KKBNA

FINAL DRAINAGE STUDY
FOR
POWERS BOULEVARD
PHASE ~~I~~ 1
PLATTE AVENUE TO SAND CREEK
COLORADO SPRINGS AND EL PASO COUNTY
COLORADO

SEPTEMBER 1986
REVISED NOVEMBER 1986

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PHASE ~~I~~ 1
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COLORADO SPRINGS AND EL PASO COUNTY
COLORADO

SEPTEMBER 1986
REVISED NOVEMBER 1986
REVISED MAY 1987

Prepared for: Kiewit Western Co.
7926 South Platte Canyon Road
Littleton, CO 80123
(303) 979-9330

Prepared by: KKBNA, Inc.
Consulting Engineers
4251 Kipling Street
Wheat Ridge, CO 80033
(303) 431-6100

William R. Hamilton, P.E.
Principal-in-Charge

William Honer, P.E.
Project Manager

8895.03.0007
Project Number

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DRAINAGE REPORT STATEMENTS

POWERS BOULEVARD
PLATTE AVENUE TO WOODMEN ROAD

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 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.

X ____________________
William R. Hamilton, P.E.
Number ________

FLOODPLAIN STATEMENT

To the best of my knowledge and belief and according to FEMA Flood Insurance Rate Maps 080060 0281B and 080060 0170B effective December 18, 1986, the only portions affected by floodplains in this project are the Sand Creek Crossing, the intersection of Platte Avenue and Powers Boulevard, and the intersection of Bijou Street with the Powers Boulevard temporary transition.

X ____________________
William R. Hamilton, P.E.
Number ________

DEVELOPER'S STATEMENT

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

X ____________________ 6-19-87
Terry Schooler Date
Chairman of the Board
Metex District

CITY OF COLORADO SPRINGS

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

____________________ 6-24-87
City Engineer Date

EL PASO COUNTY

Reviewed and approved:

____________________ ________
Date

PURPOSE

The purpose of this study is to define a storm water management scheme which will convey runoff through Powers Boulevard assuming fully developed conditions for areas adjacent to the proposed expressway. In addition, the study is to discuss the impacts of the proposed scheme on existing facilities and call attention to problems that could potentially arise due to construction of Powers Boulevard.

SITE DESCRIPTION

Powers Boulevard is currently a 2-lane roadway east of downtown Colorado Springs, Colorado. The portion to be improved lies between the intersections with Platte Avenue and Woodmen Road. The existing alignment follows the west line of Sections 6 and 7, Township 14 South, and Sections 31, 30, 19, 18, and 7, Township 13 South, Range 65 West of the Sixth Principal Meridian. Portions of this alignment are the city limits of Colorado Springs, with the city to the west of the section line and El Paso County to the east. Please refer to the drainage plan. The drainage improvements required along Powers Boulevard between Platte Avenue and ~~Sand Creek~~ Waynoka Road (Phase ~~I~~ 1) will be addressed in this report. Improvements along the remainder of the project will be addressed in subsequent reports.

DESIGN CRITERIA

The City of Colorado Springs' "Determination of Storm Runoff Criteria" dated March 1977 and the applicable addenda, are used as the design criteria for this report. Peak flows for each basin are determined by using the Modified Soil Conservation Service methodology as outlined in the report. The hydrologic soils classification and land use assumed for each basin are shown on the Soils and Land Use Plan included in the appendix. The soils groups are determined from the Soil Survey of El Paso County. The land use is taken from the City of Colorado Springs Zone Maps Revised 1985, plats on file at El Paso County, and discussions with City and County Engineering Departments. Nomographs and tables utilized to determine peak runoff rates are reproduced and included in the appendix.

Runoff quantities are determined for the 5- and 100-year, 6-hour duration storm and for the 5- and 100-year, 24-hour duration storm and compared at the request of Bill McCall of the City of Colorado Springs. Since the difference in peak flow quantities between the 6and 24-hour storm durations is minimal, the 24-hour duration storm is used to determine the design flows as required by the above-mentioned criteria. The criteria also states that the design storm shall be the 5-year frequency unless the 100-year frequency peak flow rate is greater than 500 cfs. However, to keep ditch flow quantities at a minimum and to eliminate transferring flows from historic basins, the 100-year frequency storm is used as the design storm. Generally a headwater to diameter ratio of 1.5 was used as a guideline to design the culverts crossing Powers Boulevard. However, there are cases where the H_w /D ratio exceeds 1.5. When the headwater to diameter ratio reaches 2, outlet velocities and outlet protection as well as upstream inundation was calculated.

PROPOSED IMPROVEMENTS

Powers Boulevard between Platte Avenue and Woodmen Road is proposed to be improved to the standards of an expressway. This phase of the improvement is to widen the roadway to four traveling lanes with a 10' gravel shoulder on each side. Other improvements in this phase include upgrading intersections and the Sand Creek Crossing. The Metropolitan Expressway District, METEX, was formed to finance these improvements. In the future, it is anticipated that Powers Boulevard will be widened to eight travel lanes with several major interchanges.

The storm water management system for the first phase of Powers Boulevard improvements consists of culvert crossings and roadside ditches. The culvert crossings are sized to allow for future widening to eight lanes without extension, where possible. It is assumed that at the time of construction of the seventh and eighth lanes, a storm sewer system will be required to replace the roadside ditches. The design of that system, however, is beyond the scope of this report.

Powers Boulevard lies within two major drainage basins previously studied by the City of Colorado Springs--the Cottonwood Creek Basin and the Sand Creek Basin. Basins designated C-1 through C-7 lie within the Cottonwood Creek Basin. Basins designated S-1 through S-15 lie within the Sand Creek Basin. Phase 1 includes Basins S-1 through S-7. A Hydrologic Summary Table is included in the appendix summarizing the flow from each basin. Hydrologic calculations can also be found in the appendix.

The roadside ditch section for Phase ~~A~~ 1 has a two-foot bottom width with 3h:1v side slopes (typ. Ditch 2) or 3h:1v on inside and 2h:1v on outside in area between acceleration/deceleration lanes (typ. Ditch 1), as shown in Figure 1. Typically, the ditches are three feet deep but vary to accommodate superelevations, existing utilities and culvert crossings. The ditches were sized for the 100-year frequency storm using a Manning's n-value of 0.035. A summary of ditch depths, velocities, and available freeboard for the 100-year frequency storm are included in the Appendix of this report. The ditch velocities for the 5-year frequency storm were checked along the various slopes of the roadway by Manning's equation and prorating the flow quantity from intersection to intersection. Ditch flows and velocities ranging from 3.3 to 5.9 fps are noted on the construction drawings not included in this report. ~~After rough cut work was finished, Metex informed us that the exposed soil was cohesive which will allow 6 fps with grass.~~

From Palmer Park to Platte Avenue (Phase 1), the alignment of Powers Boulevard is in a valley. Currently, runoff is collected and conveyed down Powers Boulevard to Platte Avenue. By raising the elevations of the Galley, Omaha, and Palmer Park intersections to accommodate a storm sewer system and utilizing the existing storm sewer system at Omaha, the proposed storm water management system conveys the 100-year frequency storm across Powers Boulevard to Sand Creek.

Sand Creek Basin

Powers Boulevard, from the high point north of the Lariat Drive/ Bridlespur intersection south, is in the Sand Creek Basin. Drainage from the Sand Creek Basin flows across Powers Boulevard from the west to east from the high point down to the Sand Creek crossing. From here south, the basin drains from east to west. Land uses in this basin vary from residential (1/8-acre lots) to industrial parks. Please refer to the Soils and Land Use Map for uses in each basin.

Basin S8 includes area that drains to the west ditch between South Carefree and Constitution intersections. The 100-year flow will be piped across Constitution in a 60" CSP and will drain down to Sand Creek along with flow from Basins S-7 and S-7A. It is our understanding that the railroad crossing has been declared abandoned. Metex will build a ditch OR STRUCTURES AS NECESSARY along the east and west side of

Powers Boulevard through the railroad tracks~~. which will prevent any~~ No flows ~~from running~~ WILL BE ALLOWED TO RUN west along the tracks. These ditches AND STRUCTURES on either side of Powers will ~~run down~~ CONVEY FLOWS SOUTH to Sand Creek along the road, with a temporary 66" CSP at Victor Road.

Basin S8A lies in Villa Loma Subdivision Filing No. 7. The majority of the 100-year flow is picked up in Rio Vista Drive by an existing 48" RCP. According to the drainage plan and report prepared by Leigh Whitehead & Associates, October 2, 1972, the 48" RCP has a capacity of 195 cfs. This flow is carried southwest away from Powers Boulevard leaving 10 cfs, which will flow down Constitution Avenue to inlets at Powers Boulevard. During a site visit, the locations of the improvements mentioned in the 1972 drainage report were verified.

Basin S6B will drain to the northeast corner of the intersection of Constitution and Powers. It will be carried under Constitution in a 54" CSP and added to the runoff from Basins S6 and S6A which will be carried in the east ditch to Sand Creek. Flows from Waynoka Road are also to be conveyed to Sand Creek in this ditch. Also, at Waynoka Road, a temporary 60" CSP will be installed to carry the ditch flows.

Design Point S5 represents the Sand Creek Crossing. The Sand Creek flow rate of 8620 cfs is taken from the Sand Creek Major Drainage

Planning Study by Simons, Li and Associates. The land uses assumed in the study are based on the Colorado Springs Zone Maps. Areas zoned agricultural at this time are considered to be mixed use. The mixed usage includes 10% public, 47% residential, 2% drainageways, 12% commercial industrial, 11% parks, and 18% streets. This usage appears to be a valid assumption for the as yet undeveloped areas.

A SIX CELL ~~Six~~ 12' x 12' RCB ~~culverts are~~ IS being constructed at the Sand Creek Crossing. The hydraulics for this bridge and improved channel has been submitted by Simons, Li & Associates and approved. Their report is included in the appendix of this report.

Basin S4 includes area contributing to the Palmer Park Road intersection. Runoff is to be collected by two 38" x 24" elliptical RCP at the northeast corner of the intersection and conveyed across Powers Boulevard to the west. The elliptical RCPs were used because of a conflict with the 24" waterline in Powers. A ditch will be graded from the outlet of this pipe to allow positive drainage to Sand Creek. Hydraulic calculations of this ditch and the ditches at Omaha Boulevard and Galley Road are included in the appendix.

Basin S3 includes the area contributing to the Omaha Boulevard intersection. Runoff is to be collected by an existing 36" RCP and a proposed 36" CSP. Both pipes will collectively convey the 100-year flow across Powers Boulevard to the west. The existing pipe carries 52 cfs according to the construction plans by Leight Whitehead and Associates, dated April 2, 1984, for the 5-year storm. No drainage report could be found at the county, and we received a "drainage letter" dated January 16, 1984 from Leigh Whitehead and Associates which did not have any design calculations for the system. Since we do not know the actual design capacity of this system, we will use the 52 cfs, 5-year flow to be conservative. The new 36" CSP is designed to carry the remaining 43 cfs. A ditch will be graded from the outlet of the proposed pipe to allow positive drainage to Sand Creek.

Basin S2 includes the area contributing to the Galley Road intersection. Runoff is to be collected by a 60" CSP at the northeast corner of the intersection and conveyed across Powers Boulevard to the west. A ditch will also be graded from this outlet to allow the water to reach Sand Creek.

The ditches at Palmer Park, Omaha and Galley will have two foot bottoms with 3:1 side slopes. They will be graded at approximately 1.0% from Powers to Sand Creek. At Sand Creek the bank will have riprap where the ditches enter the creek.

Basin S1 and S1A consist of the east and west sides of Powers from Galley Road to Platte Avenue. This runoff will flow south in the roadside ditches to Platte Avenue. Runoff from Basin S1A will flow west along the Platte Avenue roadside ditch to where it empties into Sand Creek. In Basin S1 there is a cul-de-sac located approximately 300 feet north of Platte Avenue. Since this is not a major crossing a 36" CSP was designed for the 5-year storm. During the 100-year storm the additional water will flow around the westerly edge of the cul-de-sac. The runoff from this basin will flow east to the central tributary of the east fork of Sand Creek. The central tributary passes under Platte Avenue in an 8' x 14' box culvert. This box culvert is inadequately sized for the 100-year storm which causes shallow flooding in this area. The improvements on Powers will not change this floodplain. In the future when Platte Avenue is improved, the existing box culvert should be improved to pass the 100-year storm.

Basins ST1 and ST2 are in the area south of Platte Avenue where the new Powers Boulevard road will be transitioned back to the existing road. Basin ST1 lies on the east side of Powers Boulevard. There will be a 24" CSP constructed under the access from Powers Boulevard to the frontage road. This culvert is designed to pass the 5-year flow with part of the 100-year flow overtopping the access road. This runoff will join the central tributary before it crosses over Bijou and Powers Boulevard, as it has historically. Basin ST2 lies on the west side of Powers and runoff from it will cross over the private drive in a concrete cross pan at Powers Boulevard. Since this part of the road is temporary we will not try to cure the drainage problems where the central tributary crosses over Powers Boulevard.

For this phase of construction, curb and gutter is being placed at the intersections from PCR to PCR only, therefore, inlets will be placed in the northeast flowline of Palmer Park, Omaha Boulevard, and Galley Road to drain these localized low points. The calculations for these inlets can be found in the Appendix of this report.

In addition to the inlets at the intersection low points, inlets are also being placed along the median flowline to pick up water draining to that gutter due to superelevation of the roadway. The inlets will be placed at the point where the street section is superelevated at 2% to the median. The calculations for these inlets can also be found in the Appendix.

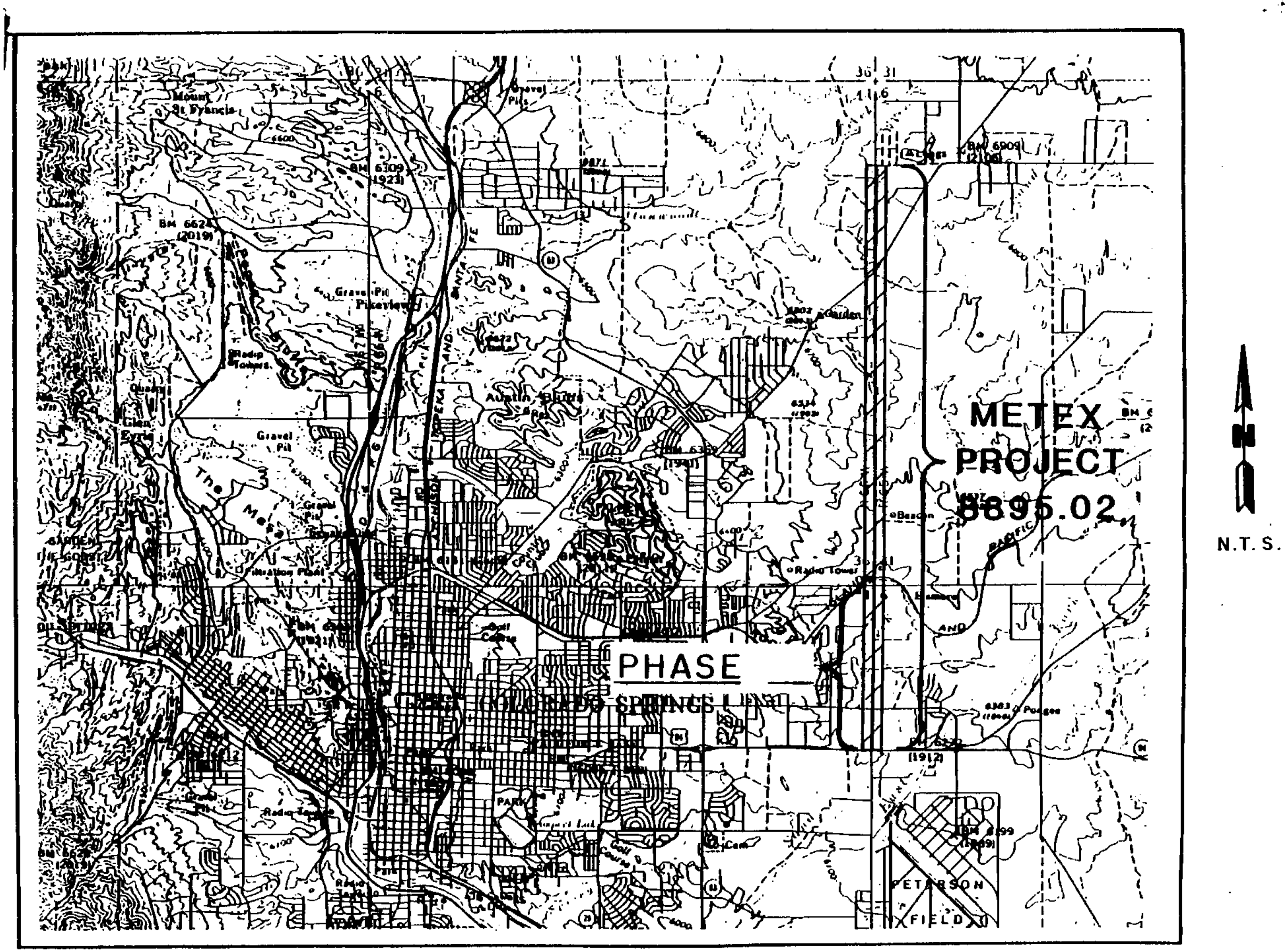
Roadside Ditches

The typical road section consists of grading for a future section of three lanes in each direction with curb and gutter. Roadside ditches will provide the drainage system until the time of construction of the seventh and eighth lanes. These ditches are typically three feet deep with a two foot bottom and 3:1 side slopes. These ditches will be shallowed up in a couple of areas where the capacity is not critical in order to miss existing utilities. All ditches will be sized so that there is a minimum of one (1) foot freeboard to the hinge point in fill sections.

SUMMARY AND CONCLUSIONS

Powers Boulevard improvements include the upgrading of approximately seven miles of 2-lane highway to a 4-lane expressway. This report has addressed Phase ~~I~~ 1 which includes that portion from Platte Avenue to ~~Sand Creek~~ WAYNOKA ROAD. The storm water management plan includes the use of ditches, cross culverts and inlets to convey runoff through the roadway. The ditches in this phase were designed to convey the 100-year flow. Riprap outlet protection has been designed and will be constructed at the outlet of the proposed culvert crossings.

APPENDIX



VICINITY MAP

DRAINAGE FACILITIES COST ESTIMATE
PHASE I
BIJOU STREET TO WAYNOKA ROAD

DESCRIPTION	UNIT	UNIT COST	QUANTITY	TOTAL COST
66" CSP 1	LF	66	90	$ 5,940
60" CSP 1	LF	62	353	21,900
36" CSP 1	LF	36	290	10,440
24" CSP 1	LF	32	70	2,240
18" CSP 1	LF	28	58	1,600
38" X 24" CL III RCPE	LF	96	523	50,200
18" CL III RCP	LF	40	172	6,900
66" END SECTION 2	EA	1100	2	2,200
60" END SECTION 2	EA	1035	4	4,140
36" END SECTION 2	EA	378	3	1,130
24" END SECTION 2	EA	220	2	440
18" END SECTION 3	EA	480	2	960
38" X 24" END SECTIONS 4	EA	750	4	3,000
5' TYPE R INLET	EA	2000	4	8,000
15' TYPE R INLET	EA	3500	1	3,500
MODIFIED TYPE D INLET	EA	2750	1	2,800
38" X 24" X 38" X 24" WYE 4	EA	850	1	850
60" X 18" WYE 2	EA	690	1	690
45° - 60" BEND 2	EA	1000	1	1,000
RIPRAP	CY	30	500	15,000
			SUBTOTAL	$142,930
			10% ENGINEERING & CONTINGENCIES	14,300
			TOTAL	$157,230

1. 16 gage
2. 16 gage CSP
3. Class III RCP
4. Class III RCPE

STRUCTURE SUMMARY TABLE
PHASE I

DESIGN POINT	STRUCTURE	Hw/D
ST1	24" CSP	1.35
S1	36" CSP	1.00
S2	60" CSP	1.00
S3	36" CSP	~~1.48~~ 1.10
S4	2 - 38" x 24" RCPE	~~1.60~~ 1.70
S5	6 - 12' x 12' Box Bridge	0.90
S6	60" CSP	1.10
S7	66" CSP	1.00

HYDROLOGIC SUMMARY
PHASE I

SUBBASIN	AREA (ACRES)	CURVE NUMBER OR COEFFICIENT	Q100 (CFS)	Q5 (CFS)
ST1	4.3	.77	32.7	17.4
ST2	2.2	.84	16.1	8.3
S1	15.0	91	62.2	32.8
S1A	5.5	.83	41.5	18.6
S2	28.9	91	119.5	62.7
S2A	5.0	.87	39.2	17.8
M1	0.8	.90	8.0	3.6
M2	0.8	.90	8.4	3.8
S3	19.3	92	95.1	50.8
S3A	2.6	.85	25.1	11.4
S3B	2.6	.86	25.2	11.4
S4	14.2	92	71.4	38.1
S4A	3.1	.89	27.2	12.3
S6	38.0	91	132.0	69.1
S6A	35.8	91	139.4	72.8
S6B	23.9	92	124.3	66.4
S7	5.7	92	30.8	16.4
S7A	41.9	92	~~119.8~~ 138.3	~~64.3~~ 74.3
S8	31.3	92	144.5	77.6
S8A	60.6	81	204.7	89.9

Basin S3 includes overflow from Basin S3A
Basin S6A includes overflow from Basin S6B
Basin S6 includes overflow from Basin S6A
Basin S7 includes overflow from Basin S8
Basin S7A includes overflow from Basin S7

PEAK FLOW DETERMINATION

Job title: METEX POWERS Blvd.
Job number: 8895.03.0007
Date: May 14, 1987

BASIN: S1

Area: A = 15 Acres = 0.0234 Square Miles

			(6 hour)	(24hour)	
1)	Precipitation	- 5 year	2.1	2.7	inches/hour
		- 100 year	3.5	4.4	inches/hour

2) Areal adjustment factor : 1
3) Time of Concentration: 20.7 minutes= 0.34 hour
4) Weighted Curve Number and % Imperviosness:

Land use	Area	Curve Num.	% Imperviousness
Office/Comm.	10.4	92	85
Office/Comm.	4.6	89	85

* Weighted Curve Number: 91.1

* Total % Imperviosness: 85.0

* Lag factor: 0.690376

* Corrected Time of Concentration: 0.23 hours

			(6 hour)	(24 hour)	
5)	Depth of runoff:	Q =	1.25	1.8 inches	(5 year)
		Q =	2.55	3.41 inches	(100 year)

6) Determine Peak Rate of Discharge:

q (24 hour)	780	CSM/in	From Fig 1
q (6 hour)	1020	CSM/in	=====

PEAK FLOW

q*A*Q (cfs)

	5 year	100 year
24 hour	32.8	62.2
6 hour	29.8	60.8

PEAK FLOW DETERMINATION
========================

Job title: METEX POWERS Blvd.
Job number: 8895.02.0007
Date: May 14, 1987

BASIN: S2

Area: A = 28.9 Acres = 0.0452 Square Miles

			(6 hour)	(24hour)	
1)	Precipitation	- 5 year	2.1	2.7	inches/hour
		- 100 year	3.5	4.4	inches/hour

2) Areal adjustment factor : 1
3) Time of Concentration: 20.5 minutes= 0.34 hour
4) Weighted Curve Number and % Imperviosness:

Land use	Area	Curve Num.	% Imperviousness
Office/Comm.	18.0	92	85
Office/Comm.	10.9	89	85

* Weighted Curve Number: 90.9

* Total % Imperviosness: 85.0

* Lag factor: 0.685513

* Corrected Time of Concentration: 0.23 hours

			(6 hour)	(24 hour)	
5)	Depth of runoff:	Q =	1.24	1.78 inches	(5 year)
		Q =	2.53	3.39 inches	(100 year)

6) Determine Peak Rate of Discharge:

q (24 hour)	780	CSM/in	From Fig 1
q (6 hour)	1020	CSM/in	=====

PEAK FLOW
=========
q*A*Q (cfs)

	5 year	100 year
24 hour	62.7	119.5
6 hour	57.1	116.6

PEAK FLOW DETERMINATION

Job title: METEX POWERS Blvd.
Job number: 6895.03.0007
Date: May 14, 1987

BASIN: S3

Area: A = 19.3 Acres = 0.0302 Square Miles

			(6 hour)	(24hour)	
1)	Precipitation	- 5 year	2.1	2.7	inches/hour
		- 100 year	3.5	4.4	inches/hour

2) Areal adjustment factor : 1
3) Time of Concentration: 13.2 minutes= 0.22 hour
4) Weighted Curve Number and % Inperviosness:

Land use	Area	Curve Num.	% Imperviousness
Office/Comm.	19.3	92	85

* Weighted Curve Number: 92.0
* Total % Imperviosness: 85.0
* Lag factor: 0.712798
* Corrected Time of Concentration: 0.15 hours

		(6 hour)	(24 hour)	
5) Depth of runoff:	Q =	1.32	1.87 inches	(5 year)
	Q =	2.63	3.5 inches	(100 year)

6) Determine Peak Rate of Discharge:

q (24 hour)	900	CSM/in	From Fig 1
q (6 hour)	1160	CSM/in	=====

PEAK FLOW

q*A*Q (cfs)

	5 year	100 year
24 hour	50.8	95.1
6 hour	46.2	92.1

PEAK FLOW DETERMINATION

Job title: METEX POWERS Blvd.
Job number: 8895.03.0007
Date: May 14, 1987

BASIN: S4

Area: A = 14.2 Acres = 0.0222 Square Miles

			(6 hour)	(24hour)	
1)	Precipitation	- 5 year	2.1	2.7	inches/hour
		- 100 year	3.5	4.4	inches/hour

2) Areal adjustment factor : 1
3) Time of Concentration: 12.5 minutes= 0.2 hour
4) Weighted Curve Number and % Imperviosness:

Land use	Area	Curve Num.	% Imperviousness
COMMERCIAL	14.2	92	85

* Weighted Curve Number: 92.0
* Total % Imperviosness: 85.0
* Lag factor: 0.712798
* Corrected Time of Concentration: 0.14 hours

			(6 hour)	(24 hour)	
5)	Depth of runoff:	Q =	1.32	1.87 inches	(5 year)
		Q =	2.63	3.5 inches	(100 year)

6) Determine Peak Rate of Discharge:

q (24 hour)	920	CSM/in	From Fig 1
q (6 hour)	1180	CSM/in	=====

PEAK FLOW

q*A*Q (cfs)

	5 year	100 year
24 hour	38.1	71.4
6 hour	34.5	68.8

PEAK FLOW DETERMINATION

Job title: METEX POWERS Blvd.
Job number: 8895.03.0007
Date: May 14, 1987

S6+S6A+S6 (DESIGN POINT S6)

Area: A = 37.9 Acres = 0.0592 Square Miles

			(6 hour)	(24hour)	
1)	Precipitation	- 5 year	2.1	2.7	inches/hour
		- 100 year	3.5	4.4	inches/hour

2) Areal adjustment factor : 1
3) Time of Concentration: 33.9 minutes= 0.56 hour
4) Weighted Curve Number and % Imperviosness:

Land use	Area	Curve Num.	% Imperviousness
OFFICE/COMM.	26.1	92	85
INDUSTRIAL	11.8	88	72

* Weighted Curve Number: 90.8

* Total % Imperviosness: 80.9

* Lag factor: 0.698384

* Corrected Time of Concentration: 0.39 hours

			(6 hour)	(24 hour)	
5)	Depth of runoff:	Q =	1.23	1.77 inches	(5 year)
		Q =	2.52	3.38 inches	(100 year)

6) Determine Peak Rate of Discharge:

q (24 hour)	660	CSM/in	From Fig 1
q (6 hour)	860	CSM/in	=====

PEAK FLOW

q*A*Q (cfs)

	5 year	100 year
24 hour	69.1	132.0
6 hour	62.6	128.2

PEAK FLOW DETERMINATION
========================

Job title: METEX POWERS Blvd.
Job number: 8895.03.0007
Date: May 14. 1987

S6A+S6B (DESIGN POINT S6A)

Area: A = 35.8 Acres = 0.0559 Square Miles

			(6 hour)	(24hour)	
1)	Precipitation	- 5 year	2.1	2.7	inches/hour
		- 100 year	3.5	4.4	inches/hour

2) Areal adjustment factor : 1
3) Time of Concentration: 26.1 minutes= 0.43 hour
4) Weighted Curve Number and % Imperviosness:

Land use	Area	Curve Num.	% Imperviousness
OFFICE/COMM.	24	92	85
INDUSTRIAL	11.8	88	72

* Weighted Curve Number: 90.7

* Total % Imperviosness: 80.7

* Lag factor: 0.696847

* Corrected Time of Concentration: 0.29 hours

			(6 hour)	(24 hour)	
5)	Depth of runoff:	Q =	1.22	1.76 inches	(5 year)
		Q =	2.51	3.37 inches	(100 year)

6) Determine Peak Rate of Discharge:

q (24 hour)	740	CSM/in	From Fig 1
q (6 hour)	960	CSM/in	=====

PEAK FLOW
=========
q*A*Q (cfs)

	5 year	100 year
24 hour	72.8	139.4
6 hour	65.4	134.6

PEAK FLOW DETERMINATION

Job title: METEX POWERS Blvd.
Job number: 6835.03.0007
Date: May 14. 1987

BASIN: S6B

Area: A = 23.91 Acres = 0.0374 Square Miles

			(6 hour)	(24hour)	
1)	Precipitation	- 5 year	2.1	2.7	inches/hour
		- 100 year	3.5	4.4	inches/hour

2) Areal adjustment factor : 1
3) Time of Concentration: 11.1 minutes= 0.18 hour
4) Weighted Curve Number and % Imperviosness:

Land use	Area	Curve Num.	% Imperviousness
Office/Comm.	23.91	92	85

* Weighted Curve Number: 92.0

* Total % Imperviosness: 85.0

* Lag factor: 0.712798

* Corrected Time of Concentration: 0.12 hours

			(6 hour)	(24 hour)	
5)	Depth of runoff:	Q =	1.32	1.87 inches	(5 year)
		Q =	2.63	3.5 inches	(100 year)

6) Determine Peak Rate of Discharge:

q (24 hour)	950	CSM/in	From Fig 1
q (6 hour)	1225	CSM/in	=====

PEAK FLOW

q*A*Q (cfs)

	5 year	100 year
24 hour	66.4	124.3
6 hour	60.4	120.4

PEAK FLOW DETERMINATION

Job title: METEX POWERS Blvd.
Job number: 3895.03.0007
Date: May 14, 1987

BASIN: 67+68

Area: A = [illegible]7.83 Acres = 0.0577 Square Miles

		(6 hour)	(24hour)	
1) Precipitation	- 5 year	2.1	2.7	inches/hour
	- 100 year	3.5	4.4	inches/hour

2) Areal adjustment factor : 1
3) Time of Concentration: 21.6 minutes= 0.36 hour
4) Weighted Curve Number and % Imperviousness:

Land Use	Area	Curve Num.	% Imperviousness
COMMERCIAL	31.63	92	85
COMMERCIAL	5.2	93	85

* Weighted Curve Number: 92.1

* Total % Imperviousness: 84.9

* Lag Factor: 0.715679

* Corrected Time of Concentration: 0.26 hours

		(6 hour)	(24 hour)	
5) Depth of runoff:	Q =	1.35	1.98 inches	5 year
	Q =	2.84	3.51 inches	(100 year)

6) Determine Peak Rate of Discharge:

q (24 hour) ~~[illegible]~~ 760 CSM/in (from Fig 1)

q (6 hour) ~~[illegible]~~ 980 CSM/in

PEAK FLOW

q*A*Q (cfs)

	5 year	100 year
24 hour	~~[illegible]~~ 82.7	~~[illegible]~~ 154.4
6 hour	~~[illegible]~~ 75.4	~~[illegible]~~ 149.7

PEAK FLOW DETERMINATION

Job title: METEX POWERS Blvd.
Job number: 8895.03.0007
Date: May 14, 1987

BASIN: S7A+S7+S8

Area: A = 41.91 Acres = 0.0655 Square Miles

		(6 hour)	(24 hour)	
1) Precipitation	- 5 year	2.1	2.7	inches/hour
	- 100 year	3.5	4.4	inches/hour

2) Areal adjustment factor : 1
3) Time of Concentration: 36.3 minutes= 0.51 hour
4) Weighted Curve Number and % Imperviosness:

Land use	Area	Curve Num.	% Imperviousness
COMMERCIAL	31.83	92	85
COMMERCIAL	5.2	93	85
COMMERCIAL	4.88	93	85

* Weighted Curve Number: 92.2

* Total % Imperviosness: 85.0

* Lag factor: 0.717901

* Corrected Time of Concentration: 0.43 hours

		(6 hour)	(24 hour)	
5) Depth of runoff:	Q =	1.34	1.69 inches	(5 year)
	Q =	2.66	3.32 inches	(100 year)

6) Determine Peak Rate of Discharge:

q (24 hour) ~~[illegible]~~ 600 CSM/in From Fig 1

q (6 hour) ~~[illegible]~~ 780 CSM/in

PEAK FLOW

q*A*Q (cfs)

	5 year	100 year
24 hour	~~[illegible]~~ 74.3	~~[illegible]~~ 138.3
6 hour	~~[illegible]~~ 68.41	~~[illegible]~~ 135.4

PEAK FLOW DETERMINATION

Job title: METEX POWERS Blvd.
Job number: 8835.03.0007
Date: May 14, 1987

BASIN: S7

Area: A = 5.73 Acres = 0.009 Square Miles

			(6 hour)	(24hour)	
1)	Precipitation	- 5 year	2.1	2.7	inches/hour
		- 100 year	3.5	4.4	inches/hour

2) Areal adjustment factor : 1
3) Time of Concentration: 10 minutes= 0.16 hour
4) Weighted Curve Number and % Imperviosness:

Land use	Area	Curve Num.	% Imperviousness
COMMERCIAL	5.73	92	85

* Weighted Curve Number: 92.0
* Total % Imperviosness: 85.0
* Lag factor: 0.712798
* Corrected Time of Concentration: 0.11 hours

		(6 hour)	(24 hour)	
5) Depth of runoff:	Q =	1.32	1.87 inches	(5 year)
	Q =	2.63	3.5 inches	(100 year)

6) Determine Peak Rate of Discharge:

q (24 hour)	980	CSM/in	From Fig 1
q (6 hour)	1250	CSM/in	=====

PEAK FLOW

q*A*Q (cfs)

	5 year	100 year
24 hour	16.4	30.8
6 hour	14.8	29.5

PEAK FLOW DETERMINATION

Job title: METEX POWERS Blvd.
Job number: 6895.03.0007
Date: May 14, 1987

BASIN: S8

Area: A = 31.3 Acres = 0.0489 Square Miles

			(6 hour)	(24hour)	
1)	Precipitation	- 5 year	2.1	2.7	inches/hour
		- 100 year	3.5	4.4	inches/hour

2) Areal adjustment factor : 1
3) Time of Concentration: 15.8 minutes= 0.26 hour
4) Weighted Curve Number and % Imperviosness:

Land use	Area	Curve Num.	% Imperviousness
COMMERCIAL	26.1	92	85
COMMERCIAL	5.2	93	85

* Weighted Curve Number: 92.2

* Total % Imperviosness: 85.0

* Lag factor: 0.717901

* Corrected Time of Concentration: 0.18 hours

			(6 hour)	(24 hour)	
5)	Depth of runoff:	Q =	1.34	1.89 inches	(5 year)
		Q =	2.65	3.52 inches	(100 year)

6) Determine Peak Rate of Discharge:

q (24 hour)	840	CSM/in	From Fig 1
q (6 hour)	1100	CSM/in	=====

PEAK FLOW

q*A*Q (cfs)

	5 year	100 year
24 hour	77.6	144.5
6 hour	72	142.5

PEAK FLOW DETERMINATION

Job title: METEX POWERS Blvd.
Job number: 6895.03.0007
Date: May 14, 1987

BASIN: S8A

Area: A = 60.55 Acres = 0.0946 Square Miles

			(6 hour)	(24hour)	
1)	Precipitation	- 5 year	2.1	2.7	inches/hour
		- 100 year	3.5	4.4	inches/hour

2) Areal adjustment factor : 1
3) Time of Concentration: 14.4 minutes= 0.24 hour
4) Weighted Curve Number and % Inperviosness:

Land use	Area	Curve Num.	% Imperviousness
RESIDENTIAL	60.55	81	56

* Weighted Curve Number: 81.0
* Total % Imperviosness: 56.0
* Lag factor: 0.668810
* Corrected Time of Concentration: 0.16 hours

			(6 hour)	(24 hour)	
5)	Depth of runoff:	Q =	0.66	1.08 inches	(5 year)
		Q =	1.7	2.46 inches	(100 year)

6) Determine Peak Rate of Discharge:

q (24 hour)	880	CSM/in	From Fig 1
q (6 hour)	1140	CSM/in	=====

PEAK FLOW

q*A*Q (cfs)

	5 year	100 year
24 hour	89.9	204.7
6 hour	71.1	183.3

BASIN ST1

BASIN SE OF POWERS/PLATTE INTERSECTION

RATIONAL METHOD

Q = CIA

COEFFICIENT (C):

This sub basin is made up of 64% open area, ditch, & cut or fill slope and 36% pavement

From Table 3 page 49 of the Colorado Springs Subdivision Policy Manual.
C for pavement = 0.90
C for ditch area = 0.70

64% × 0.7 = .448
36% × 0.9 = .324
C = 0.77

Intensity (I):

T_c: Overland flow: 120' across pavement
T = 37.5 sec. = .63 min.
Channel flow = 1000' Dif in Elev. = 3
T = 6.6 min. (From fig. II)
T_c = overland time + channel time
T_c = 7.23 min.

From Figure 3 in the Col. Springs Manual
I_5 = 5.25 inches/hr.

AREA (A):

Sub basin area = 4.30 acres

ST 1 (CONT)
BASIN SE OF POWERS/PLATTE INT. (CONT.)

FLOW (Q):

$Q_5 = C I_5 A$

$Q_5 = (0.77)(5.25)(4.30)$

$Q_5 = 17.4$ CFS

100 YR. FLOW

$I_{100} = 7.9$ in/hr (from PPACG FIG III-2 duration intensity curve)

$Q_{100} = (0.77)(7.9)(4.3)(1.25)$

$Q_{100} = 32.7$ CFS

BASIN ST2

BASIN SW OF POWERS/PLATTE INTERSECTION

COEFFICIENT (C):

This sub basin is made up of 30% open area, ditch & cut slope and 70% pavement

From Table 3 page 49 of the Col. Springs Subdivision Policy Manual.
C = 0.90 for pavement
C = 0.70 for open area etc.

30% × 0.7 = .21
70% × 0.9 = .63
.84

INTENSITY (I):

T_c: Overland flow = 120'
T = .63 min.
Channel flow = 1550' Dif in elev. = 36.1
T = .16 hours
T_c = overland time + channel time
T_c = .63 min + (.16 hours × 60 min/hr) = 10.23 min

From Figure 3 in the Colorado Springs Manual
I_5 = 4.5 inches/hr.

AREA (A):

Sub basin area = 2.19 acres

FLOW (Q)

$Q_5 = C I_5 A$

$Q_5 = (0.84)(4.5)(2.19)$

$Q_5 = 8.3$ CFS

100 YR. FLOW

$I_{100} = 7$ in/hr (From PPACG FIG III-2 duration-intensity curve)

$Q_{100} = (.84)(7.0)(2.19)(1.25)$

$Q_{100} = 16.1$ CFS

BASIN S1A

This basin is the west half of Powers Blvd. from Galley Road to Platte Ave. This is a relatively small area, therefore the Rational Method will be used to calculate the flow.

$Q = CIA$

COEFFICIENT (C)

This basin is comprised of 67% pavement and 33% ditch area

From Table 3, page 49 of the Colorado Springs Subdivision Policy Manual,
C for pavement = 0.9
Since gravel will be used, use 0.7 for the remaining area.

67% x 0.9 = 0.60
33% x 0.7 = 0.23
0.83

INTENSITY (I)

T_c : Channel flow
L: L = 2500'
ELEVATION DIFF. = 38
S = 38/2500 = 1.52%
Using Manning Eq V = 4.7 ft/sec
T_c = 8.9 MIN.
I_5 = 4.1 in./hr.
I_{100} = 7.3 in./hr.

BASIN S1 A (CONTINUED)

AREA (A)

BASIN AREA = 5.48 AC.

RUNOFF (Q)

$Q_5 = C I_5 A$

$Q_5 = (.83)(4.1)(5.48)$

$Q_5 = 18.6$ CFS

$Q_{100} = C I_{100} A (1.25)$

$Q_{100} = (.83)(7.3)(5.48)(1.25)$

$Q_{100} = 41.5$ CFS

KKBNA

Incorporated Consulting Engineers

Job Title METEX - POWERS BLVD. By JT Date 8/6/86 Job no. 8895

Subject DRAINAGE - WEST SIDE Checked Sheet of

OF POWERS FROM OMAHA BLVD TO GALLEY

BASIN S2A

This basin is the west draining half of Powers Blvd. from the Omaha Inter. South to Galley Road. This is a relatively small area, therefore the Rational Method will be used to calculate the flow.

$Q = CIA$

COEFFICIENT (C)

This sub basin is comprised of 83% pavement and 17% ditch area.

From Table 3, page 49 of the Colorado Springs Subdivision Policy Manual.

C for pavement 0.9

Since gravel will be oiled, use 0.7 for remainder

83% x 0.9 = .75

17% x 0.7 = .12

.87

INTENSITY (I)

T_c = CHANNEL FLOW

L = 2,600 FT

ΔELEV = 42.5

FROM MANNINGS V = 4.7 FT/SEC

T_c = 9.2 MIN

FROM FIG III-2

I_5 = 4.1 IN/HR I_{100} = 7.2 IN/HR

PALMER PARK TO GALLEY

BASIN S2A (CONTINUED)

AREA (A):

Sub basin area = 5.0 acres

FLOW (Q):

$Q_5 = C I_5 A$

$Q_5 = (0.87)(4.1)(5.0)$

$Q_5 = 17.8$ CFS

$I_{100} = 7.2$ in/hr

$Q_{100} = (0.87)(7.2)(5.0)(1.25)$

$Q_{100} = 39.2$ CFS

BASIN M1

Basin M1 is the roadway basin draining toward median inlet at STA 136+79.69

Area:

$670' \times \left(\frac{68+35}{2}\right) = 0.79$ AC

Coefficient: C = 0.90 all pavement

Intensity:

Use $t_c = 5$ min (minimum)

FIG III-2 PPACG → $I_5 = 5.1$ In/Hr
$I_{100} = 9.0$ In/Hr

Flow:

$Q_5 = 0.90(5.1)(0.79)$ $Q_5 = 3.6$ cfs

$Q_{100} = 0.90(1.25)(9.0)(0.79)$ $Q_{100} = 8.0$ cfs

Inlet Capacity:

Table 6 ⟶ L=5, S=1.7%

$Q_{CAP} = 9.2$ cfs

CCS/EPC DCM:
$y = 0.26'$ $T = 17.3'$ $L = 5.0'$ $Q_i/Q = 0.29$ $Q_i = 2.3$ cfs
$Q_{by} = 5.7$ cfs

KKBNA
Incorporated Consulting Engineers

Job Title METEX | Date 5-4-87 | Job no. 8895.03

Subject Drainage Basins | By RA | Sheet of

BASIN M2

Basin M2 is the roadway basin draining toward the median inlet at STA 146+16.

Area: $600' \times (46+14) = 0.83$ AC

Coefficient: $C = 0.90$ all pavement

Intensity:

$t_c = 5$ min (minimum)

FIG III-2 P.R.ACO → $I_5 = 5.1$ In/Hr
$I_{100} = 9.0$ In/Hr

Flow:

$Q_5 = 0.90(5.1)(0.83)$ $Q_5 = 3.8$ cfs

$Q_{100} = 0.90(9.0)(0.83)(1.25)$ $Q_{100} = 8.4$ cfs

Inlet Capacity:

Table 6 → L=5' s=2%

$Q_{CAP} = 9.3$ cfs ✓

CCS/EPC DCM:
$y = 0.26'$ $T = 17.3'$ $L = 5.0'$ $Q_i/Q = 0.29$ $Q_i = 2.4$ CFS
$Q_{by} = 5.6$ CFS

KKBNA

Incorporated Consulting Engineers

Job Title METEX - POWERS BLVD. By JT Date 9/19/96 Job no. 8895.03

Subject DRAINAGE - EAST SIDE OF POWERS FROM PALMER PARK TO OMAHA Checked Sheet of

BASIN 53 A

$Q = CIA$

COEFFICIENT (C)

This basin is comprised of 78% pavement and 22% ditch area

$78\% \times 0.9 = 0.70$
$22\% \times 0.7 = 0.15$
0.85

INTENSITY (I)

CHANNEL FLOW
$L = 1350$ FT
Δ ELEV = 26
FROM MANNINGS $V = 4.4$
$T_c = 5.1$ MIN

$I_5 = 5.1$ in./hr. $I_{100} = 9.0$ in./hr.

AREA (A)

BASIN AREA = 2.62 AC

RUNOFF (Q)

$Q_5 = C I_5 A$
$Q_5 = (.85)(5.1)(2.62)$
$Q_5 = 11.4$ CFS

$Q_{100} = C I_{100} A$
$Q_{100} = (.85)(9.0)(2.62)(1.2$
$Q_{100} = 25.1$ CFS

BASIN S 3B

This basin is the west draining half of Powers Blvd. from Palmer Park Road south to Omaha.

$Q = CIA$

COEFFICIENT (C):

This basin is comprised of 82% pavement and 18% ditch area

Composite C value = 0.86

INTENSITY (I):

SAME AS S3A

T_C = 5.1 min.

From Fig. 3 in the City of Col. Springs Ma...

I_5 = 5.1 in/hr. I_{100} = 9.0 in/hr.

AREA (A):

Basin Area = 2.6 Ac

FLOW (Q):

$Q_5 = C I_5 A$

$Q_5 = (.86)(5.1)(2.6)$

Q_5 = 11.4 CFS

$Q_{100} = C I_{100} A (1.25)$

$Q_{100} = (.86)(9.0)(2.6)(1.25)$

Q_{100} = 25.2 CFS

KKBNA
Incorporated Consulting Engineers

Job Title METEX - POWERS BLVD. By JT Date 9/18/86 Job no. 3895

Subject DRAINAGE - WEST SIDE OF Checked Sheet of
POWERS FROM SAND CR. TO PALMER PK.

BASIN S4 A

This basin is the west half of Powers Blvd. from Sand Creek to Palmer Park. This is a small area, therefore the Rational Method will be used to calculate the flow.

$Q = C I A$

COEFFICIENT (C)

This basin is comprised of 82% pavement and 22% ditch area

$$82\% \times 0.9 = 0.74$$
$$22\% \times 0.7 = 0.15$$
$$0.89$$

INTENSITY (I)

L = 1,900 FT
Δ ELEV = 30'
FROM MANNINGS V = 4.2
$T_c = 7.5$ MIN
FROM RAINFALL INTENSITY CURVES,
$I_5 = 4.4$ in./hr $I_{100} = 7.8$ in/hr

AREA (A)

BASIN AREA = 3.14 AC

RUNOFF (Q)

$Q_5 = C I_5 A$
$Q_5 = (.89)(4.4)(3.14)$
$Q_5 = 12.3$ CFS

$Q_{100} = C I_{100} A (1.25)$
$Q_{100} = (.89)(7.8)(3.14)(1.25)$
$Q_{100} = 27.2$ CFS

STA 91+92 - Culvert at Access Road

Basin ST-1 :

$Q_5 = 17.4$ cfs
$Q_{100} = 32.7$ cfs

East ditch flow at sta 91+92 is 90% of Basin ST-1 flows:

Design Flows:

$Q_5 = 15.7$ cfs ←
$Q_{100} = 29.4$ cfs ←

One 24" CSP (21" RCP) will carry the 5-year storm, 100-year storm will overtop the access road.

PLAN

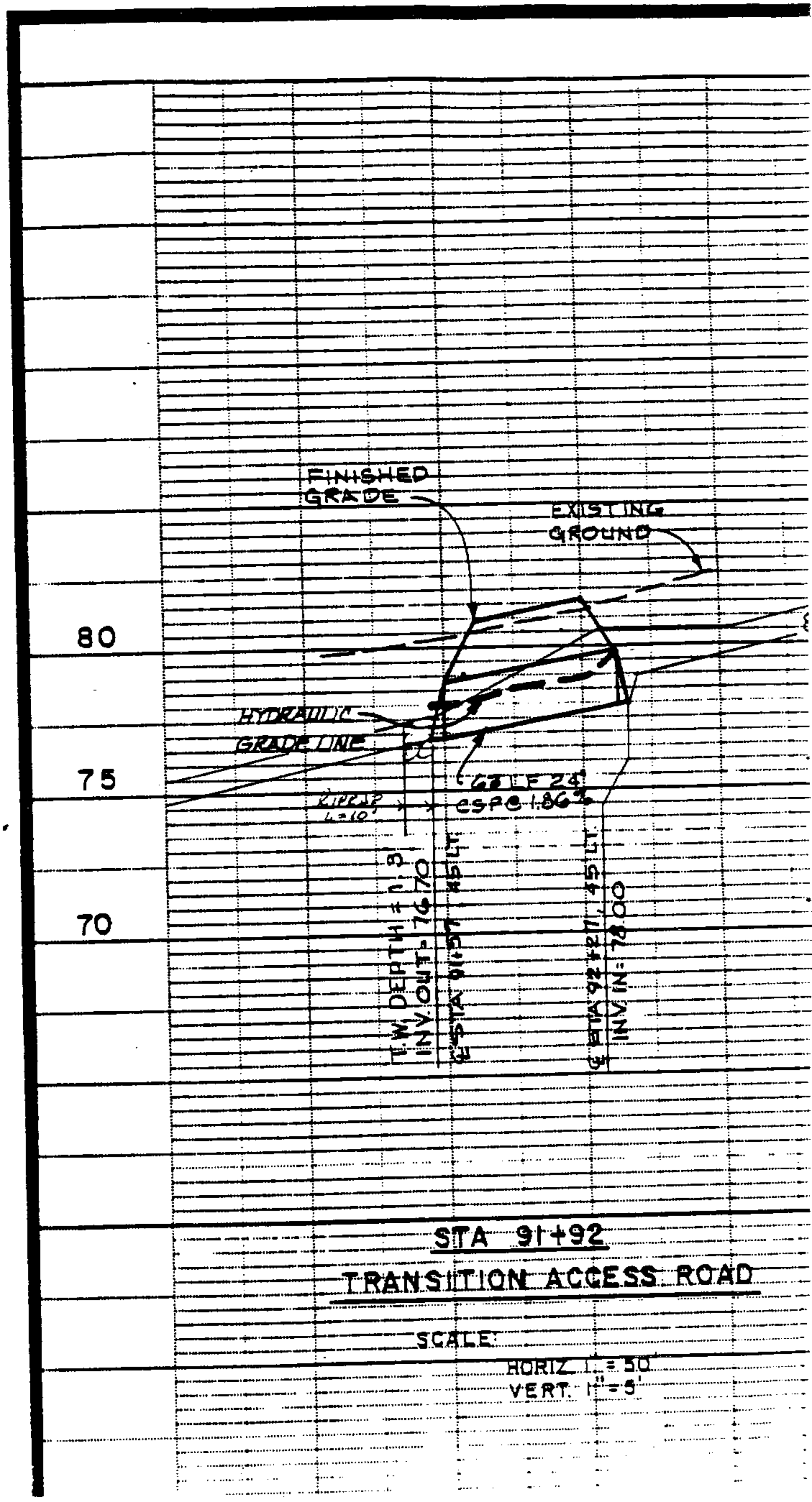
NOTE BOOK

NO.

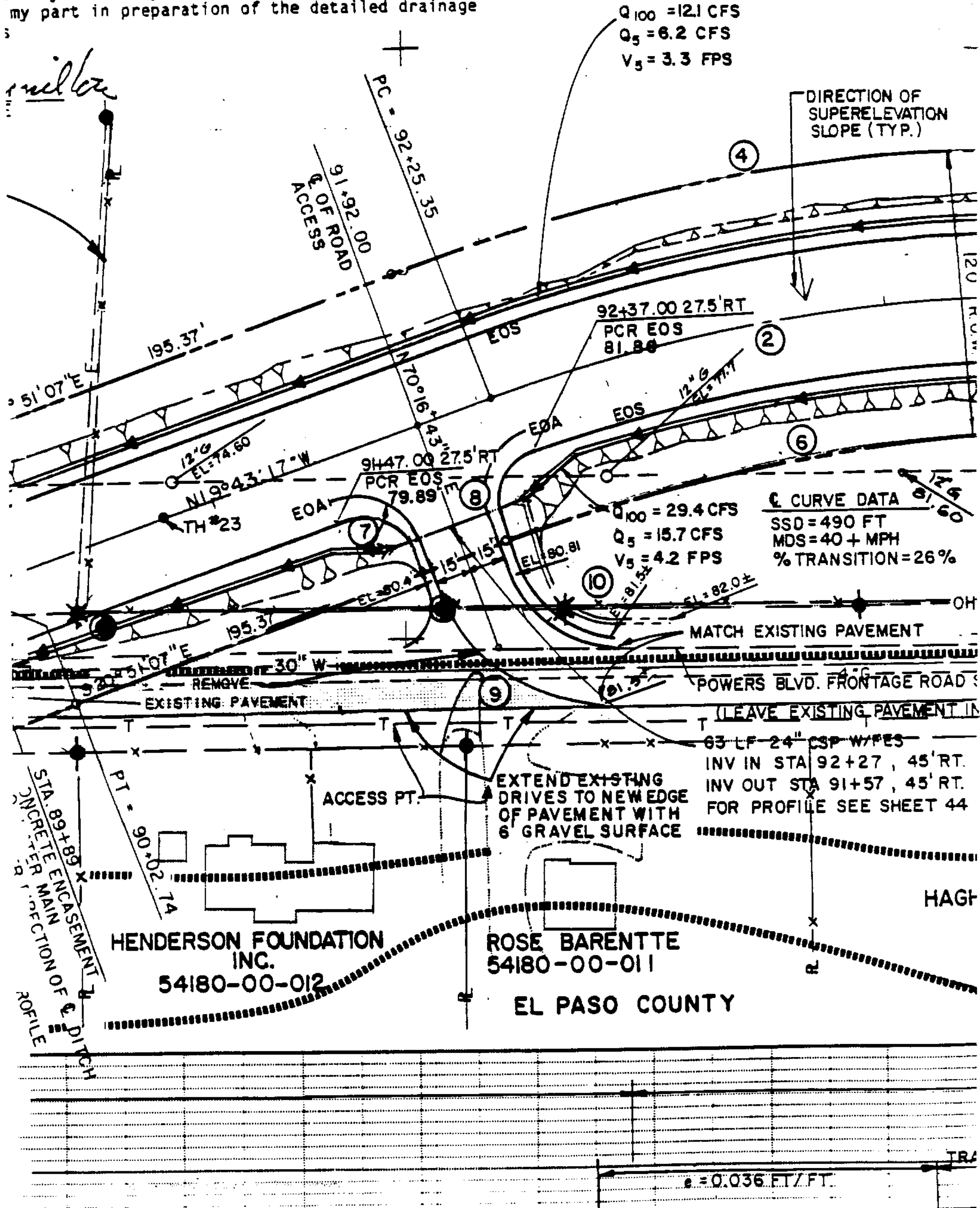
SURVEYED
PLOTTED
CHECKED
REVIEWED
DESIGNED

BY

DATE



...onformity with the master plan of the drainage ...ainage plans and specifications meet the ...rticular drainage facility is designed. I ... any liability caused by the negligent acts, ... my part in preparation of the detailed drainage ...s



PROJECT: METEX
Transition South of Platte

DESIGNER: RA
DATE: 5-1-87

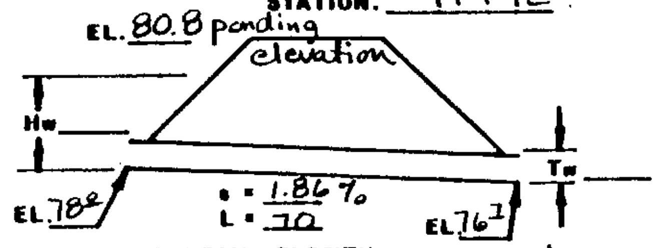
HYDROLOGIC AND CHANNEL INFORMATION

Station 91+92 Access Road
East Ditch Along Powers

$Q_5 = Q_1$ = 15.7 cfs TAILWATER ELEVATION = 1.2
$Q_{100} = Q_2$ = 29.4 cfs TAILWATER ELEVATION = 1.4

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH
STATION: 91+92



MEAN STREAM VELOCITY = ______ $\frac{L}{100s}$ = ______
MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. Hw/D	INLET CONT. Hw	OUTLET CONTROL $HW = H + h_o - Ls$: K_e	H	d_c	$\frac{d_c+D}{2}$	Tw	h_o	Ls	Hw	CHART No.	CHART Hw	CONTROLLING Hw	OUTLET VELOCITY	COST	COMMENTS
CSP w/FES	15.7	24"	1.35	2.7	0.5	2.2	1.5	1.75	~~1.2~~ 0.8	1.75	1.3	2.65			2.7			OK
~~CSP w/FES~~	~~29.4~~	~~24"~~	~~3.0~~	~~6.0~~														
RCP w/FES	15.7	21"	1.45	2.5	0.5	1.7	1.6	1.75	1.2	1.75	1.3	2.15	—	—	2.5	—	—	~~OK~~

SUMMARY & RECOMENDATIONS: Will carry 5-year storm. Road will be overtopped during 100-year storm

Form BPR

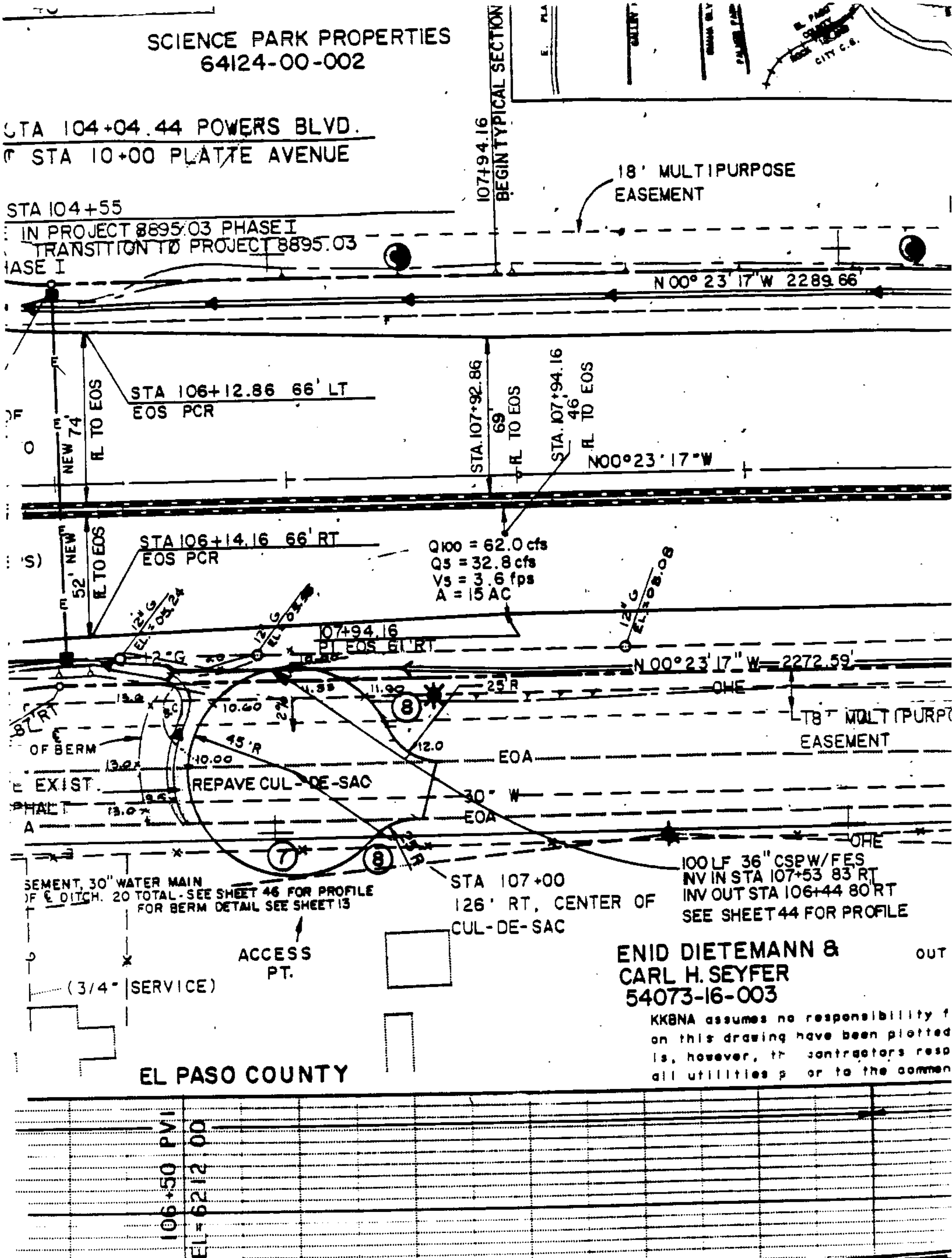
FIGURE 4-4. DESIGN COMPUTATION FORM FOR CULVERTS

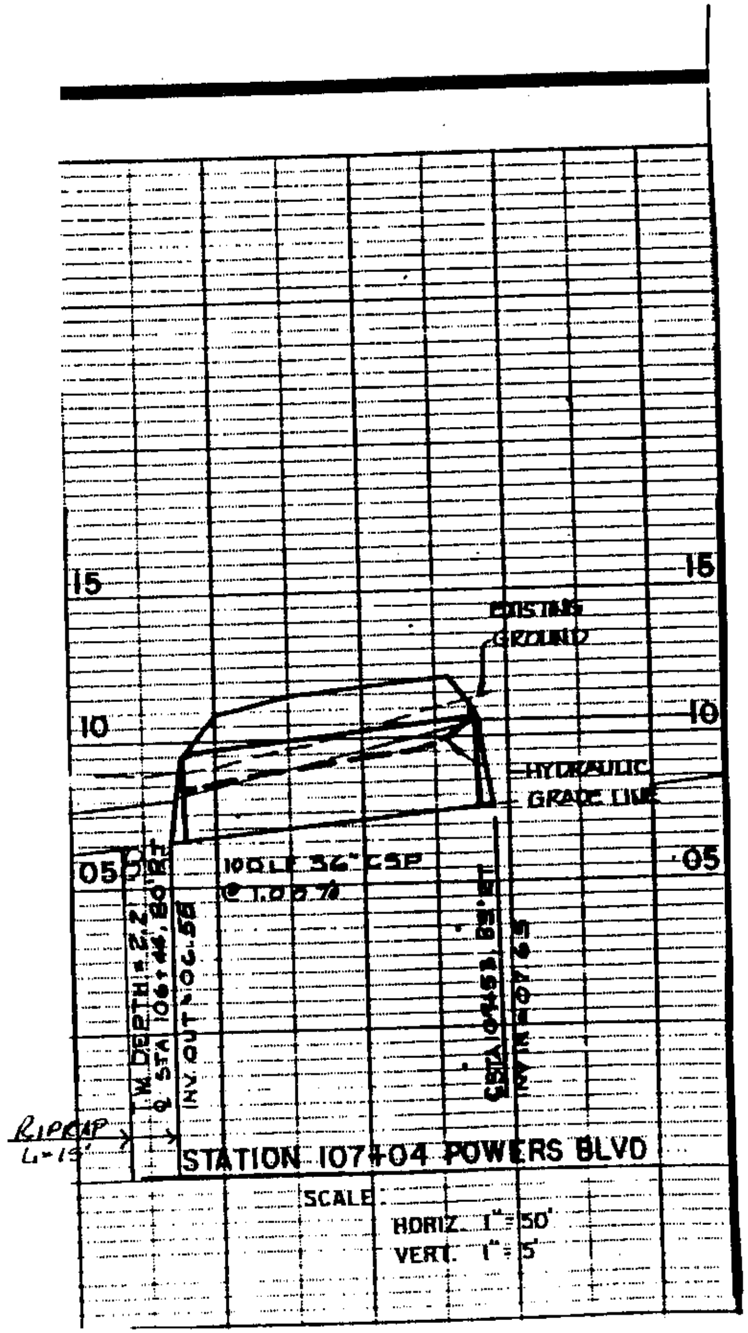
STA 107+04 - CULVERT BELOW CUL-DE-SAC

Basin S1 Flows to Culvert:

$$Q_5 = 32.8 \text{ cfs}$$
$$Q_{100} = 62.0 \text{ cfs}$$

Flows are in east ditch. One 36" CSP (30" RCP) will carry the 5-year storm, flows from the 100-year storm will flow around the west end of the cul-de-sac and back into the ditch.


SCIENCE PARK PROPERTIES
64124-00-002
STA 104+04.44 POWERS BLVD.
STA 10+00 PLATTE AVENUE
STA 104+55
IN PROJECT 8895.03 PHASE I
TRANSITION TO PROJECT 8895.03
PHASE I
107+94.16
BEGIN TYPICAL SECTION
18' MULTIPURPOSE
EASEMENT
N 00° 23' 17" W 2289.66'
STA 106+12.86 66' LT
EOS PCR
NEW 74'
℄ TO EOS
STA. 107+92.86
69
℄ TO EOS
STA. 107+94.16
46
℄ TO EOS
N00°23'17"W
STA 106+14.16 66' RT
EOS PCR
52' NEW
℄ TO EOS
Q100 = 62.0 cfs
Qs = 32.8 cfs
Vs = 3.6 fps
A = 15 AC
107+94.16
PT EOS 61' RT
N 00° 23' 17" W 2272.59'
OHE
25' R
18' MULTIPURPOSE
EASEMENT
OF BERM
45' R
EOA
REPAVE CUL-DE-SAC
EXIST.
ASPHALT
30" W
EOA
OHE
SEMENT, 30" WATER MAIN
OF ℄ DITCH. 20 TOTAL - SEE SHEET 46 FOR PROFILE
FOR BERM DETAIL SEE SHEET 13
STA 107+00
126' RT, CENTER OF
CUL-DE-SAC
100 LF 36" CSPW/FES
INV IN STA 107+53 83' RT
INV OUT STA 106+44 80' RT
SEE SHEET 44 FOR PROFILE
ACCESS
PT.
(3/4" SERVICE)
ENID DIETEMANN &
CARL H. SEYFER
54073-16-003
KKBNA assumes no responsibility f
on this drawing have been plotted
is, however, the contractors resp
all utilities prior to the commen
EL PASO COUNTY
106+50 PVI
EL=6212.00


15
15
EXISTING GROUND
10
10
HYDRAULIC GRADE LINE
05
05
100 LF 36" CSP
T.W. DEPTH = 2.2
INV. OUT
RIPRAP L=15'
STATION 107+04 POWERS BLVD
SCALE
HORIZ. 1" = 50'
VERT. 1" = 5'

PROJECT: METEX

FRONTAGE ROAD CULVERT

DESIGNER: JAF

DATE: 5/11/87

HYDROLOGIC AND CHANNEL INFORMATION

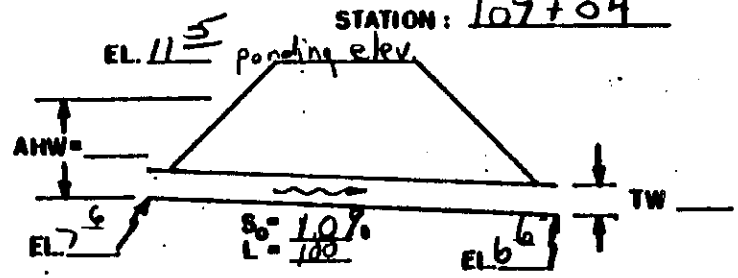
Q_1 = 32.8 cfs Q5 TW_1 = ______

Q_2 = 62.0 cfs Q100 TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 107+04



MEAN STREAM VELOCITY = ______

MAX. STREAM VELOCITY = ______

HEADWATER COMPUTATION

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	INLET CONT.		OUTLET CONTROL $HW = H + h_o - LS_o$								CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
CSP w/FES	32.8	36"	1.0	3.0	0.5	1.4	1.8	2.4	1.4	2.4	1.0	2.8	3.0			
CSP w/FES	62.0	36"	2.4	7.2	0.5	5.0	2.5	2.75	-	2.75	1.0	6.8	7.2			
RCP w/FES	32.8	30"	1.4	3.5	0.5	1.5	2.0	2.25	—	2.25	1.0	2.75	3.5			

SUMMARY & RECOMMENDATIONS: CULVERT WILL PASS THE 5-YEAR STORM. 100-YEAR FLOW AROUND CUL-DE-SAC

Figure 7

STA 131+74 STORM SEWER AT GALLEY

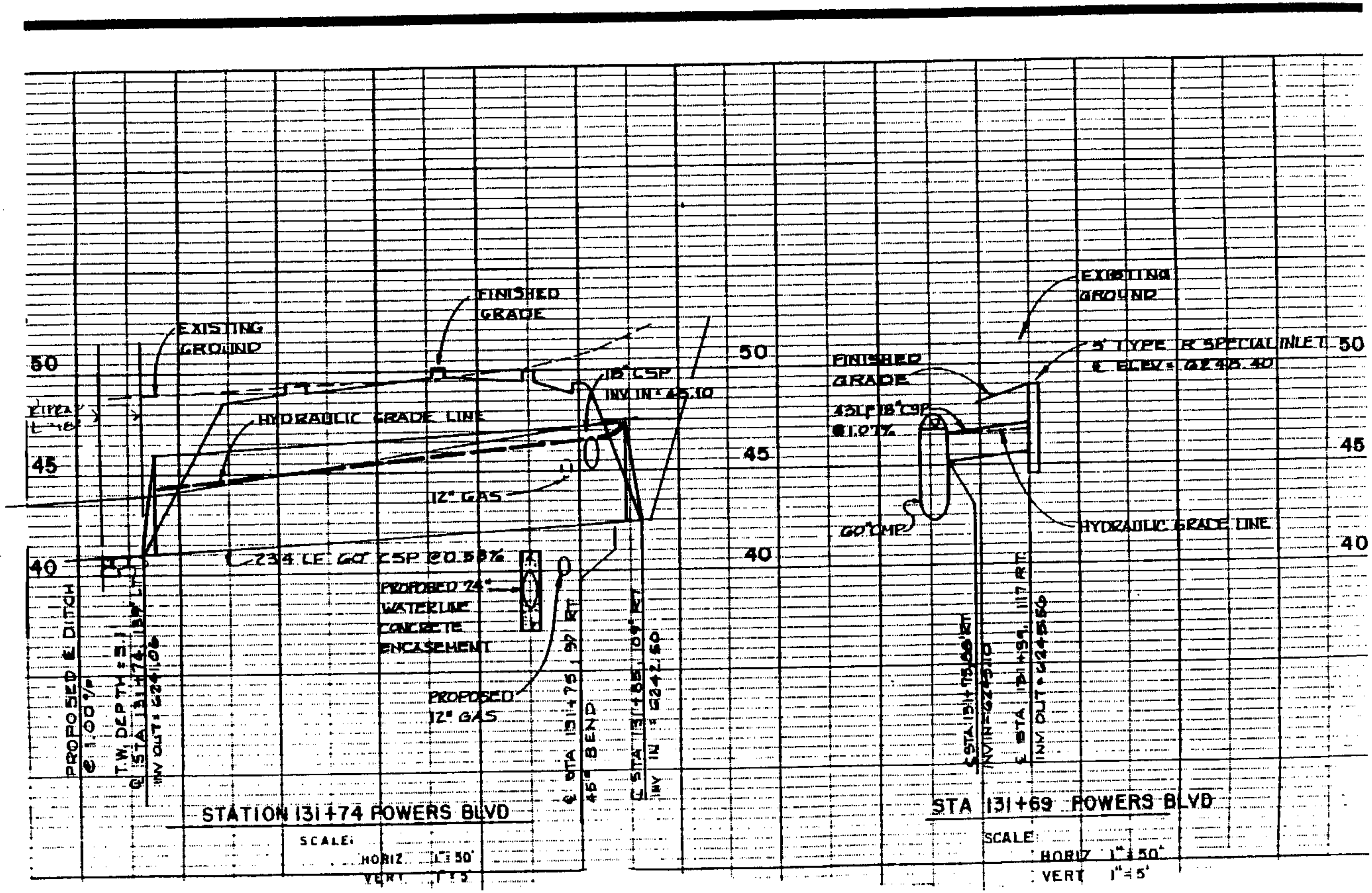
Basin S2 Flows to Storm Sewer:

Q_5 = 62.7 cfs
Q_{100} = ~~119.1~~ 119.5 cfs

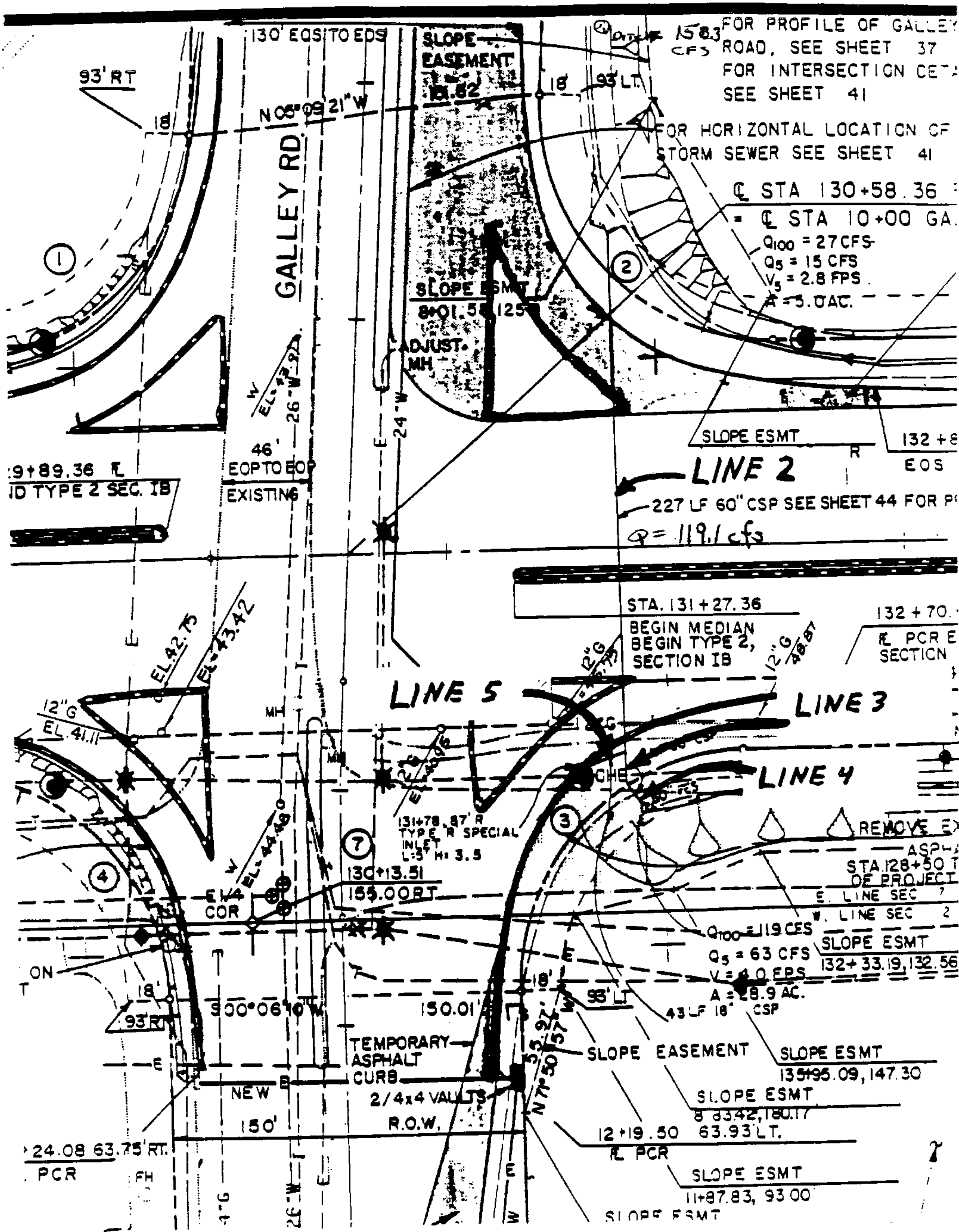
Flows are in the east ditch and in the street.

~~$Q_{100\ INLET}$ = 2.8 cfs → use 3.0 cfs~~
~~$Q_{100\ DITCH}$ = 119.1 − 2.8 = 116.3 use 117.0 cfs~~
~~$Q_{100\ TOTAL}$ = 117.0 + 3.0 = 120.0~~

The attached storm sewer calculations verify the hydraulic operations of the system. ~~119.1~~ 119.5 cfs is then released down the north ditch of Galley Rd. to Sand Creek.



EXISTING GROUND
FINISHED GRADE
HYDRAULIC GRADE LINE
18" CSP INV IN = 45.10
12" GAS
234 LF 60" CSP @0.58%
PROPOSED 24" WATERLINE CONCRETE ENCASEMENT
PROPOSED 12" GAS
PROPOSED Ę DITCH
Ę 1.00%
T.W. DEPTH = 3.1
45° BEND
50
45
40
STATION 131+74 POWERS BLVD
SCALE:
HORIZ 1" = 50'
VERT 1" = 5'
EXISTING GROUND
FINISHED GRADE
5' TYPE R SPECIAL INLET
Ę ELEV = 6248.40
43LF 18" CSP @1.07%
60" CMP
HYDRAULIC GRADE LINE
STA 131+69 POWERS BLVD
SCALE:
HORIZ 1" = 50'
VERT 1" = 5'



FOR PROFILE OF GALLEY ROAD, SEE SHEET 37
FOR INTERSECTION DETAIL SEE SHEET 41
FOR HORIZONTAL LOCATION OF STORM SEWER SEE SHEET 41
℄ STA 130+58.36
= ℄ STA 10+00 GA
Q100 = 27 CFS
Q5 = 15 CFS
V5 = 2.8 FPS
A = 5.0 AC.
130' EOS TO EOS
SLOPE EASEMENT
93' RT
93' LT.
18'
N 05°09'21" W
GALLEY RD.
SLOPE ESMT
ADJUST MH
46' EOP TO EOP EXISTING
SLOPE ESMT
EOS
LINE 2
227 LF 60" CSP SEE SHEET 44 FOR P
Q = 119.1 cfs
STA. 131 + 27.36
BEGIN MEDIAN
BEGIN TYPE 2, SECTION IB
132 + 70.
℄ PCR E SECTION
LINE 5
LINE 3
LINE 4
EL. 42.75
EL. 43.42
12" G
EL. 41.11
MH
131+79.87' R TYPE R SPECIAL INLET L:5' H: 3.5
130+13.51
155.00 RT
E 1/4 COR
REMOVE EX
ASPH
STA.128+50 T OF PROJECT
E. LINE SEC
W. LINE SEC
Q100 = 119 CFS
Q5 = 63 CFS
V = 4.0 FPS
A = 28.9 AC.
43 LF 18" CSP
SLOPE ESMT
132+33.19, 132.56
S 00°06'10" W
150.01'
TEMPORARY ASPHALT CURB
SLOPE EASEMENT
SLOPE ESMT
135+95.09, 147.30
NEW
2/4x4 VAULTS
R.O.W.
150'
12+19.50 63.93 LT.
℄ PCR
SLOPE ESMT
11+87.83, 93.00
SLOPE ESMT
24.08 63.75' RT.
PCR
FH

PROJECT: METEX

STORM SEWER NEAR GALLEY RD. INTERSECTION

DESIGNER: RA

DATE: 5-4-87

HYDROLOGIC AND CHANNEL INFORMATION

Q_1 = 62.7 cfs = Q_5 TW_1 = ______

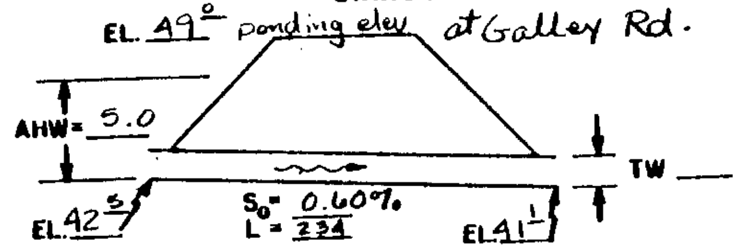
Q_2 = ~~119.1~~ cfs = Q_{100} TW_2 = 3.1

119.5

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 131+74



MEAN STREAM VELOCITY = ______

MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT.		OUTLET CONTROL $HW = H + h_o - LS_o$								CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
1 CSP w/FES	119.1	60"	1.0	5.0									5.0			OK

SUMMARY & RECOMMENDATIONS: See storm sewer calculations for hydraulic computations.

Figure 7

GALLEY

1JOB: CB METEX GALLEY INTERSECTION 60 INCH FOR 100 YR. WFH 4-1-87 KKBNA INC. CONSULTING ENGINEERS
8895. 2. 7 05/15/87 7:11 STORM

STORM DRAIN ANALYSIS PROGRAM

KKBNA VERSION 1.0
JUNE 06, 1983

(INPUT)

CD	L2	MAX Q	ADJ Q	LENGTH	FL 1	FL 2	CTL/TW	D	W	S	KJ	KE	KM	LC	L1	L3	L4	A1	A3	A4	J	N
2	2	120.0	120.0	225.00	41.10	42.33	0.00	60.	0.	3	0.00	0.00	0.00	1	3	5	0	0.	54.	0.	0.00	0.024
2	3	117.0	117.0	9.00	42.33	42.38	0.00	60.	0.	3	0.00	0.50	0.00	0	4	0	0	45.	0.	0.	0.00	0.024
2	4	117.0	117.0	14.00	42.38	42.46	49.38	60.	0.	1	0.00	0.50	0.00	0	0	0	0	0.	0.	0.	0.00	0.024
2	5	3.0	3.0	43.00	45.10	45.56	48.40	18.	0.	1	0.00	0.00	0.00	3	0	0	0	0.	0.	0.	0.00	0.024

STORM DRAIN ANALYSIS

LINE NO	Q (CFS)	D (IN)	W (IN)	DN (FT)	DC (FT)	FLOW TYPE	SF-FULL (FT/FT)	V 1 (FPS)	V 2 (FPS)	FL 1 (FT)	FL 2 (FT)	HG 1 CALC	HG 2 CALC	D 1 (FT)	D 2 (FT)	TW CALC	TW CK	REMARKS
1	HYDRAULIC GRADE LINE CONTROL = 43.50																	
2	120.0	60	0	5.00	3.12	PART	0.00723	9.3	6.7	41.10	42.33	44.22	46.63	3.12	4.30	0.00	0.00	
3	117.0	60	0	5.00	3.08	PART	0.00688	6.4	8.2	42.33	42.38	46.72	45.78	4.39	3.40	0.00	0.00	
4	117.0	60	0	5.00	3.08	PART	0.00688	6.6	8.0	42.38	42.46	46.59	45.93	4.21	3.47	47.44	49.38	

3 HYDRAULIC GRADE LINE CONTROL = 46.68

```
 5   3.0  18   0  0.76  0.66  SEAL  0.00278   1.7   2.0    45.10   45.56   46.68   46.77    1.58    1.21   46.83   48.40
        X =    9.54  X(N) =    0.00
```

1JOB: CB METEX GALLEY INTERSECTION 60 INCH FOR 100 YR. WFH 4-1-87 KKBNA INC, CONSULTING ENGINEERS

8895. 2. 7-- 05/15/87 7:11 STORM

EXPLANATION OF CODES

V 1, FL 1, D 1 AND HG 1 REFER TO DOWNSTREAM END
V 2, FL 2, D 2 AND HG 2 REFER TO UPSTREAM END
X - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE HG INTERSECTS SOFFIT IN SEAL CONDITION
X(N) - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE WATER SURFACE REACHES NORMAL DEPTH BY EITHER DRAWDOWN OR BACKWATER
X(J) - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE HYDRAULIC JUMP OCCURS IN LINE
F(J) - THE COMPUTED FORCE AT THE HYDRAULIC JUMP
D(BJ) - DEPTH OF WATER BEFORE THE HYDRAULIC JUMP (UPSTREAM SIDE)
D(AJ) - DEPTH OF WATER AFTER THE HYDRAULIC JUMP (DOWNSTREAM SIDE)
SEAL INDICATES FLOW CHANGES FROM PART TO FULL OR FROM FULL TO PART
HYD JUMP INDICATES THAT FLOW CHANGES FROM SUPERCRITICAL TO SUBCRITICAL THROUGH A HYDRAULIC JUMP
HJ @ UJT INDICATES THAT HYDRAULIC JUMP OCCURS AT THE JUNCTION AT THE UPSTREAM END OF THE LINE
HJ @ DJT INDICATES THAT HYDRAULIC JUMP OCCURS AT THE JUNCTION AT THE DOWNSTREAM END OF THE LINE

** END OF JOB ** 05/15/87 7:11

STA 136+79.69 Inlet + Storm Sewer

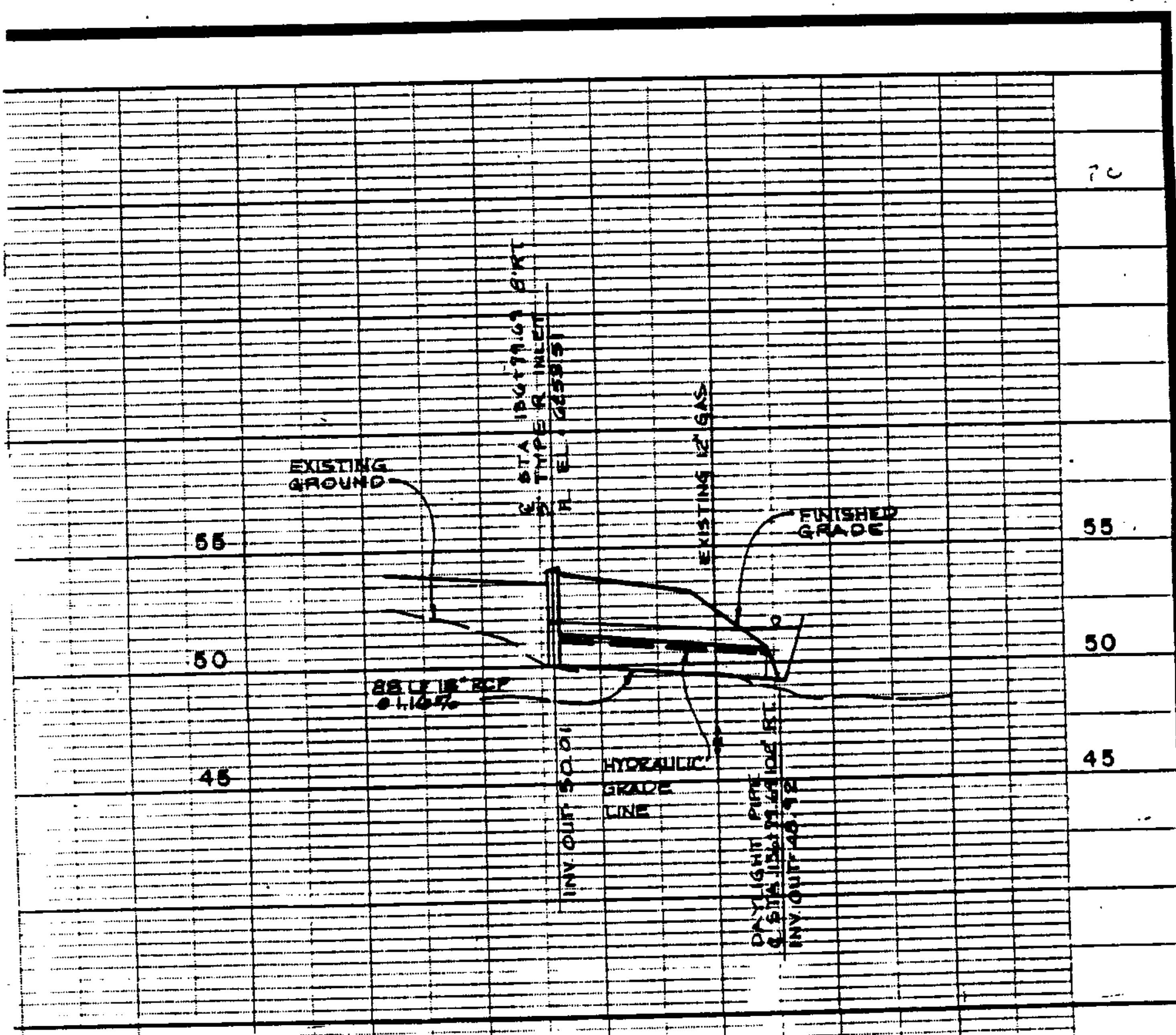
Basin M1:

$$Q_5 = 3.6 \text{ cfs}$$

$$Q_{100} = 8.0 \text{ cfs}$$

Flows are in the west median flowline of the roadway due to runoff from the superelevated section.

A five foot type 'R' Inlet collects flows into an 18" RCP pipe, which then discharges into the east ditch.

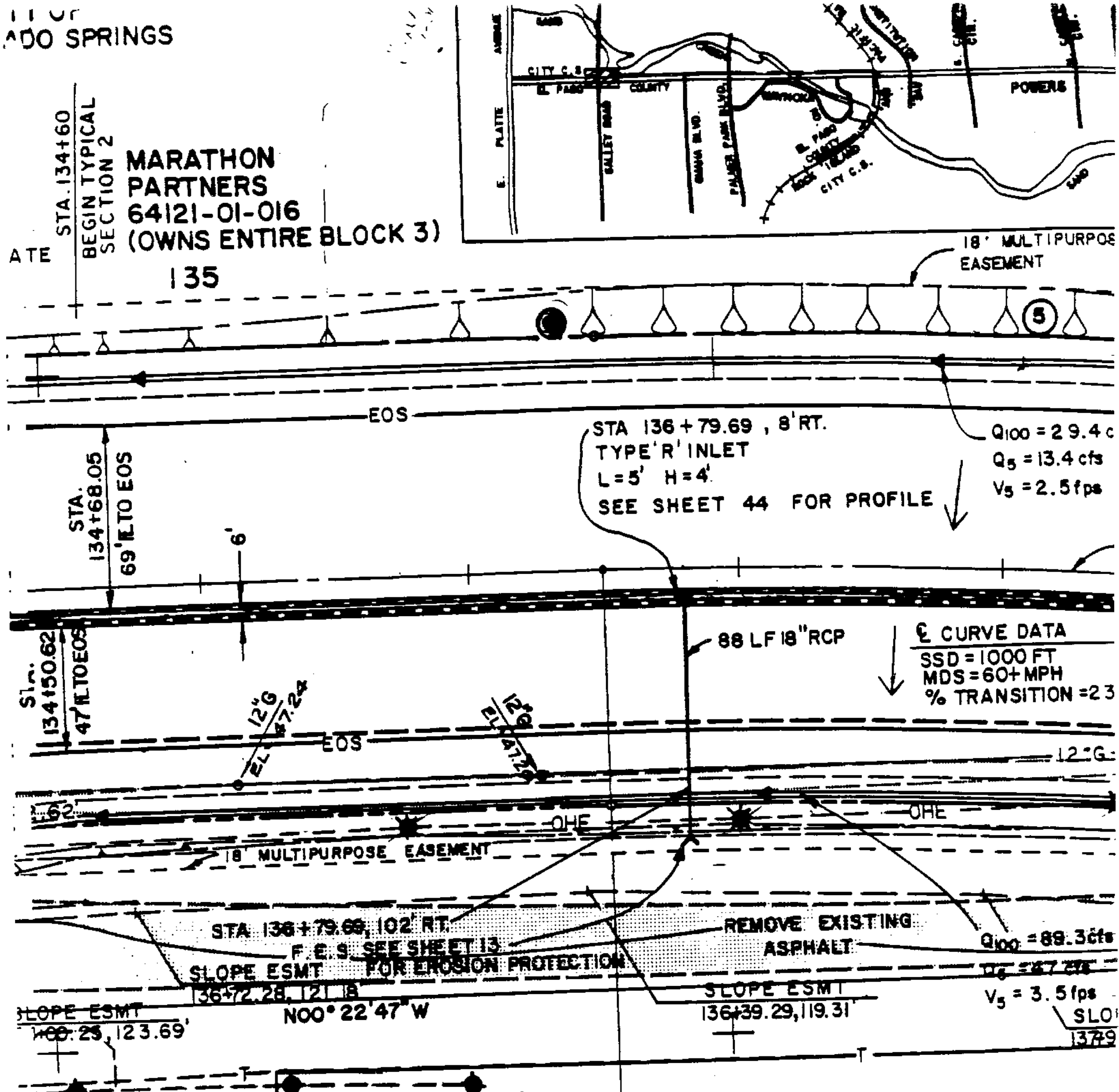


STATION 136+79.69 POWERS BLVD

SCALE:

HORIZ. 1" = 50'
VERT. 1" = 5'

...ADO SPRINGS



...ecifications were prepared under my direction
...iled plans and specifications have been
criteria established by the City for detailed
...cations, and said detailed plans and
...rmity with the master plan of the drainage
...nage plans and specifications meet the
...rticular drainage facility is designed. I
any liability caused by the negligent acts,
... part in preparation of the detailed drainage

EL PASO COUNTY

P. DALE BE...
54072-00-...

KKBNA assumes no responsibility for utility ...
on this drawing have been plotted from the be...
is, however, the contractors responsibility ...
all utilities prior to the commencement of ar...

1JOB: CB METEX BASIN M1 STA 136+79 - 5-YEAR 5-5-87 RA KKBNA INC, CONSULTING EN Page 1

1JOB: CB METEX BASIN M1 STA 136+79 - 5-YEAR 5-5-87 RA KKBNA INC, CONSULTING ENGINEERS
8895. 2. 7-- 05/05/87 13:56 STORM

STORM DRAIN ANALYSIS PROGRAM

KKBNA VERSION 1.0
JUNE 06, 1983

(INPUT)

CD	L2	MAX Q	ADJ Q	LENGTH	FL 1	FL 2	CTL/TW	D	W	S	KJ	KE	KM	LC	L1	L3	L4	A1	A3	A4	J	N
2	2	3.6	3.6	94.00	48.92	50.01	53.51	18.	0.	1	0.00	0.00	0.00	1	0	0	0	0.	0.	0.	0.00	0.013

STORM DRAIN ANALYSIS

LINE NO	Q (CFS)	D (IN)	W (IN)	DN (FT)	DC (FT)	FLOW TYPE	SF-FULL (FT/FT)	V 1 (FPS)	V 2 (FPS)	FL 1 (FT)	FL 2 (FT)	HG 1 CALC	HG 2 CALC	D 1 (FT)	D 2 (FT)	TW CALC	TW CK	REMARKS
1	HYDRAULIC GRADE LINE CONTROL = 50.92																	
2	3.6	18	0	0.58	0.72	SEAL	0.00117	2.0	3.1	48.92	50.01	50.92	50.95	2.00	0.94	51.10	53.51	

X = 47.98 X(N) = 0.00

EXPLANATION OF CODES

V 1, FL 1, D 1 AND HG 1 REFER TO DOWNSTREAM END
V 2, FL 2, D 2 AND HG 2 REFER TO UPSTREAM END
X - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE HG INTERSECTS SOFFIT IN SEAL CONDITION
X(N) - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE WATER SURFACE REACHES NORMAL DEPTH BY EITHER DRAWDOWN OR BACKWATER
X(J) - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE HYDRAULIC JUMP OCCURS IN LINE
F(J) - THE COMPUTED FORCE AT THE HYDRAULIC JUMP
D(BJ) - DEPTH OF WATER BEFORE THE HYDRAULIC JUMP (UPSTREAM SIDE)
D(AJ) - DEPTH OF WATER AFTER THE HYDRAULIC JUMP (DOWNSTREAM SIDE)
SEAL INDICATES FLOW CHANGES FROM PART TO FULL OR FROM FULL TO PART
HYD JUMP INDICATES THAT FLOW CHANGES FROM SUPERCRITICAL TO SUBCRITICAL THROUGH A HYDRAULIC JUMP

1JOB: CB METEX BASIN M1 STA 136+79 - 100-YEAR 5-5-87 RA KKBNA INC. CONSULTING ENGINEERS
8895. 2. 7 05/05/87 13:55 STORM

STORM DRAIN ANALYSIS PROGRAM

KKBNA VERSION 1.0
JUNE 06, 1983

(INPUT)

CD	L2	MAX Q	ADJ Q	LENGTH	FL 1	FL 2	CTL/TW	D	W	S	KJ	KE	KM	LC	L1	L3	L4	A1	A3	A4	J	N
2	2	8.0	8.0	94.00	48.92	50.01	53.51	18.	0.	1	0.00	0.00	0.00	1	0	0	0	0.	0.	0.	0.00	0.013

1JOB: CB METEX BASIN M1 STA 136+79 - 100-YEAR 5-5-87 RA KKBNA INC. CONSULTING ENGINEERS
8895. 2. 7 05/05/87 13:55 STORM
PAGE 2

STORM DRAIN ANALYSIS

LINE NO	Q (CFS)	D (IN)	W (IN)	DN (FT)	DC (FT)	FLOW TYPE	SF-FULL (FT/FT)	V 1 (FPS)	V 2 (FPS)	FL 1 (FT)	FL 2 (FT)	HG 1 CALC	HG 2 CALC	D 1 (FT)	D 2 (FT)	TW CALC	TW CK	REMARKS
1	HYDRAULIC GRADE LINE CONTROL = 51.42																	
2	8.0	18	0	0.93	1.10	FULL	0.00580	4.5	4.5	48.92	50.01	51.42	51.97	2.50	1.96	52.28	53.51	

1JOB: CB METEX BASIN M1 STA 136+79 - 100-YEAR 5-5-87 RA KKBNA INC. CONSULTING ENGINEERS
8895. 2. 7 05/05/87 13:55 STORM

EXPLANATION OF CODES

V 1, FL 1, D 1 AND HG 1 REFER TO DOWNSTREAM END
V 2, FL 2, D 2 AND HG 2 REFER TO UPSTREAM END
X - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE HG INTERSECTS SOFFIT IN SEAL CONDITION
X(N) - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE WATER SURFACE REACHES NORMAL DEPTH BY EITHER DRAWDOWN OR BACKWATER
X(J) - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE HYDRAULIC JUMP OCCURS IN LINE
F(J) - THE COMPUTED FORCE AT THE HYDRAULIC JUMP
D(BJ) - DEPTH OF WATER BEFORE THE HYDRAULIC JUMP (UPSTREAM SIDE)
D(AJ) - DEPTH OF WATER AFTER THE HYDRAULIC JUMP (DOWNSTREAM SIDE)
SEAL INDICATES FLOW CHANGES FROM PART TO FULL OR FROM FULL TO PART
HYD JUMP INDICATES THAT FLOW CHANGES FROM SUPERCRITICAL TO SUBCRITICAL THROUGH A HYDRAULIC JUMP

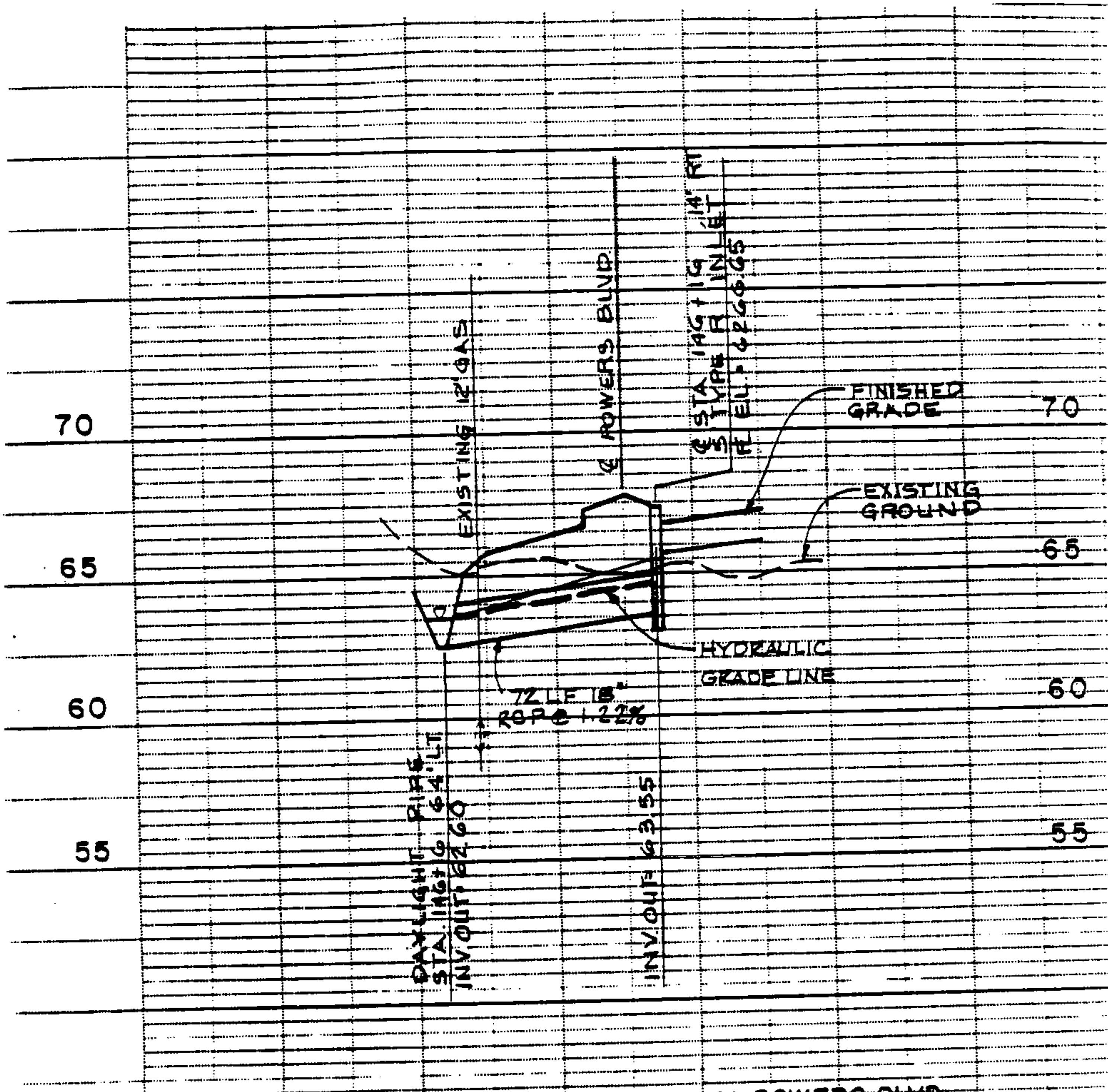
STA 146+16 Inlet + Storm Sewer

Basin M2:

$Q_5 = 3.8$ cfs
$Q_{100} = 8.4$ cfs

Flows are in the east median flowline of the roadway due to runoff from the superelevated section.

A five-foot Type 'R' Inlet collects flows into an 18" RCP pipe, which then discharges into the west ditch.

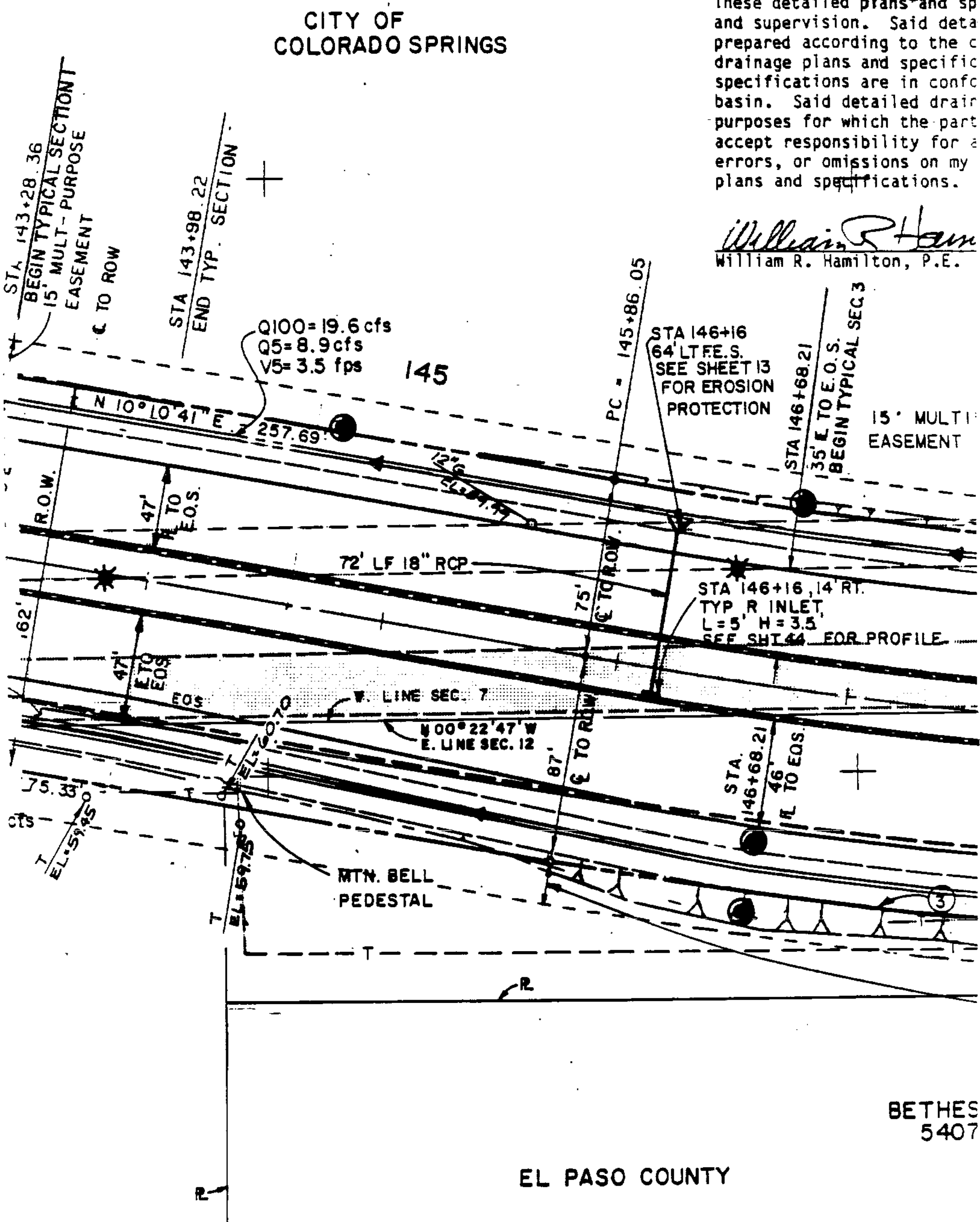


STATION 146+16.21 POWERS BLVD

SCALE:
HORIZ. 1" = 50'
VERT. 1" = 5'

These detailed plans and sp
and supervision. Said deta
prepared according to the c
drainage plans and specific
specifications are in confo
basin. Said detailed drair
purposes for which the part
accept responsibility for a
errors, or omissions on my
plans and specifications.

William R. Hamilton, P.E.



1JOB: CB METEX BASIN M2 STA 146+16 - 5-YEAR 5-5-87 RA KKBNA INC. CONSULTING ENGINEERS
8895. 2. 7-- 05/05/87 11:26 STORM

STORM DRAIN ANALYSIS PROGRAM

KKBNA VERSION 1.0
JUNE 06, 1983

(INPUT)

CD	L2	MAX Q	ADJ Q	LENGTH	FL 1	FL 2	CTL/TW	D	W	S	KJ	KE	KM	LC	L1	L3	L4	A1	A3	A4	J	N
2	2	3.8	3.8	78.00	62.60	63.55	66.65	18.	0.	1	0.00	0.00	0.00	1	0	0	0	0.	0.	0.	0.00	0.013

1JOB: CB METEX BASIN M2 STA 146+16 - 5-YEAR 5-5-87 RA KKBNA INC. CONSULTING ENGINEERS
8895. 2. 7-- 05/05/87 11:26 STORM
PAGE 2

STORM DRAIN ANALYSIS

LINE NO	Q (CFS)	D (IN)	W (IN)	DN (FT)	DC (FT)	FLOW TYPE	SF-FULL (FT/FT)	V 1 (FPS)	V 2 (FPS)	FL 1 (FT)	FL 2 (FT)	HG 1 CALC	HG 2 CALC	D 1 (FT)	D 2 (FT)	TW CALC	TW CK	REMARKS
1	HYDRAULIC GRADE LINE CONTROL = 63.35																	
2	3.8	18	0	0.59	0.74	PART	0.00131	5.9	4.3	62.60	63.55	63.19	64.29	0.59	0.74	64.59	66.65	

X = 0.00 X(N) = 35.78

1JOB: CB METEX BASIN M2 STA 146+16 - 5-YEAR 5-5-87 RA KKBNA INC. CONSULTING ENGINEERS
8895. 2. 7-- 05/05/87 11:26 STORM

EXPLANATION OF CODES

V 1, FL 1, D 1 AND HG 1 REFER TO DOWNSTREAM END
V 2, FL 2, D 2 AND HG 2 REFER TO UPSTREAM END
X - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE HG INTERSECTS SOFFIT IN SEAL CONDITION
X(N) - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE WATER SURFACE REACHES NORMAL DEPTH BY EITHER DRAWDOWN OR BACKWATER
X(J) - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE HYDRAULIC JUMP OCCURS IN LINE
F(J) - THE COMPUTED FORCE AT THE HYDRAULIC JUMP
D(BJ) - DEPTH OF WATER BEFORE THE HYDRAULIC JUMP (UPSTREAM SIDE)
D(AJ) - DEPTH OF WATER AFTER THE HYDRAULIC JUMP (DOWNSTREAM SIDE)
SEAL INDICATES FLOW CHANGES FROM PART TO FULL OR FROM FULL TO PART
HYD JUMP INDICATES THAT FLOW CHANGES FROM SUPERCRITICAL TO SUBCRITICAL THROUGH A HYDRAULIC JUMP

1JOB: CB METEX BASIN M2 STA 146+16 - 100-YEAR 5-5-87 RA KKBNA INC. CONSULTING EN PAGE 1

1JOB: CB METEX BASIN M2 STA 146+16 - 100-YEAR 5-5-87 RA KKBNA INC. CONSULTING ENGINEERS
8895. 2. 7-- 05/05/87 11:26 STORM

STORM DRAIN ANALYSIS PROGRAM

KKBNA VERSION 1.0
JUNE 06, 1983

(INPUT)

CD	L2	MAX Q	ADJ Q	LENGTH	FL 1	FL 2	CTL/TW	D	W	S	KJ	KE	KM	LC	L1	L3	L4	A1	A3	A4	J	N
2	2	8.4	8.4	78.00	62.60	63.55	66.65	18.	0.	1	0.00	0.00	0.00	1	0	0	0	0.	0.	0.	0.00	0.013

STORM DRAIN ANALYSIS

LINE NO	Q (CFS)	D (IN)	W (IN)	DN (FT)	DC (FT)	FLOW TYPE	SF-FULL (FT/FT)	V 1 (FPS)	V 2 (FPS)	FL 1 (FT)	FL 2 (FT)	HG 1 CALC	HG 2 CALC	D 1 (FT)	D 2 (FT)	TW CALC	TW CK	REMARKS
1	HYDRAULIC GRADE LINE CONTROL = 63.60																	
2	8.4	18	0	0.95	1.12	PART	0.00639	6.7	5.9	62.60	63.55	63.60	64.67	1.00	1.12	65.22	66.65	
	X = 0.00 X(N) = 32.15																	

EXPLANATION OF CODES

V 1, FL 1, D 1 AND HG 1 REFER TO DOWNSTREAM END
V 2, FL 2, D 2 AND HG 2 REFER TO UPSTREAM END
X - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE HG INTERSECTS SOFFIT IN SEAL CONDITION
X(N) - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE WATER SURFACE REACHES NORMAL DEPTH BY EITHER DRAWDOWN OR BACKWATER
X(J) - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE HYDRAULIC JUMP OCCURS IN LINE
F(J) - THE COMPUTED FORCE AT THE HYDRAULIC JUMP
D(BJ) - DEPTH OF WATER BEFORE THE HYDRAULIC JUMP (UPSTREAM SIDE)
D(AJ) - DEPTH OF WATER AFTER THE HYDRAULIC JUMP (DOWNSTREAM SIDE)
SEAL INDICATES FLOW CHANGES FROM PART TO FULL OR FROM FULL TO PART
HYD JUMP INDICATES THAT FLOW CHANGES FROM SUPERCRITICAL TO SUBCRITICAL THROUGH A HYDRAULIC JUMP

STA 157+37 - Storm Sewer at Omaha

- Basin S3 Flows to Storm Sewer:

$$\left.\begin{array}{l} Q_5 = 50.8 \text{ cfs} \\ Q_{100} = 95.1 \text{ cfs} \end{array}\right\rangle \text{SCS}$$

- Basin S3A is that portion of Basin S3 draining to the east ditch along Powers Blvd down to Omaha Blvd:

$$\left.\begin{array}{l} Q_5 = 11.4 \text{ cfs} \\ Q_{100} = 25.1 \text{ cfs} \end{array}\right\rangle \text{RATIONAL}$$

- Existing 36" RCP pipe carries 56 cfs of the total flow to Sand Creek (see text).

- Flow in street to Type 'R' Inlet:

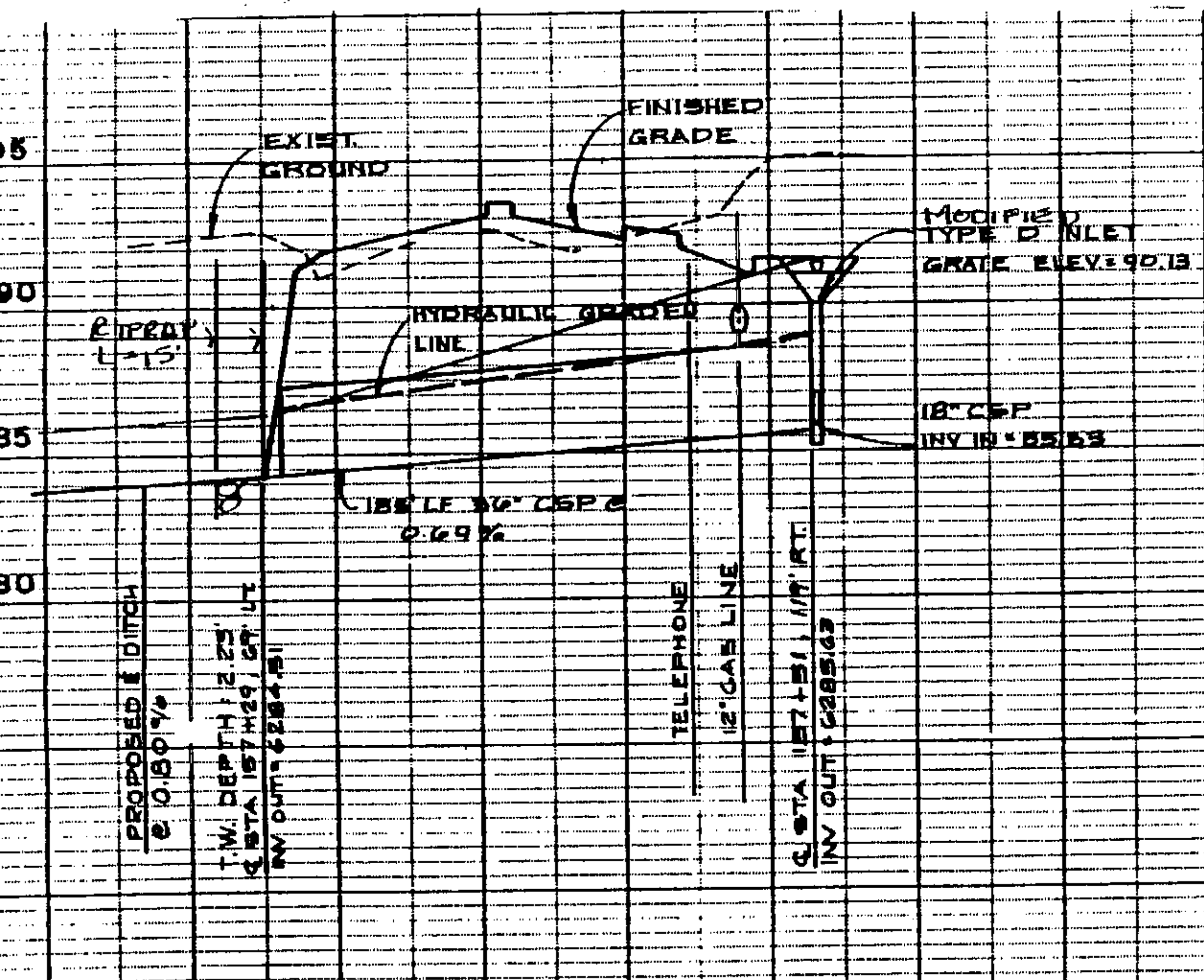
$$Q_5 = \sout{2.8}\ 3.4 \text{ cfs}$$
$$Q_{100} = \sout{6.2}\ 7.5 \text{ cfs}$$

- Flow to Type 'D' Inlet in east ditch:

$$Q_{100} = \underset{\text{SCS}}{95.1} - \underset{\text{SCS}}{56} - \underset{\text{RATIONAL}}{\sout{6.2}} = \sout{32.9} \text{ cfs}$$

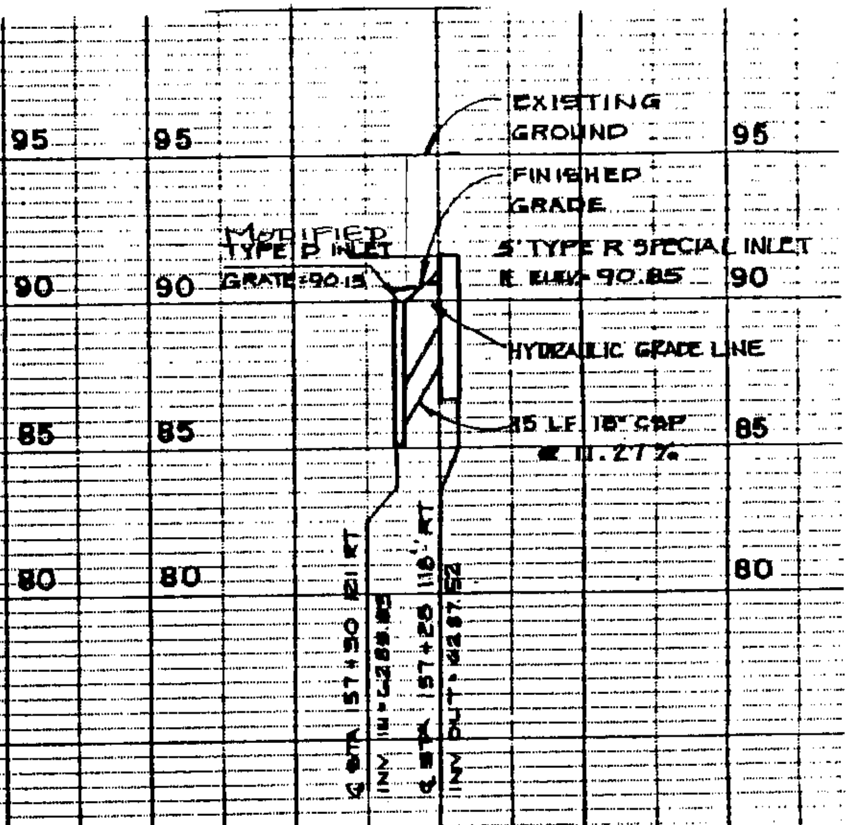
- Flow in proposed 36" CSP:

$$Q_{100} = \sout{32.9 + 6.2}\ 95.1 - 56.0 = 39.1 \text{ cfs}$$



STATION 157+37 POWERS BLVD

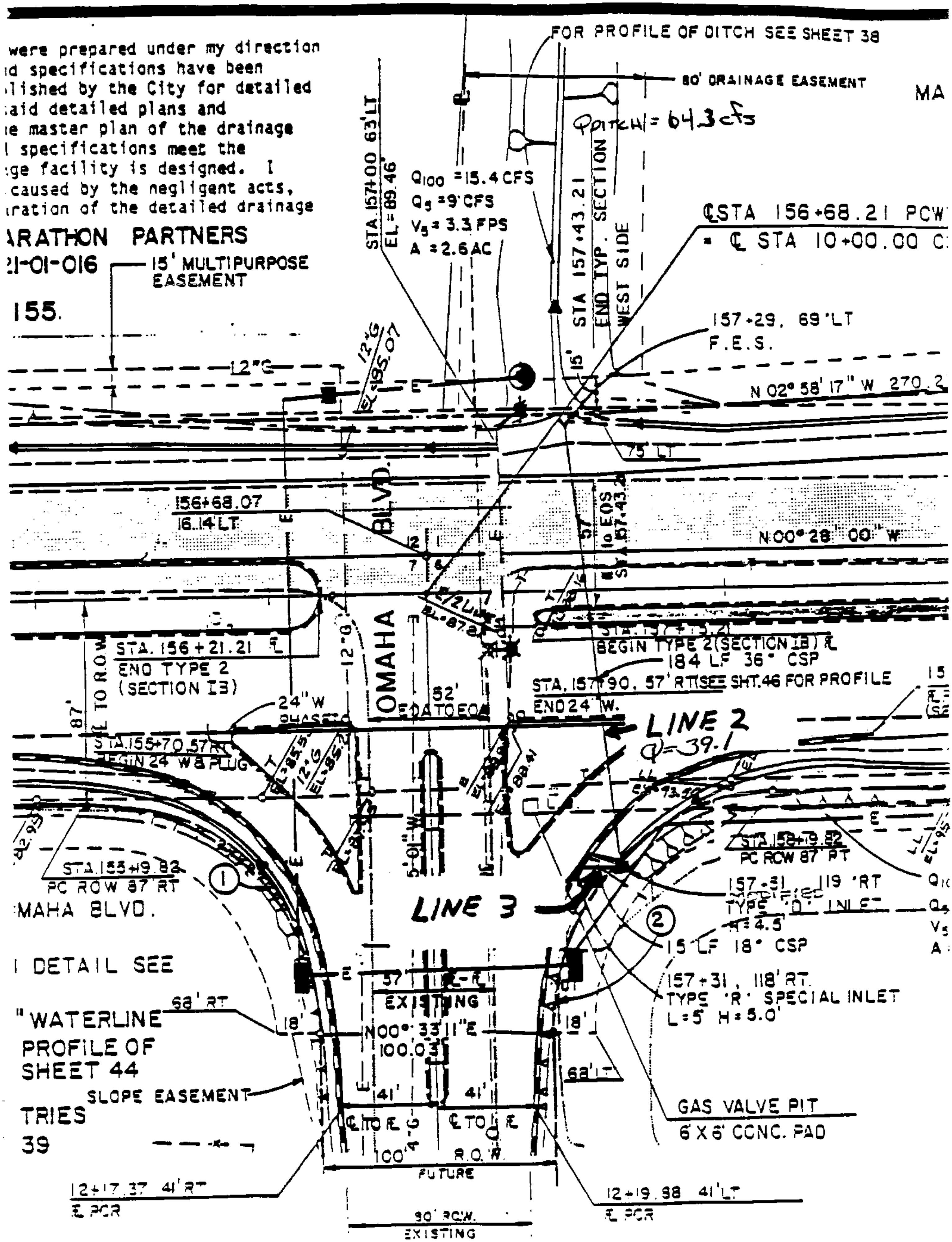
SCALE:
HORIZ 1" = 50'
VERT 1" = 5'



STATION 157+34 POWERS BLVD

SCALE:
HORIZ 1" = 50'
VERT 1" = 5'

were prepared under my direction
id specifications have been
lished by the City for detailed
said detailed plans and
e master plan of the drainage
specifications meet the
ge facility is designed. I
caused by the negligent acts,
ration of the detailed drainage



1JOB: CB METEX OMAHA INTERSECTION FOR 100 YR. RA 4-30-87 KKBNA INC. CONSULTING ENGINEERS
8895. 2. 46-- 05/01/87 15:27 STORM

STORM DRAIN ANALYSIS PROGRAM

KKBNA VERSION 1.0
JUNE 06, 1983

(INPUT)

CD	L2	MAX Q	ADJ Q	LENGTH	FL 1	FL 2	CTL/TW	D	W	S	KJ	KE	KM	LC	L1	L3	L4	A1	A3	A4	J	N
2	2	39.0	39.0	190.00	84.31	85.63	90.13	36.	0.	3	0.00	0.00	0.00	1	2	0	0	102.	0.	0.	0.00	0.024
2	3	6.2	6.2	15.00	85.83	87.52	90.85	18.	0.	1	0.00	0.00	0.00	0	0	0	0	0.	0.	0.	0.00	0.024

1JOB: CB METEX OMAHA INTERSECTION FOR 100 YR. RA 4-30-87 KKBNA INC. CONSULTING ENGINEERS
8895. 2. 46-- 05/01/87 15:27 STORM
PAGE 2

STORM DRAIN ANALYSIS

LINE NO	Q (CFS)	D (IN)	W (IN)	DN (FT)	DC (FT)	FLOW TYPE	SF-FULL (FT/FT)	V 1 (FPS)	V 2 (FPS)	FL 1 (FT)	FL 2 (FT)	HG 1 CALC	HG 2 CALC	D 1 (FT)	D 2 (FT)	TW CALC	TW CK	REMARKS
1	HYDRAULIC GRADE LINE CONTROL = 86.56																	
2	39.0	36	0	3.00	2.03	SEAL	0.01165	6.9	5.5	84.31	85.63	86.56	88.89	2.25	3.26	0.00	0.00	
	X = 134.39 X(N) = 0.00																	
3	6.2	18	0	0.59	0.96	FULL	0.01187	3.5	3.5	85.83	87.52	90.43	90.61	4.60	3.09	90.80	90.85	

1JOB: CB METEX OMAHA INTERSECTION FOR 100 YR. RA 4-30-87 KKBNA INC. CONSULTING ENGINEERS
8895. 2. 46-- 05/01/87 15:27 STORM

EXPLANATION OF CODES

V 1, FL 1, D 1 AND HG 1 REFER TO DOWNSTREAM END
V 2, FL 2, D 2 AND HG 2 REFER TO UPSTREAM END
X - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE HG INTERSECTS SOFFIT IN SEAL CONDITION
X(N) - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE WATER SURFACE REACHES NORMAL DEPTH BY EITHER DRAWDOWN OR BACKWATER
X(J) - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE HYDRAULIC JUMP OCCURS IN LINE
F(J) - THE COMPUTED FORCE AT THE HYDRAULIC JUMP

D(BJ) - DEPTH OF WATER BEFORE THE HYDRAULIC JUMP (UPSTREAM SIDE)
D(AJ) - DEPTH OF WATER AFTER THE HYDRAULIC JUMP (DOWNSTREAM SIDE)
SEAL INDICATES FLOW CHANGES FROM PART TO FULL OR FROM FULL TO PART
HYD JUMP INDICATES THAT FLOW CHANGES FROM SUPERCRITICAL TO SUBCRITICAL THROUGH A HYDRAULIC JUMP
HJ @ UJT INDICATES THAT HYDRAULIC JUMP OCCURS AT THE JUNCTION AT THE UPSTREAM END OF THE LINE
HJ @ DJT INDICATES THAT HYDRAULIC JUMP OCCURS AT THE JUNCTION AT THE DOWNSTREAM END OF THE LINE

** END OF JOB ** 05/01/87 15:27

PALMER PARK STORM SEWER

2- 38"x24" RCP

Basin S4:
(See SCS Peak Flow Calculations)

Q_{100} = 71.4 cfs
t_c = 12.5 min
} SCS

Inlet Subbasin (Portion of Basin S4)

(See Palmer Park Inlet Calculations)

t_c = ~~6.3~~ 5.0 min Q_{100} = ~~27.8~~ 30.8 cfs } RATIONAL
C = 0.74

Scenario 1:

Early Peak - During the early peak (6.3 min) the total Basin S4 flow ≈ 50 cfs. At this time 27.8 cfs is in the street, therefore 50 - 27.8 = 22.2 cfs is in the ditch at this time.

All 22.2 cfs will enter into one culvert due to backwater in the second culvert from the inlet flows.

(see attached storm sewer calculations)

The hydraulic grade calculated at the inlet = 17.85', therefore the total drop is FE 18.10 - 17.85 = 0.25' during the 100-year storm.

✓

Scenario 2:

Late Peak: During the later peak the total basin S4 flow = 71.4 cfs, while the portion in the inlet has dropped to 21.7 cfs. Therefore the flow at the culvert opening is 71.4 - 21.7 = 49.7 cfs

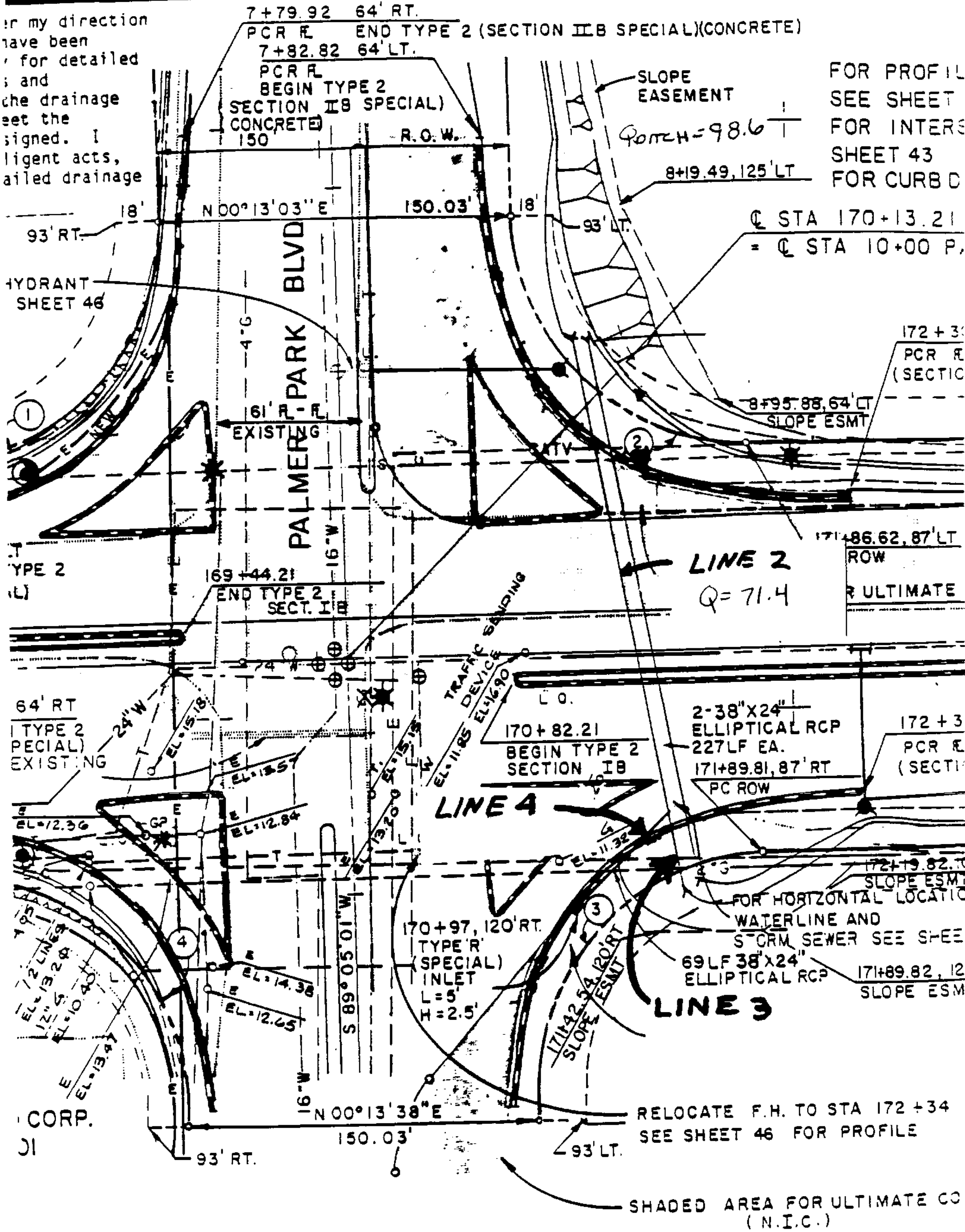
$Q_{100\ BASIN} = 71.4$ cfs

$Q_{100\ INLET} = \underset{C}{0.74(1.25)}(\underset{I}{6.4})(\underset{A}{3.66}) = 21.7$ cfs

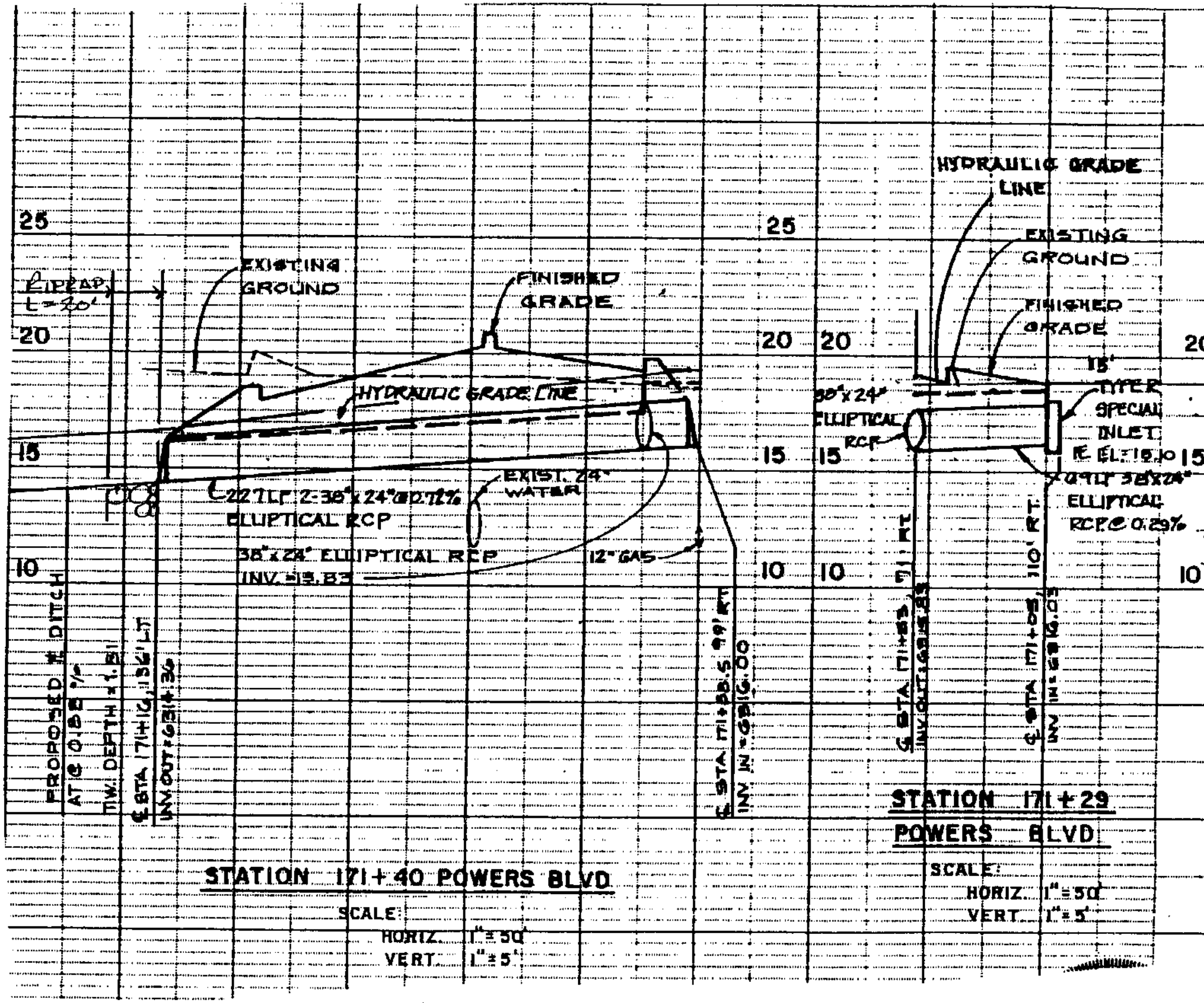
$Q_{100\ CULVERT} = 71.4 - 21.7 = 49.7$ cfs

By balancing the headwater at the two culverts, the flow into the "storm sewer" culvert = 14.0 cfs, while the flow into the second culvert = 35.7 cfs (See storm sewer calculations).

The hydraulic grade calculated at the inlet = 18.51'. As the flowline elevation at the inlet = 18.10, this yields 18.51 - 18.10 = 0.41' or five inches of ponding at flowline during the 100-year storm.



r my direction
have been
for detailed
s and
the drainage
eet the
signed. I
ligent acts,
ailed drainage
7+79.92 64' RT.
PCR ℄ END TYPE 2 (SECTION IIB SPECIAL)(CONCRETE)
7+82.82 64' LT.
PCR ℄
BEGIN TYPE 2
SECTION IIB SPECIAL)
CONCRETE)
150
R.O.W.
SLOPE EASEMENT
Qonch = 98.6
FOR PROFIL
SEE SHEET
FOR INTERS
SHEET 43
FOR CURB D
8+19.49, 125' LT
18'
N 00°13'03"E
150.03'
18'
93' RT.
93' LT.
℄ STA 170+13.21
= ℄ STA 10+00 P.
HYDRANT
SHEET 46
PALMER PARK BLVD
4"G
61' ℄-℄
EXISTING
172+3
PCR ℄
(SECTIO
8+95.88, 64' LT
SLOPE ESMT
16"W
171+86.62, 87' LT
ROW
LINE 2
Q = 71.4
ULTIMATE
169+44.21
END TYPE 2
SECT. IB
LT
TYPE 2
L)
TRAFFIC SENSING DEVICE
EL=16.90
EL=11.95
64' RT
TYPE 2
PECIAL)
EXISTING
24"W
EL=15.18
EL=13.57
EL=15.13
L O.
170+82.21
BEGIN TYPE 2
SECTION IB
2-38"X24"
ELLIPTICAL RCP
227LF EA.
171+89.81, 87' RT
PC ROW
172+3
PCR ℄
(SECTI
LINE 4
EL=12.36
GP
EL=12.84
EL=13.20
EL=11.38
172+19.82
SLOPE ESMT
FOR HORIZONTAL LOCATIO
WATERLINE AND
STORM SEWER SEE SHEE
S 89°05'01"W
170+97, 120' RT.
TYPE 'R'
(SPECIAL)
INLET
L=5'
H=2.5'
69LF 38"X24"
ELLIPTICAL RCP
171+89.82, 12
SLOPE ESM
171+42.54, 120' RT
SLOPE ESMT
LINE 3
EL=14.38
EL=12.65
EL=13.47
EL=10.4
12"
EL=13.24
CORP.
01
N 00°13'38"E
150.03'
93' RT.
93' LT.
RELOCATE F.H. TO STA 172+34
SEE SHEET 46 FOR PROFILE
SHADED AREA FOR ULTIMATE CO
(N.I.C.)



HYDRAULIC GRADE LINE
EXISTING GROUND
FINISHED GRADE
RIPRAP, L=30'
HYDRAULIC GRADE LINE
227 LF 2-38"x24" @0.72% ELLIPTICAL RCP
EXIST. 24" WATER
38"x24" ELLIPTICAL RCP INV =13.83
12" GAS
PROPOSED ℄ DITCH AT @ 0.58 %
T.W. DEPTH = 1.81
℄ STA 171+16, 136' LT
INV OUT = 614.36
℄ STA 171+38.5, 99' RT
INV IN = 616.00
STATION 171+40 POWERS BLVD
SCALE:
HORIZ. 1" = 50'
VERT. 1" = 5'
38"x24" ELLIPTICAL RCP
15' TYPE R SPECIAL INLET
℄ EL=19.10
29 LF 38"x24" ELLIPTICAL RCP @ 0.29%
℄ STA 171+35, 71' RT
INV OUT = 615.85
℄ STA 171+05, 110' RT
INV IN = 616.05
STATION 171+29 POWERS BLVD
SCALE:
HORIZ. 1" = 50'
VERT. 1" = 5'
25
20
15
10

From BPR

11-15-68
Denver Regional Council of Governments

FIGURE 4-4. DESIGN COMPUTATION FORM FOR CULVERTS

PROJECT: METEX

DESIGNER: RA

DATE: 4-24-87

HYDROLOGIC AND CHANNEL INFORMATION

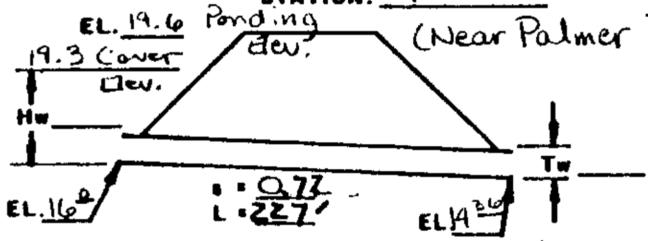
Basin S4 Q_{100} = 71.4 cfs
-Culvert below Powers at Palmer Park Rd.

Q_{100} = Q_1 = 71.4 cfs TAILWATER ELEVATION = 2.0
Q_2 = ______ TAILWATER ELEVATION = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 171+40 (Near Palmer Park)



MEAN STREAM VELOCITY = ______
MAX. STREAM VELOCITY = ______
$\frac{L}{100s}$ = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. Hw/D	INLET CONT. Hw	OUTLET CONTROL HW = H + h_o − Ls: K_e	H	d_c	$\frac{d_c+D}{2}$	Tw	h_o	Ls	Hw	CHART No.	CHART Hw	CONTROLLING Hw	OUTLET VELOCITY	COST	COMMENTS
2 RCP w/FES	35.7	38x24 ell.	1.7 ~~1.5~~	3.4 ~~3.0~~	0.5	2.6 ~~2.7~~	1.7	1.85	2.3 ~~1.5~~	2.3 ~~1.85~~	1.64	3.3 ~~2.9~~			3.4 3.0			
CHECK STORM SEWER SCENARIOS 1 + 2																		
~~1 RCP w/FES~~	~~[illegible]~~	~~38x24 ell.~~	~~1.0~~	~~2.0~~	~~0.5~~	~~1.0~~	~~1.4~~	~~1.7~~	~~1.3~~	~~1.7~~	~~1.64~~	~~1.06~~	—	—	~~2.0~~	—	✓	~~Scenario 1~~
1 RCP w/FES	49.7	38x24 ellip.	2.0	4.0	0.5	5.0	2.0	~~2.0~~	~~2.0~~	~~2.0~~	~~1.6~~	~~5.4~~	—	—	5.4	—	—	—

SUMMARY & RECOMENDATIONS: See Storm Sewer Calculations for Additional Info.

Ditch must be graded to shoulder elevation for HW ponding.

Approx. 5" of flooding on the roadway flowline will occur during the 100-year event.

1JOB: CB METEX - PALMER PARK STORM SEWER SYSTEM 4-24-87 RA KKBNA INC, CONSULTING EN Page 1

1JOB: CB METEX - PALMER PARK STORM SEWER SYSTEM 4-24-87 RA KKBNA INC, CONSULTING ENGINEERS
8895. 2. 7-- 04/27/87 15:17 STORM

SCENARIO 1

STORM DRAIN ANALYSIS PROGRAM

KKBNA VERSION 1.0
JUNE 06, 1983

(INPUT)

CD	L2	MAX Q	ADJ Q	LENGTH	FL 1	FL 2	CTL/TW	D	W	S	KJ	KE	KM	LC	L1	L3	L4	A1	A3	A4	J	N
2	2	27.8	27.8	207.00	14.36	15.83	0.00	24.	30.	3	0.00	0.00	0.00	1	3	4	0	0.	60.	0.	0.00	0.013
2	3	0.1	0.1	20.00	15.83	16.00	19.50	24.	30.	1	0.00	0.00	0.00	0	0	0	0	0.	0.	0.	0.00	0.013
2	4	27.8	27.8	69.00	15.83	16.27	0.00	24.	30.	1	0.00	0.00	0.00	3	0	0	0	0.	0.	0.	0.00	0.013

1JOB: CB METEX - PALMER PARK STORM SEWER SYSTEM 4-24-87 RA KKBNA INC, CONSULTING ENGINEERS
8895. 2. 7-- 04/27/87 15:17 STORM
PAGE 2

STORM DRAIN ANALYSIS

LINE NO	Q (CFS)	D (IN)	W (IN)	DN (FT)	DC (FT)	FLOW TYPE	SF-FULL (FT/FT)	V 1 (FPS)	V 2 (FPS)	FL 1 (FT)	FL 2 (FT)	HG 1 CALC	HG 2 CALC	D 1 (FT)	D 2 (FT)	TW CALC	TW CK	REMARKS
1	HYDRAULIC GRADE LINE CONTROL = 15.70																	
2	27.8	24	30	1.49	1.56	PART	0.00518	7.5	7.1	14.36	15.83	15.85	17.39	1.49	1.56	0.00	0.00	
	X = 0.00 X(N) = 193.94																	
3	0.1	24	30	0.03	0.04	FULL	0.00000	0.0	0.0	15.83	16.00	18.23	18.23	2.40	2.23	18.23	19.50	
3	HYDRAULIC GRADE LINE CONTROL = 17.81																	
4	27.8	24	30	1.56	1.56	PART	0.00518	5.6	7.0	15.83	16.27	17.81	17.85	1.98	1.58	18.62	0.00	
	X = 0.00 X(N) = 67.22																	

1JOB: CB METEX - PALMER PARK STORM SEWER SYSTEM 4-24-87 RA KKBNA INC, CONSULTING ENGINEERS
8895. 2. 7-- 04/27/87 15:17 STORM

EXPLANATION OF CODES

V 1, FL 1, D 1 AND HG 1 REFER TO DOWNSTREAM END
V 2, FL 2, D 2 AND HG 2 REFER TO UPSTREAM END
X - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE HG INTERSECTS SOFFIT IN SEAL CONDITION
X(N) - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE WATER SURFACE REACHES NORMAL DEPTH BY EITHER DRAWDOWN OR BACKWATER
X(J) - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE HYDRAULIC JUMP OCCURS IN LINE
F(J) - THE COMPUTED FORCE AT THE HYDRAULIC JUMP
D(BJ) - DEPTH OF WATER BEFORE THE HYDRAULIC JUMP (UPSTREAM SIDE)
D(AJ) - DEPTH OF WATER AFTER THE HYDRAULIC JUMP (DOWNSTREAM SIDE)
SEAL INDICATES FLOW CHANGES FROM PART TO FULL OR FROM FULL TO PART
HYD JUMP INDICATES THAT FLOW CHANGES FROM SUPERCRITICAL TO SUBCRITICAL THROUGH A HYDRAULIC JUMP
HJ @ UJT INDICATES THAT HYDRAULIC JUMP OCCURS AT THE JUNCTION AT THE UPSTREAM END OF THE LINE
HJ @ DJT INDICATES THAT HYDRAULIC JUMP OCCURS AT THE JUNCTION AT THE DOWNSTREAM END OF THE LINE

** END OF JOB ** 04/27/87 15:17

1JOB: CB METEX - PALMER PARK STORM SEWER SYSTEM 4-24-87 RA KKBNA INC. CONSULTING ENGINEERS
8895. 2. 46-- 05/01/87 15:34 STORM

STORM DRAIN ANALYSIS PROGRAM

SCENARIO 2

KKBNA VERSION 1.0
JUNE 06, 1983

(INPUT)

CD	L2	MAX Q	ADJ Q	LENGTH	FL 1	FL 2	CTL/TW	D	W	S	KJ	KE	KM	LC	L1	L3	L4	A1	A3	A4	J	N
2	2	35.7	35.7	207.00	14.36	15.83	0.00	24.	30.	3	0.00	0.20	0.00	1	3	4	0	0.	60.	0.	0.00	0.013
2	3	14.0	14.0	20.00	15.83	16.00	19.50	24.	30.	1	0.00	0.20	0.00	0	0	0	0	0.	0.	0.	0.00	0.013
2	4	21.7	21.7	69.00	15.83	16.03	0.00	24.	30.	1	0.00	0.20	0.00	3	0	0	0	0.	0.	0.	0.00	0.013

1JOB: CB METEX - PALMER PARK STORM SEWER SYSTEM 4-24-87 RA KKBNA INC. CONSULTING ENGINEERS
8895. 2. 46-- 05/01/87 15:34 STORM

STORM DRAIN ANALYSIS

LINE NO	Q (CFS)	D (IN)	W (IN)	DN (FT)	DC (FT)	FLOW TYPE	SF-FULL (FT/FT)	V 1 (FPS)	V 2 (FPS)	FL 1 (FT)	FL 2 (FT)	HG 1 CALC	HG 2 CALC	D 1 (FT)	D 2 (FT)	TW CALC	TW CK	REMARKS
1	HYDRAULIC GRADE LINE CONTROL = 15.70																	
2	35.7	24	30	1.81	1.85	PART	0.00854	7.9	7.7	14.36	15.83	16.17	17.68	1.81	1.85	0.00	0.00	
	X = 0.00 X(N) = 200.89																	
3	14.0	24	30	0.84	0.99	FULL	0.00131	2.8	2.8	15.83	16.00	18.90	18.97	3.07	2.97	19.04	19.50	
3	HYDRAULIC GRADE LINE CONTROL = 18.29																	
4	21.7	24	30	1.74	1.33	FULL	0.00316	4.3	4.3	15.83	16.03	18.29	18.51 Tailwater at Inlet	2.46	2.48	18.86	0.00	

1JOB: CB METEX - PALMER PARK STORM SEWER SYSTEM 4-24-87 RA KKBNA INC. CONSULTING ENGINEERS
8895. 2. 46-- 05/01/87 15:34 STORM

EXPLANATION OF CODES

```
V 1, FL 1, D 1 AND HG 1  REFER TO DOWNSTREAM END
V 2, FL 2, D 2 AND HG 2  REFER TO UPSTREAM END
X      - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE HG INTERSECTS SOFFIT IN SEAL CONDITION
X(N)   - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE WATER SURFACE REACHES NORMAL DEPTH BY EITHER DRAWDOWN OR BACKWATER
X(J)   - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE HYDRAULIC JUMP OCCURS IN LINE
F(J)   - THE COMPUTED FORCE AT THE HYDRAULIC JUMP
D(BJ)  - DEPTH OF WATER BEFORE THE HYDRAULIC JUMP (UPSTREAM SIDE)
D(AJ)  - DEPTH OF WATER AFTER THE HYDRAULIC JUMP (DOWNSTREAM SIDE)
SEAL INDICATES FLOW CHANGES FROM PART TO FULL OR FROM FULL TO PART
HYD JUMP INDICATES THAT FLOW CHANGES FROM SUPERCRITICAL TO SUBCRITICAL THROUGH A HYDRAULIC JUMP
HJ @ UJT INDICATES THAT HYDRAULIC JUMP OCCURS AT THE JUNCTION AT THE UPSTREAM END OF THE LINE
HJ @ DJT INDICATES THAT HYDRAULIC JUMP OCCURS AT THE JUNCTION AT THE DOWNSTREAM END OF THE LINE
```

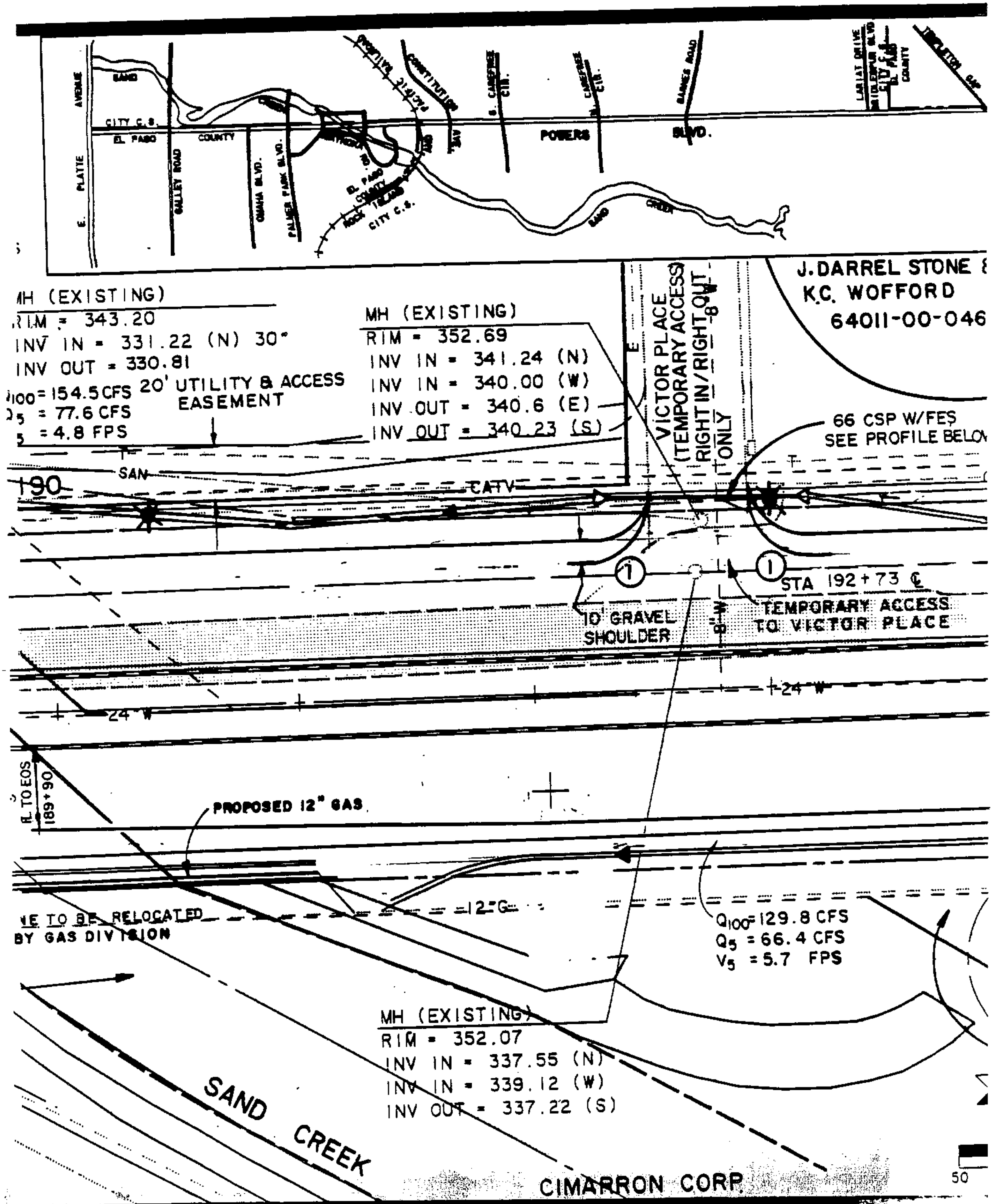
** END OF JOB **   05/01/87   15:34

STA 192+73 Culvert at Victor Place

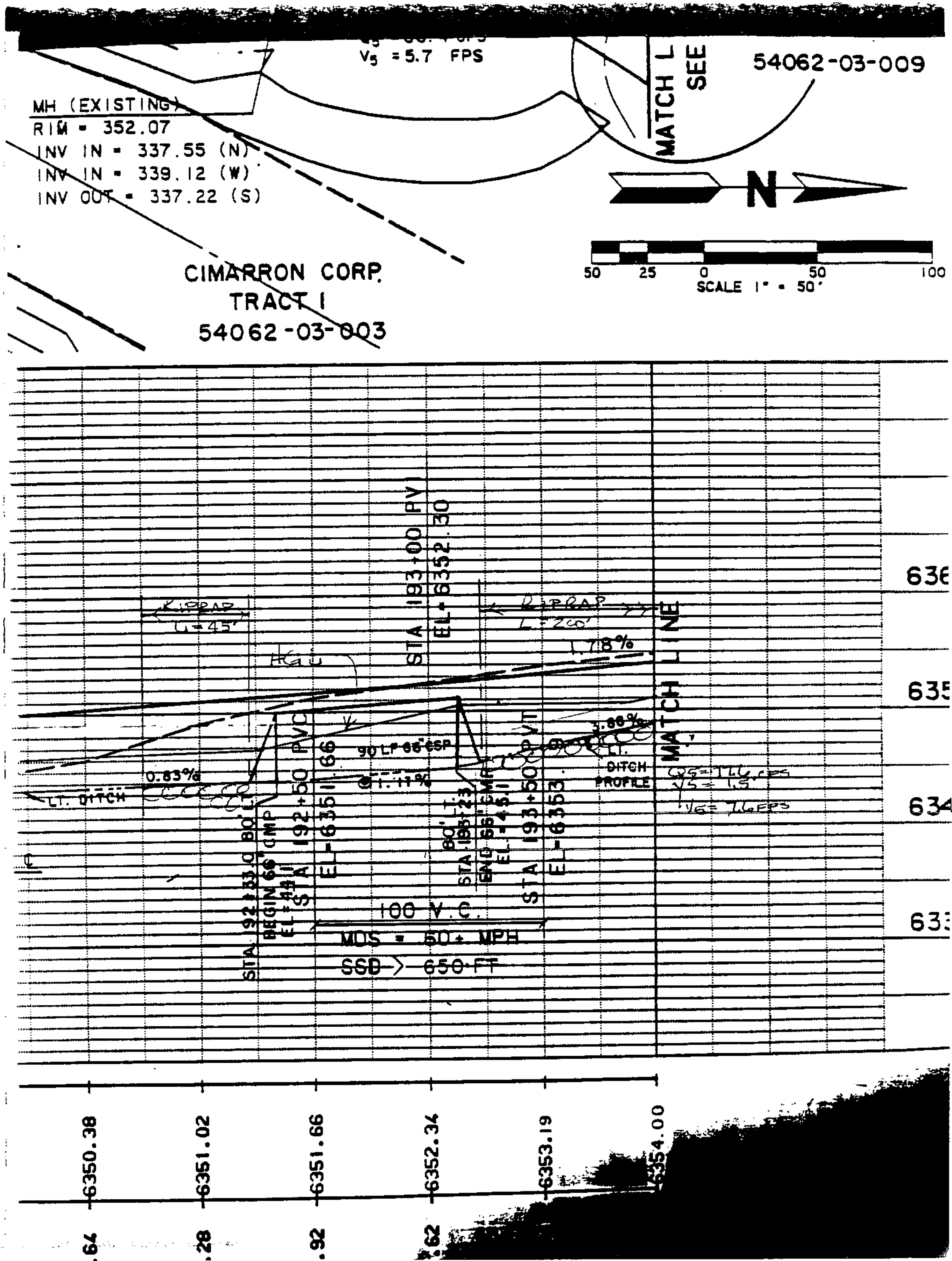
Ditch flow in west ditch from
Basins S7, S7A, S8, S8A:

Q_5 = 77.6 cfs
Q_{100} = 154.5 cfs

One 66" CSP will carry the flows below Victor Place without inundating either Victor Place or Powers Blvd.



AVENUE
SAND
CITY C.S.
EL PASO COUNTY
E. PLATTE
GALLEY ROAD
OMAHA BLVD.
PALMER PARK BLVD.
CONSTITUTION
POWERS BLVD.
BARNES ROAD
SAND CREEK
LARIAT DRIVE
TEMPLETON GAP
J.DARREL STONE &
K.C. WOFFORD
64011-00-046
MH (EXISTING)
RIM = 343.20
INV IN = 331.22 (N) 30"
INV OUT = 330.81
Q100 = 154.5 CFS
Q5 = 77.6 CFS
V5 = 4.8 FPS
20' UTILITY & ACCESS EASEMENT
MH (EXISTING)
RIM = 352.69
INV IN = 341.24 (N)
INV IN = 340.00 (W)
INV OUT = 340.6 (E)
INV OUT = 340.23 (S)
VICTOR PLACE (TEMPORARY ACCESS) RIGHT IN/RIGHT OUT ONLY
8" W
66 CSP W/FES SEE PROFILE BELOW
SAN
190
CATV
10' GRAVEL SHOULDER
STA 192+73 ℄
TEMPORARY ACCESS TO VICTOR PLACE
24" W
℄ TO EOS 189+90
PROPOSED 12" GAS
12" G
LINE TO BE RELOCATED BY GAS DIVISION
Q100 = 129.8 CFS
Q5 = 66.4 CFS
V5 = 5.7 FPS
MH (EXISTING)
RIM = 352.07
INV IN = 337.55 (N)
INV IN = 339.12 (W)
INV OUT = 337.22 (S)
SAND CREEK
CIMARRON CORP.
50



V5 = 5.7 FPS
MATCH L SEE
54062-03-009
MH (EXISTING)
RIM = 352.07
INV IN = 337.55 (N)
INV IN = 339.12 (W)
INV OUT = 337.22 (S)
N
50 25 0 50 100
SCALE 1" = 50'
CIMARRON CORP.
TRACT I
54062-03-003
STA 193+00 PVI
EL=6352.30
RIPRAP
L=45'
RIPRAP
L=200'
1.78%
HGL
MATCH LINE
636
635
634
633
3.88%
0.83%
LT. DITCH
90 LF 66" CSP
@ 1.17%
LT. DITCH PROFILE
STA 192+33.0 80' LT
BEGIN 66" CMP
STA 192+50 PVC
EL=6351.66
80' LT
STA 193+23
END 66" CMP
STA 193+50 PVT
EL=6353.
100 V.C.
MDS = 50+ MPH
SSD > 650 FT
6350.38
6351.02
6351.66
6352.34
6353.19
6354.00
.64
.28
.92
.62

PROJECT: METEX
VICTOR PLACE - TEMP CROSSING

DESIGNER: JAF
DATE: 5/13/87

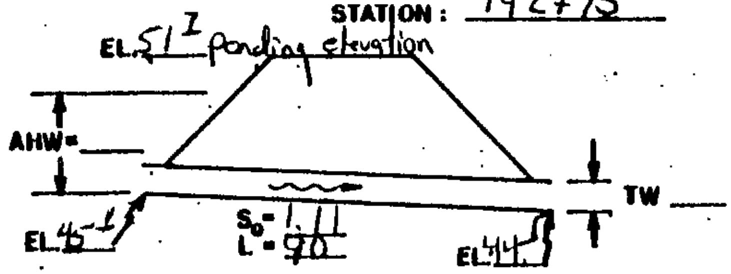
HYDROLOGIC AND CHANNEL INFORMATION

Q_1 = 77.6 cfs (Q25) TW_1 = ______
Q_2 = 154.5 cfs (Q100) TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 192+75



MEAN STREAM VELOCITY = ______
MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. HW/D	INLET CONT. HW	OUTLET CONTROL HW=H+h_o−LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
CSP w/FES	77.6	66"	0.55	3.0	—	0.4	2.5	4.0	—	4.0	1.0	3.4	3.4	-		
CSP w/FES	154.5	66"	0.98 0.95	5.4 5.2	0.5	1.75 2.2	3.45 3.2	4.48 4.35	2.4	4.48 4.35	1.0	5.2 5.6	5.4 5.6			
									[illegible]	[illegible]	83%					

SUMMARY & RECOMMENDATIONS:

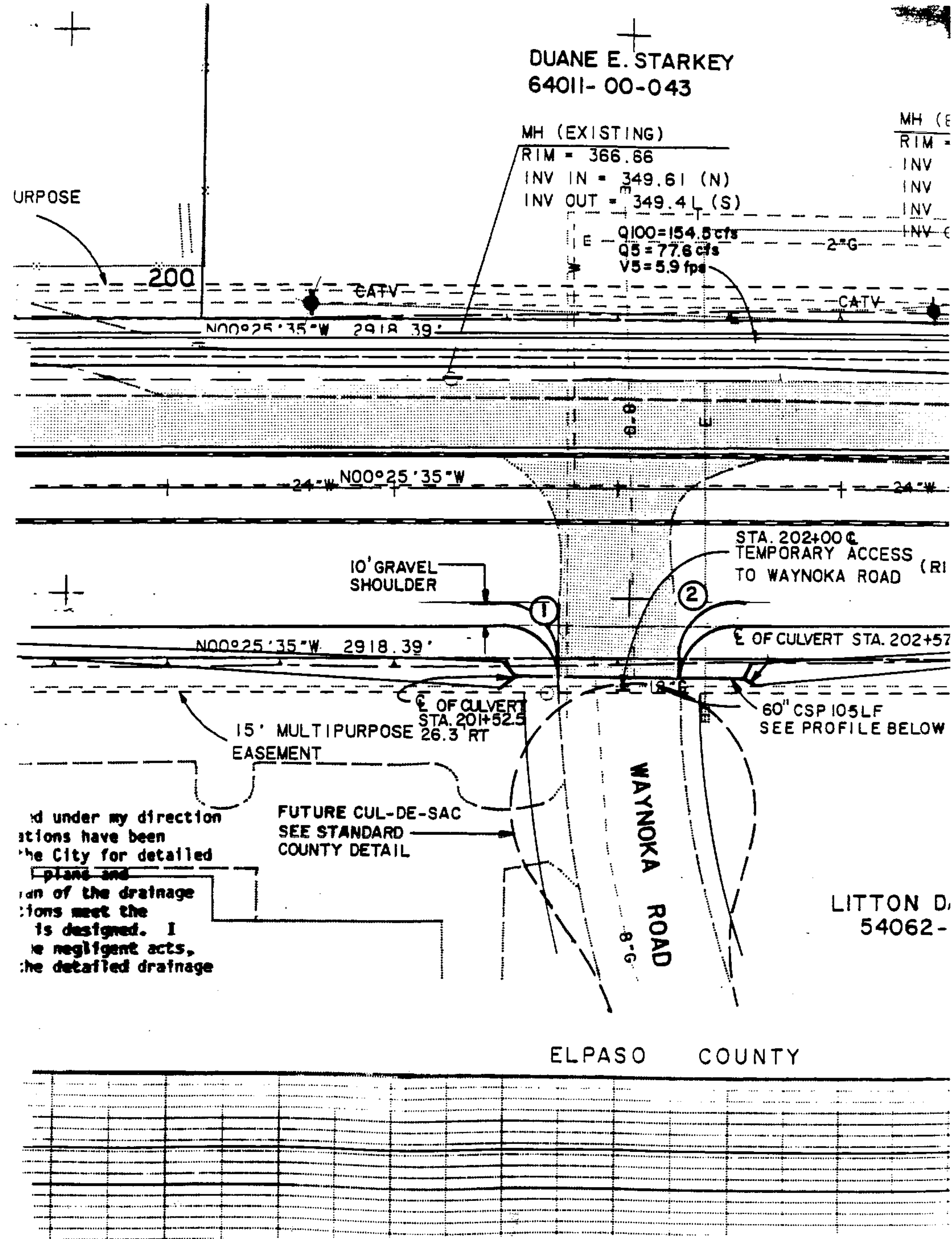
Figure 7

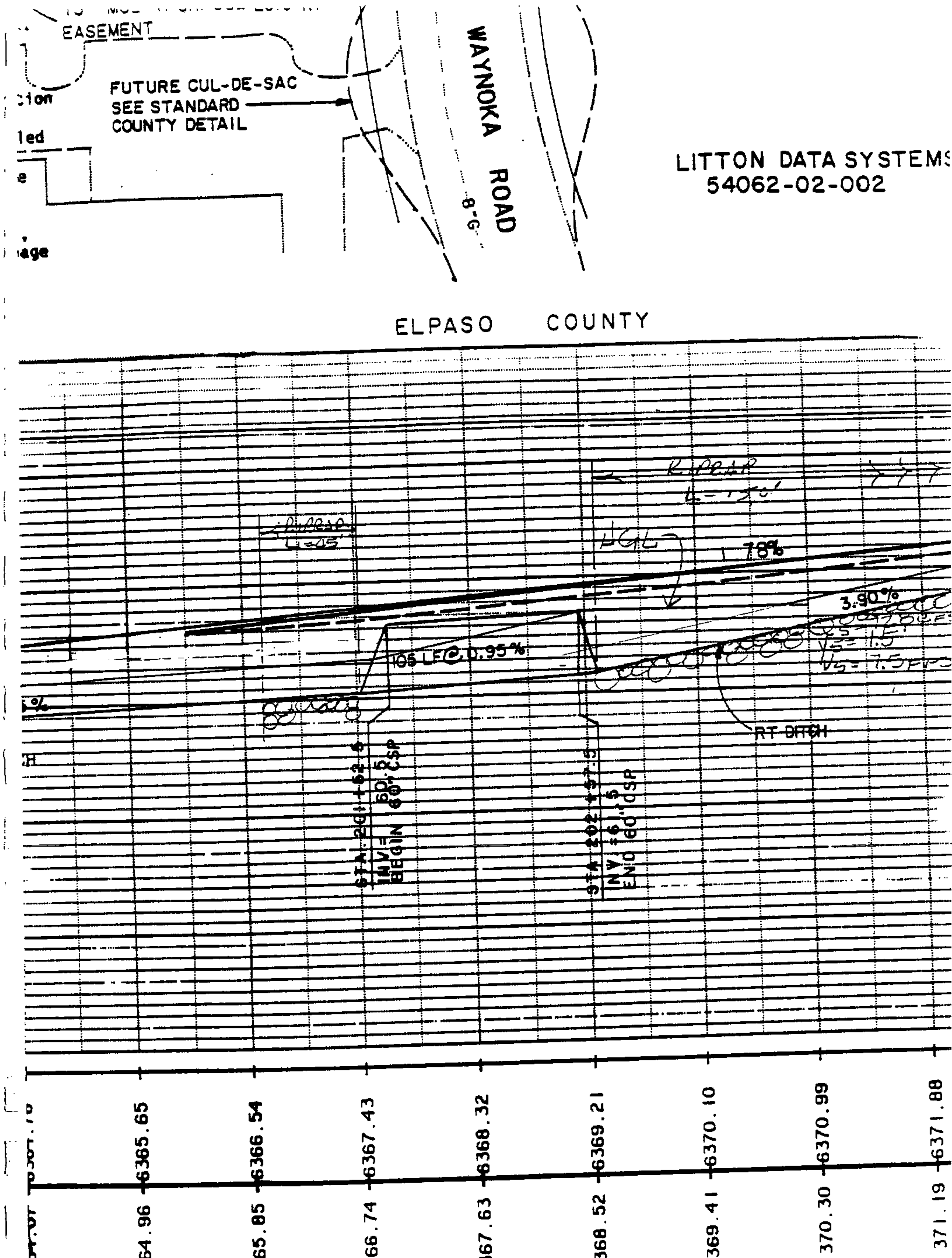
STA 202+00 Culvert at Waynoka Rd.

Ditch flow in east ditch from Basins S6, S6A, S6B:

Q_5 = ~~73.2~~ 72.8 cfs
Q_{100} = 139.4 cfs

One 60" CSP will carry the flows below Waynoka without ponding upon the roadways.


DUANE E. STARKEY
64011-00-043
MH (EXISTING)
RIM = 366.66
INV IN = 349.61 (N)
INV OUT = 349.41 (S)
Q100=154.5 cfs
Q5 = 77.6 cfs
V5 = 5.9 fps
URPOSE
200
CATV
N00°25'35"W 2918.39'
2"G
8"G
24"W
N00°25'35"W
STA. 202+00 ℄
TEMPORARY ACCESS
TO WAYNOKA ROAD
10' GRAVEL
SHOULDER
N00°25'35"W 2918.39'
℄ OF CULVERT STA. 202+57
℄ OF CULVERT
STA. 201+52.5
26.3' RT
60" CSP 105LF
SEE PROFILE BELOW
15' MULTIPURPOSE
EASEMENT
FUTURE CUL-DE-SAC
SEE STANDARD
COUNTY DETAIL
WAYNOKA ROAD
ed under my direction
ations have been
the City for detailed
plans and
ian of the drainage
tions meet the
is designed. I
e negligent acts,
the detailed drainage
LITTON D
54062-
ELPASO COUNTY


EASEMENT
FUTURE CUL-DE-SAC
SEE STANDARD
COUNTY DETAIL
WAYNOKA ROAD
LITTON DATA SYSTEMS
54062-02-002
ELPASO COUNTY
HGL
3.90%
105 LF @ 0.95%
RT DITCH
6365.65
6366.54
6367.43
6368.32
6369.21
6370.10
6370.99
6371.88

PROJECT: METEX
WAYNOKA ROAD - TEMP. ACCESS

DESIGNER: JAF
DATE: 5/13/87

HYDROLOGIC AND CHANNEL INFORMATION

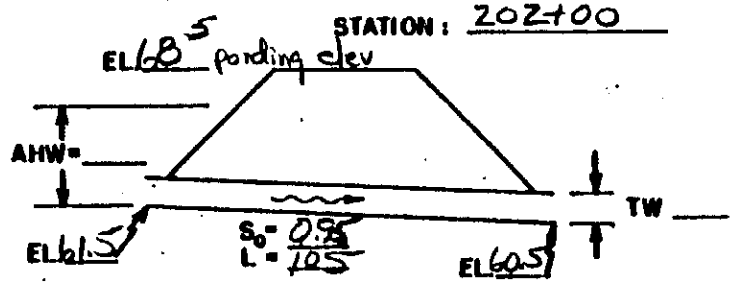
BASIN 56A + 56B
EAST DITCH OF POWERS BLVD

Q_1 = 72.8 cfs (Q_5) TW_1 = ______
Q_2 = 139.4 cfs (Q_{100}) TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: 202+00



MEAN STREAM VELOCITY = ______
MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	INLET CONT. HW/D	INLET CONT. HW	OUTLET CONTROL K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
CSP w/FES	72.8	60"	0.65	3.25	0.5	0.6	2.5	3.75	===	3.75	1.0	3.35	3.35			
CSP w/FES	139.4	60"	1.1	5.5	0.5	2.3 / 2.1	3.4 / 3.3	4.20 / 4.15	2.7	4.20 / 4.15	1.0	5.5 / 5.25	5.5			
									↑ For S = 0.86%							

HEADWATER COMPUTATION: OUTLET CONTROL $HW = H + h_o - LS_o$

SUMMARY & RECOMMENDATIONS:

5-18

Figure 7

RIPRAP DESIGN

STA 91+92 – CULVERT AT ACCESS ROAD – 24" CSP

Q = 15.7 CFS – 5 YEAR FLOW ONLY BECAUSE 100 YR FLOW WILL NOT PASS THROUGH THE PIPE

$V_{ALLOWABLE}$ = ~~5.5~~ 5.0 FPS (ASSUME HIGHLY EROSIVE SOILS)

$d_o = 24" = 2'$

CRITICAL DEPTH:

$$Z = \frac{Q}{\sqrt{g}} = \frac{15.7}{\sqrt{32.2}} = 2.8$$

$$\frac{Z}{d_o^{2.5}} = \frac{2.8}{(2)^{2.5}} = 0.50$$

$\frac{Y_c}{d_o}$ = ~~0.68~~ 0.72 FROM FIGURE 2-2 (ENCLOSED) OF THE DENVER REGIONAL COUNCIL OF GOVERNMENTS DRAINAGE CRITERIA MANUAL (D.C.M.) MAJOR DRAINAGE

Y_c = ~~1.4'~~ 1.44'

NORMAL DEPTH

$$\frac{AR^{2/3}}{d_o^{8/3}} = \frac{\frac{nQ}{1.486\sqrt{S}}}{d_o^{8/3}} = \frac{\frac{0.024\,(15.7)}{1.486\,\sqrt{.0186}}}{(2)^{8/3}} = 0.29$$

$\frac{Y_n}{d_o}$ = ~~0.67~~ 0.76 FROM FIGURE 2-1 (ENCLOSED) OF THE D.C.M.

Y_n = ~~1.3'~~ 1.52' ∴ ~~SUPER~~ SUB CRITICAL FLOW

AREA OF FLOW

$\frac{A}{D^2}$ = ~~0.5594~~ 0.6405

FROM TABLE 4-1 (ENCLOSED) OF THE D.C.M.

$A = \sout{2.24}\ 2.56\ ft^2$

<u>OUTLET VELOCITY</u>

$$V = \frac{Q}{A} = \frac{15.7}{\sout{2.24}\ 2.56} = \sout{7.0}\ 6.1\ fps$$

<u>RIPRAP</u>

<u>SUPER CRITICAL</u>

~~$D_a = \frac{1}{2}(D + Y_n) = \frac{1}{2}(2 + 1.3) = 1.65'$~~

$$\frac{Q}{D^{2.5}} = \frac{15.7}{(\sout{1.65}\ 2.0)^{2.5}} = \sout{4.5}\ 2.78 < 6 \checkmark$$

$$\frac{Q}{D^{1.5}} = \frac{15.7}{(\sout{1.65}\ 2.0)^{2.5}} = \sout{7.4}\ 5.6$$

~~ASSUME~~: $\frac{Y_t}{D} = 0.4 \therefore Y_t = 0.8'$

TYPE L RIPRAP FROM FIG. 5-7 (ENCLOSED) OF THE D.C.M.
→ BUT USE TYPE M MINIMUM

$$\frac{1}{2 \tan\theta} = \sout{2.9}\ 4.6$$ — FIGURE 5-9 (ENCLOSED) OF THE D.C.M.

$$A_t = \frac{Q}{V_{allowable}} = \frac{15.7}{\sout{5.5}\ 5.0} = \sout{2.9}\ 3.1\ ft^2$$

$$L = \frac{1}{2\tan\theta}\left(\frac{A_t}{Y_t} - W\right) = \sout{2.9}\ 4.6\left(\frac{\sout{2.9}\ 3.1}{0.8} - 2.0\right) = \sout{4.7}\ 8.6' < 3D$$

~~∴ L = 6'~~

<u>USE TYPE 'M' RIPRAP W/ L = ~~6'~~ 10'</u>

RIPRAP DESIGN

STA 107+04 - FRONTAGE ROAD CULVERT - 36" CSP

$Q_5 = 32.8$ CFS - Q_{100} WILL NOT PASS THROUGH CULVERT

$V_{ALLOWABLE} = 5.0$ ~~5.5~~ FPS (- ASSUME HIGHLY ERROSIVE SOIL)

$d_o = 36" - 3'$

CRITICAL DEPTH:

$$Z = \frac{Q}{\sqrt{g}} = \frac{32.8}{\sqrt{32.2}} = 5.8$$

$$\frac{Z}{d_o^{2.5}} = \frac{5.8}{(3)^{2.5}} = 0.37$$

$$\frac{Y_c}{d_o} = 0.6$$ FIG 2-2 (ENCLOSED) OF THE D.C.M.

$Y_c = 1.8'$

NORMAL DEPTH

$$\frac{AR^{2/3}}{d_o^{8/3}} = \frac{\frac{n\ Q}{1.486\sqrt{S}}}{d_o^{8/3}} = \frac{\frac{0.024\ (32.8)}{1.486\sqrt{.01}}}{(3)^{8/3}} = 0.28$$

$$\frac{Y_n}{d_o} = 0.74$$ FIG 2-1 (ENCLOSED) OF THE D.C.M.

$Y_n = 2.2'$ ∴ SUB CRITICAL FLOW

AREA OF FLOW

$$\frac{A}{D^2} = 0.6231$$ TABLE 4-1 (ENCLOSED) OF THE D.C.M.

$A = 5.61\ Ft^2$

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Subject DRAINAGE – RIPRAP By BF Sheet R4 of R16

<u>OUTLET VELOCITY</u> :

$$V = \frac{Q}{A} = \frac{32.8}{5.61} = \underline{\underline{5.8\ fps}}$$

<u>RIPRAP</u> :

$$\frac{Q}{D^{1.5}} = \frac{32.8}{(3)^{1.5}} = 6.31$$

$$\frac{Q}{D^{2.5}} = \frac{32.8}{(3)^{2.5}} = 2.10 < 6 \ ✓$$

~~ASSUME~~ $\frac{Y_t}{D} =$ ~~0.4~~ 0.47 $\therefore\ Y_t =$ ~~1.2~~ 1.4'

TYPE 'L' RIPRAP – FIG 5-7 (ENCLOSED) OF D.C.M.
BUT USE TYPE 'M' MINIMUM

$\frac{1}{2\tan\theta} =$ ~~5.6~~ 6.3 FIG 5-9 (ENCLOSED) OF D.C.M.

$A_t = \frac{Q}{V_{allow.}} = \frac{32.8}{\text{~~5.5~~ } 5.0} =$ ~~6.0~~ 6.6 ft^2

$L = \left(\frac{1}{2\tan\theta}\right)\left(\frac{A_t}{Y_t} - W\right) =$ ~~5.6~~ 6.3 $\left(\frac{\text{~~6.0~~ } 6.6}{\text{~~1.2~~ } 1.4} - 3.0\right) =$ ~~11.2~~ 10.8' ⇒ USE 15

3D < L < 10D ✓

<u>USE TYPE 'M' RIPRAP W/ L = 15'</u>

RIPRAP DESIGN

CULVERT STA 131+74 - GALLEY - 60" CSP

$Q = 120$ CFS $d_0 = 60" = 5'$

~~+39.2 DITCH FLOW~~

$HW = 5.0'$

INVERT IN ELEV. = 42.5

$V_{allowable} = 5.0$ ~~5.5~~ fps (assuming highly erosive soils)

CRITICAL DEPTH:

$$Z = \frac{Q}{\sqrt{g}} = \frac{120}{\sqrt{32.2}} = 21.1$$

$$\frac{Z}{d_0^{2.5}} = \frac{21.1}{5^{2.5}} = 0.38$$

$\frac{Y_c}{d_0} = 0.61$ From Figure 2-2 of the Drainage Criteria Manual - also included in this report

$Y_c = 3.1'$ ✓ against attached computer output

NORMAL DEPTH:

$$\frac{AR^{2/3}}{d_0^{8/3}} = \frac{\frac{nQ}{1.486\sqrt{S}}}{d_0^{8/3}} = \frac{\frac{0.024\,(120)}{1.486\,\sqrt{.006}}}{(5)^{8/3}} = 0.34$$

(~~240~~ corrected to 120; ~~0.68~~ corrected to 0.34)

$\frac{y_n}{d_0} = 0.92$ (~~1~~) $y_n = 4.6'$ (~~5.0'~~) ∴ subcritical Flow

✓ against attached computer output

OUTLET VELOCITY = 9.3 FPS - See attached computer output

~~Assume~~: $\frac{Y_t}{D}$ = 0.56 ~~0.4~~ Y_t = 2.8' ~~2.0'~~

RIPRAP

$$\frac{Q}{D^{1.5}} = \frac{120}{(5)^{1.5}} = 10.73$$

$$\frac{Q}{D^{2.5}} = \frac{120}{(5)^{2.5}} = 2.15 < 6 \checkmark$$

From Fig. 5-7 (Included) of the Drainage Criteria Manual:
USE TYPE M RIPRAP

$$L = \left(\frac{1}{2\tan\theta}\right)\left(\frac{A_t}{Y_t} - W\right) \qquad A_t = \frac{Q}{V_{allowable}} = \frac{120}{5.0\ (\cancel{5.5})} = 24.0\ (\cancel{21.8})\ ft^2$$

$$L = 6.7\ (\cancel{5.5})\left(\frac{24.0\ (\cancel{21.8})}{2.8\ (\cancel{2.0})} - 5.0\right) \qquad \frac{1}{2\tan\theta} = 6.7\ (\cancel{5.5})$$

From Figure 5 (included) of Drainage Criteria Manual

L = 23.9' ~~32.5'~~ ⇒ USE 35'

$3D < L < 10D$ ✓

OUTLET → USE TYPE 'M' RIPRAP w/ L = 35'

INLET RIPRAP → USE TYPE 'M' RIPRAP w/ L = 18' TO PROVIDE PROTECTION WHERE CHANNEL BENDS INTO CULVERT

RIPRAP DESIGN

STA 136+79 STORM SEWER DRAINING MEDIAN INLET - 18" RCP

Q_{100} = 8.0 CFS

$V_{ALLOWABLE}$ = ~~5.5~~ 5.0 FPS (ASSUME HIGHLY EROSIVE SOILS)

d_0 = 18" = 1.5'

CRITICAL DEPTH :

Y_c = 1.10' - SEE ATTACHED COMPUTER OUTPUT

NORMAL DEPTH : Y_n = 0.93' - SEE ATTACHED COMPUTER OUTPUT

∴ SUPERCRITICAL FLOW

OUTLET VELOCITY :

V = 4.5 FPS - SEE ATTACHED COMPUTER OUTPUT

NOTE : $V < V_{ALLOWABLE}$ BUT CULVERT FLOW ENTERS CHANNEL AT A 90° ANGLE AND RIPRAP WILL BE SPECIFIED AS FOLLOWS TO PROTECT THE CHANNEL :

RIPRAP :

USE TYPE 'M' RIPRAP w/ L = 6' AND W = 7' AT A DEPTH OF 2 d_{50} .

RIPRAP DESIGN

STA 146+16 STORM SEWER DRAINING MEDIAN INLET - 18" RCP

$Q_{100} = 8.4$

$V_{allowable} = 5.0$ fps (Assume highly erosive soils)

$d_0 = 18'' = 1.5'$

CRITICAL DEPTH:

$y_c = 1.12$ - see attached computer output

NORMAL DEPTH:

$y_n = 0.95$ - see attached computer output

∴ SUPER CRITICAL FLOW

OUTLET VELOCITY:

V = 6.7 FPS - see attached computer output

RIPRAP:

ASSUME $\frac{y_t}{D} = 0.4$ $y_t = 0.6'$

$D_a = \frac{1}{2}(D + y_n) = \frac{1}{2}(1.5 + 0.95) = 1.2'$

$\frac{Q}{D_a^{2.5}} = \frac{8.4}{(1.2)^{2.5}} = 5.3 < 6$ ✓

$\frac{Q}{D_a^{1.5}} = \frac{8.4}{(1.2)^{1.5}} = 6.4$

TYPE 'L' RIPRAP - FIG. 5-7 OF O.C.M.
BUT USE TYPE 'M' MIN.

$\frac{1}{2\tan\theta} = 2.2$ - FIG 5-9 OF O.C.M.

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$$A_t = \frac{Q}{V_{allowable}} = \frac{8.4}{5.0} = 1.7 \ ft^2$$

$$L = \frac{1}{2\tan\theta}\left(\frac{A_t}{y_t} - W\right) = 2.2\left(\frac{1.7}{0.6} - 1.5\right) = 2.9'$$

2.9' < 3.0 ∴ MIN L = 4.5'

NOTE: CULVERT FLOW ENTERS CHANNEL AT A 90° ANGLE AND RIPRAP WILL BE SPECIFIED AS FOLLOWS TO PROTECT THE CHANNEL:

USE TYPE 'M' RIPRAP w/ L = 6' AND W = 7' AT A DEPTH OF $2d_{50}$.

RIPRAP DESIGN

CULVERT 157+37 - OMAHA - 36" CSP

$Q = 39$ CFS

$V_{ALLOWABLE} = 5.0$ FPS (ASSUME HIGHLY EROSIVE SOILS)

CRITICAL DEPTH : 2.03' - SEE ATTACHED COMPUTER OUTPUT

NORMAL DEPTH : 3.0' - SEE ATTACHED COMPUTER OUTPUT

∴ SUBCRITICAL FLOW

OUTLET VELOCITY : 6.9 FPS - SEE ATTACHED COMPUTER OUTPUT

RIPRAP :

ASSUME $\frac{Y_t}{D} = 0.4 \quad \therefore Y_t = 1.2'$

$$\frac{Q}{D^{1.5}} = \frac{39}{(3)^{1.5}} = 7.5$$

$$\frac{Q}{D^{2.5}} = \frac{39}{(3)^{2.5}} = 2.5 < 6 \checkmark$$

TYPE 'L' RIPRAP - FIG 5-7 (ENCLOSED) OF D.C.M.
BUT USE TYPE 'M' MINIMUM

$\frac{1}{2\tan\theta} = 5.0$ FIG 5-9 (ENCLOSED) OF D.C.M.

$$A_t = \frac{Q}{V_{allow.}} = \frac{39}{5.0} = 7.8 \text{ ft}^2$$

$$L = \frac{1}{2\tan\theta}\left(\frac{A_t}{Y_t} - W\right) = 5.0\left(\frac{7.8}{1.2} - 3.0\right) = 17.5 \Rightarrow \text{USE } 20\_C$$

$3D < L < 10D \checkmark$

USE TYPE 'M' RIPRAP W/ L = 20'

RIPRAP DESIGN

STA 171+40 - PALMER PARK - 2 38"x24" RCP

$Q_1 = 35.7$ CFS

$Q_2 = 35.7$ CFS

$V_{ALLOWABLE}$ = ~~5.5~~ 5.0 FPS (ASSUME HIGHLY EROSIVE SOIL)

CONVERT TO A SINGLE HYDRAULICALLY SIMILAR RECTANGULAR CONDUIT:

- ASSUME A 38"x24" ELLIPSE APPROX. EQUAL TO A 30"x24" RECTA
- SUBCRITICAL FLOW - SEE COMPUTER OUTPUT ATTACHED

$$\frac{Q}{WH^{1.5}} = \frac{35.7}{(2.5)(2)^{1.5}} = \text{~~5.05~~ 4.95 (OK)}$$

$H_e = 2'$ = equivalent height

$$\frac{Q_T}{W_e H_e^{1.5}} = \text{~~5.05~~ } 4.95$$

$$W_e = \frac{Q_T}{4.95\, H_e^{1.5}} = \frac{71.4}{4.95\,(2)^{1.5}} = \text{~~5.0'~~ } 5.1' = \text{equivalent Width}$$

RIPRAP:

~~Assume~~ $\frac{Y_t}{H_e}$ = ~~0.4~~ 1.15 Y_t = ~~0.8'~~ 2.3'

$$\frac{Q_T}{W_e H_e^{0.5}} = \frac{71.4}{5.1\,(2)^{0.5}} = \text{~~10.1~~ } 9.9$$

TYPE 'L' RIPRAP - FIG. 5-8 (ENCLOSED) OF D.C.M.

USE TYPE 'M' MINIMUM

$$\frac{1}{2\tan\theta} = \text{~~7.0~~ } 6.7 \text{ (OK)}$$ - FIG 5-10 (ENCLOSED) OF D.C.M.

$$A_t = \frac{Q}{V_{ALLOW}} = \frac{71.4}{5.0} = \text{~~13.0~~ } 14.3$$

$$L = \frac{1}{2\tan\theta}\left(\frac{A_t}{y_t} - W\right) = 1.6\left(\frac{14.3}{0.8} - 5.0\right) = 20.6$$

$\Rightarrow$ USE 25'

$3D < L < 10D$ ✓

USE TYPE 'M' RIPRAP W/ L = 25'

INLET RIPRAP → USE TYPE 'M' RIPRAP W/ L=30'
TO PROVIDE PROTECTION WHERE
CHANNEL BENDS INTO CULVERT
PLUS USE TYPE 'M' RIPRAP ON AN
AREA WITH APPROX. DIMENSIONS OF
50' × 40' IN ADDITION TO THE INLET
CHANNEL AS SHOWN ON PLANS

RIPRAP DESIGN

STA 192+73 - CULVERT AT VICTOR PLACE - 66" CSP

$Q = 154.5$ CFS

$V_{ALLOWABLE}$ = ~~5.5~~ 5.0 FPS (ASSUME HIGHLY EROSIVE SOILS)

$d_o = 66'' = 5.5'$

CRITICAL DEPTH:

$$Z = \frac{Q}{\sqrt{g}} = \frac{154.5}{\sqrt{32.2}} = 27.2$$

$$\frac{Z}{d_o^{2.5}} = \frac{27.2}{(5.5)^{2.5}} = 0.38$$

$$\frac{Y_c}{d_o} = 0.64$$ FIG 2-2 (ENCLOSED) OF D.C.M.

$Y_c = 3.5'$

NORMAL DEPTH:

$$\frac{AR^{2/3}}{d_o^{8/3}} = \frac{\frac{nQ}{1.486\sqrt{S}}}{d_o^{8/3}} = \frac{\frac{0.024\,(154.5)}{1.486\,\sqrt{.0106}}}{5.5^{8/3}} = 0.26$$

$$\frac{Y_n}{d_o} = 0.70$$ FIG 2-1 (ENCLOSED) OF D.C.M.

$Y_n = 3.9'$ ∴ SUBCRITICAL FLOW

AREA OF FLOW:

$$\frac{A}{D^2} = 0.5872$$

$A = 17.8\ ft^2$

OUTLET VELOCITY:

$$V = \frac{Q}{A} = \frac{154.5}{17.8} = \underline{\underline{8.7\ ft/s}}$$

RIPRAP:

~~ASSUME~~ $\frac{Y_t}{D}$ = ~~0.4~~ 0.45 ∴ Y_t = ~~2.2'~~ 2.5

$$\frac{Q}{D^{1.5}} = \frac{154.5}{(5.5)^{1.5}} = 12.0$$

$$\frac{Q}{D^{2.5}} = \frac{154.5}{(5.5)^{2.5}} = 2.2 < 6 \checkmark$$

TYPE 'M' RIPRAP – FIG 5-7 (ENCLOSED) – OF D.C.M.

$\frac{1}{2\tan\theta}$ = ~~5.5~~ 6.0 – FIG 5-9 (ENCLOSED) – OF D.C.M.

$A_t = \frac{Q}{V_{ALLOW}} = \frac{154.5}{\text{~~5.5~~ } 5.0}$ = ~~28.1~~ 30.9 ft^2

$L = \frac{1}{2\tan\theta}\left(\frac{A_t}{Y_t} - W\right)$ = ~~5.5~~ 6.0 $\left(\frac{\text{~~28.1~~ } 30.9}{\text{~~2.2~~ } 2.5} - 5.5\right)$ = ~~40.0'~~ 41.2'

$3D < L < 10D$ ✓

USE TYPE 'M' RIPRAP W/ L = ~~40'~~ 45'

RIPRAP DESIGN

STA 202+00 - CULVERT AT WAYNOKA ROAD - 60" CSP

$Q = \sout{129.8}$ 139.4 CFS

$V_{ALLOWABLE} = \sout{3.5}$ 5.0 FPS (ASSUME HIGHLY EROSIVE SOILS)

$d_o = 60" = 5'$

CRITICAL DEPTH:

$$Z = \frac{Q}{\sqrt{g}} = \frac{139.4 \; (\sout{129.8})}{\sqrt{32.2}} = 24.6 \; (\sout{22.9})$$

$$\frac{Z}{d_o^{2.5}} = \frac{24.6 \; (\sout{22.9})}{(5)^{2.5}} = 0.44 \; (\sout{0.41})$$

$$\frac{Y_c}{d_o} = 0.68 \; (\sout{0.65})$$ - FIG 2-2 (ENCLOSED) OF D.C.M.

$$Y_c = 3.4' \; (\sout{3.3'})$$

NORMAL DEPTH:

$$\frac{AR^{2/3}}{d_o^{8/3}} = \frac{\frac{nQ}{1.486\sqrt{S}}}{d_o^{8/3}} = \frac{\frac{0.024\,(139.4 \; \sout{129.8})}{1.486\sqrt{.01}}}{5^{8/3}} = 0.31 \; (\sout{0.29})$$

$$\frac{Y_n}{d_o} = 0.81 \; (\sout{0.76})$$ - FIG 2-1 (ENCLOSED) OF D.C.M.

$Y_n = 4.1 \; (\sout{3.8})$ ∴ SUB CRITICAL

AREA OF FLOW:

$$\frac{A}{D^2} = 0.6815 \; (\sout{0.6405})$$

$$A = 17.0 \; (\sout{16.0}) \; ft^2$$

OUTLET VELOCITY:

$V = \frac{Q}{A} = \frac{139.4\ (\text{~~129.8~~})}{17.0\ (\text{~~16.0~~})} = 8.2$ (~~8.1~~) FPS

RIPRAP

ASSUME $\frac{Y_t}{D} = 0.46$ (~~0.4~~) $\therefore Y_t = 2.3'$ (~~2.0~~)

$\frac{Q}{D^{1.5}} = \frac{139.4\ (\text{~~129.8~~})}{(5)^{1.5}} = 12.5$ (~~11.6~~)

$\frac{Q}{D^{2.5}} = \frac{139.4\ (\text{~~129.8~~})}{(5)^{2.5}} = 2.5$ (~~2.3~~) < 6 ✓

TYPE 'M' RIPRAP - FIG 5-7 (ENCLOSED) - OF D.C.M.

$\frac{1}{2\tan\theta} = 5.9$ (~~5.3~~) - FIG 5-9 (ENCLOSED) OF D.C.M.

$A_t = \frac{Q}{V_{allow}} = \frac{139.4\ (\text{~~129.8~~})}{5.0\ (\text{~~5.5~~})} = 27.9$ (~~23.6~~) ft^2

$L = \frac{1}{2\tan\theta}\left(\frac{A_t}{Y_t} - W\right) = 5.9\ (\text{~~5.3~~})\left(\frac{27.9\ (\text{~~23.6~~})}{2.3\ (\text{~~2.0~~})} - 5.0\right) = 42.0'$ (~~36.0~~)

$3D < L < 10D$ ✓

USE TYPE 'M' RIPRAP w/ L = ~~36'~~ 45'

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Job Title METEX | Date 6/17/87 | Job no. 8895.03
Subject DRAINAGE | By JAF | Sheet of

DETERMINE SIZE OF RIPRAP
IN DITCHES

REFERENCE : URBAN STORM DRAINAGE CRITERIA MANUAL (DENVER REGIONAL COUNCIL OF GOVERNMENTS)

EAST SIDE DITCH - STA 202+50 (WAYNOKA ROAD)

WEST SIDE DITCH - STA 193+00 (VICTOR PLACE)

FROM TABLE 1 SLOPING RIPRAP DROP STRUCTURE DESIGN CHART

USE TYPE 'H' RIPRAP

FLOW TO GALLEY INLET

$Q = CIA$

COEFFICIENT (C):

The basin is made up entirely of pavement surface, therefore $C = 0.9$

INTENSITY (I):

T_c: $L = 240'$ $\Delta EL = 0.77'$

$S = .77/240 = 0.32\%$

~~FROM FIG. 3-2, V = 1.2 fps~~

$T_c =$ ~~240/1.2 = 200 sec = 3.33 min.~~

Use min. $T_c = 5$ min.

From Fig. III-2 in the PPACG

$I_5 = 5.1$ inches/hr. $I_{100} = 9.0$ in/hr.

AREA (A):

Basin area = 0.28 Ac

FLOW (Q):

$Q_5 = CI_5A = (0.9)(5.1)(0.28)$ $Q_{100} = (.9)(9.0)(0.28)$

$Q_5 = 1.3$ CFS $Q_{100} = 2.8$ CFS

FROM TABLE 6

4' OF CURB OPENING INLET HAS $Q_{CAP} = 7.9$

USE (1) 5' TYPE R

FLOW TO OMAHA INLET

$Q = CIA$

COEFFICIENT (C):

The basin is made up of 82% pavement and 18% open area.

From Table 3, page 49 of the City of Col. Springs Drid. Policy Manual

C for pavement = 0.9 × 82% = 0.74
C for open area = 0.3 × 18% = 0.05
C = 0.79

INTENSITY (I):

T_c: L = 884' ΔEL = 6.71'
S = 6.71/884 = 0.76%
~~V = 1.75 fps (from Fig. 3-2)~~
T_c = ~~884/1.75 = 505 sec = 8.4 min.~~ 5.0 MIN

From Fig. III-2 in the PPAG

I_5 = ~~4.25~~ 5.1 inches/hr. I_{100} = ~~7.5~~ 9.0 in/hr.

AREA (A):

Basin Area = 0.84 Ac

FLOW (Q):

$Q_5 = CI_5A$ = (0.79)(~~4.25~~ 5.1)(0.84) Q_{100} = (.79)(~~7.5~~ 9.0)(.84)

Q_5 = ~~2.8~~ 3.4 CFS

Q_{100} = ~~6.2~~ 7.5 CFS

FROM TABLE 6
4' OF CURB OPENING INLET HAS QCAP 7.9

USE (1) 5' TYPE R

FLOW TO PALMER PARK INLET

$Q = C I A$

COEFFICIENT (C):

The basin is made up of 21% pavement and 79% business and commercial area.

C for pavement - 0.9 × 21% = 0.19
C for bus./com. - 0.7 × 79% = 0.55
= 0.74

INTENSITY (I):

T_c: L = 755' ΔEL = 7.9
S = 7.9/755 = 1.05%
~~From Fig. 3-2, V = 2.0 fps~~
T_c = ~~755/2 = 377 sec = 6.3 min.~~ 5.0 MIN
I_5 = ~~4.7~~ 5.1 in/hr. I_{100} = ~~8.2~~ 9.0 in/hr.

AREA (A):

Basin area = 3.66 Ac

FLOW (Q):

$Q_5 = C I_5 A$
Q_5 = (.74)(~~4.7~~ 5.1)(3.66)
~~Q_5 = 12.7 CFS~~ 13.8

$Q_{100} = C I_{100} A (1.25)$
Q_{100} = (.74)(~~8.2~~ 9.0)(3.66)(1.25)
Q_{100} = ~~27.8~~ 30.5 CFS

FROM TABLE 6
14' OF CURB OPENNING HAS A CAPACITY OF 34.5 CFS

USE (1) 15' TYPE R

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Job Title METEX — By JT — Date 11-5-86 — Job no. 8895.03
Subject DRAINAGE — Sheet — of

CAPACITY OF TYPE 'D' INLET AT OMAHA

TYPE D INLET HAS 2 TYPE C INLET GRATES

AREA = (68" x 35") − 8 (35" x 2 5/8")

AREA = 11.42 SF

$Q = C A \sqrt{2gh}$ C = 0.6 (USE 0.5) REDUCED CAPAC DUE TO CLOGGIN

HEAD (h, ft)	CAPACITY (Q, CFS)	
0.5	38.9	19.4
1.0	55.0	27.5
1.5	67.3	33.7
2.0	77.8	38.9
2.5	86.9	43.5
3.0	95.2	47.6

Q_{ACT} = 39 CFS $h_{AVAIL.}$ = 1.4' ∴ 1 TYPE D INLET IS NOT ADEQUATE

TRY A MODIFIED TYPE D INLET WITH 3 GRATES

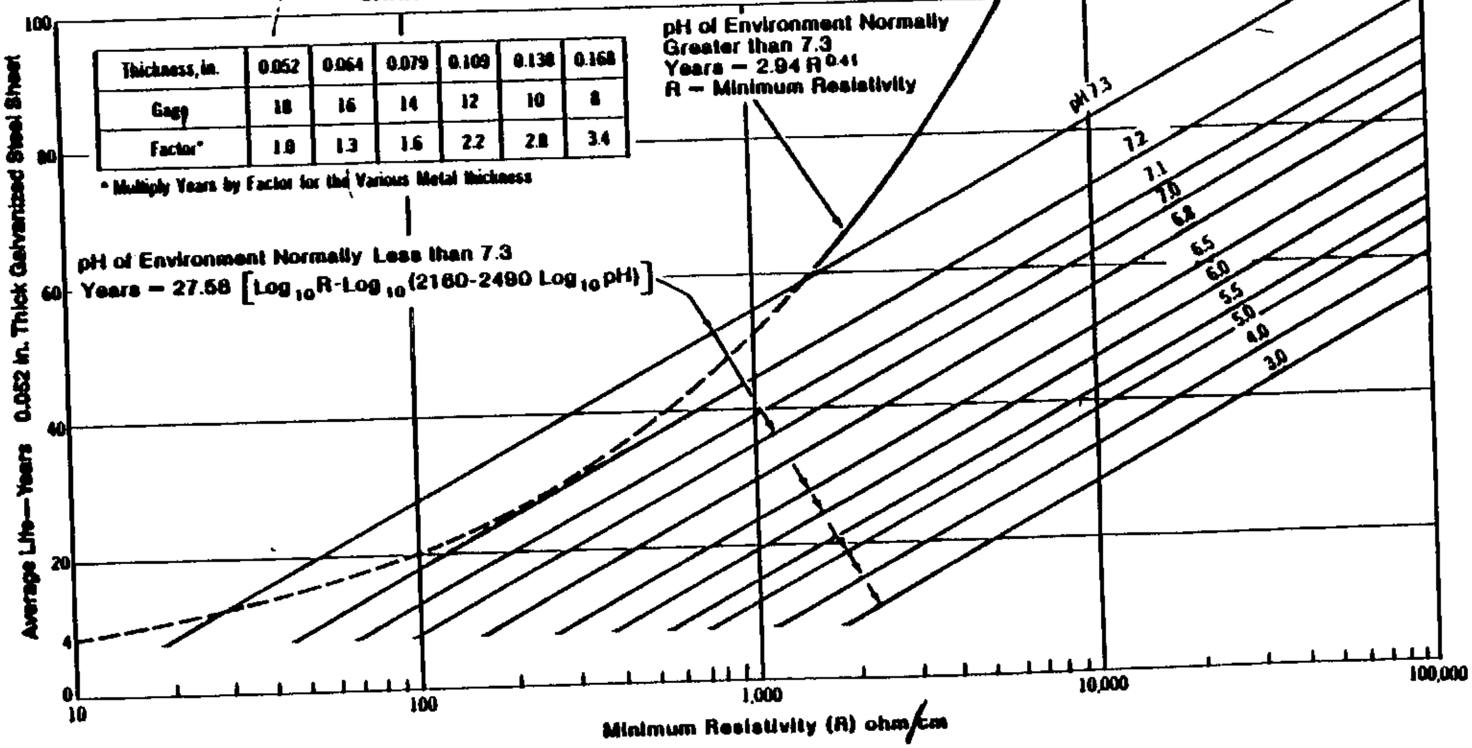
AREA = (101" x 35") − 12 (35" x 2 5/8")
AREA = 16.89 SF
$Q = C A \sqrt{2gh}$ C = 0.6
$Q = (0.6)(16.89)\sqrt{2(32.2)(1.4)}$

Q = 96.2 CFS x 0.5 (CLOGGING RED.)

Q = 48.1 CFS > 39 CFS OK

NOT MADE

Figure 5-4
CHART FOR ESTIMATING AVERAGE LIFE OF PLAIN GALVANIZED CULVERTS



Thickness, in.	0.052	0.064	0.079	0.109	0.138	0.168
Gage	18	16	14	12	10	8
Factor*	1.0	1.3	1.6	2.2	2.8	3.4

* Multiply Years by Factor for the Various Metal thickness

METEX - CSP DESIGN LIFE

Station	R ohm/cm	pH	Required Gage 50 Yr.	Theoretical Life Span	Army Corps of Engineers Criteria Gage	Army Corps of Engineers Criteria Life Span
91+92	3,800	7.2	16+	78	16	78
107+00	1,280	7.2	16	61	14	75
131+75	25,200	7.4	16+	243	16	243
157+45	4,800	7.1	16+	74	16	74
171+25	3,280	7.1	16+	69	16	69
224+70	520	7.6	14	61	12	84
244+50	1,760	7.2	16+	66	16	66
273+25*	2,720	6.8	16	53	14	66
273+25**	2,440	7.2	16+	72	16	72
298+00	880	7.5	16	61	14	75
303+00	1,640	7.4	16+	79	16	79
341+20	3,840	7.2	16+	78	16	78
366+50	3,840	7.2	16+	78	16	78
397+37	6,000	5.1	14	53	12	73
407+00	8,000	6.6	16+	65	16	65
425+30	8,400	6.5	16+	64	16	64
441+50	3,640	7.2	16+	78	16	78
449+75	8,800	7.0	16+	79	16	79
471+72	760	5.3	***			

* LT
**RT
***Because of Soils CSP cannot be used
+ Gage has been increased from 18 since they do not make it

Required gage was determined from "Handbook of Steel Drainage and Highway Construction Products."
Army Corps of Engineers Criteria from Engineer Manual EM 1110-2-2902, 3 Mar 1969 "Conduits, Culverts and Pipes"

THE FOLLOWING REFERENCES AND PARAMETERS WERE USED TO CREATE THE CULVERT PIPE DESIGN WORKSHEET

REFERENCE:
HANDBOOK OF STEEL DRAINAGE & HIGHWAY CONSTRUCTION PRODUCTS
BY: American Iron and Steel Institute

PARAMETERS:
TABLE 3-1 HIGHWAY & RAILWAY LIVE LOADS

$DL = w \times h$ where
DL = Deal load pressure, lb/ft^2
w = Unit weight of soil, lb/ft^3 ($120\ lb/ft^3$)
h = height of fill over pipe

SECTION B - STRUCTURAL DESIGN OF BURIED STRUCTURES

FIGURE 3-6
TABLE 3-2

CULVERT PIPE DESIGN WORKSHEET

[illegible]

[illegible]
[illegible] COLORADO SPRINGS
DATE: MAY [illegible] 19[illegible]
[illegible]

	UNITS	
CULVERT PIPE DIAMETER	INCHES	24
CORRUGATION NUMBER		1
HEIGHT OF COVER	FEET	2
BACKFILL SOIL DENSITY	PERCENTAGE	95
LIVE LOAD NUMBER		1
DESIGN PRESSURE	LB/SQFT.	340
RING COMPRESSION	LB/FT	340
ALLOWABLE WALL STRESS	LB/SQ.IN.	22500
WALL CROSS SECT. AREA	SQIN/FT	0.032
WALL THICKNESS	IN	0.034
FLEXIBILITY FACTOR		0.00[illegible]714

1 --- 2 2/3 x 1/2
2 --- 3 x 1
3 --- 5 x 1
4 --- 6 x 2

1 FOR HIGHWAY
[illegible]

ACCEPTABLE FLEXIBILITY FACTOR IS LESS THAN :

0.0433 FOR FACTORY MADE PIPE WITH DIAMETER [illegible]
0.0200 FOR FIELD-ASSEMBLED PIPE WITH DIAMETER [illegible]

CULVERT PIPE DESIGN WORKSHEET

JOB NUMBER [illegible]
LOCATION: [illegible]METEX PHASE [illegible], COLORADO SPRINGS
DATE: [illegible] 1987
STATION [illegible]

CULVERT PIPE DIAMETER	INCHES	[illegible]
CORRUGATION NUMBER		1
HEIGHT OF COVER	FEET	1.5
BACKFILL SOIL DENSITY	PERCENTAGE	[illegible]
LIVE LOAD NUMBER		1
DESIGN PRESSURE	LB/SQFT	[illegible]
RING COMPRESSION	LB/FT	[illegible]
ALLOWABLE WALL STRESS	LB/SQIN	[illegible]
WALL CROSS SEC. AREA	SQIN/FT	[illegible]
WALL THICKNESS	IN	[illegible]
FLEXIBILITY FACTOR		[illegible]

ACCEPTABLE FLEXIBILITY FACTOR IS LESS THAN :

0.0433 FOR FACTORY MADE PIPE WITH [illegible]
0.0200 FOR FIELD ASSEMBLED PIPE WI[illegible]

[illegible] OF HIGHWAY

[illegible] DESIGN [illegible]

JOB NUMBER [illegible] 03 0144
LOCATION [illegible] CREEK (PHASE I [illegible] SPRINGS
DATE MAY 10 1987
STATION [illegible]

	UNITS	
CULVERT PIPE DIAMETER	INCHES	[illegible]0
CORRUGATION NUMBER		3
HEIGHT OF COVER	FEET	[illegible]7
BACKFILL SOIL DENSITY	PERCENTAGE	95
LIVE LOAD NUMBER		1
DESIGN PRESSURE	LB/SQFT.	[illegible]
RING COMPRESSION	LB/FT	[illegible]
ALLOWABLE WALL STRESS	LB/SQ IN	[illegible]
WALL CROSS-SEC. AREA	SQIN/FT	[illegible]
WALL THICKNESS	IN	0.0[illegible]4
FLEXIBILITY FACTOR		0.0[illegible]

[illegible]
2 [illegible] 3 x 1
3 [illegible] 3 x 1
4 [illegible] 6 x 2

[illegible] HIGHWAY

ACCEPTABLE FLEXIBILITY FACTOR IS LESS THAN :

0.0433 FOR FACTORY-MADE PIPE WITH [illegible]
0.0200 FOR FIELD ASSEMBLED PIPE WITH [illegible]

[illegible] DESIGN WORKSHEET

[illegible]

[illegible] (PHASE [illegible]) COLORADO SPRINGS

[illegible]

[illegible]

[illegible]

	UNITS	
[illegible] PIPE DIAMETER	INCHES	1[illegible]
CORRUGATION NUMBER		[illegible]
HEIGHT OF COVER	FEET	2.[illegible]
[illegible] SOIL DENSITY	PERCENTAGE	7[illegible]
LIVE LOAD NUMBER		1
DESIGN PRESSURE	LBS/SQFT.	[illegible]
RING COMPRESSION	[illegible]	[illegible]
[illegible] WALL STRESS	[illegible]	[illegible]
[illegible] AREA	SQIN/FT	[illegible]
WALL THICKNESS	IN	[illegible]
FLEXIBILITY FACTOR		0.[illegible]

[illegible] 2 2/3 [illegible]

1 - 3 x 1

3 - 5 x 1

[illegible] - 6 x 2

[illegible] HIGHWAY

[illegible] TABLE FLEXIBILITY FACTOR IS LESS THAN [illegible]

0.0433 FOR [illegible]

0.0200 FOR [illegible]

[illegible]

NOMINAL PIPE DIAMETER	INCHES	[illegible]
CORRUGATION NUMBER		[illegible]
HEIGHT OF COVER	FEET	2.3
BACKFILL SOIL DENSITY	PERCENTAGE	95
LIVE LOAD NUMBER		1
DESIGN PRESSURE	LB/SQ.FT.	37[illegible]
RING COMPRESSION	LB/FT	[illegible]
ALLOWABLE WALL STRESS	LB/SQ.IN.	[illegible]
REQUIRED WALL AREA	SQIN/FT	[illegible]
WALL THICKNESS	IN	0.0[illegible]
FLEXIBILITY FACTOR		0.00[illegible]357

ACCEPTABLE FLEXIBILITY FACTOR IS LESS THAN -

0.0433 FOR FACTORY-MADE PIPE WITH DIAMETER [illegible]
0.0200 FOR FIELD-ASSEMBLED PIPE WITH DIAMETER [illegible]

[illegible] OR HIGHWAY

[illegible] DESIGN ANALYSIS

[illegible]

UNITS

CULVERT PIPE DIAMETER	INCHES	18
CORRUGATION NUMBER		1
HEIGHT OF COVER	FEET	1.7
BACKFILL SOIL DENSITY	PERCENTAGE	70
LIVE LOAD NUMBER		1
DESIGN PRESSURE	LBS/SQ.FT.	[illegible]504
RING COMPRESSION	LB/FT	115[illegible]
ALLOWABLE WALL STRESS	LB/SQ.IN.	[illegible]
WALL CROSS SECT. AREA	SQ.IN./FT	0.045
WALL THICKNESS	IN	[illegible]
FLEXIBILITY FACTOR		0.03[illegible]

1 - 2 2/3 x 1/2
2 - 3 x 1
3 - 5 x 1
4 - 6 x 2

1 - [illegible] HIGHWA[illegible]
2 [illegible]

ACCEPTABLE FLEXIBILITY FACTOR IS LESS THAN =

0.0433 FOR [illegible]
0.0200 FOR [illegible]

[illegible]

[illegible]

[illegible]
[illegible]
DATE [illegible]
[illegible]

CULVERT PIPE DIAMETER	INCHES	60
CORRUGATION NUMBER		3
HEIGHT OF COVER	FEET	[illegible]
BACKFILL SOIL DENSITY	PERCENTAGE	75
LIVE LOAD NUMBER		[illegible]
DESIGN PRESSURE	LB/SQ.FT.	1500
RING COMPRESSION	LB/FT	[illegible]
ALLOWABLE WALL STRESS	LB/SQ.IN.	[illegible]
WALL CROSS SEC. AREA	SQ.IN/FT	[illegible]
WALL THICKNESS	IN	[illegible]
FLEXIBILITY FACTOR		[illegible]

ACCEPTABLE FLEXIBILITY FACTOR IS LESS THAN:

0.0433 FOR FACTORY-MADE PIPE WITH [illegible]
0.0200 FOR FIELD-ASSEMBLED PIPE WITH [illegible]

[illegible]

[illegible] [illegible] 3 [illegible]

[illegible] PIPE DIAMETER	INCHES	54
[illegible] NUMBER		3
HEIGHT OF COVER	FEET	[illegible]
BACKFILL SOIL [illegible]	PERCENTAGE	85
LIVE LOAD NUMBER		[illegible]
DESIGN [illegible]	LBS/SQ [illegible]	[illegible]
[illegible]	LB/FT	[illegible]
[illegible] WALL STRESS	LB/[illegible]	[illegible]
[illegible] AREA	SQIN/FT	[illegible]
[illegible]	IN	[illegible]
[illegible] FLEXIBILITY FACTOR		[illegible].005

ACCEPTABLE FLEXIBILITY FACTOR [illegible]

0.0433 FOR FACTORY [illegible]
0.0200 FOR FIELD-ASSEMBLED [illegible]

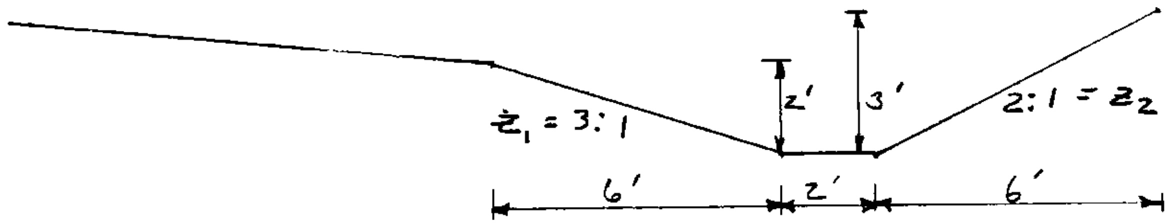
FIGURE 1

POWERS BLVD. DITCHES

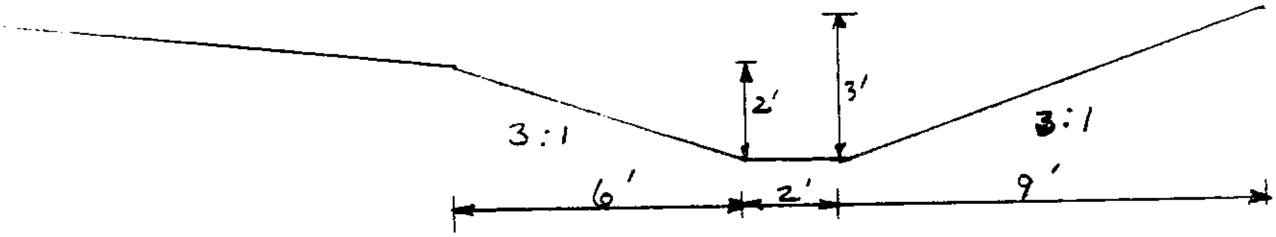
check ditches for flow, velocity, + depth

There are two typical ditch sections:

TYP. DIT. # 1
where road section is 37' asphalt & 10' gravel shoulder



TYP. DIT. #2
road section includes additional paved lane



Check 5-year & 100-year flows in both east and west roadside ditches along Powers Blvd.

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Job Title METEX
Subject Drainage - Ditches
Date 5-5-87
Job no. 8895.03
By RA
Sheet 1 of

$n = 0.035$
$b = 2'$
$z - 3:1$

DITCH FLOWS

STATION ±	SIDE	SLOPE (%)	Q_5 (cfs)	V_5 (fps)	Y_5 (ft)	Q_{100} (cfs)	V_{100} (fps)	Y_{100} (ft)
BASIN ST-1								
88+00	R	2.21	17.4	4.2	0.9	32.7	5.0	1.2
92+00	R	2.21	15.7	4.1	0.8	29.4	4.8	1.1
96+00	R	2.80	8.7	3.8	0.6	16.4	4.5	0.8
100+00	R	1.60	4.4	2.6	0.5	8.2	3.0	0.7
BASIN ST-2								
88+00	L	2.21	8.3	3.5	0.6	16.1	4.1	0.9
92+00	L	2.21	6.2	3.3	0.5	12.1	3.8	0.7
96+00	L	2.80	4.2	3.1	0.4	8.1	3.8	0.6
100+00	L	1.60	2.1	2.0	0.3	4.0	2.5	0.5
BASIN S1								
107+00	R	0.95	32.8	3.6	1.4	62.0	4.3	1.9
112+00	R	0.95	24.6	3.4	1.3	46.5	4.0	1.7
* 117+00	R	0.95	16.4	3.0	1.1	31.0	3.6	1.4
122+00	R	3.03	8.2	4.0	0.6	15.5	4.6	0.8
BASIN S1A								
107+00	L	0.95	18.6	3.1	1.1	41.5	3.9	1.6
112+00	L	0.95	14.0	2.9	1.0	31.1	3.6	1.4
* 117+00	L	0.95	9.3	2.8	0.9	20.8	3.2 ~~3.5~~	1.2 ~~1.3~~
122+00	L	3.03	4.7	3.2	0.4	16.4	4.1	0.6

* indicates Ditch #1

KKBNA
Incorporated Consulting Engineers

Job Title METEX | Date 5-5-87 | Job no. 8895.03
Subject Drainage - Ditches | By RA | Sheet 2 of

$n = 0.035$
$b = 2'$
$z = 3:1$

DITCH FLOWS

STATION ±	SIDE	SLOPE (%)	Q_5 (cfs)	V_5 (fps)	Y_5 (ft)	Q_{100} (cfs)	V_{100} (fps)	Y_{100} (ft)
BASIN S2								
133+00	R	0.70	62.7	3.8	2.0	119.5 ~~119.7~~	4.5	2.7
138+00	R	0.70	47.0	3.5	1.8	89.3	4.2	2.4
*143+00	R	1.69	31.4	4.6 ~~4.8~~	1.3 ~~1.2~~	59.6	5.4 ~~5.5~~	~~1.8~~ 1.7
*149+00	R	2.60	15.7	4.5 ~~4.7~~	0.8	29.8	5.3 ~~5.5~~	1.2
BASIN S2A								
133+00	L	0.70	17.8	2.8	1.2	39.2	3.4	1.7
138+00	L	0.70	13.4	2.5	1.0	29.4	3.2	1.5
*143+00	L	1.69	8.9	3.3 ~~3.5~~	0.7 ~~0.8~~	19.6	4.1 ~~4.2~~	1.0 ~~1.1~~
*149+00	L	2.60	4.5	3.2 ~~3.3~~	0.5	9.8	4.1	0.7
BASIN S3A								
158+00	R	1.95	11.4	3.6	0.7 ~~0.8~~	25.1	4.4	1.1
162+00	R	1.95	7.6	3.2	0.6	16.7	3.9	0.9
166+00	R	1.95	3.8	2.6	0.4	8.4	3.3 ~~3.4~~	0.6 ~~0.7~~
BASIN S3B								
*158+00	L	1.95	11.4	3.8	0.8	25.2	4.6 ~~4.7~~	1.1 ~~1.2~~
162+00	L	1.95	7.6	3.2	0.6	16.7	3.9	0.9
166+00	L	1.95	3.8	2.6	0.4	8.4	3.3 ~~3.4~~	0.6 ~~0.7~~

* indicates Ditch #1

KKBNA
Incorporated Consulting Engineers

Job Title METEX | Date 5-5-8‾ | Job no. 8895.03

Subject Drainage - Ditches | By RA | Sheet 3 of

DITCH FLOWS

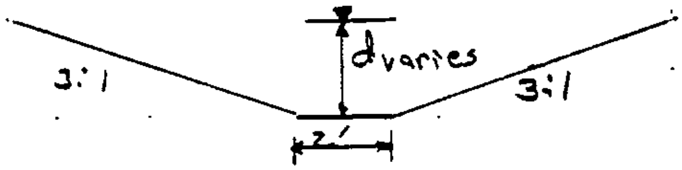
n = 0.035
b = 2'
z = 3:1

STATION †	SIDE	SLOPE (%)	Q_s (cfs)	V_s (fps)	Y_s (ft)	Q_{100} (cfs)	V_{100} (fps)	Y_{100} (ft)
BASIN 4								
172+00	R	1.87	38.1	4.9	1.3	71.4	5.7	~~1.8~~ 1.7
177+00	R	1.87	25.4	4.4	1.1	47.6	5.1 ~~5.2~~	1.5
* 182+00	R	1.28	12.7	3.3 ~~3.5~~	0.9 ~~1.0~~	23.8	3.8 ~~4.0~~	~~1.3~~ 1.2
BASIN 4A								
172+00	L	1.87	12.3	3.7	0.8	27.2	4.4	1.1
177+00	L	1.87	8.2	3.3	0.6 ~~0.7~~	18.1	4.0	0.9
* 182+00	L	1.28	4.1	2.4 ~~2.6~~	0.5	9.1	3.1	0.8
BASIN S6								
† 193+00	R	1.78	69.1 ~~66.4~~	5.5 ~~5.7~~	1.7 ~~1.8~~	132.0 ~~129.8~~	6.5 ~~6.7~~	~~2.4~~ 2.3
† 198+00	R	1.78	69.1 ~~66.4~~	5.5 ~~5.7~~	1.7 ~~1.8~~	132.0 ~~129.8~~	6.5 ~~6.7~~	~~2.4~~ 2.3
BASIN S6A								
† 203+00	R	1.78	72.8 ~~66.4~~	5.6 ~~5.5~~	1.8 ~~1.7~~	139.4 ~~129.8~~	6.6 ~~6.5~~	2.3
BASIN S7A								
190+00	L	1.28	77.6	5.0	2.0 ~~2.2~~	154.5	6.0 ~~5.7~~	~~3.0~~ 2.4
† 194+00	L	1.78	77.6	5.1 ~~5.6~~	1.8 ~~1.9~~	154.5	6.8 ~~7.0~~	~~2.6~~ 2.4
† 198+00	L	1.78	77.6	5.1 ~~5.9~~	1.8 ~~1.9~~	154.5	6.8 ~~7.0~~	~~2.6~~ 2.4
† 202+00	L	1.78	77.6	5.1 ~~5.9~~	1.8 ~~1.9~~	154.5	6.8 ~~7.0~~	~~2.6~~ 2.4
† * 206+00	L	1.78	77.6	5.9	1.9	154.5	7.0	2.6

* indicates DITCH #1
† INDICATES RIPRAP REQUIRED

SPECIAL DITCHES FROM
POWER TO SAND CREEK AT GALLEY,
OMAHA, AND PALMER PARK

DITCH SECTION (TYP)



LOCATION	SLOPE (%)	Q_{100} (cfs)	V_{100} (fps)	Y_{100} (ft)
GALLEY	1.0	158.3	ǂ 5.5	2.8
OMAHA	0.8	64.3	~~4.1~~ 4.0	~~2.1~~ 2.0
PALMER PARK	0.88	98.6	~~4.7~~ 4.6	~~2.4~~ 2.3

ǂ INDICATES RIPRAP REQUIRED

THESE NUMBERS WERE COMPUTED USING MANNINGS EQUATION WITH $n = 0.035$, $b = 2$, $z = 3$

KKBNA

Incorporated
Consulting Engineers

Job Title METEX | Date 6/15/87 | Job no. 8895.03

Subject DRAINAGE | By JAF | Sheet 1 of

VELOCITY CHECK DURING 5 YEAR STORM AT GALLEY IN NORTH DITCH OUTLETING TO SAND CREEK

Q_5 (from 60" culvert) = 62.7 cfs
Q_5 (west ditch) = 15 cfs

Q_5 TOTAL = 77.7 cfs

USE MANNINGS EQT'N TO CALCULATE VELOCITY WHERE:

S = 1.0%
b = 2'
Z = 3H:1V
n = 0.035

FOR 80.0 cfs
y = 2.1'

V_5 = 4.64 fps < 5.0

∴ no ditch protection req'd.

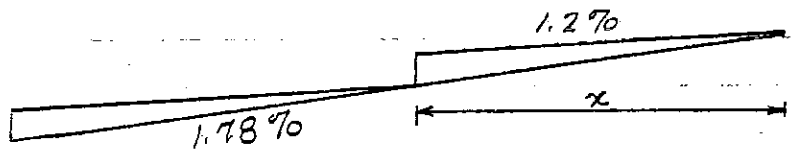
WEST DITCH STA 195+20 TO 208+00

S = 1.78% Q_5 = 77.6 CFS V_5 = 5.7 FPS Y = 1.8'

5 year velocity must be < 5.0 FPS

∴ need S = 1.2% ⟹ Q = 79 CFS, Y = 2.0', & V = 4.9 FPS

CALCULATE NUMBER OF DROPS NEEDED & SPACING:



$.0178x - .012x = 1'$
$x = 172'$

Length of channel = 1280'

∴ 8 - 1' DROPS NEEDED @ 172'

EAST DITCH STA 203+00 TO 208+00

S = 1.78% Q_5 = 72.8 CFS V_5 = 5.6 FPS Y = 1.8'

5 year velocity must be < 5.0 FPS

∴ need S = 1.25% ⟹ Q = 73 CFS, Y = 1.9', & V = 4.9 FPS

CALCULATE THE NUMBER OF DROPS NEEDED & SPACING

$.0178x - .0125x = 1'$
$x = 188'$

Length of channel = 500'

∴ 3 - 1' DROPS @ 188'

NOTE: THESE DROPS WILL BE CONTINUED IN THE NEXT PHASE OF CONSTRUCTION. (BEYOND STA. 208+00)

EAST DITCH SAND CREEK TO STA 199+00

$S = 1.78\%$ $Q_5 = 69.1$ CFS $V_5 = 5.5$ FPS $Y_5 = 1.7'$

5 year velocity must be < 5.0 FPS

∴ need $S = 1.25\%$ ⇒ $Q = 73$ CFS, $Y = 1.9'$ & $V = 4.9$ FPS

$x = 188'$ (FROM PREVIOUS CALC.)

Length of channel = 550'

∴ USE 3-1' DROPS @ 183'

DROPS @ STA 193+50, 195+33, 197+16

WEST DITCH FROM SAND CREEK TO VICTOR PLACE

$S = 1\%$ $Q_5 = 77.6$ CFS $V_5 = 4.6$ FPS $Y_5 = 2.1'$
OK, NO CHECKS OR PROTECTION NEEDED

NOTE: STEEP ENTRANCES TO CULVERTS WILL BE PROTECTED BY RIPRAP.

KKBNA
Incorporated
Consulting Engineers

Job Title METEX　　Date 6-17-87　　Job no. 8895

Subject CHECK DAM LOCATIONS　　By JET　　Sheet　　of

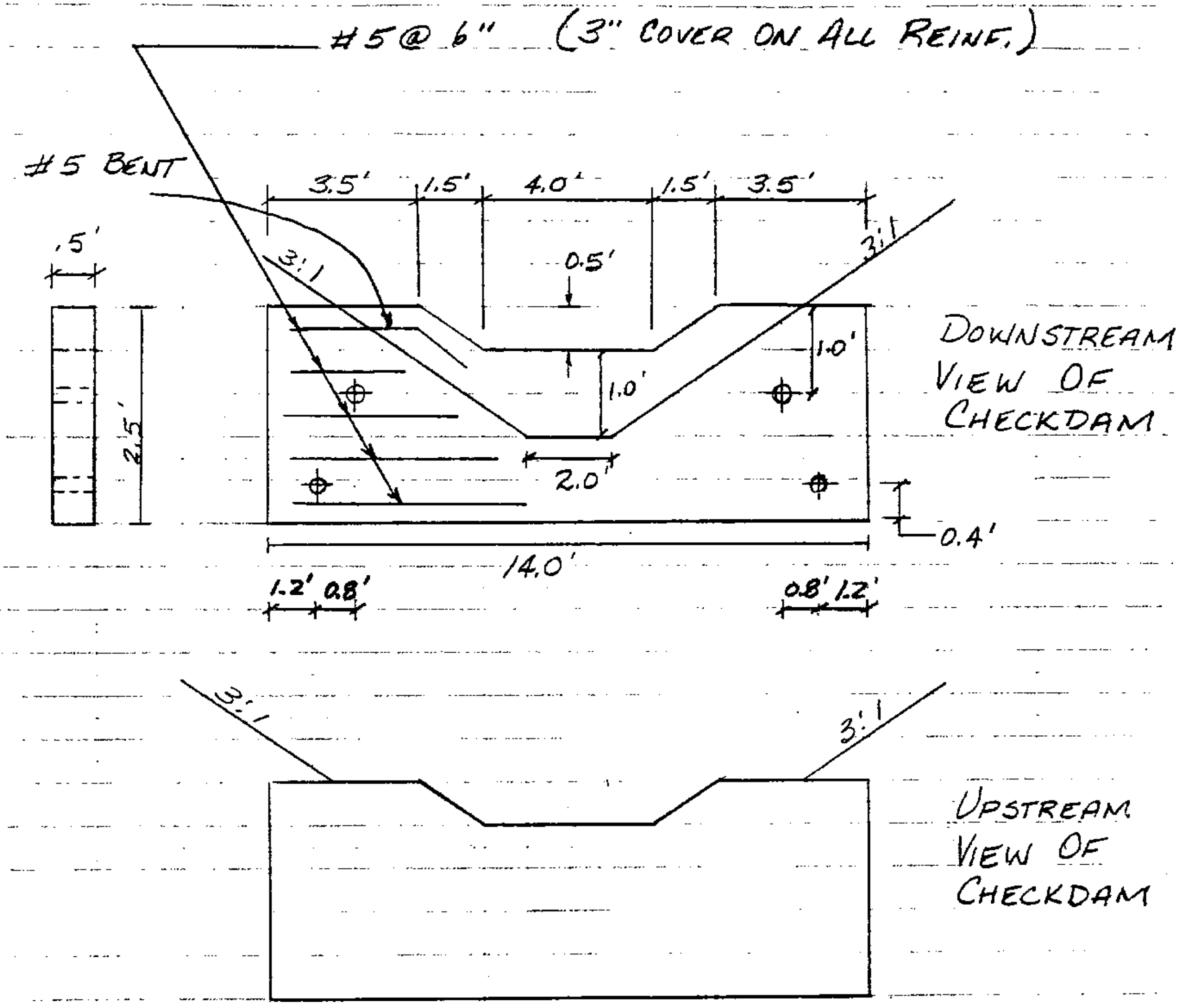
CHECK DAM LOCATIONS

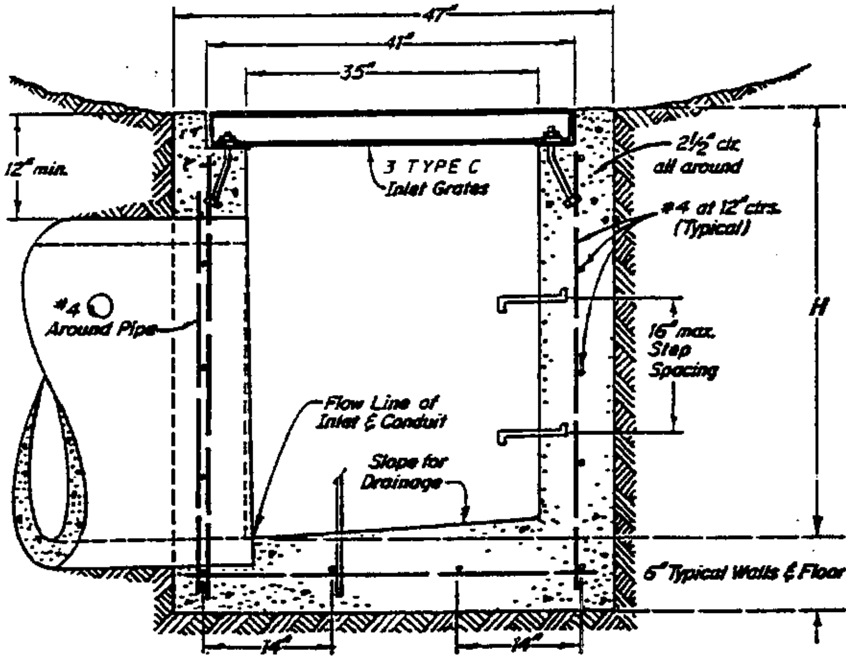
WEST	EAST
195+20	193+50
196+92	195+33
198+64	197+16
200+36	
202+08	203+00
203+80	204+88
205+52	206+76
207+24	

KKBNA
Incorporated
Consulting Engineers

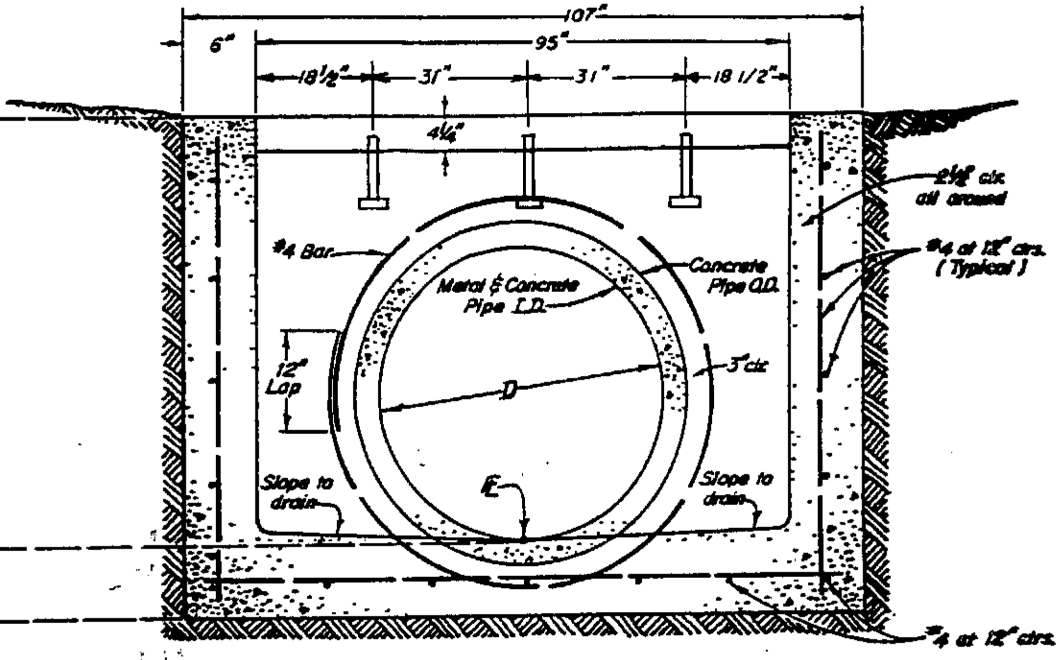
Job Title METEX — Date 6-17-87 — Job no. 8895

Subject CHECK DAM DETAIL — By JET — Sheet — of

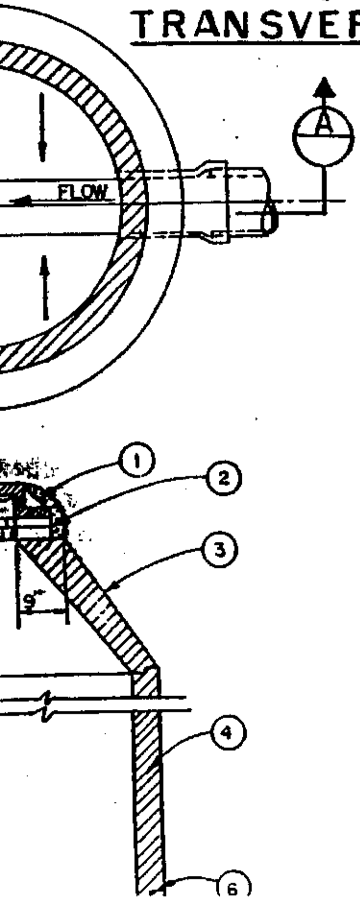


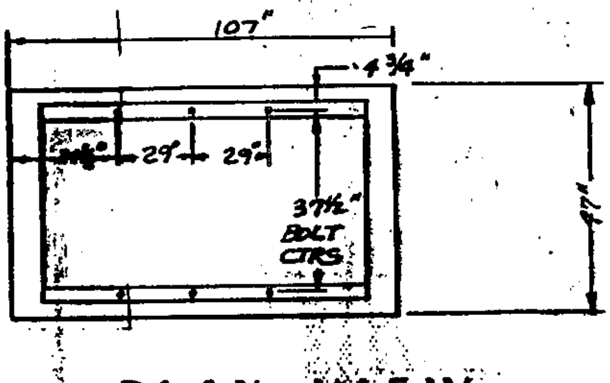


TRANSVERSE CROSS SECTION



LONGITUDINAL CROSS SECTION





PLAN VIEW
SHOWING ANCHOR BOLT LAYOUT

GENERAL NOTES

All work shall be done in accordance with the Standard Specifications applicable to the project.

Concrete shall be Class A or B.

See plans for size and location of Conduit.

Inlet Grating shall be galvanized as described for Frames, Grates, Covers & Steps in Section 712.

All exposed concrete surfaces shall receive Class I finish.

Footings in rock shall be poured out to rock and not formed.

Inlet may be Cast-in-Place or Precast.

Steps will be required when Inlet "H" exceeds 3'-6".

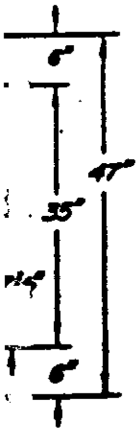
For detail of Inlet Step, see Standard M-604-D.

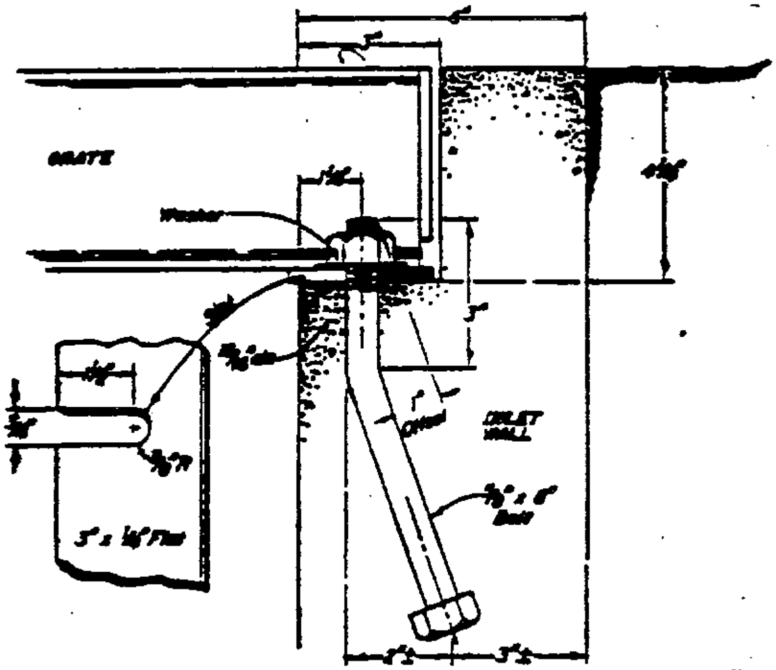
Steps shall be included in the cost for "Inlet, Type D".

Grating shall conform to Section 604.

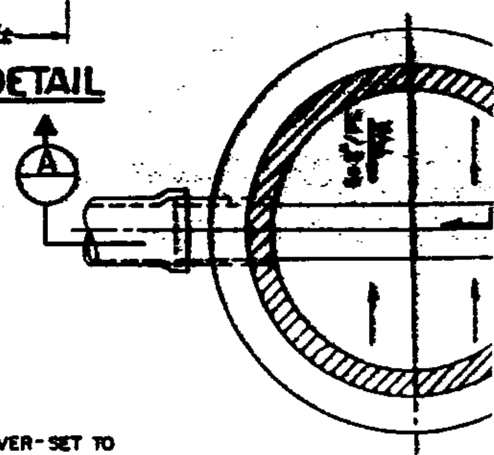
DETAIL FOR OMAHA
TYPE D INLET (3 GRATES)

DETAIL FOR OMAHA
TYPE 1 INLET (SPECIAL)





GRATE INSTALLATION DETAIL



GENERAL NOTES

All work shall be done in accordance with the Standard Specifications applicable to the project.

All concrete shall be Class A or B.

For detail of Inlet Step, see M-Standard "Steps for Manholes and Inlets".

All reinforcing bars shall be deformed, of intermediate grade, and shall be tagged with the station number and bar designation.

All edge distances not marked "clear" are to ℄ of bar.

Concrete slope and ditch paving shall conform to Section 507. Reinforcement for concrete slope paving shall be WWF 4 x 4 -W1.4 x W1.4 or WWF 6x6 -W2.1 x W2.1.

Grating shall conform to Section 604.

Inlet grating shall be galvanized as described for Frames, Grates, Covers and Steps in Section 712.

Steps or ladder will be required when Inlet "H" exceeds 3'-6".

Y——— Concrete Slope and Ditch Paving will be required when shown on Plans.

NOTES:

1. RING & COVER-SET TO PARALLEL FINISHED SURFACE.
2. RING & COVER GRADE AD-JUSTMENT-PRECAST RINGS OR BRICK LEVELING COURSE.
3. PRECAST ECCENTRIC CONE
4. PRECAST BARREL RISER SECTION WITH STEPS
5. FOR PVC & ABS COMPOSITE PIPE, USE EXPANDABLE WATER STOP OR SPECIAL SLEEVE AS PER MANUFACTURER'S SPECIFICATIONS
6. JOINT SEALANT: RUBBERNEK
7. BASES CAST IN PLACE CONCRETE

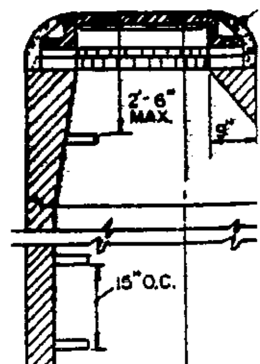


TABLE 1 - SLOPING RIPRAP DROP STRUCTURE DESIGN CHART

MAXIMUM UNIT DISCHARGE q (cfs/ft	ALLOWABLE CHUTE SLOPE - So FOR EACH RIPRAP CLASSIFICATION			LENGTH OF DOWNSTREAM APRON L_B (Ft)
	M	H	VH	
15	0 to 7:1	7:1 to 4:1	N/A	15
20	0 to 8:1	8:1 to 5:1	5:1 to 4:1	20
25	0 to 10:1	10:1 to 6:1	6:1 to 4:1	20
30	0 to 12:1	12:1 to 7:1	7:1 to 4.5:1	25
35	0 to 13:1	13:1 to 8:1	8:1 to 6:1	25
DR*	1.75'	2.6'	3.5'	
DR*	2.0'	3.0'	4.0'	
DRW	1.5 x DR	1.25 x DR	1.0 x DR	

* For Erosion Resistant, Cohesive Soils
** For Sandy or Highly Erosive Soils

NOTES:

1. q = Unit discharge = VnYn, where Vn = average channel velocity and Yn = normal depth of the upstream channel.
2. So = Longitudinal channel slope expressed in feet horizontal per foot vertical.
3. Dr = Depth of riprap blanket in feet.
4. Drw = Depth of riprap blanket at the downstream face of the crest wall.
5. Rock size, Dr and Drw shall be the same throughout the drop structure.
6. Chute and channel side slopes shall not be steeper than 4:1.
7. Maximum allowable drop = 4.0'
8. See "Urban Storm Drainage Criteria Manual" for riprap gradation, classification and bedding requirements.
9. This chart is for ordinary riprap structures only. The dimensions contained herein should not be used for grouted riprap or other types of drop structures. Other types of drop structures require their own hydraulic analysis.

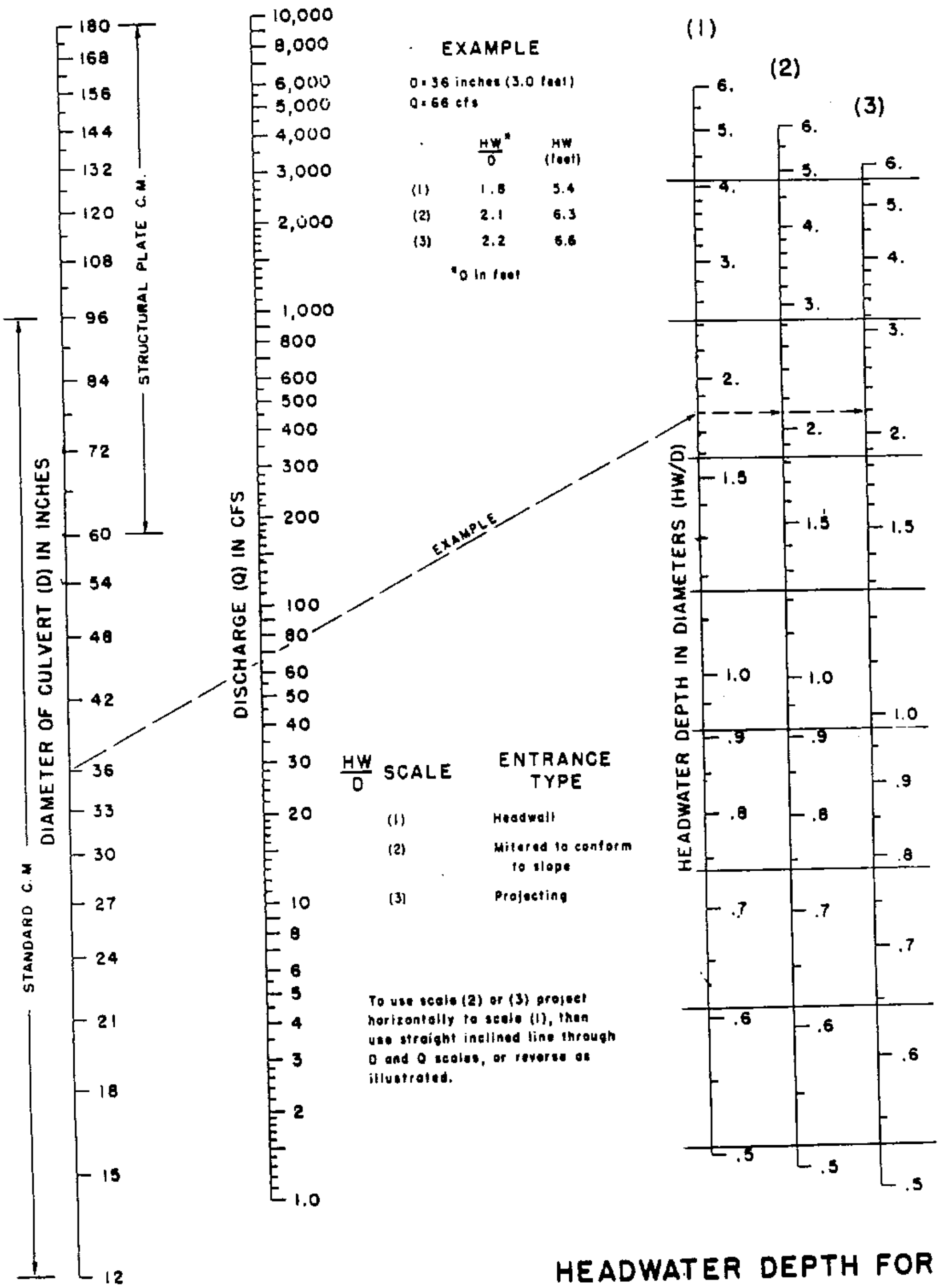
CURB OPENING INLET CAPACITIES (cfs)

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	9.6	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	16.0	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	13.9	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

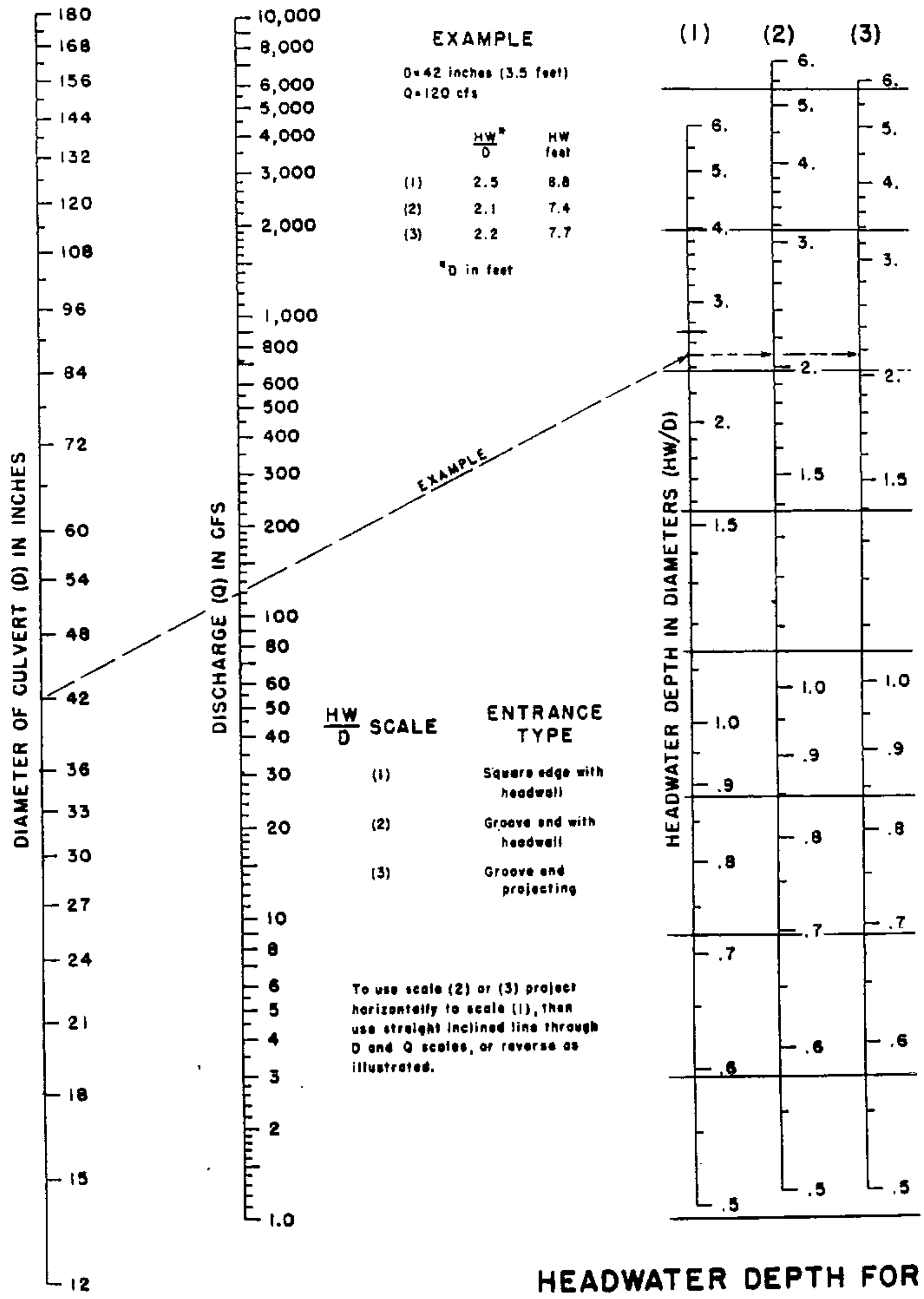
Revised: C.Aamold/5-16-74



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

BUREAU OF PUBLIC ROADS JAN. 1963

CHART 2



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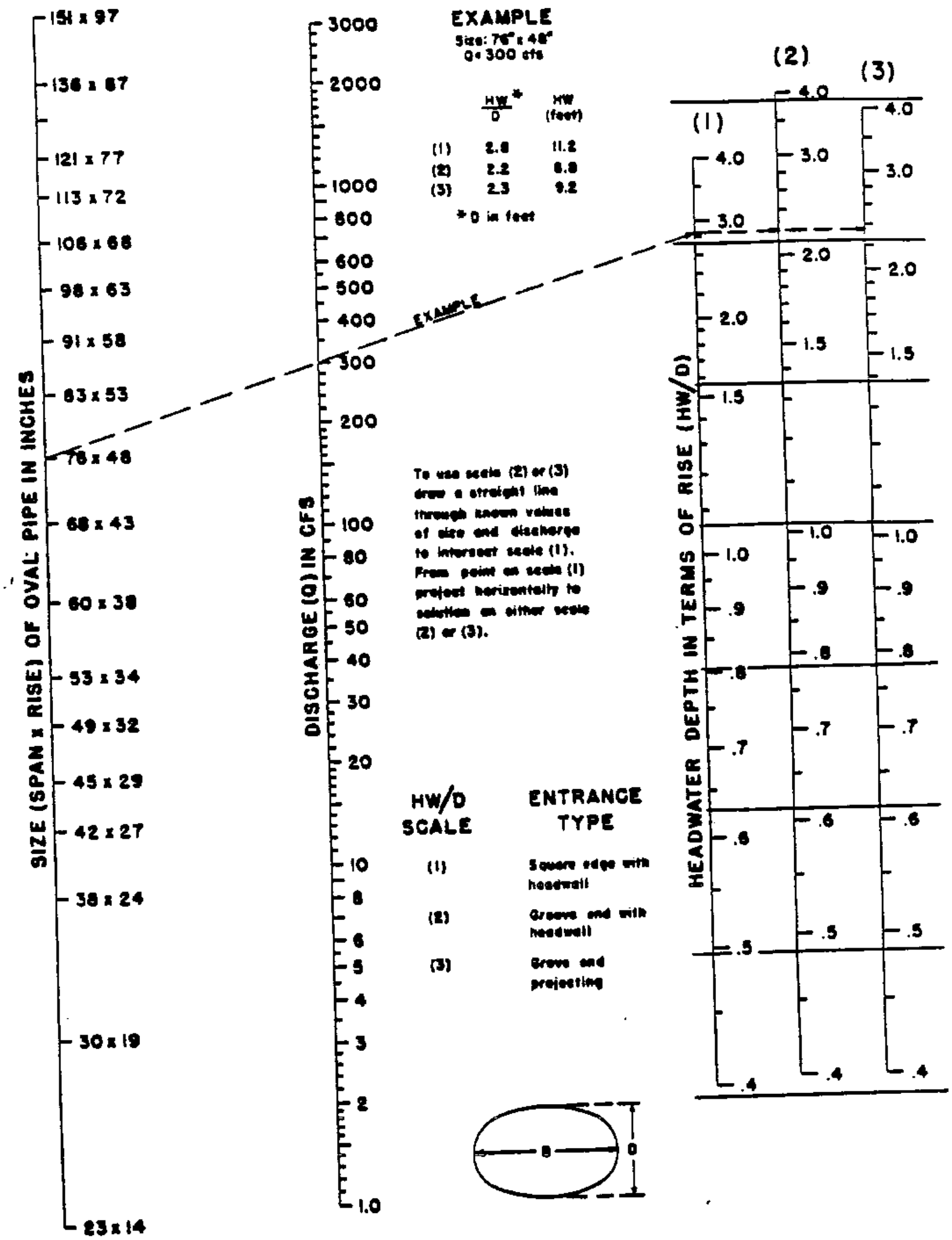
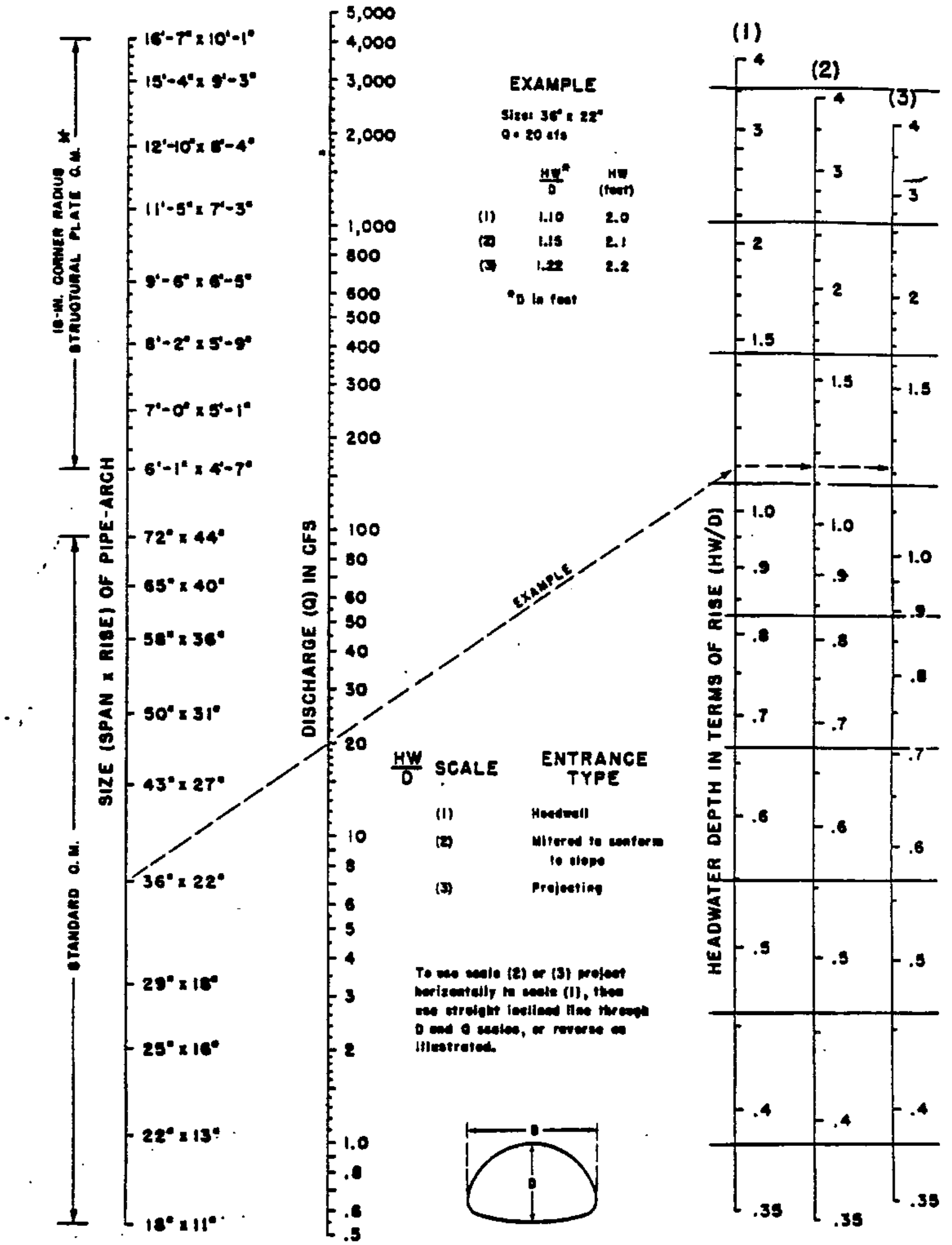
HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

CHART 3



HEADWATER DEPTH FOR
OVAL CONCRETE PIPE CULVERTS
LONG AXIS HORIZONTAL
WITH INLET CONTROL

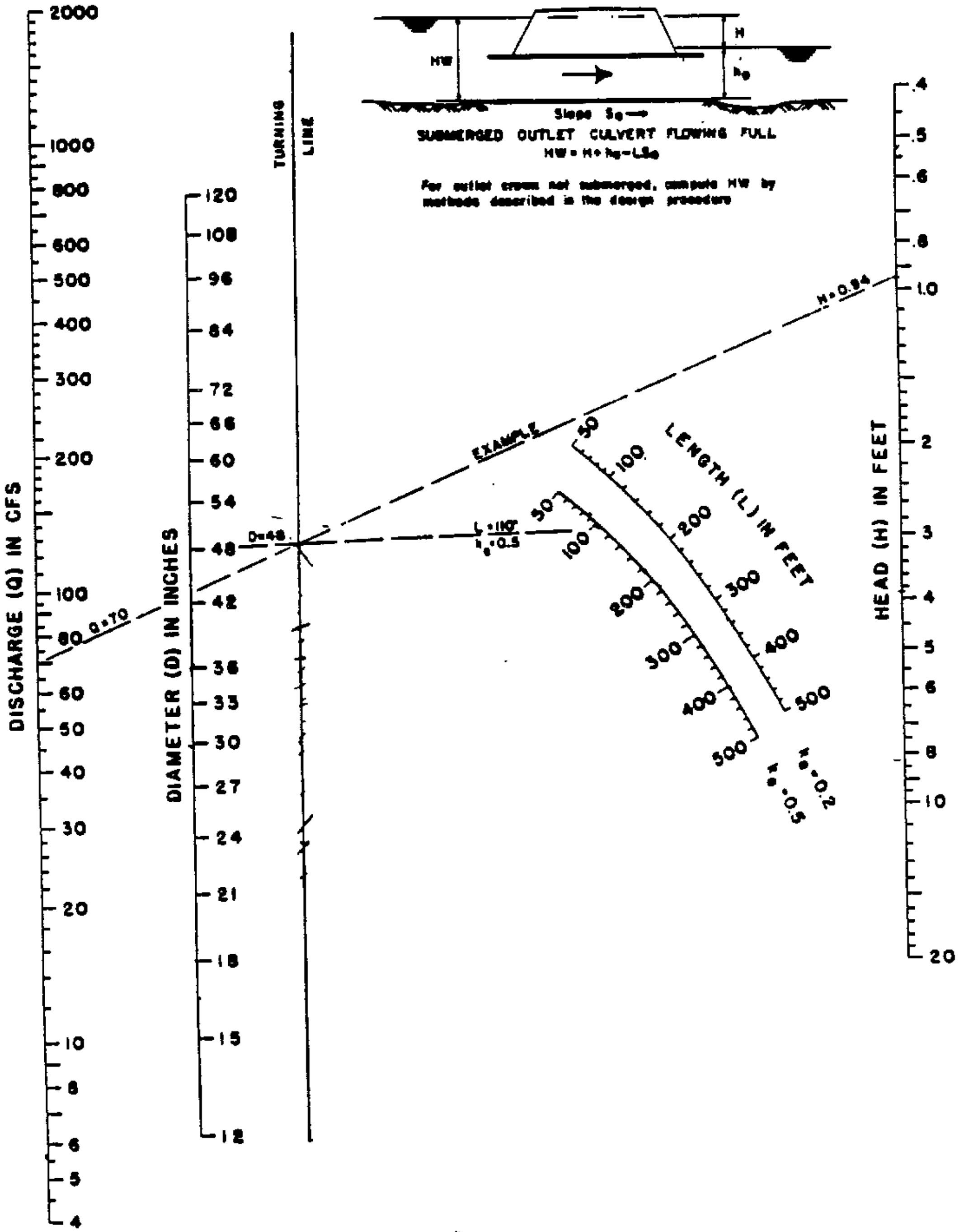
BUREAU OF PUBLIC ROADS JAN. 1963



*ADDITIONAL SIZES NOT DIMENSIONED ARE LISTED IN FABRICATOR'S CATALOG

BUREAU OF PUBLIC ROADS JAN. 1963

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



HEAD FOR CONCRETE PIPE CULVERTS FLOWING FULL
n = 0.012

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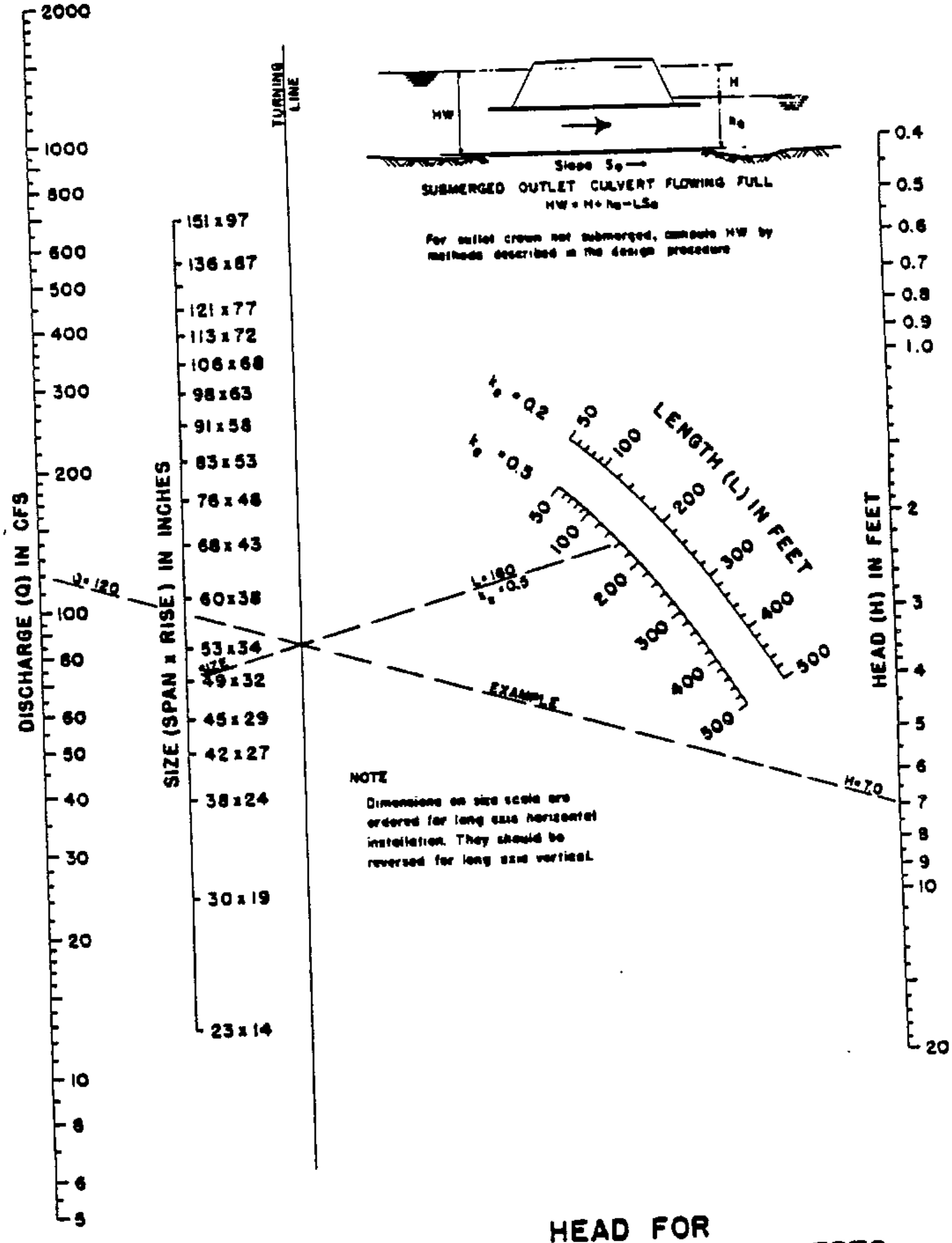
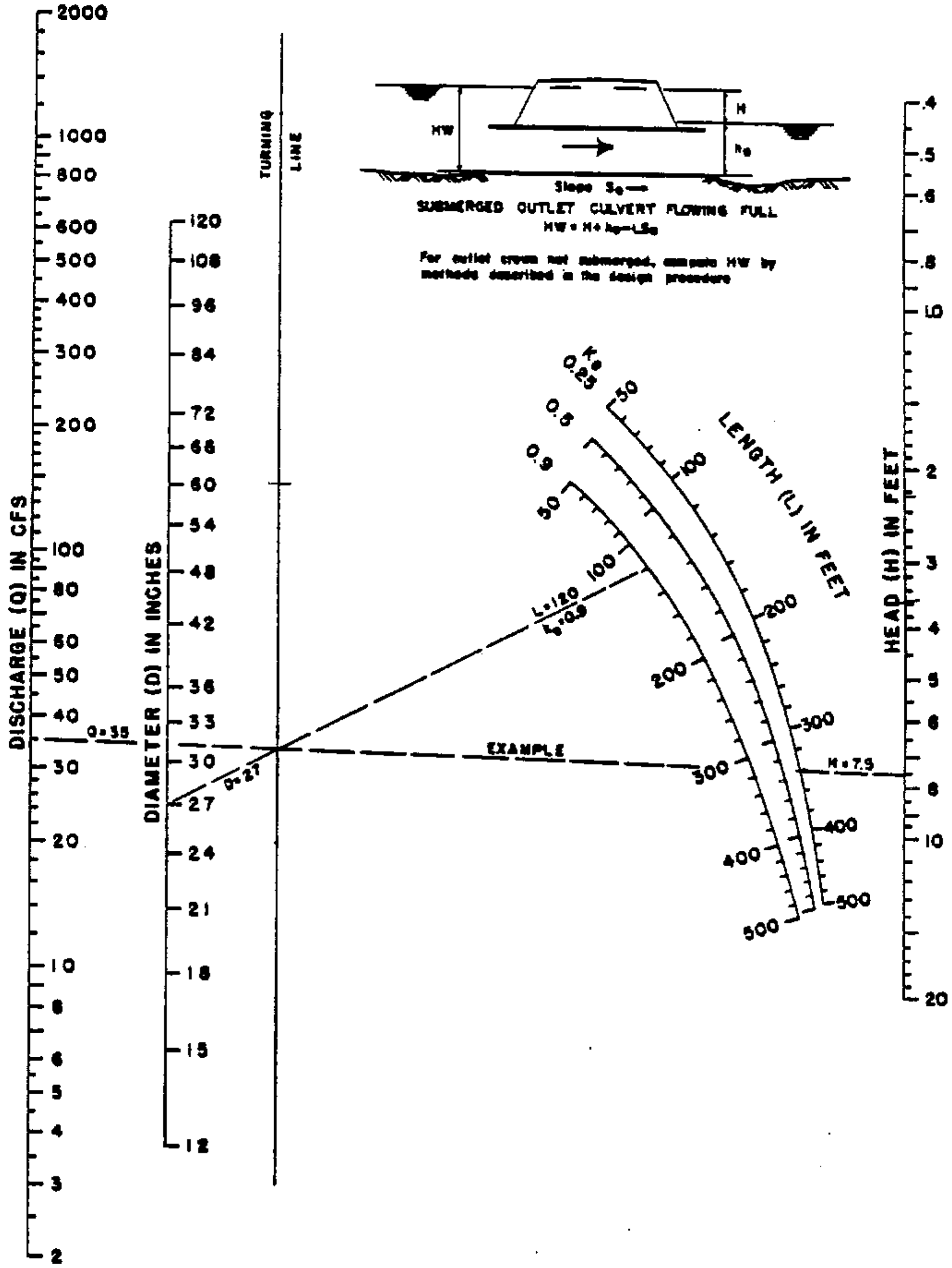


HEAD FOR OVAL CONCRETE PIPE CULVERTS LONG AXIS HORIZONTAL OR VERTICAL FLOWING FULL

$n = 0.012$

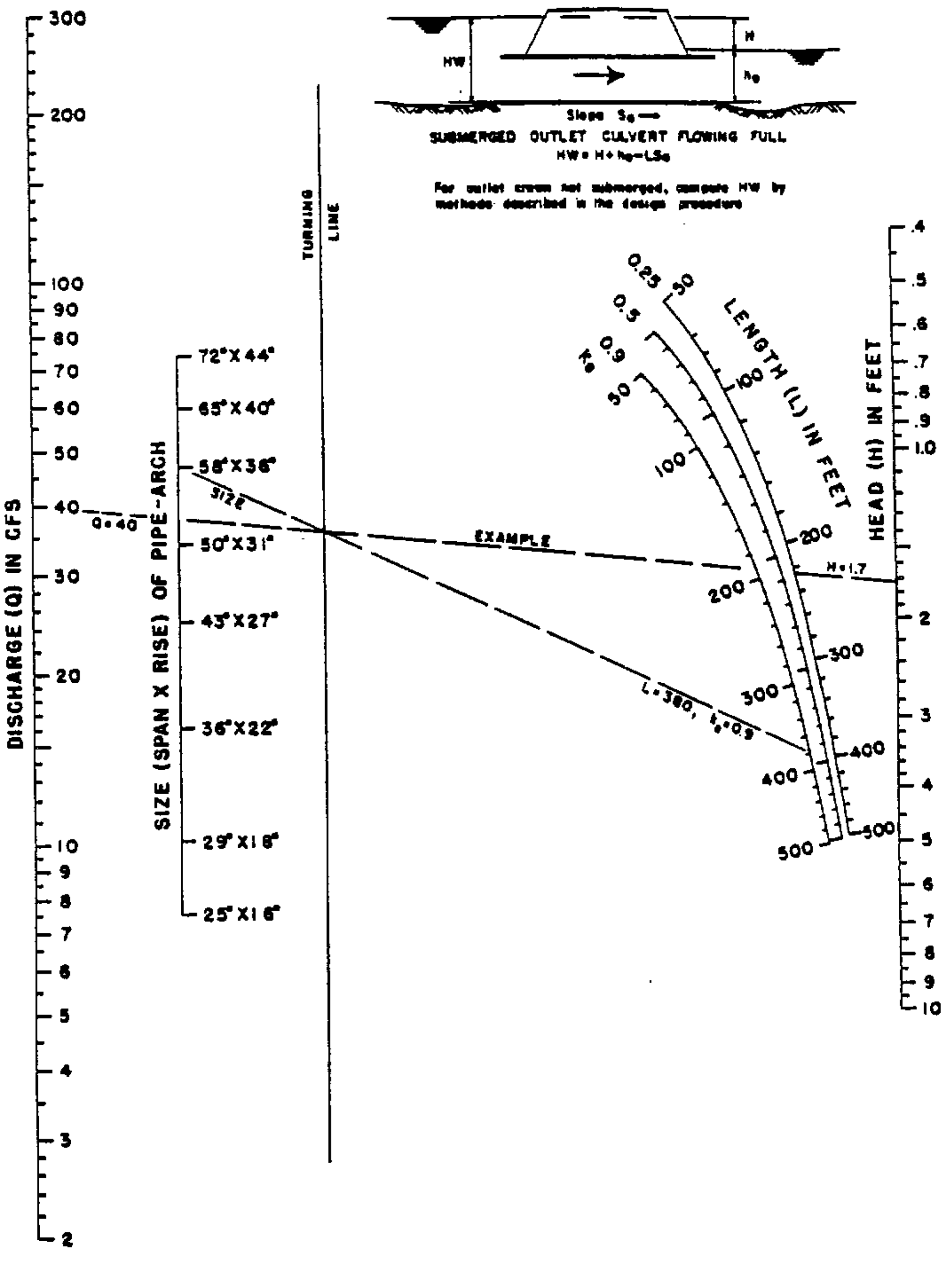
BUREAU OF PUBLIC ROADS JAN. 1963



HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

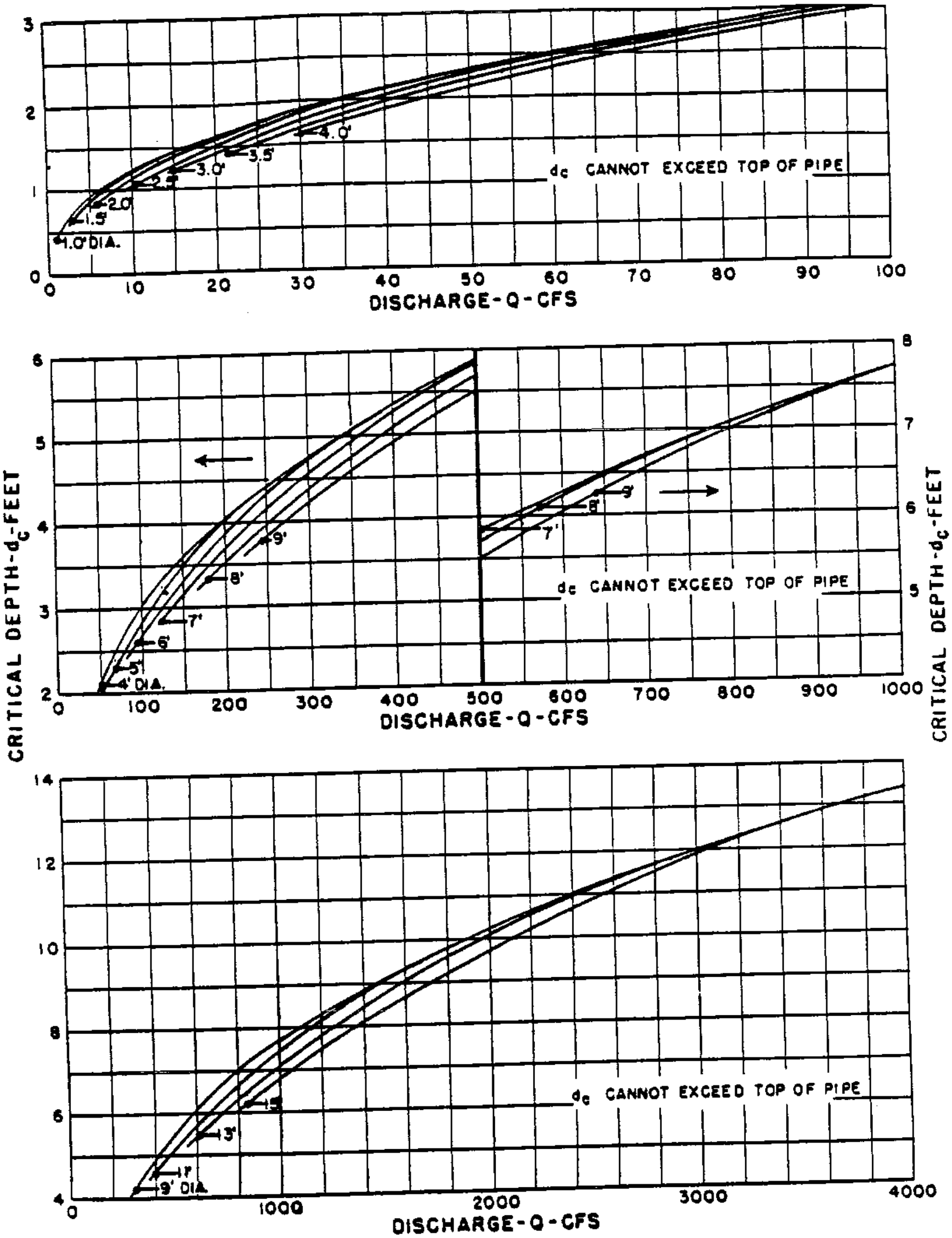
BUREAU OF PUBLIC ROADS JAN. 1963

CHART 12



BUREAU OF PUBLIC ROADS JAN. 1963

HEAD FOR STANDARD C. M. PIPE-ARCH CULVERTS FLOWING FULL n=0.024



BUREAU OF PUBLIC ROADS
JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

FIGURE 25

CRITICAL DEPTH
CIRCULAR PIPE

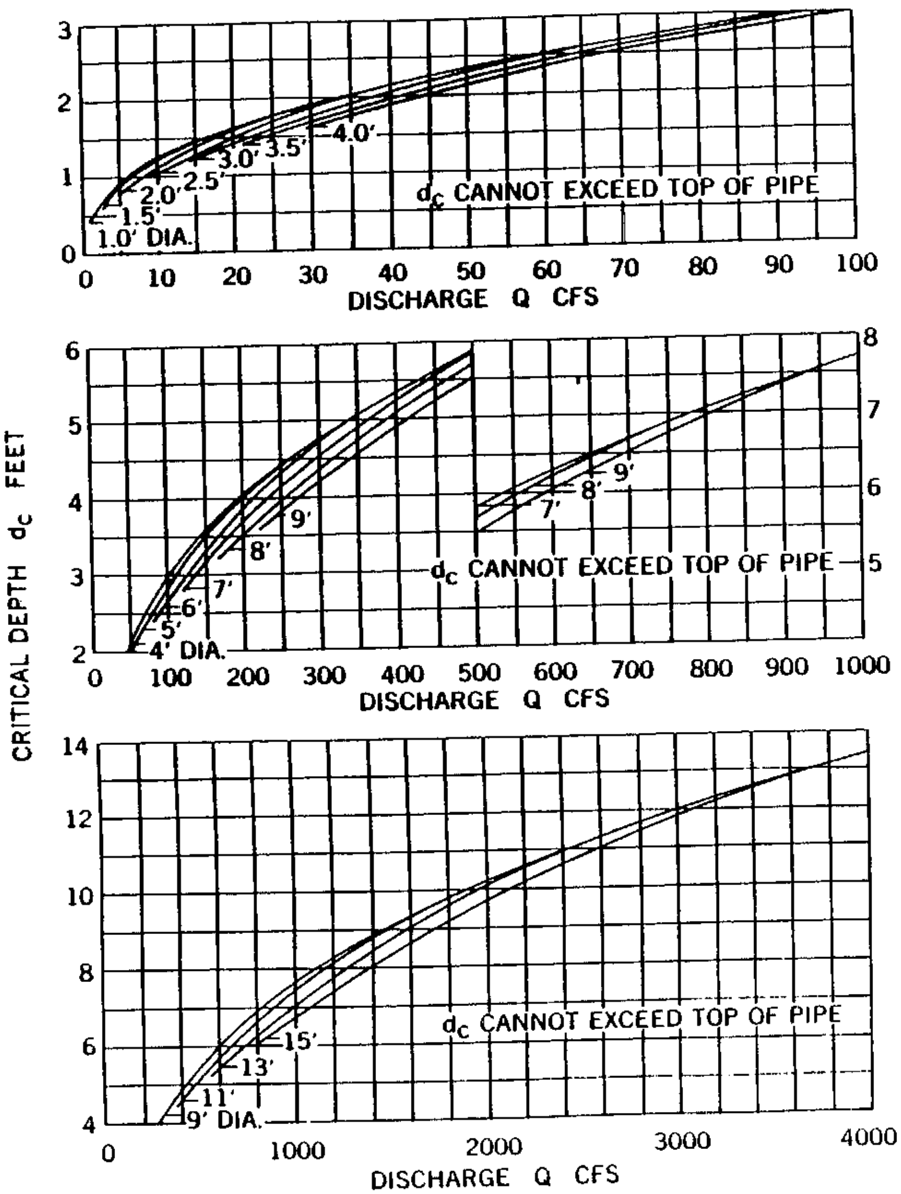
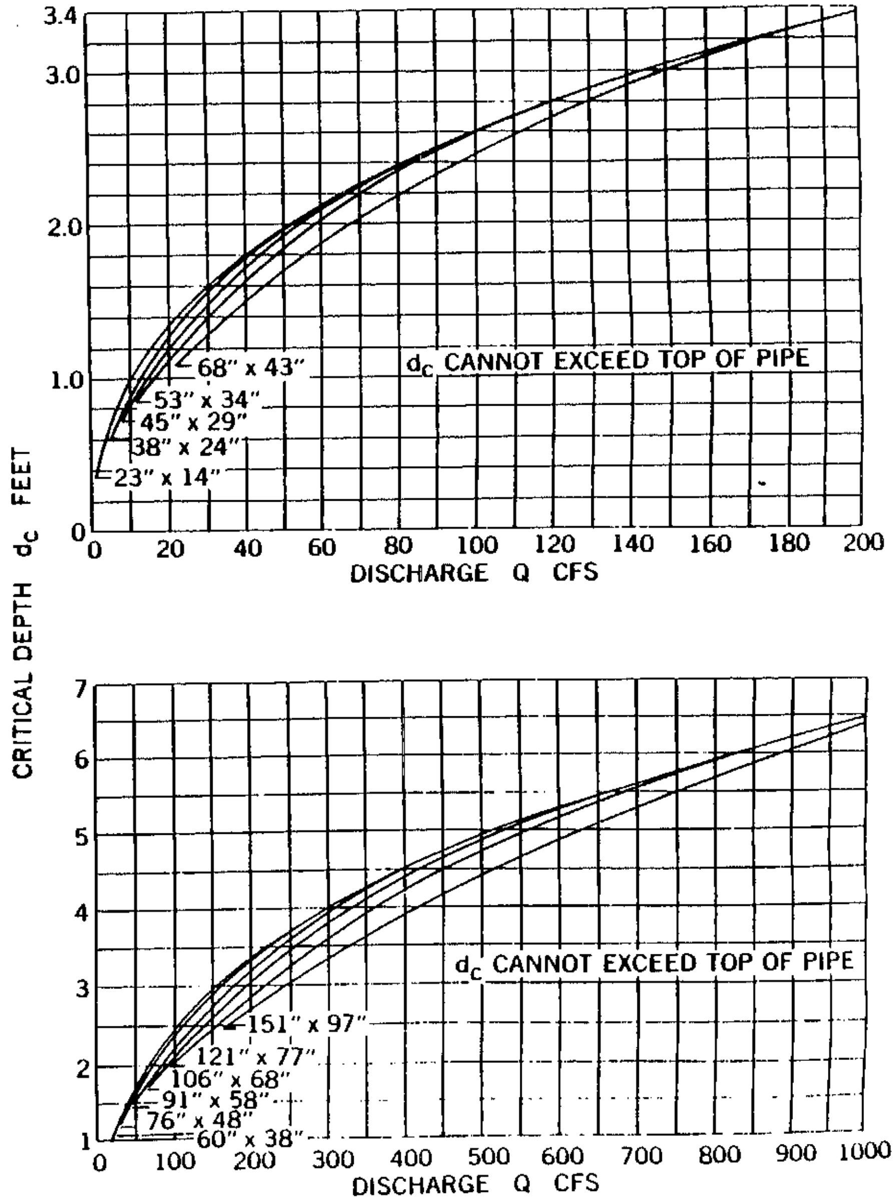


FIGURE 26

CRITICAL DEPTH
HORIZONTAL ELLIPTICAL PIPE



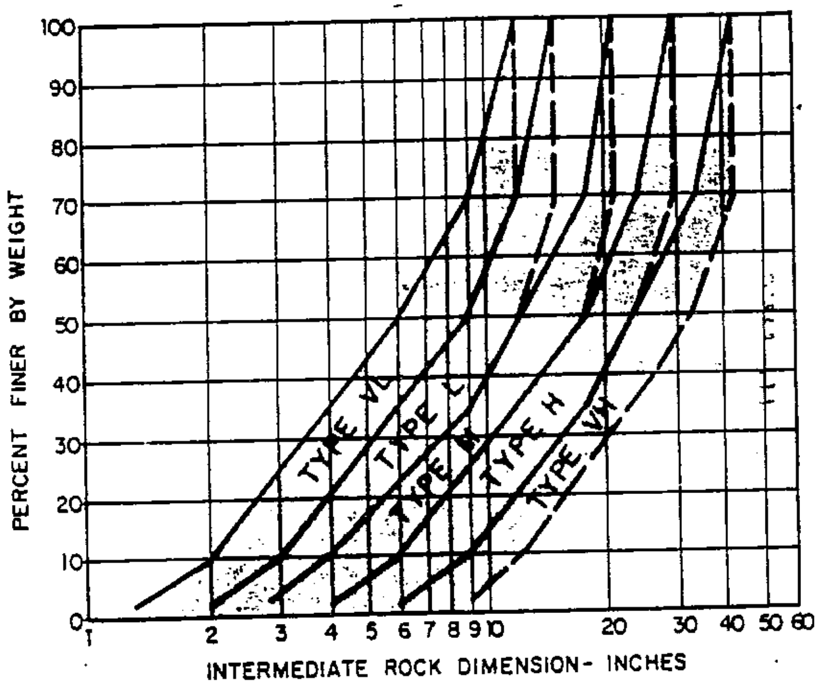
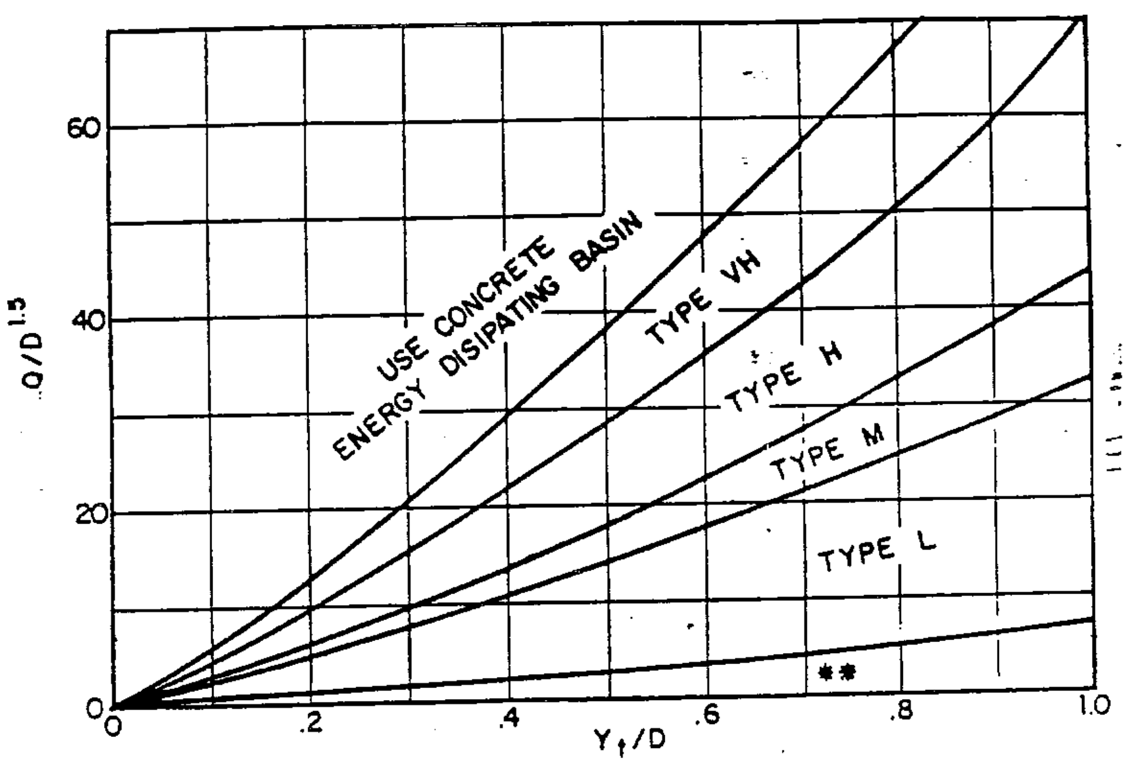
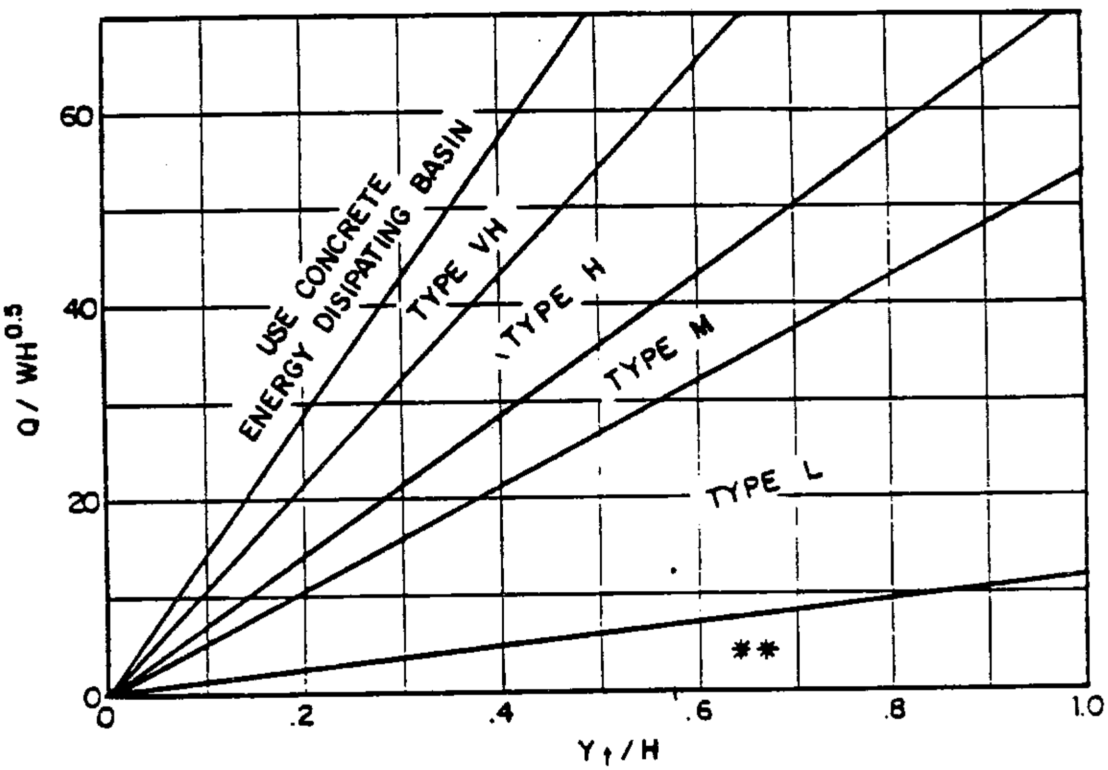


FIGURE 5-1. GRADATION OF ORDINARY RIPRAP



Use D_a instead of D whenever flow is supercritical in the barrel.
** Use Type L for a distance of 3D downstream.

FIGURE 5-7. RIPRAP EROSION PROTECTION AT CIRCULAR CONDUIT OUTLET.



Use H_a instead of H whenever culvert has supercritical flow in the barrel.
**Use Type L for a distance of 3H downstream

FIGURE 5-8. RIPRAP EROSION PROTECTION AT RECTANGULAR CONDUIT OUTLET.

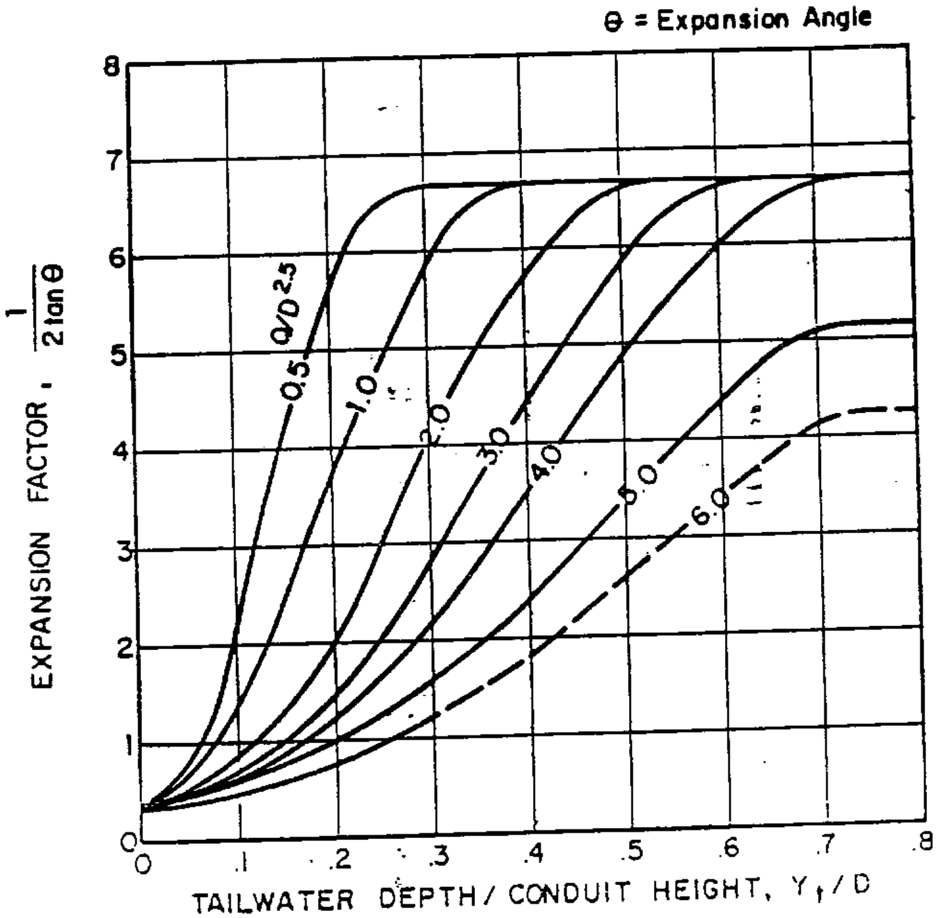


FIGURE 5-9. EXPANSION FACTOR FOR CIRCULAR CONDUITS

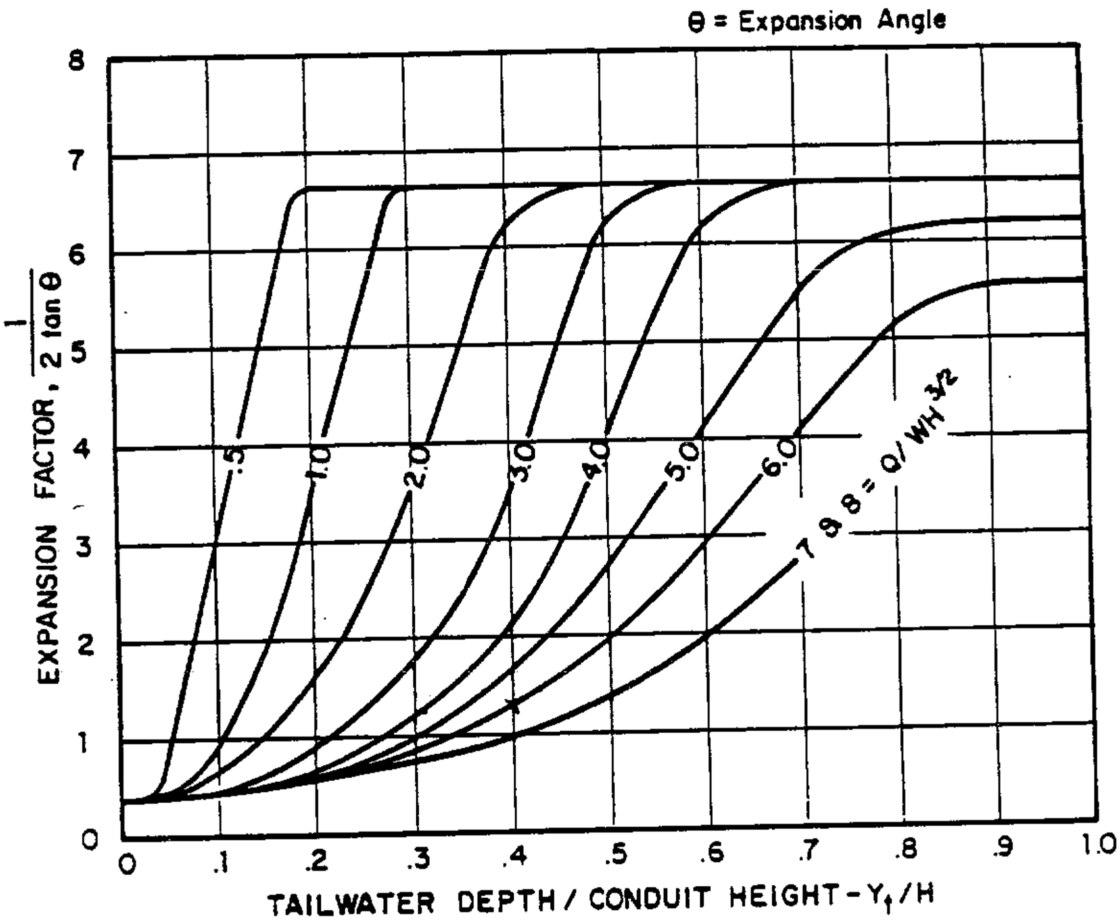


FIGURE 5-10. EXPANSION FACTOR FOR RECTANGULAR CONDUITS

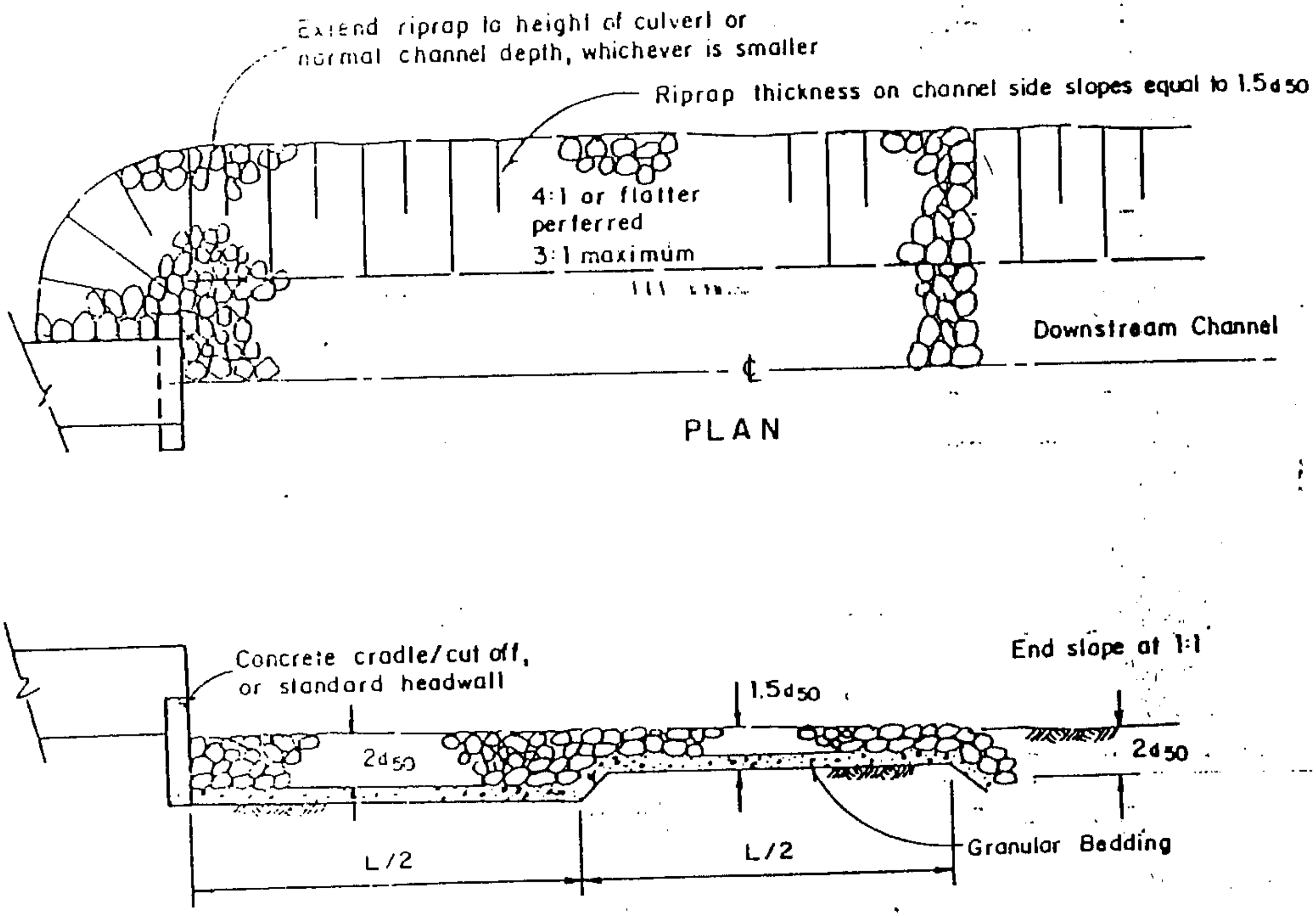


FIGURE 5-6 CONDUIT OUTLET EROSION PROTECTION

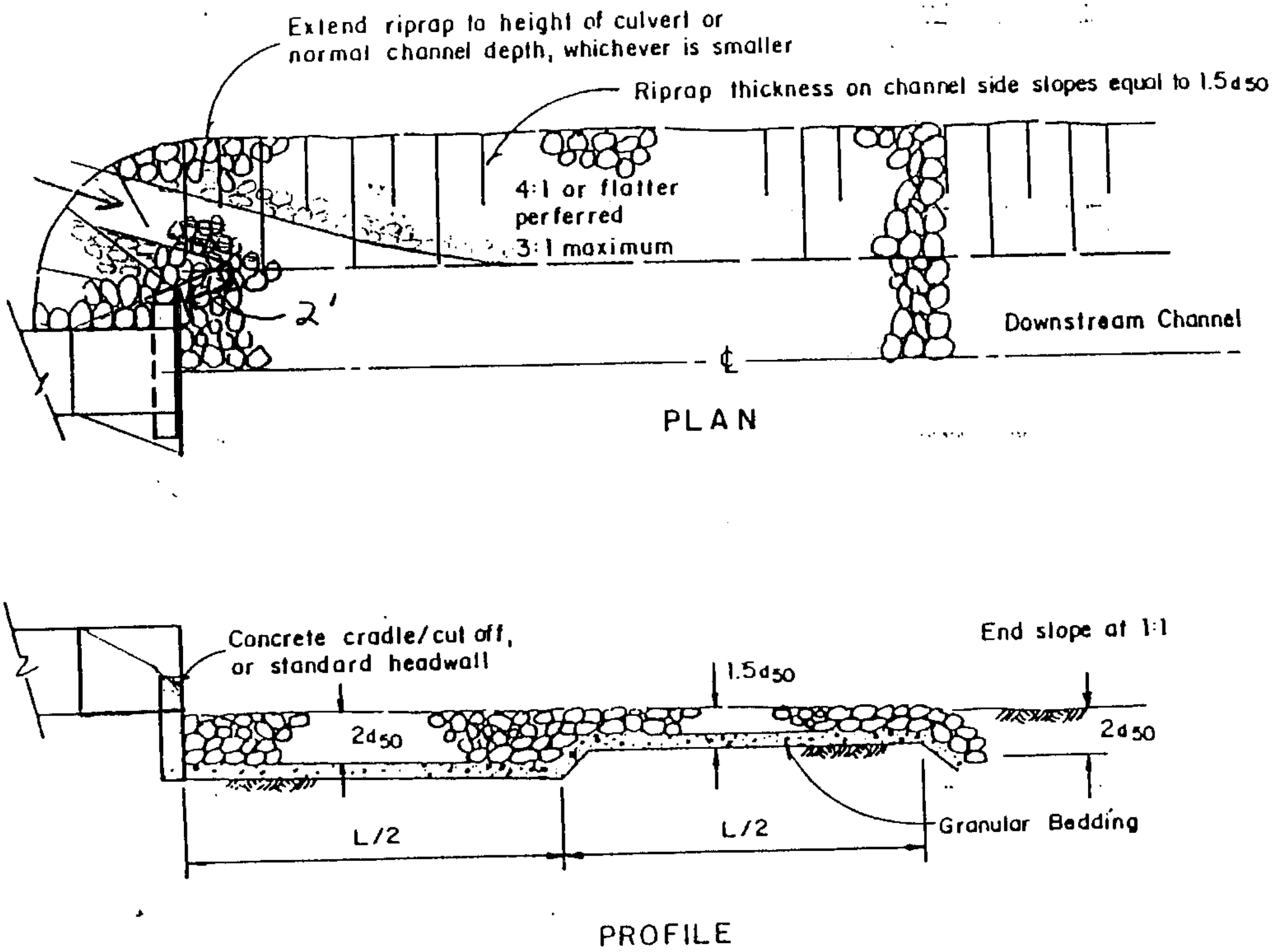


FIGURE 5-6. CONDUIT OUTLET EROSION PROTECTION

Table 2-2.--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
1/4 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.[5]	98	98	98	98
Streets and roads:				
paved with curbs and storm sewers[5]	98	98	98	98
gravel	76	85	89	91
dirt	72	82	87	89

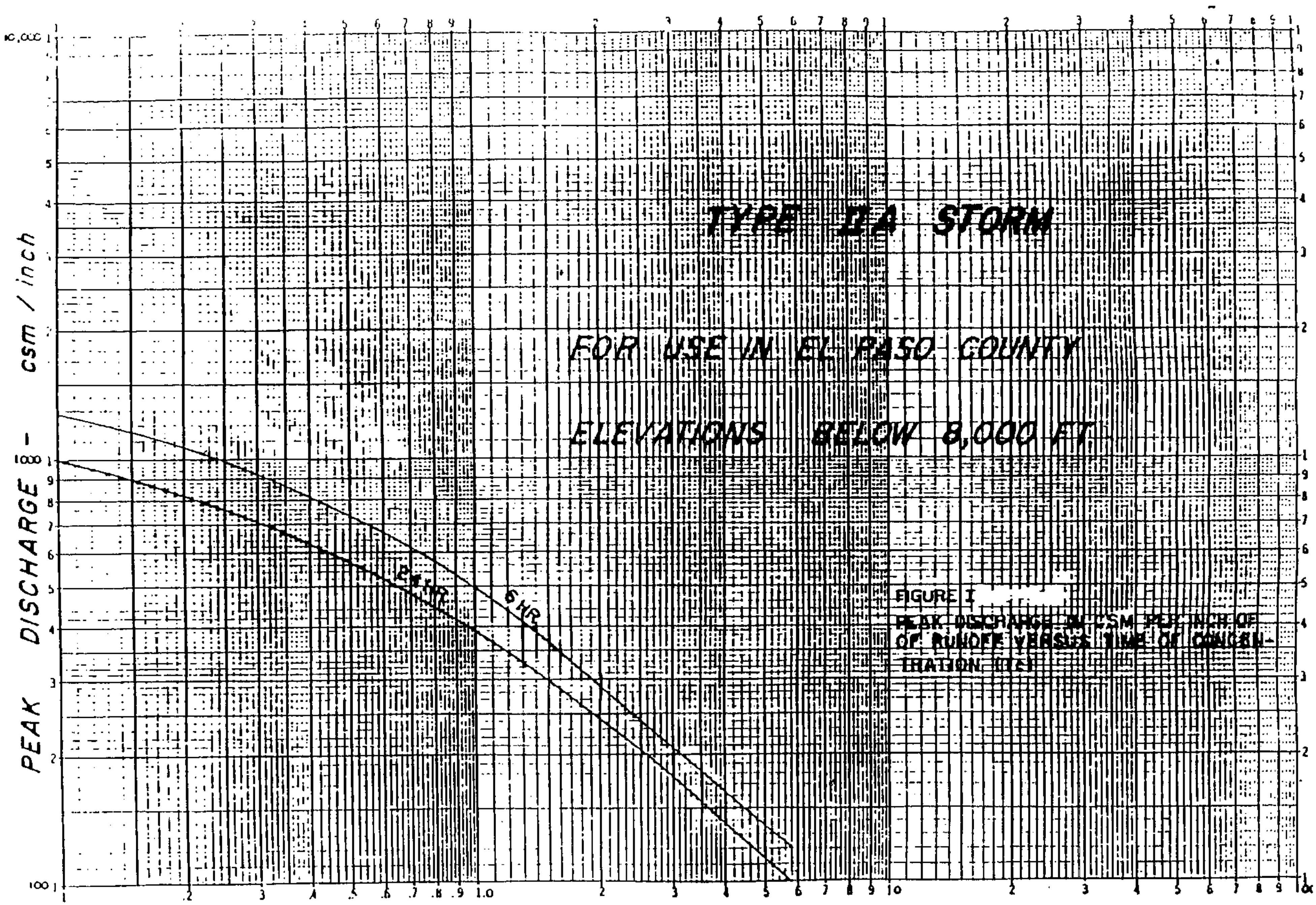
[1] For a more detailed description of agricultural land use curve numbers refer to National Engineering Handbook, Section 4, Hydrology, Chapter 9, Aug. 1972.

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

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

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

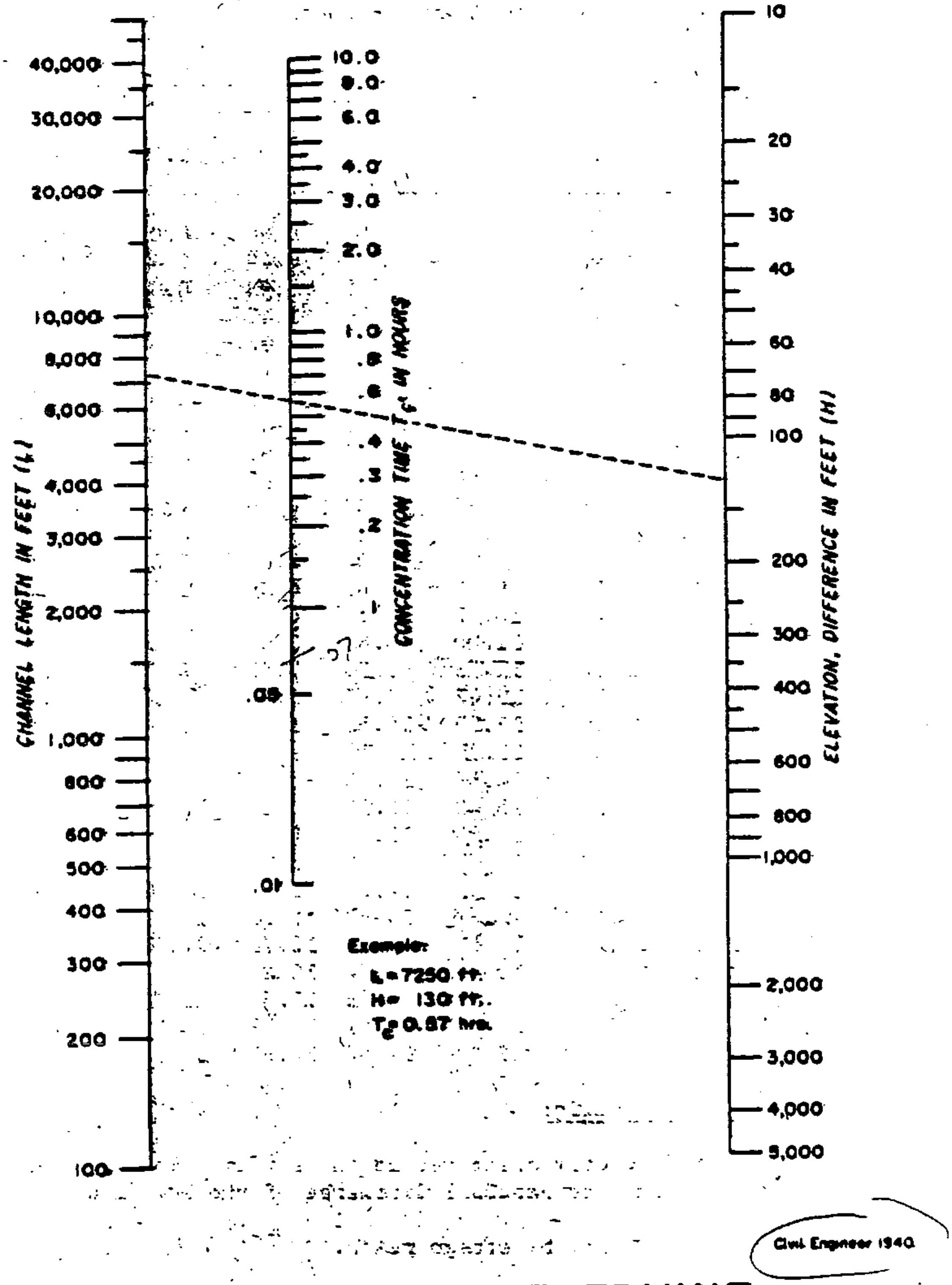
[5] In some warmer climates of the country a curve number of 95 may be used.



TIME OF CONCENTRATION - HOURS

FIGURE I

Revised 7-13-77 CA



NOMOGRAPH TO DETERMINE TIME OF CONCENTRATION

For Use on Drainage Areas ≷ 1,000 Acres

FIGURE S—6

then computed by dividing the total overland flow length by the average velocity.

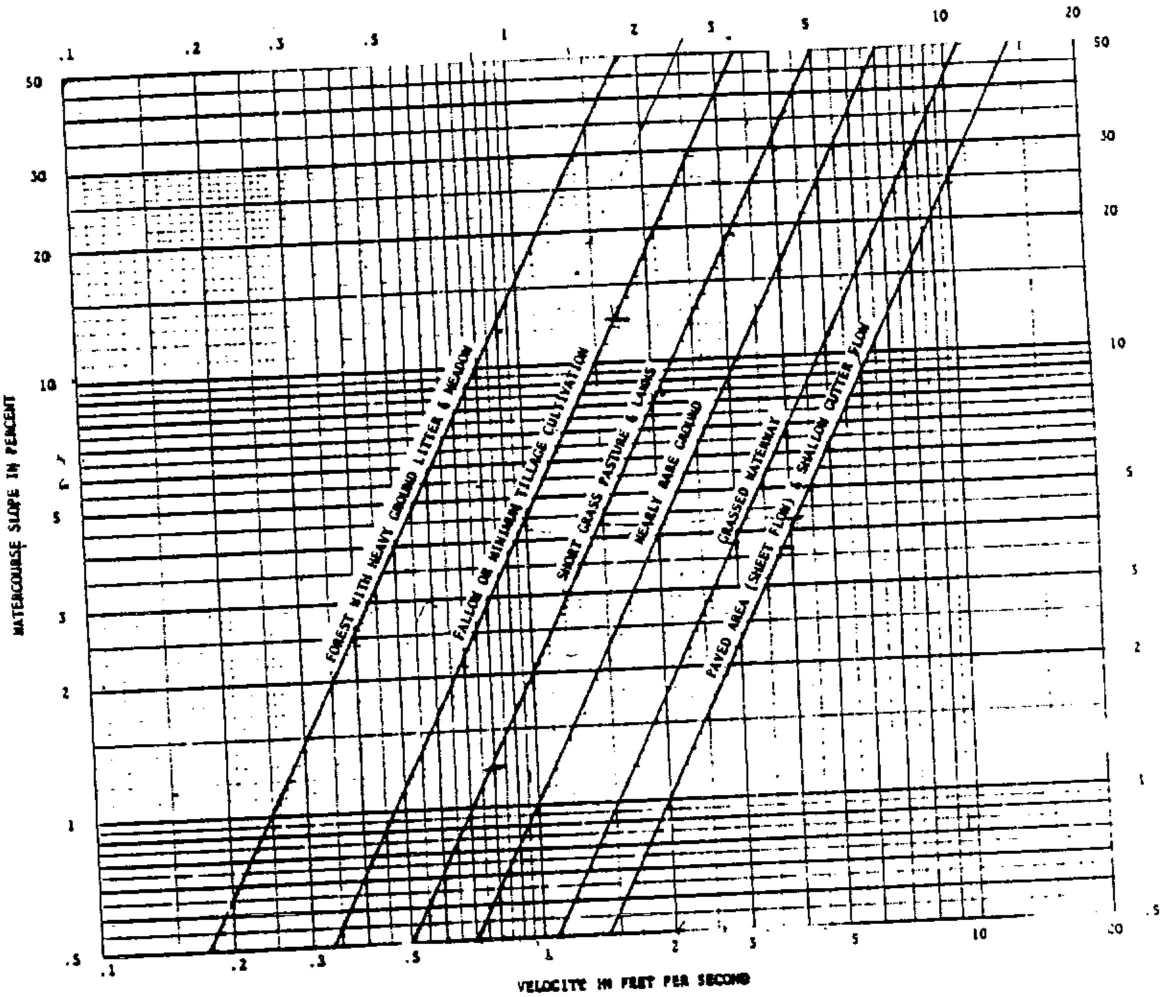
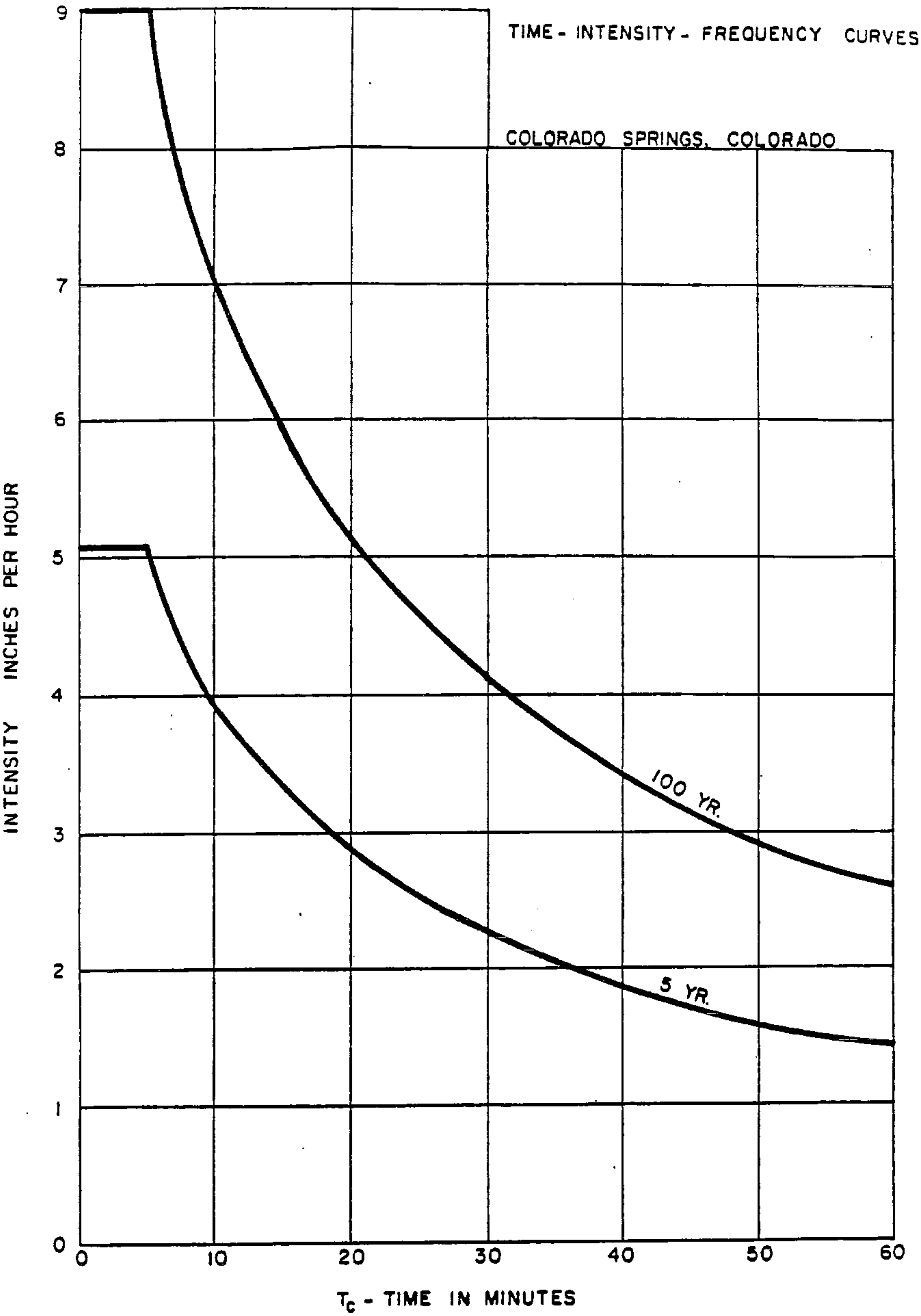


Figure 3-1.--Average velocities for estimating travel time for overland flow.

<u>Storm sewer or road gutter flow</u>

Travel time through the storm sewer or road gutter system to the main open channel is the sum of travel times in each individual component of the system between the uppermost inlet and the outlet. In most cases average velocities can be used without a significant loss of accuracy. During major storm events, the sewer system may be fully taxed and additional overland flow may occur, generally at a significantly lower velocity than the flow in the storm sewers. By using average conduit sizes and an average slope (excluding any vertical drops in the system), the average velocity can be estimated using Manning's formula.

Since the hydraulic radius of a pipe flowing half full is the same as when flowing full, the respective velocities are equal. Travel time may



TIME - INTENSITY - FREQUENCY CURVES
COLORADO SPRINGS, COLORADO
INTENSITY INCHES PER HOUR
9
8
7
6
5
4
3
2
1
0
0
10
20
30
40
50
60
100 YR.
5 YR.
T_c - TIME IN MINUTES

FIGURE III - 2

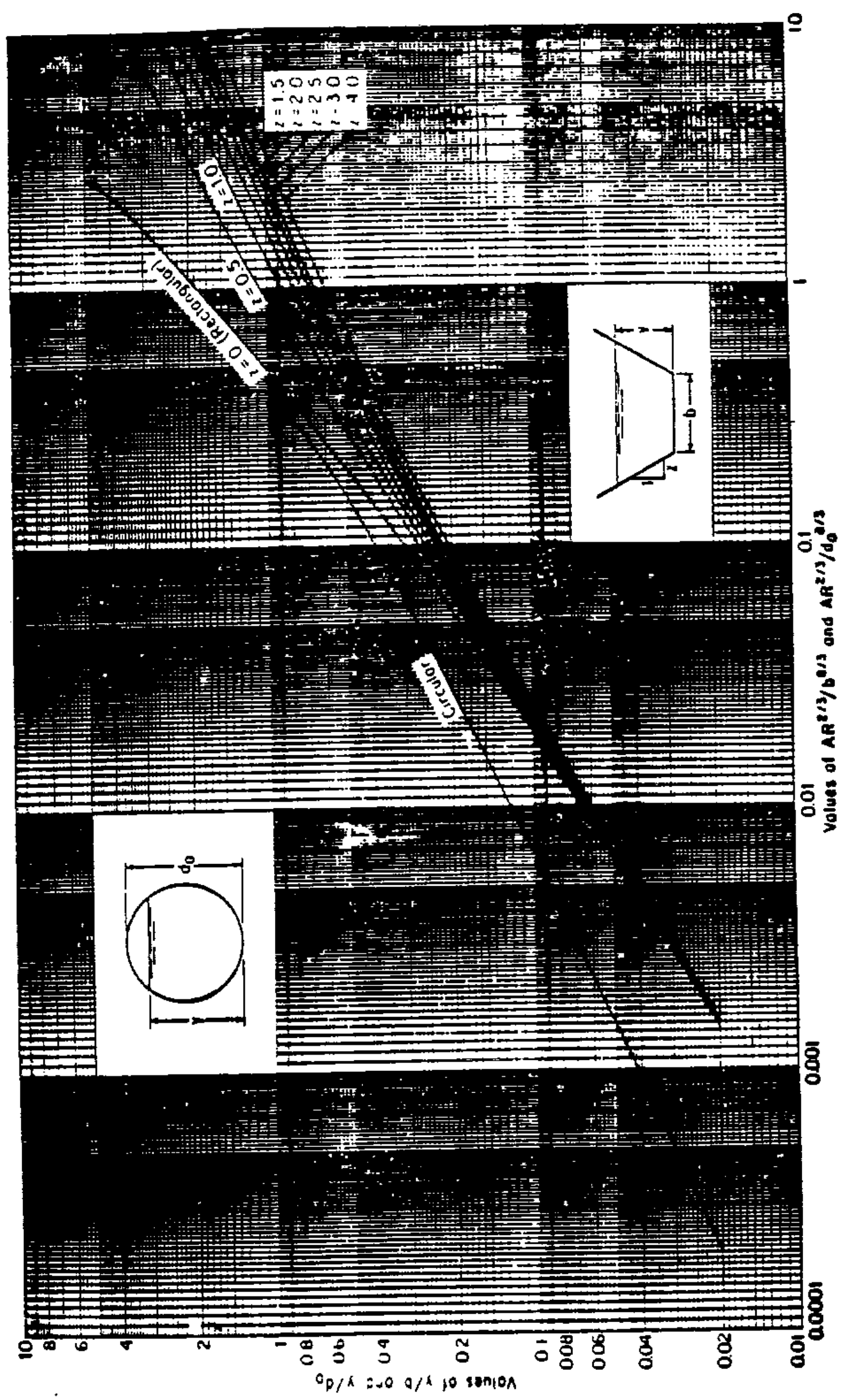


FIGURE 2-1. NORMAL DEPTH FOR UNIFORM FLOW IN OPEN CHANNELS (5)

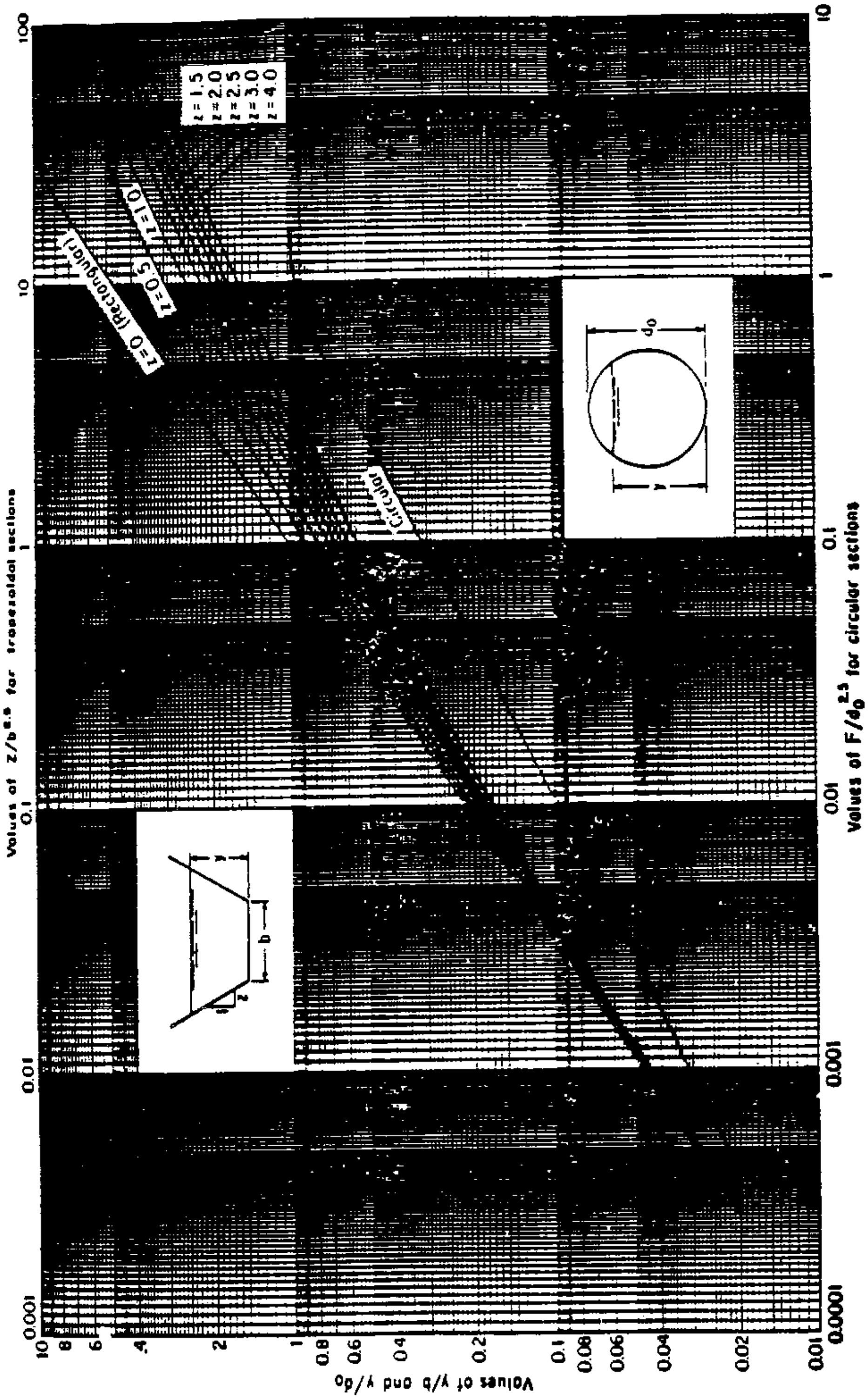


FIGURE 2-2. CURVES FOR DETERMINING THE CRITICAL DEPTH IN OPEN CHANNELS (5)

TABLE 4-1

UNIFORM FLOW IN CIRCULAR SECTIONS FLOWING PARTLY FULL (4)

y_0 = depth of flow
D = diameter of pipe
A = area of flow
R = hydraulic radius
Q = discharge in cfs by Manning formula
n = Manning coefficient
S_0 = slope of the channel bottom and of the water surface

$\frac{y_0}{D}$	$\frac{A}{D^2}$	$\frac{R}{D}$	$\frac{Qn}{D^{8/3}S_0^{1/2}}$	$\frac{Qn}{y_0^{8/3}S_0^{1/2}}$	$\frac{y_0}{D}$	$\frac{A}{D^2}$	$\frac{R}{D}$	$\frac{Qn}{D^{8/3}S_0^{1/2}}$	$\frac{Qn}{y_0^{8/3}S_0^{1/2}}$
0.01	0.0013	0.0066	0.00007	15.04	0.51	0.4027	0.2531	0.239	1.442
0.02	0.0037	0.0132	0.00031	10.57	0.52	0.4127	0.2562	0.247	1.415
0.03	0.0069	0.0197	0.00074	8.56	0.53	0.4227	0.2592	0.255	1.388
0.04	0.0105	0.0262	0.00138	7.38	0.54	0.4327	0.2621	0.263	1.362
0.05	0.0147	0.0325	0.00222	6.55	0.55	0.4426	0.2649	0.271	1.336
0.06	0.0192	0.0389	0.00328	5.95	0.56	0.4526	0.2676	0.279	1.311
0.07	0.0242	0.0451	0.00455	5.47	0.57	0.4625	0.2703	0.287	1.286
0.08	0.0294	0.0513	0.00604	5.09	0.58	0.4724	0.2728	0.295	1.262
0.09	0.0350	0.0575	0.00775	4.76	0.59	0.4822	0.2753	0.303	1.238
0.10	0.0409	0.0635	0.00967	4.49	0.60	0.4920	0.2776	0.311	1.215
0.11	0.0470	0.0695	0.01181	4.25	0.61	0.5018	0.2799	0.319	1.192
0.12	0.0534	0.0755	0.01417	4.04	0.62	0.5115	0.2821	0.327	1.170
0.13	0.0600	0.0813	0.01674	3.86	0.63	0.5212	0.2842	0.335	1.148
0.14	0.0668	0.0871	0.01952	3.69	0.64	0.5308	0.2862	0.343	1.126
0.15	0.0739	0.0929	0.0225	3.54	0.65	0.5404	0.2882	0.350	1.105
0.16	0.0811	0.0985	0.0257	3.41	0.66	0.5499	0.2900	0.358	1.084
0.17	0.0885	0.1042	0.0291	3.28	0.67	0.5594	0.2917	0.366	1.064
0.18	0.0961	0.1097	0.0327	3.17	0.68	0.5687	0.2933	0.373	1.044
0.19	0.1039	0.1152	0.0366	3.06	0.69	0.5780	0.2948	0.380	1.024
0.20	0.1118	0.1206	0.0406	2.96	0.70	0.5872	0.2962	0.388	1.004
0.21	0.1199	0.1259	0.0448	2.87	0.71	0.5964	0.2975	0.395	0.985
0.22	0.1281	0.1312	0.0492	2.79	0.72	0.6054	0.2987	0.402	0.965
0.23	0.1365	0.1364	0.0537	2.71	0.73	0.6143	0.2998	0.409	0.947
0.24	0.1449	0.1416	0.0585	2.63	0.74	0.6231	0.3008	0.416	0.928
0.25	0.1535	0.1466	0.0634	2.56	0.75	0.6319	0.3017	0.422	0.910
0.26	0.1623	0.1516	0.0686	2.49	0.76	0.6405	0.3024	0.429	0.891
0.27	0.1711	0.1566	0.0739	2.42	0.77	0.6489	0.3031	0.435	0.873
0.28	0.1800	0.1614	0.0793	2.36	0.78	0.6573	0.3036	0.441	0.856
0.29	0.1890	0.1662	0.0849	2.30	0.79	0.6655	0.3039	0.447	0.838
0.30	0.1982	0.1709	0.0907	2.25	0.80	0.6736	0.3042	0.453	0.821
0.31	0.2074	0.1756	0.0966	2.20	0.81	0.6815	0.3043	0.458	0.804
0.32	0.2167	0.1802	0.1027	2.14	0.82	0.6893	0.3043	0.463	0.787
0.33	0.2260	0.1847	0.1089	2.09	0.83	0.6969	0.3041	0.468	0.770
0.34	0.2355	0.1891	0.1153	2.05	0.84	0.7043	0.3038	0.473	0.753
0.35	0.2450	0.1935	0.1218	2.00	0.85	0.7115	0.3033	0.477	0.736
0.36	0.2546	0.1978	0.1284	1.958	0.86	0.7186	0.3026	0.481	0.720
0.37	0.2642	0.2020	0.1351	1.915	0.87	0.7254	0.3018	0.485	0.703
0.38	0.2739	0.2062	0.1420	1.875	0.88	0.7320	0.3007	0.488	0.687
0.39	0.2836	0.2102	0.1490	1.835	0.89	0.7384	0.2995	0.491	0.670
0.40	0.2934	0.2142	0.1561	1.797	0.90	0.7445	0.2980	0.494	0.654
0.41	0.3032	0.2182	0.1633	1.760	0.91	0.7504	0.2963	0.496	0.637
0.42	0.3130	0.2220	0.1705	1.724	0.92	0.7560	0.2944	0.497	0.621
0.43	0.3229	0.2258	0.1779	1.689	0.93	0.7612	0.2921	0.498	0.604
0.44	0.3328	0.2295	0.1854	1.655	0.94	0.7662	0.2895	0.498	0.588
0.45	0.3428	0.2331	0.1929	1.622	0.95	0.7707	0.2865	0.498	0.571
0.46	0.3527	0.2366	0.201	1.590	0.96	0.7749	0.2829	0.496	0.553
0.47	0.3627	0.2401	0.208	1.559	0.97	0.7785	0.2787	0.494	0.535
0.48	0.3727	0.2435	0.216	1.530	0.98	0.7817	0.2735	0.489	0.517
0.49	0.3827	0.2468	0.224	1.500	0.99	0.7841	0.2644	0.483	0.496
0.50	0.3927	0.2500	0.232	1.471	1.00	0.7854	0.2500	0.463	0.463

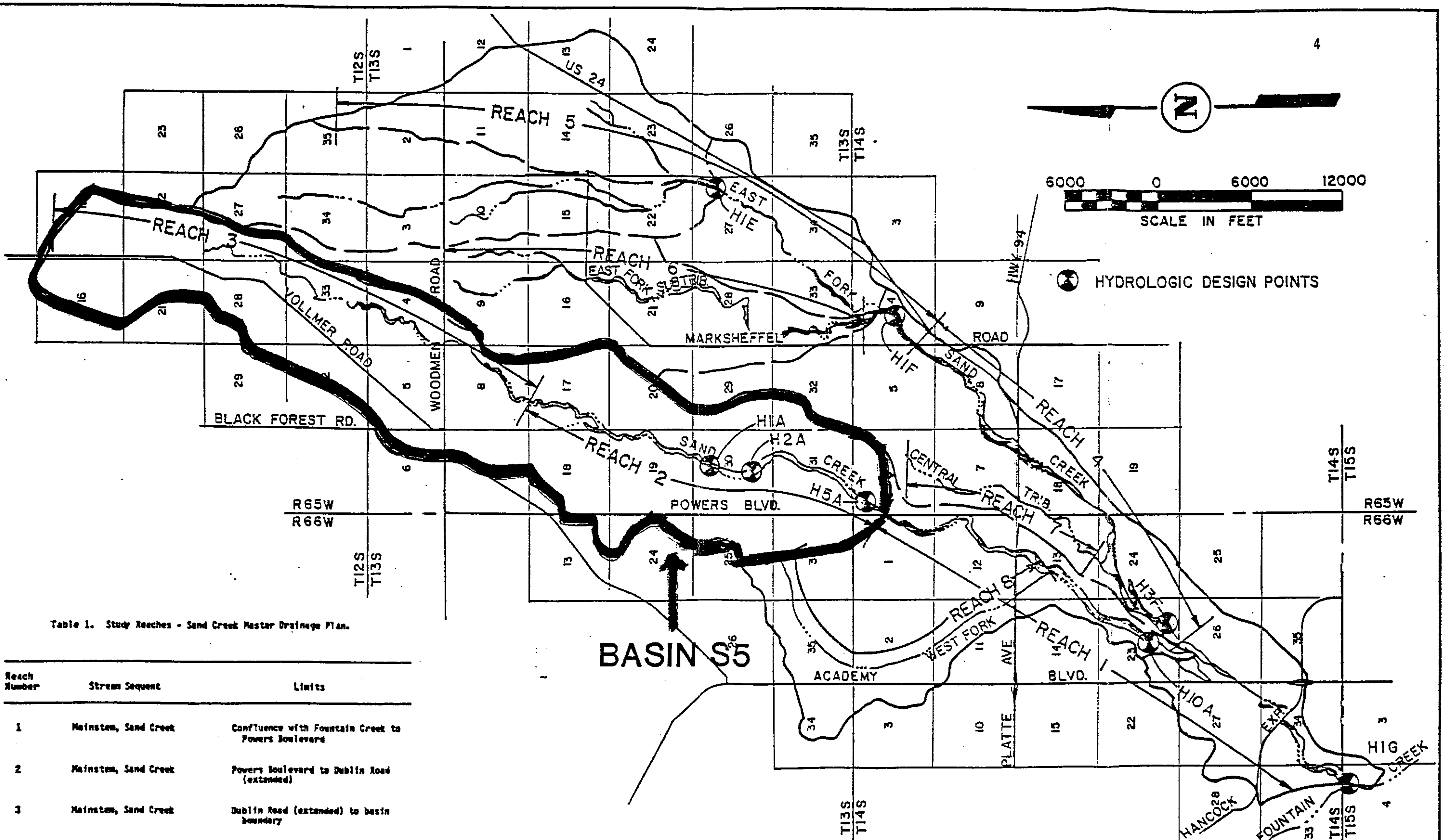


Table 1. Study Reaches - Sand Creek Master Drainage Plan.

Reach Number	Stream Sequent	Limits
1	Mainstem, Sand Creek	Confluence with Fountain Creek to Powers Boulevard
2	Mainstem, Sand Creek	Powers Boulevard to Dublin Road (extended)
3	Mainstem, Sand Creek	Dublin Road (extended) to basin boundary
4	East Fork Sand Creek	Confluence with mainstem to Marksheffel Road
5	East Fork Sand Creek	Marksheffel Road to basin boundary
6	East Fork Subtributary	Confluence with East Fork to basin boundary
7	Central Tributary	Confluence with East Fork Sand Creek to Palmer Park Boulevard
8	[illegible]	[illegible]

NOTE: MAP IS TAKEN FROM THE "SAND CREECK MASTER DRAINAGE PLANNING STUDY" DATED JULY 1985

SAND CREEK MASTER DRAINAGE PLANNING STUDY

STUDY REACHES & DESIGN POINTS

Designed by: R.N.W.
Drawn by: L.F. GOOD Date: 10-5-84
Checked by: R.N.W.

sla SIMONS, LI & ASSOCIATES, INC.

FIG. 1