SOUTHFACE SUBDIVISION

FINAL DRAINAGE STUDY FOR FILINGS 5, 6A AND 10

COLORADO SPRINGS, COLORADO
June 1993

Prepared for:

Schuck Interests, Inc.

Prepared by:

KLH Engineering, Inc.
208 Sutton Lane
Colorado Springs, CO 80907

KLH
ENGINEERING, INC.

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208 Sutton Lane
Colorado Springs, CO 80907

June 7, 1993
KLH #925770

Mr. Dave Lethbridge
City of Colorado Springs
Engineering Division
30 South Nevada Avenue
Colorado Springs, CO 80903

Re: Final Drainage Study for the Southface Subdivision Filings 5, 6A and 10

Dear Mr. Lethbridge,

In accordance with the subdivision regulations for the City of Colorado Springs, a Final Drainage Study has been completed for the above referenced project. The results of the study are included herein.

Please contact KLH if you have any questions or desire further information.

Sincerely,

Brian J. Huth

Brian J. Huth, P.E.
KLH Engineering, Inc.

Enclosure

DRAINAGE PLAN STATEMENTS
Southface Subdivision Filings No. 5, 6A and 10

ENGINEER'S STATEMENT:

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/County for drainage reports and said report is in conformity with the master plan of the basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

Kent D. Rockwell, P.E.

DEVELOPER'S STATEMENT

I, the developer, have read and will comply with all the requirements in this drainage report and plan.

BY: _____ DATE: 6-15-93

TITLE V.P. Schuck Interests

ADDRESS: 2 North Cascade Avenue, Suite 1280

Colorado Springs, Colorado 80903

CITY OF COLORADO SPRINGS

Filed in accordance with Section 15-3-906 of the code of the City of Colorado Springs, 1980, as amended.

CITY ENGINEER _____ DATE

- SOUTHFACE -
FINAL DRAINAGE STUDY FOR FILINGS 5, 6A AND 10
April 1993

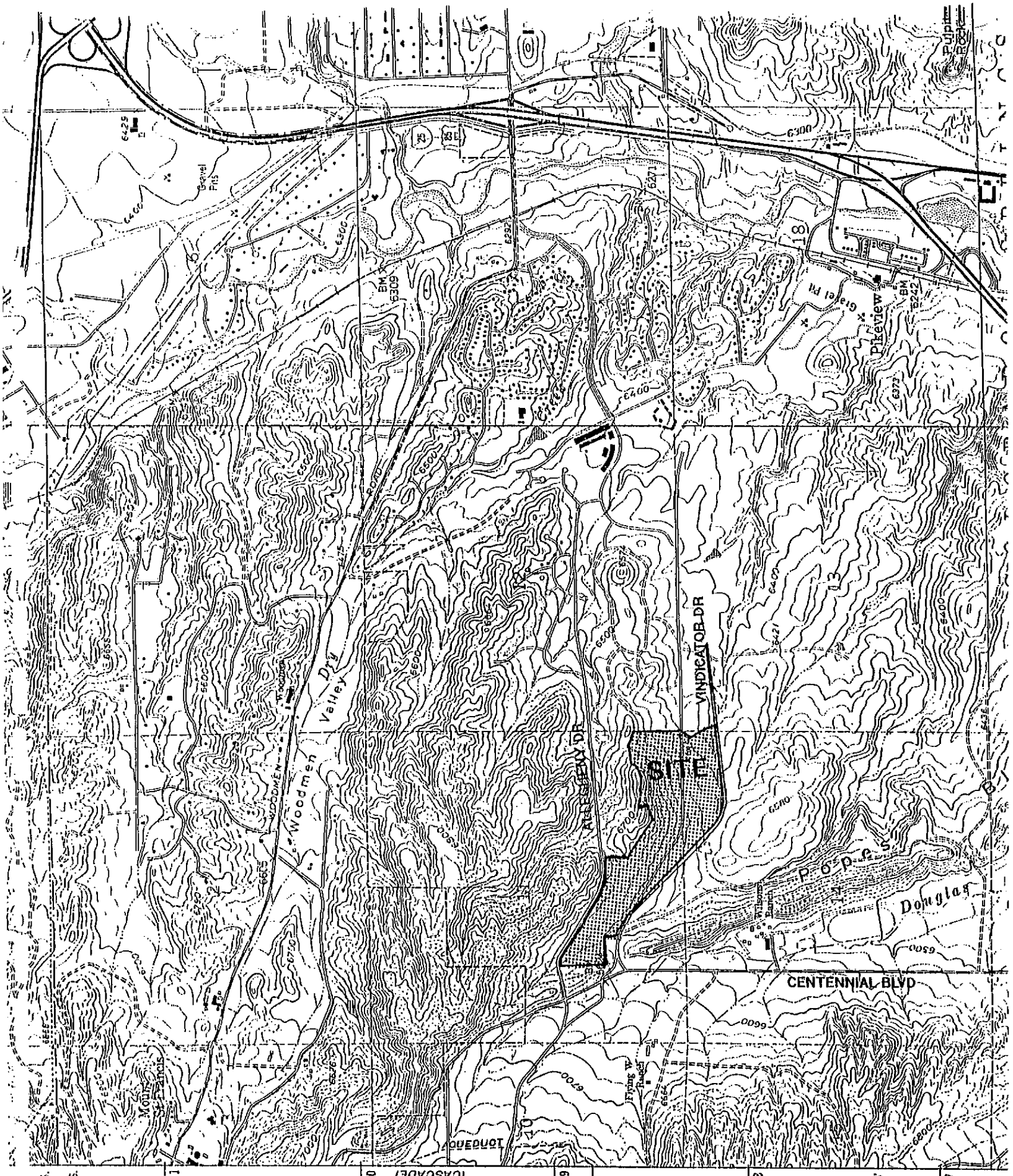
I. INTRODUCTION

This study, titled the Final Drainage Study for Filings 5, 6A and 10 for the Southface Subdivision, was authorized by Schuck Interests, Inc. This study has been prepared and submitted in conjunction with the approval process for this development, and fulfills the drainage and flood plain management requirements for the City of Colorado Springs. This final drainage study is in conformance with the Southface Master Development Drainage Plan (MDDP) prepared by KLH Engineering dated 1-13-93. This final study analyzes Filings 5, 6A and 10 in enough additional detail to address the preliminary construction details for the drainage improvements.

Southface is located in the City of Colorado Springs, in the western portion of Rockrimmon, (see Figure 1). Southface contains 97.92 acres, is situated between Vindicator Drive and Allegheny Drive and east of Centennial Boulevard. Filing 5 is within the Rockrimmon North drainage basin and contains 10.331 acres. Filing 6A is within the Rockrimmon South drainage basin and contains 8.430 acres. Filing 10 is within the Rockrimmon South drainage basin and contains 1.256 acres. The entire development is zoned Hillside Residential (R-1-6000). The soils on the site fall within the hydrologic soils groups of A, C & D as shown on Figure 2. The Rational Method of calculating storm runoff was used as required in the current City of Colorado Springs/El Paso County Drainage Criteria. The Flood Insurance Rate Maps indicate that no portion of the site is located within a flood hazard area.

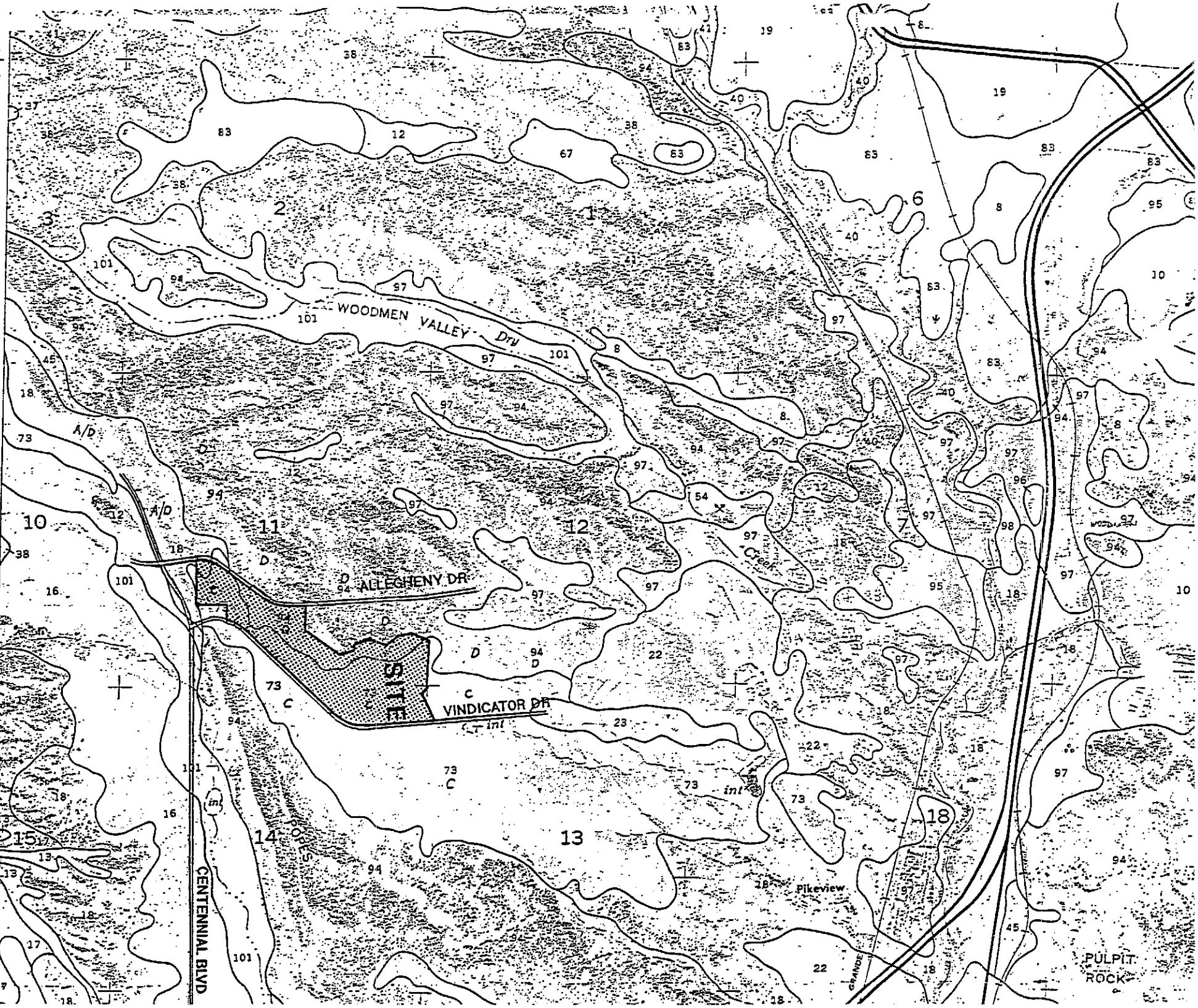
This will be a residential development of single family dwellings. The north/central portion of the site, along the steep rock outcroppings, will remain undisturbed. The improvements will be located in the sloping grassed area.

The "Overlot Grading and Erosion Control Plan" for the entire development has already been prepared and is on file with the city. A copy is enclosed for convenience.



VICINITY MAP

FIGURE 1



SOILS MAP

FIGURE 2

SOILS MAP NO. 8

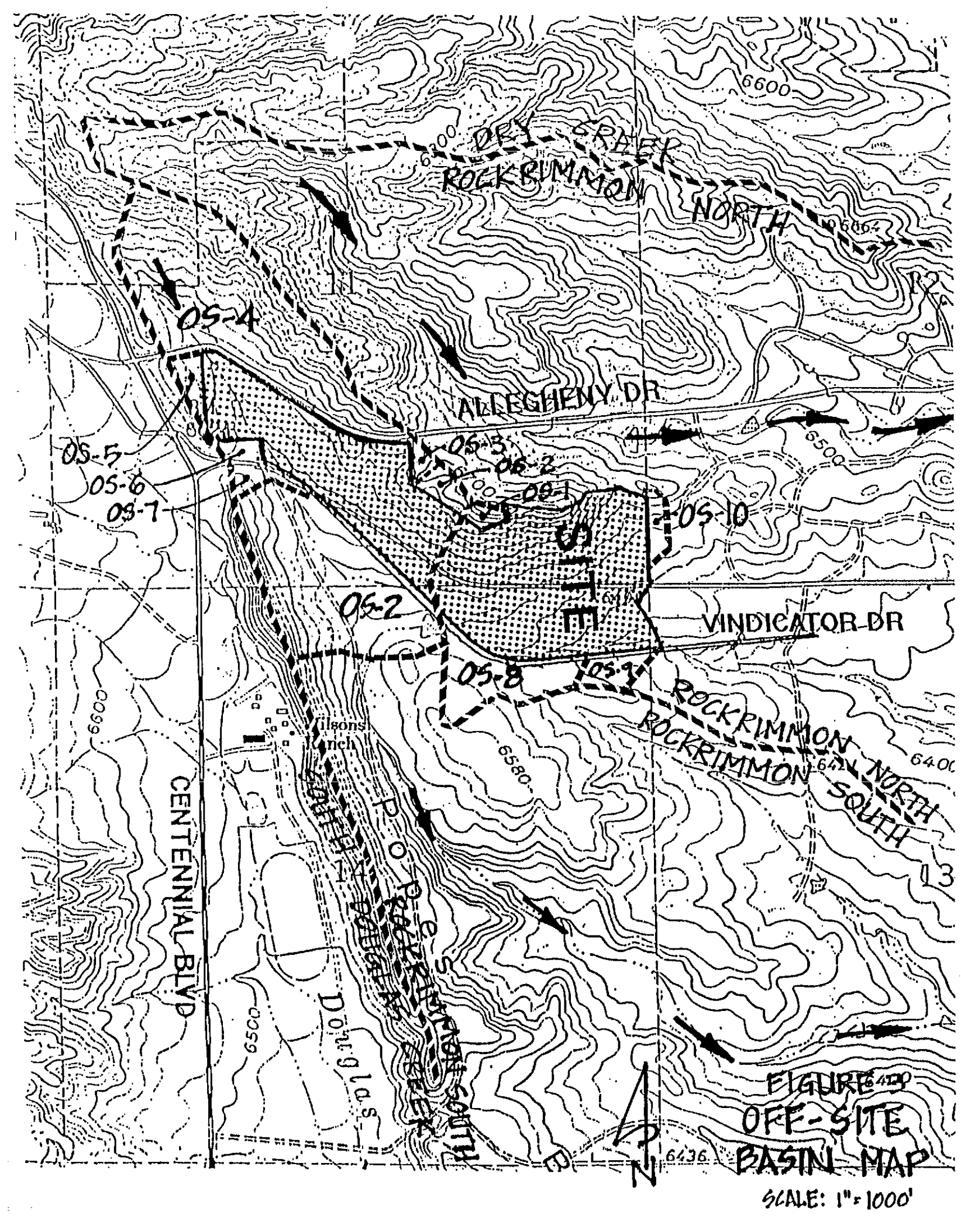


FIGURE 4
OFF-SITE
BASIN MAP
SCALE: 1" = 1000'

II. HYDROLOGIC ANALYSIS

Currently, the terrain of the site slopes to the southeast and southwest with approximate slopes of five to twenty percent (5% - 20%) on the buildable portions of the site. The existing ground cover consists of native grasses with pine trees and mountain shrubs in the higher portions of the site.

The enclosed developed drainage plan is a copy of the developed drainage plans from the MDDP. Additional information and details have been added where necessary to describe the intermediate flow conditions. Also included is a map depicting proposed filing boundaries.

FILING NO. 5

For the historic condition runoff calculations, two on-site basins and two off-site basins impact Filing 5 (see Existing Drainage Plan). The historic on-site basins that impact this filing are H4 and H6. A portion of off-site basins OS-1 and OS-2 drain onto the filing and runoff from the filing drains onto Filing 1 and Vindicator Drive. This filing is in the Rockrimmon North Basin.

Developed condition basins include portions of D12, D13, D13.1, D15, D19, D20, D21, D22, D23 and D27. Most of the runoff will leave the filing at three locations; Bison Ridge Drive, Bear Cloud Drive and Owl Ridge Drive. The street capacities are not exceeded in this filing and no storm sewer improvements are required. Cross pans are required on Bison Ridge Drive at Bear Cloud Drive and Owl Ridge Drive. 8" vertical curb and gutter will be installed on all of Bison Ridge Drive.

FILING NO. 6A

For the historic condition runoff calculations, two on-site basins and two off-site basins impact Filing 6A (see Existing Drainage Plan). The historic on-site basins that impact this filing are H6 and H7. A portion of off-site basins OS-2 and OS-3 drain onto the filing and most of the runoff from the filing drains onto Filing 6B with a small portion draining onto Filing 2 and Vindicator Drive.

Developed condition basins include portions of D7.1, D7.2, D8, D9, D10 and D10.1. About 86% of the runoff from Filing 6A discharges to the "Central Outfall" as described in the MDDP. This drains into the proposed storm sewer at DP7. This storm sewer conveys the 100 year flows directly to the Rockrimmon South channel. An 8' stub of 18" RCP will be installed for later connection to Last Light Court.

The remaining 14% of the filing is the rear of about 7 lots that sheet flows directly onto Vindicator Drive. A portion of this flow in Vindicator Drive is captured by 4 on-grade storm sewer inlets that drain into the existing retention pond. The remainder of the runoff by-passes these inlets and continues down Vindicator Drive to the east into the Rockrimmon North Basin as described in the MDDP.

A cross pan is required across Grey Wolf Court at Smoke Ridge Drive and Type 1 vertical curb and gutter is required as shown on the Drainage Plan. For traffic reasons, all of Smoke Ridge Drive will contain type 1 vertical curb and gutter.

FILING NO. 10

Filing 10 consists of three lots along Allegheny Drive. Drainage from these three lots will produce only a small increase of flows and will not significantly impact the drainage patterns below the filing. These lots have access onto Allegheny Drive and will have driveway ramps that will keep street flow in Allegheny Drive. Runoff will drain onto undeveloped rangeland below the site. The area below this filing is within the future Filing No's. 8 and 9.

These lots are adjacent to the low point of Allegheny Drive. It is expected that the existing inlets at this low point will not handle the 100 year flow. Flow will overtop the curb and run into the filing. A 20' D-10-R inlet is proposed on the south curb line at this low point of Allegheny Drive to eliminate this problem. This inlet will connect with the existing system to capture the 100 year flows. The existing 27" Reinforced Concrete Pipe (RCP) that drains these inlets will be replaced with a 48" RCP. This 48" RCP will continue for about 40' until enough head is produced to allow the pipe to be reduced to a 36" RCP. This pipe will continue south and connect into the existing storm sewer system in Filing 2.

A 12" high berm should also be installed along the street to direct any overflows toward the drainage easement. A wide shallow swale will be graded through this easement to convey overflows if they occur. This Filing conforms to the MDDP for Southface Subdivision. It should be noted that Bristlecone Drive, in Filings 2, 8 and 9, has been renamed to Warm Tree Drive.

The drainage generated by these three lots will not require special erosion control measures. The builders will be required to provide erosion control on each lot during the home construction.

III. HYDRAULIC ANALYSIS

Information on the existing storm sewer systems in Allegheny Drive and in Vindicator Drive were derived from the actual design plan and profiles. The inlet sizes and locations were field verified. These systems were analyzed for their capacity based on existing and proposed 10 and 100 year street flows. According to City Traffic Division, Vindicator Drive is a Collector/Minor Arterial and Allegheny Drive is a Major Residential/Collector. See the appendix for charts on allowable street flows for Vindicator Drive and residential streets within the site. The MDDP includes a detailed analysis on the proposed drainage patterns in the developed site, within Vindicator Drive and within Allegheny Drive.

The storm sewer from Design Point 7 will convey the 100 year flows from the proposed sump in Smoke Ridge Drive to the Rockrimmon South drainageway within the Ute Valley Park. This system will cross under and be sperate from the existing storm sewer system in Vindicator Drive. The pipe flow will discharge into a riprap energy dissipator before it enters the existing drainageway. Adjacent to the energy dissipator will be a grade control structure on the main drainageway. These were located adjacent to each other for ease of construction and to minimize disturbance to the park.

The storm sewer through Filing 10 will capture the 100 year flows at the low point in Allegheny Drive. A 20' D-10-R inlet will assist in this 100 year capture. About 40 linear feet of 48" RCP will be drain this network of inlets to satisfy entrance conditions. This 48" RCP will reduce to a 36" RCP which will then be able to convey this flow to the proposed junction box in the intersection of Anasazi Court and Warm Tree Drive (formerly Bristlecone Drive). Here the flow will combine with other laterals and continue in a 48" RCP to filing 2. The other laterals will be stubbed out 8' from the junction box for future connection.

IV. EROSION CONTROL PLAN

GENERAL CONDITION

The objectives of this plan are to analyze the drainage characteristics of the site and to provide necessary designs so as to prevent damage to adjacent properties due to sediment, or storm water runoff and to regulate the on-site effects of erosion. An erosion control/grading plan and cost estimate has been prepared and approved by the city. A copy of this plan is enclosed. The cost estimate for erosion control is on the plan and the required financial assurances have already been provided to the city.

STRUCTURAL EROSION CONTROL

Hay bales would be used as the structural erosion control. Hay bales will be placed at concentrated flow discharge points.

NON-STRUCTURAL EROSION CONTROL

Non-structural erosion control would be accomplished by reseeding the disturbed portions of the site. An erosion control mat would be installed on slopes that are steep enough to be subject to erosion (steeper than 3h:1v).

V. COST ESTIMATE

BASIN FEES

The 1993 drainage fees for Southface are $ 2,556 per acre for the Rockrimmon North Basin and $ 1,998 per acre for the Rockrimmon South Basin. There are no bridge fees for these basins. The fees for this development are:

Rockrimmon North Drainage Basin:	
Filing No. 5 = 10.331 acres	$ 26,406
Rockrimmon South Drainage Basin:	
Filing No. 6A = 8.430 acres	$ 16,843
Filing No. 10 = 1.256 acres	$ 2,509

CONSTRUCTION COST ESTIMATE

Storm drainage improvements are shown on the Developed Drainage Plan. All major drainage improvements are public. Drainage swale improvements and erosion control is private. As mentioned above, the costs for erosion control have already been issued. The construction cost estimate will be separated into the appropriate North or South Rockrimmon Drainage Basin.

North Rockrimmon Basin:

Filing 5 - There are no construction costs for Filing 5. The Filing 5 fees are covered in part by the fact that Filings 1 and 3 construction cost estimate ($ 49,005) exceeded the required fees ($ 46,420) by $ 2,585. The remainder of the required fees for Filing 5 ($26,406 - $2,585 = $23,821) will be provided to the City.

South Rockrimmon Basin:

Filing 6A - The estimated public construction costs for Filing 6A are $ 64,922. The Filing 6A fees are $ 16,843. The construction costs exceeded required fees, therefore, no fees are due. Financial assurances will be provided for the construction costs.

Filing 10 - The estimated public construction costs for Filing 10 are $ 46,065. The Filing 10 fees are $ 2,509. The construction costs exceeded required fees, therefore, no fees are due. Financial assurances will be provided for the construction costs.

SOUTHFACE
DRAINAGE IMPROVEMENTS – CONSTRUCTION COST ESTIMATE

PUBLIC CONSTRUCTION COSTS:

Item	Unit	Unit Cost	– Quantities – Filing 10 Portions of Filings 8 & 9 Bristlecone & Anasazi	– Quantities – Filing 6A Portions of Filing 6 Last Light & Smoke Ridge	Total Quantity	Total Cost
PIPE:						
18" RCP	LF	$20	8	8	16	$320
24" RCP	LF	$25	8		8	$200
30" RCP	LF	$36		1,050	1,050	$37,800
36" RCP	LF	$45	330		330	$14,850
48" RCP	LF	$60	240		240	$14,400
36" x 48" Reducer	EA	$1,200	1		1	$1,200
18" - 45deg Bend	EA	$300		1	1	$300
Manholes:						
6' MH, Type II	EA	$1,600		3	3	$4,800
Box MH, Type I	EA	$2,500	1		1	$2,500
Inlets:						
4' D10R Inlet, (>4' deep)	EA	$2,500		1	1	$2,500
10' D10R Inlet	EA	$4,000		1	1	$4,000
20' D10R Inlet, (>4' deep)	EA	$8,000	1		1	$8,000
Other:						
Remove Asphalt/C & G	SY	$5	27	160	187	$935
Replace Curb & Gutter	LF	$15		20	20	$300
Replace Asphalt & Base	SY	$16	27	160	187	$2,992
Utility Crossings (est)	EA	$3,000		1	1	$3,000
Park Improvements:						
Pipe - see above						
Riprap - Energy Dissipators	CY	$30		30	30	$900
Riprap - Grade Control	CY	$30		4	4	$120
Reseeding & Matting	SY	$1.30		1,300	1,300	$1,690
Excavation	CY	$3		30	30	$90
SUBTOTAL			$41,877	$59,020		$100,897
Contingency 10%			$4,188	$5,902		$10,090
TOTAL			$46,065	$64,922		$110,987

File: Cost5610.wq 04-Jun-93

PRIVATE CONSTRUCTION COSTS:

Grass Drainage Swale	LF	$4	350		350	$1,400

APPENDIX

HYDROLOGIC AND HYDRAULIC DESIGN INFORMATION

MAJOR BASIN	SUB BASIN	AREA		BASIN		Tc Min.	I	SOIL GROUP	DEV. TYPE	C	FLOW		RETURN PERIOD
		PLANIMETER READING	Ac.	LENGTH	HEIGHT						Q	q_p	
FLING NO. 5	D12		5.62			19.5	3.5 / 5.2	C/D	RESID + OPEN SPACE	.49 / .61		9.6 / 18	10 / 100
	D13												
	D15		0.65			8.0	5.0 / 7.6	C	RESID.	.60 / .70		2.0 / 3.5	
	D19		1.05			10.1	4.6 / 7.0	"	"	" / "		2.9 / 5.1	
	D20		5.08			14.3	4.0 / 6.0	"	"	" / "		12 / 21	
	D22		0.96			14.2	4.0 / 6.0	"	"	" / "		2.3 / 4.0	
	D23		4.81			13.1	4.1 / 6.2	"	"	" / "		12 / 21	
	OS-1		0.87			6.3	5.5 / 8.3	D	OPEN SPACE	.30 / .45		1.4 / 3.2	
	DP 13	D13 D12 D15	7.85			21.1	3.3 / 5.0	C/D	RESID + OPEN SPACE	.51 / .63		13 / 25	
	DP 13.1	D13.1 & 15 DP 13 .46×DP 11.1	11.25			21.1	3.3 / 5.0	"	"	.52 / .64		19 / 36	
	DP 23	DP 21 D23	14.88			17.1	3.7 / 5.5	"	"	.60 / .70		33 / 57	

HYDROLOGIC COMPUTATION – BASIC DATA
RATIONAL METHOD Q=CIA

PAGE 1 of 2

KLH Engineering Consultants, Inc.
PROJECT: SOUTH FACE S,6A,10

By: BJH
Date: 6-2-93

MAJOR BASIN	SUB BASIN	AREA		BASIN		Tc Min.	I	SOIL GROUP	DEV. TYPE	C	FLOW		RETURN PERIOD
		PLANIMETER READING	Ac.	LENGTH	HEIGHT						Q	q_p	
FILING	D7.1		1.95			11.6	4.4 / 6.6	C	RESID.	.60 / .70		5.1 / 9.0	10 / 100
NO. 6A	D7.2												
	D8		3.26			15.3	3.9 / 5.8	C/D	"	" / "		7.6 / 13.2	
	D9		5.96			14.6	4.0 / 6.0	"	RES + OPEN SPACE	.45 / .57		10.6 / 20	
	D10		6.85			15.3	3.9 / 5.8	"	"	.43 / .56		16.5 / 22	
	OS-3		1.28	250	45	9.1	4.8 / 7.2	D	OPEN SPACE	.30 / .45		1.8 / 4.1	
	OS-2		3.70	300	54	10	4.6 / 70	"	"	" / "		5.1 / 11.7	
	DP7	DP9 D7 & 10	17.05			16.3	3.8 / 5.7	C/D	RESID OPEN SPC	.48 / .60		31 / 58	
	DP9	D7.2 DB D9	9.57			15.3	3.9 / 5.8	"	"	.51 / .62		19 / 34	
FILING NO. 10	D3												
	D4												
	OS-4.1		42.2			22.3	3.2 / 4.8	A/C/D	MULTI FAM + OPEN SPACE	.50 / .63		68 / 128	
													Y

HYDROLOGIC COMPUTATION – BASIC DATA
RATIONAL METHOD Q=CIA

PAGE 2 of 2

KLH Engineering Consultants, Inc.
PROJECT: SOUTH FACE 5, 6A, 10

By: BJH
Date: 6-2-93

92-577-00
SOUTHFACE
9-30-92 BJH (1)

HYDRAULICS: -VINDICATOR DRIVE-

DETERMINE ALLOWABLE STREET FLOW

STREET CLASS: TYPE B, COLLECTOR OR MINOR ARTERIAL

10YR ⇒ NO CURB OVERTOP & FLOW SPREAD = 20' MAX

100YR ⇒ 12" MAX DEPTH AT FL

STREET SLOPE %	½ STREET FLOW CFS 10YR 20' SPREAD	100YR 12" DEPTH
0.8%	13.9 CFS	110×1.11+1.7 = 124
1.4	19.4	150×1.11 + 2.7 = 169
3.0	27.8	210×1.11 + 3 = 236
4.7	34.7	270×1.11 + 4 = 304
6.0	41.7	300×1.11 + 4.5 = 338

FIGURE 7-2 { FLOW IN ASPHALT SECTION. W/S$_X$ = 0.2.
FIGURE 7-3 { $E_{O_{10}}$ = 0.28, $E_{O_{100}}$ = 0.1

100YR: FLOW BEHIND CURB:

ON-SITE

HYDRAULICS: STREET CAPACITIES

CLASS: RESIDENTIAL ~~(THROUGH)~~ (TYPE A: LOCAL/RESIDENTIAL)

WIDTH: 34'

SLOPE: 0.5, 1, 2, 4, 6, 8, 10 %

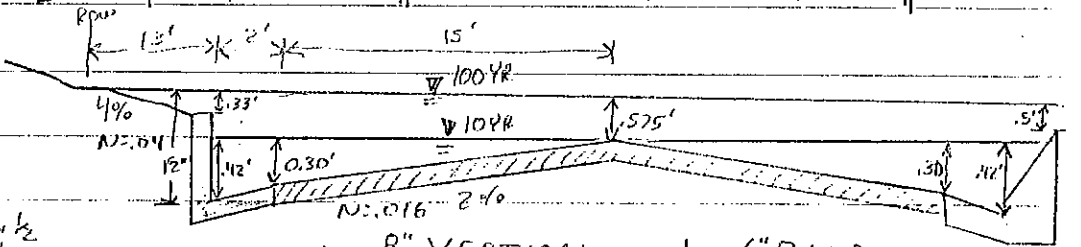
CURB: 8" VERT (TYPE 1) & RAMP (TYPE 2)

CRITERIA: 10YR - NO CURB OVERTOP & NO CROWN OVERTOP

100YR - 12" MAX DEPTH @ BF

FLOW CAPACITY: ½ STREET SECTION (CF-5)

SLOPE %	8" VERT CURB 10YR	VEL	8" VERT CURB 100YR	VEL	RAMP CURB 10YR	VEL	RAMP CURB 100YR	VEL
0.5	6	2CFPS	37.5	2.5FPS	5.5	2CFPS	41.8	2.6FPS
1.0	8.5	2.9FPS	53.1	3.6FPS	7.8	2.8FPS	59	3.7FPS
2.0	12	4.1FPS	75	5.1FPS	11.1	3.7FPS	84	5.3FPS
4.0	16.9		106		15.6		118	
6.0	20.7	7FPS	130	8.7FPS	19.1	6.8FPS	145	9.2FPS
8.0	24		150		22.1		167	
10.0	26.7	9FPS	168	11FPS	24.7	8.8FPS	187	11.8FPS
12.0	29.3		184		27.1		205	



$Q = AV$

$= \frac{1.486}{N} AR^{2/3} S^{1/2}$

		8" VERTICAL	6" RAMP
Q: 10YR 8" VERT = 84.96 $S^{1/2}$	10YR:	A = 2.97 SF N:.016	A: 2.818 N:.016
100YR 8" VERT = 530.5 $S^{1/2}$		PW: 17.5'	PW: 17.3'
10YR RAMP = 78.10 $S^{1/2}$		R = 0.1697	R = 0.1630
100YR VERT = 591.5 $S^{1/2}$	100YR:	A = 14.975 SF N:.026	A: 15.84 N:.026
		PW: 30.6'	PW: 30'
		R: 0.4882	R: 0.5281

92-577-00 SOUTHFACE (6)
9-29-92 BJH

EXISTING HYDRAULICS:

BRISTLECONE DR & ALLEGHENY DR

STORM SEWER SYSTEM #6:

FLOW: $Q_{10} = 68_{CFS}$ $Q_{100} = 128_{CFS}$

[ACTUAL CLASS: RES/MINOR COLLECTOR PER TRAFFIC DIV.]

STREET: TYPE B COLLECTOR OR MINOR ARTERIAL

10YR → NO CURB OVERTOPING / FLOW SPREAD = 20' MAX

100YR → 12" MAX @ CURB FL

EXISTING INLETS: 3 - 4' DIOR & 1 - 12' DIOR (SUMP)

ACTUAL DEPTH OF PONDING: $[Q = 3Ld^{1.5}]$ L=24'

10YR ⇒ d_{10} = 0.96' ⇒ NO CURB OVERTOP / T = 25'

100YR ⇒ d_{100} 1.47' ⇒ 5½" CURB OVER TOP

EXISTING PIPE FLOW: 27" OUTFALL:

$HW/D_{10} = 2.0 \Rightarrow HW = 4.5'$ ~~15.8'~~ TOO HIGH!

TC (MH) = 6649.01 FL MH @ 27" OUTFALL = 6644.03

$HW/D = 4.98/2.25' = 2.21 \Rightarrow$ [$Q_{ACTUAL} = 38_{CFS}$]

CHECK LATERAL PIPES: 2 - 18" RCP & 1 - 24" RCP

$HW/D_{18} = 4'/1.5' = 2.67 \Rightarrow Q_{18} = 16\ CFS \times 2 = 32_{CFS}$

$HW/D_{24} = 4/2 = 2.0 \Rightarrow Q_{24} = 26\ CFS$ +26 CFS

58 CFS

$58\ CFS > [38\ CFS\ (27")] \therefore$ 27" CONTROLS

EXISTING OVERFLOW: $Q_{10} = 68 - 38 =$ [30 CFS EXISTING OVERFLOW] !

$Q_{100} = 128 - 38 =$ [90 CFS]

PROPOSED: [INSTALL 36" RCP INSTEAD OF 27" RCP] ⇒ $HW/D = 11.98/3 = 1.66 \Rightarrow Q_{CAP} = 60_{CFS} > 58_{CFS\ ACTUAL}$ ∴ OK

[PROPOSED OVERFLOW: $Q_{10} = 10_{CFS}$, $Q_{100} = 70_{CFS}$]

12-30-92
BJH

HYDRAULICS:

STORM SEWER SYSTEM #6 CONT'D (ALLEGHENY DR)

FIND IMPROVEMENTS TO PROVIDE 100 YEAR CAPACITY:

FROM Pg (6) ⇒ EXIST PIPE CAPACITY (TO MH IN ALLEGHENY) = 58 CFS

EXIST INLET CAPACITY = 72 CFS

ADDITIONAL INLETS REQUIRED: 128 − 72 CFS = 56 CFS

⇒ INSTALL [20' D10R INLET] AT LOW PT ON SOUTH CURB

PIPE: Q_{100} = 128 CFS

TRY: 42" RCP $Hw/D = 2.6$ ⇒ $Hw = 9.1'$ $S_{MIN} = 1.62\%$ ok, $V_{EL} = 13.3$ FPS

" (GROVED ENT.) $Hw/D = 2.2$ ⇒ $Hw = 7.7'$

[36" RCP (GROVED)] $Hw/D = 4$ ⇒ $Hw = 12'$ $S_{MAN} = 3.7\%$, $V_{EL} = 18$ FPS

[48" RCP] $Hw/D = 1.7$ ⇒ $Hw = 6.8'$

* INSTALL 50 LF OF 48" RCP THEN REDUCE TO 36" RCP FOR REMAINDER OF WAY TO ANASAZI & CRISTIFORNI DR.

PROJECT: SOUTH FACE

STATION: DS-4.1

SHEET ____ OF ____

CULVERT DESIGN FORM

DESIGNER / DATE: CJH / 12-31

REVIEWER / DATE: ____ / ____

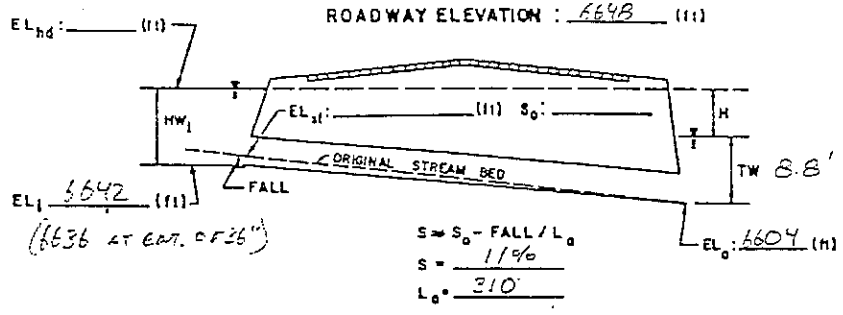
HYDROLOGICAL DATA

SEE ADD'L SHTS.

- ☐ METHOD: ____
- ☐ DRAINAGE AREA: ____ ☐ STREAM SLOPE: ____
- ☐ CHANNEL SHAPE: ____
- ☐ ROUTING: ____ ☐ OTHER: ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
100	128	



$S \approx S_o - FALL / L_a$

$S = 11\%$

$L_a = 310'$

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_hi (4)	OUTLET CONTROL TW (5)	d_c	(d_c+D)/2	h_o (6)	k_e	H (7)	EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
36" RCP	128		4	12	0	6648	8.8	-	-	8.8	0.2	12.5	6630	6645	13.1	

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) HW_i/D = HW /D OR HW_i/D FROM DESIGN CHARTS

(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g = 3.4275\ V^2/29$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

- a. APPROXIMATE
- f. CULVERT FACE
- hd. DESIGN HEADWATER
- hi. HEADWATER IN INLET CONTROL
- ho. HEADWATER IN OUTLET CONTROL
- i. INLET CONTROL SECTION
- o. OUTLET
- sf. STREAMBED AT CULVERT FACE
- tw. TAILWATER

COMMENTS / DISCUSSION:

FROM ALLEGHENY TO BRISTLECONE:
40 OF 48" RCP FOR ENT. CONDITION THEN REDUCE TO 36" FOR REMAINDER OF DIST. TO BRISTLECONE:

CULVERT BARREL SELECTED:

SIZE: 36"

SHAPE: ROUND

MATERIAL: CONC n .013

ENTRANCE: GROOVED

36" RCP: A = 7.0686

P_w = 9.4248

R = 0.7500

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The City of Colorado Springs / El Paso County
Drainage Criteria Manual

Date: OCT. 1987

Figure: 9-44

REFERENCE: Federal Highway Administration, Hydraulic Design of Highway Culverts: Hydraulic Design Series No. 5 1985

9-72

(9.2)

HYDRAULICS:

24"RCP ON ALLEGHENY BETWEEN YELLOWPINE & NORFOLK

STORM SEWER SYSTEM #7:

FLOW: Q_{10} = 25 CFS Q_{100} = 45 CFS

EXISTING INLETS: 1-14'D-10-R (SUMP) & 1-10' DIOR (4% SLOPE)

ACTUAL DEPTH OF PONDING: $Q = 3Ld^{1.5}$ $L = 14'$

14'D-10-R $\Rightarrow$ d_{10} = 0.71' OK d_{100} = 1.05' OK

∴ IF ALL FLOW PASSED 10' INLET THEN 14' WOULD WORK

PIPE FLOW: 24"RCP OUTFALL: $H_W/D_{ACTUAL} = \frac{2.2}{2'} = 3.6$ (2.2' IN ALLEGHENY) $\Rightarrow Q$ = 40 CFS

MAX FLOW IN 24"RCP = 40 CFS

THE REMAINING 5 CFS (Q_{100}) IS DETAINED AT THE SUMP AREA IN THE PARKLIGAN TOWNHOMES.

MANNINGS @ = 40 CFS $\Rightarrow$ S_{MIN} = 3.1% OK

OUTFALL PIPE IS AT 3.1% ± OK

12-30-92
BJH

HYDRAULICS: BRISTLECONE & ANASAZI

SUMMARIZE FLOWS TO INTERSECTION:

	10YR	100YR
TOTAL FLOW	121 CFS	208 CFS
PIPE FLOW: OS-4.1 (100YR CAP)	−68	−128
→ DP 3/4 N 1/2 OF STREET	−9	−9
OS-4.2	−25	−40
~~REMAINING STREET FLOW:~~ OK →	~~28~~ 19 CFS	~~40~~ 31 CFS

INSTALL INLET AT N. SIDE OF INTERSECTION AT SUMP:

10YR FLOWS: ≈ DP 4 + 1/2 of DP 3 = 14 + 1/2(9) = 23 CFS

[8' D10R INLET] Q_{CAP} (0.52' ~~10P OF CURB~~) = 9 CFS ∴ 14 CFS

∴ 14 CFS WILL OVERTOP THE CROWN & FLOW DOWN BRISTLECONE

[18" RCP] Hw/D = 1.4 Hw = 2.1' OK S_{MAN} = 0.7% OK

FLOWS ON S. SIDE OF ANASAZI WILL TURN CORNER AND FLOW DOWN BRISTLECONE DR. - OK

TOTAL PIPE FLOW AT BRISTLECONE & ANASAZI:

Q_{10} = 102 CFS Q_{100} = 177 CFS

PIPE: 42" RCP GROOVED ENT. Hw/D = 3.5 ⇒ Hw = 12.3' S_{MAN} = 3.1%

[48" RCP GROOVED ENT.] Hw/D = 2.2 ⇒ Hw = 8.8' S_{MAN} = 1.52% OK

HYDRAULICS:

DESIGN POINT 1: LOW POINT IN BRISTLECONE DRIVE

TOTAL FLOW ⇒ Q_{10} = 127 Q_{100} = 223 CFS

MINUS FLOW IN PIPE FROM DP1.1: − ~~95~~ 102 − ~~134~~ 177 CFS

= REMAINING STREET FLOW ⇒ ~~34~~ 25 CFS 89 CFS

PROVIDE 100 YEAR PICKUP OF STREET FLOWS:

$Q = 3LiH^{3/2}$ ⇒ L_{100} = ~~26~~ → 15.3' TOTAL PONDING $_{100}$ = 0" (H=13") ABOVE TOP OF CURB

INSTALL 2-~~15~~ 10' INLETS AT LOW POINT.

PIPE FLOWS:

TRY 54" RCP: Hw/D_{100} (GROVED) = 2.08 Hw = 9.4' S_{MAN} = 1.28%

60" RCP: Hw/D_{100} (GROVED) = 1.55 Hw = 7.8' S_{MAN} = 0.73%

-OR- USE EXISTING 36" RCP INVERT AT LOW PT = 92.8

T.C. AT LOW PT = 97.0 ⇒ Hw/D = 4.2/3 = 1.4 ⇒ Q_i = 52 CFS

52 CF IN 36" @ 0.71% OK $S_{MIN\,MAN}$ = 0.61%

REMAINING FLOW: Q_{100} 223 CFS − 52 CFS = 171 CFS

TRY: 54" RCP (171 CFS): Hw/D_{100} (GROVED) = 1.5 ⇒ Hw = 6.8' OK S_{MIN} (MANNINGS) = 0.76% OK

48" RCP: Hw/D (GROVED) = 2.2 ⇒ Hw = 8.8 ? S_{MIN} = 1.42% OK

∴ INSTALL 2-~~15~~ 10' INLETS AT LOW POINT & CONNECT TO EXISTING 36" RCP TO DRAIN TO THE SOUTH AND INSTALL 48" RCP TO DRAIN TO DP5.

~~15~~ 5 YR FLOW 61 CFS PARKS

DP5: Q_{10} = 127 (DP1) + 17 (DP5) = 144 CFS Q_{100} = 171 (DP1) + 30 (DP6) = 201 CFS

Check 48" RCP: Hw/D_{100} (GROVED) = 2.6 Hw = 10.4'

MAIN PIPE FLOW: 54" RCP: Hw/D (GROVED) = 1.8 Hw = 8.1' OK $S_{MIN.}$ (MANNINGS) = 1.04% OK

HYDRAULICS:

— SMOKE RIDGE DRIVE —

SIZE INLETS & PIPE

BASIN D6: (DESIGN FLOW) $Q_{10} = 17$ cfs $Q_{100} = 30$ cfs

SUMP CONDITION: INSTALL 1-6' D.I.D.R INLET

PIPE FLOW: 24" RCP: $Hw/D = 1.25 \Rightarrow Hw = 2.5'$ OK

MANNINGS $S_{MIN} = 0.6\%$

BASIN D5: $Q_{10} = 2.5$ cfs $Q_{100} = 4.4$ cfs

SUMP CONDITION: INSTALL 1-4' DIOR INLET

PIPE FLOW: DP D5: (DESIGN FLOW) $Q_{10} = 19$ cfs $Q_{100} = 34$ cfs

24" RCP: $Hw/D = 1.4 \Rightarrow Hw = 2.8'$ OK

MANNINGS $S_{MIN} = 0.7\%$

CHECK STORM SEWER FOR BASINS D6 & D5 FOR CAPACITY FOR 100 YEAR STORM: $Q_{100} = 34$ cfs

FIND ACTUAL PONDING DEPTH: 6.44' = 10' INLET LENGTH

DEPTH = $H = [P/3Li]^{2/3} = 1.09' \Rightarrow 0.09'$ OVER CURB. OK

24" RCP: $Hw/D = 3 \Rightarrow Hw = 6'$ OK, BUT CONSTRUCT INLET AT D5 5'8" FROM TOP OF CURB TO FLOWLINE OUT.

MANNINGS: $S_{MIN} = 2.26\%$

LENGTH OF PIPE = 306' ΔH(EXIST) = 86.2 - 77.5 = 8.7' = 2.9%

∴ IT SEEMS THAT A SLOPE OF 2.26% IS ACHIEVABLE TO PROVIDE 100 YEAR CAPACITY.

⇒ ∴ THE 10 YEAR SYSTEM HAS ADDITIONAL CAPACITY FOR 100 YR STORM, SO NO SPECIAL OVERFLOW SWALE IS REQUIRED. A STANDARD SWALE BETWEEN HOUSES IS RECOMMENDED AS ADEQUATE.

EXISTING DRAINAGE IN VINDICATOR

IFT6-92 BTH SOUTHFACE

HYDRAULICS:

STORM SEWER SYSTEM # 3 & 4 (INLETS # 2, 3, 4 & 5)

HISTORIC FLOW: BASIN H6 ⇒ Q_{10}: 20 cfs Q_{100} = 45 cfs

FIND SYSTEM CAPACITY: – EXISTING FLOWS – [WITHOUT PARKING LOT CAPTURE OF STREET FLOWS!]

6' DIOR

INLET # 2: ± 1/3 OF H6 ⇒ Q_{10} ≈ 6.7 cfs (T=11') Q_{100} ≈ 15 cfs (T=14.9')

SLOPE: 4.7% ⇒ INLET FLOW ± Q_{10} ≈ 1.9 cfs (.29%)

Q_{100} ≈ 3 cfs (.20%)

6' DIOR

INLET # 3: ± 1/2 OF H6 ⇒ Q_{10} = 10 − 1.9 = 8.1 cfs Q_{100} ≈ 22.5 − 3 = 19.5 cfs

SLOPE: 4.7% ⇒ INLET FLOW ± Q_{10} ≈ 2.3 cfs

Q_{100} ≈ 3.9 cfs

6' DIOR

INLET # 4: ± 3/4 OF H6 ⇒ Q_{10} = 15 − 4.2 = 11.8 cfs (T=8.3' BOX) Q_{100} = 34 − 6.9 = 27 cfs (T=11.4' (23%))

SLOPE: 3% ⇒ INLET FLOW ± Q_{10} ≈ 3.5 cfs

S_x = 5%

Q_{100} ≈ 6.2 cfs

6' DIOR

INLET # 5: ± 80% OF H6 ⇒ Q_{10} = 16 − 7.7 = 8.3 cfs Q_{100} = 36 − 13.1 = 23 cfs

SLOPE: 3% ⇒ INLET FLOW ± Q_{10} ≈ 2.5 cfs

S_x = 5%

Q_{100} ≈ 5.3 cfs

∴ TOTAL SYSTEM PICKUP (EXISTING): Q_{10} = 10.2 cfs

Q_{100} = 18.4 cfs

~~80% OF BASIN H6~~

∴ "FLOW BY" IN VINDICATOR TO RR NORTH BASIN = Q_{10}: 6 cfs

Q_{100} = 18 cfs

{⇒ EXISTING STREET FLOWS (FLOW BY) ARE WITHIN ALLOW CAPACITY}

(1/2 STREET Q_{10} ALLOW = 28 cfs, Q_{100} ALLOW = 340 cfs)

SOUTHFACE
~~11-12-92~~ CJH
11-25-92 CJH

HYDRAULICS:

DP7: LOW PT IN SMOKERIDGE DR Q_{10} = 31 CFS Q_{100} = 58 CFS

SUMP CONDITION ∴ INSTALL INLETS

N. SIDE: 1-8' DIOR
S. SIDE: 1-4' DIOR
> d_{10} = 0.9' OK d_{100} = 1.37' ≈ 1.33' ALLOW OK

10YR: PIPE: 24" RCP: Hw/D_{10} = 2.6 ⇒ Hw = 5.2' OK $S_{MIN_{10}}$ = 1.9% OK

Hw/D_{100} = 7.5 ⇒ Hw = 15' NOT OK $S_{MIN_{100}}$ = 6.6% OVERFLOW WILL OCCUR

INSTALL 8' INLET W/ FF 5.5' BELOW TOP OF CURB.

100YR: OVERFLOW: ~~58~~ - 31 = 27 CFS ⇒ PROVIDE SWALE TO VINDICATOR

SLOPE = 9% N = .04 VEL = 6.4 FPS BW = 6' d = .55' 5:1 5:1 0.55' GRASS LINED

- OR - PIPE: 30" RCP: Hw/D_{100} = 2.4 ⇒ Hw = 6.0' OK S_{MIN} = 2.0%
GROVED END

→ PROVIDE 100YR CAPACITY!: INLET = N. SIDE = 1-10' DIOR, S. SIDE = 1-4' DIOR ⇒ d_{100} = 1.24' < 1.33' OK

PIPE: GROVED ENT. 30" RCP Hw/D = 2.42 ⇒ Hw = 6' S. MIN. = 2.0% OK
GROVED END

D 7.1: VINDICATOR DR. FLOWS TO INLET #2: Q_{10} = 5.1 CFS Q_{100} = 9.0 CFS

EXISTING 6' DIOR INLET, 4.7% SLOPE, 4' DEEP TC/FE

T_{10} = 9.9' d_{10} = .16' Q_i/Q = .3 $Q_{i_{10}}$ = 1.5 CFS

T_{100} = 12.3' d_{10} = .21' Q_i/Q = .25 $Q_{i_{100}}$ = 2.3 CFS

LATERAL: EXISTING 18" RCP @ 1% Q_{CAP} = 11 CFS (MANNINGS) OK

Hw/D = 4/1.5 = 2.67 ⇒ Q_{CAP} = 15 CFS OK

MAIN: EXISTING 18" RCP @ 4.7% Q_{CAP} = 23 CFS (MANNINGS)

REMAINING STREET FLOWS: Q_{10} = 5.1 - 1.5 = 3.6 CFS

Q_{100} = 9.0 - 23 = 6.7 CFS

SOUTHFACE
11-12-92 RJH
11-25-92

HYDRAULICS: CONTD

11-25 ✓ D8: N.W. COR. OF SMOKE RIDGE DR & GREY WOLF CT. Q_{10}= 7.6 Q_{100}= 13.2

MIN. STREET SLOPE = 1.6% IN SMOKE RIDGE DR ⇒ $Q_{10}^{\frac{1}{2}\text{Allow}}$ = 9.5 $Q_{100}^{\frac{1}{2}\text{Allow}}$ = 63

± ½ OF FLOWS WILL BE IN EACH STREET ∴ ST. FLOW IS OK

11-25 D9: NE ½ OF GREY WOLF CT.: Q_{10} = 10.6 CFS Q_{100} = 20 CFS

4% STREET ⇒ ½Q_{10} ALLOW = 16 CFS, ½Q_{100} ALLOW = 106 CFS

11-25 ✓ DP9: FULL ST. FLOWS IN SMOKE RIDGE DR, JUST E. OF GREY WOLF CT.

Q_{10} = 19 CFS Q_{100} = 34 CFS

1.6% ST. SLOPE ⇒ $Q_{CAP_{10}}$ = 32 CFS $Q_{100_{CAP}}$ = 212 CFS OK

11-25 ✓ D10.1: VINDICATOR DR. FLOWS TO INLET #3: Q_{10} = 3.2 Q_{100} = 5.7

STREET FLOWS: Q_{10} = 3.2 ($D_{10.1}$) + 3.6 ($D_{7.1}$) = 6.8 CFS

Q_{100} = 5.7 ($D_{10.1}$) + 6.7 ($D_{7.1}$) = 12.4 CFS

EXISTING ③ 6' DIDR INLET, 4.7%, T_{10} = 11' Q_i/Q_{10} = .18 $Q_{i_{10}}$ = 1.2 CFS

T_{100} = 14' Q_i/Q_{100} = .22 $Q_{i_{100}}$ 2.7 CFS

PIPE FLOW: LATERAL: EXIST 18" @ 2.9% : Hw/D_{100} = 0.95 ⇒ Hw = 1.4' ok

MAIN: EXIST 24" @ 2.69%: Q_{10} = 1.2 ($\frac{D}{10.1}$) + 1.5 ($\frac{D}{7.1}$) = 2.7 CFS

Q_{100} = 2.7 ($\frac{D}{10.1}$) + 2.3 ($\frac{D}{7.1}$) = 5 CFS

Hw/D_{100} = 0.75 → OK Q_{CAP} = 37 CFS ∴ OK

SOUTHFACE
11-25-92 BJH

HYDRAULICS:

✓ D11: LAST LIGHT COURT Q_{10} = 6.6 CFS Q_{100} = 12.8 CFS

PROVIDE 100 YR CAPACITY: [1-4' DIOR INLET] d_{100} = 1.04' < 1.33' OK

[18" RCP] H_W/D = 2 ⇒ H_W = 3.0' OK S_{MIN} = 1.48% OK

✓ DP7/11: COMBINED PIPE FLOWS FROM D7 & D11 TO BE ROUTED THROUGH THE PARK TO THE CONFLUENCE 1400' W. OF THE POND.

Q_{10} = 31 CFS (DP7) + 6.6 (D11) = 38 CFS

Q_{100} = 58 CFS (DP7) + 12.8 (D11) = [71 CFS] DESIGN FLOW

CLOSED SYSTEM ∴ PRESSURE FLOW IS OK W/ BOLT DOWN LIDS ON MANHOLES.

TRY: [30" RCP] $S_{MANNINGS}$ = 3.0% OK H_W/D = 4.0 ⇒ H_W = 10' OK

24" RCP $S_{MANNINGS}$ = 9.9% ✗ H_W/D = 8.0 ⇒ H_W = 16' ?

✓ DP 11.1: STREET FLOWS: Q_{10} = 5.6 (FLOW BY D10.1) + 7.3 (D11.1) = 12.9 CFS OK

Q_{100} = 9.7 (") + 12.8 (D11.1) = 22.5 CFS OK

	TOTAL FLOWS Q_{10}	Q_{100}	
D7.1	5.1	9.0	
D10.1	3.2	5.7	+ FLOW BY
D11.1	7.3	+12.8	
TOTAL =	15.6	27.5	CFS

STREET CAPACITY: S_L = 3% S_X = 5% TO C.L. SIDE $\frac{1}{2}Q_{10}$ CAP = 28 CFS

$\frac{1}{2}Q_{100}$ CAP = 236 CFS

EXISTING INLETS: 2- 4' DIOR, 3% SLOPE $Q_{i\,10}$ = 2.8 CFS EACH

$Q_{i\,100}$ = 5 CFS EACH

PIPE FLOWS: Q_{10} = 2.7 ($D_{10.1}$) + 5.6 ($D_{11.1}$) = 8.3 CFS

Q_{100} = 5.0 ($D_{10.1}$) + 10 ($D_{11.1}$) = 15 CFS

EXIST 24" RCP @ 5.53% Q_{CAP} = 53 CFS (MANNINGS) OK

H_W/D_{100} = 1.15 ⇒ $H_{W_{100}}$ = 2.3 OK

REMAINING STREET FLOWS: Q_{10} = 12.9 − 5.6 = 7.3 CFS OK

Q_{100} = 22.5 − 10 = 12.5 CFS OK

REFERENCE : Federal Highway Administration, Hydraulic Design of Highway Culverts ; Hydraulic Design Series No. 5 1985 9-72

PROJECT: SOUTHFACE

STATION: DP 7/11

SHEET ____ OF ____

CULVERT DESIGN FORM

DESIGNER / DATE: BSH / 12-30-92

REVIEWER / DATE: ____ / ____

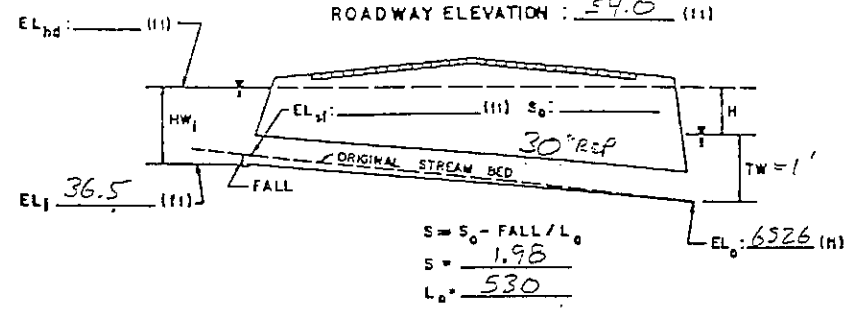
HYDROLOGICAL DATA

SEE ADD'L. SHTS.

- ☐ METHOD: ____
- ☐ DRAINAGE AREA: ____ ☐ STREAM SLOPE: ____
- ☐ CHANNEL SHAPE: ____
- ☐ ROUTING: ____ ☐ OTHER: ____

DESIGN FLOWS / TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
100	71	1



$S = S_o - FALL / L_o$

$S = 1.98$

$L_o = 530$

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW/D (2)	HW_i	FALL (3)	EL_hi (4)	OUTLET CONTROL TW (5)	d_c	(d_c+D)/2	h_o (6)	h_e	H (7)	EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
~~24" RCP~~ GROOVED ENT.			8	16	0	52.5	1	2	2	2	0.2	61.3	89.3	89.3	22.6	NOT ACCEPTABLE
30" RCP GROOVED ENT.			3.2	8	0	44.5	1	2	2	2	0.2	19.7	47.7	47.7	14.5	OK

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) HW_i/D = HW/D OR HW_i/D FROM DESIGN CHARTS

(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[(1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g = 7.73\ V^2/2g$ (30") $= 6.05\ V^2/2g$ (30")

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

- e. APPROXIMATE
- f. CULVERT FACE
- hd. DESIGN HEADWATER
- hi. HEADWATER IN INLET CONTROL
- ho. HEADWATER IN OUTLET CONTROL
- i. INLET CONTROL SECTION
- o. OUTLET
- sf. STREAMBED AT CULVERT FACE
- tw. TAILWATER

COMMENTS / DISCUSSION:

CULVERT BARREL SELECTED:

SIZE: 30"

SHAPE: ROUND

MATERIAL: CONC n = .013

ENTRANCE: GROOVED

24" RCP $A = 3.1416$ $P_w = 6.2832$ $R = 0.500$

30" RCP $A = 4.9087$ $P_w = 7.8540$ $R = 0.625$

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Drainage Criteria Manual

Date: OCT. 1987

Figure: 9-44

(9.1)

HYDRAULICS :

SOUTHFACE
11-25-92 BJH

✓ DP 13.1 : Q_{10} = 19 cfs Q_{100} = 36 cfs

½ STREET CAP: S=3% $\frac{1}{2}Q_{10}$ CAP = 28 CFS :OK / $\frac{1}{2}Q_{100}$ = 240 CFS :. OK

✓ DP OS-8 : FLOW FROM D22 & OS-8 : Q_{10} = 36 cfs Q_{100} = 66

½ STREET CAPACITY: S=6% $\frac{1}{2}Q_{10}$ CAP = 42 $\frac{1}{2}Q_{100}$ CAP = 340

SEE "STORM SEW. SYSTEM #5" = DEVELOPED FLOWS:

∴ INLET PICKUP = (2-6'DIOR) Q_{10i} = 12.6 Q_{100i} = 15.6 CFS

REMAINING ST. FLOW = Q_{10} = 23 cfs OK Q_{100} = 50 cfs OK

✓ D19 : S½ OWL RIDGE DRIVE @ BEAR CLOUD DR : Q_{10} = 2.9 cfs Q_{100} = 5.1 cfs

STREET SLOPE = 5% = $\frac{1}{2}Q_{10}$ CAP = 17 CFS - OK $\frac{1}{2}Q_{100}$ CAP = 130 CFS - OK

✓ D20 : N½ BEAR CLOUD DR. @ OWL RIDGE DR : Q_{10} = 12 Q_{100} = 21

St. SLOPE = 2.1% VC = $\frac{1}{2}Q_{10}$ CAP = 12 CFS - OK $\frac{1}{2}Q_{100}$ CAP = 75 CFS OK

∴ INSTALL VERTICAL CURB & GUTTER

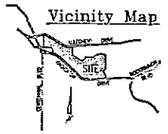
✓ D21 : S½ BEAR CLOUD DR @ OWL RIDGE DR : Q_{10} = 8.8 CFS Q_{100} = 15.2 CFS

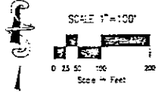
S. SLOPE = 2.1% = $\frac{1}{2}Q_{10}$ CAP = 11 CFS - OK $\frac{1}{2}Q_{100}$ CAP = 75 CFS - OK

MASTER FACILITIES PLAN
SOUTHFACE

PHASE PLAN

Vicinity Map





STREET SECTION

N.T.S.

Dwg. No. FP1

KLH ENGINEERING, INC.

MASTER FACILITIES PLAN
SOUTHFACE

DRAWN BY: MTS CHECKED BY: DAM DATE: OCT 1992
JOB NO. 93-017-00 SHEET OF