr = 34 or 17 each gutter
100yr = 187.5

Greiner Engineering

☐ DENVER, COLORADO
☒ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

Basin B
PROJECT High Chaparral
JOB NUMBER 5178806 SHEET 8 OF ____
CALCULATED BY K. Harrison DATE 2/27/86
CHECKED BY ____ DATE ____

V Design Pnt B_5

General

It is assumed that a sump inlet will be required at this location in order to pick up the 100 yr. flow so that the flow does not top Barnes Rd. The water will be picked up at the sump and then discharge into a ditch or pipe located on the north side of Barnes Rd.

A. Area to be drained

Multifamily	2.8 Ac.	93
Rio Vista (300 x 42)	0.8 Ac	98
Barnes Rd. (1000 x 50)	1.1 Ac	98
	4.2	95 Ave

B. $P_5 = 1.58$ $P_{100} = 2.94$

C. t_c

t_c @ Pnt B_4 17.6 min

Δt_c @ Pnt B_5 1.7 min
(300LF, 2.5%, 3fps)

19.3 min ≈ .32 hrs

D. $q = 900$

E. Total flow @ Design pt. B_5 (Gutter)

	Q_5 =	Q_{100} =
	63.7	128.2
B_1 Inlet	-12.0	- 12.0
B_2 Inlet	-11.0	- 11.0
B_3 Inlet	-7.9	- 10.2
B_4 Inlet	-9.1	- 9.1
	23.7 cfs	85.9 cfs

Greiner Engineering

☐ DENVER, COLORADO
☐ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

Basin B

PROJECT High Chaparral
JOB NUMBER 5178806 SHEET 9 OF ____
CALCULATED BY K. Harrison DATE 2/27/86
CHECKED BY ____ DATE ____

F. Determine how much flow can bypass inlet Barnes Rd

100 year capacity @ Rio Vista = 83.5 cfs

100 year capacity @ Powers Blvd = 29.0 cfs

The 100 year capacity in Barnes Road is smaller than normal due to the R.O.W. being located only 5 ft. behind the proposed curb. Even though the capacity of Barnes Road is 83.5 cfs @ Rio Vista, the capacity reduces to 29.0 cfs @ Powers Blvd. Therefore approximately 54.5 cfs must be picked up before Barnes the Powers Blvd intersection. The most logical place would be at the sump located @ Design Pnt B_5

G. Design of inlet @ B_5 (Inlet #7)

Install a 22 ft. sump Cap = 54.2 cfs

H. Bypass Calcs @ B_5

	5 yr	100 yr
Total Gutter flow @ B_5 =	23.7 cfs	85.9 cfs
~~In~~ Q enter	-23.7	- 54.2
Bypass	0	31.7 cfs

Greiner Engineering

☐ DENVER, COLORADO
☒ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

Basin B

PROJECT High Chaparral
JOB NUMBER 5178806 SHEET 10 OF
CALCULATED BY K. Harrison DATE 2/27/86
CHECKED BY DATE

VI Design Pnt B_6

General an inlet will be constructed here in order to catch street flow off of Rio Vista. It will not be a sump since it could cause problems in the design

A. Area drained (Area B_6)

Rio Vista (1100ft @ 35 Ave) ÷ 1.0 Acre = 98

B P_5 = 1.87 P_{100} = 3.27

C t_c

Same @ Design Pnt B_5 = 19.3 min or .32 hr.

D. Gutter flow @ Design Pnt

	5yr	100yr
Total	66.3	102.8
Flow @ B_5	-63.7	-128.2
Bypass @ A_1	+ 0	+ 1.0
Flow in Gutter	2.6 cfs	5.6 cfs

E. Inlet Design (Inlet @ B)

Install an inlet in order to prevent flow from entering Barnes Rd as well as to prevent ponding due to the bypass amount Design Pnt B_5. This inlet will also need to pick up a certain amount of the 100yr flow @ B_5 as the flow goes over the crown of the road on Rio Vista. ~~Calculations~~ Even though this will probably occur ~~not~~ no allowances will be made for this in the design

Street Slope 2.5%

Construct 6 ft inlet

Q_{in} = 14.0 (.60) = 8.4 cfs

F Q_{bypass} Calc

5_{yr} = 0 100_{yr} = 0

Greiner Engineering

Basin B

☐ DENVER, COLORADO
☐ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral
JOB NUMBER 5178806 SHEET 11 OF ____
CALCULATED BY K. Hanson DATE 3-4-86
CHECKED BY ____ DATE ____

VII Design Pnt B_7

General
Due to the cross bypass amount @ B_5 additional inlets will need to be installed so that 100% of the 100yr flow will be ~~picked~~ picked up by the time it reaches Powers Blvd.

A Area Served

Barnes Rd (1100 L.F @ 40ft)	1.0 acres	98
Powers Blvd (200 L.F @ 50ft)	0.2 acres	98
Total	1.2 acres	

B P_5 = 1.87 P_{100} = 3.27

C t_c

t_c @ B_5 = 19.3 min or .32hr

Δt_c @ B_7 = 1100 L.F @ 8fps / ft = 2.2

21.5 or .35hr

D Q = 860 870

E Q_P =

F Flow in Gutter

	5yr	100yr
Q_{Total}	67.2	133.7
Q enter @ inlets	-67.2	99.8
Q_{bypass}	0	33.9

G. Inlet Design
Several inlets will be required in order to pick up the flow

Greiner Engineering

Basin B

☐ DENVER, COLORADO
☐ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral
JOB NUMBER 5178806 SHEET 12 OF ____
CALCULATED BY K. Harrison DATE 3-4-86
CHECKED BY ____ DATE ____

Inlet #9
Location @ NE corner of Rio Vista & Barnwell Intersection

A Street Slope 6%
B Inlet Size 14'
Q_carry = 21.4 (.60) = 12.8

Inlet #10
A Street Slope 5%
B Inlet Size 14'
Q_carry 20 (.6) = 12

Inlet #11
A Street Slope = Sump
B Inlet Size = 6' Sump
Q_carry 9.1

BASIN C

Greiner Engineering

Basin C

☐ DENVER, COLORADO
☐ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral 1
JOB NUMBER 5178806 SHEET 6 OF ____
CALCULATED BY K. Harrison DATE 3/14/86
CHECKED BY ____ DATE ____

Basin C - Hydrologic Calculations

I Design Pnt C,

A Determine max 5yr flow in street,
slope = 2.5 $Q_{cap\ 5yr}$ = 360 cfs 18/gutter
$Q_{cap\ 100yr}$ = 990 cfs.

B area to be drained (C-1)

Multi Family	6.7 acre	93
Rd (900 x 30)	0.6	98
	7.3	93 Ave

C P_5 = 1.41 P_{100} = 2.74

D time of conc

Initial =	7.0 min.
Overland (2000', 6%, 5 fps)	0.7 min.
Rio Vista (2.5%, 5300 ft, 3 fps)	2.8 min
	10.5 or 0.175 hr

E q = 1100

F Q_5 = 17.7 cfs Q_{100} = 34.4 cfs

G Flow @ Des Pnt C 5yr = 17.7 100yr = ~~34.4~~ 34.4

H Inlet Design
1/4 ft inlet = 15.2 cfs Q_{enter} = 15.2(.60) = 9.1 cfs

I Bypass Calcs

	5yr	100yr
Flow in gutter	17.7	34.4
Q_{enter} Inlet C	- 9.1	- 9.1
Q_{bypass}	8.6	8.6

Basin C
High Chaparral
5178806 2 of
K. Harrison 3/14/86

II Design Pnt C_2

A. Determine Street Capacity - 2.5%

5_{yr} = 36.0 cfs of 18/gutter 100_{yr} = 290 cfs (R.O.W to R.O.W)

B. Area to be Drained (C-2)

multi-family	3.8 Acres	93
Road (350x30)	0.2 Acres	98
	4.0 Acres	93_{Ave}

C P_5 = 1.41 P_{100} = 2.74

D t_c =

t_c @ Pnt C_1 =	10.5 min	
A t_c (350 LF, 2.5%, 3fps)	1.9 min	
Total t_c	12.4 min	or 0.21 hr

E. q = 1050

F. Q - Total

Q_5 = 26.2 cfs Q_{100} = 50.8 cfs

G. Flow in gutter @ Design Pnt C_2

	5_{yr}	100_{yr}
Q total	26.2	50.8
Q enter Inlet 1C	- 9.1	- 9.1
Q_{gutter}	17.1 cfs	41.7 cfs

H. Inlet Design

Use 14ft Inlet - Q_{enter} = 9.1 cfs

I. Q_{bypass} Calculations

	5_{yr}	100_{yr}
Q_{gutter}	17.1	41.7
Q_{enter} (Inlet 2C)	- 9.1	- 9.1
	8.1	32.6

Basin C
High Chaparral
5170806 3 of
K. Harrison 3/14/86

III Design Pnt C_3

General

It is assumed that the Single Family area shown will not have any access through the Multi Family area and therefore the drainage from the SFR will discharge via a pipe located @ Res. Pnt. C_3. Since this area has not been platted a stub will be constructed in Rio Vista to the Right of way line in order to accomodate the expected flow.

A Area to be served (C-3)

SFR	8.4 Acres	82
MF	2.1 Acres	93
Road (Interior-assumed) (1300 x 36)	1.1 Acre	98
Road (Rio Vista - Negligible)		
	11.6	86 AVE.

B. $P_5 = 0.92$ $P_{100} = 2.10$

C. t_c - (on Rio Vista)

t_c @ Pnt C_2 =	12.4 min
Δt_c (200ft, 2.5%, 3fps)	1.0 min
Total t_c	13.4 min. or 0.22 hrs

t_c (from Site)

Intial	10.0 min.
Rd (1300 L.F @ 6% AVG, 6fps)	3.6 min.
	13.6 min

The time of concentration for both routes are about the same

Therefore use 0.22 hrs

Basin C
High Chaparral
5178806 4 of
K. Hurricon 3/14/86

D $q = 1.25$

E Q_{Total}

$Q_{P5yr} = 42.6$ $Q_{100yr} = 88.6$

F Flowen Gutter (Rio Vista)

It is assumed that 100% of the 5yr flow will be picked up by the storm sewer system that will be required for the road that ~~extends~~ will be extended into the SFR site. Flowen Pipe in SFR Site $(42.6 - 26.2) = 16.4$

	5yr	100yr
Q_{Total} @ Pnt C_3	42.6	88.6
Q_{enter} Inlet 1C & 2C	-18.2	-18.2
Q_{enter} (Pipe in SFR Tract)	-16.4	-16.4
Q_{bypass}	8.0	54.0

G. No inlets are required here since the street capacity has not been reached yet

III Design Pnt C_4

A. Street Cap Slope 2.5%

$Q_{cap\,5yr}$ = 36 cfs on 18'/gutter 100_{yr} = 290 cfs

B Area to be Drained (C-4)

multi-family	5.9 Acres	92
SFR	1.5 Acre	82
Rd (800ft @ 30)	0.6 Acres	98
	8.0 Acre	90_{Ave}

C. P_5 = 1.18 P_{100} = 2.45

D t_c

t_c @ C_3	13.4 min	
Δt_c @ C_4 (800 LF, 2.5%, 3 fps)	4.4 min	
Total t_c	17.8 min	, 30 min

E q = 920

F Q_5 = 51.8 Q_{100} = 107.8

G. Flow in gutter

	5yr	100yr
Q_{Total}	51.8	107.8
Q_{enter} (Inlet 1C, 2C, SFR Pipe)	-34.6	-34.6
Q_{gutter}	17.2	73.2

Inlet #3C H. Inlet Design - Use 14' Q_{enter} 9.1

I Q_{bypass} Calcs

Q in gutter	17.2	73.2
$Q_{enter\ inlet\ \#3C}$	-9.1	-9.1
Q_{bypass}	8.1	64.1

This water will be bypassed to the Old Farm Heights area. M.L. to obtain letter of ~~use~~ acceptance of developed flow from Old Farm.

Basin C
High Chaparral
5178806 6 of
K. Harrison 8/14/86

V Check to see if an inlet is required on the east side of Rio Vista at High Chap. North property line

A Area to be drained

Rio Vista 2100 L.F @ 30 ft 1.4 Acre 98

B P_5 = 1.87 P_{100} = 3.27

C. t_c

Ck t_c on Street 2100 L.F @ 3 fps 12 min , 20 hrs

D. C_f = 1075

E $Q = P A C_f$

$Q_5 = 1.87 \left(\frac{1.4}{640}\right) 1075 = 4.1$ cfs

This flow will start at this point does not require an inlet. The gutter flow will be bypassed to Old Farm Heights S/D. M.L. Prop to obtain a letter from Old Farm Heights accepting developed flow

Basin C
High Chaparral
5178806 1 of
K. Harrison 3/17/86

Basin C - Pipe Sizing Calculation

A. MH 1 → 3

$Q = 9.1$; Size = 18", Cap = 17.5 cfs @ 2.5%, $V_{cap} = 9.5$

V_{actual}

$\frac{Q_A}{Q_c} = \frac{9.1}{17.5} = .52$ $\frac{V_{act}}{V_{cap}} = 1.0$; $V_{act} = 9.5$

B. MH 3 → 4

$Q_{act} = 18.2$, Size 24"; $Q_{cap} = 36$ @ 2.5%; $V_{cap} = 11.5$ fps

$V_{act} = 11.5$ fps ±

C. MH #4 → #5

$Q_{act} = 34.6$; Size = 27" @ 2.5%; $Q_{cap} = 49$ $V_{cap} = 12.5$

$Q_{act}/Q_{cap} = .71$ $V_{act}/V_{cap} = 1.12$

$V_{act} = 1.12(12.5) = 14$ fps

D. MH #5 → offsite

$Q_{act} = 43.7$, Size 30" @ 2.5%, $Q_{cap} = 65$ cfs V_{act} 13.5 fps

$Q_A/Q_c = 43.7/65 = .67$; $V_A/V_c = 1.11$; $V_A = 1.11(13.5) = 15$

BASIN D

Basin D- Hydrologic Calculations

I Design Pnt D-1 (Area D-1)

General - This area will drain to a swale located on the west side of Powers Blvd and will discharge offsite into the Old Farm Heights project. The ~~of~~ eventual outfall point will be a culvert located under Powers Blvd which will discharge into a drainage channel located on Hulsen Hill.

A. Area to be drained

Park	1.5 Acres	69
ORD	11.2 Acres	93
Powers Blvd (2000' @ 50)	2.3 Acres	98
	15.0 Acre	91 Acre

B. $P_5 = 1.26$ $P_{100} = 2.55$

C. time of Concentration

Initial t_i	=	7.0 min
Swale (2.5%, 2000ft, 6fps)		5.6 min
Total t_c)		12.6 0.21 hr

D. $q = 1050$

E. $Q_{P5} = 31.0$ $Q_{100} = 62.8$

This runoff will ~~be~~ drain via a ditch located on the west side of Powers Blvd.

II Design Pnt D-1 (Area D-2

A. Area drained

ORD 5.3 Acres 93

B $P_5 = 1.41$ $P_{100} = 2.74$

C. t_c

Same as Area D-1

D $q = 1050$

E $Q_{P5} = 43.2$ (Total) $Q_{100} = 86.6$

Flow off of Area D-2

	5 yr	100 yr
Total	43.2	86.6
Q from D-1	31.0	62.8
Q from D-2	12.2	23.8

The runoff will be carried to the outfall point via a parking lot curb & gutter system

Greiner Engineering

☐ DENVER, COLORADO
☐ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral
JOB NUMBER 5178806 SHEET 1 OF ____
CALCULATED BY K. Harriger DATE 2/28/86
CHECKED BY ____ DATE ____

Design of Swale "C"

I General

This ditch will be constructed from the open space to Design Pt D-1. The ditch will be concrete lined A type may be substituted but size and location will be will be determined as the various areas ~~flood~~ are platted

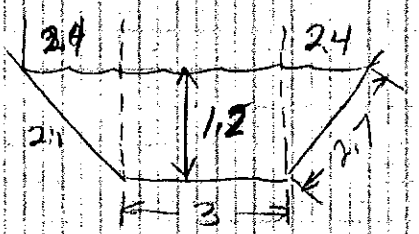
II Design Considerations

A Flow @ D-1 = 63 cfs (100 year) see Basin Summary Calc Basin D

B Slope

(6790 - 6740)/1500 = 3.3%

C Trial Section



$A = \frac{1}{2}(1.2)(3 + 7.8) = 6.5$

$P = 3 + 2.7(2) = 8.4$

$R = .774$

$Q = \frac{1.49}{.017}(6.5)(.774)^{2/3}(.033)^{1/2} = 87$ cfs close enough

Greiner Engineering

☐ DENVER, COLORADO
☐ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral
JOB NUMBER _____ SHEET ____ OF ____
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____

III Quantity Estimate

Use same cross section as Swale 'A'
Use 2 sections to determine costs

L of Swale "C" = 1500
L of Swale "A" = 1150 ft

Excavation

$\frac{1500}{1150}$ (2500) = ~~3250~~ Y 3250 C.Y.

Lining

$\frac{1500}{1150}$ (280) = 365 C.Y.

BASIN C AND D OFFSITE

Basin C and D Offsite

Attached are copies of the following:

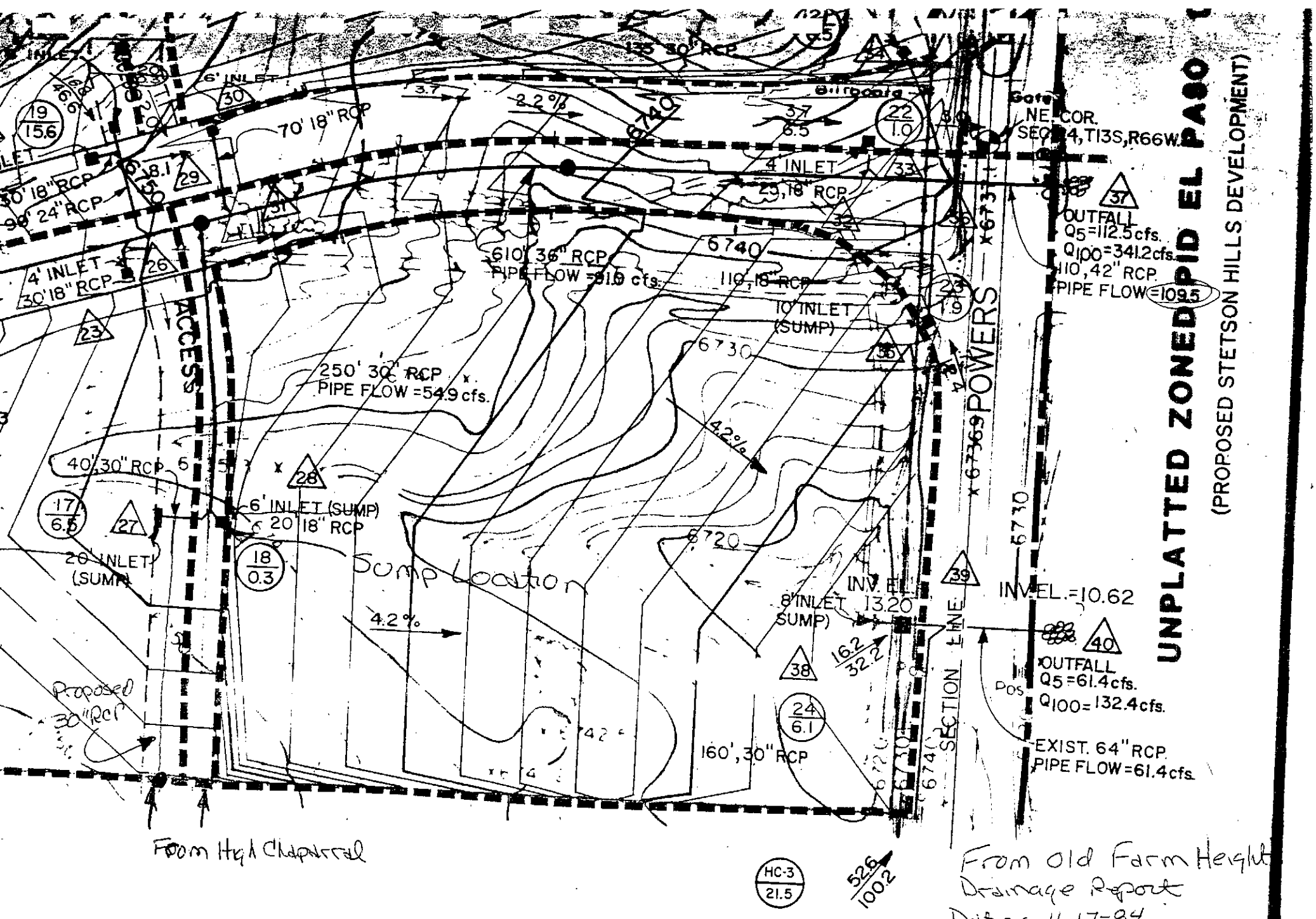
a) Drainage Plan for the Old Farm Heights Subdivision. This plan shows the sump to which the storm water in Rio Vista will flow and the existing 64" RCP under Powers Boulevard. The Drainage Report is currently under review by the City of Colorado Springs.

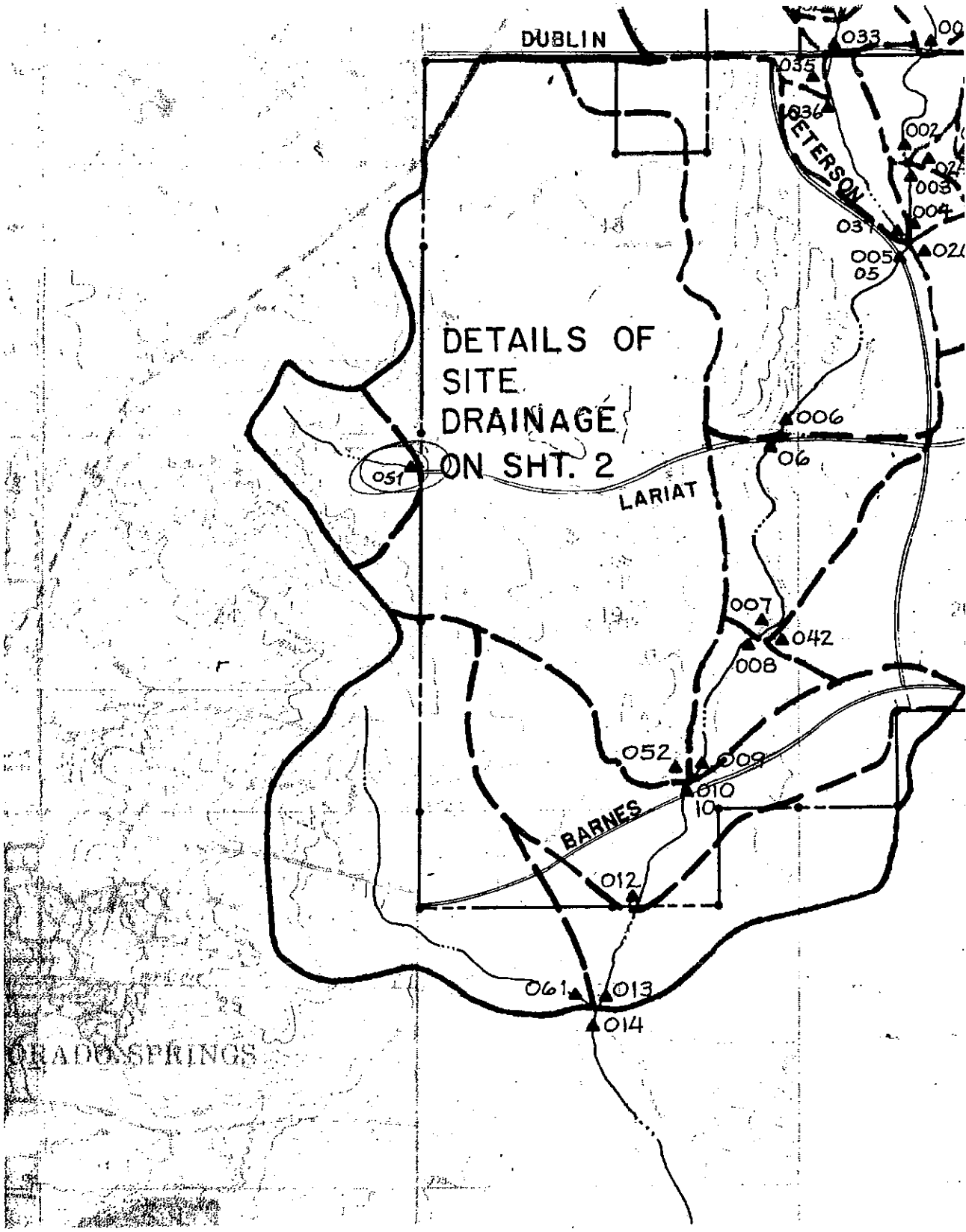
b) Copies of pertinent sections of the Master Drainage Study for Stetson Hills, prepared by Greiner Engineering, Inc., dated April 1985, filed by the City of Colorado Springs in September 1985.

These copies indicated that the outfall for the High Chaparral Development was based on the following criteria:

100-Year/24-Hour Flows
CN Value of 92
Soil Type D

The above is very conservative, and as a result, the outfall ditch which will serve the High Chaparral and Old Farm Heights Developments should be adequate to handle the developed flows from these sites.


135' 30" RCP
6' INLET
70' 18" RCP
4' INLET
30' 18" RCP
99' 24" RCP
610' 36" RCP
PIPE FLOW =81.9 cfs.
110' 18" RCP
10' INLET
(SUMP)
250' 30" RCP
PIPE FLOW =54.9 cfs.
ACCESS
POWERS
40' 30" RCP
6' INLET (SUMP)
20' 18" RCP
20' INLET
(SUMP)
Sump Location
4.2%
8' INLET
(SUMP)
INV. EL. 13.20
INV. EL. =10.62
160', 30" RCP
SECTION LINE
OUTFALL
Q5 =112.5 cfs.
Q100 =341.2 cfs.
110', 42" RCP
PIPE FLOW =109.5
OUTFALL
Q5 =61.4 cfs.
Q100 =132.4 cfs.
EXIST. 64" RCP
PIPE FLOW =61.4 cfs.
UNPLATTED ZONED PID EL PASO
(PROPOSED STETSON HILLS DEVELOPMENT)
Proposed
30" RCP
From High Chaparral
From Old Farm Height
Drainage Report
Date: 11-17-84
By: URS/NES
(PROPOSED HIGH CHAPARRAL DEVELOPMENT)



Master Drainage Study for Stetson Hills

From: April, 1985
Filed, 9/85

TR-20 100YR 24HR FLOWS

DESIGN POINT	Q 100
001	3440
002	3450
003	3480
004	3480
005	3945
006	4020
007	4060
008	5100
009	5190
010	7080
012	7660
013	8080
014	9230
021	460
022	920
023	1030
024	1130
025	370
026	570
031	1740
032	1920
033	1930
034	420
035	550
036	2270
037	2320
041	930
042	1460
051	720
052	1900
061	1870

▲010 DESIGN POINT
FOR TR-20 ANALYSIS

☑ DENVER, COLORADO
☐ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ CASPER, WYOMING
☐ KEMMERER, WYOMING

PROJECT Stetson Hills
JOB NUMBER 5161701 SHEET 23 OF
CALCULATED BY CMB DATE 8-1-91
CHECKED BY SE DATE

Curve Numbers - Future Conditions

Basin No.	Soil	Offsite	SF 4-6 DU/A	M.F. 8-12 DU/A	MF 18-22 DU/A	MF 25-35 DU/A	Retail-Office	School	Park	
035	total	32%		65%			3%			75
	A	100%		100%			50%			
	B						50%			
037	total B		100%							79
041	total B	100%								84
042	total B	28%	53%	17%		2%				80
051	total D	100%								97
052	total	10%	41%	13%	14%		20%	2%		76
	A	33%	100%	83%	80%		20%	100%		
	B			17%			20%			
	D	67%			20%		60%			
061	total	68%					32%			11
	B	33%								
	D	67%					100%			

Sample Calculation: Basin 052

Offsite	=	10%	composed of (2/3) D + (1/3) A
SF 4-6 DU/A	=	41%	composed of A
MF 8-12 DU/A	=	15%	composed of (5/6) A + (1/6) D
MF 18-22 DU/A	=	12%	composed of (4/5) A + (1/5) D
Retail/Office	=	20%	composed of (1/5) D + (1/5) A + (3/5) B
School	=	2%	composed of A

Composite CN = .10 [(2/3) 95* + (1/3) 75.8] + .41 (65) + .15 [(5/6) 74 + (1/6) 83]
+ .12 [(4/5) 80 + (1/5) 93] + .20 [(3/5) 95 + (1/5) 39 + (1/5) 42]
+ .02 (68) = 76.3

* For curve number for various land uses see Table 2. (Figure 3)

From: Master Drainage Study for Stetson Hills April, 1985 Filed 9/85

BASIN E

Greiner Engineering

☐ DENVER, COLORADO
☐ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral - Basin E
JOB NUMBER 5178806 SHEET 1 OF
CALCULATED BY K. Harrison DATE
CHECKED BY DATE

Analysis of Impact of Areas E-1 & E-2 & E-3

I Area E-1

A General.
This area was included as part of the Old Farm Master Drainage Study. The study states that the interior drainage entering the S/D from the east is of very small magnitude that it was included as a part of the internal drainage basin into which it drains.

B Area included in the report = 29.2 acres

Wt CN used in Old Farm Drainage Report = 81.0

C Conclusion:
It appears that there is ~~no~~ reason for the future development and that the Old Farm Heights Master Drainage study sufficiently allows for this land to drain into the basin.

II Area E-2

Park area.

It is assumed that this park will have no developed buildups such and only playground equipment. The improvements would only consist of small recreational ~~improvements~~ areas, sheds, etc. Also if the area were improved w/ a good grass cover, the runoff rate would be reduced greatly.

Therefore, since this area was included in the Master Drainage Report for Old Farm it appears that adequate considerable compensation has been made concerning this area.

III E-3

Too small too mess with.

ALTERNATE ANALYSIS NO. 1

III Design of Ditch from Culvert outfall @ Design Pnt A1 to Design Pnt A2

Ditch B

Given Outfall amount

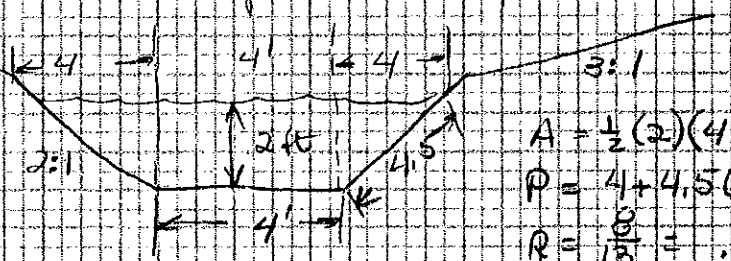
Q in culvert	=	66.5 cfs
Q inlet #1		7.6 cfs } see sheet 2 of Basin A calcs
Q inlet #2		7.6 cfs }
Total Q @ outfall		81.7 cfs.

n = .017 , S.S = 2:1 , Slope = flat

Channel Design

The slope on this channel can be pretty flat since it is located on a flat area (after overlot grading). The velocity will be slower than the upstream velocities which may cause a submerged entrance condition and it may cause a backwater. Detail design of this type is not possible at this time due to the lack of information available in order to produce an accurate design - 13889

From Chart 1



S = .003

$A = \frac{1}{2}(2)(4+12) = 16.0$

$P = 4 + 4.5(2) = 13.0$

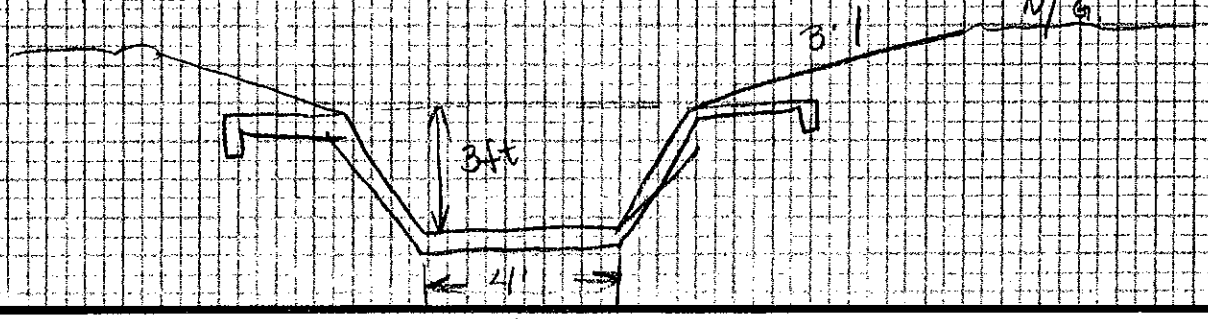
$R = \frac{8}{16} = .615 = 1.231$

$$Q = \frac{1.49}{.017}(16.0)(1.231)^{2/3}(.003)^{1/2}$$

$= 88.2$ cfs.

$V = Q/A = 5.5$ fps (Good)

Proposed Cross Section



Alt Anal #1

Greiner Engineering

- ☐ DENVER, COLORADO
- ☒ COLORADO SPRINGS, COLORADO
- ☐ ALBUQUERQUE, NEW MEXICO
- ☐ KEMMERER, WYOMING

PROJECT High Chaparral
JOB NUMBER 5178806 SHEET 3 OF
CALCULATED BY K. Harrison DATE 2/28/86
CHECKED BY DATE

Because of drainage characteristics of this ditch, additional culvert analysis is necessary for the culvert under Rio Vista

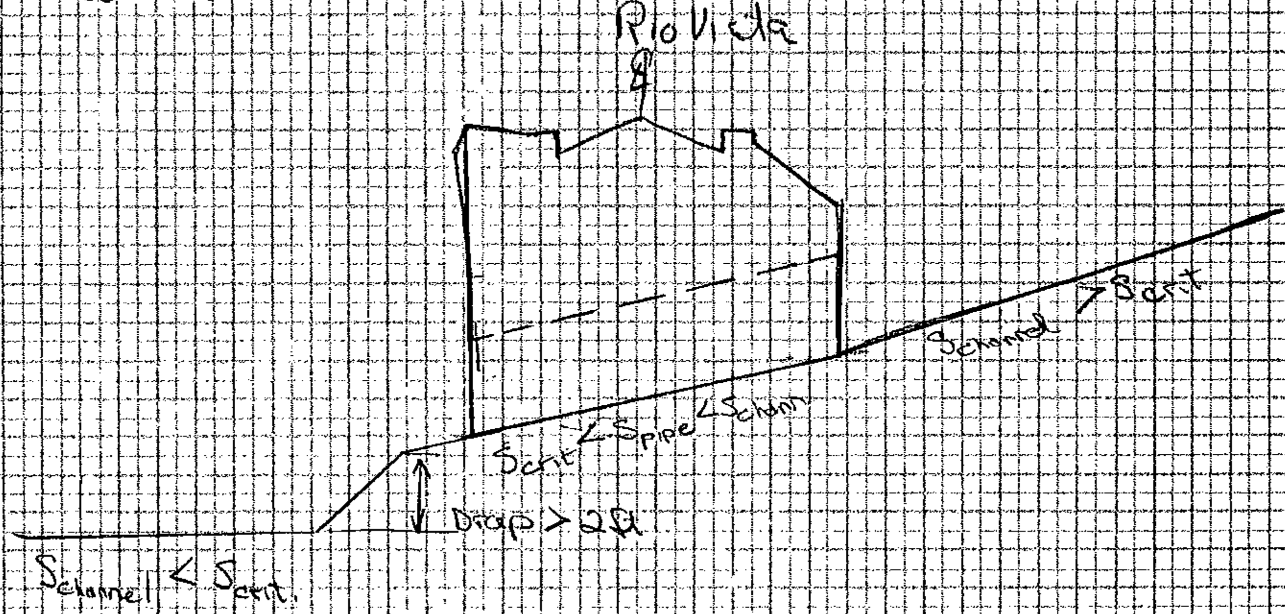
~~The exit condition~~

The entrance condition is one of supercritical flow and the exit condition is one of subcritical.

It is possible since the depths are not that great to maintain supercritical flow through the box and out the other side ~~until a ditch~~

At this point the channel could drop via a drop structure or a small sluice way about 2 feet so that when the flow passed from critical to subcritical ~~the backwater~~ there would be no backwater affect

Solution



Greiner Engineering

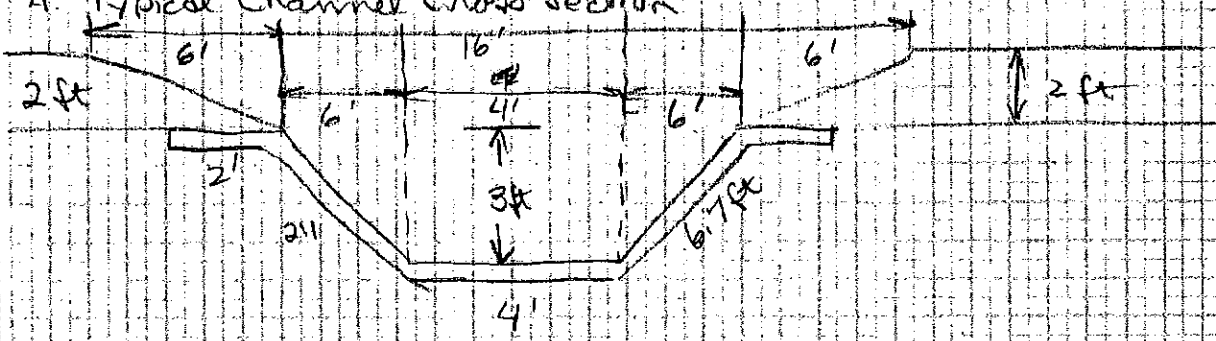
☐ DENVER, COLORADO
☐ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral
JOB NUMBER 5178806 SHEET 3 OF ____
CALCULATED BY K. Harrison DATE 3-3-86
CHECKED BY ____ DATE ____

Alternate #2 Backup

Calculation of Ditch Quantities

A. Typical Channel Cross Section



Length of Ditch = 600 L.F

A. Excavation =

$$\left[\tfrac{1}{2}(3)(4+16)+\tfrac{1}{2}(2)(16+28)\right]600\,ft/27 = 1650\,C.Y.$$

B. Channel Lining (4" thick)

$$21.4\,L.F\,(600\,L.F)(.33ft)/27 = 160\,C.Y.$$

Cut off walls, assume 10% 20

180 C.Y.

ALTERNATE ANALYSIS NO. 2

Greiner Engineering

Alt. And #2

☐ DENVER, COLORADO
☒ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral
JOB NUMBER 5178806 SHEET 1 OF
CALCULATED BY DATE
CHECKED BY DATE

Design of Ditch Alternate From Pnt A_2 to A_3

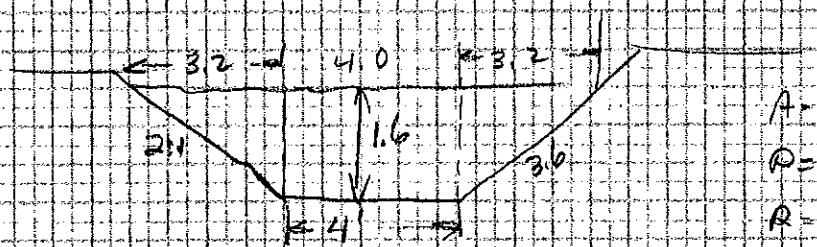
Given: Flow @ the beginning = $Q_{100} = 158.8$

Flow @ outfall $Q_{100} = 200.8$

Slope = (6670 - 6610)/1300 = 4.6%

N = 0.017 for concrete lined

Design



$A = \frac{1}{2}(1.6)(4 + 10.4) = 11.52$

$P = 4 + 3.6(2) = 11.2$

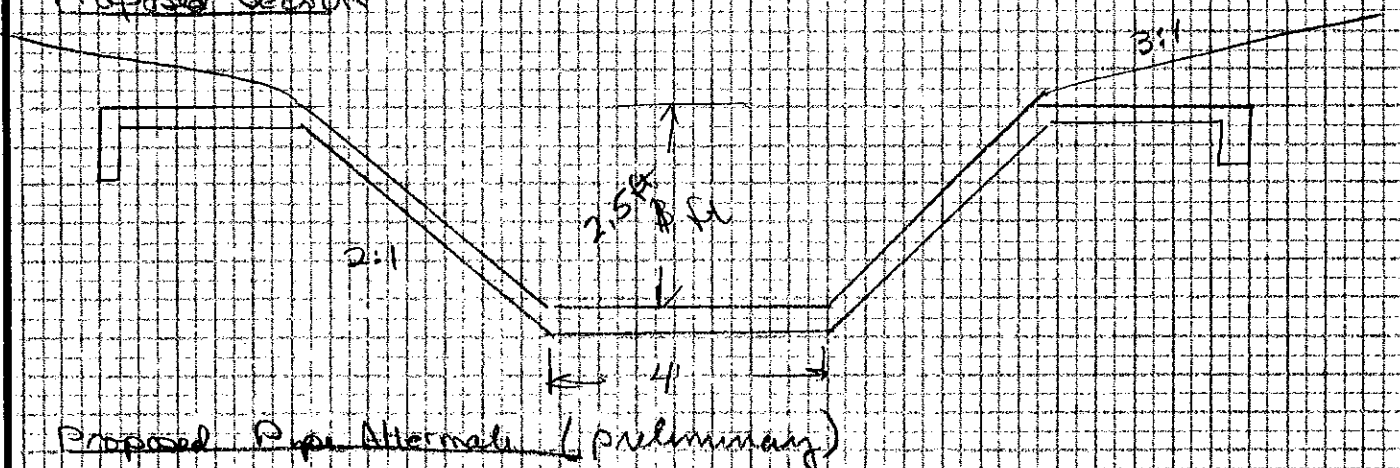
$R = \frac{A}{P} = 1.03$

$Q = \frac{1.49}{.017}(11.52)(1.03)^{2/3}(.048)^{1/2}$

$= 220$ cfs

Velocity = 19 fps

Proposed Section



Proposed Pipe Alternate (preliminary)

42" pipe @ 4.5%, Velocity in pipe ≥ 20 fps when full

Alt Anal #2

Greiner Engineering

☐ DENVER, COLORADO
☐ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral
JOB NUMBER 517880 SHEET 2 OF
CALCULATED BY K. Harrison DATE
CHECKED BY DATE

Design of Pipe System through Area A

A Culvert under Road

42" - Sheet 2 of Drainage Facilities Design
Q_{design} = 66.5 cfs @ 100% of the 100yr flows since there is no place to bypass to

B From Inlet #2 to M.H #1A (From Pnt A_1 - A_2)

Q_{design} @ Inlet 1 & 2 = 7.6 cfs each (Sheet 2 - Basin A calcs)

It is assumed that nothing will drain into the storm sewer between all of the drainage will be directed to Design Pt A_2

42" @ 1% = 100 cfs

Vel_{cap} = 10.5 fps

Vel_{actual}

Q_A/Q_{cap} = 81.7/100 = .82

V_A/V_c = 1.13 V_A = 10.5 (1.13) = 12 fps

C From M.H. 2A to Area Sump (Pnt A_2 - A_3)

Flow @ Design Pnt A_2 = 160 See Summary Calcs Basin A

Flow @ Area Inlet 200 cfs

Assume that from M.H 2A to MH 3A Q = 160 cfs

" " " M.H 3A to MH 4A Q = 180 cfs

" " " M.H 4A to Sump Q = 200 cfs

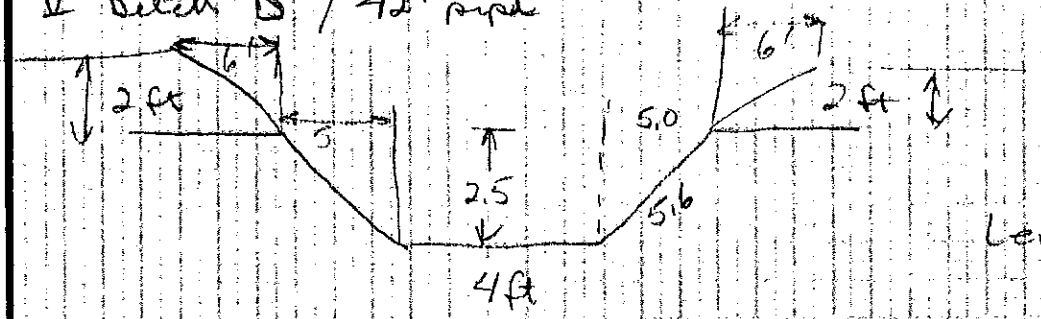
Greiner Engineering

Alt Anal #2

☐ DENVER, COLORADO
☐ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral
JOB NUMBER 5178806 SHEET 3 OF ____
CALCULATED BY K. Harrison DATE 3-3-86
CHECKED BY ____ DATE ____

II Ditch "D" / 42" pipe



Length = 1200 L.F.

Excavation

$\left[\frac{1}{2}(2.5)(4+14.0) + \frac{1}{2}(2)(14+26)\right] 1200 L.F. / 27 = 2800 c.y.$

Channel lining

19.2 (1200 L.F.) (.5") / 27 = 425
10% for cut off walls 40
465 c.y.

Costs Summary

2800 c.y.	@ $1.10	= $3,080	
465 c.y.	@ 250	116,250	
Total		$119,330	or $99/L.F.

Pipe Alternate

42" RCP	1200 L.F.	@ $62.00	=	74,400
Manhole	4 Ea	@ $1500	=	6,000
Total				$89400
			or	$67/L.F.

Pipe Alternate is less expensive.

ALTERNATE ANALYSIS NO. 3

Greiner Engineering

Alt Anal #3

☐ DENVER, COLORADO
☐ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

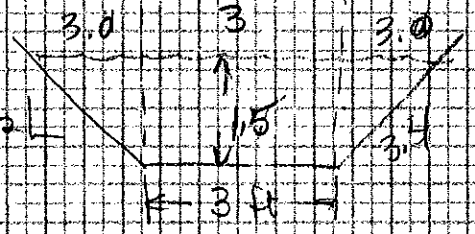
PROJECT High Chaparral
JOB NUMBER 5178806 SHEET 1 OF ____
CALCULATED BY K. Hansen DATE 3-3-86
CHECKED BY ____ DATE ____

Basin B outfall
Ditch from Rio Vista / Barnes to Barnes / Powers Blvd

A. General
a concrete ditch will be designed as an alternate to that which could be established

B. Design Flow (See Basin B - Summary Sheet
Use ≈ 110 cfs.

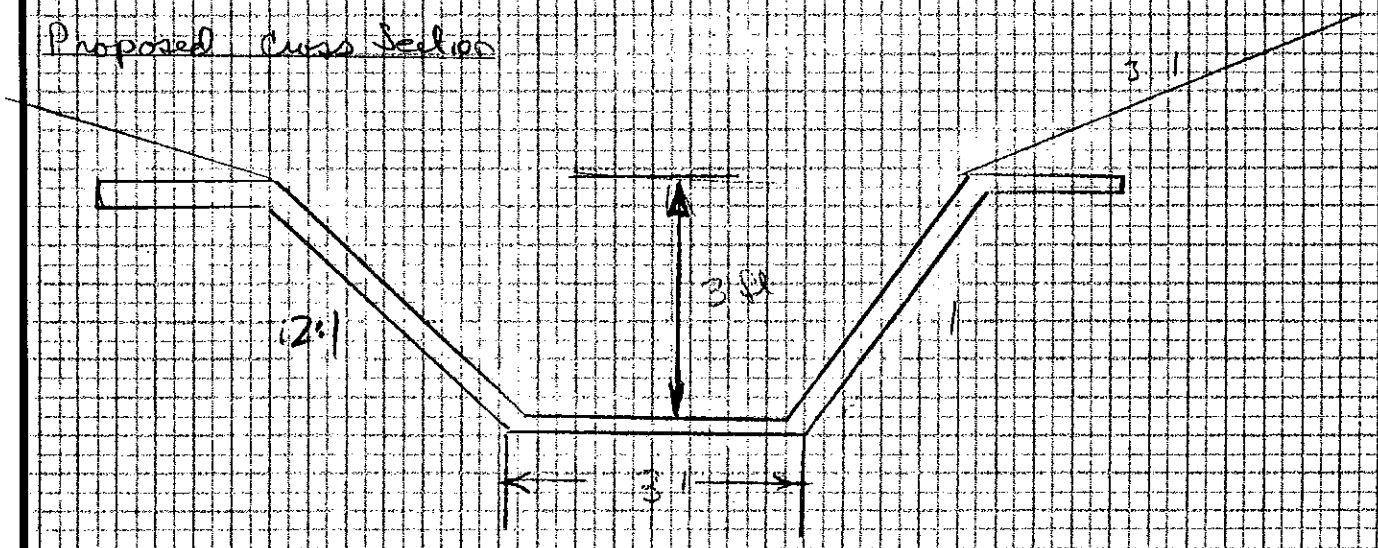
C. Design from Barnes / Rio Vista to 450 Feet
Slope = 4% ≈ Barnes Rd slope
$Q_n = 110(.017) = 1.87$



$A = \frac{1}{2}(1.5)(3+9) = 9.0$
$P = 9.8$
$R = 0.92$

$$Q = \frac{1.49}{.017}(9.0)(0.92)^{2/3}(.04)^{1/2} = 150 \text{ cfs}$$

Proposed Cross Section



Greiner Engineering

Alt Anal #3

☐ DENVER, COLORADO
☐ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

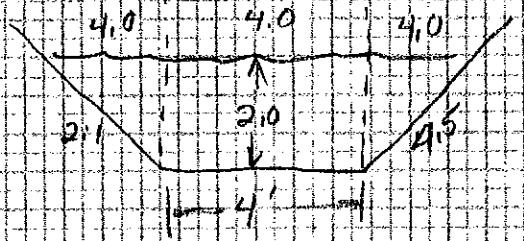
PROJECT High Chaparral
JOB NUMBER 5178806 SHEET 12 OF ____
CALCULATED BY K. Harrison DATE 3/3/86
CHECKED BY ____ DATE ____

D. Design from 450 East of Intersection to Barnes Powers Inlet Structure

Design flow = 160 cfs (see Basin B comp sheet)

Slope = 1.5% proposed to approximate Barnes Rd. slope

$Q_n = 160(.017) = 2.72$



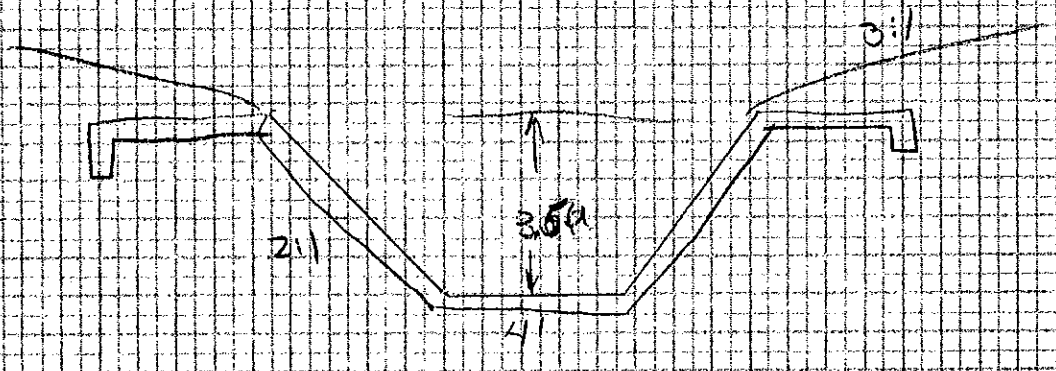
$A = \frac{1}{2}(2)(4+12) = 16.0$

$P = 13.0$

$R = 1.23$

$Q = \frac{1.49}{.017}(16)(1.23)^{2/3}(.01)^{1/2} = 160$ cfs

Proposed Section



Greiner Engineering

Alt. Analysis #3

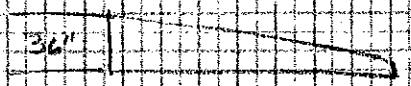
☐ DENVER, COLORADO
☒ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral
JOB NUMBER 5178806 SHEET 3 OF ____
CALCULATED BY K. Harrison DATE 3/3/86
CHECKED BY ____ DATE ____

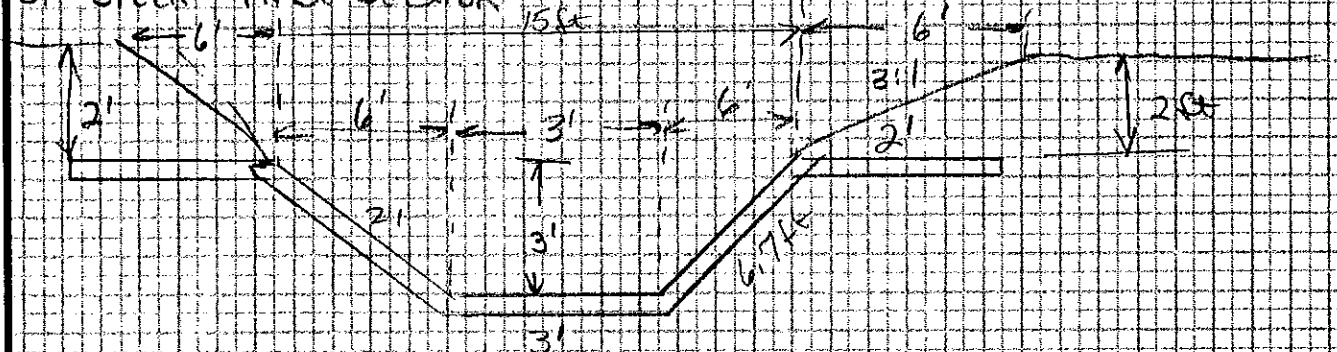
Alternate #2 - Basis for Cost Estimate

1) Manholes
#6B Mill would only only Required

2) Outfall for 36"



3) Ditch First Section



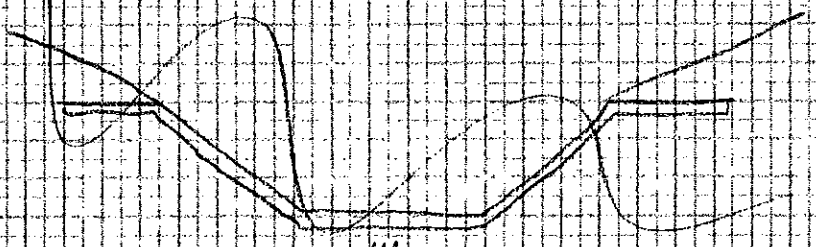
Length = 450 ft

Excavation = $\left[\frac{1}{2}(3)(3+15) + \frac{1}{2}(2)(15+27)\right] 7450/27 \approx 1,200$ C.Y.

Channel lining (6')

$$3+4.7(2)+(2)2 = \frac{20.4 \text{ L.F.}(450 \text{ L.F.})(0.5 \text{ ft})}{27} = 170 \text{ C.Y.}$$

4) Second Sect



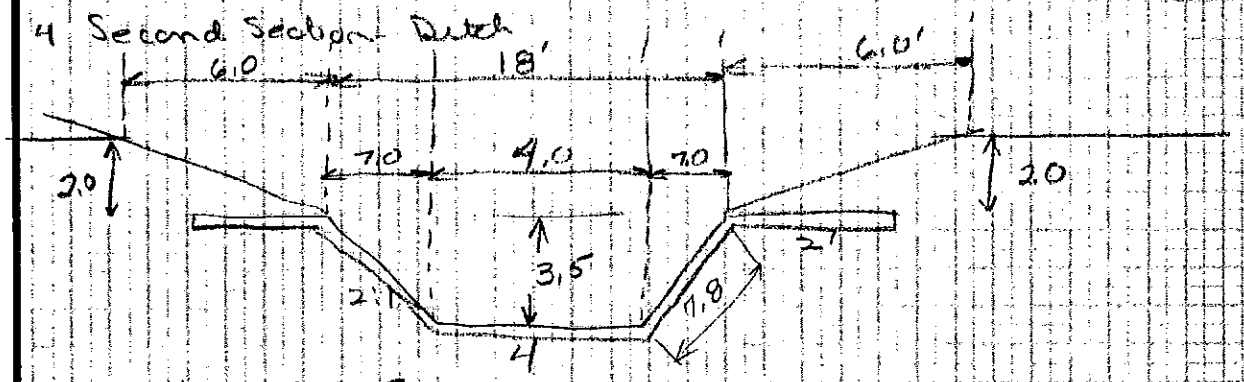
Greiner Engineering

Alt And #3

☐ DENVER, COLORADO
☒ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral
JOB NUMBER 5.178806 SHEET 4 OF ____
CALCULATED BY L. Harrison DATE 3/3/06
CHECKED BY ____ DATE ____

4 Second Section Ditch



Length = 550 L.F.

Excavation

$\left[\frac{1}{2}(3.5)(4+18)+\frac{1}{2}(2)(18+30)\right](550\text{ L.F.})/27 = 1800$ C.Y.

Channel Lining

$[2(2)+7.8(2)+4]\,550\,(.5)/27 =$ 240 C.Y.

~~Summary~~

Grand Total

Excavation	3000 C.Y.
6" Channel Lining	410 C.Y.
+10% for cut off wall	40
	450 C.Y.

A guardrail will be required along Barnes Rd

ALTERNATE ANALYSIS NO. 4

High Chaparral
5178806 Pg - of
K. Harrison 201—

Alternate Analysis #4

Option 1 (see attached map)

Design of concrete lined ditch located south of Barnes road and east of Powers Blvd assuming that this option would be reimbursable by the Drainage Basin Fund

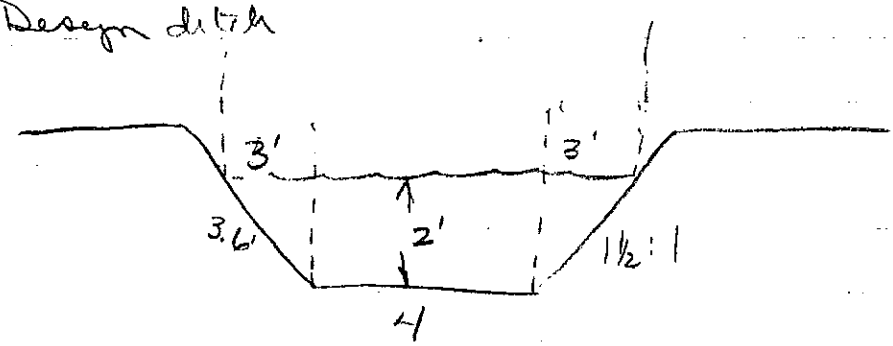
A Given

~~Flow~~

From High Chaparral =	355
(from A+B Summary Sheet)	
From South side of Barnes Rd	15±
Total Flow	370 cfs

- Slope 4.6% (from Barnes Rd Culvert Plans)
- n = .017

B Design ditch

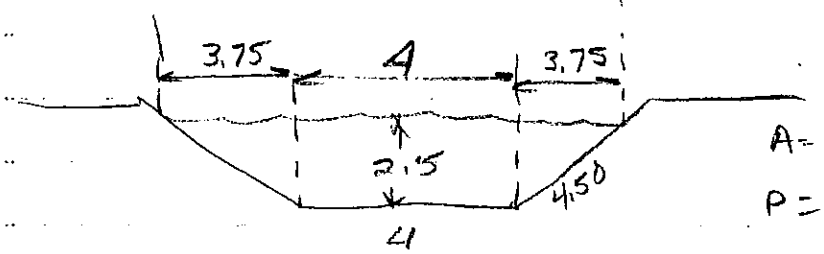


$A = \frac{1}{2}(2)(4+10) = 14$

$P = 3.6(2) + 4 = 11.2$

$R = \frac{A}{P} = 1.25$

$Q = \frac{1.49}{.017}(14)(1.25)^{.667}(.046)^{1/2} = 284$ cfs ; 20 fps



$A = \frac{1}{2}(2.5)(4+11.5) = 19.4$

$P = 4.5(2) + 4 = 13.0$

$R = \frac{19.4}{13.0} = 1.49$

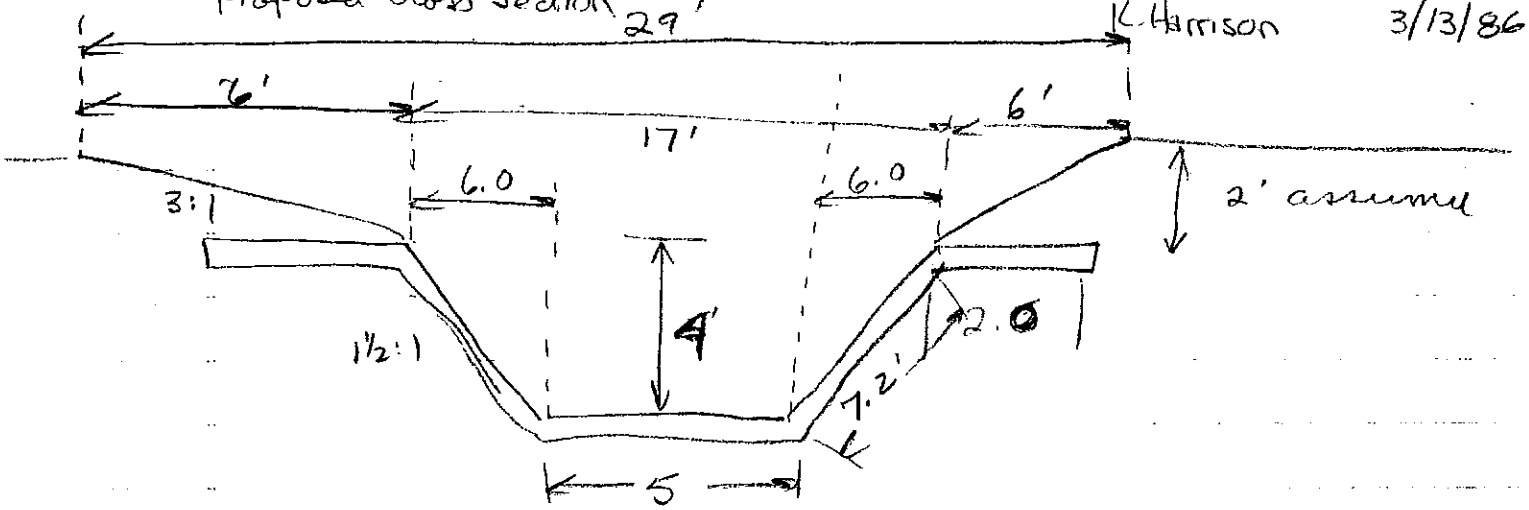
$Q = \frac{1.49}{.017}(19.4)(1.49)^{2/3}(.046)^{1/2} = 476$ cfs Vel = 25 fps too fast

Use the following section

Alt. Anal #4

High Chaparral
5178806 3of
K. Harrison 3/13/86

Proposed Cross Section



Excavation

$$\left[\tfrac{1}{2}(4)(5+17) + \tfrac{1}{2}(2)(17+29)\right]350\text{ft} \Big/ 27 \approx 1{,}200\text{C.Y.}$$

Concrete Channel Lining

$$[2(2)+7.2(2)+5]\,350\text{ft}\,(0.5\text{ft(thick)}) \Big/ 27 = 150$$

$$+ 10\%\text{ cut off walls, etc} \qquad 15$$

$$165\text{ C.Y.}$$

3/13/86
4 of —

Alternate And. #4

II Size Box Culvert under Powers Blvd

Assumptions

Q = 595 (see attached summary sheet

HW/D = 1.2

Inlet Control

Outlet = supercritical

Design see attached sheet

Use a Double 6 x 6 RCB.

SUBDIVISION High Cheparral
LOCATION Colorado Springs
JOB NO. 5178906
DESIGN STORM 5 YR. RECURRENCE INTERVAL
MAJOR STORM 100 YR.
COMPUTATIONS BY K. Harrison DATE 2/27/85
CHECKED BY _____ DATE _____

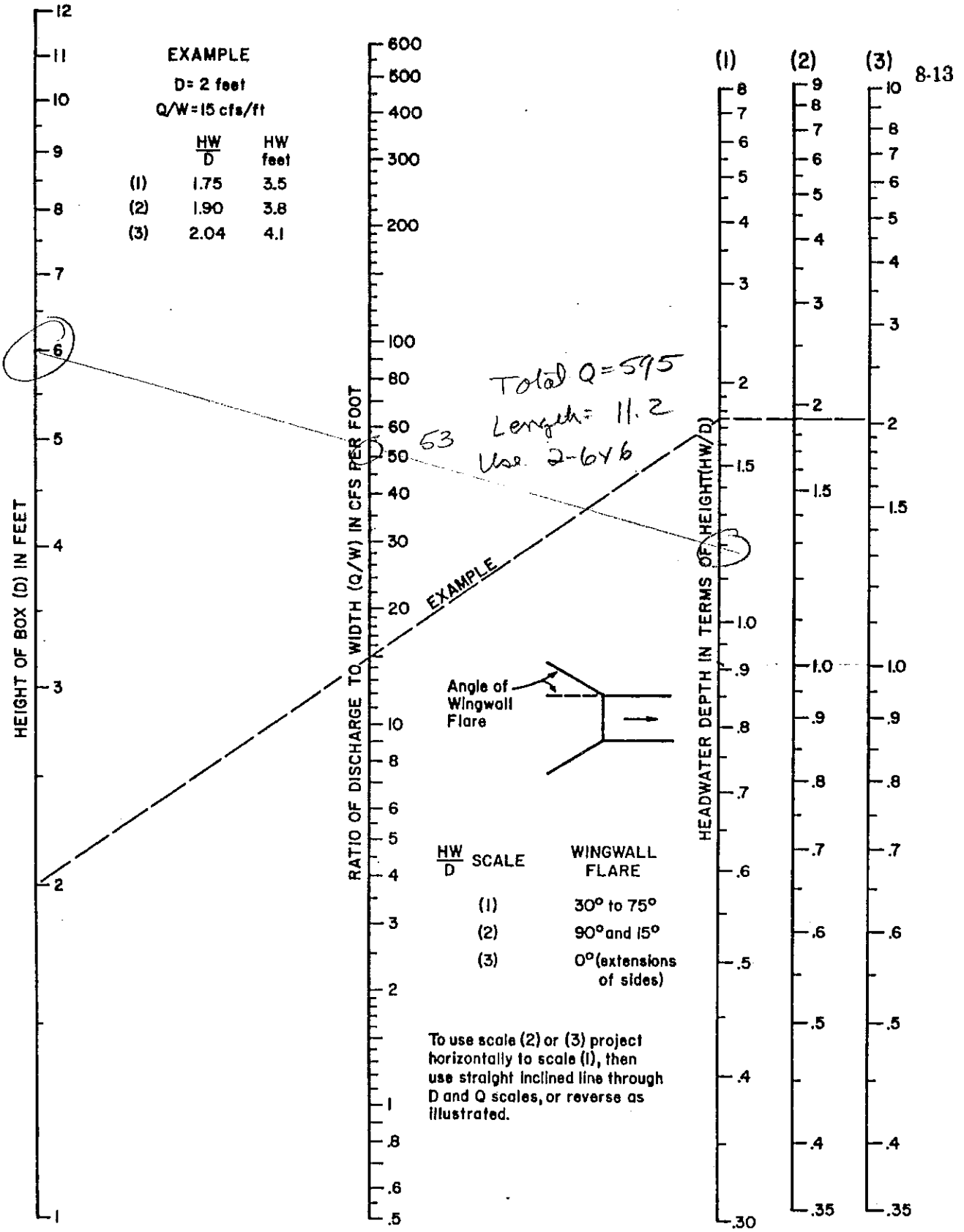
GREINER ENGINEERING SCIENCES, INC.
5373 N. UNION BOULEVARD
COLORADO SPRINGS, COLORADO
80918

RUNOFF COMPUTATIONS
(SCS METHOD)
$Qp = (AQ)\,q$

Basin A + B
(For Alternate Analysis #4)

PAGE ____ OF ____

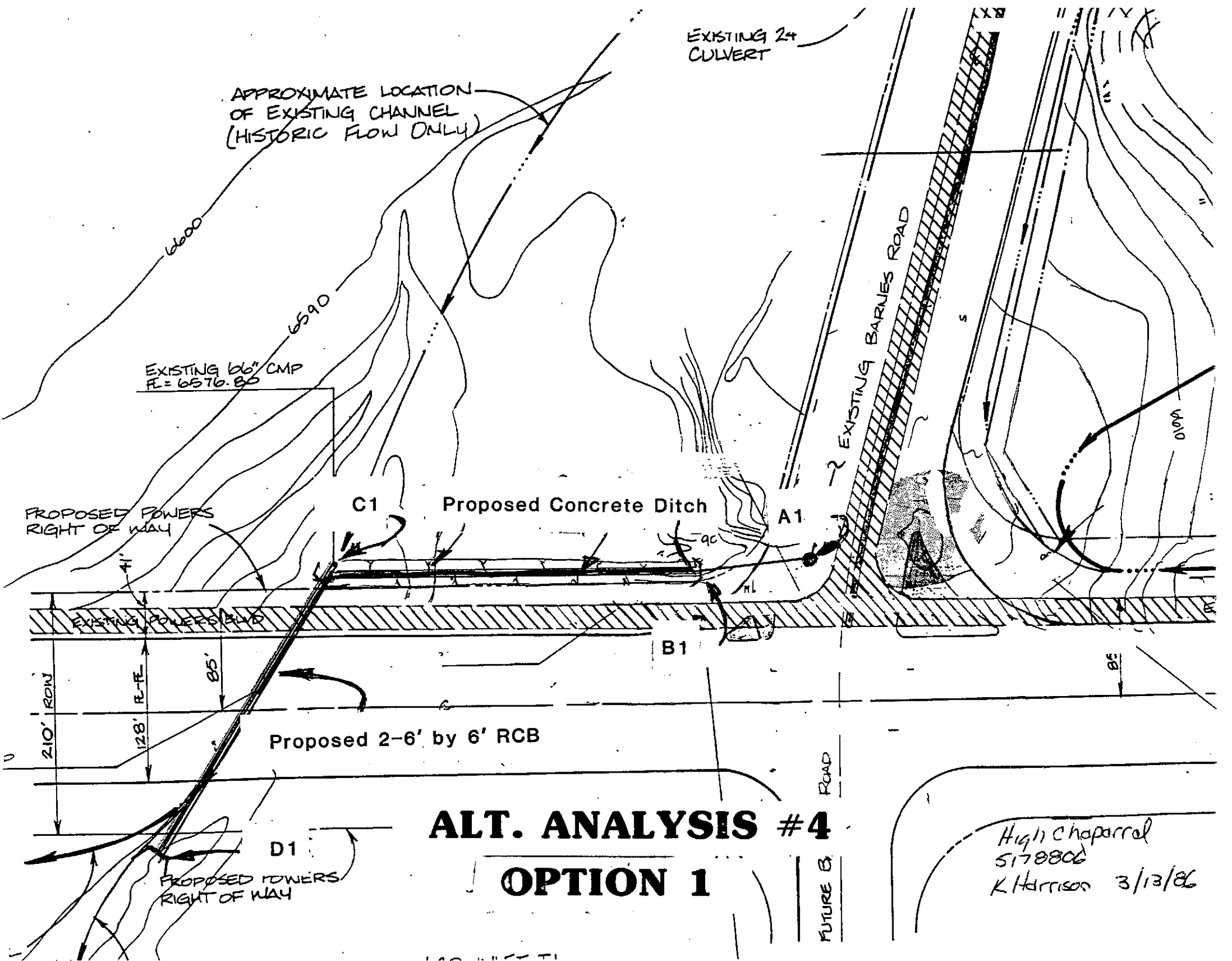
Area Designation	A (Acres) (Mi^2)	CN		Q in.	AQ $mi.^2$ -in.	ΣAQ $mi.^2$ -in.	t_c hr.	q csm / in.	Q p cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in.	Min. Slope %	Length ft	VEL V fps	at (min)	
ΣA	68.2	—				.1219	0.30	920	112.1								
	0.1070					.2534	0.30	"	233.1								
ΣB	38.1	—				.0772	0.35	870	67.2								
	.0595					.1537	"	"	133.7								
ΣA+B	106.3					0.1991	0.35	870	173.2								
	.1661					0.4071	0.35	870	354.2								
Tract So. of Barnes-West of Powers	71	92		1.33	0.1475	0.3466	0.36	850	294.6								
	0.1109			2.64	0.2929	0.7000	"	"	595.0								
M.L. Tract Southeast of Barnes No of proposed Pipeline	63 Acres	92		1.33	0.1309	0.4775	0.38	830	396.3								
	.0984			2.64	0.2599	0.9599	"	"	796.7								



HEADWATER DEPTH FOR BOX CULVERTS WITH INLET CONTROL

TEXAS HIGHWAY DEPARTMENT

Figure 8-8


EXISTING 24" CULVERT
APPROXIMATE LOCATION OF EXISTING CHANNEL (HISTORIC FLOW ONLY)
6600
6590
EXISTING 66" CMP FL = 6576.80
EXISTING BARNES ROAD
PROPOSED POWERS RIGHT OF WAY
C1
Proposed Concrete Ditch
A1
EXISTING POWERS BLVD
B1
210' ROW
128' R-FF
85'
Proposed 2-6' by 6' RCB
D1
PROPOSED POWERS RIGHT OF WAY
FUTURE B. ROAD
ALT. ANALYSIS #4
OPTION 1
High Chaparral
5178806
K Harrison 3/13/86

Alt. And #4
High Chaparral
3/10/86
K. Harrison

101

~~Alternate~~ #2 backup

~~Offsite Analysis~~

Pipe Design

Objective: Determine pipe sizes and costs for offsite drainage system as it passes through MLO 63 acre property.

Assumptions

1. 72" outfall @ S E Corner of Barnes and Powers Blvd.
2. City will approve the flows off of High Chaparral
3. City will approve the outfall point.

Drainage Calcs (~~From RKL A to B~~ at B

A Flow @ outfall located @ S.F. Corner of Barnes / Powers

Qp (from Basin A+B calc. sheet, 2/27/86)	354.2 cfs
Assume additional 10 cfs off of Powers & Barnes	10.0 cfs
Total @ outfall point	364.2 cfs

Assume no additional flow entering pipe until the pipe intersects with the natural channel

B Pipe design

Limit velocity to 15 fps.

72" @ 0.9 %, Q_{cap} = 400 cfs V_{cap} = 14 fps

Q_A / Q_C = 365/400 = 0.91

V_A / V_C = 1.13 ; V_A = 1.13 (14) = 17 fps.

High Chaparral
3/10/86 - K. Harrison

Alt Anal # 4
2 of

~~Alternate #2 Detention~~ Option 2

II Flow entering @ Point B.

A. Area Served (Additional) Tract located south of Barnes Road and West of Powers Blvd.

R.U.D. 71 Acres 92

B $P_5 = 1.33$

$P_{100} = 2.64$

C. t_c

t_c @ High Chaparral outfall point 21.0

750 L.F @ pipe @ 17 fps 0.8

21.8 min = .36 hr.

D $\theta = 850$

E $Q_{P5} = 294.6$ $Q_{P100} = 595$ cfs (pipe flow)

This is the total flow in the pipe at the time of concentration. Peak flow from the 71 acres that will occur prior to this. Therefore assume that peak flow will occur @ about 18 min. or 0.30 hrs

$\theta = 920$

$Q_{100} = \left(\frac{71}{640}\right)(2.64)(920) = 270$ cfs

Design Culvert under Powers Blvd to handle this flow

Assume 1) Inlet Control

2) Free outfall

3) HW/D = 1.3

It appears that that culvert under Powers will have to be at least a 72" pipe if the system is not totally enclosed

High Chaparral
3/10/86 - K. Harrison

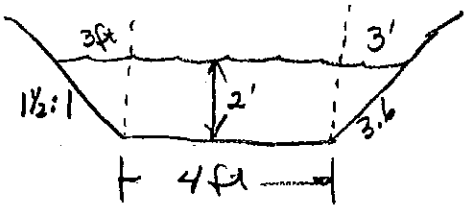
Alt. Anal #4
Pg 1 of —

Option ~~Alternate~~ #2 backup
City Reimbursement Ditch

A Design Criteria

Qoutfall = 364.2
Slope = 2.8% (assumption)
n = .017
Side Slopes = 1½/1

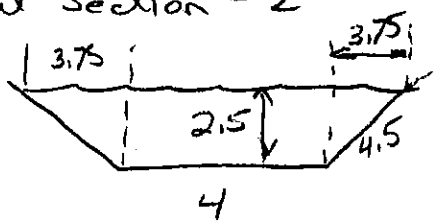
B Trial Section #1



$A = \frac{1}{2}(2)(4+10) = 14$
$P = 4 + 3.6(2) = 11.2$
$R = \frac{A}{P} = 1.25$

$Q = \frac{1.49}{.017}(14)(1.25)^{.667}(.028)^{1/2} = 238$ cfs

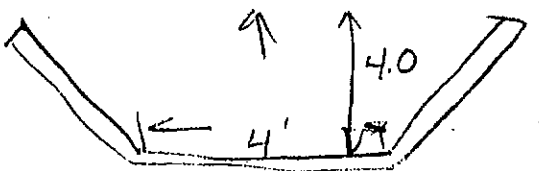
C. Trial Section #2



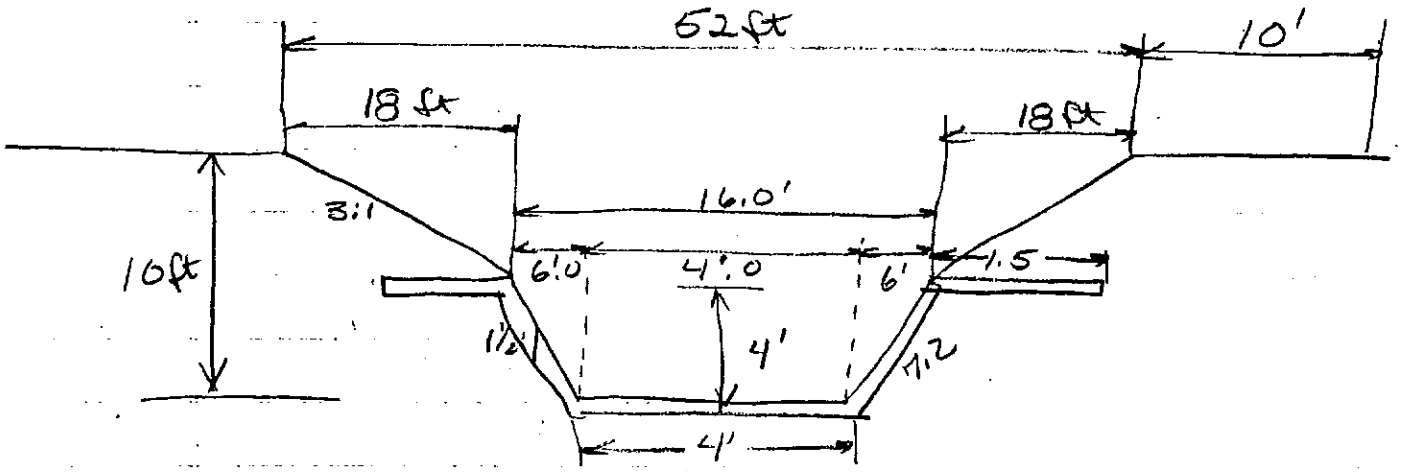
$A = \frac{1}{2}(2.5)(4+11.5) = 19.4$ ft²
$P = 4 + 4.5(2) = 13.0$
$R = \frac{A}{P} = 1.49$

$Q = \frac{1.49}{.017}(19.4)(1.49)^{.667}(.028)^{1/2} = 371$ cfs ; 19 fps = Vel.

D Proposed Section



E. Quantity Estimate



Excavation

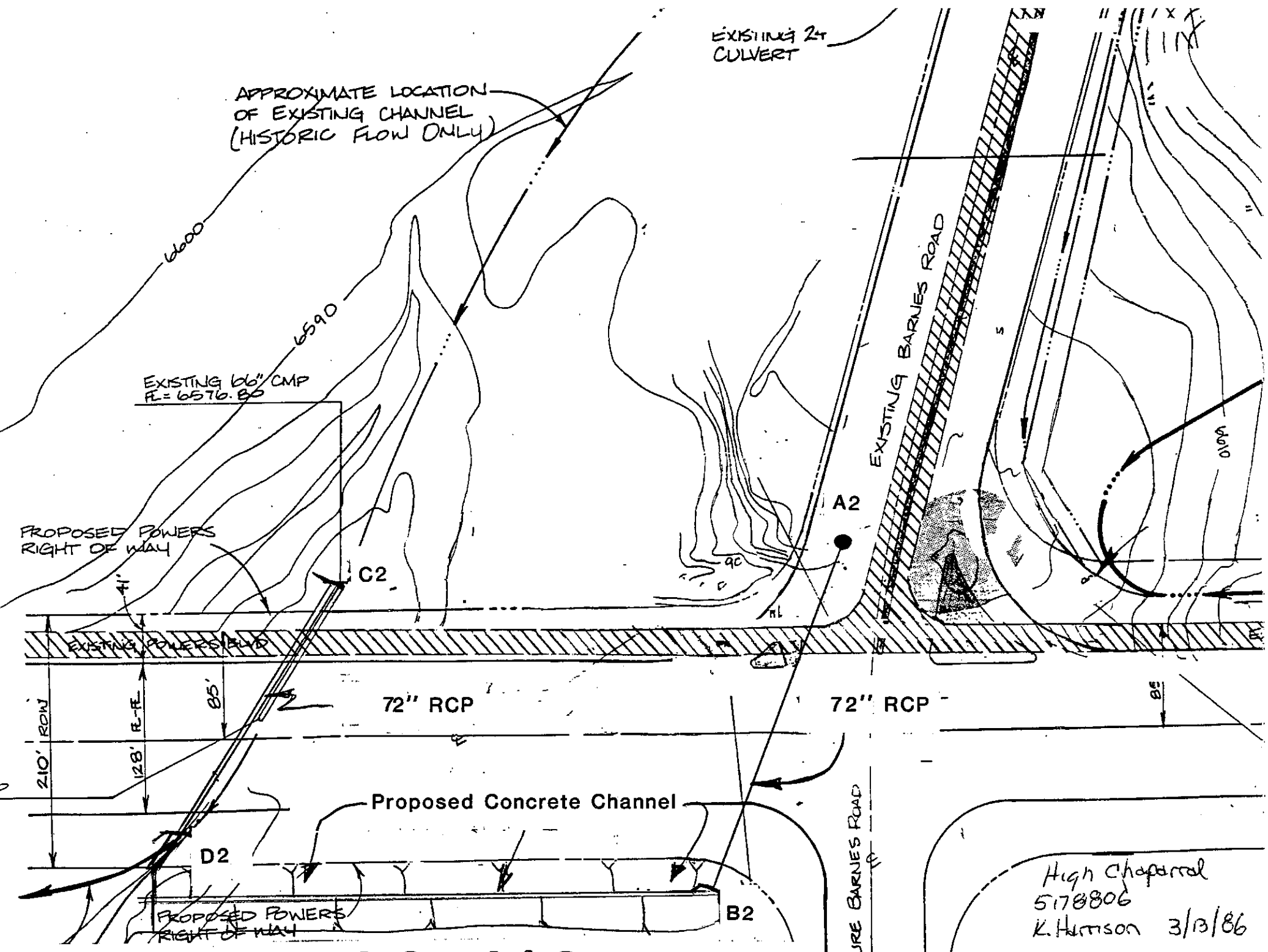
$$\left[\tfrac{1}{2}(4)(4+16)+\tfrac{1}{2}(6)(16+52)\right]450/27 = \quad 4100 \text{ C.Y.}$$

Concrete (6" thick)

$$[(2)\,1.5+7.2(2)+4]\,450\,(.5)/27 = 180$$

$$+\ 10\% = \underline{20}$$

200 C.Y.



ALT. ANALYSIS #4 OPTION #2

100-YEAR STREET CAPACITIES

Greiner Engineering

☐ DENVER, COLORADO
☒ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral - 100yr Street Cap
JOB NUMBER _____ SHEET ____ OF ____
CALCULATED BY K. Harrison DATE 6/29/95
CHECKED BY _____ DATE _____

100' R.O.W 60' C to C		100' R.O.W 84' C to C		Barnes Rd North Gutter	
%	Capacity	%	Capacity	%	Capacity
1.0	183		110		41.7
1.5	224		134		51.0
2.0	259		155		59.0
2.5	290		174		66.0
3.0	318		190		72.0
3.5	343		205		78.0
4.0	367		220		83.0
4.5	389		233		89.0
5.0	410		—		93.0
5.5	430		—		—
6.0	449		—		—
6.5	468		—		—
7.0	485		—		—
7.5	502		—		

Greiner Engineering

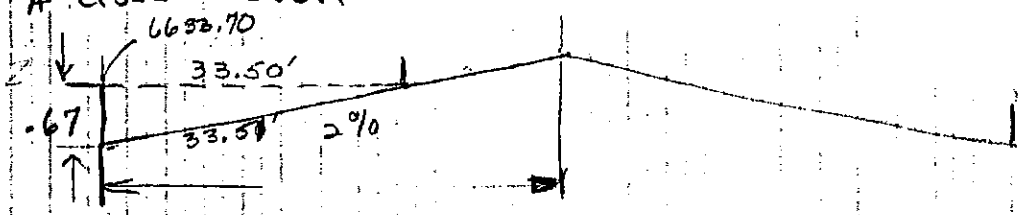
☐ DENVER, COLORADO
☐ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral - Basin "A"
JOB NUMBER _____ SHEET ____ OF ____
CALCULATED BY K. Harrison DATE _____
CHECKED BY DJT DATE 7/22/85

I Barnes Road 100yr Flow Capacity

West Bound lane @ Rio Vista

A Cross Section



$\frac{2}{100} = \frac{.67}{X}$

$X = \frac{.67}{2}(100)$

$X = 33.5$

B $n = .019$

$A = \frac{1}{2}(.67)(33.50') = 11.22 ft^2$

$P = .67 + 33.51 = 34.18 ft^2$

$R = A/P = 11.22/34.18 = .3283$

$S = .04$

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

$= \frac{1.486}{.019}(11.22)(.3283)^{2/3}(.04)^{1/2}$

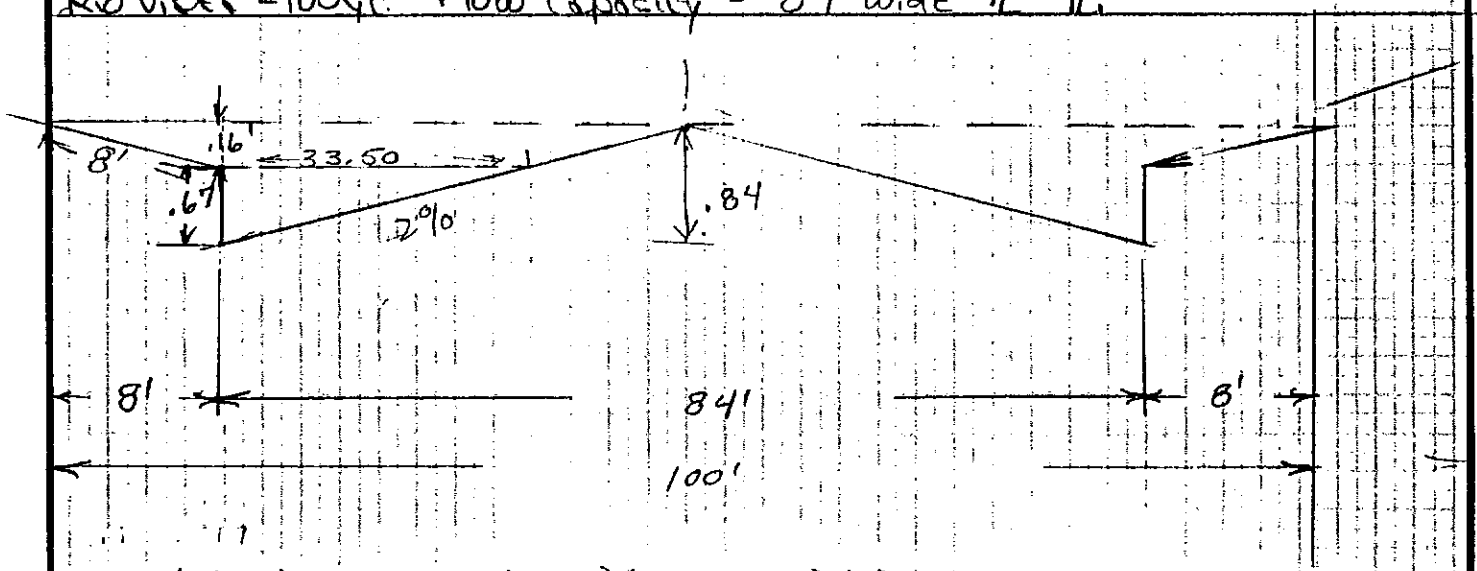
$= \boxed{83.5 \text{ cfs.}}$

Greiner Engineering

☐ DENVER, COLORADO
☒ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral Basin "A"
JOB NUMBER _____ SHEET ____ OF ____
CALCULATED BY K. Harrison DATE 6/13/85
CHECKED BY DJT DATE 7/29/85

Rio Vista - 100yr. Flow Capacity - 84' wide A - A'



$A = \frac{1}{2}(.67)33.50(2) + \frac{1}{2}(.16)(33.5+50)(2) = 33.805$

$P = [8 + .67 + 42]2 = 101.34$

$R = A/P = 33.805 / 101.34 = 0.3336$

$N_{comp} = [.040(8) + .67(.016) + 42(.019)] / \left(\frac{101.34}{2}\right) = .0221$

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

$= \frac{1.486}{.022} 33.805 (0.3336)^{2/3} S^{1/2}$

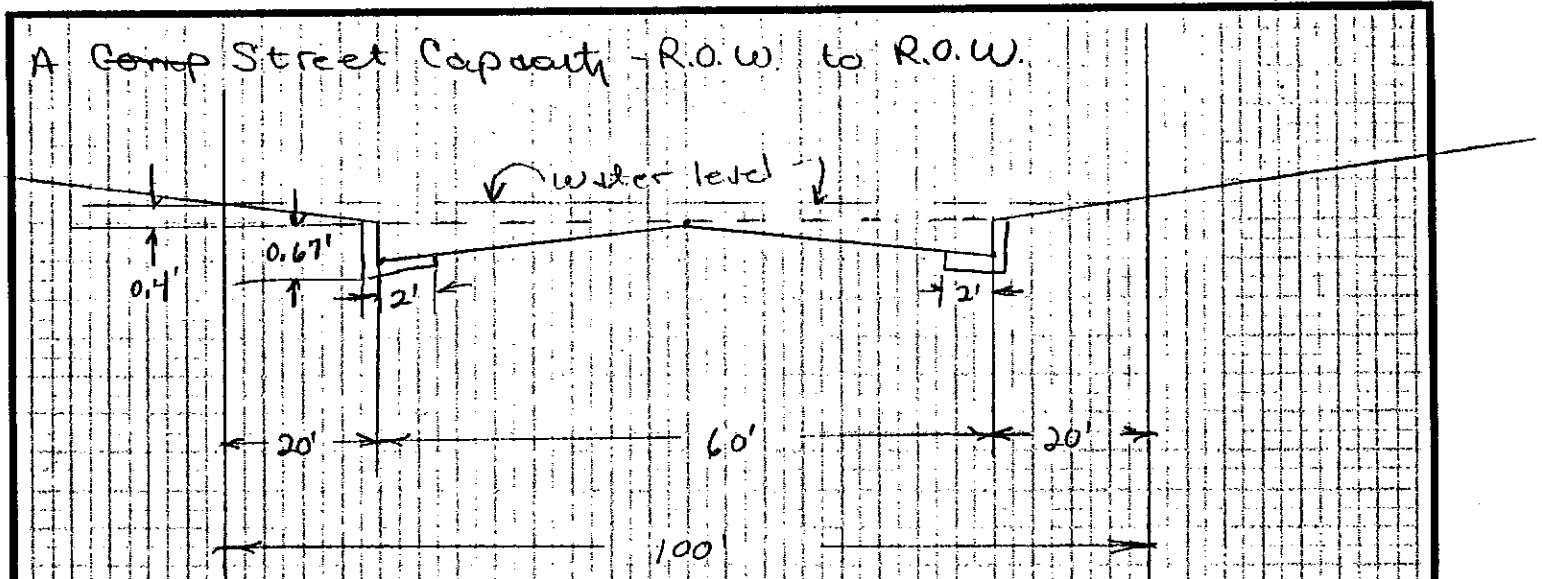
Slope	Flow
1%	100 ✓
1.5%	134 ✓
2.0%	155 ✓
2.5%	174 ✓
3.0%	190 ✓
3.5%	205 ✓
4.0%	220 ✓
4.5%	233 ✓

Greiner Engineering

☐ DENVER, COLORADO
☐ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT High Chaparral - Basin B
JOB NUMBER _____ SHEET ____ OF ____
CALCULATED BY K. Harrison DATE 6/12/85
CHECKED BY DJT DATE 7/29/85

A Comp Street Capacity - R.O.W. to R.O.W.



A. Composite n

$n_{grass} = 0.040$

$n_{gutter} = 0.015$

$n_{pavement} = 0.019$

$$\frac{.040(20)2 + .015(2.67)2 + 0.019(56)}{101.34} = n_{composite}$$

$$.0270 = n_{composite}$$

Area =

$$\frac{1}{2}(0.67)30(2) + \frac{1}{2}(0.4)(60+100) = 52.1\ ft^2$$

$$P = 20(2) + .67(2) + 60 = 101.34$$

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

$$= \frac{1.486}{.0270}(52.1)\left[\frac{52.1}{101.34}\right]^{2/3}(.025)^{1/2}$$

$$= 290\ cfs.$$

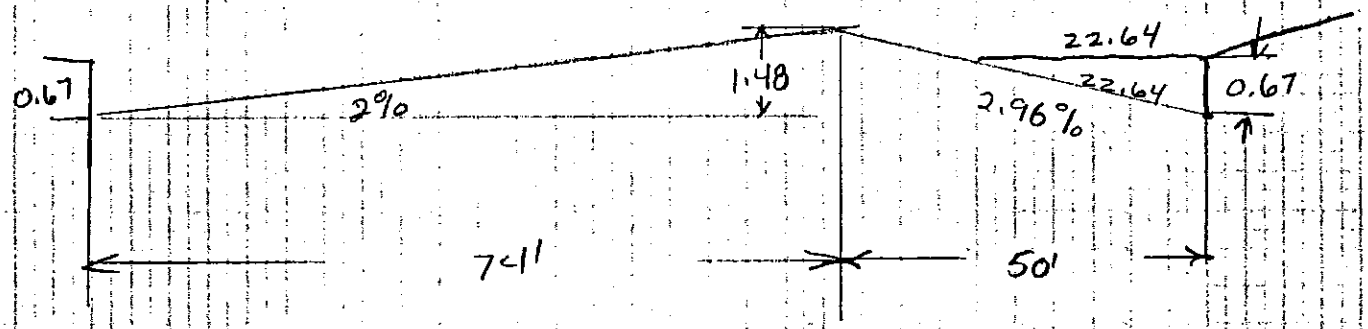
Greiner Engineering

- ☐ DENVER, COLORADO
- ☐ COLORADO SPRINGS, COLORADO
- ☐ ALBUQUERQUE, NEW MEXICO
- ☐ KEMMERER, WYOMING

PROJECT High Chaparral - Basin "A"
JOB NUMBER _____ SHEET ____ OF ____
CALCULATED BY K. Harrison DATE 6/13/84
CHECKED BY DJT DATE 7/20/84

100 year Flood Capacity - North Gutter of Barnes Road

$\frac{2.96}{100} = .67$



$A = \frac{1}{2}(0.67)(22.64) = 7.58\ ft^2$

$P = 0.67 + 22.64 = 23.31\ ft$

$R = A/P = 7.58/23.31 = .3252$

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

$= \frac{1.486}{.019}(7.58)(0.3252)^{2/3}(S^{1/2})$ where $S = .0107$

$= 29\ cfs$

A T T A C H M E N T S