

DRAINAGE ANALYSIS
ZEBULON PIKE YOUTH DETENTION CENTER

Kiowa Engineering Corporation

DRAINAGE ANALYSIS
ZEBULON PIKE YOUTH DETENTION CENTER

Prepared for:

State of Colorado
Department of Institutions
3550 West Oxford Avenue
Denver, Colorado 80236

Prepared by:

Kiowa Engineering Corporation
419 West Bijou Street
Colorado Springs, Colorado 80905-1308

KIOWA Project No. 93.08.57
DX/R243

December 1993

Kiowa Engineering Corporation

December 21, 1993

Mr. Michael J. Guthrie
Regional Physical Plant Manager
State of Colorado
Department of Institutions
3550 West Oxford Avenue
Denver, Colorado 80236

RE: Zebulon Pike Youth Detention Center Drainage Analysis (KIOWA Project No. 93.08.57)

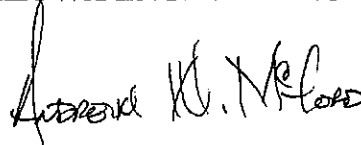
Dear Mr. Guthrie:

Enclosed are copies of the Drainage Analysis for the Zebulon Pike Youth Detention Center. This report outlines the drainage improvements necessary to relieve the Detention Center of its current flooding problems. This report lays out a conceptual approach to providing the necessary drainage improvements. Final design of the facilities will commence after acceptance of the provisions of this report. Copies of this report will be submitted to the City of Colorado Springs, Colorado Springs Fire Department, El Paso County Parks and Recreation Department, and the El Paso County Department of Public Works for their review and comments. We will address their concerns as they are made available to us.

If there are any questions or if we may be of further assistance, please feel free to call at any time.

Sincerely,

KIOWA ENGINEERING CORPORATION



Andrew W. McCord, P.E.

AWM^c/rms
DX/R243

Enclosure

SCOPE

The intent and purpose of this report is to analysis the current flooding problems associated with the Zebulon Pike Youth Detention Center and to provide solutions to relieve the flooding. The Zebulon Pike Youth Detention Center is situated on an unplatted parcel of ground within the Colorado Springs city limits. Both the City and County have no record of a drainage report being submitted for the site.

PROJECT DESCRIPTION

Zebulon Pike Youth Detention Center is situated on an unplatted parcel of land adjacent to Bear Creek Regional Park. The center is bounded on the north by Rio Grande Avenue and on the east, south, and west by Bear Creek Regional Park. Bear Creek Regional Park is within the City of Colorado Springs corporate limits, however it is an El Paso County Park. Bear Creek Regional Park is operated by the El Paso County Parks and Recreation Department. The site originally contained one building located just east of the existing two building center. The two new buildings were constructed in the late 1980's and the old building was demolished. Land which contained the old building was transfer back to the County after demolition. As indicated there are currently two buildings situated on the site.

The buildings are located below a high point in Rio Grande Drive. Currently water from north of Rio Grande Drive sheetflows across the road and onto the Detention Center property. The Detention Center is graded in such a manner as to channelize the stormwater runoff between the two buildings. The runoff is directed through the courtyard between the two buildings and across the existing basket ball court located adjacent to the south east corner of the west building. The southeast portion of the west building houses the gymnasium which is subject to flooding. The runoff is collected in a 'drop inlet' located immediately south of the gymnasium. This inlet has a 6" PVC pipe as an outlet and does not have much storage capacity or ability to develop any head on the discharge pipe.

The water that enters from the north and onto the Detention Center carries a heavy sediment load. This sediment is deposited on the north side of the Detention Center in the access drive where the slope shallows considerably.

The Detention Center also appears to have flooding problems associated with the existing roof drains. The drains currently discharge out of the building walls approximately 18 to 24 inches above the ground. Some of the scuppers have concrete splash blocks below them which direct the runoff away from the building. There is a significant amount of erosion which is occurring along the west side of the building due both to the roof drainage and surface flow.

Drains located between the buildings are causing flooding due to the lack of positive drainage away from the buildings at the outlet locations.

HYDROLOGY

For the purpose of this analysis, two drainage subbasins were delineated. Basin 1 is the off site area which contributes runoff onto Zebulon Pike Detention Center. Basin 2 is generally the area within the Detention Center. The subbasin boundary is the south edge of Rio Grande Drive. Runoff calculations are based upon the current El Paso County/City of Colorado Springs Drainage Criteria. The Rational Method has been used to determine runoff amounts expected to be developed on and off the site. The hydrologic calculations are attached to this report.

STORM ROUTING

It is evident that the site has experienced flooding problems in the past. The slope north of the center shows signs of erosion. A small ditch has formed on the west side of the center and the drive on the far east end of the center shows evidence of past storm flows. Mud deposition on the access road is quite evident. Mud is being eroded from north of the building, especially from off the steep slope, and deposited on the Detention Center. The courtyard is well maintained and there is now visible flooding evidence on the exterior. However, it is quite evident from the lay of the land that the majority of the flow is directed between the buildings through the courtyard.

Flow through the courtyard needs to be minimized as much as possible. This includes trying to eliminate the potential for sediment deposition onto the site. This can be achieved if the sediment source is eliminated. The majority of the flood flow is generated off site. If this flow can be redirected around the project, a large portion of the flooding source will be eliminated. The remaining on site flooding needs to be controlled and redirected away from the problem areas.

PROPOSED DRAINAGE IMPROVEMENTS

Proposed improvements for the Detention Center include both on and off site work. The proposed improvements as shown on Exhibit 1 included with this report. In order to greatly reduce the off site flow onto the site, we have proposed that a small roadside ditch be built on the south side of Rio Grande Drive. This ditch should be graded to drain the off site flows toward the west and into the existing swale located approximately 300 feet west of the Center's west

property line. This ditch is the future location of a 36" RCP storm sewer as proposed by the Bear Creek Master Drainage basin Planning Study currently being prepared for the City of Colorado Springs. An alternative to constructing the roadside ditch would be to construct curb and gutter on the south side of Rio Grande Drive. In order to be consistent with the current road section, we have proposed the roadside ditch.

The steep slope located between the Detention Center and Rio Grande Drive should be terraced. The terracing should include three walls approximately four feet in height. The terraces are proposed to be eight feet wide. The construction of this terracing will help to eliminate the source of sediment which is currently being deposited onto the site during storm events. The terracing will also slow down the runoff velocities coming from the north and prevent erosion of the slope.

Roof drains should be collected into a collection system as shown on Exhibit 1. This will prevent the localized flooding caused by the roof drains not draining away from the building. The roof drain system will allow this runoff to be efficiently and safely directed away from the buildings and into an appropriate outfall.

The roof drain system will be connected to a small drainage system which includes a curb inlet and an area drain. Runoff collected in these inlets and from the roof drains will be directed by way of an eighteen inch RCP to the previously mentioned swale located west of the Detention Center. This pipe can eventually be connected to the proposed outfall pipe as proposed in the Bear Creek Master Drainage Basin Planning Study. Easements will need to be acquired from El Paso County for the outfall pipe.

SUMMARY

The construction of the proposed drainage improvements will help to reduce to potential for flooding of the Detention Center. The proposed drainage pattern is consistent with the proposed Bear Creek Drainage Basin Plan and improvements. The reduction of area contributing flow onto the Detention Center will lower the potential of flooding for the site. Controlling the source of sediment by terracing the northern slope will help to eliminate the silting problem associated with past flooding events. Collection of the roof drainage will eliminate the localized flooding problems associated with the roof drains.

COST ESTIMATE

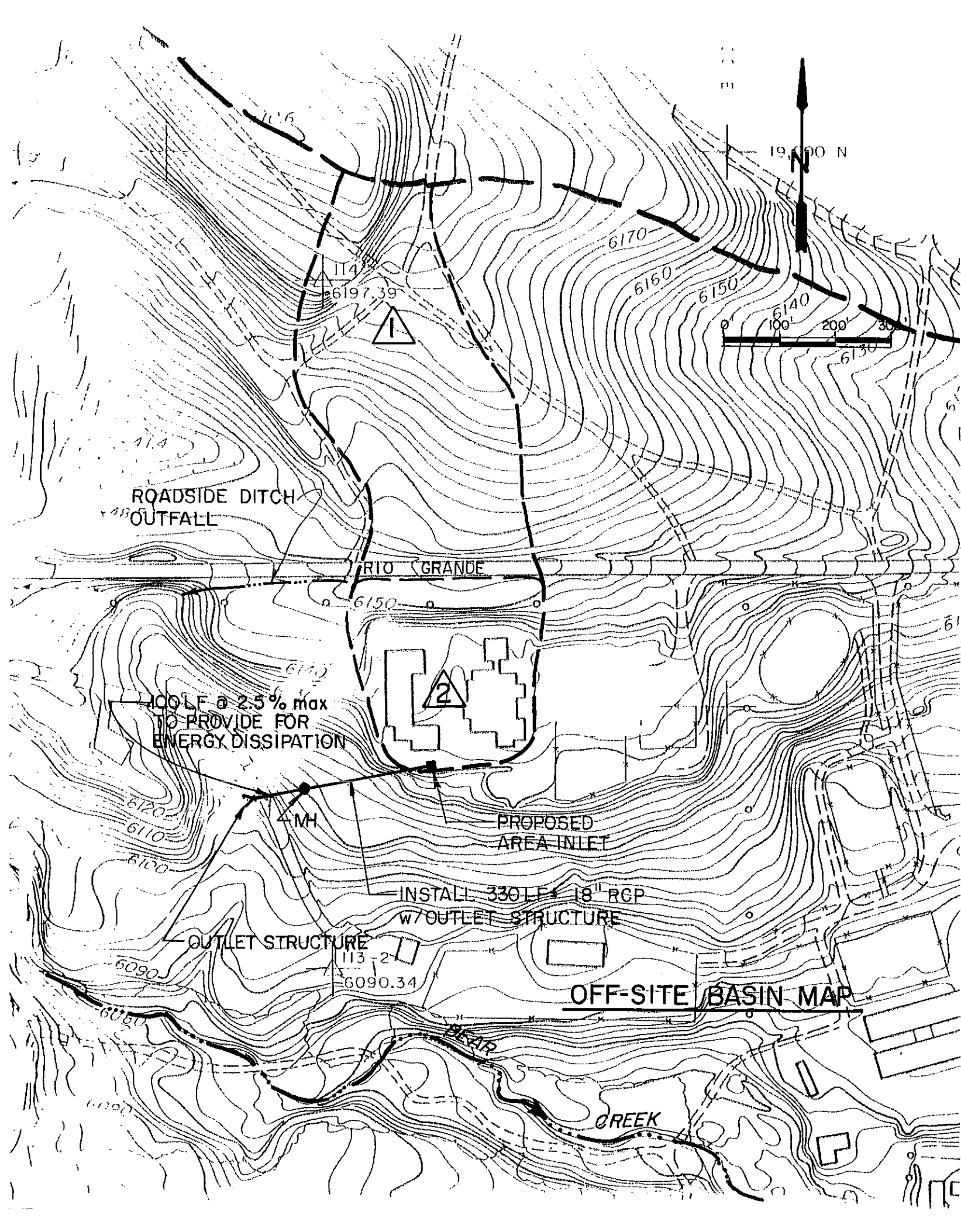
A cost estimate for the proposed improvements has been prepared. This cost estimate is included on the following page.

TABLE 1

**Opinion of Cost
Zebulon Pike Youth Detention Center
Proposed Drainage Improvements
Colorado Department of Institutions
December 20, 1993**

ITEM	UNIT	UNIT COST	QUANTITY	AMOUNT
Roadside Ditch	lf	\$15.00	600	\$9,000
4' High Terracing	lf	\$50.00	1,075	\$53,750
Curb & Gutter	lf	\$10.00	200	\$2,000
Road Grading	ls	\$5,000.00	1	\$5,000
Roof Drain Connections	ea	\$100.00	12	\$1,200
Cleanouts	ea	\$250.00	9	\$2,250
Manhole	ea	\$1,800.00	1	\$1,800
Curb Inlet D-10R	ac	\$2,250.00	1	\$2,250
Area Inlet	ea	\$2,000.00	1	\$2,000
6" PVC Pipe	lf	\$18.00	400	\$7,200
12" PVC Pipe	lf	\$22.00	295	\$6,490
15" Reinforced Concrete Pipe	lf	\$30.00	60	\$1,800
18" Reinforced Concrete Pipe	lf	\$35.00	490	\$17,150
18" Reinforced Concrete Pipe Flared End Secti	ea	\$500.00	1	\$500

Construction Subtotal	\$112,390
Contingencies (10%)	\$11,239
Construction Total	\$123,629



ROADSIDE DITCH
OUTFALL

RIO GRANDE

400 LF @ 2.5% max
TO PROVIDE FOR
ENERGY DISSIPATION

PROPOSED
AREA INLET

INSTALL 330 LF 18" RGP
W/ OUTLET STRUCTURE

OUTLET STRUCTURE

OFF-SITE BASIN MAP

CREEK

19,000 N

6197.39

6090.34

113-2

TYPE ZEBPIKE.LST

***** HYCHL ***** (Version 1.1) *****

Date 12-01-93

Commands Read From File: A:\ZEBPIKE.CHL

jobZebulon Pike Detention Center Roadside Ditch Analysis 93.08.57
chl.008 10.9 0

vr3

** THE V-SHAPE W ROUND BOT HAS SIDE SLOPES OF 3.0

lvD

end

*****END OF COMMAND FILE*****

Zebulon Pike Detention Center Roadside Ditch Analysis 93.08.57

INPUT REVIEW

DESIGN PARAMETERS:

DESIGN DISCHARGE (CFS): 10.90

CHANNEL SHAPE: VSWRB

CHANNEL SLOPE (FT/FT): .008

HYDRAULIC CALCULATIONS USING NORMAL DEPTH

	DESIGN	MAXIMUM
	-----	-----
FLOW (CFS)	10.90	19.53
DEPTH (FT)	.96	1.20
AREA (FT^2)	6.28	8.94
WETTED PERIMETER (FT)	8.06	9.57
HYDRAULIC RADIUS (FT)	.78	.93
VELOCITY (FT/SEC)	1.74	2.18
MANNINGS N (LOW FLOW)	.065	.058

STABILITY ANALYSIS

CONDITION	LINING TYPE	PERMIS SHR (LB/FT^2)	CALC. SHR (LB/FT^2)	STAB. FACTOR	REMARKS
-----	-----	-----	-----	-----	-----
LOW FLOW LINING BOTTOM; STRAIGHT	VEGETATIVE D	.60	.48	1.25	STABLE

*** NORMAL END OF HYCHL ***

A:\>

BASIN 1:

PLUMETER READING \Rightarrow 254

$$AREA = \frac{254}{50} = 5.08 \text{ in}^2$$

$$AREA = 5.08(200^2) = 203,200 \text{ ft}^2 \\ = 4.665 \text{ ac}$$

HYDROLOGIC SOIL GROUP "D"

C:
 $C_{10} = 0.60 \quad C_{100} = 0.70$

t_c :
 $t_c = 1.87(1.1 - C_{10})L^{0.5}S^{-0.33}$
 $= 1.87(1.1 - 0.6)750^{0.5}S^{-0.33}$

$$S = \frac{40}{750} = 5.33\%$$

$$t_c = 14.74 \text{ min}$$

\dot{C} :
 FROM FIG. 5-1

$$\dot{C}_{10} = 3.9 \text{ in/hr} \quad \dot{C}_{100} = 5.9 \text{ in/hr}$$

$$Q = C_i A$$

$$Q_{10} = 0.6(3.9)(4.665) = 10.9 \text{ cfs}$$

$$Q_{100} = 0.7(5.9)(4.665) = 19.3 \text{ cfs}$$

BASIN 2:

PLUMETER READING \Rightarrow 123

$$AREA = \frac{123}{50} = 2.56 \text{ in}^2$$

$$AREA = 2.56(200^2) = 102,400 \text{ ft}^2 \\ = 2.351 \text{ ac}$$

HYDROLOGIC SOIL GROUP "D"

C:
 $C_{10} = 0.70 \quad C_{100} = 0.80$

t_c :
 $t_c = 1.87(1.1 - C_{10})L^{0.5}S^{-0.33}$
 $= 1.87(1.1 - 0.7)520^{0.5}S^{-0.33}$

$$S = \frac{21}{520} = 3.96\%$$

$$t_c = 10.93 \text{ min}$$

\dot{C} :
 FROM FIG. 5-1

$$\dot{C}_{10} = 4.5 \text{ in/hr} \quad \dot{C}_{100} = 6.8 \text{ in/hr}$$

$$Q = C_i A$$

$$Q_{10} = 0.7(4.5)(2.351) = 7.4 \text{ cfs}$$

$$Q_{100} = 0.8(6.8)(2.351) = 12.8 \text{ cfs}$$

Basin 1+2:

$$A = 4.665 + 2.351 = 7.016 \text{ ac}$$

C:

$$C_{10} = 0.63 \quad C_{100} = 0.73$$

t_c :

$$S = \frac{4.1}{1050} = 5.81\%$$

$$t_c = 1.87(1.1 - 0.63) 1050^{0.5} 5.81^{-0.33}$$
$$= 15.94 \text{ MIN}$$

i :

FROM FIGURE 5-1

$$i_{10} = 3.87 \text{ IN/HR} \quad i_{100} = 5.80 \text{ IN/HR}$$

$$Q = C_i A$$

$$Q_{10} = 0.63(3.87)(7.016) = 17.1 \text{ cfs}$$

$$Q_{100} = 0.73(5.80)(7.016) = 29.7 \text{ cfs}$$

DETERMINE FLOW CAPACITY OF 6" PVC DRAIN

ASSUME $n = 0.011$
 $S = 2\%$

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

$$Q = \frac{1.486}{0.011} (0.1963) \left(\frac{0.1963}{1.5708}\right)^{2/3} (0.02)^{1/2}$$

$$Q = 0.94 \text{ cfs} \quad \text{USE } 1 \text{ cfs}$$

DETERMINE FLOW CAPACITY OF 12" PVC DRAIN

ASSUME $n = 0.011$
 $S = 1.5\%$

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

$$Q = \frac{1.486}{0.011} (0.7854) \left(\frac{0.7854}{3.1416}\right)^{2/3} 0.015^{1/2}$$

$$Q = 5.2 \text{ cfs}$$

DETERMINE FLOW CAPACITY OF 15" & 18" RCP DRAINS:

15"
 $n = 0.013$ $A = 1.227 \text{ ft}^2$
 $S = 0.01$

$$Q = 6.5 \text{ cfs}$$

18"
 $n = 0.013$ $A = 1.7671 \text{ ft}^2$
 $S = 0.01$

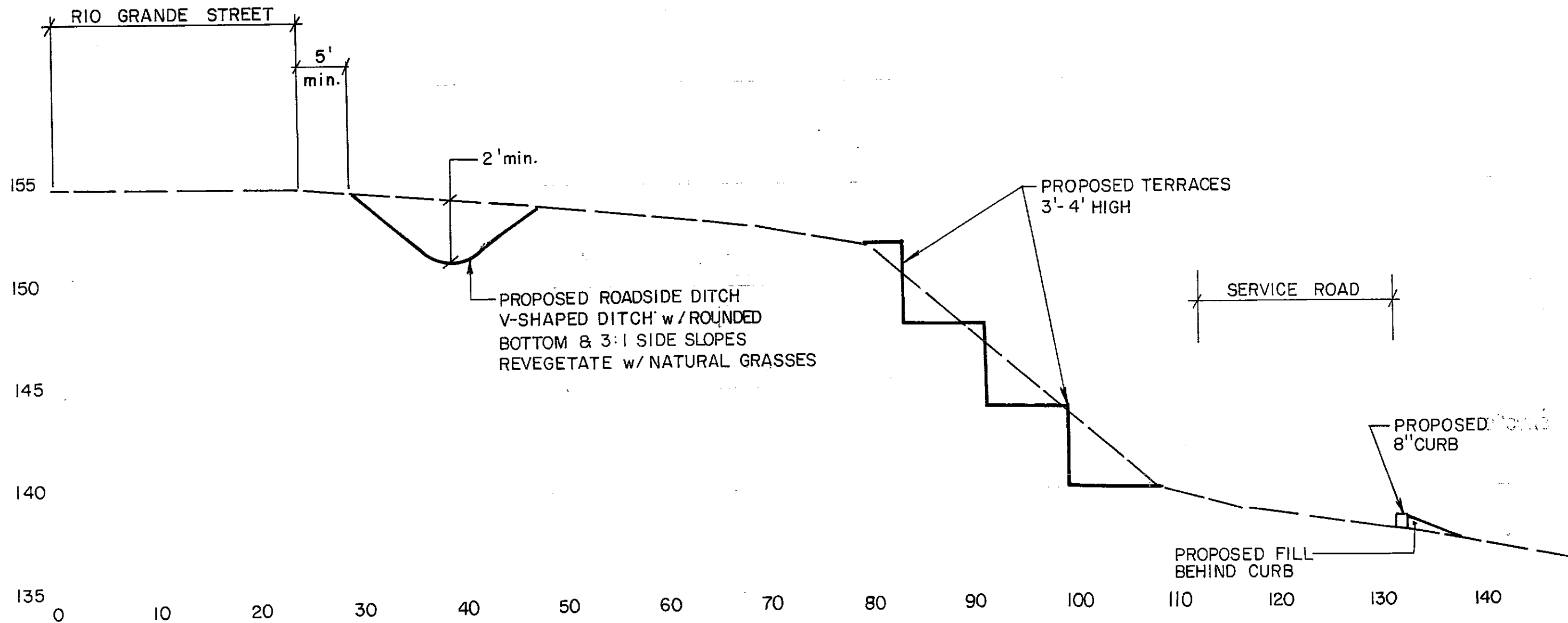
$$Q = 10.5 \text{ cfs}$$

AT $S = 0.02$

$$Q = 14.9 \text{ cfs}$$

AT 8%

$$Q = 29.7 \text{ cfs}$$



SECTION A-A