AIRPORT ROAD/CHURCHMANS ROAD INTERSECTION IMPROVEMENTS

DRAINAGE REPORT

FOR

THE DELAWARE DEPARTMENT OF TRANSPORTATION

Contract No. 22-111-02

Federal Aid Project No. ESTP-N339 (4)

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TABLE OF CONTENTS

Summary.....1

- Introduction
- Inlet Spacing
- Storm Drainage System
- Culvert Analyses
- Roadside Ditches

Inlet Spread Computations.....Appendix A

Storm Drain System Analysis .....Appendix B

Culvert Analyses .....Appendix C

Roadside Ditch Computations.....Appendix D

Storm Drain Inlet Drainage Area Maps.....Appendix E

SUMMARY

Introduction

The Delaware Department of Transportation proposes to widen and reconstruct the intersection of Airport Road and Churchmans Road in New Castle County. The goal of the project is to address safety deficiencies and increase traffic capacity within the intersection area. This will be accomplished by widening the intersection and portions of the approaches, and installing channelizing medians to delineate turning movements and control points of access to roadside properties. Sidewalk will also be provided for improved pedestrian travel along both Airport Road and Churchmans Road. Much of the project is proposed as a closed section with curb and gutter and enclosed storm drainage.

Inlet Spacing

Inlets were spaced for the project based on Section 6.10.1.9 of the DelDOT Road Design Manual. The design frequency was determined from Figure 6-2 and the allowable water spread was established via Figure 6-83. The nomographs and tables in Figures 6-95, 6-96, 6-106, and 6-107 were used to calculate spread for the proposed inlets and existing catch basins throughout the project. Calculations for spread are provided in Appendix A.

Storm Drainage System

The enclosed storm drainage system was designed to provide for efficient collection of surface runoff within the curb and gutter sections of the project design. The number of inlets and depth of pipe cover was minimized where possible, and the overall system was designed with maximum hydraulic efficiency with respect to pipe size, material, slope and junction orientation. Existing sections of storm drain system were salvaged and used as part of the new design for cost efficiency, where conditions allowed. Pipe video inspection was used to determine where this was feasible, such as with the trunkline along Airport Road, north of Churchmans Road. The configuration of the storm drain system and roadside ditches are shown on the contract design plans.

The storm drain design frequency conforms to the provisions of Figure 6-2 of the DelDOT Road Design Manual. To help prevent the deposition of sediments and debris within the storm drain systems, the full flow minimum velocity was designed at a minimum of 3 fps. To prevent erosion of the pipe material, the maximum full flow design velocity was designed to not exceed 15 fps. Access to all storm drain was provided at least every 300 feet by way of drainage inlets or manholes, where peactical. The minimum pipe size of any proposed pipe is 15 incehs in diameter and proposed pipe slopes conform to original ground slope as much as possible. The minimum proposed pipe slope was designed at 0.3% throughout the project. At changes in pipe sizes, the top inside surfaces were maintained at the same level by dropping the invert of the larger pipe where conditions allowed. Figure 6-126 – Storm Drain Computation Table can be found in Appendix B.

Culvert Analyses

A 38" x 60" Reinforced Concrete Elliptical Pipe culvert is proposed beneath Churchmans Road, approximately 2,150 feet west of the intersection - near Sta. 91+50. The culvert is proposed to carry runoff from the roadside ditches on the east side of Churchmans Road, as well as discharge from a proposed stormwater management pond, across Churchmans Road and out to a tributary to the Christina River. The Federal Highway Administration's (FHWA) *Hydraulic Design Series Number 5 – Hydraulic Design of Highway Culverts* was used to determine the proposed headwater and tailwater elevations at the culvert. The dissipater pool at the outlet of the culvert was designed using FHWA's *HEC 14 – Hydraulic Design of Energy Dissipators for Culverts & Channels*. See Appendix C for computations. Three existing culverts will be extended in order to span the proposed roadway widening in several locations. These include the dual 24" x 38" RCEP culvert beneath Airport Road at Sta. 21+50, the 30" RCP culvert at Sta. 29+75, and the 48" RCP culvert beneath Churchmans Road at Sta. 110+00.

Roadside Ditches

All roadside ditches have been designed via the Rational Method with design frequencies determined from Figure 6-2 of the DelDOT Road Design Manual. All ditches conform to the clear zone criteria outlined in the Road Design Manual and have been set on at least a 0.3 percent grade. All proposed ditches are trapezoidal in geometry with varying bottom widths. At least 6 inches of freeboard is maintained between the edge of roadway shoulder and the design water surface of all proposed ditches. The shear stresses computed in all ditches call for Soil Retention Blanket Mulch, Type 5 to line the ditches to protect against erosion. However, in order to protect against higher stresses and velocities that may occur in the ditches, Soil Retention Blanket Mulch, Type 6 has been specified instead. Computations are included in Appendix D.

APPENDIX A
Inlet Spread Computations

Airport/Churchmans Inlet Spacing

DI
1

STA.
14+84, LT

$A_{impervious}$	5,785	SF	=	0.133 ac	C_i	= 0.85
A_{grass}	1,546	SF	=	0.035 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	7,331	SF	=	0.168 ac		

$$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$$

$$C = 0.70$$

S_{long} : from pr01airp.plf, S_{long} = 0.0304 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

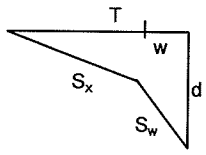
Q = ciA

t_c = 5 min
i = 6.99

Q_i = 0.83 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.00 cfs (no upstream inlet)
Q_t = 0.83 cfs

T = 3.15 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.08 '/ft		
d =	0.16 ft	~	2 in

Q_i = 0.82 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.01 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.99 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 3.15 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
3

STA.
17+17, LT

$A_{impervious}$	12,286	SF	=	0.282 ac	C_i	= 0.85
A_{grass}	645	SF	=	0.015 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	12,931	SF	=	0.297 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.82$

S_{long} : from pr01airp.dgn, S_{long} = 0.0311 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

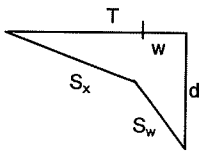
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.69 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.01 cfs from DI 1
Q_t = 1.70 cfs

T = 5.44 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.23 ft	~	3 in

Q_i = 1.47 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.23 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.87 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 5.44 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI / 6

STA. 19+66, LT

$A_{impervious}$	9,468	SF	=	0.217 ac	C_i	= 0.85
A_{grass}	708	SF	=	0.016 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	10,176	SF	=	0.234 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.80$

S_{long} : from pr01airp.dgn, S_{long} = 0.0127 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

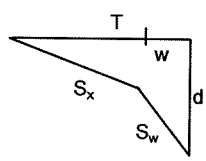
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.31 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.23 cfs from DI / 3
Q_t = 1.54 cfs

T = 6.70 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.25 ft	~	4 in

Q_i = 1.25 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.29 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.81 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 6.7 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
74

STA.
20+77, LT

$A_{impervious}$	6,927	SF	=	0.159 ac	C_i	= 0.85
A_{grass}	206	SF	=	0.005 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	7,133	SF	=	0.164 ac		

$$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$$

$$C = 0.83$$

S_{long} : from pr02airp.dgn, S_{long} = 0.0102 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

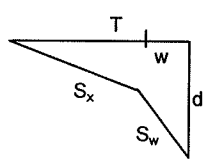
Q = ciA

t_c = 5 min
i = 6.99

Q_i = 0.95 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.29 cfs from DI 6
Q_t = 1.24 cfs

T = 6.30 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.24 ft	~	3 in

Q_i = 1.04 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.20 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.84 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 6.3 ft < 8 ft **OK**
next inlet 8 ft downstream

Airport/Churchmans Inlet Spacing

DI
8

STA.
21+33, LT

$A_{impervious}$	3,600	SF	=	0.083 ac	C_i	= 0.85
A_{grass}	167	SF	=	0.004 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	3,767	SF	=	0.086 ac		

$$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$$

$$C = 0.82$$

S_{long} : from pr02airp.dgn, S_{long} = 0.0025 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

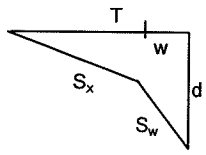
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 0.50 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.20 cfs from DI 74
Q_t = 0.69 cfs

T = 6.40 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.24 ft	~	3 in

Q_i = 0.65 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.04 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.94 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 6.4 ft < 8 ft **OK**
next inlet 8 ft downstream

Airport/Churchmans Inlet Spacing

DI
20

STA.
24+70, LT

$A_{impervious}$	12,303	SF	=	0.282 ac	C_i	= 0.85
A_{grass}	5,574	SF	=	0.128 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	17,877	SF	=	0.410 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.63$

S_{long}: from pr01airp.dgn, S_{long} = 0.0124 '/ft

S_x: from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

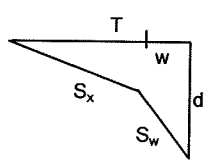
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.81 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.00 cfs (no upstream inlet)
Q_t = 1.81 cfs

T = 7.38 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.26 ft	~	4 in

Q_i = 1.04 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.77 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.57 ≠ 0.70

allowable spread:
full shoulder (auxiliary) width 11 ft so use shldr width 8 ft or wider

T = 7.38 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

DI
73

STA.
24+19, LT

$A_{impervious}$	2,100	SF	=	0.048 ac	C_i	= 0.85
A_{grass}	1,086	SF	=	0.025 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	3,186	SF	=	0.073 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.61$

S_{long} : from pr01airp.dgn, S_{long} = 0.014 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

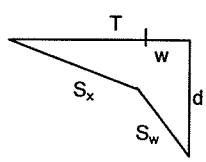
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 0.31 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.77 cfs from DI 20
Q_t = 1.08 cfs

T = 5.28 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.22 ft	~	3 in

Q_i = 0.96 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.12 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.89 > 0.70 **OK**

allowable spread:
full shoulder (auxiliary) width 11 ft so use shldr width 8 ft or wider

T = 5.28 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

DI
15

STA.
22+84, LT

$A_{impervious}$	13,417	SF	=	0.308 ac	C_i	= 0.85
A_{grass}	2,369	SF	=	0.054 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	15,786	SF	=	0.362 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.74$

S_{long}: from pr01airp.dgn, S_{long} = 0.0153 '/ft

S_x: from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

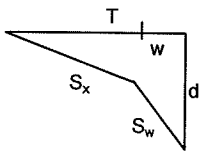
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.89 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.12 cfs from DI 73
Q_t = 2.01 cfs

T = 7.33 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$
w = 20 in = 1.67 ft
S_x = 0.02 '/ft
S_w = 0.09 '/ft
d = 0.26 ft ~ 4 in

Q_i = 1.55 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.46 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.77 > 0.70 **OK**

allowable spread:
full shoulder (auxiliary) width 11 ft so use shldr width 8 ft or wider

T = 7.33 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

DI
10

STA.
21+40, LT

$A_{impervious}$	762	SF	=	0.017 ac	C_i	=	0.85
A_{grass}	23	SF	=	0.001 ac	C_g	=	0.15
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	785	SF	=	0.018 ac			

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.83$

S_{long} : from pr02airp.dgn, S_{long} = 0.0014 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

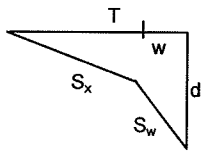
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 0.10 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.04 cfs from DI 8
Q_t = 0.15 cfs

T = 5.20 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.22 ft	~	3 in

Q_i = 0.45 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.00 cfs (to be applied to next downstream inlet)

E = Q_i / Q 1.00 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 5.2 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI 12

STA. 21+50, LT

SUMP

$A_{impervious}$	6,771	SF	=	0.155 ac	C_i	= 0.85
A_{grass}	3,652	SF	=	0.084 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	10,423	SF	=	0.239 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.60$

S_{long} : from pr02airp.dgn, S_{long} = 0.0005 '/ft (use 0.005 as avg. for sump)

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope

Integral PCC Curb and Gutter Type 3

$Q = ciA$

t_c = 5 min

i_{50} = 8.8 50-yr design storm for depressed roadways

Q_{50} = 1.27 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.46 cfs

Q_t = 1.73 cfs

from DI 10 DI 15

$Q_i = C_wPd^{1.5}$ for grate inlet acting as a weir in sump conditions

C_w = 3

P = perimeter of sides approached by runoff (ft)

P = [(20"/1.5) x 72"x (20"/1.5)]/12 factor of safety = 1.5 (Fig. 120)

P = 8.22 ft

d = avg depth of water adjacent to inlet (ft)

d = 6" = 0.5 ft

Q_i = 8.72 cfs

E = Q_i / Q 1.00 = 1.00 **OK**

from other worksheets:

Q_i = 1.01 cfs

E = 1.00

Q_b = 0.00 cfs

Airport/Churchmans Inlet Spacing

DI
14

STA.
21+71, LT

SUMP

$A_{impervious}$	5,311	SF =	0.122 ac	C_i	=	0.85
A_{grass}		SF =	0.000 ac	C_g	=	0.15
A_{woods}		SF =	0.000 ac	C_w	=	0.25
A_{total}	5,311	SF =	0.122 ac			

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr02airp.dgn, S_{long} = 0 '/ft (use sump design criteria)

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

$Q = ciA$

t_c = 5 min
i_{50} = 8.8 50-yr design storm for depressed roadways

Q = 0.91 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.00 cfs
Q_t = 0.91 cfs

$Q_i = C_wPd^{1.5}$ for grate inlet acting as a weir in sump conditions
C_w = 3
P = perimeter of sides approached by runoff (ft)
P = 20"x36"x 20" = 5.22 ft factor of safety = 1.5 (Fig. 120)
d = avg depth of water adjacent to inlet (ft)
d = 6" = 0.5 ft

Q_i = 5.54 cfs

E = Q_i / Q 1.00 > 0.70 **OK**

Airport/Churchmans Inlet Spacing

DI
2

STA.
14+80, RT

$A_{impervious}$	6,150	SF	=	0.141 ac	C_i	=	0.85
A_{grass}	45,136	SF	=	1.036 ac	C_g	=	0.15
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	51,286	SF	=	1.177 ac			

$$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$$

$$C = 0.23$$

S_{long} : from pr01airp.plf, S_{long} = 0.0293 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

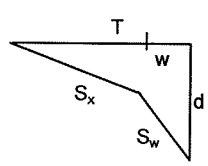
Q = ciA

t_c = 15 min
i = 4.95

Q_i = 1.36 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.00 cfs (no upstream inlet)
Q_t = 1.36 cfs

T = 4.78 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.08 '/ft		
d =	0.20 ft	~	3 in

Q_i = 1.20 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.16 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.88 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 4.78 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
88

STA.
16+11, RT

$A_{impervious}$	5,211	SF	=	0.120 ac	C_i	=	0.85
A_{grass}	82,539	SF	=	1.895 ac	C_g	=	0.15
A_{crops}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	87,750	SF	=	2.014 ac			

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.19$

S_{long} : from pr01airp.dgn, S_{long} = 0.0311 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

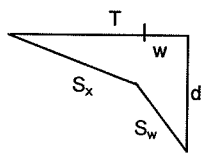
$Q = ciA$

t_c = 18 min
i = 4.6

Q_i = 1.78 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.16 cfs from DI 2
Q_t = 1.94 cfs

T = 5.92 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.24 ft	~	3 in

Q_i = 1.71 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.23 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.88 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 5.92 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
4

STA.
17+46, RT

$A_{impervious}$	6,584	SF	=	0.151 ac	C_i	=	0.85
A_{grass}	131,705	SF	=	3.024 ac	C_g	=	0.15
A_{crops}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	138,289	SF	=	3.175 ac			

$$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$$

$$C = 0.18$$

S_{long} : from pr01airp.dgn, S_{long} = 0.0308 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

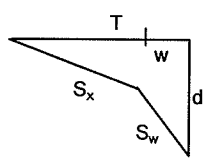
$Q = ciA$

t_c = 27 min
i = 3.78

Q_i = 2.20 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.23 cfs from DI 88
Q_t = 2.43 cfs

T = 6.73 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.25 ft	~	4 in

Q_i = 1.91 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.52 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.79 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 6.73 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
5

STA.
19+07, RT

$A_{impervious}$	8,888	SF	=	0.204 ac	C_i	=	0.85
A_{grass}	213,849	SF	=	4.909 ac	C_g	=	0.15
A_{crops}	94,505	SF	=	2.170 ac	C_w	=	0.25
A_{total}	317,242	SF	=	7.283 ac			

$$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$$

$$C = 0.20$$

S_{long} : from pr01airp.dgn, S_{long} = 0.0172 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

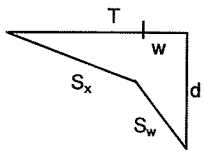
$Q = ciA$

t_c = 30 min
i = 3.56

Q_i = 5.17 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.52 cfs from DI 4
Q_t = 5.69 cfs

T = 10.00 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.32 ft	~	4 in

Q_i = 2.55 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 3.14 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.45 ≠ 0.70

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 10 ft < 8 ft **VIOLATES**

Airport/Churchmans Inlet Spacing

DI
7

STA.
20+36, RT

$A_{impervious}$	6,700	SF	=	0.154 ac	C_i	= 0.85
A_{grass}	12,721	SF	=	0.292 ac	C_g	= 0.15
A_{crops}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	19,421	SF	=	0.446 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.39$

S_{long} : from pr01airp.dgn, S_{long} = 0.0127 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

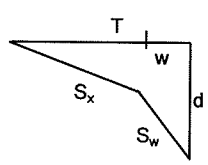
$Q = ciA$

t_c = 14 min
i = 5.12

Q_i = 0.89 cfs

$Q_t = Q_i + Q_b$ Q_b = 3.14 cfs from DI 5
Q_t = 4.03 cfs

T = 10.00 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.32 ft	~	4 in

Q_i = 2.24 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 1.79 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.56 ≠ 0.70 -

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 10 ft < 8 ft **VIOLATES**

Airport/Churchmans Inlet Spacing

DI / 11

STA. 21+19, RT

$A_{impervious}$	3,600	SF	=	0.083 ac	C_i	= 0.85
A_{grass}	3,917	SF	=	0.090 ac	C_g	= 0.15
A_{crops}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	7,517	SF	=	0.173 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.49$

S_{long} : from pr01airp.dgn, S_{long} = 0.0043 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope

Integral PCC Curb and Gutter Type 3

$Q = ciA$

t_c = 12 min

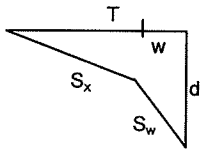
i = 5.45

Q_i = 0.46 cfs

$Q_t = Q_i + Q_b$ Q_b = 1.79 cfs from DI / 7

Q_t = 2.25 cfs

T = 10.00 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.32 ft	~	4 in

Q_i = 1.46 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.79 cfs (to be applied to next downstream inlet)

$E = Q_i / Q$ 0.65 ≠ 0.70

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 10 ft < 8 ft **VIOLATES**

Airport/Churchmans Inlet Spacing

DI
83

STA.
134+35, RT

$A_{impervious}$	11,061	SF	=	0.254 ac	C_i	=	0.85
A_{crops}	162,679	SF	=	3.735 ac	C_g	=	0.25
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	173,740	SF	=	3.989 ac			

$$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$$

$$C = 0.29$$

S_{long} : from pr11airp.plf, S_{long} = 0.0134 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

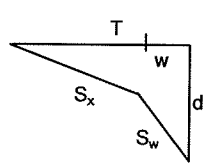
Q = ciA

t_c = 25 min
i = 3.92

Q_i = 4.51 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.00 cfs (no upstream inlet)
Q_t = 4.51 cfs

T = 10.00 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.08 '/ft		
d =	0.30 ft	~	4 in

Q_i = 2.30 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 2.21 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.51 ≠ 0.70 -

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 10 ft < 8 ft **VIOLATES**

Airport/Churchmans Inlet Spacing

DI
71

STA.
134+24,RT

$A_{impervious}$	297	SF	=	0.007 ac	C_i	=	0.85
A_{crops}	255	SF	=	0.006 ac	C_g	=	0.25
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	552	SF	=	0.013 ac			

$$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$$

$$C = 0.57$$

S_{long} : from pr11airp.dgn, S_{long} = 0.0138 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

Q = ciA

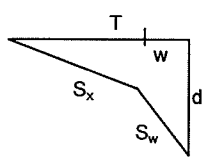
t_c = 5 min
i = 6.99

Q_i = 0.05 cfs

Q_t = $Q_i + Q_b$ Q_b = 2.21 cfs
Q_t = 2.26 cfs

from DI 83

T = 7.99 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.28 ft	~	4 in

Q_i = 1.67 cfs (interpolating Figure 6- 109)

Q_b = $Q_t - Q_i$ = 0.59 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.74 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 7.99 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
69

STA.
132+22, RT

$A_{impervious}$	5,873	SF	=	0.135 ac	C_i	=	0.85
A_{crops}	53,738	SF	=	1.234 ac	C_g	=	0.25
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	59,611	SF	=	1.368 ac			

$$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$$

$$C = 0.31$$

S_{long} : from pr11airp.dgn, S_{long} = 0.0213 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

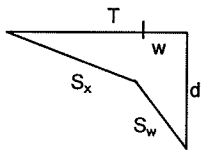
$Q = ciA$

t_c = 18 min
i = 4.6

Q_i = 1.95 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.59 cfs from DI 71
Q_t = 2.53 cfs

T = 7.59 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.27 ft	~	4 in

Q_i = 1.87 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.66 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.74 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 7.59 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
67

STA.
130+17, RT

$A_{impervious}$	7,017	SF	=	0.161 ac	C_i	= 0.85
A_{crops}	31,009	SF	=	0.712 ac	C_g	= 0.25
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	38,026	SF	=	0.873 ac		

$$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$$

$$C = 0.36$$

S_{long} : from pr11airp.dgn, S_{long} = 0.0286 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

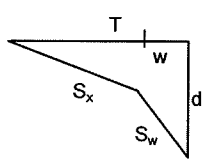
$Q = ciA$

t_c = 19 min
i = 4.49

Q_i = 1.41 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.66 cfs from DI 69
Q_t = 2.08 cfs

T = 6.30 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.24 ft	~	3 in

Q_i = 1.70 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.38 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.82 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 6.3 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
65

STA.
128+13, RT

$A_{impervious}$	7,770	SF	=	0.178 ac	C_i	= 0.85
A_{crops}	47,419	SF	=	1.089 ac	C_g	= 0.25
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	55,189	SF	=	1.267 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.33$

S_{long} : from pr11airp.dgn, S_{long} = 0.0286 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

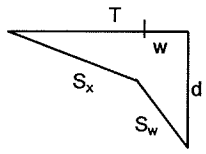
$Q = ciA$

t_c = 18 min
i = 4.6

Q_i = 1.95 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.38 cfs from DI 67
Q_t = 2.33 cfs

T = 6.71 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.25 ft	~	4 in

Q_i = 1.84 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.49 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.79 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 6.71 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
64

STA.
126+04, RT

$A_{impervious}$	10,194	SF	=	0.234 ac	C_i	=	0.85
A_{grass}	49,377	SF	=	1.134 ac	C_g	=	0.15
A_{crops}	37,930	SF	=	0.871 ac	C_w	=	0.25
A_{total}	97,501	SF	=	2.238 ac			

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.26$

S_{long} : from pr11airp.dgn, S_{long} = 0.0264 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

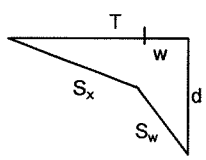
$Q = ciA$

t_c = 20 min
i = 4.37

Q_i = 2.56 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.49 cfs from DI 65
Q_t = 3.05 cfs

T = 7.88 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.27 ft	~	4 in

Q_i = 2.28 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.77 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.75 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 7.88 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
62

STA.
124+14, RT

$A_{impervious}$	10,074	SF	=	0.231 ac	C_i	=	0.85
A_{grass}	39,278	SF	=	0.902 ac	C_g	=	0.15
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	49,352	SF	=	1.133 ac			

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.29$

S_{long} : from pr11airp.dgn, S_{long} = 0.0229 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

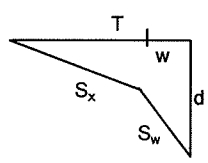
$Q = ciA$

t_c = 16 min
i = 4.83

Q_i = 1.60 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.77 cfs from DI 64
Q_t = 2.37 cfs

T = 7.21 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.26 ft	~	4 in

Q_i = 1.82 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.55 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.77 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 7.21 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
60

STA.
122+04, RT

$A_{impervious}$	11,613	SF	=	0.267 ac	C_i	= 0.85
A_{grass}	33,110	SF	=	0.760 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	44,723	SF	=	1.027 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.33$

S_{long} : from pr11airp.dgn, S_{long} = 0.019 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

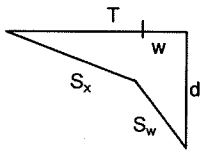
$Q = ciA$

t_c = 17 min
i = 4.72

Q_i = 1.61 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.55 cfs from DI 62
Q_t = 2.16 cfs

T = 7.23 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.26 ft	~	4 in

Q_i = 1.68 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.48 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.78 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 7.23 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI / 23

STA. 120+19, RT

$A_{impervious}$	14,328	SF	=	0.329 ac	C_i	= 0.85
A_{grass}	19,998	SF	=	0.459 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	34,326	SF	=	0.788 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.44$

S_{long} : from pr11airp.dgn, S_{long} = 0.0184 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope

Integral PCC Curb and Gutter Type 3

Q = ciA

t_c = 14 min

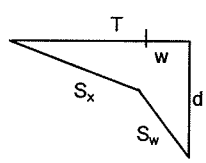
i = 5.12

Q_i = 1.78 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.48 cfs from DI / 60

Q_t = 2.26 cfs

T = 7.45 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.27 ft	~	4 in

Q_i = 1.72 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.54 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.76 > 0.70 **OK**

allowable spread:

full shoulder (auxiliary) width 11 ft so use shldr width 8 ft or wider

T = 7.45 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

DI
22

STA.
26+44, RT

$A_{impervious}$	5,115	SF	=	0.117 ac	C_i	=	0.85
A_{grass}	35,646	SF	=	0.818 ac	C_g	=	0.15
A_{crops}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	40,761	SF	=	0.936 ac			

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.24$

S_{long} : from pr01airp.dgn, S_{long} = 0.0054 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

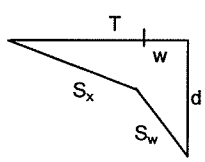
$Q = ciA$

t_c = 17 min
i = 4.72

Q_i = 1.05 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.54 cfs from DI 23
Q_t = 1.59 cfs

T = 8.62 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.29 ft	~	4 in

Q_i = 1.22 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.37 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.77 > 0.70 **OK**

allowable spread:
full shoulder (auxiliary) width 11 ft so use shldr width 8 ft or wider

T = 8.62 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

DI / 18

STA. 24+69, RT

$A_{impervious}$	7,991	SF	=	0.183 ac	C_i	= 0.85
A_{grass}	67,556	SF	=	1.551 ac	C_g	= 0.15
A_{crops}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	75,547	SF	=	1.734 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.22$

S_{long} : from pr01airp.dgn, S_{long} = 0.0153 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope

Integral PCC Curb and Gutter Type 3

$Q = ciA$

t_c = 17 min

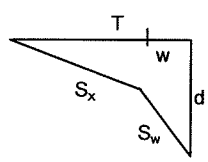
i = 4.72

Q_i = 1.83 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.37 cfs from DI / 22

Q_t = 2.21 cfs

T = 7.74 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.27 ft	~	4 in

Q_i = 1.66 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.55 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.75 > 0.70 **OK**

allowable spread:

full shoulder (auxiliary) width 11 ft so use shldr width 8 ft or wider

T = 7.74 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

DI 17

STA. 22+82, RT

$A_{impervious}$	8,254	SF	=	0.189 ac	C_i	= 0.85
A_{grass}	40,578	SF	=	0.932 ac	C_g	= 0.15
A_{crops}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	48,832	SF	=	1.121 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.27$

S_{long} : from pr01airp.dgn, S_{long} = 0.0153 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope

Integral PCC Curb and Gutter Type 3

$Q = ciA$

t_c = 16 min

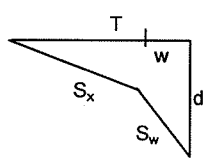
i = 4.83

Q_i = 1.45 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.55 cfs from DI 18

Q_t = 2.00 cfs

T = 7.34 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.26 ft	~	4 in

Q_i = 1.54 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.46 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.77 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 7.34 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI 13

STA. 21+50, RT

$A_{impervious}$	4,653	SF	=	0.107 ac	C_i	= 0.85
A_{grass}	19,073	SF	=	0.438 ac	C_g	= 0.15
A_{crops}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	23,726	SF	=	0.545 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.29$

S_{long}: from pr02airp.dgn, S_{long} = 0.0016 '/ft

S_x: from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope

Integral PCC Curb and Gutter Type 3

$Q = ciA$

t_c = 16 min

i_{50} = 8.5 50-yr design storm for depressed roadways

Q_{50} = 1.33 cfs

$Q_t = Q_i + Q_b$ Q_b = 1.25 cfs

Q_t = 2.58 cfs

from DI 11 DI 17

$Q_i = C_wPd^{1.5}$ for grate inlet acting as a weir in sump conditions

C_w = 3

P = perimeter of sides approached by runoff (ft)

P = [(20"/1.5) x 72"x (20"/1.5)]/12 factor of safety = 1.5 (Fig. 120)

P = 8.22 ft

d = avg depth of water adjacent to inlet (ft)

d = 6" = 0.5 ft

Q_i = 8.72 cfs

E = Q_i / Q 1.00 = 1.00 **OK**

from other worksheets:

Q_i = 1.01 cfs

E = 1.00

Q_b = 0.00 cfs

Airport/Churchmans Inlet Spacing

DI
16

STA.
117+60, RT

$A_{impervious}$	3,853	SF	=	0.088 ac	C_i	=	0.85
A_{grass}		SF	=	0.000 ac	C_g	=	0.15
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	3,853	SF	=	0.088 ac			

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr04airp.plf, S_{long} = 0.0187 '/ft

S_x : from typ. sections, S_{cross} = 0.040 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

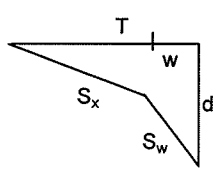
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 0.53 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.00 cfs (no upstream inlet)
Q_t = 0.53 cfs

T = 2.23 ft (via Fig. 6- 96)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.04 '/ft		
S_w =	0.08 '/ft		
d =	0.16 ft	~	2 in

Q_i = 0.42 cfs (interpolating Figure 6- 110)

$Q_b = Q_t - Q_i$ = 0.11 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.80 > 0.70 **OK**

allowable spread:
several lanes drain to median 3.7 ft so use 1/3 of inside 11 ft lane

T = 2.23 ft < 3.67 ft **OK**

Airport/Churchmans Inlet Spacing

DI
57

STA.
115+25, RT

$A_{impervious}$	11,399	SF	=	0.262 ac	C_i	=	0.85
A_{grass}		SF	=	0.000 ac	C_g	=	0.15
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	11,399	SF	=	0.262 ac			

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr04airp.dgn, S_{long} = 0.0254 '/ft

S_x : from typ. sections, S_{cross} = 0.040 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

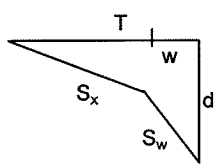
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.55 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.11 cfs from DI 16
Q_t = 1.66 cfs

T = 4.05 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.04 '/ft		
S_w =	0.09 '/ft		
d =	0.25 ft	~	3 in

Q_i = 1.51 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.15 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.91 > 0.70 **OK**

allowable spread:
several lanes drain to median 3.7 ft so use 1/3 of inside 11 ft lane

T = 4.05 ft < 3.67 ft **VIOLATES**

Airport/Churchmans Inlet Spacing

DI
39

STA.
42+18, RT

$A_{impervious}$	7,327	SF	=	0.168 ac	C_i	=	0.85
A_{grass}	12,944	SF	=	0.297 ac	C_g	=	0.15
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	20,271	SF	=	0.465 ac			

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.40$

S_{long} : from pr04airp.plf, S_{long} = 0.0235 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

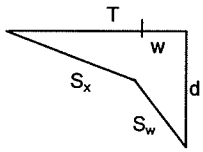
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.31 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.00 cfs (no upstream inlet)
Q_t = 1.31 cfs

T = 5.05 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.08 '/ft		
d =	0.20 ft	~	3 in

Q_i = 1.09 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.22 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.83 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 5.05 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
40

STA.
44+19, RT

$A_{impervious}$	8,930	SF	=	0.205 ac	C_i	=	0.85
A_{grass}	7,855	SF	=	0.180 ac	C_g	=	0.15
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	16,785	SF	=	0.385 ac			

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.52$

S_{long} : from pr04airp.dgn, S_{long} = 0.0484 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

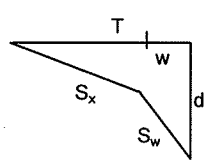
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.41 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.22 cfs from DI 39
Q_t = 1.63 cfs

T = 4.54 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.21 ft	~	3 in

Q_i = 1.45 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.18 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.89 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 4.54 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI / 41

STA. 46+07, RT

$A_{impervious}$	8,648	SF	=	0.199 ac	C_i	=	0.85
A_{grass}	13,410	SF	=	0.308 ac	C_g	=	0.15
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	22,058	SF	=	0.506 ac			

$$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$$

$$C = 0.42$$

S_{long} : from pr05airp.dgn, S_{long} = 0.0512 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

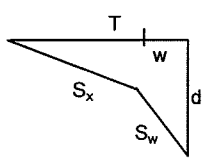
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.50 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.18 cfs from DI / 40
Q_t = 1.68 cfs

T = 4.55 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.21 ft	~	3 in

Q_i = 1.54 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.14 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.92 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 4.55 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
42

STA.
47+69,RT

$A_{impervious}$	7,625	SF	=	0.175 ac	C_i	=	0.85
A_{grass}	2,072	SF	=	0.048 ac	C_g	=	0.15
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	9,697	SF	=	0.223 ac			

$$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$$

$$C = 0.70$$

S_{long} : from pr05airp.dgn, S_{long} = 0.038 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope

Integral PCC Curb and Gutter Type 3

$Q = ciA$

t_c = 5 min

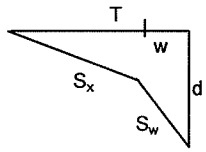
i = 6.99

Q_i = 1.09 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.14 cfs from DI 41

Q_t = 1.23 cfs

T = 4.05 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.20 ft	~	3 in

Q_i = 1.21 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.02 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.98 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 4.05 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
43

STA.
49+25, RT

$A_{impervious}$	7,285	SF	=	0.167 ac	C_i	=	0.85
A_{grass}		SF	=	0.000 ac	C_g	=	0.15
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	7,285	SF	=	0.167 ac			

$$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$$

$$C = 0.85$$

S_{long} : from pr05airp.dgn, S_{long} = 0.0253 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

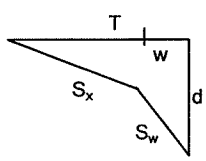
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 0.99 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.02 cfs from DI 42
Q_t = 1.01 cfs

T = 4.09 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.20 ft	~	3 in

Q_i = 0.95 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.06 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.94 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 4.09 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
44

STA.
51+08, RT

$A_{impervious}$	8,554	SF	=	0.196 ac	C_i	= 0.85
A_{grass}		SF	=	0.000 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	8,554	SF	=	0.196 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr05airp.dgn, S_{long} = 0.0209 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

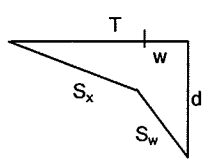
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.17 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.06 cfs from DI 43
Q_t = 1.23 cfs

T = 5.03 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.22 ft	~	3 in

Q_i = 1.10 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.13 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.89 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 5.03 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
45

STA.
52+89 RT

$A_{impervious}$	8,545	SF	=	0.196 ac	C_i	=	0.85
A_{grass}		SF	=	0.000 ac	C_g	=	0.15
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	8,545	SF	=	0.196 ac			

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr05airp.dgn, S_{long} = 0.0209 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

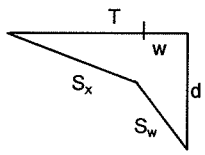
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.17 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.13 cfs from DI 44
Q_t = 1.30 cfs

T = 5.21 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.22 ft	~	3 in

Q_i = 1.15 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.15 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.89 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 5.21 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI / 46

STA. 54+60,RT

$A_{impervious}$	7,828	SF	=	0.180 ac	C_i	=	0.85
A_{grass}		SF	=	0.000 ac	C_g	=	0.15
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	7,828	SF	=	0.180 ac			

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr05airp.dgn, S_{long} = 0.016 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

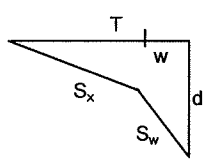
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.07 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.15 cfs from DI / 45
Q_t = 1.21 cfs

T = 5.42 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.23 ft	~	3 in

Q_i = 1.06 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.15 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.87 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 5.42 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
48

STA.
56+65 RT

$A_{impervious}$	8,898	SF	=	0.204 ac	C_i	= 0.85
A_{grass}		SF	=	0.000 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	8,898	SF	=	0.204 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr05airp.dgn, S_{long} = 0.0148 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

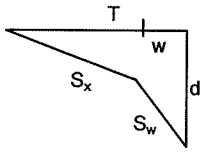
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.21 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.15 cfs from DI 46
Q_t = 1.37 cfs

T = 6.00 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.24 ft	~	3 in

Q_i = 1.16 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.21 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.85 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 6 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
49

STA.
58+46,RT

$A_{impervious}$	7,552	SF	=	0.173 ac	C_i	= 0.85
A_{grass}		SF	=	0.000 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	7,552	SF	=	0.173 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr05airp.dgn, S_{long} = 0.0148 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

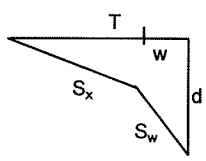
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.03 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.21 cfs from DI 48
Q_t = 1.24 cfs

T = 5.63 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.23 ft	~	3 in

Q_i = 1.07 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.17 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.86 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 5.63 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
50

STA.
60+19, RT

$A_{impervious}$	8,011	SF	=	0.184 ac	C_i	= 0.85
A_{grass}		SF	=	0.000 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	8,011	SF	=	0.184 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr05airp.dgn, S_{long} = 0.0075 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

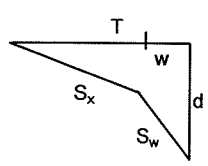
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.09 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.17 cfs from DI 49
Q_t = 1.26 cfs

T = 7.04 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.26 ft	~	4 in

Q_i = 1.05 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.21 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.83 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 7.04 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
38

STA.
38+28, RT

$A_{impervious}$	7,308	SF	=	0.168 ac	C_i	=	0.85
A_{grass}	16,163	SF	=	0.371 ac	C_g	=	0.15
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	23,471	SF	=	0.539 ac			

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.37$

S_{long} : from pr04airp.plf, S_{long} = 0.0245 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

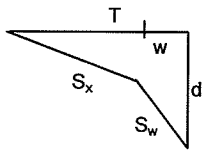
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.39 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.00 cfs (no upstream inlet)
Q_t = 1.39 cfs

T = 5.17 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.08 '/ft		
d =	0.20 ft	~	3 in

Q_i = 1.16 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.23 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.84 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 5.17 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
37

STA.
36+69, RT

$A_{impervious}$	7,567	SF	=	0.174 ac	C_i	= 0.85
A_{grass}	12,058	SF	=	0.277 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	19,625	SF	=	0.451 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.42$

S_{long} : from pr03airp.dgn, S_{long} = 0.0442 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

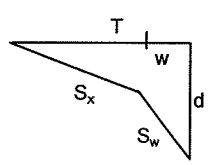
Q = ciA

t_c = 5 min
i = 6.99

Q_i = 1.32 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.23 cfs from DI 38
Q_t = 1.55 cfs

T = 4.52 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.21 ft	~	3 in

Q_i = 1.42 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.13 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.92 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 4.52 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
36

STA.
34+71,RT

$A_{impervious}$	9,934	SF	=	0.228 ac	C_i	= 0.85
A_{grass}	27,305	SF	=	0.627 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	37,239	SF	=	0.855 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.34$

S_{long} : from pr03airp.dgn, S_{long} = 0.0442 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

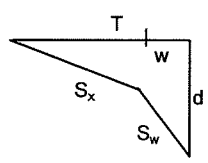
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 2.01 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.13 cfs from DI 37
Q_t = 2.14 cfs

T = 5.46 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.23 ft	~	3 in

Q_i = 1.76 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.38 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.82 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 5.46 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI / 35

STA. 32+45, RT

$A_{impervious}$	11,711	SF	=	0.269 ac	C_i	= 0.85
A_{grass}	6,355	SF	=	0.146 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	18,066	SF	=	0.415 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.60$

S_{long} : from pr03airp.dgn, S_{long} = 0.0409 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope

Integral PCC Curb and Gutter Type 3

$Q = ciA$

t_c = 5 min

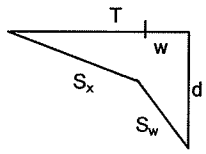
i = 6.99

Q_i = 1.75 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.38 cfs from DI / 36

Q_t = 2.13 cfs

T = 5.74 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.23 ft	~	3 in

Q_i = 1.79 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.34 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.84 > 0.70 **OK**

allowable spread:

full shoulder (auxiliary) width 11 ft so use shldr width 8 ft or wider

T = 5.74 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

DI
33

STA.
30+13, RT

SUMP

$A_{impervious}$	19,529	SF	=	0.448 ac	C_i	= 0.85
A_{grass}	18,761	SF	=	0.431 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	38,290	SF	=	0.879 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.51$

S_{long} : from pr03airp.dgn, S_{long} = 0.0028 '/ft (use 0.01 as avg. for sump)

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope

Integral PCC Curb and Gutter Type 3

$Q = ciA$

t_c = 5 min

i_{50} = 8.5 50-yr design storm for depressed roadways

Q_{50} = 3.79 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.66 cfs

Q_t = 4.45 cfs

from DI 35 DI 30

$Q_i = C_wPd^{1.5}$ for grate inlet acting as a weir in sump conditions

C_w = 3

P = perimeter of sides approached by runoff (ft)

P = [(20"/1.5) x 72"x (20"/1.5)]/12 factor of safety = 1.5 (Fig. 120)

P = 8.22 ft

d = avg depth of water adjacent to inlet (ft)

d = 6" = 0.5 ft

Q_i = 8.72 cfs

E = Q_i / Q 1.00 = 1.00 **OK**

from other worksheets:

Q_i = 1.01 cfs

E = 1.00

Q_b = 0.00 cfs

Airport/Churchmans Inlet Spacing

DI
70

STA.
134+23, LT

$A_{impervious}$	8,253	SF	=	0.189 ac	C_i	= 0.85
A_{grass}		SF	=	0.000 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	8,253	SF	=	0.189 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr11airp.plf, S_{long} = 0.0138 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

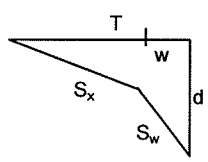
Q = ciA

t_c = 5 min
i = 6.99

Q_i = 1.13 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.00 cfs (no upstream inlet)
Q_t = 1.13 cfs

T = 5.47 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.08 '/ft		
d =	0.21 ft	~	3 in

Q_i = 0.99 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.14 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.88 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 5.47 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
68

STA.
131+13,LT

$A_{impervious}$	14,707	SF	=	0.338 ac	C_i	= 0.85
A_{grass}		SF	=	0.000 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	14,707	SF	=	0.338 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr11airp.dgn, S_{long} = 0.0253 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

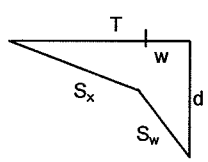
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 2.01 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.14 cfs from DI 70
Q_t = 2.14 cfs

T = 6.64 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.25 ft	~	3 in

Q_i = 1.70 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.44 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.79 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 6.64 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
66

STA.
128+22,LT

$A_{impervious}$	15,758	SF	=	0.362 ac	C_i	= 0.85
A_{grass}		SF	=	0.000 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	15,758	SF	=	0.362 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr10airp.dgn, S_{long} = 0.0286 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

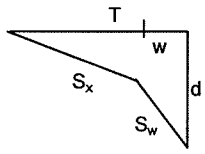
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 2.15 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.44 cfs from DI 68
Q_t = 2.59 cfs

T = 7.12 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.26 ft	~	4 in

Q_i = 1.90 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.69 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.73 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 7.12 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
79

STA.
125+28, LT

$A_{impervious}$	16,855	SF	=	0.387 ac	C_i	= 0.85
A_{grass}		SF	=	0.000 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	16,855	SF	=	0.387 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr10airp.dgn, S_{long} = 0.025 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

$Q = ciA$

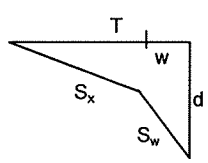
t_c = 5 min
i = 6.99

Q_i = 2.30 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.69 cfs
Q_t = 2.99 cfs

from DI 66

T = 7.93 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.28 ft	~	4 in

Q_i = 2.15 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.84 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.72 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 7.93 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
63

STA.
125+17,LT

$A_{impervious}$	636	SF	=	0.015 ac	C_i	= 0.85
A_{grass}		SF	=	0.000 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	636	SF	=	0.015 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr10airp.dgn, S_{long} = 0.0248 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

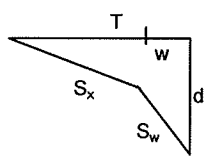
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 0.09 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.84 cfs from DI 79
Q_t = 0.93 cfs

T = 3.81 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.19 ft	~	3 in

Q_i = 0.89 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.04 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.96 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 3.81 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
61

STA.
122+38,LT

$A_{impervious}$	18,428	SF	=	0.423 ac	C_i	= 0.85
A_{grass}		SF	=	0.000 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	18,428	SF	=	0.423 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr09airp.dgn, S_{long} = 0.0196 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

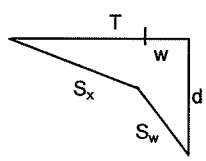
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 2.51 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.04 cfs from DI 63
Q_t = 2.55 cfs

T = 7.78 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.27 ft	~	4 in

Q_i = 1.88 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.67 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.74 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 7.78 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
29

STA.
120+37,LT

$A_{impervious}$	14,786	SF	=	0.339 ac	C_i	=	0.85
A_{grass}		SF	=	0.000 ac	C_g	=	0.15
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	14,786	SF	=	0.339 ac			

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr09airp.dgn, S_{long} = 0.0184 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

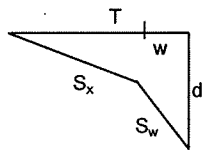
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 2.02 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.67 cfs from DI 61
Q_t = 2.69 cfs

T = 8.13 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.28 ft	~	4 in

Q_i = 1.94 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.75 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.72 > 0.70 **OK**

allowable spread:
full shoulder (auxiliary) width 11 ft so use shldr width 8 ft or wider

T = 8.13 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

DI
30

STA.
28+83, RT

$A_{impervious}$	8,283	SF	=	0.190 ac	C_i	=	0.85
A_{grass}		SF	=	0.000 ac	C_g	=	0.15
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	8,283	SF	=	0.190 ac			

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr02airp.dgn, S_{long} = 0.022 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

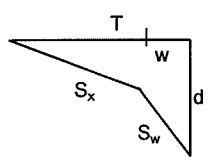
Q = ciA

t_c = 5 min
i = 6.99

Q_i = 1.13 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.75 cfs from DI 29
Q_t = 1.88 cfs

T = 6.51 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.25 ft	~	3 in

Q_i = 1.56 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.32 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.83 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 6.51 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

EX
CB1

STA.
38+25, LT

$A_{impervious}$	8,238	SF	=	0.189 ac	C_i =	0.85
A_{grass}	2,092	SF	=	0.048 ac	C_g =	0.15
A_{woods}		SF	=	0.000 ac	C_w =	0.25
A_{total}	10,330	SF	=	0.237 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.71$

S_{long} : from pr04airp.plf, S_{long} = 0.025 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

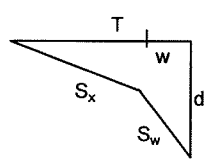
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.17 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.00 cfs (no upstream inlet)
Q_t = 1.17 cfs

T = 4.54 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.08 '/ft		
d =	0.19 ft	~	3 in

Q_i = 1.07 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.10 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.91 > 0.70 **OK**

allowable spread:
full shoulder width 11 ft so use shldr width 8 ft or wider

T = 4.54 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

EX / CB2

STA. 36+85 LT

$A_{impervious}$	7,483	SF	=	0.172 ac	C_i	=	0.85
A_{grass}	1,257	SF	=	0.029 ac	C_g	=	0.15
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	8,740	SF	=	0.201 ac			

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.75$

S_{long} : from pr03airp.dgn, S_{long} = 0.042 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

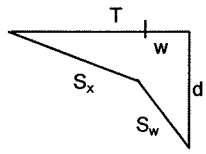
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.05 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.10 cfs from EX / CB1
Q_t = 1.15 cfs

T = 3.65 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.19 ft	~	3 in

Q_i = 1.10 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.05 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.95 > 0.70 **OK**

allowable spread:
full shoulder width 11 ft so use shldr width 8 ft or wider

T = 3.65 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

DI
80

STA.
34+71 LT

$A_{impervious}$	9,244	SF	=	0.212 ac	C_i	=	0.85
A_{grass}	1,923	SF	=	0.044 ac	C_g	=	0.15
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	11,167	SF	=	0.256 ac			

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.73$

S_{long} : from pr03airp.dgn, S_{long} = 0.0442 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

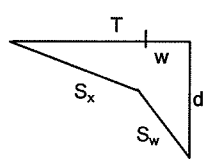
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.31 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.05 cfs from EX / CB2
Q_t = 1.36 cfs

T = 4.12 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.20 ft	~	3 in

Q_i = 1.28 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.08 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.94 > 0.70 **OK**

allowable spread:
full shoulder width 11 ft so use shldr width 8 ft or wider

T = 4.12 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

DI
34

STA.
32+43,LT

$A_{impervious}$	11,135	SF	=	0.256 ac	C_i	=	0.85
A_{grass}		SF	=	0.000 ac	C_g	=	0.15
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	11,135	SF	=	0.256 ac			

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr03airp.dgn, S_{long} = 0.0391 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

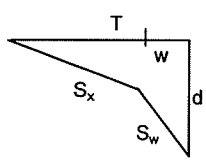
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.52 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.08 cfs from DI 80
Q_t = 1.60 cfs

T = 4.86 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.21 ft	~	3 in

Q_i = 1.54 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.06 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.96 > 0.70 **OK**

allowable spread:
auxiliary lane 11 ft so use shldr width 8 ft or wider

T = 4.86 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

DI
27

STA.
30+13, LT

SUMP

$A_{impervious}$	18,777	SF	=	0.431 ac	C_i	=	0.85
A_{grass}		SF	=	0.000 ac	C_g	=	0.15
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	18,777	SF	=	0.431 ac			

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr03airp.dgn, S_{long} = 0.0028 '/ft (use 0.01 as avg. for sump)

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

$Q = ciA$

t_c = 5 min
i_{50} = 8.5 50-yr design storm for depressed roadways

Q_{50} = 3.11 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.21 cfs
Q_t = 3.33 cfs

from DI 26 DI 34

$Q_i = C_wPd^{1.5}$ for grate inlet acting as a weir in sump conditions
C_w = 3
P = perimeter of sides approached by runoff (ft)
P = [(20"/1.5) x 72"x (20"/1.5)]/12 factor of safety = 1.5 (Fig. 120)
P = 8.22 ft
d = avg depth of water adjacent to inlet (ft)
d = 6" = 0.5 ft

Q_i = 8.72 cfs

E = Q_i / Q 1.00 = 1.00 **OK**

from other worksheets:

Q_i = 1.01 cfs
E = 1.00
Q_b = 0.00 cfs

Airport/Churchmans Inlet Spacing

DI
26

STA.
28+74, LT

$A_{impervious}$	9,314	SF	=	0.214 ac	C_i	= 0.85
A_{grass}		SF	=	0.000 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	9,314	SF	=	0.214 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr02airp.plf, S_{long} = 0.0182 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

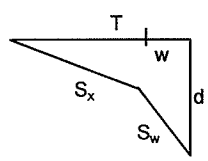
Q = ciA

t_c = 5 min
i = 6.99

Q_i = 1.27 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.00 cfs (no upstream inlet)
Q_t = 1.27 cfs

T = 5.38 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.08 '/ft		
d =	0.21 ft	~	3 in

Q_i = 1.12 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.15 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.88 > 0.70 **OK**

allowable spread:
full shoulder width 11 ft so use shldr width 8 ft or wider

T = 5.38 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

DI
25

STA.
117+61, LT

$A_{impervious}$	9,022	SF	=	0.207 ac	C_i	= 0.85
A_{grass}		SF	=	0.000 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	9,022	SF	=	0.207 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr02airp.plf, S_{long} = 0.0187 '/ft

S_x : from typ. sections, S_{cross} = 0.040 '/ft full super

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

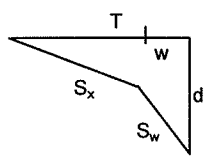
Q = ciA

t_c = 5 min
i = 6.99

Q_i = 1.23 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.00 cfs (no upstream inlet)
Q_t = 1.23 cfs

T = 3.83 ft (via Fig. 6- 96)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.04 '/ft		
S_w =	0.08 '/ft		
d =	0.22 ft	~	3 in

Q_i = 1.20 cfs (interpolating Figure 6- 110)

$Q_b = Q_t - Q_i$ = 0.03 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.98 > 0.70 **OK**

allowable spread:
auxiliary lane 11 ft so use shldr width 8 ft or wider

T = 3.83 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

DI / 58

STA. 115+25,LT

$A_{impervious}$	13,066	SF	=	0.300 ac	C_i	= 0.85
A_{grass}		SF	=	0.000 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	13,066	SF	=	0.300 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long}: from pr08airp.dgn, S_{long} = 0.0254 '/ft

S_x: from typ. sections, S_{cross} = 0.040 '/ft

S_w = 0.08 composite cross slope

Integral PCC Curb and Gutter Type 3

$Q = ciA$

t_c = 5 min

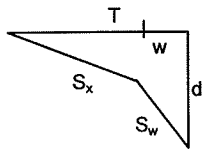
i = 6.99

Q_i = 1.78 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.03 cfs from DI / 25

Q_t = 1.81 cfs

T = 4.18 ft (via Fig. 6- 96)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.04 '/ft		
S_w =	0.09 '/ft		
d =	0.25 ft	~	4 in

Q_i = 1.60 cfs (interpolating Figure 6- 110)

$Q_b = Q_t - Q_i$ = 0.21 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.88 > 0.70 **OK**

allowable spread:
full shoulder width 11 ft so use shldr width 8 ft or wider

T = 4.18 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

DI
56
(double)

STA.
112+92,LT

$A_{impervious}$	22,179	SF	=	0.509 ac	C_i =	0.85
A_{grass}		SF	=	0.000 ac	C_g =	0.15
A_{woods}		SF	=	0.000 ac	C_w =	0.25
A_{total}	22,179	SF	=	0.509 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr08airp.dgn, S_{long} = 0.0254 '/ft

S_x : from typ. sections, S_{cross} = 0.040 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

$Q = ciA$

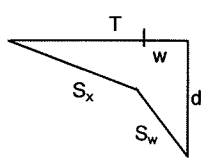
t_c = 5 min
i = 6.99

Q_i = 3.03 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.21 cfs
Q_t = 3.24 cfs

from DI 58

T = 5.54 ft (via Fig. 6- 96)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.04 '/ft		
S_w =	0.09 '/ft		
d =	0.30 ft	~	4 in

Q_i = 2.59 cfs (interpolating Figure 6- 110)

$Q_b = Q_t - Q_i$ = 0.65 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.80 > 0.70 **OK**

allowable spread:
full shoulder width 11 ft so use shldr width 8 ft or wider

T = 5.54 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

DI
54

STA.
110+66,LT

$A_{impervious}$	20,891	SF	=	0.480 ac	C_i	=	0.85
A_{grass}		SF	=	0.000 ac	C_g	=	0.15
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	20,891	SF	=	0.480 ac			

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr08airp.dgn, S_{long} = 0.0187 '/ft

S_x : from typ. sections, S_{cross} = 0.040 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

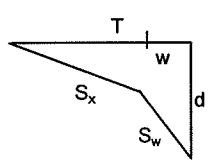
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 2.85 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.65 cfs from DI 56
Q_t = 3.50 cfs

T = 6.15 ft (via Fig. 6- 96)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.04 '/ft		
S_w =	0.09 '/ft		
d =	0.33 ft	~	4 in

Q_i = 2.70 cfs (interpolating Figure 6- 110)

$Q_b = Q_t - Q_i$ = 0.80 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.77 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 6.15 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
53

STA.
108+97,LT

$A_{impervious}$	10,455	SF	=	0.240 ac	C_i	= 0.85
A_{grass}		SF	=	0.000 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	10,455	SF	=	0.240 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr08airp.dgn, S_{long} = 0.0131 '/ft

S_x : from typ. sections, S_{cross} = 0.040 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

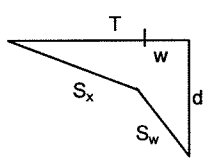
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.43 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.80 cfs from DI 54
Q_t = 2.22 cfs

T = 5.44 ft (via Fig. 6- 96)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.04 '/ft		
S_w =	0.09 '/ft		
d =	0.30 ft	~	4 in

Q_i = 2.03 cfs (interpolating Figure 6- 110)

$Q_b = Q_t - Q_i$ = 0.19 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.91 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 5.44 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
52
(double)

STA.
106+42,LT

$A_{impervious}$	14,589	SF	=	0.335 ac	C_i	= 0.85
A_{grass}		SF	=	0.000 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	14,589	SF	=	0.335 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr07airp.dgn, S_{long} = 0.0087 '/ft

S_x : from typ. sections, S_{cross} = 0.040 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

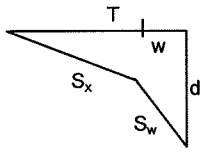
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.99 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.19 cfs from DI 53
Q_t = 2.18 cfs

T = 5.95 ft (via Fig. 6- 96)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.04 '/ft		
S_w =	0.09 '/ft		
d =	0.32 ft	~	4 in

Q_i = 1.88 cfs (interpolating Figure 6- 110)

$Q_b = Q_t - Q_i$ = 0.30 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.86 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 5.95 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
51
(double)

STA.
104+30,LT

$A_{impervious}$	14,837	SF	=	0.341 ac	C_i =	0.85
A_{grass}		SF	=	0.000 ac	C_g =	0.15
A_{woods}		SF	=	0.000 ac	C_w =	0.25
A_{total}	14,837	SF	=	0.341 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr07airp.dgn, S_{long} = 0.0082 '/ft

S_x : from typ. sections, S_{cross} = 0.040 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

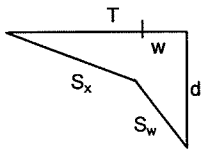
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 2.02 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.30 cfs from DI 52
Q_t = 2.33 cfs

T = 6.23 ft (via Fig. 6- 96)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.04 '/ft		
S_w =	0.09 '/ft		
d =	0.33 ft	~	4 in

Q_i = 1.82 cfs (interpolating Figure 6- 110)

$Q_b = Q_t - Q_i$ = 0.51 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.78 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 6.23 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
87

STA.
101+48,LT

$A_{impervious}$	12,336	SF	=	0.283 ac	C_i	= 0.85
A_{grass}		SF	=	0.000 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	12,336	SF	=	0.283 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr07airp.dgn, S_{long} = 0.0127 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

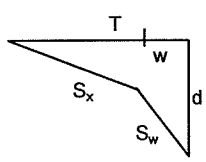
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.68 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.51 cfs from DI 51
Q_t = 2.19 cfs

T = 5.45 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.09 '/ft		
d =	0.23 ft	~	3 in

Q_i = 1.96 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.23 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.90 > 0.70 **OK**

allowable spread:
full shoulder width 8 ft so use shldr width 8 ft or wider

T = 5.45 ft < 8 ft **OK**

Airport/Churchmans Inlet Spacing

DI
97

STA.
42+39 LT.

$A_{impervious}$	25,045	SF	=	0.575 ac	C_i	= 0.85
A_{grass}		SF	=	0.000 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	25,045	SF	=	0.575 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.85$

S_{long} : from pr02airp.plf, S_{long} = 0.0526 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type :

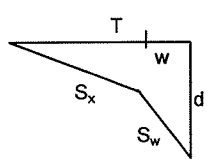
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 3.42 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.00 cfs (no upstream inlet)
Q_t = 3.42 cfs

T = 4.75 ft (via Fig. 6- 96)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.08 '/ft		
d =	0.20 ft	~	3 in

Q_i = 1.28 cfs interpolating Figure 6 110)

$Q_b = Q_t - Q_i$ = 2.14 cfs cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.37 ≠ 0.70 -

allowable spread:
auxiliary lane 11 ft so use shldr width 8 ft or wider

T = 4.75 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

EX / 13

STA. 44+16 LT.

$A_{impervious}$	11,818	SF	=	0.271 ac	C_i	= 0.85
A_{grass}	8,495	SF	=	0.195 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	20,313	SF	=	0.466 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.56$

S_{long} : from pr02airp.plf, S_{long} = 0.0526 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope

Integral PCC Curb and Gutter Type 3

$Q = ciA$

t_c = 5 min

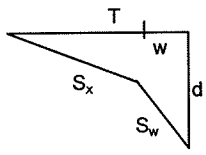
i = 6.99

Q_i = 1.82 cfs

$Q_t = Q_i + Q_b$ Q_b = 2.14 cfs from DI / 97

Q_t = 3.96 cfs

T = 7.50 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.08 '/ft		
d =	0.25 ft	~	3 in

Q_i = 2.86 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 1.10 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.72 > 0.70 **OK**

allowable spread:

auxiliary lane 11 ft so use shldr width 8 ft or wider

T = 7.5 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

EX / 14

STA. 46+06 LT.

$A_{impervious}$	13,094	SF	=	0.301 ac	C_i	= 0.85
A_{grass}	8,042	SF	=	0.185 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	21,136	SF	=	0.485 ac		

$$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$$

$$C = 0.58$$

S_{long} : from pr02airp.plf, S_{long} = 0.0526 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope

Integral PCC Curb and Gutter Type 3

$Q = ciA$

t_c = 5 min

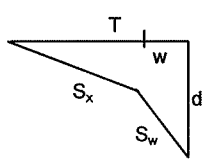
i = 6.99

Q_i = 1.98 cfs

$Q_t = Q_i + Q_b$ Q_b = 1.10 cfs from EX / 13

Q_t = 3.08 cfs

T = 6.53 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.08 '/ft		
d =	0.23 ft	~	3 in

Q_i = 2.46 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.62 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.80 > 0.70 **OK**

allowable spread:

auxiliary lane 11 ft so use shldr width 8 ft or wider

T = 6.53 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

EX / 15

STA. 47+68 LT.

$A_{impervious}$	8,484	SF	=	0.195 ac	C_i	=	0.85
A_{grass}	1,299	SF	=	0.030 ac	C_g	=	0.15
A_{woods}		SF	=	0.000 ac	C_w	=	0.25
A_{total}	9,783	SF	=	0.225 ac			

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.76$

S_{long} : from pr02airp.plf, S_{long} = 0.0526 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

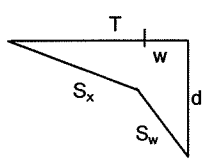
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.19 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.62 cfs from EX / 14
Q_t = 1.81 cfs

T = 4.75 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.08 '/ft		
d =	0.20 ft	~	3 in

Q_i = 1.64 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.17 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.91 > 0.70 **OK**

allowable spread:
auxiliary lane 11 ft so use shldr width 8 ft or wider

T = 4.75 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

EX / 16

STA. 49+25 LT.

$A_{impervious}$	10,878	SF	=	0.250 ac	C_i	= 0.85
A_{grass}	7,801	SF	=	0.179 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	18,679	SF	=	0.429 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.56$

S_{long} : from pr02airp.plf, S_{long} = 0.0526 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope

Integral PCC Curb and Gutter Type 3

$Q = ciA$

t_c = 5 min

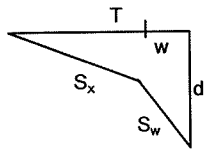
i = 6.99

Q_i = 1.67 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.17 cfs from EX / 15

Q_t = 1.84 cfs

T = 4.80 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.08 '/ft		
d =	0.20 ft	~	3 in

Q_i = 1.65 cfs (interpolating Figure 6- 110)

$Q_b = Q_t - Q_i$ = 0.19 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.90 > 0.70 **OK**

allowable spread:
auxiliary lane 11 ft so use shldr width 8 ft or wider

T = 4.8 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

EX / 17

STA. 51+08 LT.

$A_{impervious}$	13,428	SF	=	0.308 ac	C_i	= 0.85
A_{grass}	9,510	SF	=	0.218 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	22,938	SF	=	0.527 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.56$

S_{long} : from pr02airp.plf, S_{long} = 0.0209 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

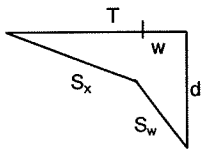
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 2.06 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.19 cfs from EX / 16
Q_t = 2.25 cfs

T = 7.25 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.08 '/ft		
d =	0.25 ft	~	3 in

Q_i = 1.72 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.53 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.76 > 0.70 **OK**

allowable spread:
auxiliary lane 11 ft so use shldr width 8 ft or wider

T = 7.25 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

EX 18

STA. 52+89 LT.

$A_{impervious}$	9,915	SF	=	0.228 ac	C_i =	0.85
A_{grass}	13,305	SF	=	0.305 ac	C_g =	0.15
A_{woods}		SF	=	0.000 ac	C_w =	0.25
A_{total}	23,220	SF	=	0.533 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.45$

S_{long} : from pr02airp.plf, S_{long} = 0.0209 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

$Q = ciA$

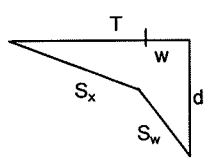
t_c = 5 min
i = 6.99

Q_i = 1.67 cfs

from EX 17

$Q_t = Q_i + Q_b$ Q_b = 0.53 cfs
Q_t = 2.22 cfs

T = 6.20 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.08 '/ft		
d =	0.22 ft	~	3 in

Q_i = 1.40 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.82 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.63 ≠ 0.70 -

allowable spread:
auxiliary lane 11 ft so use shldr width 8 ft or wider

T = 6.2 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

EX / 19

STA. 54+59 LT.

$A_{impervious}$	8,589	SF	=	0.197 ac	C_i	= 0.85
A_{grass}	2,865	SF	=	0.066 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	11,454	SF	=	0.263 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.67$

S_{long} : from pr02airp.plf, S_{long} = 0.0209 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope

Integral PCC Curb and Gutter Type 3

$Q = ciA$

t_c = 5 min

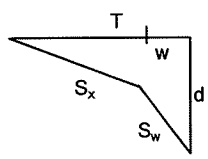
i = 6.99

Q_i = 1.24 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.82 cfs from EX / 18

Q_t = 2.06 cfs

T = 7.00 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.08 '/ft		
d =	0.24 ft	~	3 in

Q_i = 1.64 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.42 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.80 > 0.70 **OK**

allowable spread:

auxiliary lane 11 ft so use shldr width 8 ft or wider

T = 7 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

EX / 20

STA. 56+58 LT.

$A_{impervious}$	8,763	SF	=	0.201 ac	C_i	= 0.85
A_{grass}	325	SF	=	0.007 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	9,088	SF	=	0.209 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.82$

S_{long} : from pr02airp.plf, S_{long} = 0.0148 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope

Integral PCC Curb and Gutter Type 3

$Q = ciA$

t_c = 5 min

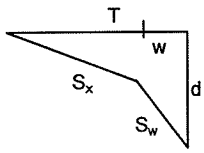
i = 6.99

Q_i = 1.20 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.42 cfs from EX / 19

Q_t = 1.62 cfs

T = 6.20 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.08 '/ft		
d =	0.22 ft	~	3 in

Q_i = 1.65 cfs (interpolating Figure 6- 110)

$Q_b = Q_t - Q_i$ = 0.00 cfs (to be applied to next downstream inlet)

E = Q_i / Q 1.00 > 0.70 **OK**

allowable spread:
auxiliary lane 11 ft so use shldr width 8 ft or wider

T = 6.2 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

EX / 22

STA. 58+49 LT.

$A_{impervious}$	8,212	SF	=	0.189 ac	C_i	= 0.85
A_{grass}	185	SF	=	0.004 ac	C_g	= 0.15
A_{woods}		SF	=	0.000 ac	C_w	= 0.25
A_{total}	8,397	SF	=	0.193 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.83$

S_{long} : from pr02airp.plf, S_{long} = 0.0148 '/ft

S_x : from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope
Integral PCC Curb and Gutter Type 3

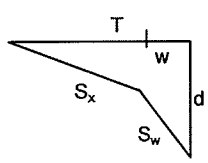
$Q = ciA$

t_c = 5 min
i = 6.99

Q_i = 1.12 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.00 cfs from EX / 20
Q_t = 1.12 cfs

T = 5.25 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.08 '/ft		
d =	0.21 ft	~	3 in

Q_i = 0.99 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.13 cfs (to be applied to next downstream inlet)

E = Q_i / Q 0.88 > 0.70 **OK**

allowable spread:
auxiliary lane 11 ft so use shldr width 8 ft or wider

T = 5.25 ft < 11 ft **OK**

Airport/Churchmans Inlet Spacing

EX / 23

STA. 60+88 LT.

$A_{impervious}$	10,189	SF	=	0.234 ac	C_i =	0.85
A_{grass}	432	SF	=	0.010 ac	C_g =	0.15
A_{woods}		SF	=	0.000 ac	C_w =	0.25
A_{total}	10,621	SF	=	0.244 ac		

$C = [(C_iA_i) + (C_gA_g) + (C_wA_w)]/A_{total}$

$C = 0.82$

S_{long}: from pr02airp.plf, S_{long} = 0.0073 '/ft

S_x: from typ. sections, S_{cross} = 0.020 '/ft

S_w = 0.08 composite cross slope

Integral PCC Curb and Gutter Type 3

$Q = ciA$

t_c = 5 min

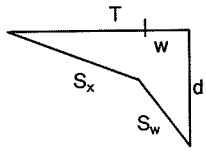
i = 6.99

Q_i = 1.40 cfs

$Q_t = Q_i + Q_b$ Q_b = 0.13 cfs from EX / 22

Q_t = 1.53 cfs

T = 6.12 ft (via Fig. 6- 95)



$d = (T-w)S_x + w(S_w)$

w =	20 in	=	1.67 ft
S_x =	0.02 '/ft		
S_w =	0.08 '/ft		
d =	0.22 ft	~	3 in

Q_i = 2.52 cfs (interpolating Figure 6- 109)

$Q_b = Q_t - Q_i$ = 0.00 cfs (to be applied to next downstream inlet)

E = Q_i / Q 1.00 > 0.70 **OK**

allowable spread:
auxiliary lane 11 ft so use shldr width 8 ft or wider

T = 6.12 ft < 11 ft **OK**

APPENDIX B
Storm Drain System Analysis

Airport/Churchmans

Figure 6-126

Storm Drain Computation Table

Open Channel Design

$S_f = (Q/K)^2$ K = (0.463/n) D^(8/3) n = 0.012 (for RCP) $T_t = L/(60V)$

PIPE UNIT			ΔA	C	CxΔA	CA	T_c	I	Q	DIA	L	S_f	S	Q full flow	V full flow	% Flow	% of Full	V	T_t	INVERT EL.	
NO.	FROM	TO	ac.				min	in/hr	cfs	in	ft	ft/ft	ft/ft	cfs	fps		Flow V	fps	min.	UPPER	LOWER
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
39	DI 38	CJB 2	0.1680	0.85	0.143	0.143	5.0	6.99	1.00	15	18.6	0.000	0.005	4.95	4.03	20.18%	74	2.98	0.104	67.84	67.75
lat	ex CB	CJB 2	0.2370	0.71	0.168	0.168	5.0	6.99	1.18	15	57.7	0.000	0.01213	7.70	6.28	15.27%	67	4.21	0.229	68.72	68.02
trunk	CJB 2	CMH 9	-	-	0.000	0.311	5.2	6.94	2.16	18	155.3	0.000	0.03599	21.58	12.21	10.00%	57	6.96	0.372	65.97	60.38
38	DI 37	CMH 9	0.1740	0.85	0.148	0.148	5.0	6.99	1.03	15	20.7	0.000	0.02	9.89	8.06	10.45%	60	4.84	0.071	62.16	61.75
lat	ex CB	CMH 9	0.2000	0.75	0.150	0.150	5.0	6.99	1.05	15	58.1	0.000	0.01187	7.62	6.21	13.76%	66	4.10	0.236	63.12	62.43
trunk	CMH 9	CJB 1	-	-	0.000	0.609	5.5	6.87	4.18	18	196.7	0.001	0.03421	21.04	11.91	19.88%	74	8.81	0.372	58.28	51.55
37	DI 36	CJB 1	0.2280	0.85	0.194	0.194	5.0	6.99	1.35	15	23.9	0.000	0.02	9.89	8.06	13.69%	66	5.32	0.075	53.23	52.75
lat	DI 80	CJB 1	0.2560	0.73	0.187	0.187	5.0	6.99	1.31	15	59.9	0.000	0.01002	7.00	5.71	18.65%	74	4.22	0.236	53.05	52.45
trunk	CJB 1	CMH 8	-	-	0.000	0.990	5.9	6.77	4.10	18	224.5	0.0030	0.02935	19.49	11.03	21.04%	75	8.27	0.452	48.25	41.66
36	DI 35	CMH 8	0.2690	0.85	0.229	0.229	5.0	6.99	1.60	15	36.8	0.0010	0.02	9.89	8.06	16.15%	70	5.64	0.109	43.24	42.50
ex	DI 34	CMH 8	0.2560	0.85	0.218	0.218	5.0	6.99	1.52	15	59.8	0.000	0.00518	5.03	4.10	30.21%	86	3.53	0.282	43.07	42.76
35	CMH 8	DI 32	-	-	0.000	1.436	6.3	6.68	9.59	18	209.8	0.0070	0.0075	9.85	5.57	97.36%	115	6.41	0.545	41.56	39.99
33	DI 33	DI 32	0.248	0.85	0.211	0.211	5.0	6.99	1.47	15	42.4	0.000	0.003	3.83	3.12	38.46%	92	2.87	0.246	39.85	39.72
90	DI 32	DI 27	0.1830	0.85	0.156	1.802	6.9	6.56	11.82	24	58.7	0.0020	0.003	13.42	4.27	88.11%	113	4.83	0.203	39.68	39.50
112	DI 27	MH 7	0.4310	0.85	0.366	2.169	7.1	6.51	14.12	24	50.4	0.0030	0.0031	13.64	4.34	103.50%	116	5.04	0.167	39.45	39.29
16	MH 7	DI 26	-	-	0.000	2.169	7.2	6.46	14.01	24	97.7	0.0030	0.003	13.42	4.27	104.40%	116	4.95	0.329	39.24	38.95

PIPE UNIT			ΔA	C	CxΔA	CA	T_c	I	Q	DIA	L	S_f	S	Q full flow	V full flow	% Flow	% of Full	V	T_t	INVERT EL.	
NO.	FROM	TO	ac.				min	in/hr	cfs	in	ft	ft/ft	ft/ft	cfs	fps		Flow V	fps	min.	UPPER	LOWER
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
67	DI 70	DI 68	0.1890	0.85	0.161	0.137	5.0	6.99	0.95	15	307.0	0.0000	0.026	11.28	9.19	8.46%	56	5.15	0.994	78.25	70.27
64	DI 68	DI 66	0.3380	0.85	0.287	0.424	6.0	6.77	2.87	15	288.7	0.0020	0.026	11.28	9.19	25.44%	81	7.45	0.646	70.07	62.56
62	DI 66	DI 63	0.3620	0.85	0.308	0.732	6.6	6.63	4.85	15	290.9	0.0050	0.025	11.06	9.01	43.85%	95	8.56	0.566	62.36	55.09
60	DI 63	DI 61	0.4020	0.85	0.342	1.073	7.2	6.49	6.97	15	284.0	0.0100	0.024	10.84	8.83	64.27%	107	9.45	0.501	54.89	48.07
57	DI 61	DI 29	0.4230	0.85	0.360	1.433	7.7	6.37	9.13	15	216.4	0.0170	0.023	10.61	8.65	86.03%	113	9.77	0.369	47.87	42.89
31	DI 29	DI 30	0.3390	0.85	0.288	1.721	8.1	6.27	10.79	18	59.0	0.0090	0.018	15.26	8.64	70.70%	109	9.41	0.104	42.62	41.56
30	DI 30	DI 28	0.1900	0.85	0.162	1.882	8.2	6.25	11.77	18	44.7	0.0110	0.016	14.39	8.14	81.77%	79	6.43	0.116	41.36	40.64
28	DI 28	DI 26	0.0290	0.85	0.025	1.907	8.3	6.22	11.86	18	58.9	0.0110	0.016	14.39	8.14	82.44%	112	9.12	0.108	40.45	39.51
27	DI 26	MH 22	0.2140	0.85	0.182	4.258	8.4	6.20	26.40	24	53.7	0.0120	0.016	30.99	9.86	85.18%	113	11.15	0.080	38.90	38.04
26	MH 22	DI 25	-	-	0.000	4.258	8.5	6.17	26.27	24	74.5	0.0110	0.016	30.99	9.86	84.77%	113	11.15	0.111	37.84	36.65
13	DI 16	DI 25	0.0880	0.85	0.075	0.075	5.0	6.99	0.52	15	30.6	0.0000	0.04	13.99	11.40	3.74%	41	4.67	0.109	37.97	36.75
25	DI 25	DI 58	0.2070	0.85	0.176	4.434	8.6	6.15	27.27	24	227.6	0.0120	0.0121	26.95	8.58	101.18%	116	9.95	0.381	36.45	33.70
68	DI 71	DI 69	4.0020	0.29	1.161	1.161	25.0	3.92	4.55	15	208.6	0.0040	0.0270	11.49	9.37	39.58%	93	8.71	0.399	78.40	72.77
66	DI 69	DI 67	1.3680	0.31	0.424	1.585	25.4	3.89	6.16	15	202.1	0.0080	0.0250	11.06	9.01	55.73%	102	9.19	0.366	72.57	67.52
65	DI 67	DI 65	0.8730	0.36	0.314	1.899	25.8	3.86	7.33	15	201.5	0.0110	0.0250	11.06	9.01	66.27%	108	9.73	0.345	67.32	62.28
63	DI 65	DI 64	1.2670	0.33	0.418	2.317	26.1	3.84	8.90	15	206.4	0.0160	0.0250	11.06	9.01	80.44%	112	10.09	0.341	62.08	56.92
61	DI 64	DI 62	2.2380	0.26	0.582	2.899	26.5	3.82	11.07	15	186.1	0.0250	0.0240	10.84	8.83	102.18%	116	10.24	0.303	56.72	52.25
59	DI 62	DI 60	1.1330	0.29	0.329	3.228	26.8	3.79	12.23	18	206.4	0.0120	0.0230	17.25	9.76	70.90%	109	10.64	0.323	52.06	47.31
58	DI 60	DI 23	1.0270	0.33	0.339	3.566	27.1	3.77	13.45	18	181.0	0.0140	0.0220	16.87	9.55	79.69%	112	10.69	0.282	47.11	43.13
22	DI 23	MH 29	0.7880	0.44	0.347	3.913	27.4	3.75	14.67	18	60.6	0.0170	0.0200	16.09	9.10	91.21%	114	10.38	0.097	42.93	41.72
21	DI 18	DI 22	1.7340	0.22	0.381	0.381	15.0	4.95	1.89	18	171.5	0.0000	0.0030	6.23	3.53	30.31%	86	3.03	0.943	42.42	41.91
107	DI 22	MH 29	0.9360	0.24	0.225	0.606	15.9	4.85	2.94	18	65.1	0.0010	0.0030	6.23	3.53	47.18%	97	3.42	0.317	41.81	41.61
108	MH 29	MH 30	-	-	0.000	4.519	27.5	3.74	16.90	18	87.9	0.0220	0.0200	16.09	9.10	105.06%	116	10.56	0.139	41.51	39.75

PIPE UNIT			ΔA	C	CxΔA	CA	T_c	I	Q	DIA	L	S_f	S	Q full flow	V full flow	% Flow	% of Full	V	T_t	INVERT EL.	
NO.	FROM	TO	ac.				min	in/hr	cfs	in	ft	ft/ft	ft/ft	cfs	fps		Flow V	fps	min.	UPPER	LOWER
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
19	DI 19	DI 20	0.1260	0.85	0.107	0.107	5.0	6.99	0.75	15	42.7	0.0000	0.0100	7.00	5.70	10.70%	60	3.42	0.208	42.97	42.54
20	DI 20	MH 30	0.4100	0.63	0.258	0.365	5.2	6.92	2.53	15	228.1	0.0010	0.0120	7.66	6.24	33.00%	87	5.43	0.700	42.44	39.70
24	MH 30	DI 24	-	-	0.000	4.885	27.6	3.73	18.22	21	108.8	0.0110	0.0200	24.27	10.09	75.08%	110	11.10	0.163	39.66	37.48
23	DI 24	DI 59	0.0900	0.56	0.050	4.935	27.8	3.72	18.36	24	215.1	0.0060	0.0050	17.32	5.51	105.97%	116	6.40	0.560	37.38	36.30
32	DI 59	DI 57	0.2450	0.51	0.125	5.060	28.3	3.68	18.62	24	61.2	0.0060	0.0080	21.91	6.97	84.98%	113	7.88	0.129	36.16	35.67
56	DI 57	DI 58	0.3500	0.85	0.298	5.358	28.4	3.67	19.66	24	38.3	0.0060	0.0460	52.54	16.73	37.42%	90	15.05	0.042	35.47	33.71
127	DI 58	MH 35	0.2620	0.85	0.223	10.014	28.5	3.67	36.75	24	55.6	0.0230	0.0246	38.43	12.23	95.64%	115	14.07	0.066	33.50	32.13
126	DI 95	MH 35	0.1930	0.85	0.164	0.164	5.0	6.99	1.15	15	17.7	0.0000	0.0200	9.89	8.06	11.59%	62	5.00	0.059	32.49	32.14
85	MH 35	DI 56	-	-	0.000	10.178	28.6	3.65	37.15	24	169.6	0.0230	0.0241	38.03	12.11	97.68%	116	14.04	0.201	31.94	27.85
55	DI 55	DI 56	0.1040	0.85	0.088	0.088	5.0	6.99	0.62	15	36.1	0.0000	0.0503	15.69	12.78	3.94%	41	5.24	0.000	29.67	27.85
54	DI 56	DI 54	0.5480	0.85	0.466	10.732	28.6	3.65	39.17	27	218.4	0.0140	0.0212	48.83	12.28	80.21%	112	13.76	0.265	27.65	23.02
53	DI 54	DI 53	0.4800	0.85	0.408	11.140	28.8	3.62	40.33	27	162.5	0.0140	0.0180	45.00	11.32	89.62%	114	12.90	0.210	22.81	19.89
76	DI 91	DI 53	0.1740	0.85	0.148	0.148	5.0	6.99	1.03	15	47.0	0.0000	0.0400	13.99	11.40	7.39%	50	5.70	0.137	21.77	19.89
96	DI 53	DI 52	0.3170	0.85	0.269	11.409	29.0	3.61	41.19	30	247.2	0.0090	0.0097	43.75	8.91	94.15%	115	10.25	0.402	19.34	16.94
29	DI 31	DI 52	0.1400	0.85	0.119	0.119	5.0	6.99	0.83	15	42.7	0.0000	0.0300	12.12	9.87	6.86%	50	4.94	0.144	18.22	16.94
97	DI 52	DI 51	0.2580	0.85	0.219	11.748	29.4	3.59	42.17	33	205.3	0.0050	0.0070	47.92	8.07	88.01%	113	9.12	0.375	16.89	15.45
98	DI 51	MH 34	0.3090	0.85	0.263	12.010	29.8	3.56	42.76	33	107.5	0.0060	0.0070	47.92	8.07	89.23%	114	9.20	0.195	15.36	14.61
109	MH 34	DI 87	-	-	0.000	12.010	30.0	3.54	42.52	33	164.2	0.0060	0.0050	40.50	6.82	104.98%	116	7.91	0.346	14.50	13.68
99	DI 87	MH 26	0.2600	0.85	0.221	12.231	30.2	3.54	43.30	36	189.7	0.0040	0.0040	45.68	6.46	94.78%	115	7.43	0.425	13.58	12.82
100	MH 26	POND	-	-	0.000	12.231	30.6	3.52	43.05	36	82.1	0.0040	0.0031	40.22	5.69	107.06%	116	6.60	0.207	12.72	12.47
71	DI 97	CJB 11	0.5260	0.70	0.368	0.368	5.0	6.99	2.57	15	18.7	0.0010	0.005	4.95	4.03	52.03%	100	4.03	0.077	67.84	67.75
ex	CJB 11	CMH 10	-	-	0.000	0.368	5.1	6.97	2.57	15	58.4	0.0010	0.0113	7.44	6.06	34.51%	89	5.39	0.180	67.65	66.99
40	DI 39	CMH 10	0.465	0.4	0.186	0.186	5.0	6.99	1.30	15	20.3	0.0000	0.02	9.89	8.06	13.14%	64	5.16	0.066	67.40	66.99
ex	CMH 10	CJB 3	-	-	0.000	0.554	5.3	6.92	3.84	15	198.0	0.0030	0.03672	13.41	10.92	28.61%	84	9.18	0.360	65.99	58.72
ex	44+10 L	CJB 3	0.5160	0.43	0.222	0.222	5.0	6.99	1.55	15	57.7	0.0000	0.01682	9.07	7.39	17.09%	71	5.25	0.183	60.99	60.02

PIPE UNIT			ΔA	C	CxΔA	CA	T_c	I	Q	DIA	L	S_f	S	Q full flow	V full flow	% Flow	% of Full	V	T_t	INVERT EL.	
NO.	FROM	TO	ac.				min	in/hr	cfs	in	ft	ft/ft	ft/ft	cfs	fps		Flow V	fps	min.	UPPER	LOWER
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
41	DI 40	CJB 3	0.3850	0.52	0.200	0.200	5.0	6.99	1.40	15	21.3	0.0000	0.02	9.89	8.06	14.14%	66	5.32	0.067	60.45	60.02
ex	CJB 3	CMH 11	-	-	0.000	0.976	5.6	6.87	6.71	15	185.4	0.0090	0.03749	13.55	11.04	49.52%	98	10.82	0.286	56.47	49.52
ex	46+05 L	CMH 11	0.4850	0.44	0.213	0.213	5.0	6.99	1.49	15	58.4	0.0000	0.01028	7.09	5.78	21.03%	75	4.33	0.225	50.87	50.27
42	DI 41	CMH 11	0.5060	0.42	0.213	0.213	5.0	6.99	1.49	15	20.6	0.0000	0.02	9.89	8.06	15.02%	67	5.40	0.064	49.93	49.52
ex	CMH 11	CJB 4	-	-	0.000	1.402	5.9	6.80	9.53	15	158.6	0.0190	0.03121	12.36	10.07	77.15%	110	11.08	0.239	46.52	41.57
ex	47+75 L	CJB 4	0.2240	0.74	0.166	0.166	5.0	6.99	1.16	15	57.9	0.0000	0.00432	4.60	3.75	25.20%	81	3.03	0.318	42.82	42.57
43	DI 42	CJB 4	0.2230	0.70	0.156	0.156	5.0	6.99	1.09	15	21.2	0.0000	0.02	9.89	8.06	11.03%	60	4.84	0.073	42.99	42.57
ex	CJB 4	CMH 12	-	-	0.000	1.724	6.1	6.75	11.64	18	153.1	0.0100	0.02841	19.17	10.85	60.69%	105	11.39	0.224	40.92	36.57
ex	49+25 L	CMH 12	0.4290	0.42	0.180	0.180	5.0	6.99	1.26	15	58.4	0.0000	0.00599	5.41	4.41	23.26%	78	3.44	0.283	39.77	39.42
44	DI 43	CMH 12	0.1670	0.85	0.142	0.142	5.0	6.99	0.99	15	20.1	0.0000	0.02	9.89	8.06	10.03%	57	4.60	0.073	38.40	38.00
ex	CMH 12	CJB 5	-	-	0.000	2.046	6.4	6.68	13.67	18	180.1	0.0140	0.01955	15.91	9.00	85.94%	113	10.17	0.295	36.47	32.95
ex	51+10 L	CJB 5	0.5270	0.41	0.216	0.216	5.0	6.99	1.51	15	58.4	0.0000	0.00531	5.10	4.15	29.63%	86	3.57	0.272	34.16	33.85
45	DI 44	CJB 5	0.1960	0.85	0.167	0.167	5.0	6.99	1.16	15	20.6	0.0000	0.02	9.89	8.06	11.77%	62	5.00	0.069	34.26	33.85
ex	CJB 5	CMH 13	-	-	0.000	2.429	6.7	6.61	16.05	18	177.9	0.0200	0.02277	17.17	9.71	93.53%	115	11.17	0.265	32.85	28.80
ex	52+90 L	CMH 13	0.5330	0.39	0.208	0.208	5.0	6.99	1.45	15	58.4	0.0000	0.01216	7.71	6.29	18.84%	74	4.65	0.209	30.71	30.00
46	DI 45	CMH 13	0.1960	0.85	0.167	0.167	5.0	6.99	1.16	15	20.5	0.0000	0.02	9.89	8.06	11.77%	62	5.00	0.068	30.41	30.00
ex	CMH 13	CJB 6	-	-	0.000	2.803	6.9	6.56	18.39	24	167.8	0.0060	0.02122	35.69	11.36	51.53%	100	11.36	0.246	28.50	24.94
ex	54+55 L	CJB 6	0.2630	0.61	0.160	0.160	5.0	6.99	1.12	15	58.4	0.0000	0.03579	13.23	10.78	8.47%	53	5.72	0.170	27.23	25.14
47	DI 46	CJB 6	0.1800	0.85	0.153	0.153	5.0	6.99	1.07	15	21.0	0.0000	0.02	9.89	8.06	10.81%	60	4.84	0.072	27.42	27.00
ex	CJB 6	CMH 14	-	-	0.000	3.117	7.2	6.49	20.23	24	202.1	0.0070	0.00812	22.08	7.03	91.63%	114	8.01	0.420	24.84	23.20
ex	56+60 L	CMH 14	0.2090	0.83	0.173	0.173	5.0	6.99	1.21	15	59.4	0.0000	0.02423	10.89	8.87	11.14%	60	5.32	0.186	23.55	22.11
84	DI 48	CMH 14	0.2040	0.85	0.173	0.173	5.0	6.99	1.21	15	16.1	0.0000	0.02	9.89	8.06	12.25%	62	5.00	0.054	24.42	24.10
ex	CMH 14	CJB7	-	-	0.000	3.464	7.6	6.39	22.13	24	178.6	0.0080	0.0084	22.45	7.15	98.57%	116	8.29	0.359	23.18	21.68
ex	58+50 L	CJB 7	0.1930	0.83	0.160	0.160	5.0	6.99	1.12	15	60.1	0.0000	0.00849	6.45	5.25	17.37%	71	3.73	0.269	22.11	21.60
49	DI 49	CJB 7	0.1730	0.85	0.147	0.147	5.0	6.99	1.03	15	15.1	0.0000	0.02	9.89	8.06	10.39%	57	4.60	0.055	21.65	21.35

PIPE UNIT			ΔA	C	CxΔA	CA	T_c	I	Q	DIA	L	S_f	S	Q full flow	V full flow	% Flow	% of Full	V	T_t	INVERT EL.	
NO.	FROM	TO	ac.				min	in/hr	cfs	in	ft	ft/ft	ft/ft	cfs	fps		Flow V	fps	min.	UPPER	LOWER
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
ex	CJB 7	CMH 18	-	-	0.000	3.771	8.0	6.29	23.72	24	171.0	0.0090	0.01415	29.14	9.28	81.39%	112	10.39	0.274	20.62	18.20
91	DI 84	DI 85	0.1740	0.15	0.026	0.026	5.0	6.99	0.18	15	10.3	0.0000	0.005	4.95	4.03	3.69%	41	1.65	0.104	20.31	20.26
92	DI 85	ex CB	0.1930	0.62	0.120	0.146	5.0	6.99	1.02	15	35.6	0.0000	0.003	3.83	3.12	26.59%	82	2.56	0.232	20.06	19.95
ex	ex CB	ex JB	0.0410	0.62	0.025	0.171	5.0	6.99	1.20	15	62.7	0.0000	0.05789	16.83	13.72	7.11%	50	6.86	0.152	19.85	16.22
ex	offsite	DI 50	91.6200	0.32	29.318	29.318	39.0	3.05	89.42	48	14.2	0.0030	0.00775	136.94	10.90	65.30%	108	11.77	0.020	17.31	17.20
ex	DI 50	CMH 18	0.1840	0.85	0.156	29.475	39.0	3.05	89.90	48	11.4	0.0030	0.007	130.15	10.36	69.07%	109	11.29	0.017	17.10	17.02
ex	CMH 18	ex JB	-	-	0.000	33.246	39.0	3.05	101.40	48	64.5	0.0040	0.007	130.15	10.36	77.91%	111	11.50	0.094	16.67	16.22
ex	ex JB	ex CB	-	-	0.000	33.417	39.1	3.04	101.59	48	97.9	0.0040	0.00725	132.45	10.54	76.70%	110	11.59	0.141	16.22	15.51
115	DI 92	DI 2	1.6670		0.000	0.000			0.00	15	10.4		0.02	9.89	8.06	0.00%	0	0.00	#DIV/0!	53.16	52.95
2	DI 2	DI 88	1.1770	0.23	0.271	0.271	15.0	4.95	1.34	15	119.2	0.0000	0.033	12.71	10.36	10.54%	60	6.21	0.320	52.86	48.93
83	DI 88	DI 4	2.0140	0.19	0.383	0.653	15.3	4.92	3.21	15	133.3	0.0020	0.03	12.12	9.87	26.53%	82	8.10	0.274	48.72	44.72
4	DI 4	DI 3	3.1750	0.18	0.572	1.225	15.6	4.88	5.98	15	82.0	0.0070	0.016	8.85	7.21	67.55%	108	7.79	0.175	44.52	43.21
1	DI 1	DI 3	0.1680	0.70	0.118	0.118	5.0	6.99	0.82	15	259.8	0.0000	0.034	12.90	10.51	6.37%	47	4.94	0.876	52.04	43.21
3	DI 3	DI 6	0.2670	0.82	0.219	1.561	15.8	4.86	7.59	18	215.5	0.0040	0.01	11.38	6.44	66.71%	108	6.95	0.517	42.94	40.79
6	DI 6	DI 74	0.2640	0.80	0.211	1.773	16.3	4.80	8.51	21	108.2	0.0020	0.003	9.40	3.91	90.53%	114	4.45	0.405	40.51	40.19
15	DI 74	outlet	0.1640	0.83	0.136	1.909	16.7	4.75	9.07	21	30.0	0.0030	0.003	9.40	3.91	96.47%	115	4.49	0.111	40.09	40.00
14	DI 17	DI 13	1.1210	0.27	0.303	0.303	16.0	4.83	1.46	18	127.7	0.0000	0.005	8.04	4.55	18.17%	72	3.28	0.649	40.18	39.54
17	DI 13	CJB 9	0.2560	0.29	0.074	0.377	16.6	4.76	1.79	18	13.1	0.0000	0.003	6.23	3.53	28.79%	84	2.96	0.074	39.44	39.40
ex	CJB 9	CMH 3	-	-	0.000	0.377	16.7	4.75	1.79	30	38.6	0.0000	0.01147	47.57	9.69	3.76%	41	3.97	0.162	39.35	38.91
111	CI 14	CMH 3	0.0420	0.85	0.036	0.036	5.0	6.99	0.25	15	31.5	0.0000	0.01	7.00	5.70	3.57%	41	2.34	0.225	39.23	38.92
10	CMH 3	DI 10	-	-	0.000	0.413	16.9	4.73	1.95	30	36.6	0.0000	0.011	46.59	9.49	4.19%	41	3.89	0.157	38.05	37.65

PIPE UNIT			Δ^A	C	C x Δ^A	CA	T_c	I	Q	DIA	L	S_f	S	Q full flow	V full flow	% Flow	% of Full	V	T_t	INVERT EL.	
NO.	FROM	TO	ac.				min	in/hr	cfs	in	ft	ft/ft	ft/ft	cfs	fps		Flow V	fps	min.	UPPER	LOWER
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
86	DI 73	DI 15	0.0730	0.61	0.045	0.045	5.0	6.99	0.31	15	131.7	0.0000	0.01	7.00	5.70	4.45%	45	2.57	0.856	41.24	39.92
12	DI 15	DI 12	0.3620	0.74	0.268	0.312	5.9	6.80	2.12	15	130.7	0.0010	0.005	4.95	4.03	42.95%	94	3.79	0.575	39.72	39.07
18	DI 12	DI 10	0.2390	0.60	0.143	0.456	6.4	6.68	3.04	15	5.8	0.0020	0.004	4.42	3.61	68.82%	109	3.93	0.025	38.87	38.85
73	DI 10	outlet	0.0180	0.83	0.015	0.883	17.0	4.72	4.17	30	28.8	0.0000	0.0032	25.13	5.12	16.59%	71	3.63	0.132	37.59	37.50
5	DI 5	DI 7	7.2830	0.20	1.457	1.834	16.7	4.75	8.71	21	126.4	0.0030	0.005	12.13	5.04	71.78%	109	5.50	0.383	40.68	40.05
7	DI 9	DI 7	5.9860	0.15	0.898	0.898	16.0	4.83	4.34	15	10.0	0.0040	0.01	7.00	5.70	61.99%	106	6.04	0.028	40.15	40.05
9	DI 7	DI 11	0.4460	0.39	0.174	2.905	17.1	4.71	13.68	24	79.3	0.0030	0.005	17.32	5.51	78.99%	111	6.12	0.216	39.95	39.55
11	DI 11	CMH 1	0.1730	0.49	0.085	2.990	17.3	4.68	13.99	24	13.5	0.0030	0.004	15.49	4.93	90.31%	114	5.62	0.040	39.45	39.40
ex	CMH 1	EX CB	-	-	0.000	2.990	17.4	4.67	13.96	30	40.4	0.0010	0.0101	44.64	9.09	31.28%	86	7.82	0.086	39.35	38.94
8	EX CB	DI 8	0.0030	0.15	0.000	2.991	17.4	4.67	13.97	30	36.8	0.0010	0.012	48.66	9.91	28.70%	84	8.33	0.074	38.25	37.81
82	DI 78	MH 19	0.4360	0.55	0.240	0.240	5.0	6.99	1.68	18	13.2	0.0000	0.01	11.38	6.44	14.73%	67	4.31	0.051	16.84	16.71
72	DI 8	outlet	0.2500	0.83	0.208	3.198	17.5	4.66	14.90	30	28.9	0.0010	0.007	37.16	7.57	40.10%	93	7.04	0.068	37.71	37.51
ex	pond	MH 19	1.8100	0.64	1.158	1.158	10.0	5.79	6.71	12	50.8		0.003	2.11	2.69	317.38%	116	3.12	0.271		
												slope is guessed at 3.0%									
50	MH 19	MH 24	-	-	0.000	1.398	10.3	5.77	8.07	18	7.2	0.0050	0.01	11.38	6.44	70.92%	109	7.02	0.017	16.15	16.08
101	MH 24	MH 36	-	-	0.000	1.398	10.3	5.77	8.07	18	109.4	0.0050	0.01	11.38	6.44	70.92%	109	7.02	0.260	15.47	14.38
117	DI 79	MH 36	0.9310	0.70	0.652	0.652	5.0	6.99	4.56	24	10.6	0.0000	0.02	34.65	11.03	13.15%	64	7.06	0.025	15.40	15.19
116	MH 36	DI 89	-	-	0.000	2.050	10.5	5.72	11.73	24	185.7	0.0020	0.0095	23.88	7.60	49.10%	98	7.45	0.416	14.18	12.42
102	DI 89	DI 90	0.1690	0.66	0.112	2.161	11.0	5.66	12.23	24	173.9	0.0020	0.0095	23.88	7.60	51.23%	99	7.52	0.385	12.21	10.56
ex	ex CB	MH 25	4.1720	0.37	1.544	1.544	22.8	4.12	6.36	24	307.0		0.005	17.32	5.51	36.71%	90	4.96	1.031	-	-
												slope is guessed at 5%									
77	MH 25	DI 90	-	-	0.000	1.544	23.8	4.03	6.22	24	7.7	0.0010	0.04	49.00	15.60	12.70%	64	9.98	0.013	10.31	10.00
103	DI 90	MH 27	1.8140	0.69	1.252	4.957	23.8	4.03	19.98	33	229.7	0.0040	0.003	31.37	5.28	63.68%	107	5.65	0.677	8.87	8.18
104	MH 27	MH 28	-	-	0.000	4.957	24.5	3.97	19.68	33	220.3	0.0030	0.003	31.37	5.28	62.73%	106	5.60	0.656	8.08	7.42
105	MH 28	outlet	-	-	0.000	4.957	25.2	3.91	19.38	33	18.9	0.0030	0.003	31.37	5.28	61.78%	106	5.60	0.056	7.32	7.26

APPENDIX C
Culvert Analyses

PROJECT: AIRPORT / CHURCHMANS

STATION: 91+50

SHEET 1 **OF** 1

CULVERT DESIGN FORM

DESIGNER / DATE: JIR / 4-22-04

REVIEWER / DATE: /

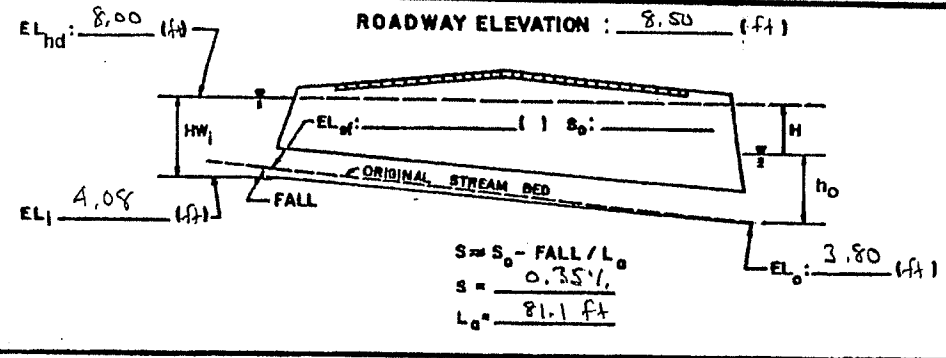
HYDROLOGICAL DATA

SEE ADD'L SHTS.

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

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
25	74	1.81



$S = S_o - FALL / L_a$

$S =$ 0.35%

$L_a =$ 81.1 ft

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_{hi} (4)	OUTLET CONTROL TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL_{ho} (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
60" x 38" RCEP	74		1.04	3.29	0	7.37	1.81	2.12	1.97	1.97	0.2	0.79	6.56			try smaller
53" x 34" RCEP	↓		1.29	3.66	0	7.74	↓	2.57	2.19	2.19	0.2	1.31	7.30			use 60" x 38"

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

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

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

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

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

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

(7) $H = \left[1 + k_e + (K_u n^2 L)/R^{1.33}\right] v^2/2g$ WHERE Ku = 19.63 (29 IN ENGLISH UNITS)

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

SUBSCRIPT DEFINITIONS:

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

COMMENTS / DISCUSSION:

CULVERT BARREL SELECTED:

SIZE: 60" x 38" RCEP

SHAPE: elliptical

MATERIAL: ____ n 0.012

ENTRANCE: ____

60" x 38": $H = \left[1 + 0.2 + \frac{(29 \times (0.012)^2 \times 81.1)}{(0.9923)^{1.33}}\right] (5.74)^2 / 2(32.2) = 0.790$

53" x 34": $H = \left[1 + 0.2 + \frac{(29 \times (0.012)^2 \times 81.1)}{(0.9[illegible])^{1.33}}\right] (7.25)^2 / 32.2 = 1.31$

WHITMAN, REQUARDT AND ASSOCIATES, LLP - ENGINEERS

W.O. NO. _____

SHEET NO. 1 OF _____

BY: JR SUBJECT AIRPORT / CHURCHMANS

DATE 4/20/04 CULVERT DESIGN

Correlate by-pass storm drain area to an SCS output to determine peak flow at pond outlet / bypass storm drain outlet for ditch and culvert design.

$\Sigma A_{bypass} = 9.33$ ac

$c = 0.69$

$t_c = 25.1$ min

convert this Rational data to SCS data:

$A = 9.33$ ac $= 0.01458$ mi^2

$c = 0.69$ $\approx$

$t_c = 25.1$ min $= 0.418$ hrs

now calculate overland flow to ditch via SCS method

Drainage Area 5

$A_T = 202,550$ SF $= 4.65$ ac

$A_{imp} = 44,192$ SF $= 1.015$ ac $c = 0.85$

$A_{res} = 76,545$ SF $= 1.757$ ac $c = 0.40$

$A_{woods} = 25,625$ SF $= 0.588$ ac $c = 0.35$

$A_{grass} = 56,184$ SF $= 1.293$ ac $c = 0.25$

$$c = \frac{0.85(1.015) + 0.40(1.757) + 0.35(0.588) + 0.25(1.293)}{4.65}$$

$c = 0.45$

t_c: 150' overland flow, grass @ 0.03'/ft (assumed)

$$T_t = \frac{0.2278(0.15 * 150)^{0.8}}{(0.03)^{0.4}} = 9.1 \text{ min}$$

shallow concentrated flow, asphalt, 1950' @ 0.03'/ft (assumed)

Form C5

WHITMAN, REQUARDT AND ASSOCIATES, LLP - ENGINEERS

W.O. NO. _____

SHEET NO. 2 OF _____

BY: JR SUBJECT AIRPORT / CHURCHMANS

DATE 4/20/04 CULVERT DESIGN

$$T_t = \frac{L}{60\,v} \qquad v = 20.3282\sqrt{0.07} = 3.52$$

$$= \frac{1950'}{60\,(3.52'/s)} = 9.2 \text{ min}$$

$$t_c = \Sigma T_t = 18.3 \text{ min} \longrightarrow i_{25} = 5.52$$

$$Q_{\text{into ditch}} = ciA = 0.45\,(5.52)\,(4.65) = \underline{\underline{11.55 \text{ cfs}}}$$

now convert overland flow to an SCS output to determine peak flow to

A	=	4.65 ac	=	0.00727 mi²
c	=	0.45	≈	60.0 CN
t_c	=	18.3 min	=	0.305 hrs

Form C5

```
0
*****************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY*****************

JOB TR-20                          FULLPRINT          SUMMARY   NOPLOTS
TITLE 001 NEW CASTLE CO. - AIRPORT/CHURCHMAN'S    2,10,100-YR STORMS
TITLE                        BMP #1 - FLEMING.DAT
 3 STRUCT      01
 8                        10.000      0.0        0.0
 8                        10.250      0.03       0.1905
 8                        10.500      0.04       0.3809
 8                        10.750      0.05       0.5714
 8                        11.000      0.06       0.7618
 8                        11.250      3.44       0.9948
 8                        11.500      10.26      1.2277
 8                        11.750      19.18      1.4607
 8                        12.000      29.80      1.6936
 8                        12.250      41.87      1.9419
 8                        12.500      55.24      2.1902
 8                        12.750      64.42      2.4385
 8                        13.000      72.16      2.6868
 8                        13.250      82.38      2.9507
 8                        13.500      85.8       3.2145
 9 ENDTBL
 6 RUNOFF 1 001       1 0.01458     67.0       0.240      1         1
 6 RUNOFF 1    01     2 0.04026     82.6       0.466      1         1   4-1
 6 RESVOR 2    01 2   3 10.000                            1 1 1 1 1 1
 6 ADDHYD 4 002   3 1 4
 6 RUNOFF 1 003       5 0.00727     60.0       0.300
 6 ADDHYD 4 003   5 4 6
   ENDATA
 7 INCREM 6             0.10
 7 COMPUT 7 001   003   0.0         5.7        1.0        2 2  01  25
   ENDCMP 1
   ENDJOB 2

*********************************END OF 80-80 LIST*********************************

 *** WARNING - UNEXPECTED RECORD(S) ENCOUNTERED WHEN LOOKING FOR "JOB" RECORD.
               IMAGES OF FIRST 10 RECORDS IGNORED FOLLOW:                   ***

0
TR20 ---------------------------------------------------------------------- SCS -
          NEW CASTLE CO. - AIRPORT/CHURCHMAN'S    2,10,100-YR STORMS     VERSION
04/14/**                     BMP #1 - FLEMING.DAT                       2.04TEST
14:09:30                    PASS   1   JOB NO.   1                      PAGE   1
```

by-pass

Pond

```
 --------     NOTE - TR-20 USER NOTE FILE (TR20NOTE.TEX) NOT FOUND.     --------
0
TR20 ---------------------------------------------------------------------- SCS -
          NEW CASTLE CO. - AIRPORT/CHURCHMAN'S    2,10,100-YR STORMS     VERSION
04/14/**                     BMP #1 - FLEMING.DAT                       2.04TEST
14:09:30                    PASS   1   JOB NO.   1                      PAGE   2


EXECUTIVE CONTROL  INCREM    MAIN TIME INCREMENT =    .100 HOURS


EXECUTIVE CONTROL  COMPUT    FROM XSECTION   1  TO XSECTION   3
   STARTING TIME =   .00        RAIN DEPTH =  5.70        RAIN DURATION =  1.00
   ANT. RUNOFF COND. = 2        MAIN TIME INCREMENT =   .100 HOURS
   ALTERNATE NO. = 1            STORM NO. =25             RAIN TABLE NO. = 2


OPERATION RUNOFF    XSECTION   1
        OUTPUT HYDROGRAPH =  1      AREA =    .01 SQ MI
        INPUT RUNOFF CURVE = 67.    TIME OF CONCENTRATION =   .24 HOURS
        COMPUTED INTERNAL TIME INCREMENT =  .0320 HOURS

   PEAK TIME(HRS)              PEAK DISCHARGE(CFS)          PEAK ELEVATION(FEET)
      12.04                          25.6                        (RUNOFF)

   RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                 2.31 WATERSHED INCHES;      22 CFS-HRS;       1.8 ACRE-FEET.


OPERATION RUNOFF    STRUCTURE  1
```

OUTPUT HYDROGRAPH = 2 AREA = .04 SQ MI
INPUT RUNOFF CURVE = 83. TIME OF CONCENTRATION = .47 HOURS
COMPUTED INTERNAL TIME INCREMENT = .0621 HOURS

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET) (RUNOFF)
12.16	85.0	

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
3.77 WATERSHED INCHES; 98 CFS-HRS; 8.1 ACRE-FEET.

OPERATION RESVOR STRUCTURE 1
INPUT HYDROGRAPH 2 OUTPUT HYDROGRAPH 3
SURFACE ELEVATION = 10.00

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
12.35	60.0	12.63

HYDROGRAPH POINTS FOR ALTERNATE = 1, STORM =25
MAIN TIME INCREMENT = .100 hr, DRAINAGE AREA = .04 SQ.MI.

HRS								
7.70	CFS	.00	.01	.01	.01	.01	.01	.01	.01
7.70	ELEV	10.00	10.05	10.05	10.06	10.06	10.07	10.08	10.08
8.50	CFS	.01	.01	.01	.01	.02	.02	.02	.02
8.50	ELEV	10.09	10.10	10.11	10.12	10.13	10.14	10.16	10.17
9.30	CFS	.02	.02	.03	.03	.03	.03	.03	.03
9.30	ELEV	10.18	10.20	10.21	10.23	10.25	10.26	10.28	10.30
10.10	CFS	.03	.03	.03	.04	.04	.04	.04	.04
10.10	ELEV	10.32	10.34	10.37	10.39	10.42	10.45	10.48	10.52
10.90	CFS	.04	.04	.05	.05	.05	.05	.06	.06

10.90	ELEV	10.55	10.60	10.64	10.69	10.75	10.81	10.88	10.96
11.70	CFS	.81	2.55	7.44	18.27	35.49	52.17	59.41	59.54
11.70	ELEV	11.06	11.18	11.40	11.72	12.12	12.44	12.61	12.62
12.50	CFS	55.39	47.12	39.28	32.70	27.24	22.86	19.31	16.85
12.50	ELEV	12.50	12.35	12.20	12.06	11.94	11.84	11.75	11.68
13.30	CFS	14.80	13.09	11.68	10.52	9.71	9.05	8.47	7.94
13.30	ELEV	11.63	11.58	11.54	11.51	11.48	11.46	11.43	11.41
14.10	CFS	7.46	7.03	6.65	6.30	6.00	5.74	5.50	5.30
14.10	ELEV	11.40	11.38	11.37	11.35	11.34	11.33	11.33	11.32
14.90	CFS	5.12	4.95	4.81	4.67	4.55	4.43	4.31	4.21
14.90	ELEV	11.31	11.31	11.30	11.30	11.29	11.29	11.28	11.28
15.70	CFS	4.10	4.00	3.90	3.81	3.71	3.62	3.52	3.44
15.70	ELEV	11.27	11.27	11.27	11.26	11.26	11.26	11.25	11.25
16.50	CFS	3.40	3.36	3.31	3.27	3.23	3.19	3.15	3.12
16.50	ELEV	11.25	11.24	11.24	11.24	11.23	11.23	11.23	11.23
17.30	CFS	3.08	3.04	3.00	2.97	2.93	2.90	2.86	2.83
17.30	ELEV	11.22	11.22	11.22	11.22	11.21	11.21	11.21	11.20
18.10	CFS	2.79	2.76	2.72	2.69	2.66	2.62	2.59	2.56
18.10	ELEV	11.20	11.20	11.20	11.19	11.19	11.19	11.19	11.18
18.90	CFS	2.52	2.49	2.46	2.42	2.39	2.36	2.32	2.29
18.90	ELEV	11.18	11.18	11.18	11.17	11.17	11.17	11.17	11.16
19.70	CFS	2.26	2.22	2.19	2.16	2.12	2.09	2.06	2.03
19.70	ELEV	11.16	11.16	11.16	11.16	11.15	11.15	11.15	11.15
20.50	CFS	2.00	1.97	1.94	1.92	1.90	1.88	1.86	1.84
20.50	ELEV	11.14	11.14	11.14	11.14	11.14	11.13	11.13	11.13
21.30	CFS	1.82	1.81	1.80	1.78	1.77	1.76	1.75	1.74
21.30	ELEV	11.13	11.13	11.13	11.13	11.13	11.13	11.12	11.12
22.10	CFS	1.73	1.72	1.71	1.70	1.69	1.68	1.67	1.66
22.10	ELEV	11.12	11.12	11.12	11.12	11.12	11.12	11.12	11.12
22.90	CFS	1.66	1.65	1.64	1.63	1.63	1.62	1.61	1.60
22.90	ELEV	11.12	11.12	11.12	11.12	11.12	11.12	11.11	11.11
23.70	CFS	1.60	1.59	1.58	1.58	1.57	1.54	1.48	1.40
23.70	ELEV	11.11	11.11	11.11	11.11	11.11	11.11	11.11	11.10
24.50	CFS	1.29	1.17	1.05	.94	.84	.75	.67	.59
24.50	ELEV	11.09	11.08	11.07	11.07	11.06	11.05	11.04	11.04
25.30	CFS	.53	.47	.41	.37	.33	.29	.26	.23
25.30	ELEV	11.03	11.03	11.03	11.02	11.02	11.02	11.01	11.01
26.10	CFS	.20	.18	.16	.14	.12	.11	.10	.09
26.10	ELEV	11.01	11.01	11.01	11.01	11.00	11.00	11.00	11.00
26.90	CFS	.08	.07	.06	.06	.06	.06	.06	.06
26.90	ELEV	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
27.70	CFS	.06	.06	.06	.06	.06	.06	.06	.06
27.70	ELEV	11.00	11.00	10.99	10.99	10.99	10.99	10.99	10.99
28.50	CFS	.06	.06	.06	.06	.06	.06	.06	.06
28.50	ELEV	10.99	10.99	10.99	10.99	10.99	10.99	10.99	10.99
29.30	CFS	.06	.06	.06	.06	.06	.06	.06	.06
29.30	ELEV	10.99	10.99	10.98	10.98	10.98	10.98	10.98	10.98
30.10	CFS	.06	.06	.06	.06	.06	.06	.06	.06
30.10	ELEV	10.98	10.98	10.98	10.98	10.98	10.98	10.98	10.98

30.90	CFS	.06	.06	.06	.06	.06	.06	.06	.06
30.90	ELEV	10.98	10.97	10.97	10.97	10.97	10.97	10.97	10.97
31.70	CFS	.06	.06	.06	.06	.06	.06	.06	.06
31.70	ELEV	10.97	10.97	10.97	10.97	10.97	10.97	10.97	10.97
32.50	CFS	.06	.06	.06	.06	.06	.06	.06	.06
32.50	ELEV	10.97	10.96	10.96	10.96	10.96	10.96	10.96	10.96
33.30	CFS	.06	.06	.06	.06	.06	.06	.06	.06
33.30	ELEV	10.96	10.96	10.96	10.96	10.96	10.96	10.96	10.96
34.10	CFS	.06	.06	.06	.06	.06	.06	.06	.06
34.10	ELEV	10.96	10.95	10.95	10.95	10.95	10.95	10.95	10.95
34.90	CFS	.06	.06	.06	.06	.06	.06	.06	.06
34.90	ELEV	10.95	10.95	10.95	10.95	10.95	10.95	10.95	10.95
35.70	CFS	.06	.06	.06	.06	.06	.06	.06	.06
35.70	ELEV	10.95	10.94	10.94	10.94	10.94	10.94	10.94	10.94

```
                                                                    DITCH2
   36.50 CFS        .06      .06      .06      .06      .06      .06      .06      .06
   36.50 ELEV     10.94    10.94    10.94    10.94    10.94    10.94    10.94    10.94
   37.30 CFS        .06      .06      .06      .06      .06      .06      .06      .06
   37.30 ELEV     10.94    10.93    10.93    10.93    10.93    10.93    10.93    10.93
   38.10 CFS        .06      .06      .06      .06      .06      .06      .06      .06
   38.10 ELEV     10.93    10.93    10.93    10.93    10.93    10.93    10.93    10.93
   38.90 CFS        .06      .06      .06      .06      .06      .06      .06      .06
   38.90 ELEV     10.93    10.92    10.92    10.92    10.92    10.92    10.92    10.92
   39.70 CFS        .06      .06      .06      .06      .06      .06      .06      .06
   39.70 ELEV     10.92    10.92    10.92    10.92    10.92    10.92    10.92    10.92
   40.50 CFS        .06      .06      .06      .06      .06      .06      .06      .06
   40.50 ELEV     10.92    10.91    10.91    10.91    10.91    10.91    10.91    10.91
   41.30 CFS        .06      .06      .06      .06      .06      .06      .06      .06
   41.30 ELEV     10.91    10.91    10.91    10.91    10.91    10.91    10.91    10.91
   42.10 CFS        .06      .06      .06      .06      .06      .06      .06      .06
   42.10 ELEV     10.91    10.90    10.90    10.90    10.90    10.90    10.90    10.90
   42.90 CFS        .06      .06      .06      .06      .06      .06      .06      .06
   42.90 ELEV     10.90    10.90    10.90    10.90    10.90    10.90    10.90    10.90
   43.70 CFS        .06      .06      .06      .06      .06      .06      .06      .06
   43.70 ELEV     10.90    10.90    10.89    10.89    10.89    10.89    10.89    10.89
   44.50 CFS        .06      .06      .06      .06      .06      .06      .06      .06
   44.50 ELEV     10.89    10.89    10.89    10.89    10.89    10.89    10.89    10.89
   45.30 CFS        .06      .06
   45.30 ELEV     10.89    10.89

   RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                 3.46 WATERSHED INCHES;      90 CFS-HRS;        7.4 ACRE-FEET.

   DURATION(HRS)   2      4      6      8     10     12     14
   FLOW(CFS)       8      4      3      2      2      2      0

 --- STRUCTURE  1, ALTERNATE  1, STORM 25, HYDROGRAPH ADDED TO READHD FILE ---


OPERATION ADDHYD    XSECTION   2
0

TR20 ------------------------------------------------------------------- SCS -
          NEW CASTLE CO. - AIRPORT/CHURCHMAN'S    2,10,100-YR STORMS    VERSION
04/14/**                    BMP #1 - FLEMING.DAT                       2.04TEST
14:09:30                   PASS   1   JOB NO.   1                      PAGE   5

        INPUT HYDROGRAPHS 3,1     OUTPUT HYDROGRAPH 4

   PEAK TIME(HRS)              PEAK DISCHARGE(CFS)          PEAK ELEVATION(FEET)
      12.29                          68.0                          (NULL)

   RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                 3.15 WATERSHED INCHES;     111 CFS-HRS;        9.2 ACRE-FEET.


OPERATION RUNOFF    XSECTION   3
        OUTPUT HYDROGRAPH =  5      AREA =     .01 SQ MI
        INPUT RUNOFF CURVE = 60.    TIME OF CONCENTRATION =    .30 HOURS
        COMPUTED INTERNAL TIME INCREMENT =  .0400 HOURS

   PEAK TIME(HRS)              PEAK DISCHARGE(CFS)          PEAK ELEVATION(FEET)
      12.09                           8.4                         (RUNOFF)

   RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                 1.73 WATERSHED INCHES;       8 CFS-HRS;         .7 ACRE-FEET.


OPERATION ADDHYD    XSECTION   3
        INPUT HYDROGRAPHS 5,4     OUTPUT HYDROGRAPH 6

   PEAK TIME(HRS)              PEAK DISCHARGE(CFS)          PEAK ELEVATION(FEET)
      12.24                          73.3                          (NULL)

   RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                 2.98 WATERSHED INCHES;     120 CFS-HRS;        9.9 ACRE-FEET.


EXECUTIVE CONTROL  ENDCMP    COMPUTATIONS COMPLETED FOR PASS   1
0

TR20 ------------------------------------------------------------------- SCS -
          NEW CASTLE CO. - AIRPORT/CHURCHMAN'S    2,10,100-YR STORMS    VERSION
04/14/**                    BMP #1 - FLEMING.DAT                       2.04TEST
14:09:30                   SUMMARY, JOB NO.   1                        PAGE   6


                           SUMMARY TABLE 1
                           ---------------
   SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL IN ORDER PERFORMED.
   A CHARACTER FOLLOWING THE PEAK DISCHARGE TIME AND RATE (CFS) INDICATES:
 F-FLAT TOP HYDROGRAPH   T-TRUNCATED HYDROGRAPH   R-RISING TRUNCATED HYDROGRAPH

 XSECTION/  STANDARD                                   PEAK DISCHARGE
 STRUCTURE   CONTROL    DRAINAGE   RUNOFF   ----------------------------------
    ID      OPERATION     AREA     AMOUNT   ELEVATION    TIME      RATE    RATE
                         (SQ MI)   (IN)      (FT)       (HR)      (CFS)   (CSM)

 RAINFALL OF   5.70 inches AND  24.00 hr DURATION, BEGINS AT    .0 hrs.
 RAINTABLE NUMBER  2,    ARC 2
 MAIN TIME INCREMENT   .100 HOURS

   ALTERNATE    1   STORM   25
   ---------------------------
 XSECTION   1  RUNOFF      .01     2.31        ---      12.04       26   2600.0
 STRUCTURE  1  RUNOFF      .04     3.77        ---      12.16       85   2125.0
 STRUCTURE  1  RESVOR      .04     3.46      12.63      12.35       60   1500.0
 XSECTION   2  ADDHYD      .05     3.15        ---      12.29       68   1360.0
 XSECTION   3  RUNOFF      .01     1.73        ---      12.09        8    800.0

 XSECTION   3  ADDHYD      .06     2.98        ---      12.24       73   1216.7
```

```
0
TR20 ---------------------------------------------------------------------- SCS -
        NEW CASTLE CO. - AIRPORT/CHURCHMAN'S    2,10,100-YR STORMS    VERSION
04/14/**                    BMP #1 - FLEMING.DAT                      2.04TEST
14:09:30                    SUMMARY, JOB NO.   1                      PAGE   7

                            SUMMARY TABLE 3
                            ---------------
     STORM DISCHARGES (CFS) AT XSECTIONS AND STRUCTURES FOR ALL ALTERNATES
     QUESTION MARK (?) AFTER: OUTFLOW PEAK - RISING TRUNCATED HYDROGRAPH.

 XSECTION/          DRAINAGE
 STRUCTURE            AREA        STORM NUMBERS..........
   ID               (SQ MI)          25

 STRUCTURE   1         .04
 ---------------------------
    ALTERNATE    1                   60

 XSECTION    1         .01
 ---------------------------
    ALTERNATE    1                   26

 XSECTION    2         .05
 ---------------------------
    ALTERNATE    1                   68

 XSECTION    3         .06
 ---------------------------
    ALTERNATE    1                   73
0
TR20 ---------------------------------------------------------------------- SCS -
        NEW CASTLE CO. - AIRPORT/CHURCHMAN'S    2,10,100-YR STORMS    VERSION
04/14/**                    BMP #1 - FLEMING.DAT                      2.04TEST


END OF  1 JOBS IN THIS RUN


                    SCS  TR-20,  VERSION 2.04TEST
                                   FILES

     INPUT  = C:DITCH2.DAT                          , GIVEN DATA FILE
     OUTPUT = C:DITCH2.OUT                          , DATED 04/14/**,14:09:30

            FILES GENERATED - DATED 04/14/**,14:09:30

    FILE C:DITCH2.TRD CONTAINS READHD INFORMATION

    FILE C:DITCH2.TMG CONTAINS MESSAGE + WARNING INFORMATION


          TOTAL NUMBER OF WARNINGS =   1,  MESSAGES =   1

                     JOB ENDED AT 14:09:30
                 *** TR-20 RUN COMPLETED ***
```

(not used)

PROJECT: AIRPORT / CHURCHMANS

STATION: 93 + 00

SHEET 1 **OF** 1

CULVERT DESIGN FORM

DESIGNER / DATE: JR / 4-21-04

REVIEWER / DATE: /

HYDROLOGICAL DATA

SEE ADD'L SHTS.

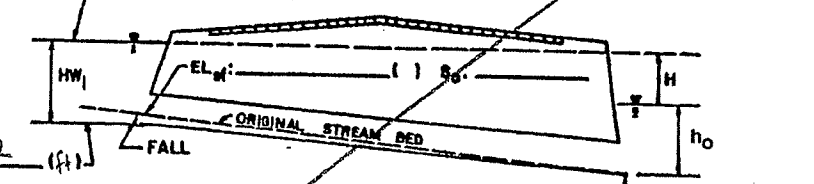
- ☐ METHOD: RATIONAL
- ☐ DRAINAGE AREA: ____ ☐ STREAM SLOPE: ____
- ☐ CHANNEL SHAPE: TRAPEZOIDAL
- ☐ ROUTING: ____ ☐ OTHER: ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
25	73.3	2.91

EL_{hd}: 10.48 (ft)

ROADWAY ELEVATION: 10.98 (ft)



EL_i 5.32 (ft)

EL_o: 4.98 (ft)

$S = S_o - FALL / L_o$

$S =$ 0.533%

$L_o =$ 62.8 ft

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_hi (4)	OUTLET CONTROL TW (5)	d_c	(d_c+D)/2	h_o (6)	k_e	H (7)	EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
DUAL 34" x 22" RCEP	73	36.5	2.0	3.67	0	8.99	2.91	1.71	2.31	2.91	0.2	2.19	10.08	10.08		try round
DUAL 27" RCP	↓	↓	1.73	3.89	0	9.21	2.91	2.05	2.48	2.91	0.2	2.31	10.20	10.20		try smaller
DUAL 24" RCP			2.30	4.60	0	9.92	2.91	1.92	1.96	2.91	0.2	3.90	11.79	X		BAD

(27")

344

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

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

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

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

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

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

(7) $H = \left[1 + k_e + (K_u n^2 L)/R^{1.33}\right] v^2/2g$ WHERE $K_u = 19.63$ (29 IN ENGLISH UNITS)

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

SUBSCRIPT DEFINITIONS:

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

COMMENTS / DISCUSSION:

CULVERT BARREL SELECTED:

SIZE: DUAL 27" RCP

SHAPE: ROUND

MATERIAL: ____ n 0.012

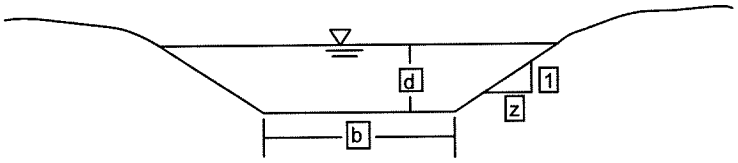
ENTRANCE: ____

34" x 22" : $H = \left[1 + 0.2 + \frac{(29 * (0.012)^2 * 62.8)}{(0.5526)^{1.33}}\right] (8.90)^2 / 2(32.2) = 2.19$

27" : $H = \left[1 + 0.2 + \frac{(29 \times (0.012)^2 \times 62.8)}{(\quad 2)^{1.33}}\right] (9.19)^2 / 2(\quad) = 2.31$

APPENDIX D
Roadside Ditch Computations

Airport/Churchmans
Ultimate Conditions



@ Sta. 127+50, LT.

channel slope, s = 0.03900 ft/ft
manning's n = 0.030
path length, L = 50.0 ft

bottom width, b = 2.0 ft
side slope, z = 2.0

Drainage Area:	1,598 SF	total		
	0 SF	impervious	c =	0.85
	1,598 SF	open space	c =	0.25

C = $[(C_iA_i) + (C_oA_o)]/A_{total}$ = 0.25

t_c = 5 min i_{25} = 8.00 Q_{25} = **0.07** cfs

25 yr flowrate, Q_{25} = 0.07 ft^3/s (TR 20 output from BMP)

d assume depth	a x-section area	p_w wetted perimeter	r hydraulic radius	v velocity	Q flow rate
	$(b+zd)*d$	$2*((zd)^2+d^2)^{0.5}+b$	a/p_w	$1.49/n*r^{2/3}*s^{1/2}$	v*a
(ft)	(ft^2)	(ft)	(ft)	(ft/s)	(ft^3/s)
0.05	0.11	2.22	0.05	1.28	0.13
0.04	0.08	2.18	0.04	1.11	0.09
0.03	0.06	2.13	0.03	0.92	0.06
0.035	0.07	2.16	0.03	1.02	**0.07**

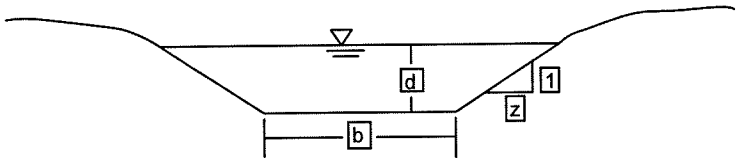
Ditch EL. @	Sta. 127+50, LT.	66.50			
	WSE =	66.54			
Edge of Shoulder Elevation =		67.1			
	Freeboard =	0.56	>	0.5	OK

SRBM Analysis:

T = 62.4*d*S

T =	0.085176	<	2	SRBM TYPE 5

Airport/Churchmans
Ultimate Conditions



@ Sta. 127+00, LT.

channel slope, s = 0.06550 ft/ft
manning's n = 0.030
path length, L = 100.0 ft

bottom width, b = 2.0 ft
side slope, z = 2.0

Drainage Area:	4,469 SF	total		
	0 SF	impervious	c =	0.85
	4,469 SF	open space	c =	0.25

C = $[(C_iA_i) + (C_oA_o)]/A_{total}$ = 0.25

t_c = 5 min i_{25} = 8.00 Q_{25} = **0.21** cfs

25 yr flowrate, Q_{25} = 0.21 ft^3/s (TR 20 output from BMP)

d assume depth	a x-section area	p_w wetted perimeter	r hydraulic radius	v velocity	Q flow rate
	$(b+zd)*d$	$2*((zd)^2+d^2)^{0.5}+b$	a/p_w	$1.49/n*r^{2/3}*s^{1/2}$	v*a
(ft)	(ft^2)	(ft)	(ft)	(ft/s)	(ft^3/s)
0.08	0.17	2.36	0.07	2.23	0.38
0.07	0.15	2.31	0.06	2.05	0.31
0.055	0.12	2.25	0.05	1.76	0.20
0.056	0.12	2.25	0.05	1.78	**0.21**

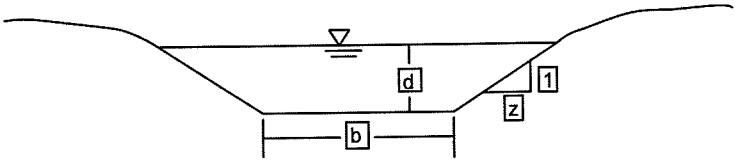
Ditch EL. @	Sta. 127+00, LT.	64.55			
	WSE =	64.61			
Edge of Shoulder Elevation =		65.64			
	Freeboard =	1.03	>	0.5	OK

SRBM Analysis:

T = 62.4*d*S

T =	0.2288832	<	2	SRBM TYPE 5

Airport/Churchmans
Ultimate Conditions



@ Sta. 126+00, LT.

channel slope, s = 0.02250 ft/ft
manning's n = 0.030
path length, L = 100.0 ft

bottom width, b = 2.0 ft
side slope, z = 2.0

Drainage Area:	7,069 SF	total		
	0 SF	impervious	c =	0.85
	7,069 SF	open space	c =	0.25

C = $[(C_iA_i) + (C_oA_o)]/A_{total}$ = 0.25

t_c = 6.6 min i_{25} = 7.58 Q_{25} = **0.31** cfs

25 yr flowrate, Q_{25} = 0.31 ft^3/s (TR 20 output from BMP)

d assume depth	a x-section area	p_w wetted perimeter	r hydraulic radius	v velocity	Q flow rate
	$(b+zd)*d$	$2*((zd)^2+d^2)^{0.5}+b$	a/p_w	$1.49/n*r^{2/3}*s^{1/2}$	v*a
(ft)	(ft^2)	(ft)	(ft)	(ft/s)	(ft^3/s)
0.08	0.17	2.36	0.07	1.30	0.23
0.1	0.22	2.45	0.09	1.50	0.33
0.09	0.20	2.40	0.08	1.40	0.28
0.096	0.21	2.43	0.09	1.46	**0.31**

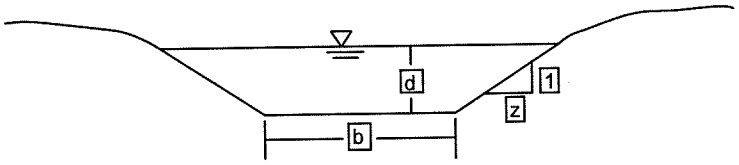
Ditch EL. @	Sta. 126+00, LT.	58.00			
	WSE =	58.10			
Edge of Shoulder Elevation =		61.9			
	Freeboard =	3.80	>	0.5	OK

SRBM Analysis:

T = 62.4*d*S

T =	0.134784	<	2	SRBM TYPE 5

Airport/Churchmans
Ultimate Conditions



@ Sta. 125+00, LT.

channel slope, s = 0.02950 ft/ft
manning's n = 0.030
path length, L = 100.0 ft

bottom width, b = 2.0 ft
side slope, z = 2.0

Drainage Area:				
	9,676 SF	total		
	0 SF	impervious	c =	0.85
	9,676 SF	open space	c =	0.25

C = $[(C_iA_i) + (C_oA_o)]/A_{total}$ = 0.25

t_c = 5 min i_{25} = 8.00 Q_{25} = **0.44** cfs

25 yr flowrate, Q_{25} = 0.44 ft^3/s (TR 20 output from BMP)

d assume depth	a x-section area	p_w wetted perimeter	r hydraulic radius	v velocity	Q flow rate
	(b+zd)*d	$2*((zd)^2+d^2)^{0.5}+b$	a/p_w	$1.49/n*r^{2/3}*s^{1/2}$	v*a
(ft)	(ft^2)	(ft)	(ft)	(ft/s)	(ft^3/s)
0.1	0.22	2.45	0.09	1.71	0.38
0.15	0.35	2.67	0.13	2.18	0.75
0.12	0.27	2.54	0.11	1.91	0.51
0.11	0.24	2.49	0.10	1.81	**0.44**

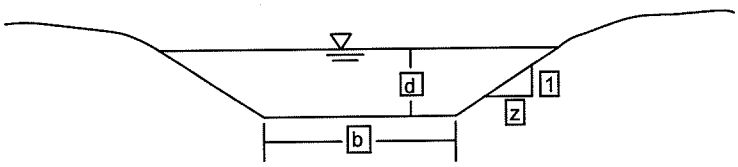
Ditch EL. @	Sta. 125+00, LT.	55.75			
	WSE =	55.86			
Edge of Shoulder Elevation =		59.36			
	Freeboard =	3.50	>	0.5	OK

SRBM Analysis:

T = 62.4*d*S

T =	0.202488	<	2	SRBM TYPE 5

Airport/Churchmans
Ultimate Conditions



@ Sta. 124+00, LT.

channel slope, s = 0.02950 ft/ft
manning's n = 0.030
path length, L = 100.0

bottom width, b = 2.0 ft
side slope, z = 2.0

Drainage Area:	12,096 SF	total		
	0 SF	impervious	c =	0.85
	12,096 SF	open space	c =	0.25

C = $[(C_iA_i) + (C_oA_o)]/A_{total}$ = 0.25

t_c = 5 min i_{25} = 8.00 Q_{25} = **0.56** cfs

25 yr flowrate, Q_{25} = 0.56 ft^3/s (TR 20 output from BMP)

d assume depth	a x-section area	p_w wetted perimeter	r hydraulic radius	v velocity	Q flow rate
	(b+zd)*d	$2*((zd)^2+d^2)^{0.5}+b$	a/p_w	$1.49/n*r^{2/3}*s^{1/2}$	v*a
(ft)	(ft^2)	(ft)	(ft)	(ft/s)	(ft^3/s)
0.1	0.22	2.45	0.09	1.71	0.38
0.15	0.35	2.67	0.13	2.18	0.75
0.13	0.29	2.58	0.11	2.00	0.59
0.126	0.28	2.56	0.11	1.97	**0.56**

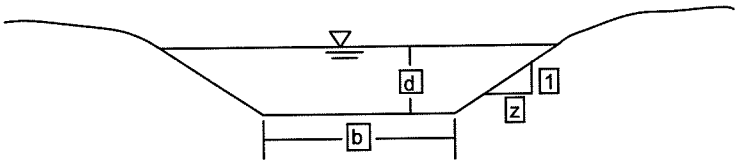
Ditch EL. @	Sta. 124+00, LT.	52.80			
	WSE =	52.93			
Edge of Shoulder Elevation =		56.98			
	Freeboard =	4.05	>	0.5	OK

SRBM Analysis:

T = 62.4*d*S

T =	0.2319408	<	2	SRBM TYPE 5

Airport/Churchmans
Ultimate Conditions



@ Sta. 123+00, LT.

channel slope, s = 0.02650 ft/ft
manning's n = 0.030
path length, L = 180.0 ft

bottom width, b = 2.0 ft
side slope, z = 2.0
100

Drainage Area:				
	14,553 SF	total		
	0 SF	impervious	c =	0.85
	14,553 SF	open space	c =	0.25

C = $[(C_iA_i) + (C_oA_o)]/A_{total}$ = 0.25

t_c = 5 min i_{25} = 8.00 Q_{25} = **0.67** cfs

25 yr flowrate, Q_{25} = 0.67 ft^3/s (TR 20 output from BMP)

d assume depth	a x-section area	p_w wetted perimeter	r hydraulic radius	v velocity	Q flow rate
	(b+zd)*d	$2*((zd)^2+d^2)^{0.5}+b$	a/p_w	$1.49/n*r^{2/3}*s^{1/2}$	v*a
(ft)	(ft^2)	(ft)	(ft)	(ft/s)	(ft^3/s)
0.15	0.35	2.67	0.13	2.07	0.71
0.1	0.22	2.45	0.09	1.62	0.36
0.14	0.32	2.63	0.12	1.98	0.63
0.145	0.33	2.65	0.13	2.03	**0.67**

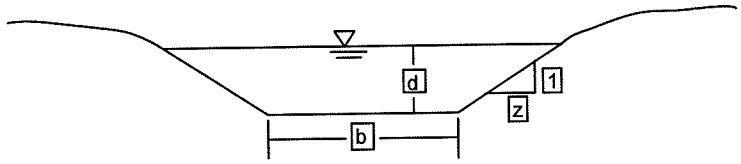
Ditch EL. @	Sta. 123+00, LT.	49.85			
	WSE =	50.00			
Edge of Shoulder Elevation =		54.77			
	Freeboard =	4.78	>	0.5	OK

SRBM Analysis:

T = 62.4*d*S

T =	0.239772	<	2	SRBM TYPE 5

Airport/Churchmans
Ultimate Conditions



@ Sta. 122+00, LT.

channel slope, s = 0.01200 ft/ft
manning's n = 0.030
path length, L = 100.0 ft

bottom width, b = 2.0 ft
side slope, z = 2.0

Drainage Area:				
	17,110 SF	total		
	0 SF	impervious	c =	0.85
	17,110 SF	open space	c =	0.25

C = $[(C_iA_i) + (C_oA_o)]/A_{total}$ = 0.25

t_c = 5 min i_{25} = 8.00 Q_{25} = **0.79** cfs

25 yr flowrate, Q_{25} = 0.79 ft^3/s (TR 20 output from BMP)

d assume depth	a x-section area	p_w wetted perimeter	r hydraulic radius	v velocity	Q flow rate
	(b+zd)*d	$2*((zd)^2+d^2)^{0.5}+b$	a/p_w	$1.49/n*r^{2/3}*s^{1/2}$	v*a
(ft)	(ft^2)	(ft)	(ft)	(ft/s)	(ft^3/s)
0.4	1.12	3.79	0.30	2.41	2.70
0.3	0.78	3.34	0.23	2.06	1.61
0.1	0.22	2.45	0.09	1.09	0.24
0.2	0.48	2.89	0.17	1.64	**0.79**

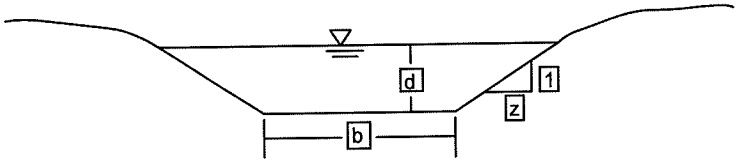
Ditch EL. @	Sta. 122+00, LT.	47.20			
	WSE =	47.40			
Edge of Shoulder Elevation =		52.78			
	Freeboard =	5.38	>	0.5	OK

SRBM Analysis:

T = 62.4*d*S

T =	0.14976	<	2	SRBM TYPE 5

Airport/Churchmans
Ultimate Conditions



@ sta. 121+00, LT.

channel slope, s = 0.01620 ft/ft
manning's n = 0.030
path length, L = 123.0 ft

bottom width, b = 2.0 ft
side slope, z = 2.0

Drainage Area:				
	21,327 SF	total		
	0 SF	impervious	c =	0.85
	21,327 SF	open space	c =	0.25

C = $[(C_iA_i) + (C_oA_o)]/A_{total}$ = 0.25

t_c = 5 min i_{25} = 8.00 Q_{25} = **0.98** cfs

25 yr flowrate, Q_{25} = 0.98 ft^3/s (TR 20 output from BMP)

d assume depth	a x-section area	p_w wetted perimeter	r hydraulic radius	v velocity	Q flow rate
	(b+zd)*d	$2*((zd)^2+d^2)^{0.5}+b$	a/p_w	$1.49/n*r^{2/3}*s^{1/2}$	v*a
(ft)	(ft^2)	(ft)	(ft)	(ft/s)	(ft^3/s)
0.2	0.48	2.89	0.17	1.91	0.92
0.3	0.78	3.34	0.23	2.40	1.87
0.25	0.63	3.12	0.20	2.17	1.35
0.208	0.50	2.93	0.17	1.95	**0.98**

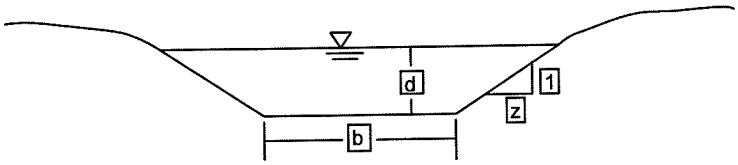
Ditch EL. @	sta. 121+00, LT.	46.00			
	WSE =	46.21			
Edge of Shoulder Elevation =		50.93			
	Freeboard =	4.72	>	0.5	OK

SRBM Analysis:

T = 62.4*d*S

T =	0.21026304	<	2	SRBM TYPE 5

Airport/Churchmans
Ultimate Conditions



@ Sta. 29+00, RT.

channel slope, s = 0.02500 ft/ft
manning's n = 0.030
path length, L = 96.0 ft

bottom width, b = 2.0 ft
side slope, z = 3.0

Drainage Area:				
	24,570 SF	total		
	0 SF	impervious	c =	0.85
	24,570 SF	open space	c =	0.25

C = $[(C_iA_i) + (C_oA_o)]/A_{total}$ = 0.25

t_c = 5 min i_{25} = 8.00 Q_{25} = **1.13** cfs

25 yr flowrate, Q_{25} = 1.13 ft^3/s (TR 20 output from BMP)

d assume depth	a x-section area	p_w wetted perimeter	r hydraulic radius	v velocity	Q flow rate
	(b+zd)*d	$2*((zd)^2+d^2)^{0.5}+b$	a/p_w	$1.49/n*r^{2/3}*s^{1/2}$	v*a
(ft)	(ft^2)	(ft)	(ft)	(ft/s)	(ft^3/s)
0.25	0.69	3.58	0.19	2.61	1.80
0.22	0.59	3.39	0.17	2.43	1.42
0.21	0.55	3.33	0.17	2.37	1.31
0.193	0.50	3.22	0.15	2.26	1.13

Ditch EL. @	Sta. 29+00, RT.	44.00			
	WSE =	44.19			
Edge of Shoulder Elevation =		46.04			
	Freeboard =	1.85	>	0.5	OK

SRBM Analysis:

T = 62.4*d*S

T =	0.30108	<	2	SRBM TYPE 5

APPENDIX E
Storm Drain Inlet Drainage Area Maps

CONTRACT	COUNTY	F.A.P. NO.	SHEET NO.	TOTAL SHTS.
22-III-02	NEW CASTLE	SEE TITLE SHEET	1	4

AIRPORT ROAD/ CHURCHMANS ROAD INTERSECTION IMPROVEMENTS

REVISIONS

STORM DRAIN DRAINAGE AREA MAP

SCALE
0 100 200 300
FEET

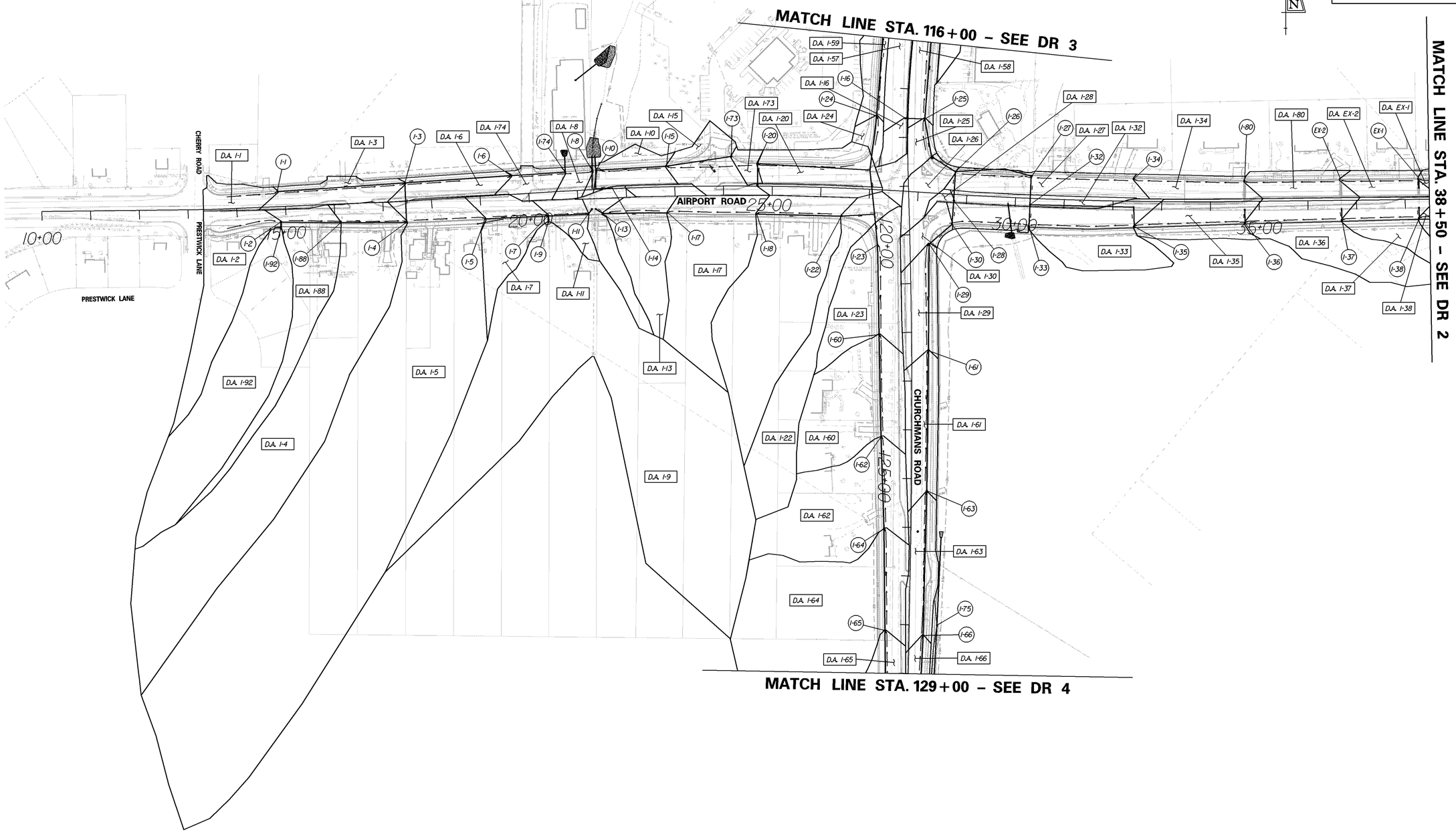
N

LEGEND

(I-X) PROPOSED INLET

(EX-X) EXISTING INLET OR MANHOLE TO REMAIN

D.A. X-X DRAINAGE AREA



PREL. TRACING ____ J.A.D. ____ DESIGN ____ R.R.W./K.M.F. ____ CHKD. ____ J.M.P. ____

9/16/2008

m:\3153302\AIRPORT CHURCHMANS DAMAPS\drainagemapl.dgn

CONTRACT	COUNTY	F.A.P. NO.	SHEET NO.	TOTAL SHTS.
22-III-02	NEW CASTLE	SEE TITLE SHEET	2	4

AIRPORT ROAD/ CHURCHMANS ROAD INTERSECTION IMPROVEMENTS

REVISIONS

STORM DRAIN DRAINAGE AREA MAP

SCALE

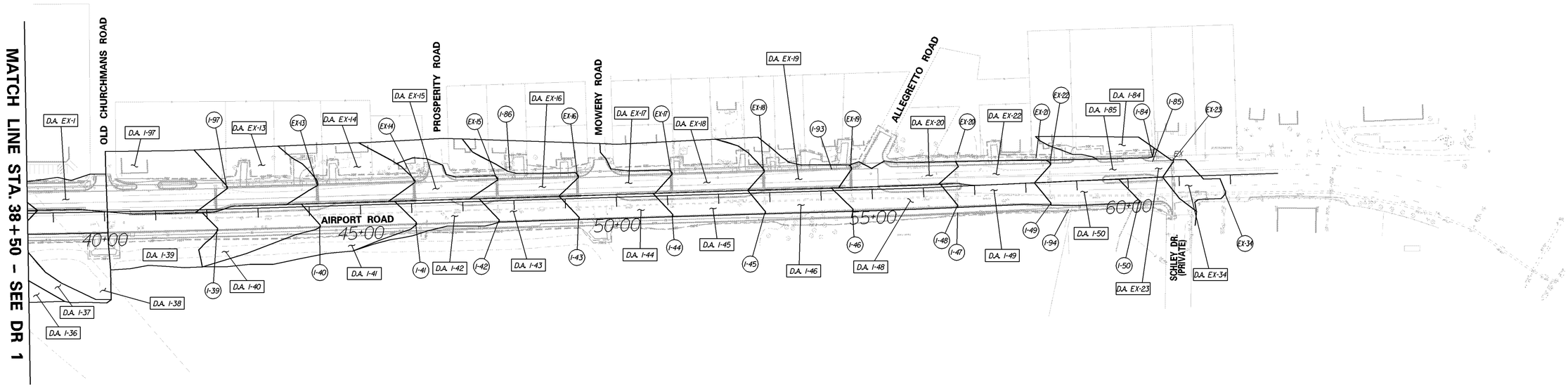
0 100 200 300

FEET

N

LEGEND

- (I-X) PROPOSED INLET
- (EX-X) EXISTING INLET OR MANHOLE TO REMAIN
- [D.A. X-X] DRAINAGE AREA



PREL. TRACING _____ J.A.D. _____ DESIGN _____ R.R.W./K.M.F. _____ CHKD. _____ J.M.P. _____

CONTRACT	COUNTY	F.A.P. NO.	SHEET NO.	TOTAL SHTS.
22-III-02	NEW CASTLE	SEE TITLE SHEET	3	4

AIRPORT ROAD/ CHURCHMANS ROAD INTERSECTION IMPROVEMENTS

REVISIONS

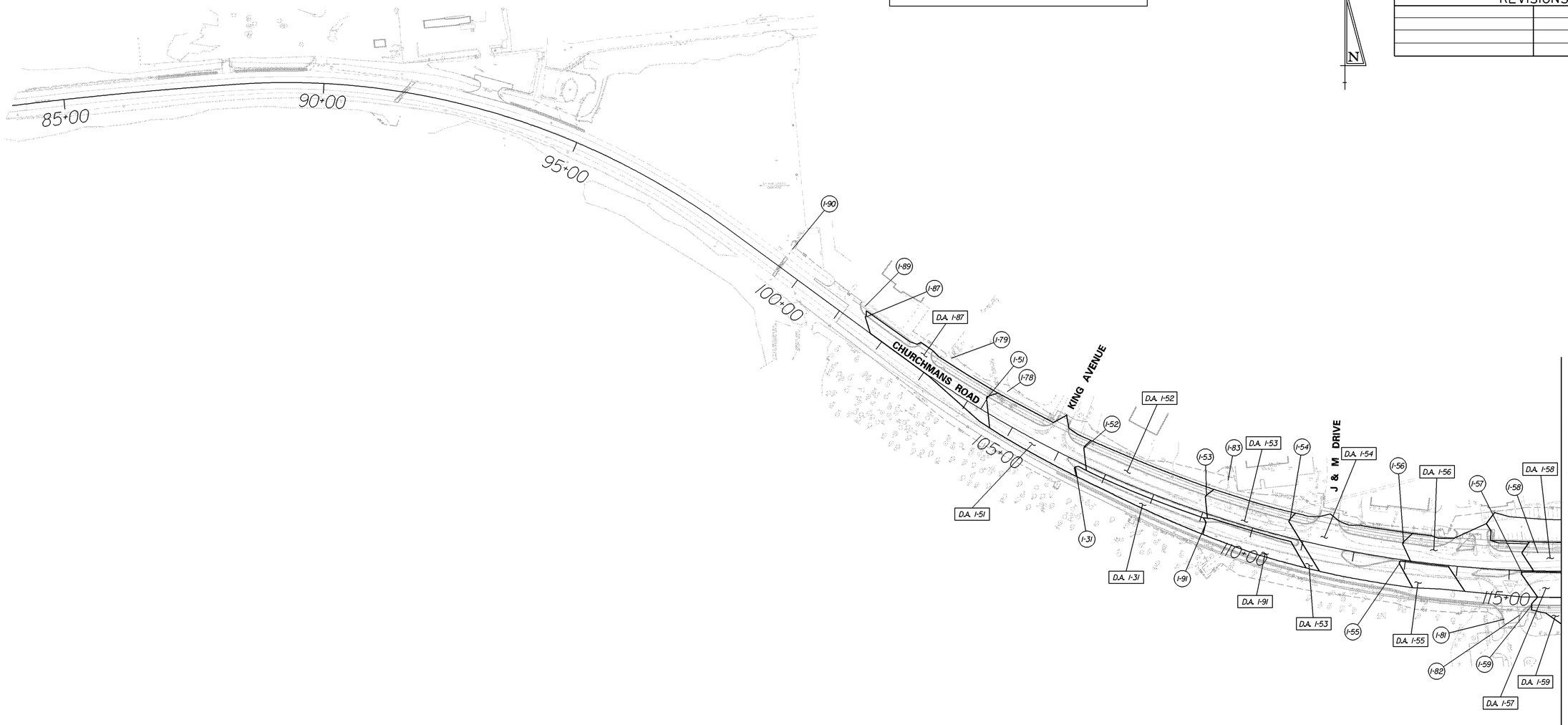
STORM DRAINAGE AREA MAP

SCALE
0 100 200 300
FEET

N

LEGEND

- (I-X) PROPOSED INLET
- (EX-X) EXISTING INLET OR MANHOLE TO REMAIN
- [D.A. X-X] DRAINAGE AREA



MATCH LINE STA. 116+00 – SEE DR 3

PREL. TRACING _____ J.A.D. _____ DESIGN _____ R.R.W./K.M.F. _____ CHK'D. _____ J.M.P. _____

9/16/2008

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CONTRACT	COUNTY	F.A.P. NO.	SHEET NO.	TOTAL SHTS.
22-III-02	NEW CASTLE	SEE TITLE SHEET	4	4

AIRPORT ROAD/ CHURCHMANS ROAD INTERSECTION IMPROVEMENTS

REVISIONS

STORM DRAIN DRAINAGE AREA MAP

SCALE

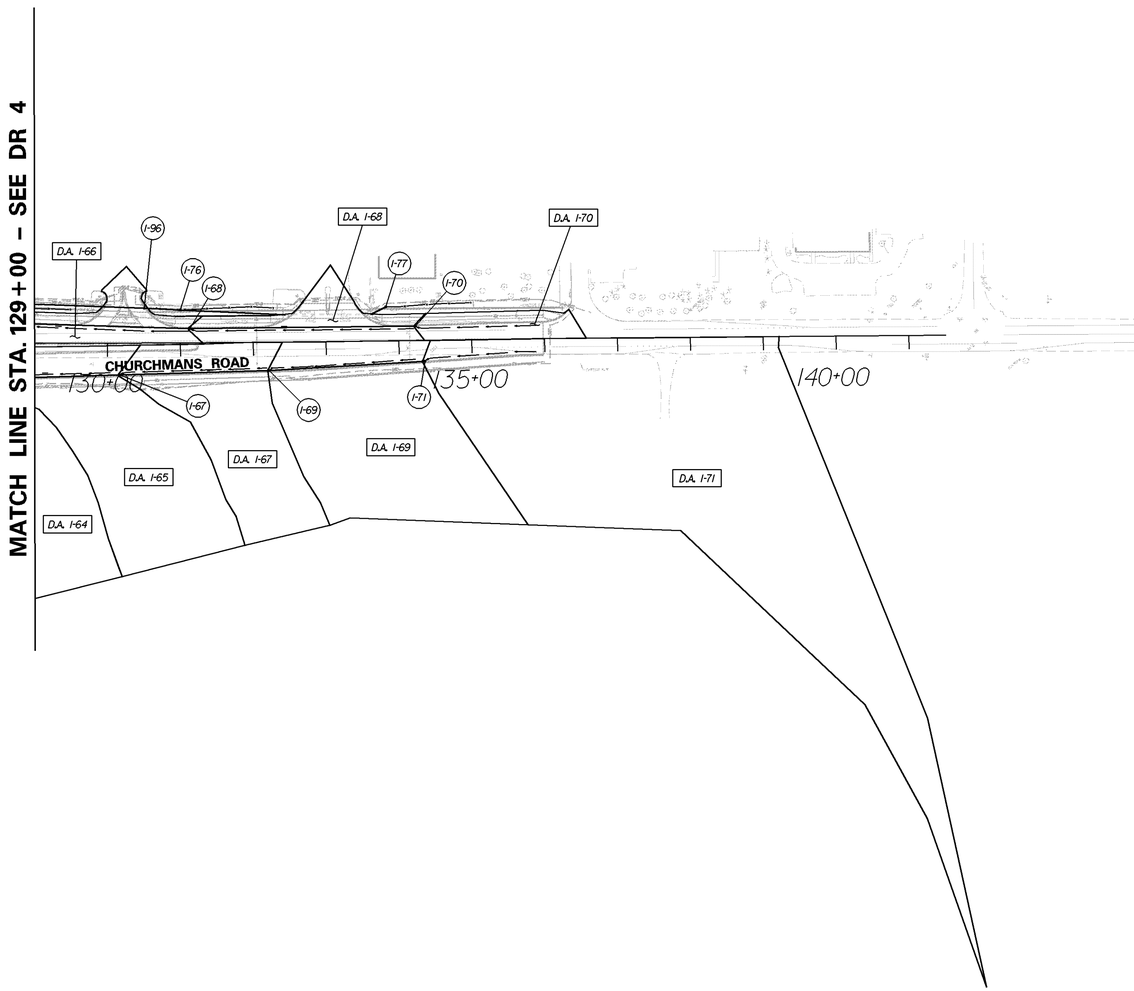
0 100 200 300

FEET

N

LEGEND

- (I-X) *PROPOSED INLET*
- (EX-X) *EXISTING INLET OR MANHOLE TO REMAIN*
- [D.A. X-X] *DRAINAGE AREA*



PRELI. TRACING _____ J.A.D. _____ DESIGN _____ R.R.W./K.M.F. _____ CHK'D. _____ J.M.P. _____

9/16/2008

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