CITY OF ALBUQUERQUE

Planning Department
David Campbell, Director

Mayor Timothy M. Keller

June 19, 2018

Mark Goodwin, P.E.
Mark Goodwin & Associates
PO Box 90606
Albuquerque, NM, 87199

RE: **Juan Tabo Hills Estates**
Manhole 47
Drainage Report Stamp Date: 5/10/18
Revision Sheet Stamp Date: 5/23/18 (5, 5.2, 6R) & 6/6/18 (5.1)
Hydrology File- M21D018; DRB# 1005278

Dear Mr. Goodwin:

Based on the submittal received 6/6/18, this plan is approved for Work Order/Change Order.

If you have any questions, you can contact me at 924-3695 or dpeterson@cabq.gov.

Sincerely,

Dana Peterson, P.E.
Senior Engineer, Planning Dept.
Development Review Services

PO Box 1293
Albuquerque
NM 87103
www.cabq.gov

D. Mark Goodwin & Associates, P.A.
Consulting Engineers
P.O. BOX 90606, ALBUQUERQUE, NM 87199
(505) 828-2200 FAX 797-9539

~ 2012 ACEC/NM Award Winner for Engineering Excellence ~
~ 2008 ACEC/NM Award Winner for Engineering Excellence ~

June 06, 2018

Mr. Dana Peterson
City of Albuquerque
PO Box 1293
Albuquerque, NM 87103

Re: **Juan Tabo Hills Estates**
Manhole 47
Drainage Report Stamp Date: 5/10/18
Revision Sheet Stamp Date: 5/11/18
Hydrology File- M@1D018; DRB# 1005278

Dear Mr. Peterson;

Below is a response to the comments dated 6/04/18 for the Storm Sewer at Juan Tabo Hills.

1. *A detail for the proposed concrete pipe anchors has been added to sheet 5.1 of 6 for all RCP with slopes greater than 20%, complete with dimensional data, reinforcement and specifications.*

Please call me if you have any questions.

Sincerely,
MARK GOODWIN & ASSOCIATES, P.A.

Hiram L. Crook
Staff Engineer

City of Albuquerque

Planning Department

Development & Building Services Division

DRAINAGE AND TRANSPORTATION INFORMATION SHEET (REV 09/2015)

Project Title: Juan Tabo Hills West Building Permit #: ______ City Drainage #: M-21D018

DRB#: 1005278 EPC#: 1001370 Work Order#: 665888

Legal Description: Tract A Juan Tabo Hills West/Tract 1-A-1 Juan Tabo Hills Unit 2

City Address: Juan Tabo and Tijeras Arroyo

Engineering Firm: Mark Goodwin & Associates, PA Contact: Hiram Crook

Address: PO BOX 90606, Albuquerque, NM 87199

Phone#: 505-828-2200 Fax#: ______ E-mail: hiram@goodwinengineers.com

Owner: Eastland Development, Inc. Contact: Rex Wilson

Address: PO BOX 9470, Albuquerque, NM 87119

Phone#: 505-899-6768 Fax#: ______ E-mail: rwr2d2@aol.com

Architect: ______ Contact: ______

Address: ______

Phone#: ______ Fax#: ______ E-mail: ______

Other Contact: Aldrich Land Surveying Contact: Tim Aldrich

Address: PO BOX 30701, Albuquerque, NM 87190

Phone#: 505-328-3988 Fax#: ______ E-mail: tim.aldrich@comcast.net

Check all that Apply:

DEPARTMENT:

x____ HYDROLOGY/ DRAINAGE
_____ TRAFFIC/ TRANSPORTATION
_____ MS4/ EROSION & SEDIMENT CONTROL

TYPE OF SUBMITTAL:

_____ ENGINEER/ ARCHITECT CERTIFICATION

_____ CONCEPTUAL G & D PLAN
_____ GRADING PLAN
_____ DRAINAGE MASTER PLAN
_____ DRAINAGE REPORT
_____ CLOMR/LOMR

_____ TRAFFIC CIRCULATION LAYOUT (TCL)
_____ TRAFFIC IMPACT STUDY (TIS)
_____ EROSION & SEDIMENT CONTROL PLAN (ESC)

X____ OTHER (SPECIFY) Revision to Sheet 5.1 of 6

CHECK TYPE OF APPROVAL/ACCEPTANCE SOUGHT:

_____ BUILDING PERMIT APPROVAL
_____ CERTIFICATE OF OCCUPANCY

_____ PRELIMINARY PLAT APPROVAL
_____ SITE PLAN FOR SUB'D APPROVAL
_____ SITE PLAN FOR BLDG. PERMIT APPROVAL
_____ FINAL PLAT APPROVAL
_____ SIA/ RELEASE OF FINANCIAL GUARANTEE
_____ FOUNDATION PERMIT APPROVAL
_____ GRADING PERMIT APPROVAL
_____ SO-19 APPROVAL
_____ PAVING PERMIT APPROVAL
_____ GRADING/ PAD CERTIFICATION
_____ WORK ORDER APPROVAL
_____ CLOMR/LOMR

_____ PRE-DESIGN MEETING
X____ OTHER (SPECIFY) Storm Sewer Plans

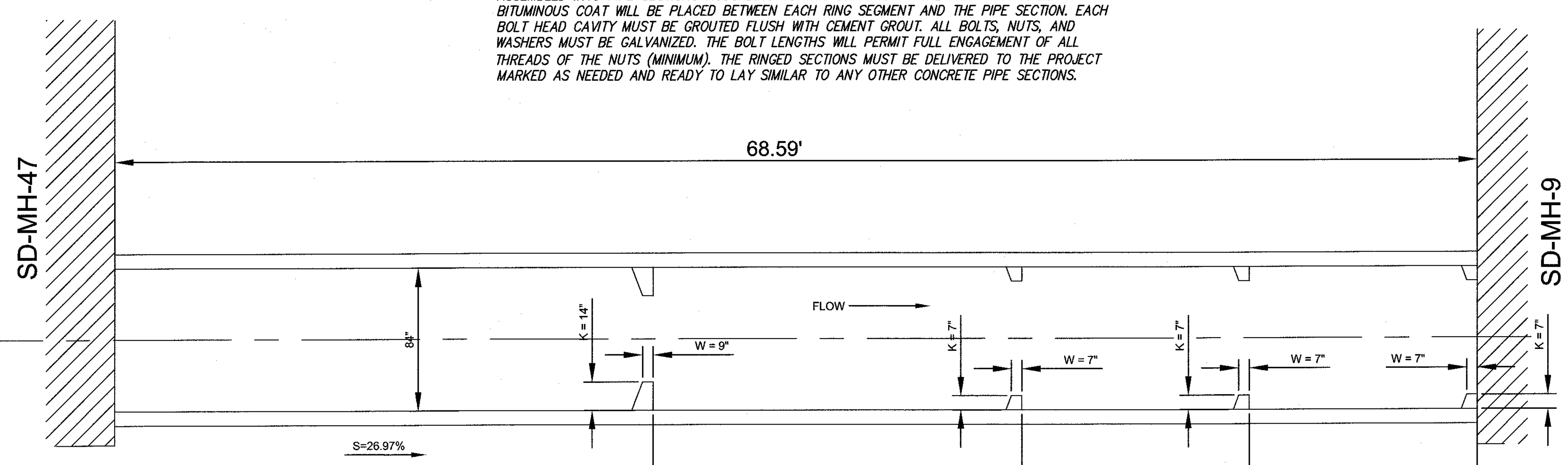
IS THIS A RESUBMITTAL?: X____ Yes ______ No

DATE SUBMITTED: June 06, 2018 By: Hiram Crook

COA STAFF: ELECTRONIC SUBMITTAL RECEIVED: ___

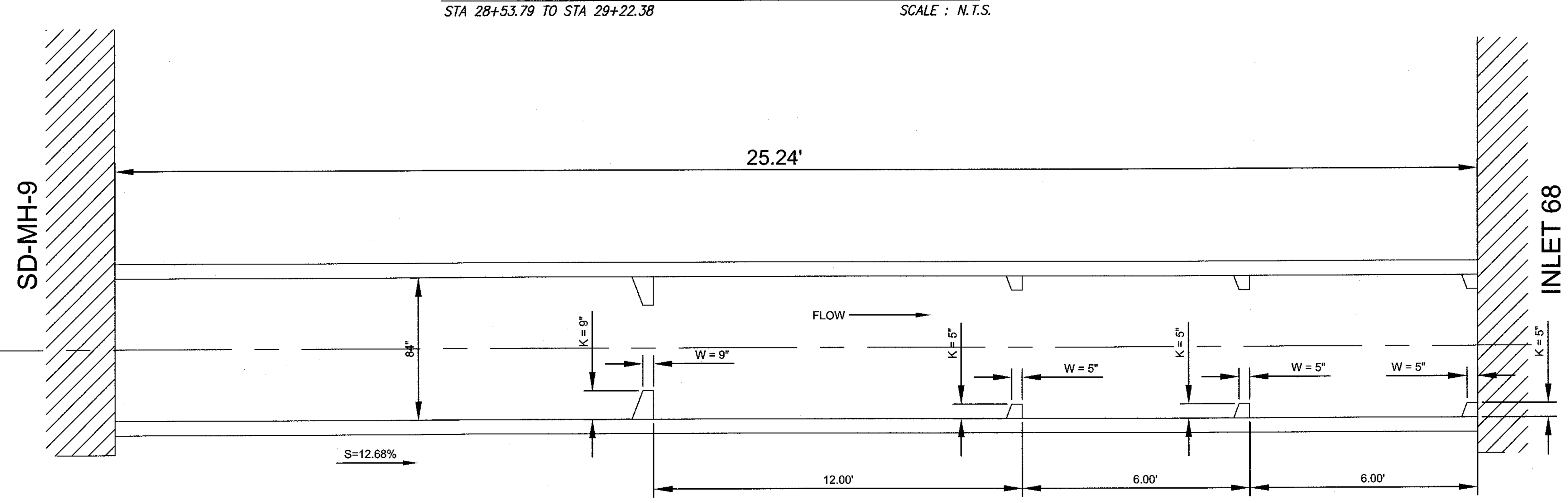
RING CHAMBER NOTES

THE RING CHAMBER IS TO BE MADE FROM THE STRENGTH AND SIZE OF CONCRETE PIPE SPECIFIED IN THE PLANS. THE RING SEGMENTS SHALL BE PRE–CAST ACCORDING TO AND ASSEMBLED INTO PIPE SECTIONS ACCORDING TO THIS DRAWING AT THE PRE–CAST FACILITY. A BITUMINOUS COAT WILL BE PLACED BETWEEN EACH RING SEGMENT AND THE PIPE SECTION. EACH BOLT HEAD CAVITY MUST BE GROUTED FLUSH WITH CEMENT GROUT. ALL BOLTS, NUTS, AND WASHERS MUST BE GALVANIZED. THE BOLT LENGTHS WILL PERMIT FULL ENGAGEMENT OF ALL THREADS OF THE NUTS (MINIMUM). THE RINGED SECTIONS MUST BE DELIVERED TO THE PROJECT MARKED AS NEEDED AND READY TO LAY SIMILAR TO ANY OTHER CONCRETE PIPE SECTIONS.



RING CHAMBER PROFILE

STA 28+53.79 TO STA 29+22.38 SCALE : N.T.S.



RING CHAMBER PROFILE

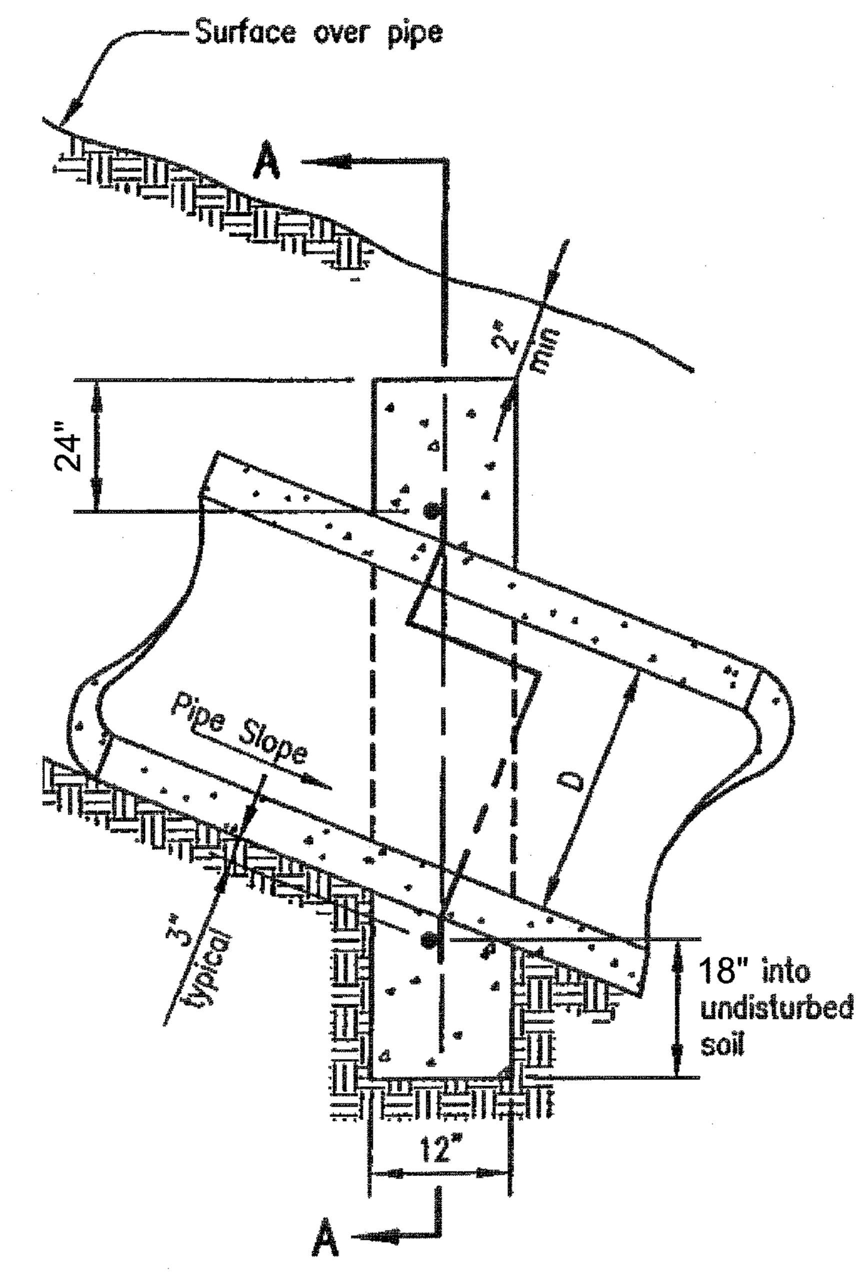
STA 28+28.55 TO STA 29+53.79 SCALE : N.T.S.

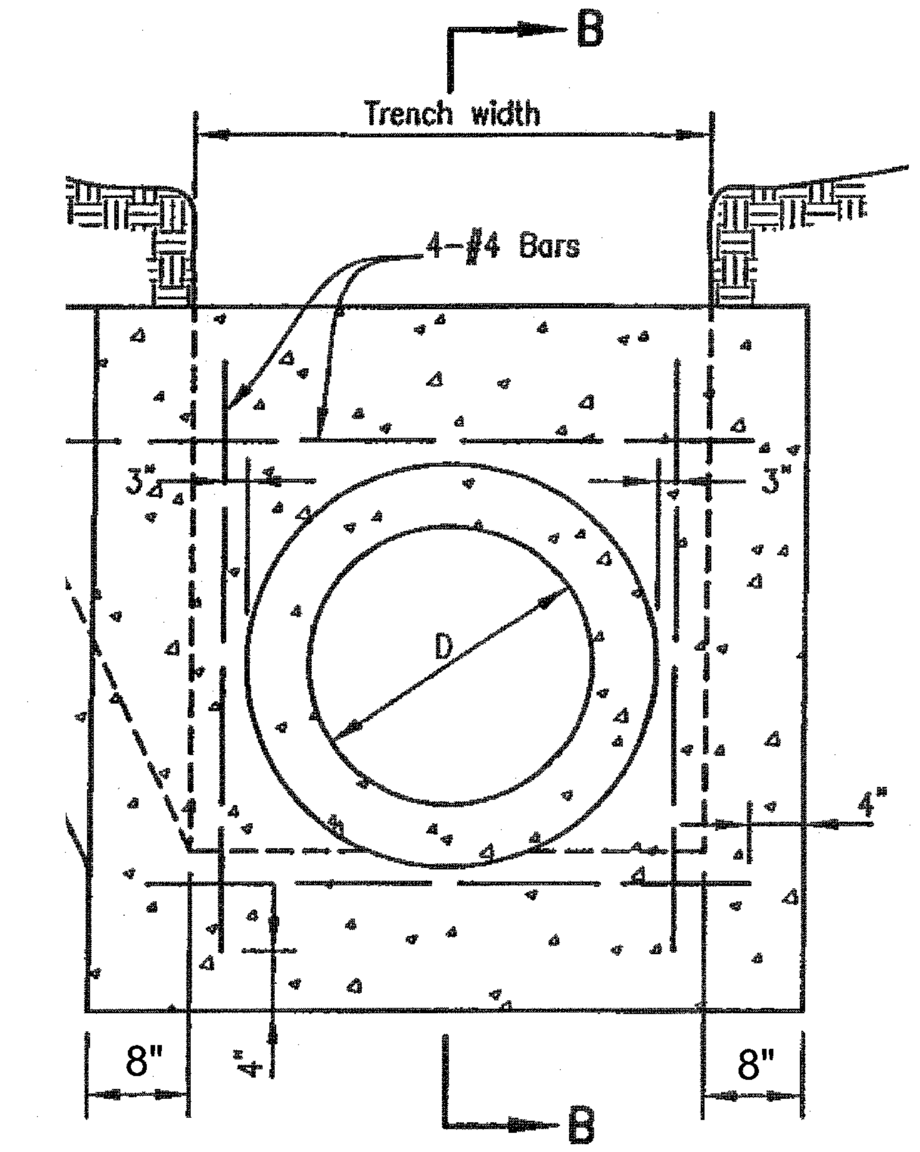
PIPE ANCHOR NOTES

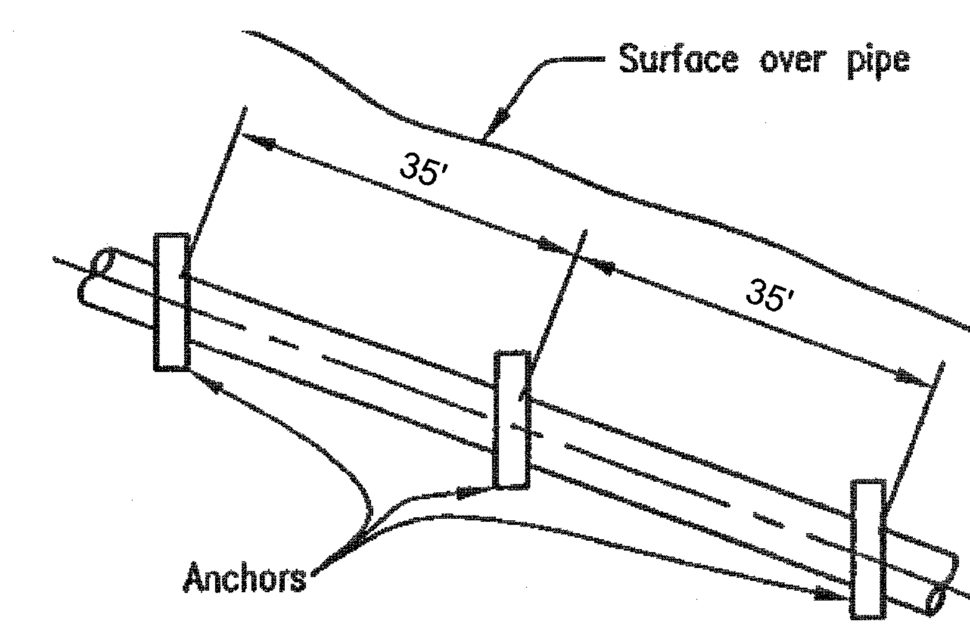
1. CONCRETE PIPE ANCHORS SHALL BE CONSTRUCTED USING FORMS WHEN STORM DRAINS ARE CONSTRUCTED WITH SLOPES 20% OR GREATER
2. CENTER TO MAXIMUM SPACING OF CONCRETE PIPE ANCHORS SHALL BE:

SLOPE	SPACING (ON SLOPE)
20–34%	35' O.C.

3. ALL REINFORCING STEEL SHALL BE #4 BAR.



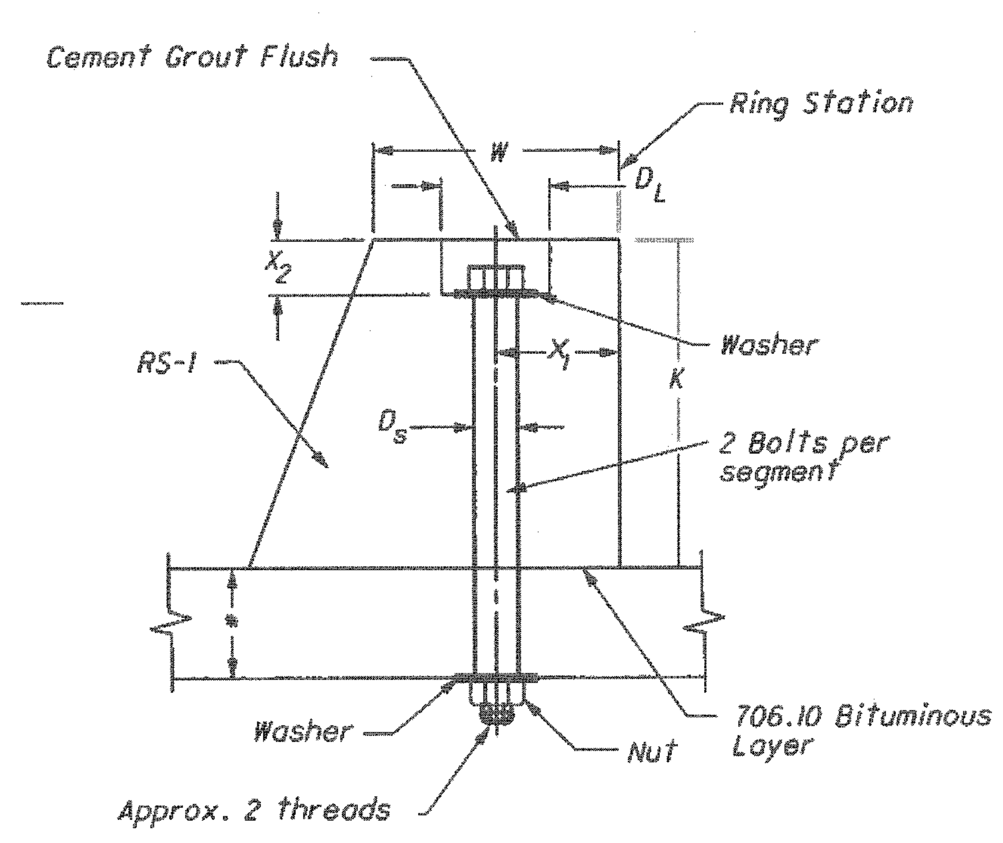




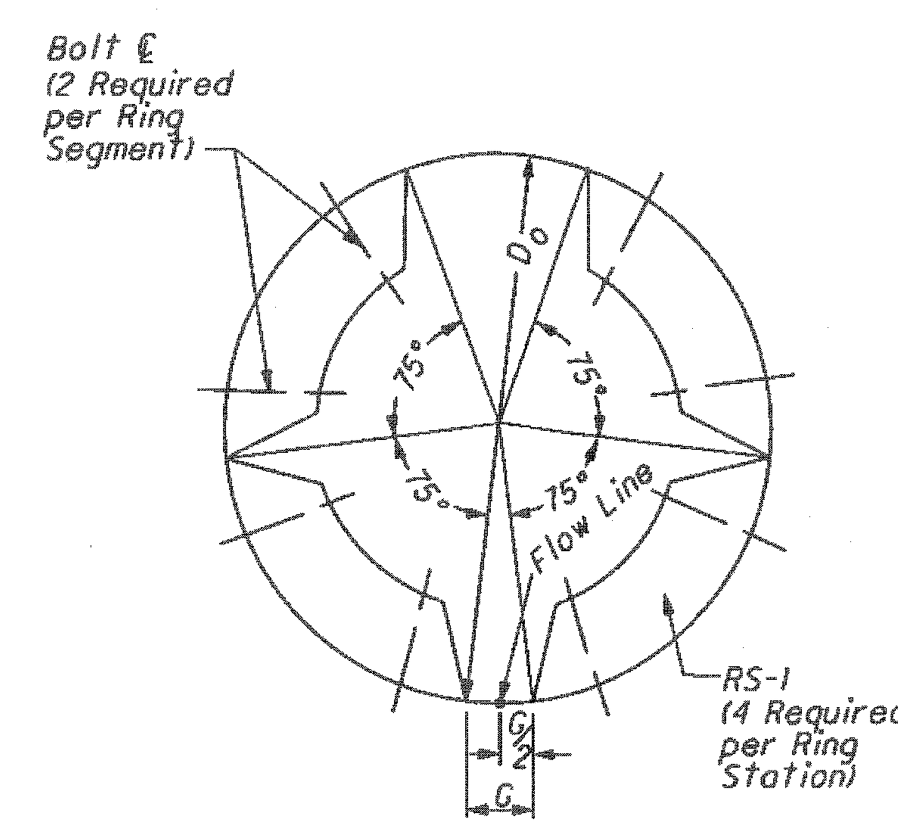
ELEVATION
CONCRETE PIPE ANCHORS

TABLE OF RING CHAMBER DATA

K		W		D_S		D_L		X_1		X_2		G	
Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm
4	102	4	102	0.625	16	1.5	38	2.0	51	1.0	25	4	102
5	127	5	127	0.625	16	2.0	51	2.5	62	1.0	25	4	102
6	152	6	152	0.750	19	2.0	51	3.0	76	1.25	32	5	127
7	178	7	178	1.000	25	3.0	76	3.5	89	1.5	38	5	127
7	178	7	178					3.5	89			6	152
8	203	8	203					4.0	102				
8	203	8	203	1.000	25			4.0	102				
10	254	8	203	1.250	32	3.0	76	4.0	102	1.5	38	6	152
12	305	9	229	1.625	41	4.0	102	4.5	114	2.0	51	8	203
												8	203
												12	305
12	305												
14	356												
14	356	9	229	1.625	41			4.5	114	2.0	51		



VIEW "A" @ BOLT ℄
(Typical)



TYPE "B"
RING CHAMBER STATION
(Typical)

AS BUILT INFORMATION

CONTRACTOR	
WORK STAKED BY	DATE
INSPECTOR'S ACCEPTANCE BY	DATE
FIELD VERIFICATION BY	DATE
DRAWINGS CORRECTED BY	DATE

MICRO–FILM INFORMATION

RECORDED BY	DATE
NO.	

SURVEY INFORMATION

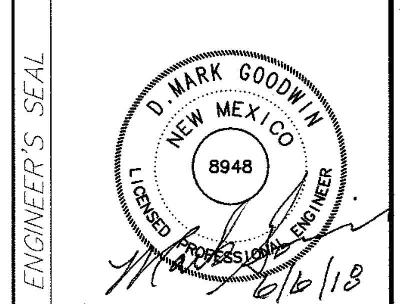
FIELD NOTES

NO.	BY	DATE

BENCH MARKS

STATION "5–M22" IS LOCATED 8.7 MI. SE OF DOWNTOWN ALBUQUERQUE ON THE EAST SIDE OF THE MUNICIPAL LIMITS LINE IN THE FOUR HILLS SUBDIVISION AREA. STATION IS 600 FT. EAST OF MUNICIPAL LIMITS LINE, 77.9' SE OF POWER POLE #3537 & 186.0' NW OF POWER POLE #60. STATION IS A STANDARD ACS BRASS DISK SET IN A CONCRETE MONUMENT IN THE GROUND. STATION IS STAMPED "5–M22". X= 1,564,263.207, Y= 1,475,762.595, (NAD 83), Z= 5597.219 (NAVD 1988)

ENGINEER'S SEAL



REVISIONS

NO.	DATE	REMARKS	BY

DESIGN	DATE	
DESIGNED BY	DMG	06/18
DRAWN BY	HLC	06/18
CHECKED BY	DMG	06/18

MARK GOODWIN & ASSOCIATES, P.A.
CONSULTING ENGINEERS
P.O. BOX 90606
ALBUQUERQUE, NEW MEXICO 87199
OFFICE (505) 828–2200, FAX (505) 797–9539

CITY OF ALBUQUERQUE
PUBLIC WORKS DEPARTMENT

TITLE: JUAN TABO HILLS ESTATES
STORM SEWER TRUNK LINE
CULVERT INTERNAL ENERGY DISSIPATERS/ PIPE ANCHORS

DESIGN REVIEW COMMITTEE	CITY ENGINEER APPROVAL	MO./DAY/YR.	MO./DAY/YR.

LAST DESIGN UPDATE

PROJECT NO.	ZONE MAP NO.	SHEET	OF
665888	M-21-Z	5.1	6

A11039 JTH WEST–PPLAT\PLANS\UTILITIES\STORM TRUNK\A11039 BANK PROTECTION_DTLS–NOTES.dwg\9/14/17\ACH

CITY OF ALBUQUERQUE

Planning Department
David Campbell, Director

Mayor Timothy M. Keller

June 4, 2018

Diane Hoelzer, P.E.
Mark Goodwin & Associates
PO Box 90606
Albuquerque, NM, 87199

RE: Juan Tabo Hills Estates
Manhole 47
Drainage Report Stamp Date: 5/10/18
Revision Sheet Stamp Date: 5/23/18
Hydrology File- M21D018; DRB# 1005278

Dear Ms. Hoelzer:

Based on the information provided in your submittal received 5/23/18, this submittal cannot be approved for Work Order by Hydrology until the following are corrected.

1. For RCP on steep slopes (greater than 20%), provide concrete pipe anchors, ~35' o.c. This must include a detail, complete with dimensional data, reinforcement if needed, and specifications. The CoA has no standard detail for this sort of thing, all build details will need to be provided by the Engineer.

If you have any questions, you can contact me at 924-3695 or dpeterson@cabq.gov.

Sincerely,

Dana Peterson, P.E.
Senior Engineer, Planning Dept.
Development Review Services

PO Box 1293
Albuquerque
NM 87103
www.cabq.gov

City of Albuquerque

Planning Department

Development & Building Services Division

DRAINAGE AND TRANSPORTATION INFORMATION SHEET (REV 09/2015)

Project Title: Juan Tabo Hills West Building Permit #: ____ City Drainage #: M-21D018

DRB#: 1005278 EPC#: 1001370 Work Order#: 665888

Legal Description: Tract A Juan Tabo Hills West/Tract 1-A-1 Juan Tabo Hills Unit 2

City Address: Juan Tabo and Tijeras Arroyo

Engineering Firm: Mark Goodwin & Associates, PA Contact: Hiram Crook

Address: PO BOX 90606, Albuquerque, NM 87199

Phone#: 505-828-2200 Fax#: ____ E-mail: hiram@goodwinengineers.com

Owner: Eastland Development, Inc. Contact: Rex Wilson

Address: PO BOX 9470, Albuquerque, NM 87119

Phone#: 505-899-6768 Fax#: ____ E-mail: rwr2d2@aol.com

Architect: ____ Contact: ____

Address: ____

Phone#: ____ Fax#: ____ E-mail: ____

Other Contact: Aldrich Land Surveying Contact: Tim Aldrich

Address: PO BOX 30701, Albuquerque, NM 87190

Phone#: 505-328-3988 Fax#: ____ E-mail: tim.aldrich@comcast.net

Check all that Apply:

DEPARTMENT:

x HYDROLOGY/ DRAINAGE
____ TRAFFIC/ TRANSPORTATION
____ MS4/ EROSION & SEDIMENT CONTROL

TYPE OF SUBMITTAL:

____ ENGINEER/ ARCHITECT CERTIFICATION

____ CONCEPTUAL G & D PLAN
____ GRADING PLAN
____ DRAINAGE MASTER PLAN
____ DRAINAGE REPORT
____ CLOMR/LOMR

____ TRAFFIC CIRCULATION LAYOUT (TCL)
____ TRAFFIC IMPACT STUDY (TIS)
____ EROSION & SEDIMENT CONTROL PLAN (ESC)

X OTHER (SPECIFY) Revision to Sheet 5.1 of 6

IS THIS A RESUBMITTAL?: X Yes ____ No

CHECK TYPE OF APPROVAL/ACCEPTANCE SOUGHT:

____ BUILDING PERMIT APPROVAL
____ CERTIFICATE OF OCCUPANCY

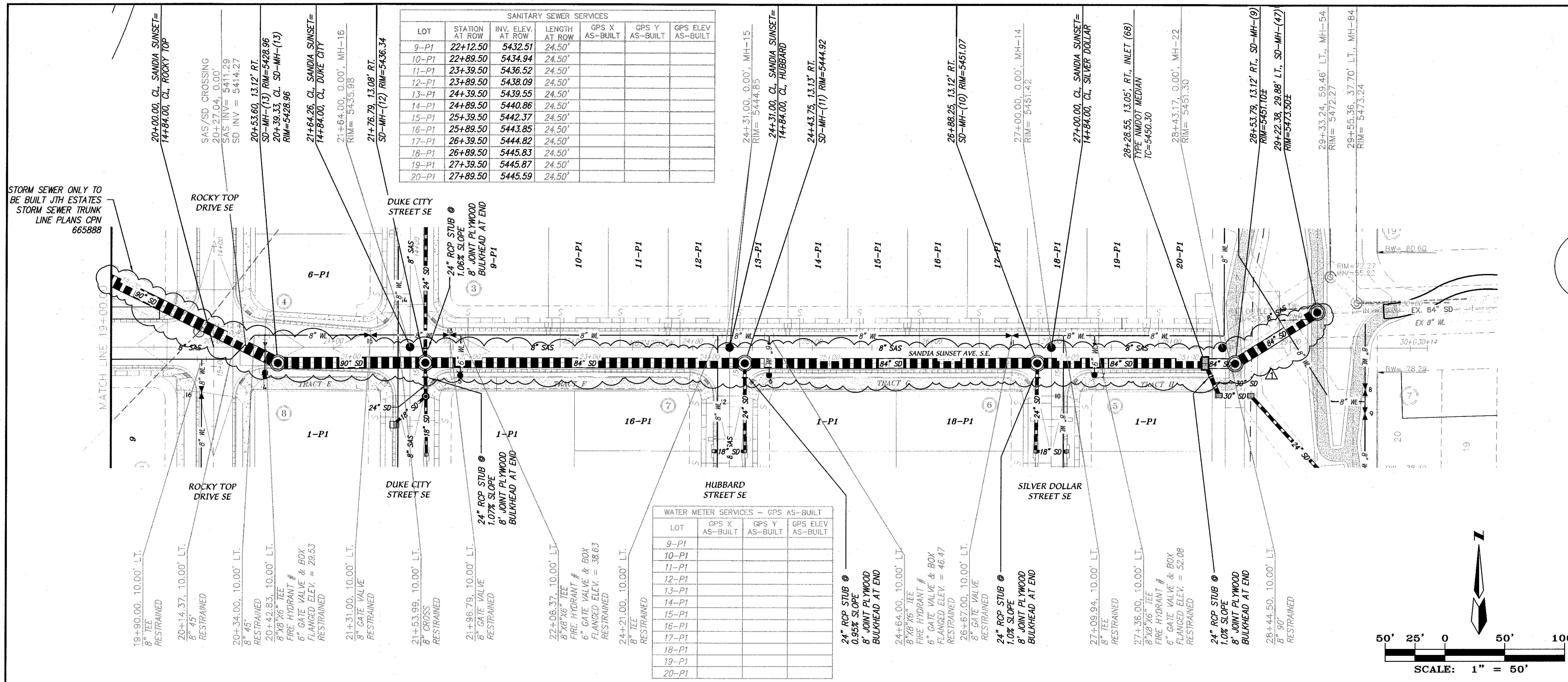
____ PRELIMINARY PLAT APPROVAL
____ SITE PLAN FOR SUB'D APPROVAL
____ SITE PLAN FOR BLDG. PERMIT APPROVAL
____ FINAL PLAT APPROVAL
____ SIA/ RELEASE OF FINANCIAL GUARANTEE
____ FOUNDATION PERMIT APPROVAL
____ GRADING PERMIT APPROVAL
____ SO-19 APPROVAL
____ PAVING PERMIT APPROVAL
____ GRADING/ PAD CERTIFICATION
____ WORK ORDER APPROVAL
____ CLOMR/LOMR

____ PRE-DESIGN MEETING
X OTHER (SPECIFY) Storm Sewer Plans

DATE SUBMITTED: June 06, 2018 By: Hiram Crook

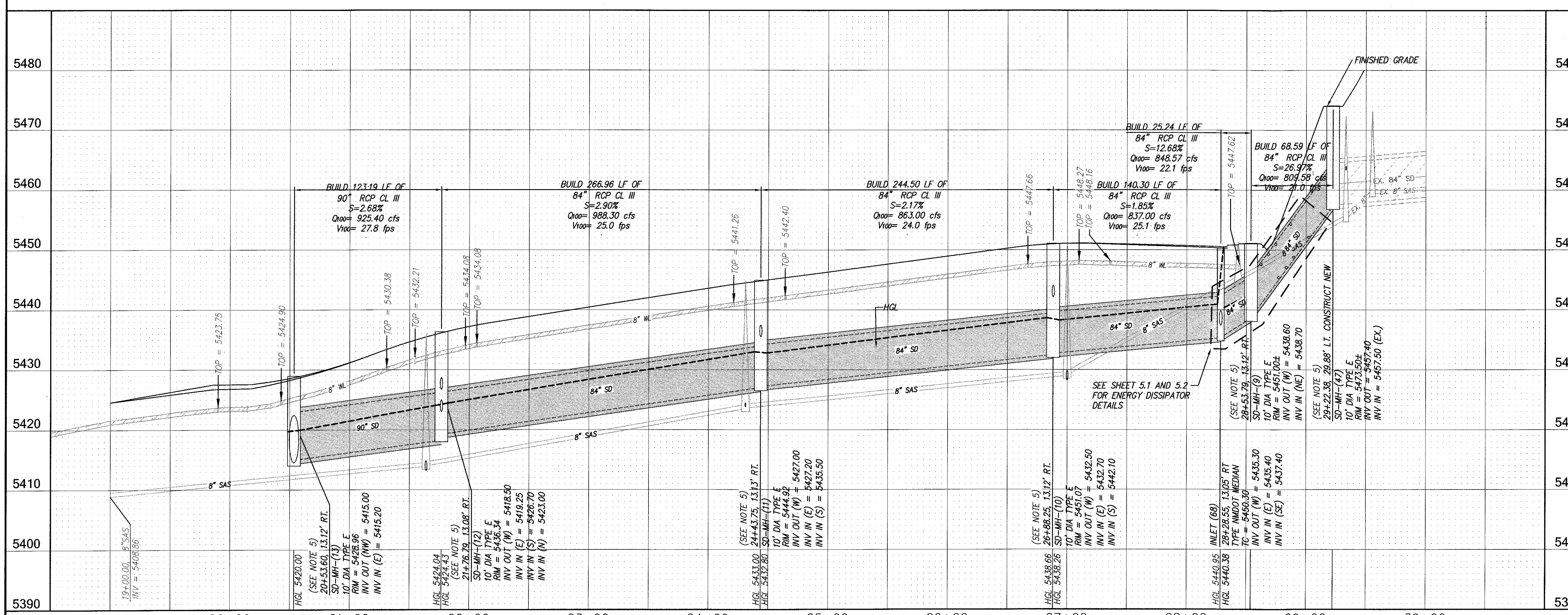
COA STAFF: ELECTRONIC SUBMITTAL RECEIVED: ____

SANITARY SEWER SERVICES						
LOT	STATION AT ROW	INV. ELEV. AT ROW	LENGTH AT ROW	GPS X AS-BUILT	GPS Y AS-BUILT	GPS ELEV AS-BUILT
9-P1	22+12.50	5432.51	24.50'			
10-P1	22+89.50	5434.94	24.50'			
11-P1	23+39.50	5436.52	24.50'			
12-P1	23+89.50	5438.09	24.50'			
13-P1	24+39.50	5439.55	24.50'			
14-P1	24+89.50	5440.86	24.50'			
15-P1	25+39.50	5442.37	24.50'			
16-P1	25+89.50	5443.85	24.50'			
17-P1	26+39.50	5444.82	24.50'			
18-P1	26+89.50	5445.83	24.50'			
19-P1	27+39.50	5445.87	24.50'			
20-P1	27+89.50	5445.59	24.50'			



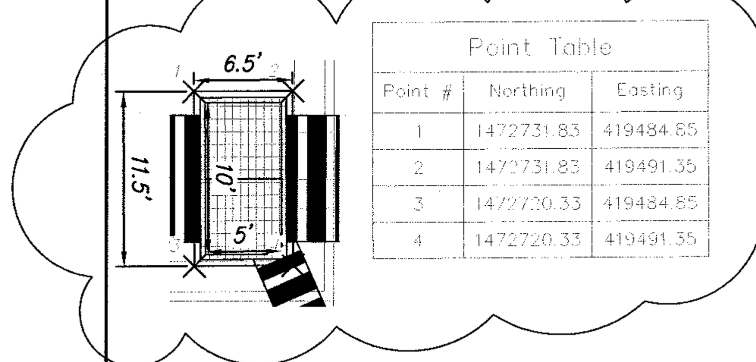
WATER METER SERVICES - GPS AS-BUILT			
LOT	GPS X AS-BUILT	GPS Y AS-BUILT	GPS ELEV AS-BUILT
9-P1			
10-P1			
11-P1			
12-P1			
13-P1			
14-P1			
15-P1			
16-P1			
17-P1			
18-P1			
19-P1			
20-P1			

SCALE: 1" = 50'



NOTES

1. ALL STORM SEWER MANHOLES PER ABCWUA TYPE 'E' STD DWG AND #2102, #2107 AND #2110.
2. HGL BASED ON PROFILE 3 IN DRAINAGE REPORT.
3. INLET (68) GRATE TO BE TACK WELD.
4. CONSTRUCTION BASELINE IS BASED ON CENTERLINE OF SANDIA SUNSET RIGHT OF WAY.
5. ALL STORM DRAIN MANHOLE LIDS IN SANDIA SUNSET SHALL BE BOLTED DOWN. THIS INCLUDES MANHOLES 9-13, 47, AND THE MANHOLE LID AT THE JUNCTION BOX BETWEEN MH-13 AND TIJERAS.
6. FOR ALL RCP ON SLOPES GREATER THAN 20%, CONCRETE PIPE ANCHORS WILL BE PROVIDED AT 35' O.C.



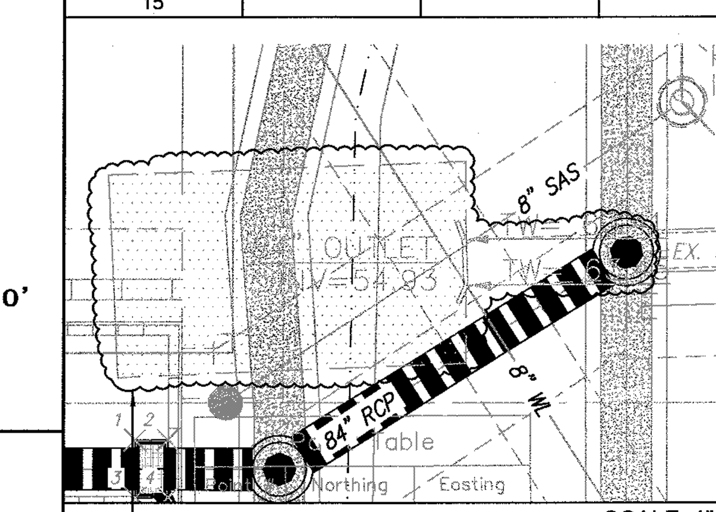
Point Table		
Point #	Northing	Easting
1	1472731.83	419484.85
2	1472731.83	419491.35
3	1472720.33	419484.85
4	1472720.33	419491.35

FIRE HYDRANT - GPS AS-BUILT

FIRE HYDRANT #	GPS X AS-BUILT	GPS Y AS-BUILT	GPS ELEV AS-BUILT
4			
5			
6			
7			

GATE VALVE - GPS AS-BUILT

GATE VALVE #	GPS X AS-BUILT	GPS Y AS-BUILT	GPS ELEV AS-BUILT
11			
13			
15			



SCALE: 1" = 30'

REMOVE & DISPOSE APPROXIMATE 40 LF OF EXISTING 84" RCP AS NECESSARY TO CONSTRUCT NEW MH. REMOVE & DISPOSE 2797 S.F. EXISTING A.C. APRON

CERTIFICATE OF SUBSTANTIAL COMPLIANCE

AS BUILT INFORMATION: CONTRACTOR / WORK STARTED BY / INSPECTOR'S ACCEPTANCE BY / FIELD VERIFICATION BY / DRAWINGS CORRECTED BY — DATE

MICRO-FILM INFORMATION: RECORDED BY / NO. — DATE

BENCH MARKS: STATION "5-M22" IS LOCATED 8.7 MI. SE OF DOWNTOWN ALBUQUERQUE ON THE EAST SIDE OF THE MUNICIPAL LIMITS LINE IN THE FOUR HILLS SUBDIVISION AREA. STATION IS 600 FT. EAST OF MUNICIPAL LIMITS LINE, 77.9 SE OF POWER POLE #SE37 & 186.0' NW OF POWER POLE #60. STATION IS A STANDARD ACS BRASS DISK SET IN A CONCRETE MONUMENT IN THE GROUND. STATION IS STAMPED "5-M22". X= 1,564,263.207, Y= 1,475,762.595, (NAD 83), Z= 5597.219 (NAVD 1988)

SURVEY INFORMATION: FIELD NOTES — NO. / BY / DATE

ENGINEER'S SEAL: D. MARK GOODWIN, NEW MEXICO, 8948, LICENSED PROFESSIONAL ENGINEER — 5/23/18

NO.	DATE	REMARKS	BY
1	5/18	ADD ENERGY DISSIPATOR	

REVISIONS

DESIGN		DATE
DESIGNED BY	JDH	02/17
DRAWN BY	SPS	02/17
CHECKED BY	DMG	02/17

MARK GOODWIN & ASSOCIATES, P.A.
CONSULTING ENGINEERS
P.O. BOX 90606
ALBUQUERQUE, NEW MEXICO 87199
OFFICE (505) 828-2200, FAX (505) 797-9539

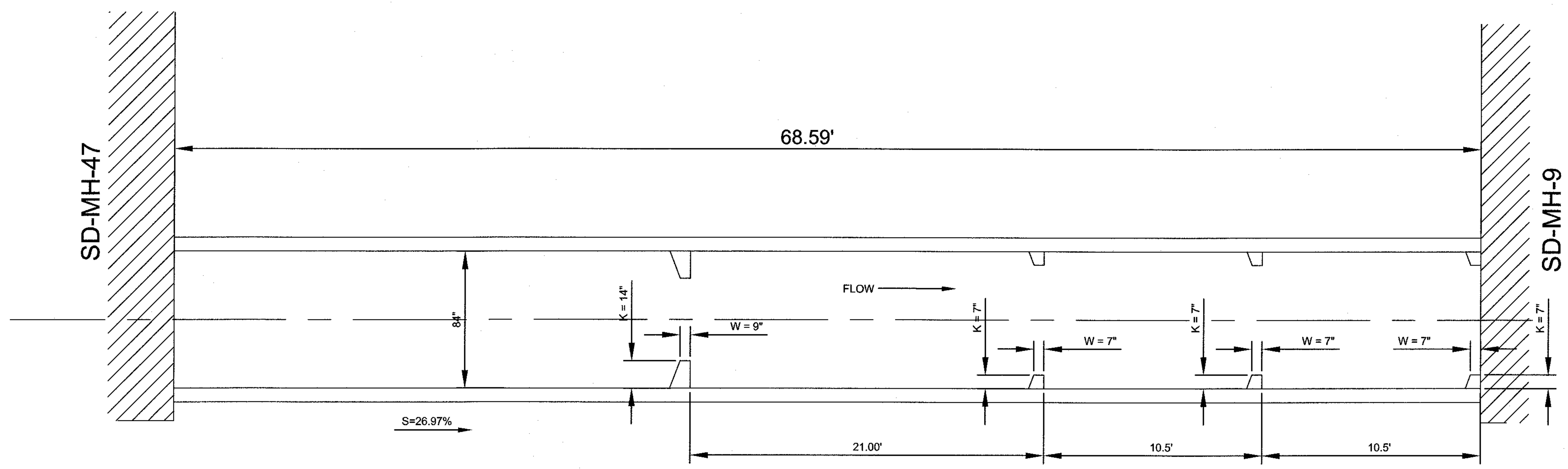
CITY OF ALBUQUERQUE
PUBLIC WORKS DEPARTMENT

TITLE: JUAN TABO HILLS ESTATES STORM SEWER TRUNK LINE UTILITY PLAN & PROFILE

DESIGN REVIEW COMMITTEE	CITY ENGINEER APPROVAL	MO./DAY/YR.	MO./DAY/YR.

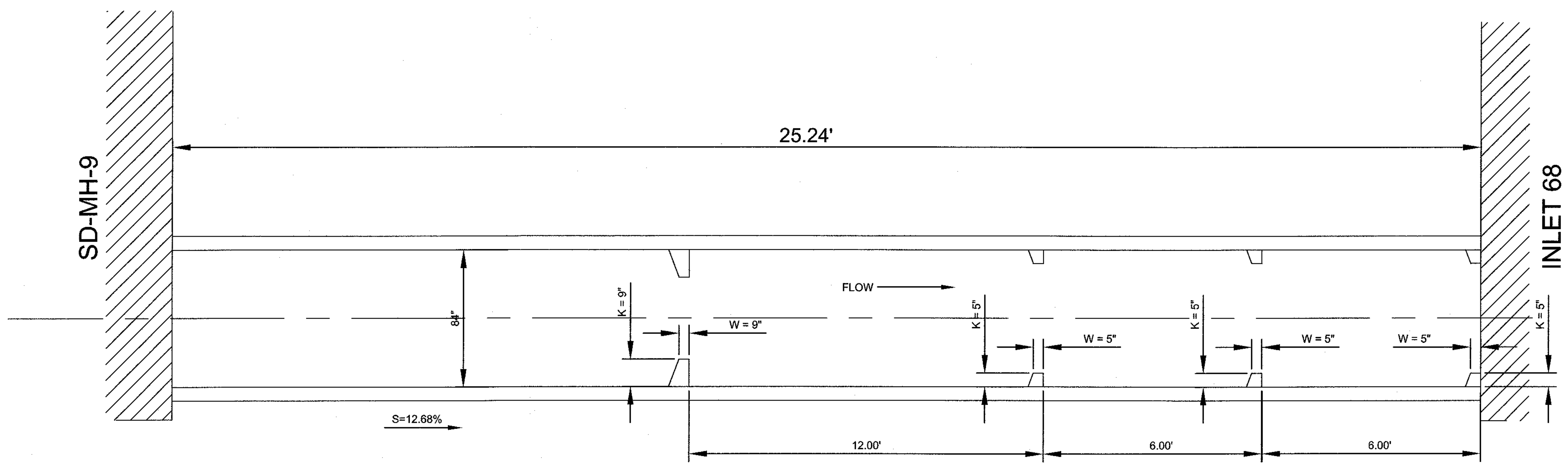
LAST DESIGN UPDATE

CITY PROJECT NO.	ZONE MAP NO.	SHEET	OF
665888	M-21	5	6



RING CHAMBER PROFILE

STA 28+53.79 TO STA 29+22.38 SCALE : N.T.S.



RING CHAMBER PROFILE

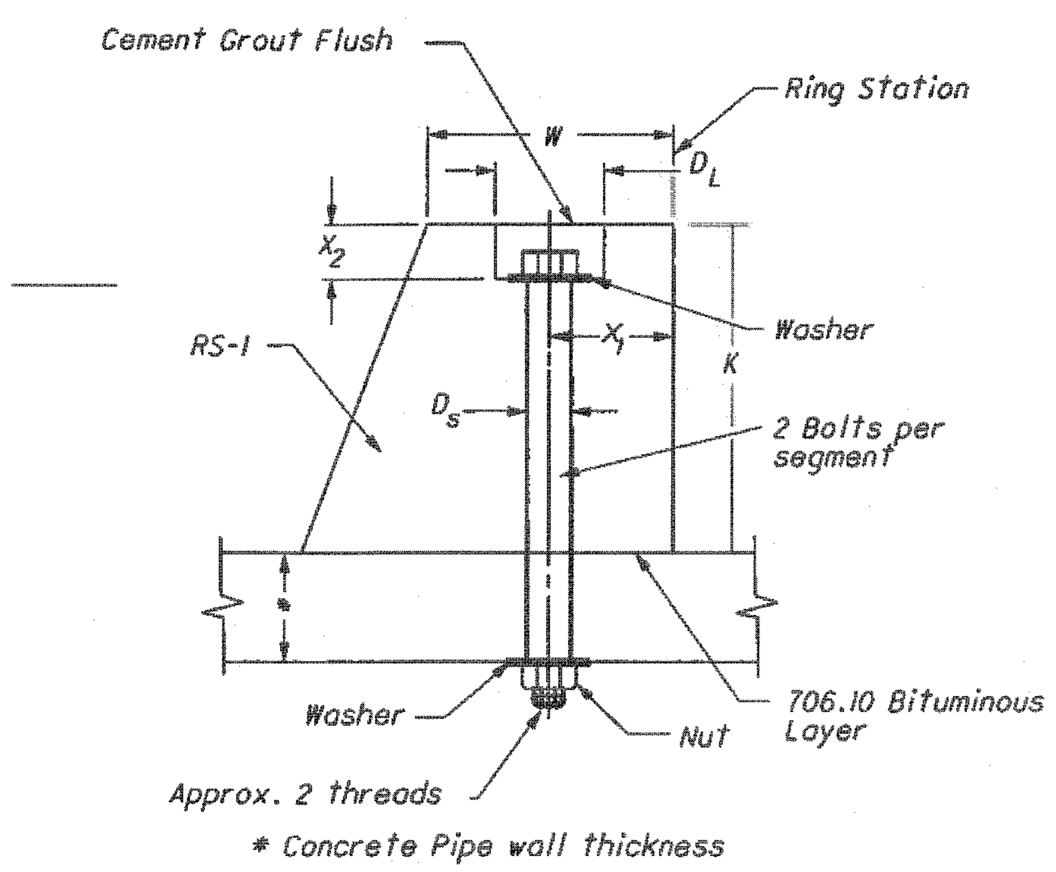
STA 28+28.55 TO STA 29+53.79 SCALE : N.T.S.

TABLE OF RING CHAMBER DATA

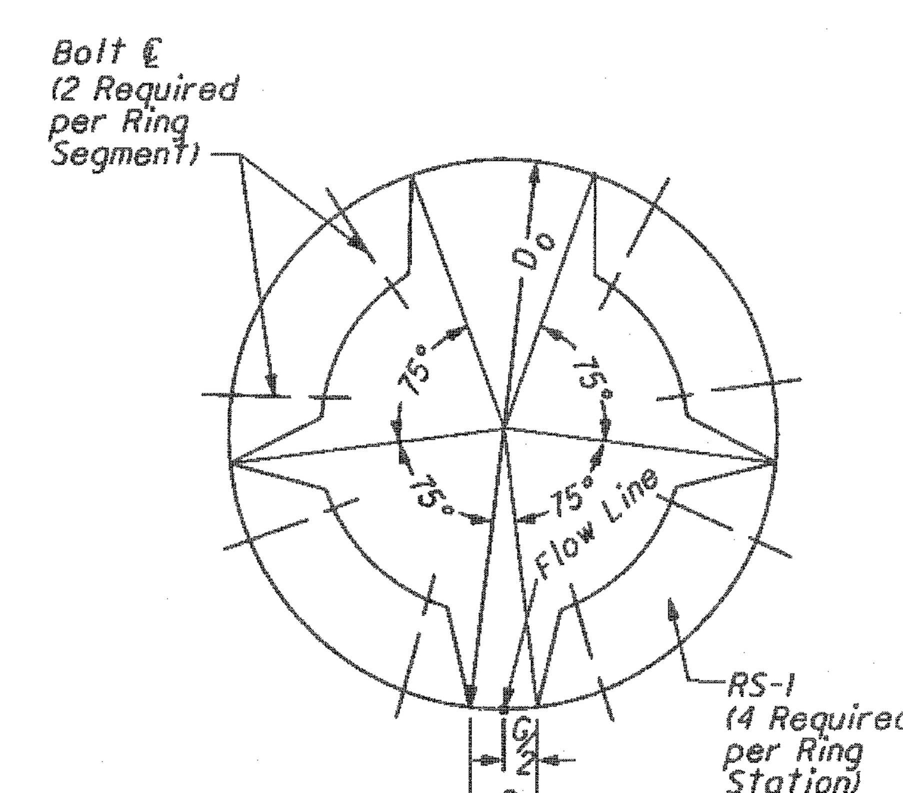
K		W		D_S		D_L		X_1		X_2		G	
Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm
4	102	4	102	0.625	16	1.5	38	2.0	51	1.0	25	4	102
5	127	5	127	0.625	16	2.0	51	2.5	62	1.0	25	4	102
6	152	6	152	0.750	19	2.0	51	3.0	76	1.25	32	5	127
7	178	7	178	1.000	25	3.0	76	3.5	89	1.5	38	5	127
7	178	7	178					3.5	89			6	152
8	203	8	203					4.0	102				
8	203	8	203	1.000	25			4.0	102				
10	254	8	203	1.250	32	3.0	76	4.0	102	1.5	38	6	152
12	305	9	229	1.625	41	4.0	102	4.5	114	2.0	51	8	203
												8	203
												12	305
12	305												
14	356												
14	356	9	229	1.625	41			4.5	114	2.0	51		

NOTES

THE RING CHAMBER IS TO BE MADE FROM THE STRENGTH AND SIZE OF CONCTRETE PIPE SPECIFIED IN THE PLANS. THE RING SEGMENTS SHALL BE PRE-CAST ACCORDING TO AND ASSEMBLED INTO PIPE SECTIONS ACCORDING TO THIS DRAWING AT THE PRE-CAST FACILITY. A BITUMINOUS COAT WILL BE PLACED BETWEEN EACH RING SEGMENT AND THE PIPE SECTION. EACH BOLT HEAD CAVITY MUST BE GROUTED FLUSH WITH CEMENT GROUT. ALL BOLTS, NUTS, AND WASHERS MUST BE GALVANIZED. THE BOLT LENGTHS WILL PERMIT FULL ENGAGEMENT OF ALL THREADS OF THE NUTS (MINIMUM). THE RINGED SECTIONS MUST BE DELIVERED TO THE PROJECT MARKED AS NEEDED AND READY TO LAY SIMILAR TO ANY OTHER CONCRETE PIPE SECTIONS.



VIEW "A" @ BOLT ℄ (Typical)



TYPE "B" RING CHAMBER STATION (Typical)

AS BUILT INFORMATION

CONTRACTOR

WORK STAKED BY DATE

INSPECTOR'S ACCEPTANCE BY DATE

FIELD VERIFICATION BY DATE

DRAWINGS CORRECTED BY DATE

MICRO-FILM INFORMATION

RECORDED BY DATE

NO.

BENCH MARKS

STATION "5-M22" IS LOCATED 8.7 MI. SE OF DOWNTOWN ALBUQUERQUE ON THE EAST SIDE OF THE MUNICIPAL LIMITS LINE IN THE FOUR HILLS SUBDIVISION AREA. STATION IS 600 FT. EAST OF MUNICIPAL LIMITS LINE, 77.9' SE OF POWER POLE #SE37 & 186.0' NW OF POWER POLE #60. STATION IS A STANDARD ACS BRASS DISK SET IN A CONCRETE MONUMENT IN THE GROUND. STATION IS STAMPED "5-M22". X= 1,564,263.207, Y= 1,475,762.595, (NAD 83), Z= 5597.219 (NAVD 1988).

SURVEY INFORMATION

FIELD NOTES

NO. BY DATE

ENGINEER'S SEAL

D. MARK GOODWIN NEW MEXICO 8948 LICENSED PROFESSIONAL ENGINEER

REMARKS

REVISIONS

NO. DATE BY

DESIGN DATE

DESIGNED BY JDH 05/16

DRAWN BY SPS 05/16

CHECKED BY DMG 05/16

MARK GOODWIN & ASSOCIATES, P.A.
CONSULTING ENGINEERS
P.O. BOX 90606
ALBUQUERQUE, NEW MEXICO 87199
OFFICE (505) 828-2200, FAX (505) 797-9539

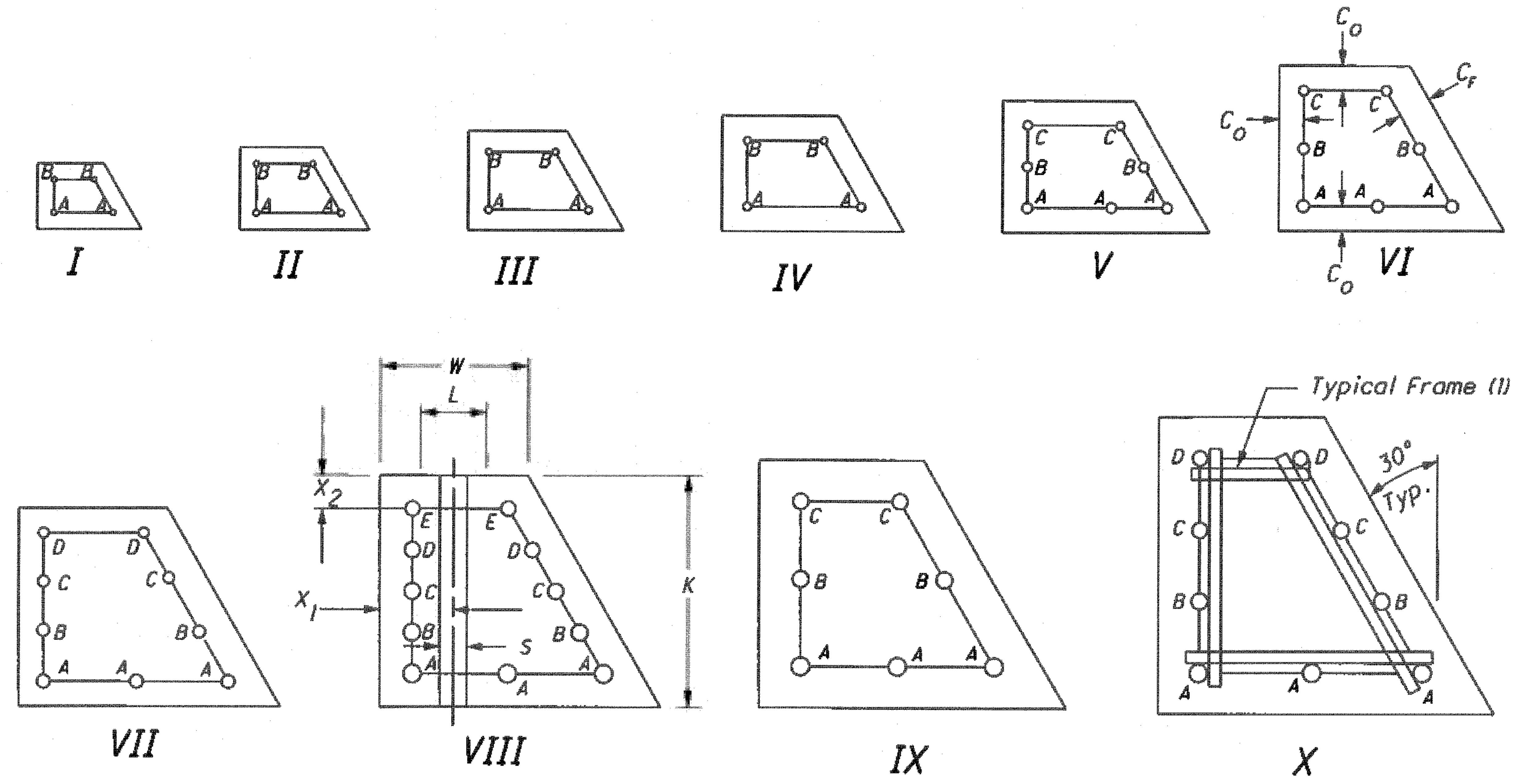
CITY OF ALBUQUERQUE
PUBLIC WORKS DEPARTMENT

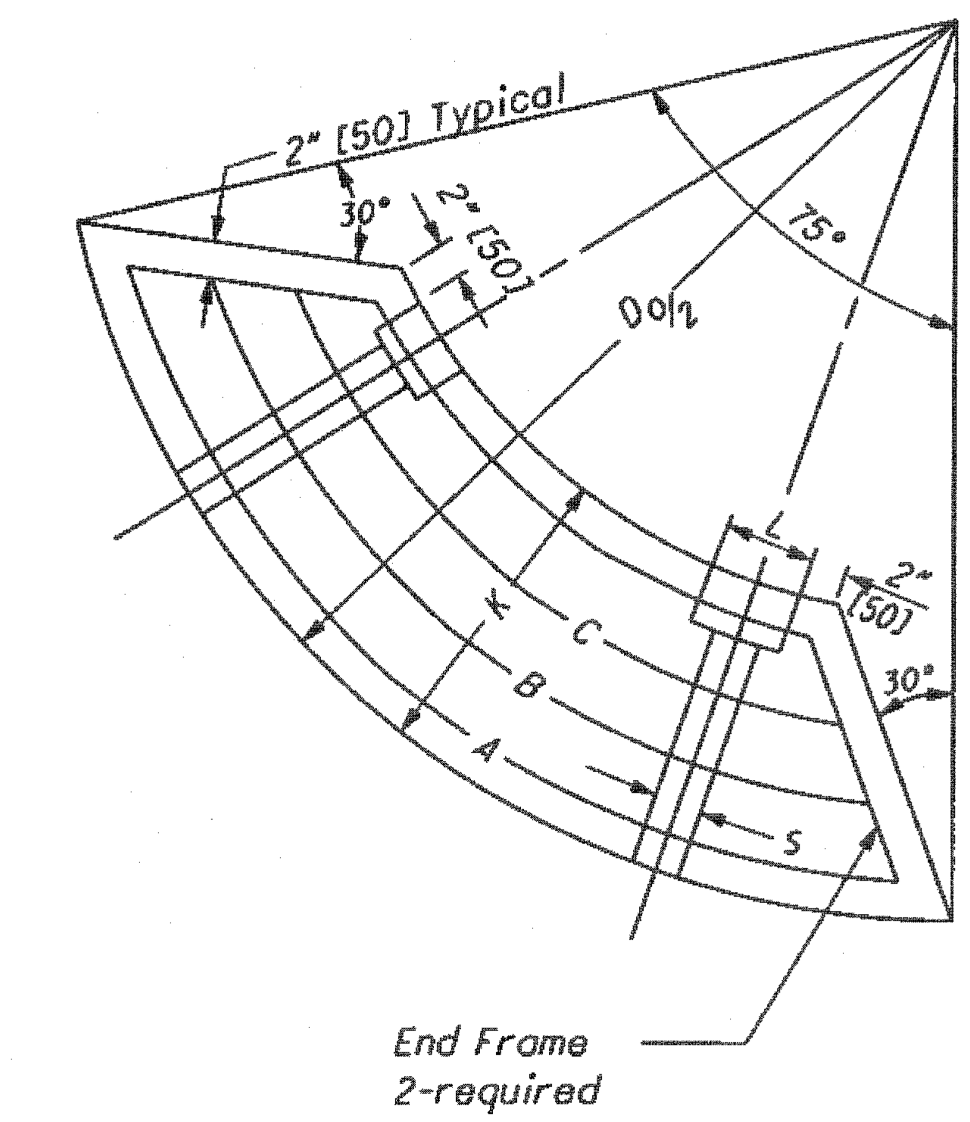
TITLE: JUAN TABO HILLS ESTATES STORM SEWER TRUNK LINE CULVERT INTERNAL ENERGY DISSAPATORS

DESIGN REVIEW COMMITTEE	CITY ENGINEER APPROVAL	LAST DESIGN UPDATE	MO./DAY/YR.	MO./DAY/YR.

PROJECT NO.	ZONE MAP NO.	SHEET	OF
665888	M-21-Z	5.1	6

A11039 JTH WEST-PPLAT\PLANS\UTILITIES\STORM TRUNK\A11039 BANK PROTECTION_DTLS-NOTES.dwg\9/14/17\ACH





RING SEGMENT PROFILE

TABLE OF RING SEGMENT DATA FOR EACH PIPE SIZE (Do)

K		W		D_S		D_L		X_1		X_2		Approx. Length of Curved Bars Inches (mm)										Approx. Radius of Curved Bars Inches (mm)										Number of Frames	C_o		C_F		Reinforcing Bar Size		Section Number
												A		B		C		D		E		R_A		R_B		R_C		R_D		R_E									
Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm		Inches	mm	Inches	mm	Feet	m	
4	102	4	102	0.625	16	1.5	38	2.00	51	1.00	25	17.1	434	12.2	310	—	—	—	—	—	—	17.0	432	15.0	381	—	—	—	—	—	—	3	1.0	25	1.5	38	#4	#13	I
5	127	5	127	0.625	16	2.0	51	2.50	64	1.00	25	21.0	533	13.6	345	—	—	—	—	—	—	20.0	508	17.0	432	—	—	—	—	—	—	3	1.0	25					II
6	152	6	152	0.750	19	2.0	51	3.00	76	1.25	32	23.7	602	16.3	414	—	—	—	—	—	—	22.5	572	19.5	495	—	—	—	—	—	—	3	1.5	38					III
7	178	7	178	1.000	25	3.0	76	3.50	89	1.50	38	27.6	701	17.8	452	—	—	—	—	—	—	25.5	648	21.5	546	—	—	—	—	—	—	3							IV
7	178	7	178					3.50	89			31.6	803	21.7	551	—	—	—	—	—	—	28.5	724	24.5	622	—	—	—	—	—	—	3			1.5	38			IV
8	203	8	203					4.00	102			35.5	902	29.3	744	23.2	589	—	—	—	—	31.5	800	29.0	737	26.5	673	—	—	—	—	4			2	51			V
8	203	8	203	1.000	25			4.00	102			39.4	1001	33.3	846	27.1	688	—	—	—	—	34.5	876	32.0	813	29.5	749	—	—	—	—	4							V
10	254	8	203	1.250	32	3.0	76	4.00	102	1.50	38	43.4	1102	34.7	881	26.1	663	—	—	—	—	37.5	953	34.0	864	30.5	775	—	—	—	—	4							VI
12	305	9	229	1.625	41	4.0	102	4.50	114	2.00	51	47.3	1201	39.9	1013	32.5	825	25.1	638	—	—	40.5	1029	37.5	953	34.5	876	31.5	800	—	—	5							VII
												51.2	1300	43.8	1113	36.4	925	29.0	737	—	—	43.5	1105	40.5	1029	37.5	953	34.5	876	—	—	5							VII
												55.1	1400	47.7	1212	40.3	1024	32.9	836	—	—	46.5	1181	43.5	1105	40.5	1029	37.5	953	—	—	5							VII
												59.0	1499	51.7	1313	44.3	1125	36.9	937	—	—	49.5	1257	46.5	1181	43.5	1105	40.5	1029	—	—	5							VII
12	305											63.0	1600	55.6	1412	48.2	1224	40.8	1036	—	—	52.5	1334	49.5	1257	46.5	1181	43.5	1105	—	—	5	1.5	38					VII
14	356											65.7	1669	59.5	1511	53.4	1356	47.2	1199	41.0	1041	55.0	1397	52.5	1334	50.0	1270	47.5	1206	45.0	1143	5	2	51					VIII
14	356	9	229	1.625	41			4.50	114	2.00	51	69.6	1768	63.4	1610	57.3	1455	51.1	1298	45.0	1143	58.0	1473	55.5	1410	53.0	1346	50.5	1283	48.0	1219	5					#4	#13	VIII

AS BUILT INFORMATION

CONTRACTOR
WORK STAKED BY — DATE
INSPECTOR'S ACCEPTANCE BY — DATE
FIELD VERIFICATION BY — DATE
DRAWINGS CORRECTED BY — DATE

MICRO-FILM INFORMATION

RECORDED BY — DATE
NO.

BENCH MARKS

STATION "5-M22" IS LOCATED 8.7 MI. SE OF DOWNTOWN ALBUQUERQUE ON THE EAST SIDE OF THE MUNICIPAL LIMITS LINE IN THE FOUR HILLS SUBDIVISION AREA. STATION IS 600 FT. EAST OF MUNICIPAL LIMITS LINE, 77.9' SE OF POWER POLE #SE37 & 186.0' NW OF POWER POLE #60. STATION IS A STANDARD ACS BRASS DISK SET IN A CONCRETE MONUMENT IN THE GROUND. STATION IS STAMPED "5-M22". X= 1,564,263.207, Y= 1,475,762.595, (NAD 83), Z= 5597.219 (NAVD 1988).

SURVEY INFORMATION

FIELD NOTES
NO. | BY | DATE

ENGINEER'S SEAL

NO. | DATE | BY | REMARKS
REVISIONS

DESIGN
DESIGNED BY HLC — DATE 05/18
DRAWN BY HLC — DATE 05/18
CHECKED BY DMG — DATE 05/18

MARK GOODWIN & ASSOCIATES, P.A.
CONSULTING ENGINEERS
P.O. BOX 90606
ALBUQUERQUE, NEW MEXICO 87199
OFFICE (505) 828-2200, FAX (505) 797-9539

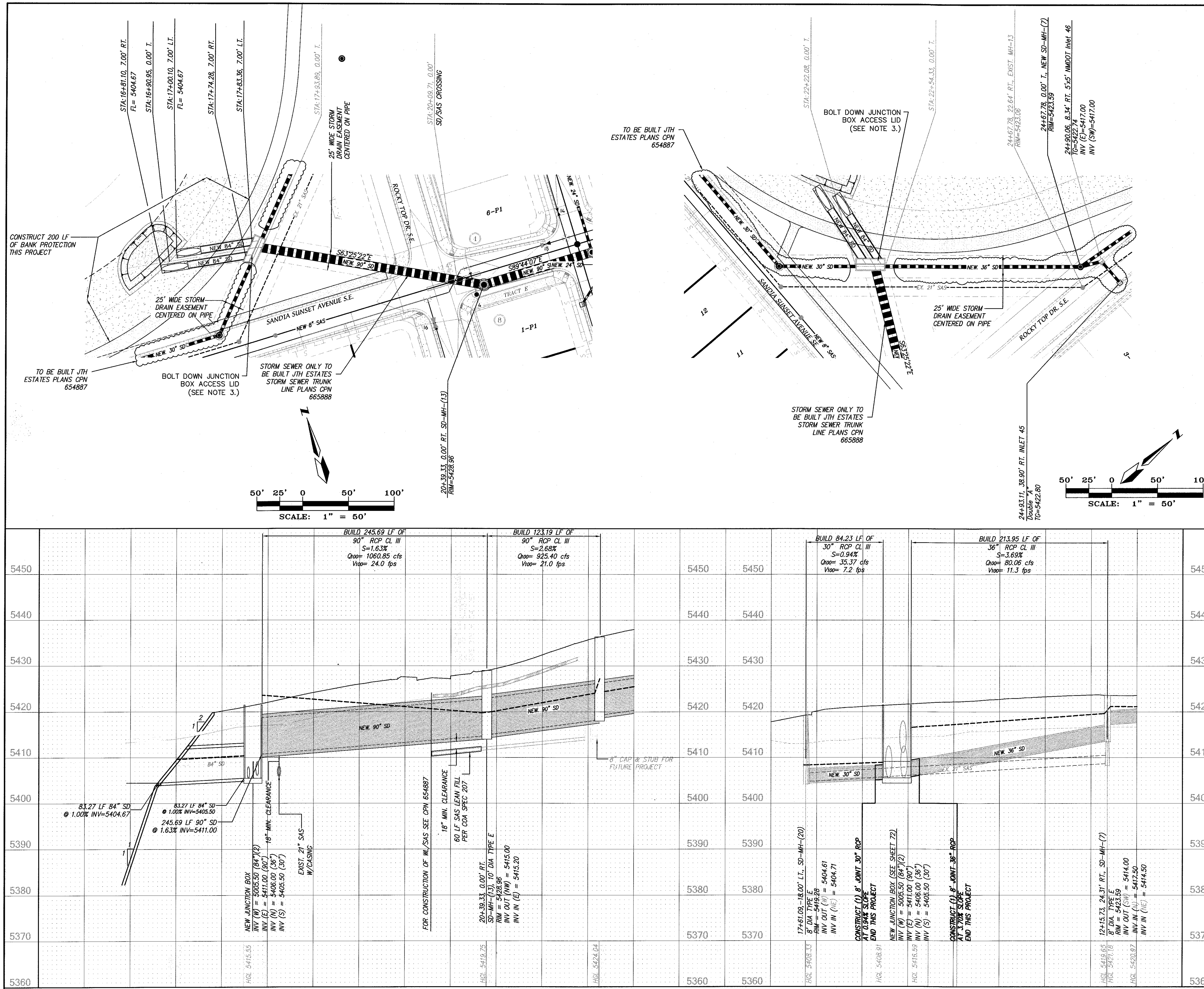
CITY OF ALBUQUERQUE
PUBLIC WORKS DEPARTMENT

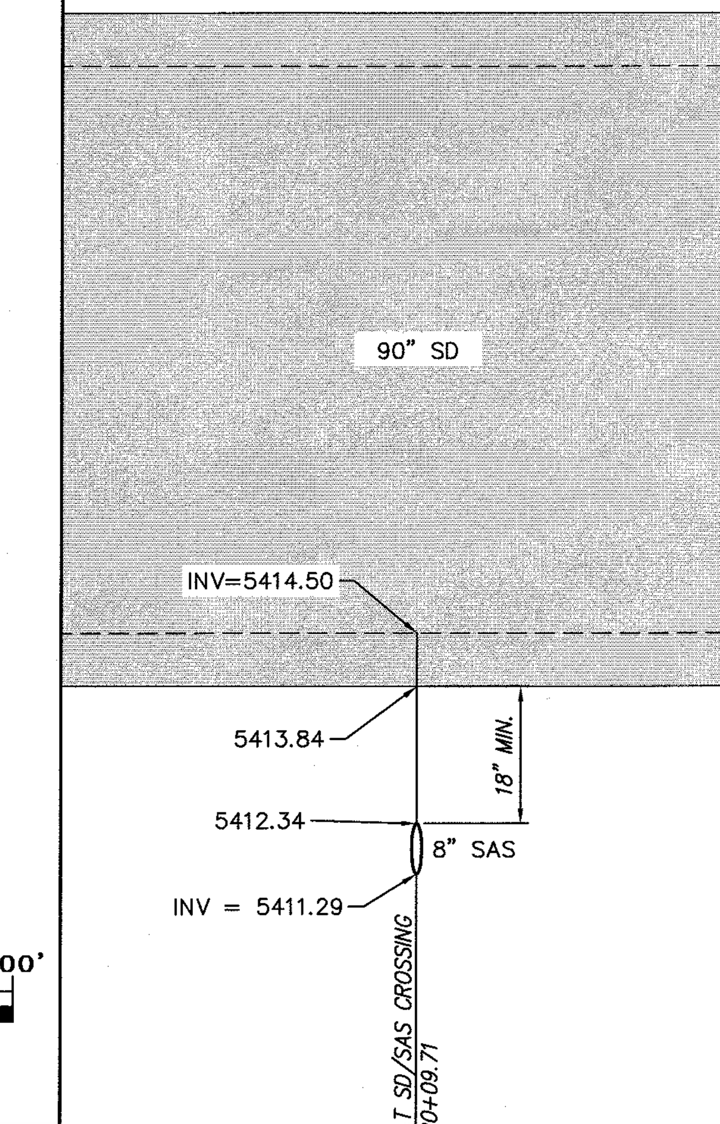
TITLE: JUAN TABO HILLS ESTATES
STORM SEWER TRUNK LINE
CULVERT INTERNAL ENERGY DISSAPATORS

DESIGN REVIEW COMMITTEE | CITY ENGINEER APPROVAL | LAST DESIGN UPDATE | MO./DAY/YR. | MO./DAY/YR.

PROJECT NO. 665888 | ZONE MAP NO. M-21-Z | SHEET 5.2 OF 6

A11039 JTH WEST-PPLAT\PLANS\UTILITIES\STORM TRUNK\A11039 BANK PROTECTION_DTLS-NOTES.dwg\9/14/17\ACH





STATION: 20+09.71
SD/SAS CROSSING

NOTES

1. ALL STORM SEWER MANHOLES PER ABCWUA TYPE 'E' STD DWG AND #2102, #2107 AND #2110.
2. HGL BASED ON PROFILE 3 IN DRAINAGE REPORT.
3. LID OPENING ON JUNCTION BOX SHALL BE BOLTED DOWN SAME AS IS DONE ON ALL THE STORM MANHOLE LIDS LOCATED IN SANDIA SUNSET AVENUE.

AS BUILT INFORMATION
CONTRACTOR
WORK STAKED BY — DATE
INSPECTOR'S ACCEPTANCE BY — DATE
FIELD VERIFICATION BY — DATE
DRAWINGS CORRECTED BY — DATE

MICRO-FILM INFORMATION
RECORDED BY — DATE
NO.

BENCH MARKS
STATION "5-M22" IS LOCATED 8.7 MI. SE OF DOWNTOWN ALBUQUERQUE ON THE EAST SIDE OF THE MUNICIPAL LIMITS LINE IN THE FOUR HILLS SUBDIVISION AREA. STATION IS 600 FT. EAST OF MUNICIPAL LIMITS LINE, 77.9' SE OF POWER POLE #SE37 & 186.0' NW OF POWER POLE #60. STATION IS A STANDARD ACS BRASS DISK SET IN A CONCRETE MONUMENT IN THE GROUND. STATION IS STAMPED "5-M22". X= 1,564,263.207, Y= 1,475,762.595, (NAD 83), Z= 5597.219 (NAVD 1988).

SURVEY INFORMATION
FIELD NOTES
NO. | BY | DATE

ENGINEER'S SEAL
D. MARK GOODWIN — NEW MEXICO — 8948 — LICENSED PROFESSIONAL ENGINEER
5/23/18

CERTIFICATE OF SUBSTANTIAL COMPLIANCE

NO.	DATE	REMARKS	BY
		REVISIONS	
DESIGN	DATE 02/17	DESIGNED BY	JDH
	DATE 02/17	DRAWN BY	SPS
	DATE 02/17	CHECKED BY	DMG

MARK GOODWIN & ASSOCIATES, P.A.
CONSULTING ENGINEERS
P.O. BOX 90606
ALBUQUERQUE, NEW MEXICO 87199
OFFICE (505) 828-2200, FAX (505) 797-9539

CITY OF ALBUQUERQUE
PUBLIC WORKS DEPARTMENT

TITLE: *JUAN TABO HILLS ESTATES STORM SEWER TRUNK LINE UTILITY PLAN & PROFILE*

DESIGN REVIEW COMMITTEE	CITY ENGINEER APPROVAL	LAST DESIGN UPDATE	MO./DAY/YR.	MO./DAY/YR.

CITY PROJECT NO.	ZONE MAP NO.	SHEET	OF
665888	M-21	6R	6

F:\A11039 JTHWEST-PPLAT\PLANS\UTILITIES\STORM TRUNK\STORMK(1)23 R.DWG (DLH 5-23-18)

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T1 JTH ESTATES SANDIA MAIN STORM DRAIN                                                           0
T2 TIJERAS ARROYO TO JTH UNIT 1 EXISTING 84" STORM PIPE (FILE:JTH_I.WSW)
T3 STARTING POINT AT MANHOLE 13- ASSUMING JHUGHES WSEL (3-21-17)
SO    1357.700 415.000  4                                    420.164
R     1470.900 418.750  4          .013                                              .000      .000 1
JX    1480.900 419.250  7   5    6.013      17.880     24.440 423.000 426.700 90.0-90.0       .000
R     1737.900 427.000  7          .013                                              .000      .000 1
JX    1747.900 427.200  9   8      .013      19.990              435.500           -90.0            .000
R     1982.900 432.500  9          .013                                              .000      .000 1
JX    1992.400 432.700 11  10      .013      25.620              442.100           -90.0            .000
R     2125.200 435.300 11          .013                                              .000      .000 1
JX    2130.200 435.400 13  12      .013      41.950              437.400           -70.0            .000
R     2147.900 438.600 13          .013                                              .000    33.000 1
JX    2157.900 438.700 14          .013
SH    2157.900 438.700 15                                    438.700
CD    1   4    2      .000     7.000     .000    .000    .000    .00
CD    2   2    0      .000    15.000   30.000    .000    .000    .00
CD    3   4    1      .000     7.500     .000    .000    .000    .00
CD    4   4    1      .000     7.500     .000    .000    .000    .00
CD    5   4    1      .000     2.000     .000    .000    .000    .00
CD    6   4    1      .000     2.000     .000    .000    .000    .00
CD    7   4    1      .000     7.000     .000    .000    .000    .00
CD    8   4    1      .000     2.000     .000    .000    .000    .00
CD    9   4    1      .000     7.000     .000    .000    .000    .00
CD   10   4    1      .000     2.000     .000    .000    .000    .00
CD   11   4    1      .000     7.000     .000    .000    .000    .00
CD   12   4    1      .000     2.500     .000    .000    .000    .00
CD   13   4    1      .000     7.000     .000    .000    .000    .00
CD   14   4    1      .000     7.000     .000    .000    .000    .00
CD   15   4    1      .000     7.000     .000    .000    .000    .00
CD   16   4    1      .000     3.500     .000    .000    .000    .00
CD   17   4    1      .000     6.000     .000    .000    .000    .00
CD   18   4    1      .000     5.500     .000    .000    .000    .00
CD   19   4    1      .000     2.000     .000    .000    .000    .00
CD   20   4    1      .000     3.000     .000    .000    .000    .00
CD   21   4    1      .000     4.500     .000    .000    .000    .00
CD   22   4    1      .000     1.500     .000    .000    .000    .00
CD   23   4    1      .000     4.500     .000    .000    .000    .00
CD   24   4    1      .000     2.000     .000    .000    .000    .00
CD   25   4    1      .000     4.500     .000    .000    .000    .00
CD   26   4    1      .000     1.500     .000    .000    .000    .00
CD   27   4    1      .000     2.500     .000    .000    .000    .00
CD   28   4    1      .000     4.500     .000    .000    .000    .00
CD   29   4    1      .000     2.000     .000    .000    .000    .00
CD   30   4    1      .000     4.500     .000    .000    .000    .00
Q             795.520    .0
```

DIANE HOELZER
NEW MEXICO
11987
LICENSED PROFESSIONAL ENGINEER

5-10-18

FILE: JTH-I.WSW

W S P G W - CIVILDESIGN Version 14.05

Program Package Serial Number: 1454

WATER SURFACE PROFILE LISTING

Date: 3-22-2018 Time: 5:45:43

JTH ESTATES SANDIA MAIN STORM DRAIN

TIJERAS ARROYO TO JTH UNIT 1 EXISTING 84" STORM PIPE (FILE:JTH_I.WSW)

STARTING POINT AT MANHOLE 13- ASSUMING JHUGHES WSEL (3-21-17)

	Station / L/Elem	Invert Elev / Ch Slope	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head / SF Ave	Energy Grd.El. / HF	Super Elev / SE Dpth	Critical Depth / Froude N	Flow Top Width / Norm Dp	Height/ Dia.-FT / "N"	Base Wt or I.D. / X-Fall	ZL / ZR	No Wth Prs/Pip / Type Ch
MH 13	1357.700	415.000	5.009	420.009	925.40	29.52	13.53	433.54	.00	7.17	7.06	7.500	.000	.00	1 .0
	29.229	.0331					.0231	.68	5.01	2.47	4.46	.013	.00	.00	PIPE
	1386.929	415.968	5.067	421.035	925.40	29.13	13.18	434.21	.00	7.17	7.02	7.500	.000	.00	1 .0
	83.971	.0331					.0215	1.81	5.07	2.41	4.46	.013	.00	.00	PIPE
MH 12	1470.900	418.750	5.292	424.042	925.40	27.78	11.98	436.02	.00	7.17	6.84	7.500	.000	.00	1 .0
	JUNCT STR	.0500					.0220	.22	5.29	2.22		.013	.00	.00	PIPE
	1480.900	419.250	5.183	424.433	883.08	28.90	12.97	437.41	.00	6.81	6.14	7.000	.000	.00	1 .0
	118.944	.0302					.0225	2.68	5.18	2.28	4.72	.013	.00	.00	PIPE
	1599.844	422.837	5.424	428.261	883.08	27.60	11.83	440.09	.00	6.81	5.85	7.000	.000	.00	1 .0
	81.412	.0302					.0203	1.66	5.42	2.08	4.72	.013	.00	.00	PIPE
	1681.255	425.292	5.700	430.992	883.08	26.31	10.75	441.74	.00	6.81	5.44	7.000	.000	.00	1 .0
	56.645	.0302					.0185	1.05	5.70	1.87	4.72	.013	.00	.00	PIPE
MH 11	1737.900	427.000	6.018	433.018	883.08	25.09	9.77	442.79	.00	6.81	4.86	7.000	.000	.00	1 .0
	JUNCT STR	.0200					.0184	.18	6.02	1.64		.013	.00	.00	PIPE
	1747.900	427.200	5.591	432.791	863.09	26.19	10.65	443.44	.00	6.79	5.61	7.000	.000	.00	1 .0
	133.061	.0226					.0185	2.46	5.59	1.91	5.19	.013	.00	.00	PIPE
	1880.961	430.201	5.824	436.025	863.09	25.22	9.88	445.90	.00	6.79	5.23	7.000	.000	.00	1 .0
	101.939	.0226					.0171	1.74	5.82	1.74	5.19	.013	.00	.00	PIPE

FILE: JTH-I.WSW

W S P G W - CIVILDESIGN Version 14.05

Program Package Serial Number: 1454

WATER SURFACE PROFILE LISTING

Date: 3-22-2018 Time: 5:45:43

JTH ESTATES SANDIA MAIN STORM DRAIN

TIJERAS ARROYO TO JTH UNIT 1 EXISTING 84" STORM PIPE (FILE:JTH_I.WSW)

STARTING POINT AT MANHOLE 13- ASSUMING JHUGHES WSEL (3-21-17)

	Station / L/Elem	Invert Elev / Ch Slope	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head / SF Ave	Energy Grd.El. / HF	Super Elev / SE Dpth	Critical Depth / Froude N	Flow Top Width / Norm Dp	Height/ Dia.-FT / "N"	Base Wt or I.D. / X-Fall	ZL / ZR	No Wth Prs/Pip / Type Ch
MH 10	1982.900	432.500	6.165	438.665	863.09	24.05	8.98	447.64	.00	6.79	4.54	7.000	.000	.00	1 .0
	JUNCT STR	.0211					.0173	.16	6.17	1.51		.013	.00	.00	PIPE
	1992.400	432.700	5.565	438.265	837.47	25.53	10.12	448.38	.00	6.76	5.65	7.000	.000	.00	1 .0
	132.800	.0196					.0179	2.38	5.56	1.87	5.38	.013	.00	.00	PIPE
VMDOT	2125.200	435.300	5.657	440.957	837.47	25.13	9.81	450.77	.00	6.76	5.51	7.000	.000	.00	1 .0
	JUNCT STR	.0200					.0194	.10	5.66	1.80		.013	.00	.00	PIPE
NLET 68	2130.200	435.400	4.982	440.382	795.52	27.16	11.45	451.83	.00	6.71	6.34	7.000	.000	.00	1 .0
	2.257	.1808					.0207	.05	4.98	2.23	2.60	.013	.00	.00	PIPE
	2132.457	435.808	5.077	440.885	795.52	26.61	10.99	451.88	.00	6.71	6.25	7.000	.000	.00	1 .0
	4.710	.1808					.0192	.09	5.08	2.14	2.60	.013	.00	.00	PIPE
	2137.167	436.660	5.315	441.975	795.52	25.37	9.99	451.97	.00	6.71	5.99	7.000	.000	.00	1 .0
	3.940	.1808					.0172	.07	5.32	1.95	2.60	.013	.00	.00	PIPE
	2141.107	437.372	5.579	442.951	795.52	24.19	9.08	452.04	.00	6.71	5.63	7.000	.000	.00	1 .0
	3.202	.1808					.0156	.05	5.58	1.76	2.60	.013	.00	.00	PIPE
	2144.310	437.951	5.876	443.827	795.52	23.06	8.26	452.09	.00	6.71	5.14	7.000	.000	.00	1 .0
	2.390	.1808					.0143	.03	5.88	1.57	2.60	.013	.00	.00	PIPE
	2146.699	438.383	6.229	444.612	795.52	21.99	7.51	452.12	.00	6.71	4.38	7.000	.000	.00	1 .0
	1.200	.1808					.0136	.02	6.23	1.35	2.60	.013	.00	.00	PIPE

Program Package Serial Number: 1454

WATER SURFACE PROFILE LISTING Date: 3-22-2018 Time: 5:45:43

JTH ESTATES SANDIA MAIN STORM DRAIN

TIJERAS ARROYO TO JTH UNIT 1 EXISTING 84" STORM PIPE (FILE:JTH_I.WSW)

STARTING POINT AT MANHOLE 13- ASSUMING JHUGHES WSEL (3-21-17)

Station	Invert Elev	Depth (FT)	Water Elev	Q (CFS)	Vel (FPS)	Vel Head	Energy Grd.El.	Super Elev	Critical Depth	Flow Top Width	Height/ Dia.-FT	Base Wt or I.D.	ZL	No Wth Prs/Pip
L/Elem	Ch Slope					SF Ave	HF	SE Dpth	Froude N	Norm Dp	"N"	X-Fall	ZR	Type Ch
2147.900	438.600	6.712	445.312	795.52	20.96	6.82	452.14	.00	6.71	2.78	7.000	.000	.00	1 .0
JUNCT STR	.0100					.0138	.14	6.71	1.00		.013	.00	.00	PIPE
2157.900	438.700	6.903	445.603	795.52	20.73	6.67	452.27	.00	6.71	1.64	7.000	.000	.00	1 .0

MH9

NOTE: BETWEEN INLET 68 and MH9, THE VELOCITIES WILL BE CLOSER TO 25-26 FPS, ACCORDING TO ANALYSIS WITH PIPE BAFFLES.

IT IS RECOMMENDED THAT MANHOLES IN SANDIA SUNSET BE BOLTED. THIS INCLUDES MH 13, 12, 11, 10, 9.

CP Info
american concrete pipe association ▲ 8320 old courthouse road ▲ vienna, virginia 22180

CULVERT VELOCITY REDUCTION BY INTERNAL ENERGY DISSIPATORS

The designer is often concerned with possible scour or erosion at the outlet of a drainage culvert constructed on a steep slope. Such erosion can cause serious maintenance, silting and pollution problems. The high velocity associated with flow on steep slopes is the critical parameter in the erosion process.

Reduction of the velocity of such flows is generally accomplished by the formation of a hydraulic jump. A hydraulic jump converts shallow, high velocity flow to deeper, low velocity flow while losing considerable energy in the resulting turbulence. Most outlet protection devices are essentially stilling basins, designed so the hydraulic jump is formed in the basin.

This article describes dissipators intended to form the hydraulic jump within the culvert, thus eliminating costly outlet structures. These dissipators are cirular rings spaced along the pipe at the downstream end. The rings cause a series of hydraulic jumps to form in the barrel of the pipe, resulting in a near optimum dissipation of energy and virtually minimum possible total energy at the outlet.

GENERAL

Previous research conducted at Virginia Polytechnic Institute on the use of roughness elements in open channels established that excess energy in storm water flowing down steep drainage channels could be dissipated by constructing roughness elements within the channel. Since culverts operating under inlet control simulate open channel flow, application of this type of internal energy dissipation to culverts could possibly result in more efficient utilization of the culvert barrel and reduced outlet velocities.

In August, 1969, the American Concrete Pipe Association contracted with Virginia Polytechnic Institute and State University (VPI) to investigate and determine the feasibility and applicable design procedures for using roughness elements as energy dissipators of free-surface flow in circular concrete pipe culverts. Results of the research are published in Highway Research Record Number 373 **Roughness Elements as Energy Dissipators of Free-Surface Flow in Circular Pipes.** Because of the criteria of assuring free surface flow, full capacity of the conduit was not realized and necessitated an increase in pipe size within the length of culvert in which the roughness elements are placed. Based on the laboratory and field observations during this initial research, subsequent tests were conducted for full flow conditions occurring near the outlet end at maximum design discharge. By eliminating the criteria of free surface flow and allowing the culvert

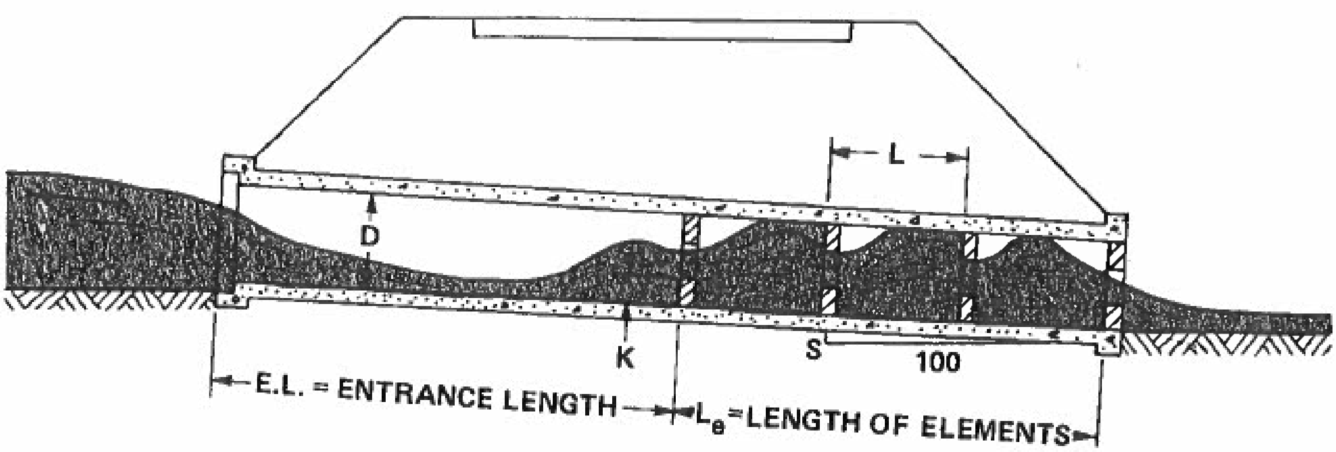


FIGURE 1. TUMBLING FLOW IN PIPE CULVERT.

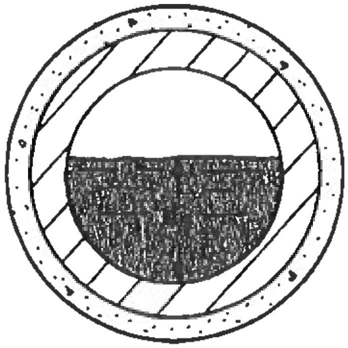


FIGURE 2. ROUGHNESS ELEMENT IN PIPE.

to approach full flow, it was found velocity reduction could be effected without an increase in pipe size. The results of this later research and design procedures for both the full flow condition and the free surface flow condition are presented in the following paragraphs.

FREE SURFACE FLOW TESTS

The performance characteristics of dissipator rings were investigated initially in laboratory models and later with a full scale 18-inch reinforced concrete pipe prototype. Different numbers of rings of various cross-sectional dimensions and spacings were tested in the 6-inch diameter clear plastic model pipe which could be adjusted to any slope from zero to 30 percent. An early conclusion was that only five rings were necessary to achieve consistent results. The full scale prototype was tested at flatter slopes than the laboratory model because test facilities with unlimited quantities of water were not available within a reasonable distance of VPI.

Since the objectives of the research were to dissipate energy and reduce high velocities associated with culverts on what are considered steep slopes, the culverts were operating under inlet control. Accordingly, the flow characteristics were observed to be one of critical flow at the entrance of the pipe with the flow accelerating down the length of the pipe until the first ring, or roughness element, was reached. At that point, a hydraulic jump was formed, with extreme turbulence. The flow then encountered another roughness element while still in an agitated condition from the first and this pattern of action was repeated until a cyclic condition was reached, where the flow conditions over the roughness elements were uniform. Generally, this cyclic action was attained after the second or third element. The agitated flow, characterized by a greater depth over the element than before it, a fall into a *valley* between the elements, and a form resembling a hydraulic jump shortly before the next element, is called *tumbling* flow. Thus one cycle is completed and the flow *tumbles* into the next cycle until the outlet is reached. This *tumbling* flow can only be established and maintained under less than full flow conditions. Figure 3 shows how tumbling flow with a free flow surface at less than maximum design discharge appeared in the 6-inch clear plastic pipe.

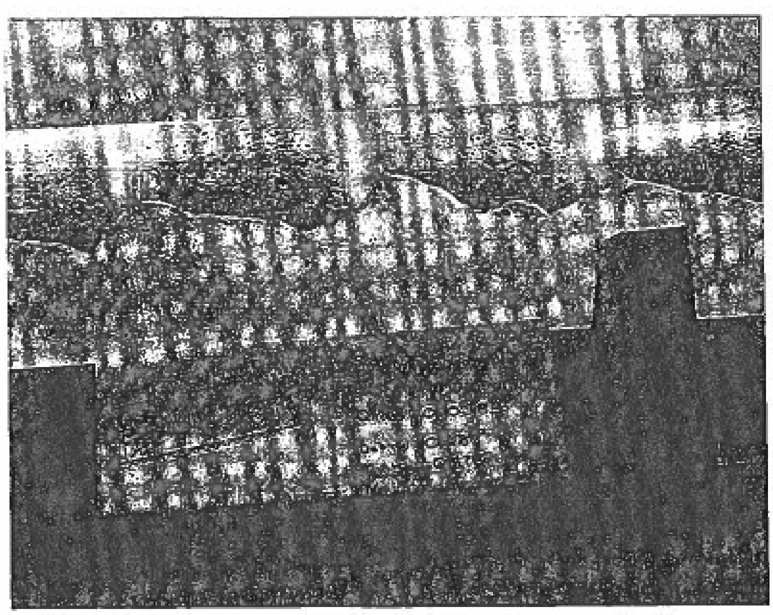


FIGURE 3. TUMBLING FLOW IN 6-INCH PLASTIC PIPE.

FULL FLOW TESTS

During the previous VPI research on open channel flow, it was observed that if one large dissipator element was placed upstream it created a large hydraulic jump which was maintained by the smaller downstream elements. In applying this observation to pipe flow at maximum design discharges, it was theorized that the hydraulic jump at the large upstream ring would cause the pipe to flow full with the smaller downstream rings maintaining the full flow condition.

Several tests of various ring configurations quickly indicated the soundness of this approach. Subsequently extended tests for the full flow condition were made in the laboratory model with a ring configuration consisting of three small rings at the exit preceded by one large ring at double spacing as illustrated in Figure 4. The three small rings were spaced at spacing-diameter ratio (L/D) of 1.5 with a ring height-diameter ratio (K/D) of 0.0625. The large ring, at double spacing, had a height ratio K/D of 0.146.

Model tests were run for this configuration at three slopes of 4.3, 9.3 and 15.2 percent. In order to compare these model tests with the full scale prototype tests under *free surface flow*, the range of test flows was equivalent to 10 to 15 cubic feet per second in an

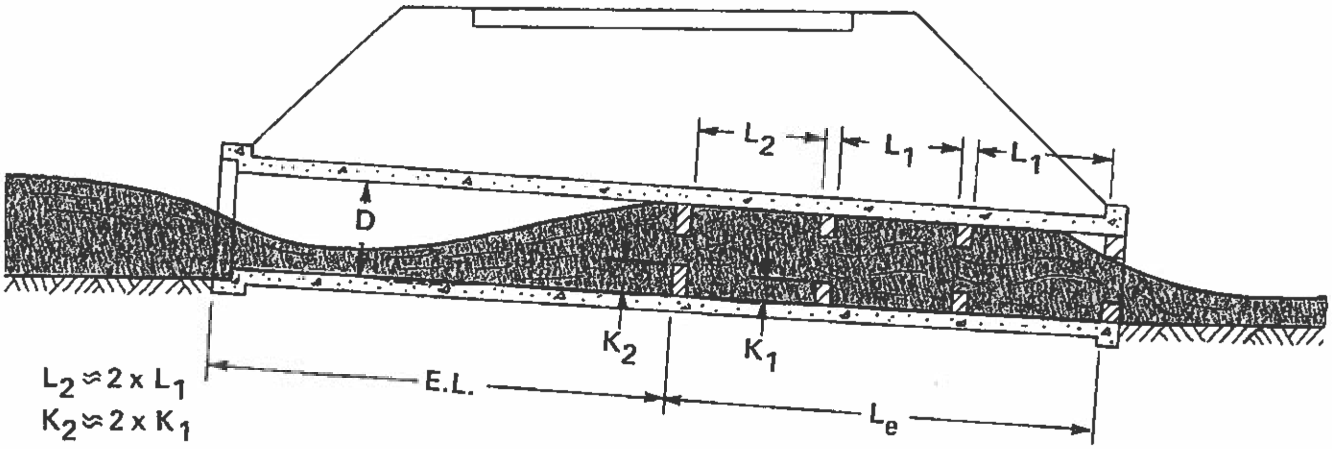


FIGURE 4. FULL FLOW IN PIPE CULVERT.

18-inch diameter pipe. In all of these larger flows (larger than indicated by tumbling flow criteria), the pipe flowed full at the outlet with the initial hydraulic jump varying in position above the leading ring depending upon the slope and flow rate. In some cases there were slugs of air moving unsteadily down the pipe, entering at a vortex in the headwater and moving through regions of full flow in entrained bubbles. In such cases, the quantity and movement of air through the pipe would indicate pressures only slightly above atmospheric and inlet control still governed. Table I details the test data and results and Table II lists the computations relating the test results to the expected performance of an 18-inch diameter prototype pipe. The prototype discharge Q_p was determined by using a Froude relationship for similitude, $Q_r = L_r^{5/2}$. In all cases except where tumbling flow is noted, the model pipe was flowing full at the downstream end. Therefore, prototype velocity Q_p was determined by dividing prototype discharge by prototype area, where the prototype area is the area of the pipe at the outlet minus the decrement in area resulting from the last ring.

TABLE I. TEST RESULTS OF 6-INCH PLASTIC PIPE.

Test Number	Slope (percent)	Q_{model} (cfs)	HW (inches)	$Q_{prototype}$ (cfs)	Remarks
1	15.2	0.946	7.00	14.7	Cavity from ring to approximately 10 feet upstream from first ring.
2	15.2	0.825	7.00	12.9	Cavity from ring to approximately 1 foot upstream from first ring.
3	15.2	0.676	6.00	10.5	Some air entrainment in ring area.
4	15.2	0.509	–	7.9	Verge of tumbling flow.
5	9.3	0.527	–	8.2	Verge of tumbling flow.
6	9.3	0.676	6.75	10.5	–
7	9.3	0.825	7.50	12.9	Cavity from 5 feet to 15 feet upstream from first ring.
8	9.3	0.946	8.00	14.7	Essentially full, some unsteady slugs of air.
9	4.3	0.858	15.00	13.4	Full.
10	4.3	0.769	10.25	12.0	Essentially full, some unsteady slugs of air.
11	4.3	0.676	7.75	10.5	Slugs of fluid progressing upstream to entrance, Jump in front of ring.
12	4.3	0.588	6.50	9.2	Cavity from 6 feet to 1 foot, intermittent.
13	4.3	0.482	6.00	7.5	Tumbling flow.

TABLE II. CALCULATED PERFORMANCE OF 18-INCH CONCRETE PIPE.

Test Number	$Q_{prototype}$ (cfs)	V = Q/A (fps)	Q_{full} (cfs)	$\frac{Q_{prototype}}{Q_{full}}$	$\frac{V_{prototype}}{V_{full}}$	Percent Velocity Reduction
1	14.7	9.90	46	0.32	0.88	56.8
2	12.9	8.69	46	0.28	0.86	61.2
3	10.5	7.07	46	0.23	0.82	66.8
4	7.9	–	46	0.17	0.75	–
5	8.2	–	35	0.23	0.82	–
6	10.5	7.07	35	0.30	0.87	59.4
7	12.9	8.69	35	0.37	0.93	53.3
8	14.7	9.90	35	0.42	0.95	47.9
9	13.4	9.03	23	0.58	1.03	34.1
10	12.0	8.09	23	0.52	1.01	39.6
11	10.5	7.07	23	0.46	0.98	45.6
12	9.2	6.20	23	0.40	0.94	50.4
13	7.5	–	23	0.33	0.89	–

FULL FLOW DESIGN PROCEDURE

Based on the preceding full flow test results, the following design procedure is suggested:

1. Select required pipe size based on the hydraulic design procedures presented in Hydraulic Engineering Circular Nos. 5 or 10 prepared by the Federal Highway Administration or the Concrete Pipe Design Manual published by the American Concrete Pipe Association.
2. For culverts operating under inlet control, determine outlet velocity by means of Manning's Formula.
3. If velocity reduction is desired, select a roughness element size for the three downstream rings with a height-diameter ratio between 0.06 and 0.09,

   $$0.06 \leqq K/D \leqq 0.09$$

   and a spacing-diameter ratio of 1.5. $L/D = 1.5$

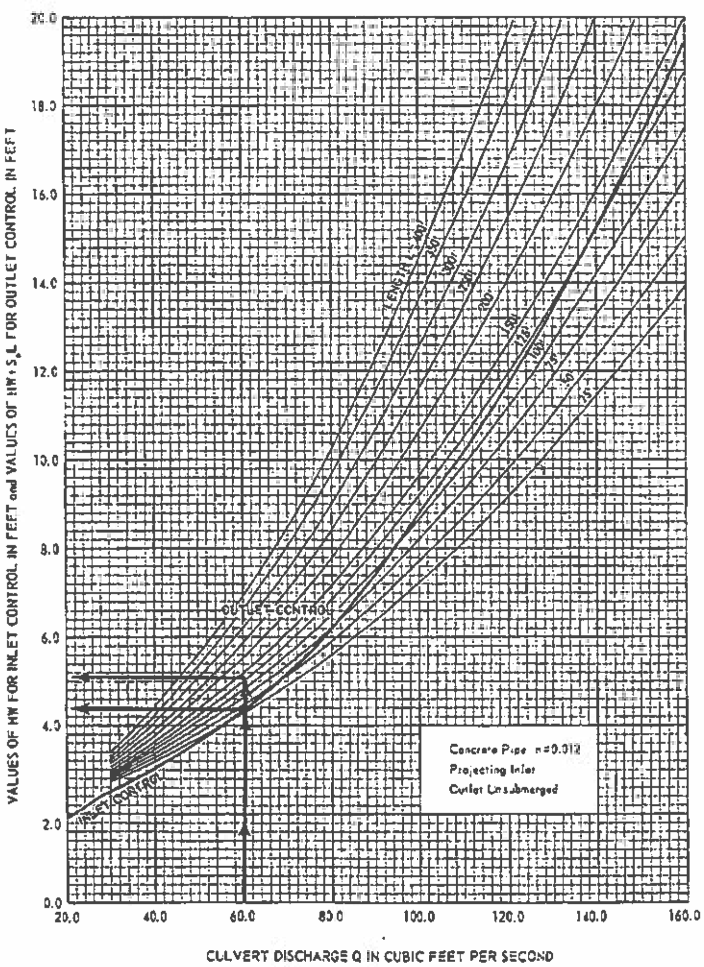
   The single upstream ring would then be located at twice this spacing and sized to be approximately double the downstream rings.
4. Determine the hydraulic cross-sectional area at the last downstream ring.
5. Divide the design discharge by the resultant area determined in Step 4 to determine the outlet velocity.

Example 1.

Given: Culvert, 36-inch diameter, 125 feet long, $n = 0.012$, 4% slope
Design $Q = 60$ cfs
$AHW = 4.5$ feet

Find: Size and spacing of roughness elements for full flow conditions

FIGURE 44 CULVERT CAPACITY 36-INCH DIAMETER PIPE



Solution:

1. Check culvert control.
   Figure 44, p. 222 Concrete Pipe Design Manual

   Inlet control:
   $HW = 4.4$ feet o.k.
   Outlet control:
   $HW + S_oL = 5.1$ feet
   $HW = 5.1 - 0.04 \times 125$
   $HW = 0.1$ feet o.k.

   Therefore, Inlet Control governs.

2. Determine outlet velocity
   Figure 4, p. 181 Concrete Pipe Design Manual

   $Q_{full} = 145$ cfs
   $V_{full} = 20.5$ fps

   Figure 18, p. 195 Concrete Pipe Design Manual

   $Q_d/Q_{full} = 60/145 = 0.41$
   $V_d / V_{full} = 0.94$
   $V_d = 0.94 \times 20.5 = 19.3$ fps

3. Velocity reduction desired.
   Downstream ring height
   $0.06 \leqq K/D \leqq 0.09$

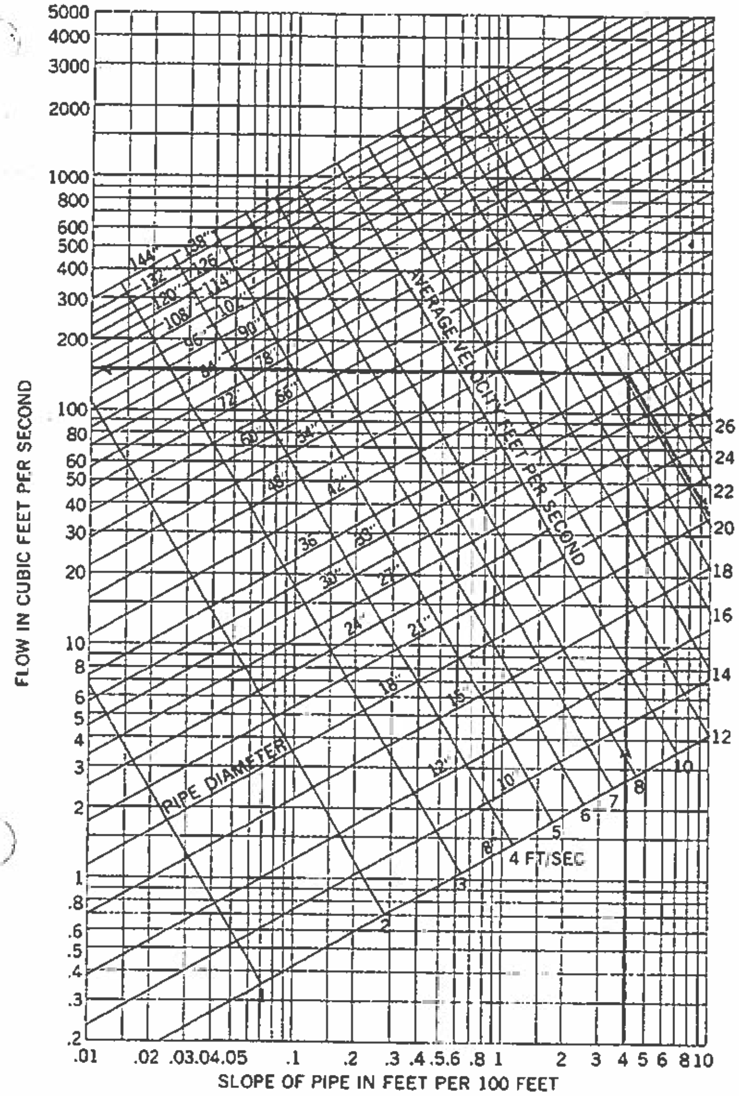
   Use $K = 0.25$ feet or 3 inches

   Downstream ring spacing
   $L/D = 1.5$
   Use $L = 4.5$ feet

   Upstream ring height
   Use $K = 6$ inches

   Upstream ring spacing
   Use $L = 9$ feet

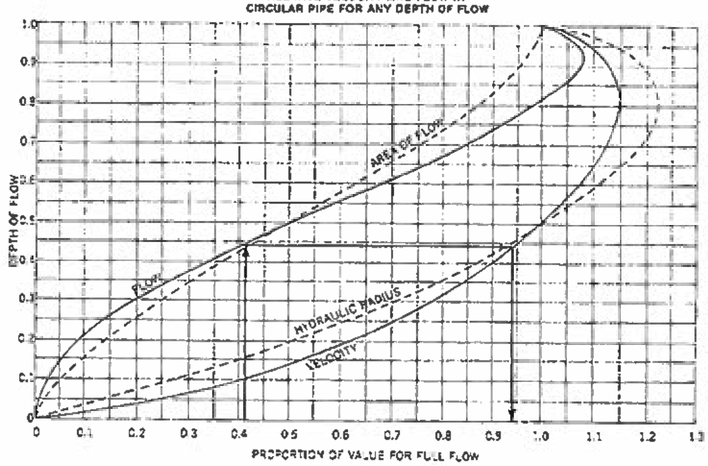
FIGURE 4 FLOW FOR CIRCULAR PIPE FLOWING FULL
BASED ON MANNING'S EQUATION n=0.012

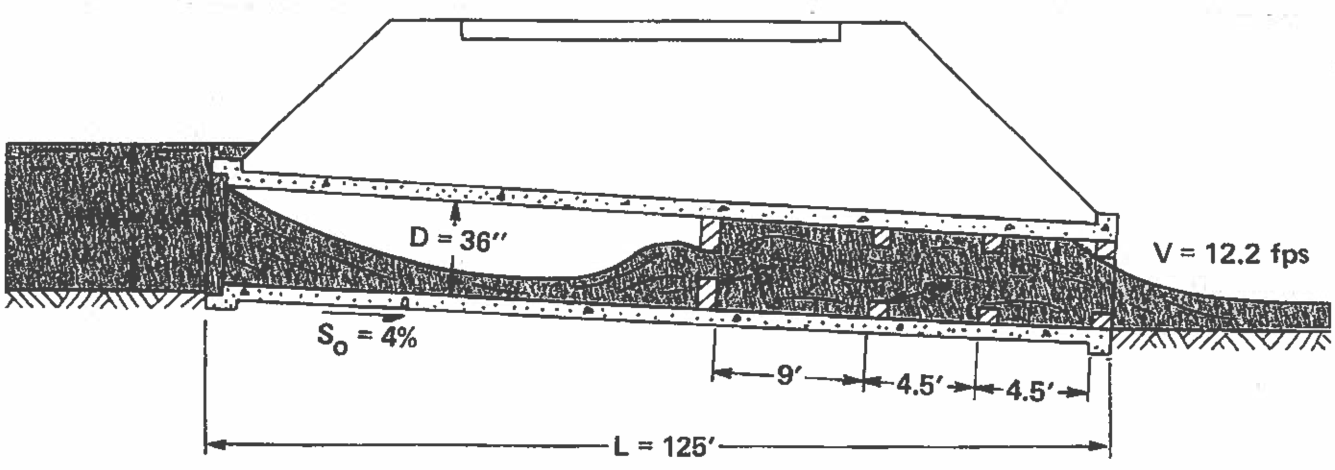


4. Determine Hydraulic cross-sectional area at last ring
   Pipe diameter = 36 inches
   Ring diameter = 30 inches
   From Table A-8 (on page 94) hydraulic cross-sectional area = 4.91 sq. ft.
5. Outlet Velocity
   $V = Q_d/A$
   $V = 60/4.91 = 12.2$ fps

Answer: Therefore, use three downstream elements, 3 inches high, spaced 4.5 feet, preceded by one upstream element, 6 inches high, spaced 9 feet as illustrated.

FIGURE 16 RELATIVE VELOCITY AND FLOW IN CIRCULAR PIPE FOR ANY DEPTH OF FLOW





FREE SURFACE FLOW DESIGN PROCEDURE

Based upon the free surface flow test results, the following design procedure is suggested:

1. Select required pipe size based on the hydraulic design procedures presented in Hydraulic Engineering Circular Nos. 5 or 10 prepared by the Federal Highway Administration or the Concrete Pipe Design Manual published by the American Concrete Pipe Association.
2. For culverts operating under inlet control, determine outlet velocity by means of Manning's Formula.
3. If velocity reduction is desired, select a pipe diameter within the following range:

$$\left[\frac{Q^2}{0.10g}\right]^{1/5} \leqq D \leqq \left[\frac{Q^2}{0.044g}\right]^{1/5}$$

where Q = design discharge

g = acceleration due to gravity (32.2)

The five dissipator rings will be placed within this pipe diameter.

4. Select a roughness element size for the dissipator rings with a height-diameter ratio between 0.10 and 0.15,

$$0.10 \leqq K/D \leqq 0.15$$

and a spacing-diameter ratio between 1.5 and 2.5.

$$1.5 \leqq L/D \leqq 2.5$$

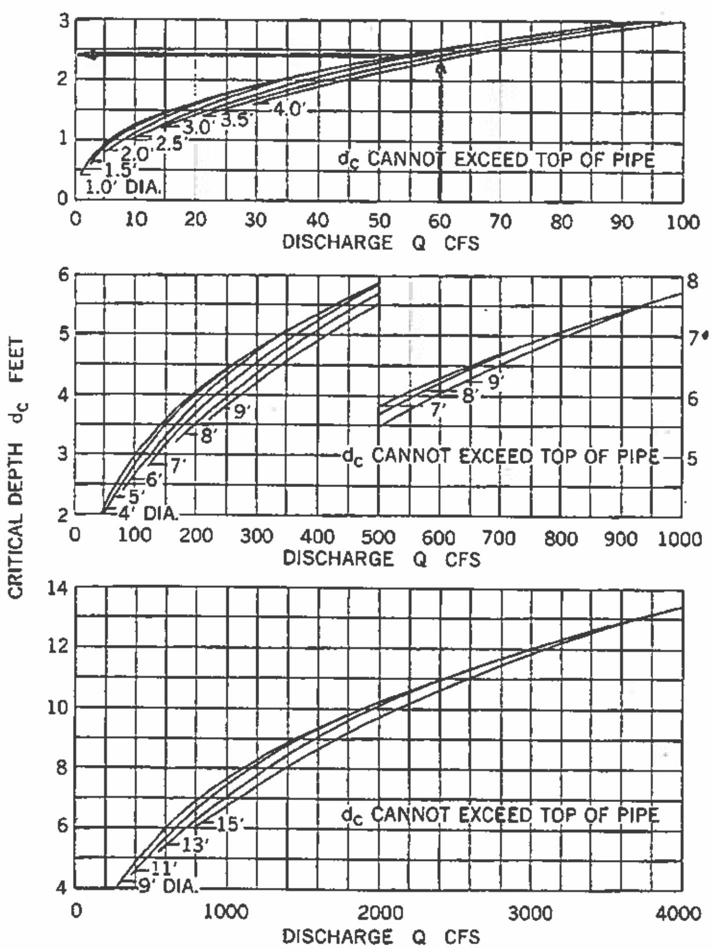
5. Determine hydraulic cross-sectional area at last dissipator ring based upon critical depth.
6. Divide the design discharge by the resultant area determined in Step 5 to determine the outlet velocity.

Example 2.

Given: Same as Example 1.

Find: Size and spacing of roughness elements for free surface flow conditions.

FIGURE 25 CRITICAL DEPTH CIRCULAR PIPE



Solution:

1. Check culvert control (see Example 1).
Inlet control governs.

2. Determine outlet velocity (see Example 1).

$Q_{full} = 145$ cfs

$V_{full} = 20.5$ fps

$Q_{design} = 60$ cfs

$V_{design} = 19.3$ fps

3. Velocity reduction desired, select pipe diameter for culvert outlet.

$$\left[\frac{Q^2}{0.10g}\right]^{1/5} \leqq D \leqq \left[\frac{Q^2}{0.044g}\right]^{1/5}$$

$$\left[\frac{(60)^2}{(0.10)\ (32.2)}\right]^{1/5} \leqq D \leqq \left[\frac{(60)^2}{(0.044)\ (32.2)}\right]^{1/5}$$

$$4.0 \leqq D \leqq 4.8$$

Try a 48-inch diameter pipe.

4. Select roughness element size and spacing.

Size— $0.10 \leqq \frac{K}{D} \leqq 0.15$

$$4.8 \leqq K \leqq 6.0$$

Try K = 5 inches.

Spacing— $1.5 \leqq \frac{L}{D} \leqq 2.5$

$72 \leqq L \leqq 120$

Spacing of five elements between 6 and 10 feet allows placing one element in each of five last culvert sections.

5. Determine hydraulic cross-sectional area of last ring

   inside pipe diameter = 48-inches

   inside ring diameter = 38-inches (3.2 feet)

   From Figure 25, page 202, Concrete Pipe Design Manual, for $D = 3.2$-feet, $d_c = 2.45$-feet

   $$\frac{d_c}{D} = \frac{2.45}{3.2} = 0.765$$

   From Table A-10, page 363, Concrete Design Manual,

   $$\frac{\text{Area}}{D^2} = 0.6446$$

   Area $= 0.6446\,(3.2)^2$

   Area $= 6.62$ sq. ft.

6. Determine outlet velocity.

   $V = Q/A$

   $V = 60/6.62$

   $V = 9.1$ fps

Answer: Therefore, use five elements, 5 inches high spaced 6 to 10 feet or the length of the pipe section if within this range, in the last five sections of pipe which are increased to 48 inches in diameter.

Discussion

The joining of the two sizes of pipe could be accomplished by telescoping or slipping the 36-inch pipe into the 48-inch pipe for at least the length of a normal joint and using normal sealing materials in the annular space.

Although the velocity reduction is somewhat greater for free surface flow than for full flow conditions, the method used should be selected only after a complete review of the economics, installation procedures and requirements of the project. Early consultation with the concrete pipe producer is suggested to take full advantage of manufacturing capabilities and design details.

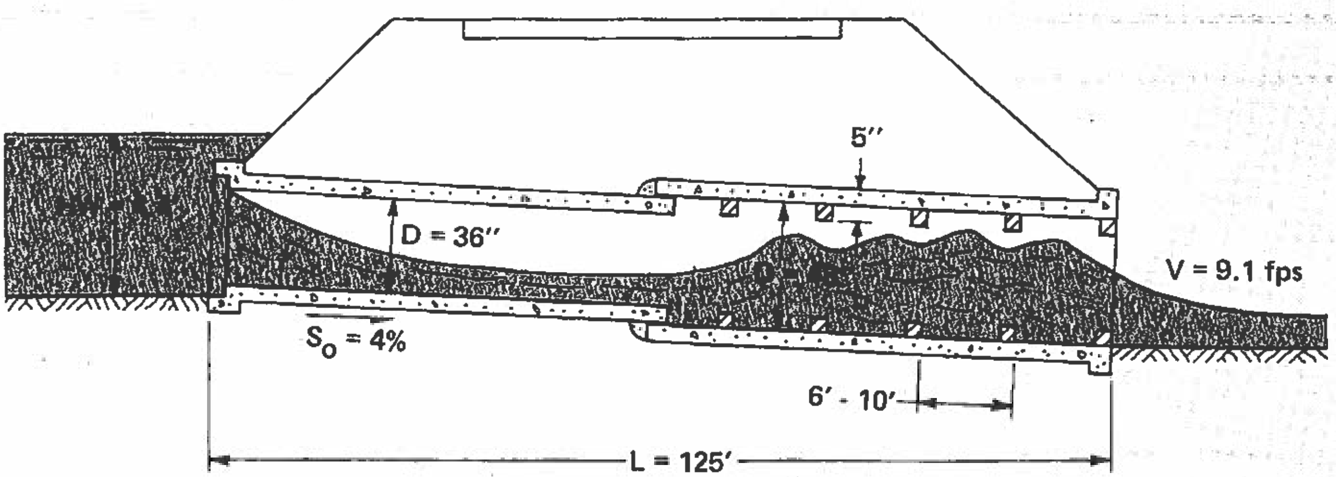


TABLE A-10

AREA, WETTED PERIMETER AND HYDRAULIC RADIUS OF PARTIALLY FILLED CIRCULAR PIPE

d/D	area/D²	wet. per./D	hyd. rad./D	d/D	area/D²	wet. per./D	hyd. rad./D
0.01	0.0013	0.2003	0.0066	0.51	0.4027	1.5908	0.2531
0.02	0.0037	0.2838	0.0132	0.52	0.4127	1.6108	0.2561
0.03	0.0069	0.3482	0.0197	0.53	0.4227	1.6308	0.2591
0.04	0.0105	0.4027	0.0262	0.54	0.4327	1.6509	0.2620
0.05	0.0147	0.4510	0.0326	0.55	0.4426	1.6710	0.2649
0.06	0.0192	0.4949	0.0389	0.56	0.4526	1.6911	0.2676
0.07	0.0242	0.5355	0.0451	0.57	0.4625	1.7113	0.2703
0.08	0.0294	0.5735	0.0513	0.58	0.4723	1.7315	0.2728
0.09	0.0350	0.6094	0.0574	0.59	0.4822	1.7518	0.2753
0.10	0.0409	0.6435	0.0635	0.60	0.4920	1.7722	0.2776
0.11	0.0470	0.6761	0.0695	0.61	0.5018	1.7926	0.2799
0.12	0.0534	0.7075	0.0754	0.62	0.5115	1.8132	0.2821
0.13	0.0600	0.7377	0.0813	0.63	0.5212	1.8338	0.2842
0.14	0.0668	0.7670	0.0871	0.64	0.5308	1.8546	0.2862
0.15	0.0739	0.7954	0.0929	0.65	0.5404	1.8755	0.2881
0.16	0.0811	0.8230	0.0986	0.66	0.5499	1.8955	0.2899
0.17	0.0885	0.8500	0.1042	0.67	0.5594	1.9177	0.2917
0.18	0.0961	0.8763	0.1097	0.68	0.5687	1.9391	0.2933
0.19	0.1039	0.9020	0.1152	0.69	0.5780	1.9606	0.2948
0.20	0.1118	0.9273	0.1206	0.70	0.5872	1.9823	0.2962
0.21	0.1199	0.9521	0.1259	0.71	0.5964	2.0042	0.2975
0.22	0.1281	0.9764	0.1312	0.72	0.6054	2.0264	0.2987
0.23	0.1365	1.0003	0.1364	0.73	0.6143	2.0488	0.2998
0.24	0.1449	1.0239	0.1415	0.74	0.6231	2.0714	0.3008
0.25	0.1535	1.0472	0.1466	0.75	0.6318	2.0944	0.3017
0.26	0.1623	1.0701	0.1516	0.76	0.6404	2.1176	0.3025
0.27	0.1711	1.0928	0.1566	0.77	0.6489	2.1412	0.3032
0.28	0.1800	1.1152	0.1614	0.78	0.6573	2.1652	0.3037
0.29	0.1890	1.1373	0.1662	0.79	0.6655	2.1895	0.3040
0.30	0.1982	1.1593	0.1709	0.80	0.6736	2.2143	0.3042
0.31	0.2074	1.1810	0.1755	0.81	0.6815	2.2395	0.3044
0.32	0.2167	1.2025	0.1801	0.82	0.6893	2.2653	0.3043
0.33	0.2260	1.2239	0.1848	0.83	0.6969	2.2916	0.3041
0.34	0.2355	1.2451	0.1891	0.84	0.7043	2.3186	0.3038
0.35	0.2450	1.2661	0.1935	0.85	0.7115	2.3462	0.3033
0.36	0.2546	1.2870	0.1978	0.86	0.7186	2.3746	0.3026
0.37	0.2642	1.3078	0.2020	0.87	0.7254	2.4038	0.3017
0.38	0.2739	1.3284	0.2061	0.88	0.7320	2.4341	0.3008
0.39	0.2836	1.3490	0.2102	0.89	0.7384	2.4655	0.2996
0.40	0.2934	1.3694	0.2142	0.90	0.7445	2.4981	0.2980
0.41	0.3032	1.3898	0.2181	0.91	0.7504	2.5322	0.2963
0.42	0.3130	1.4101	0.2220	0.92	0.7560	2.5681	0.2944
0.43	0.3229	1.4303	0.2257	0.93	0.7612	2.6061	0.2922
0.44	0.3328	1.4505	0.2294	0.94	0.7662	2.6467	0.2896
0.45	0.3428	1.4706	0.2331	0.95	0.7707	2.6906	0.2864
0.46	0.3527	1.4907	0.2366	0.96	0.7749	2.7389	0.2830
0.47	0.3627	1.5108	0.2400	0.97	0.7785	2.7934	0.2787
0.48	0.3727	1.5308	0.2434	0.98	0.7816	2.8578	0.2735
0.49	0.3827	1.5508	0.2467	0.99	0.7841	2.9412	0.2665
0.50	0.3927	1.5708	0.2500	1.00	0.7854	3.1416	0.2500

TABLE A-8

AREAS OF CIRCULAR SECTIONS (Square Feet)

Diameter									
Inches	Feet and inches	0	⅛	¼	⅜	½	⅝	¾	⅞
0	0-0		.0001	.0003	.0008	.0014	.0021	.0031	.0042
1	0-1	.0055	.0069	.0085	.0103	.0123	.0144	.0167	.0192
2	0-2	.0218	.0246	.0276	.0308	.0341	.0376	.0413	.0451
3	0-3	.0491	.0533	.0576	.0621	.0668	.0717	.0767	.0819
4	0-4	.0873	.0928	.0985	.1044	.1104	.1167	.1231	.1296
5	0-5	.1364	.1433	.1503	.1576	.1650	.1726	.1803	.1883
6	0-6	.1963	.2046	.2131	.2217	.2304	.2394	.2485	.2578
7	0-7	.2673	.2769	.2867	.2967	.3068	.3171	.3276	.3382
8	0-8	.3491	.3601	.3712	.3826	.3941	.4057	.4176	.4296
9	0-9	.4418	.4541	.4667	.4794	.4922	.5053	.5185	.5319
10	0-10	.5454	.5591	.5730	.5871	.6013	.6157	.6303	.6450
11	0-11	.6600	.6750	.6903	.7057	.7213	.7371	.7530	.7691
12	1-0	.7854	.8018	.8185	.8353	.8522	.8693	.8866	.9041
13	1-1	.9218	.9396	.9575	.9757	.9940	1.013	1.031	1.050
14	1-2	1.069	1.088	1.108	1.127	1.147	1.167	1.187	1.207
15	1-3	1.227	1.248	1.268	1.289	1.310	1.332	1.353	1.375
16	1-4	1.396	1.418	1.440	1.462	1.485	1.507	1.530	1.553
17	1-5	1.576	1.600	1.623	1.647	1.670	1.694	1.718	1.743
18	1-6	1.767	1.792	1.817	1.842	1.867	1.892	1.917	1.943
19	1-7	1.959	1.995	2.021	2.047	2.074	2.101	2.127	2.154
20	1-8	2.182	2.209	2.237	2.264	2.292	2.320	2.348	2.377
21	1-9	2.405	2.434	2.463	2.492	2.521	2.551	2.580	2.610
22	1-10	2.640	2.670	2.700	2.731	2.761	2.792	2.823	2.854
23	1-11	2.885	2.917	2.948	2.980	3.012	3.044	3.076	3.109
24	2-0	3.142	3.174	3.207	3.241	3.274	3.307	3.341	3.375
25	2-1	3.409	3.443	3.477	3.512	3.547	3.581	3.616	3.652
26	2-2	3.687	3.723	3.758	3.794	3.830	3.866	3.903	3.939
27	2-3	3.976	4.013	4.050	4.087	4.125	4.162	4.200	4.238
28	2-4	4.276	4.314	4.353	4.391	4.430	4.469	4.508	4.547
29	2-5	4.587	4.627	4.666	4.706	4.746	4.787	4.827	4.868
30	2-6	4.909	4.950	4.991	5.032	5.074	5.115	5.157	5.199
31	2-7	5.241	5.284	5.326	5.369	5.412	5.455	5.498	5.541
32	2-8	5.585	5.629	5.673	5.717	5.761	5.805	5.850	5.895
33	2-9	5.940	5.985	6.030	6.075	6.121	6.167	6.213	6.259
34	2-10	6.305	6.351	6.398	6.445	6.492	6.539	6.586	6.634
35	2-11	6.681	6.729	6.777	6.825	6.874	6.922	6.971	7.020
36	3-0	7.069	7.118	7.167	7.217	7.266	7.316	7.366	7.416
37	3-1	7.467	7.517	7.568	7.619	7.670	7.721	7.773	7.824
38	3-2	7.876	7.928	7.980	8.032	8.084	8.137	8.190	8.243
39	3-3	8.296	8.349	8.402	8.456	8.510	8.564	8.618	8.672
40	3-4	8.727	8.781	8.836	8.891	8.945	9.001	9.057	9.113
41	3-5	9.168	9.224	9.281	9.337	9.393	9.450	9.507	9.564
42	3-6	9.621	9.678	9.736	9.794	9.852	9.910	9.968	10.03
43	3-7	10.08	10.14	10.20	10.26	10.32	10.38	10.44	10.50
44	3-8	10.56	10.62	10.68	10.74	10.80	10.86	10.92	10.98
45	3-9	11.04	11.11	11.17	11.23	11.29	11.35	11.42	11.48
46	3-10	11.54	11.60	11.67	11.73	11.79	11.86	11.92	11.98
47	3-11	12.05	12.11	12.18	12.24	12.31	12.37	12.44	12.50
48	4-0	12.57	12.63	12.70	12.76	12.83	12.90	12.96	13.03
49	4-1	13.10	13.16	13.23	13.30	13.36	13.43	13.50	13.57

by
Doctor J. M. Wiggert and Paul D. Erfle
Department of Civil Engineering
Virginia Polytechnic Institute and State University
Blacksburg, Virginia

Cp Info 28105

dmg D. Mark Goodwin & Associates, P.A.
Consulting Engineers
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(505) 828-2200 FAX 797-9539

PROJECT JTH Storm Trunk
SUBJECT
BY DATE
CHECKED DATE
SHEET OF

28+28.55 to 28+53.79

84" Pipe, 25.24' long, n = .012, S = 12.68%

Design Q = 810 cfs, V = 30.34

① Culvert Control

Inlet Control

HW = 19.1'

Outlet Control

$HW + S_o L = 19.1'$

Hw = 19.1' − (.12 x 25.24)

Hw = 16.07'

Inlet Control Governs

② Outlet Velocity

Q_{full} = 2554

V_{full} = 72.79

Q_d / Q_{full} = 810 / 2554 = .317 ≈ .32

V_d / V_{full} = 57 / 73 = .78

V_d = .78 X 73 cfs = 57 fps

③ Velocity Reduction

Down stream Ring Height

.06 ≤ K/D ≤ .09

K = 4.5"

K/D = 4.5" / 84"

= .057

L/D = 1.5

L = 4' x 1.5

L = 6.0' spacing

Upstream Ring Height

Use K = 9"

Upstream Ring Spacing

Use L = 12.0'

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PROJECT ____
SUBJECT ____
BY ____ DATE ____
CHECKED ____ DATE ____
SHEET ____ OF ____

④ Determine Hydraulic Cross-Sectional Area at last Ring

Pipe Dia = 84"
Ring Dia = 75"

75" ≈ 6.25'
R = 6.25'/2 = 3.125'
Sf = 3.125 × 3.125 = 9.765
A = 9.765 × π = 30.679

⑤ Outlet Velocity

$V = Q_d / A$
= 810 / 30.679
= 26.40 fps

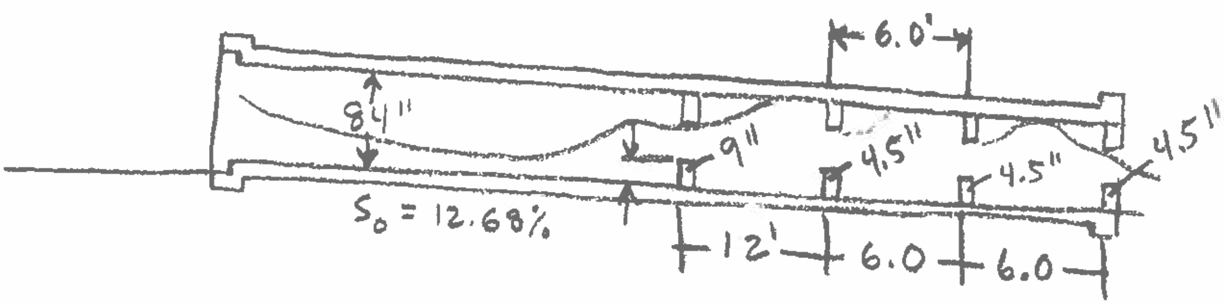
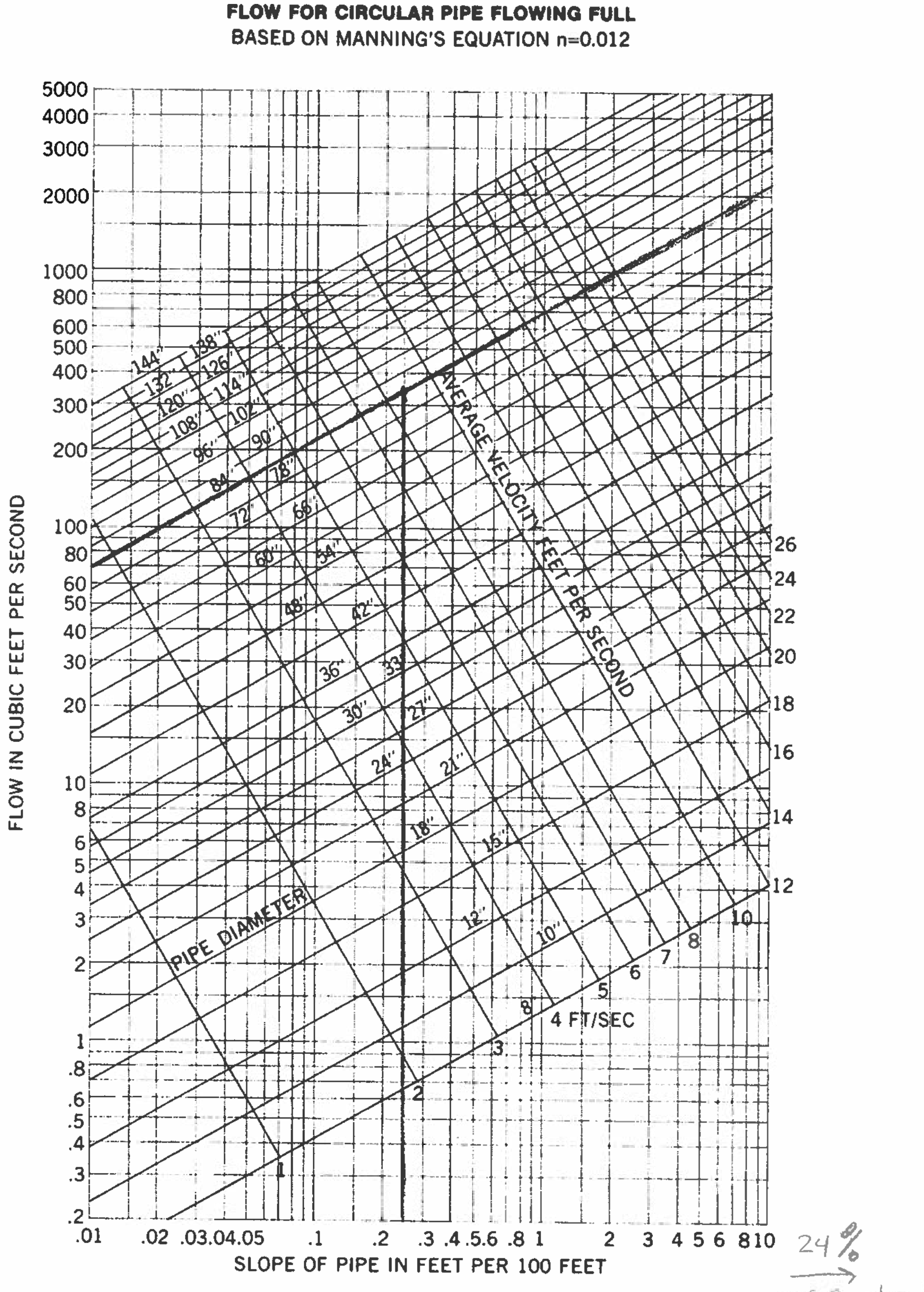


Figure 4

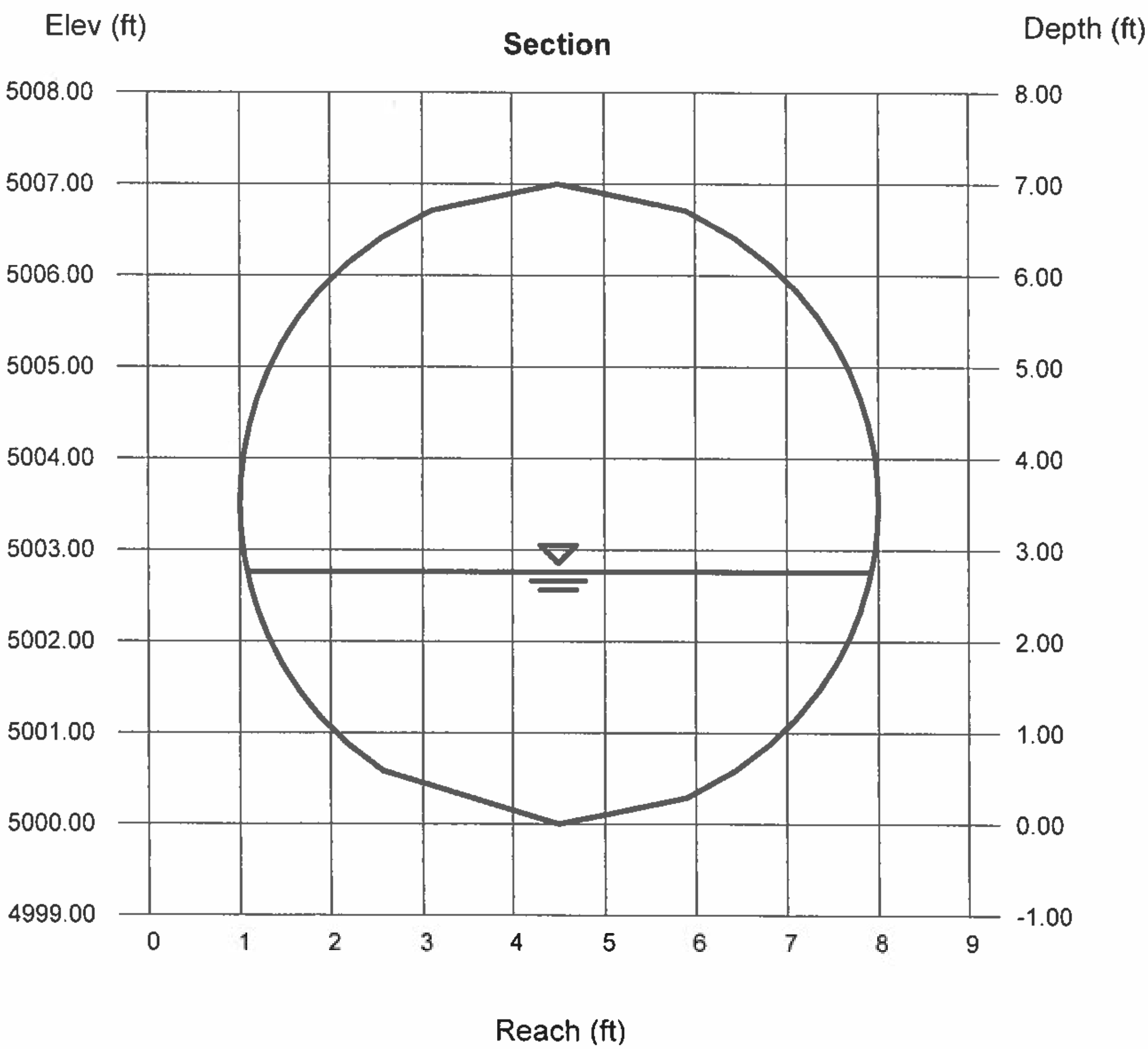

FLOW FOR CIRCULAR PIPE FLOWING FULL
BASED ON MANNING'S EQUATION n=0.012
FLOW IN CUBIC FEET PER SECOND
SLOPE OF PIPE IN FEET PER 100 FEET
PIPE DIAMETER
AVERAGE VELOCITY FEET PER SECOND
4 FT/SEC
5000
4000
3000
2000
1000
800
600
500
400
300
200
100
80
60
50
40
30
20
10
8
6
5
4
3
2
1
.8
.6
.5
.4
.3
.2
.01
.02
.03.04.05
.1
.2
.3 .4 .5.6 .8 1
2
3
4 5 6 8 10
144"
138"
132"
126"
120"
114"
108"
102"
96"
90"
84"
78"
72"
66"
60"
54"
48"
42"
36"
33"
30"
27"
24"
21"
18"
15"
12"
10"
8"
26
24
22
20
18
16
14
12
10
8
7
6
5
3
2
1
24%
off chart

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, May 1 2018

<Name>

Circular		**Highlighted**	
Diameter (ft)	= 7.00	Depth (ft)	= 2.76
		Q (cfs)	= 810.00
		Area (sqft)	= 14.15
Invert Elev (ft)	= 5000.00	Velocity (ft/s)	= 57.23
Slope (%)	= 12.68	Wetted Perim (ft)	= 9.52
N-Value	= 0.012	Crit Depth, Yc (ft)	= 6.73
		Top Width (ft)	= 6.85
Calculations		EGL (ft)	= 53.68
Compute by:	Known Q		
Known Q (cfs)	= 810.00		



Channel Report

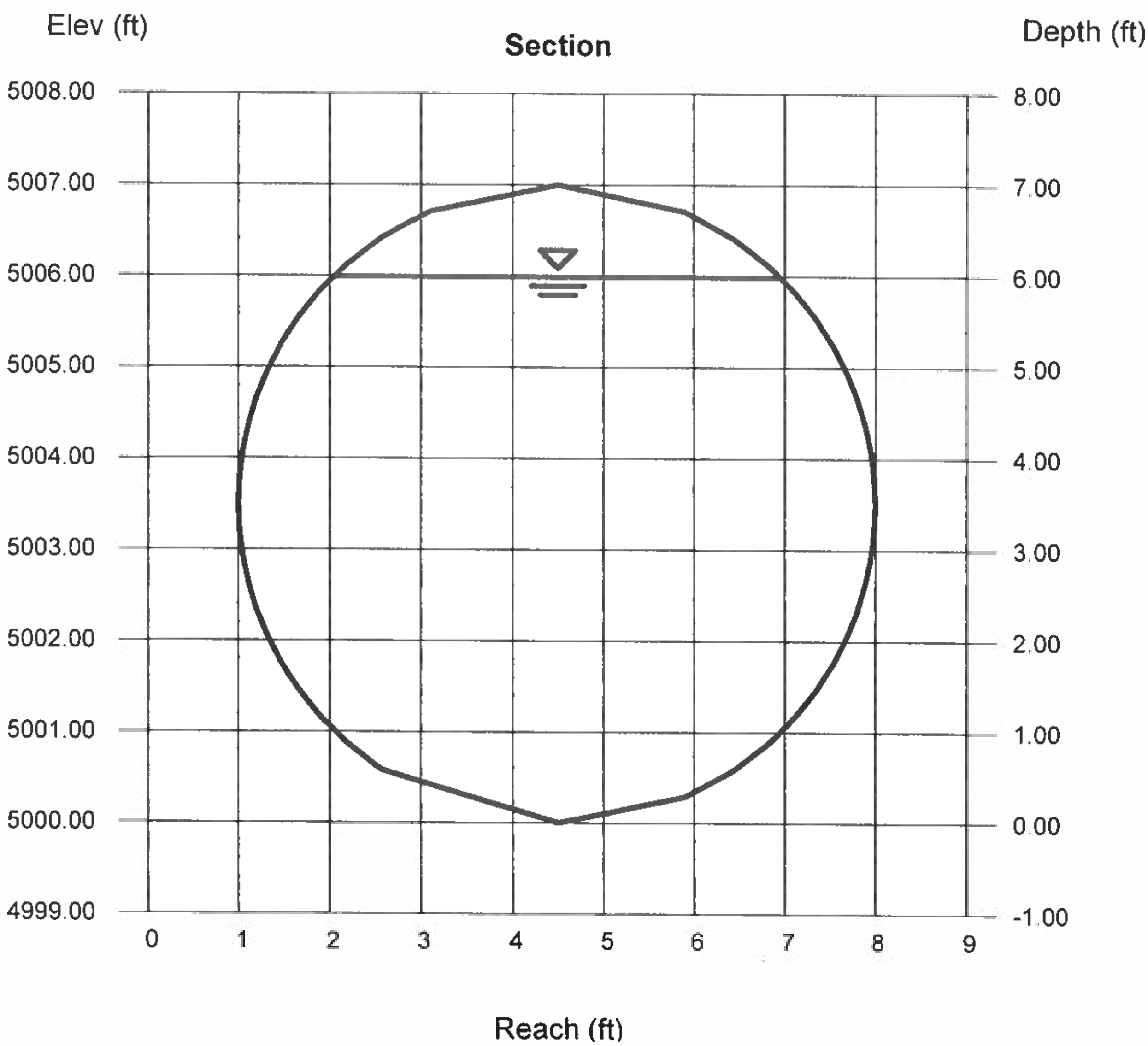
<Name>

Circular
Diameter (ft) = 7.00

Invert Elev (ft) = 5000.00
Slope (%) = 12.68
N-Value = 0.012

Calculations
Compute by: Known Depth
Known Depth (ft) = 5.99

Highlighted
Depth (ft) = 5.99
Q (cfs) = 2,554
Area (sqft) = 35.10
Velocity (ft/s) = 72.79
Wetted Perim (ft) = 16.56
Crit Depth, Yc (ft) = 6.99
Top Width (ft) = 4.91
EGL (ft) = 88.36



dmg D. Mark Goodwin & Associates, P.A.
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PROJECT: STH Storm Trunk
SUBJECT:
BY: DATE:
CHECKED: DATE:
SHEET OF

Sta 28+53.79 to Sta 29+22.38

84" Pipe, 68.59' Long, n = .012, s = 26.97% ≈ 27%

Design Q = 810 cfs, V = 21 cfs

① Culvert Control

Inlet Control

HW = 19.1'

Outlet Control

$HW + S_o L = 19.1'$

HW = 19.1' − (.27 x 68.6)

HW = 0.58'

Inlet Control Governs

② Outlet Velocity

Q_{full} = 3390 cfs

V_{full} = 88 fps

Q_d / Q_{full} = 810/3390 = .238 ≈ .24

V_d / V_{full} = 72/88 = .818 ≈ .82

V_d = .82 x 88 cfs = 72.16 fps

③ Velocity Reduction

Downstream Ring Height

.06 ≤ K/D ≤ .09

K = 7.0"

K/D = 7.0"/84"

= .083

L/D = 1.5

L = 7' x 1.5

L = 10.5' spacing

Upstream Ring Height

Use K = 14"

Upstream Ring Spacing

Use L = 21'

dmg D. Mark Goodwin & Associates, P.A.
Consulting Engineers
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PROJECT ____________
SUBJECT ____________
BY ____________ DATE ________
CHECKED ____________ DATE ________
SHEET ____ OF ____

④ Determine Hydraulic Cross-Sectional Area at last ring

Pipe Dia = 84"

Ring Dia = 70"

70" ≈ 5.83'

R = 5.83'/2 = 2.915

Sf = 2.915 × 2.915 = 8.497

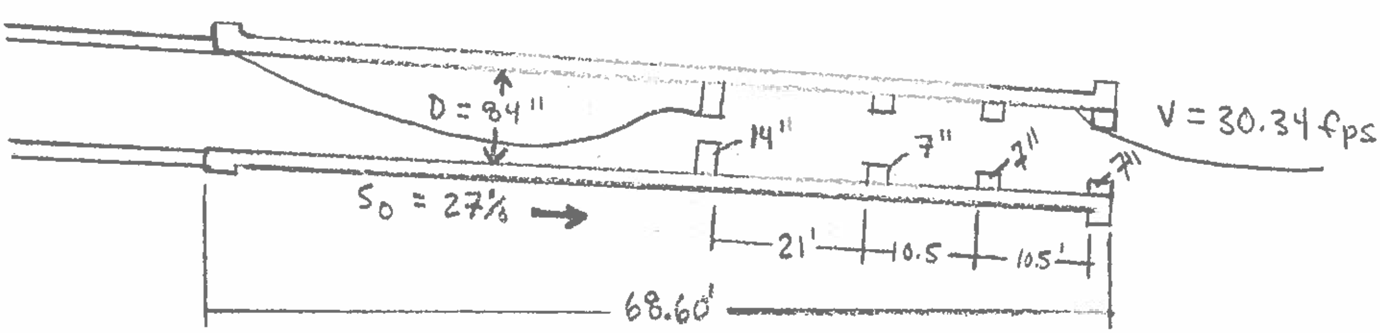
A = 8.497 × π = 26.694

⑤ Outlet Velocity

$V = Q_d / A$

V = 810/26.694

V = 30.34 fps



Channel Report

Pipe 2 Design

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

Wednesday, Apr 11 2018

<Name>

Circular

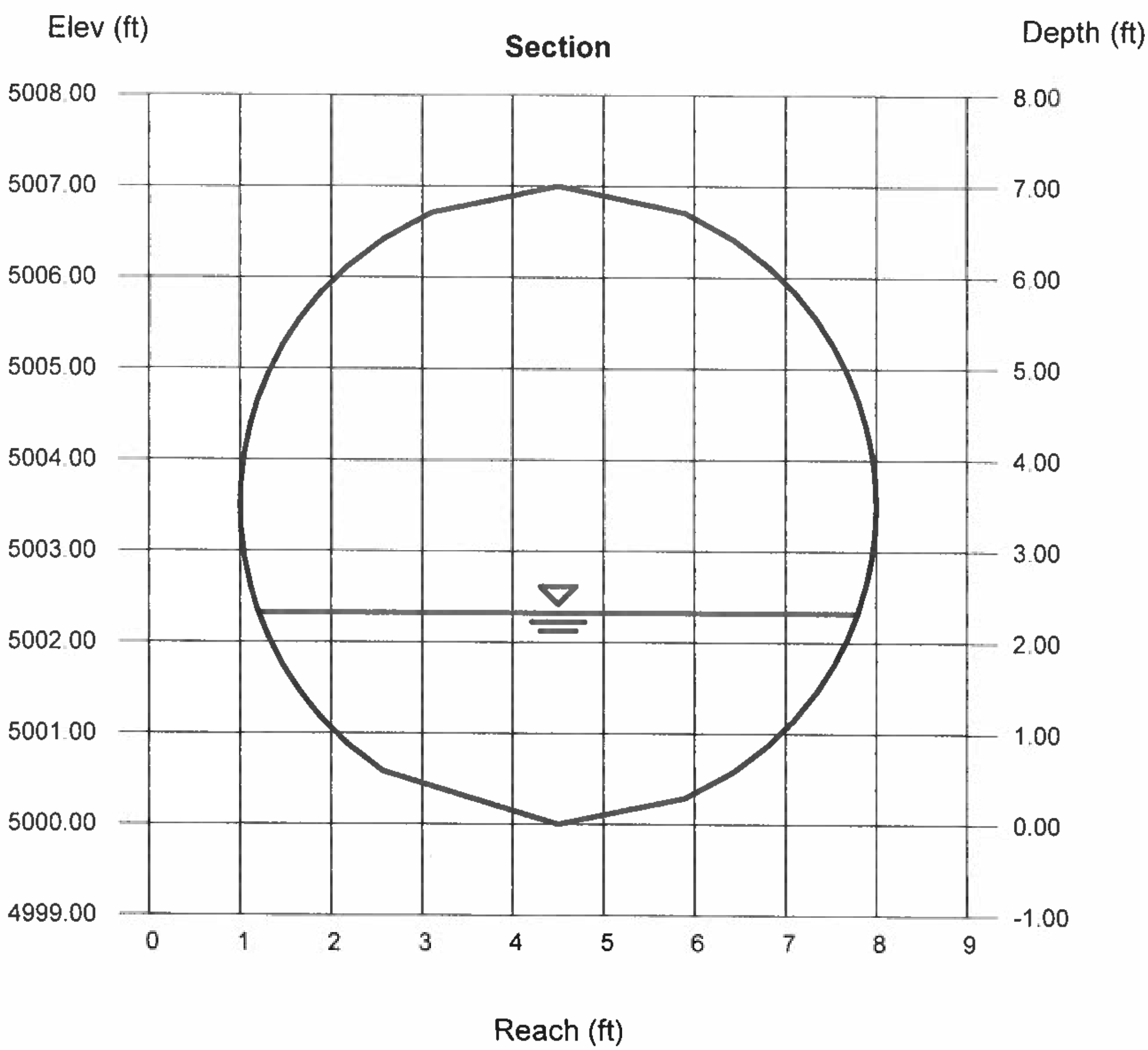
Diameter (ft)	= 7.00
Invert Elev (ft)	= 5000.00
Slope (%)	= 24.00
N-Value	= 0.012

Calculations

Compute by:	Known Q
Known Q (cfs)	= 810.00

Highlighted

Depth (ft)	= 2.32
Q (cfs)	= 810.00
Area (sqft)	= 11.21
Velocity (ft/s)	= 72.27
Wetted Perim (ft)	= 8.61
Crit Depth, Yc (ft)	= 6.73
Top Width (ft)	= 6.60
EGL (ft)	= 83.51



Depth	Q	Area	Veloc	Wp	Yc
(ft)	(cfs)	(sqft)	(ft/s)	(ft)	(ft)
2.32	810.0	11.21	72.27	8.61	6.73

Channel Report

Pipe 2 Full

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

Wednesday, Apr 11 2018

<Name>

Circular

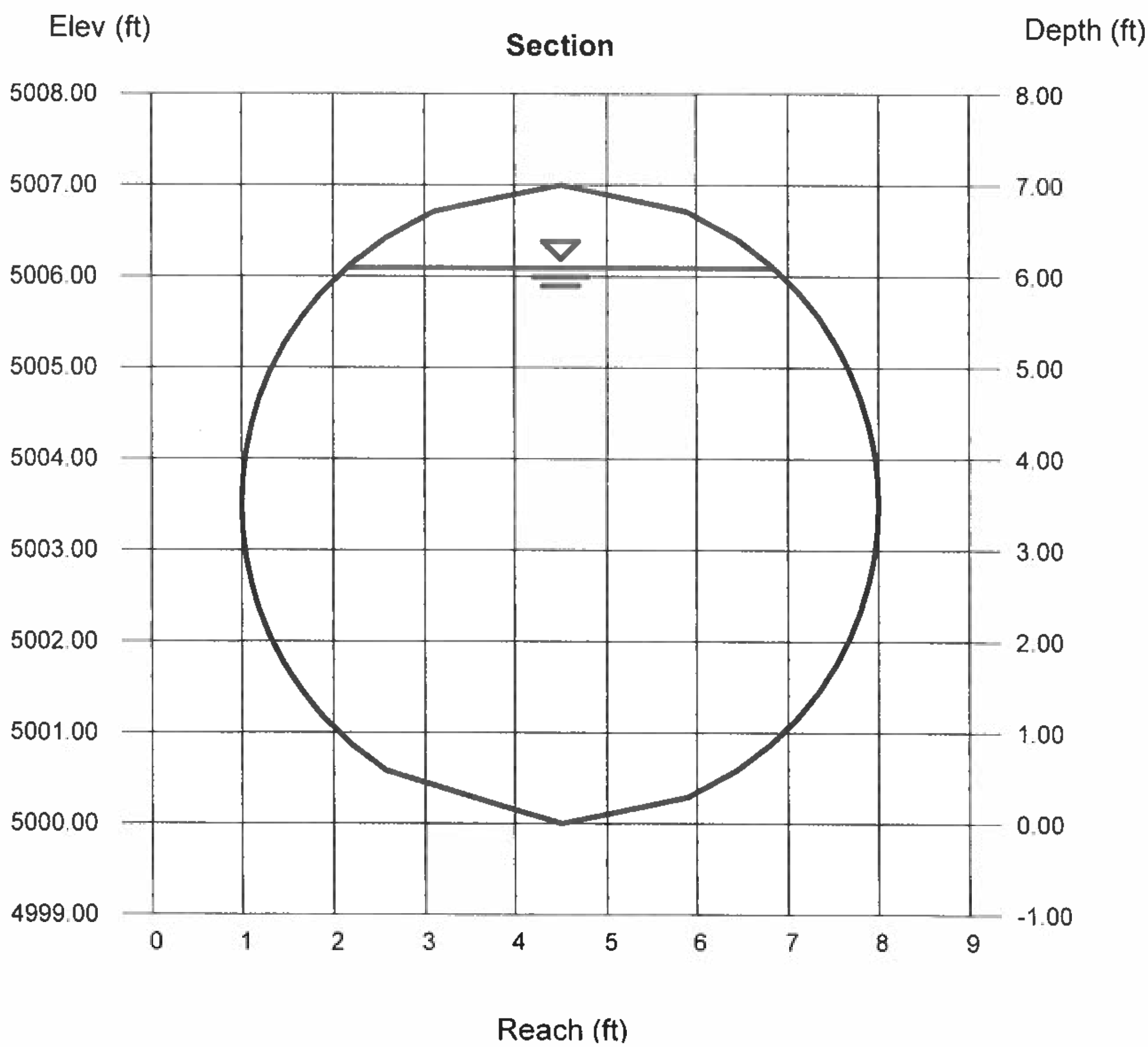
Diameter (ft)	= 7.00
Invert Elev (ft)	= 5000.00
Slope (%)	= 24.00
N-Value	= 0.012

Calculations

Compute by:	Known Q
Known Q (cfs)	= 3551.84

Highlighted

Depth (ft)	= 6.09
Q (cfs)	= 3,552
Area (sqft)	= 35.56
Velocity (ft/s)	= 99.89
Wetted Perim (ft)	= 16.84
Crit Depth, Yc (ft)	= 6.99
Top Width (ft)	= 4.70
EGL (ft)	= 161.22



TopWidth	Energy
(ft)	(ft)
6.60	83.51

~ 2012 ACEC/NM Award Winner for Engineering Excellence ~
~ 2008 ACEC/NM Award Winner for Engineering Excellence ~

May 23, 2018

Mr. Dana Peterson
City of Albuquerque
PO Box 1293
Albuquerque, NM 87103

Re: ***Juan Tabo Hills Estates***
Manhole 47
Drainage Report Stamp Date: 5/10/18
Revision Sheet Stamp Date: 5/11/18
Hydrology File- M@1D018; DRB# 1005278

Dear Mr. Peterson;

Below is a response to the comments dated 5/22/18 for the Storm Sewer at Juan Tabo Hills.

1. *An addition has been added to note 5 on sheet 5 of 6 to bolt down the lid at MH-47.*
2. *An addition has been added to the notes on sheet 5 and 6 of 6 to bolt down the lid at the junction box between MH-13 and Tijeras.*
3. *Note 6 has been added on sheet 5 of 6 to provide concrete pipe anchors spaced 35' O.C.*
4. *MH-47 missing DIA and INV OUT has been corrected.*
5. *The slope between MH-47 and MH-9 has been corrected*
6. *Additional sheets 5.1 and 5.2 have been revised to show COA in title block and have been stamped and signed.*

Please call me if you have any questions.

Sincerely,
MARK GOODWIN & ASSOCIATES, P.A.

Hiram L. Crook
Staff Engineer