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DYSART ROAD

WORK ORDER NO. 68644

FINAL DRAINAGE CALCULATIONS

(REVISED)

APRIL 12, 1993

Registered Professional Engineer (Civil)
CERTIFICATE NO. 11855
MARTIN H. ROSNESS
DATE SIGNED 4/15/93
Arizona U.S.A.

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SUMMARY

The following are the drainage calculations for the Dysart Road Project (RID Canal to Camelback Road) (MCDOT Work Order No. 68644) which are divided into onsite and offsite calculations.

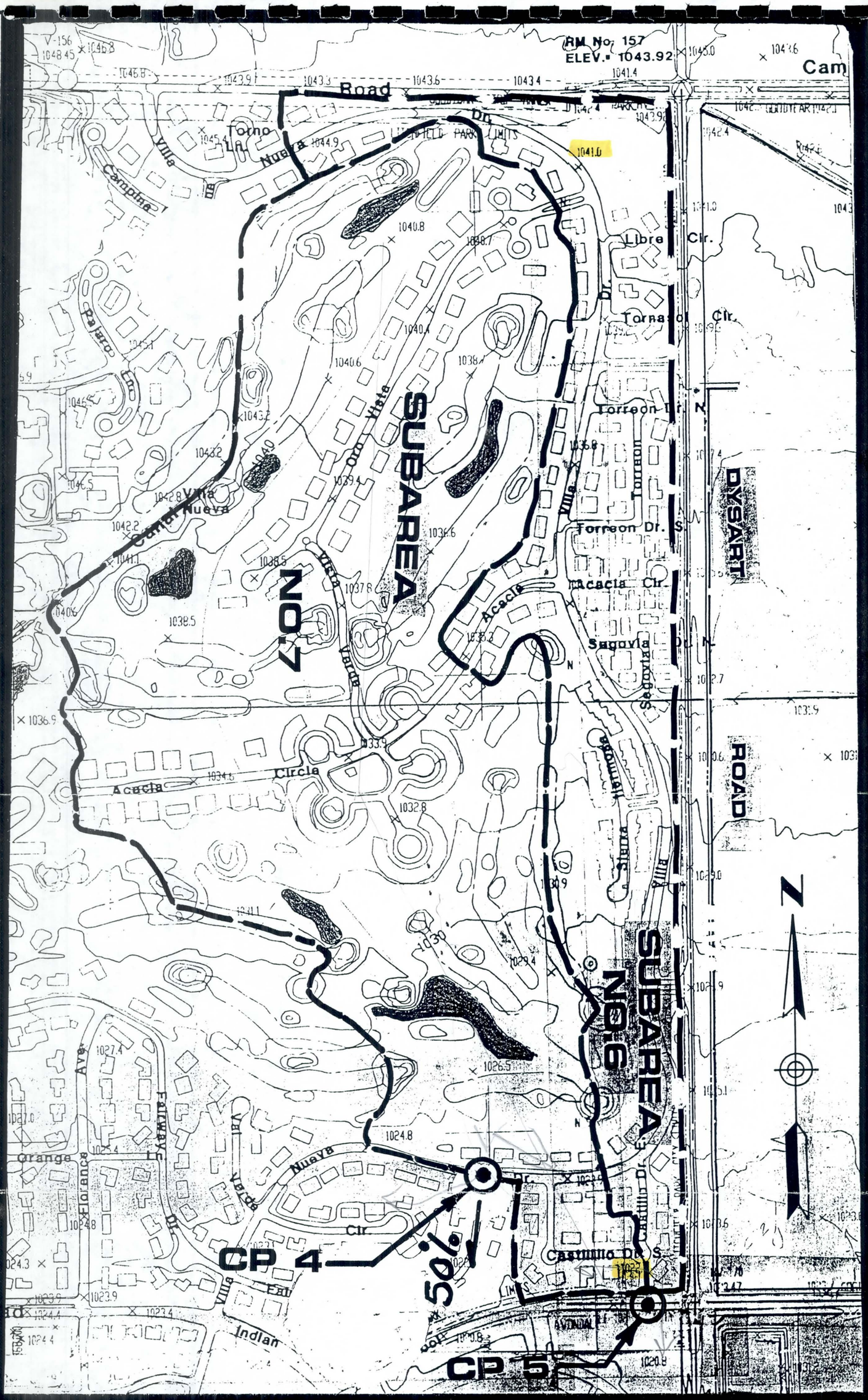
Initially, the entire watershed that presently drains towards this section of Dysart Road was considered in a Hydrological Study, and a HEC-1 analysis was performed for 3 different storm frequencies of 10, 50 and 100 years. The results of this study were submitted to the County for review and comment. It indicated that the 100 year runoff volume at the south end of this project would be 668 cfs. The northern boundary of the drainage area was Camelback Road since all runoff north of Camelback was assumed to flow either to the proposed Colter Channel or the Camelback Road Channel. After review, it was decided by the County that with the exception of a portion of the City of Litchfield Park development west of Dysart Road, which presently drains to the intersection of Indian School Road and Dysart Road, all of the other offsite drainage areas would not be considered in the drainage analysis. The main areas that were eliminated were the agricultural areas east of Dysart Road. It was assumed they would have on-site retention when developed and any 100 year storms would overflow the roadway as they currently do.

Thus a 100 year peak flow of 238 cfs (188 cfs offsite + 50 cfs roadway r/w) was used to size the Dysart Channel and culverts along it, from Indian School Road south to the RID Canal on the west side of Dysart Road. This 100 year peak flow is the runoff from eastern portions of the City of Litchfield Park. For the remaining portions of the project, the 10 year storm and the Rational Method were used to compute the runoff generated within the roadway right-of-way. Drainage structures along the roadway were sized accordingly.

In general, catch basins, storm drain laterals and roadside ditches were sized to accommodate the right-of-way drainage and transport it to the northwest corner of the RID Canal and Dysart Road. From there it will be transported in a channel westerly to SunCor property. Pipe culverts and an inlet structure were sized to intercept the offsite 100 year flow from the City of Litchfield Park northwest of the Indian School Road and Dysart Road intersection. It is transported under Indian School Road and into an open channel (Dysart Channel). From there it flows southerly along the west side of Dysart Road to the SunCor channel.

The calculations provided hereafter begin at the upstream end of the project (Camelback Road) and continue downstream to the RID Canal. The peak flow has been computed at the confluence point of each subdrainage area which is also the inlet of a new drainage structure.

Drainage Areas No. 11 and 12, located north of Camelback Road and south of Colter Street, were added to the report by a change order. These two right-of-way areas drain into an existing channel along Camelback Road and will not affect the drainage system proposed to the south of Camelback Road.



OFF-SITE DRAINAGE MAP

SCALE: 1" = 400'

DYRAST ROAD
R.I.D. CANAL TO CAMELBACK ROAD
WORK ORDER NO. 68644

Z & H ENGINEERING, INC.

ON-SITE DRAINAGE

Z & H ENGINEERING, INC.
717 West Dunlap Avenue
PHOENIX, ARIZONA 85021
(602) 997-7536

JOB Dysart Rd. (68644)
SHEET NO. _____ OF _____
CALCULATED BY SHM DATE 7/92
CHECKED BY _____ DATE _____
SCALE _____

DRAINAGE AREA No. 1. (Sta. 192+68 to Sta. 205+57 Rt.)

$$\text{Area} = [(80-22)(1289)](1/43560) = 1.72 \text{ Acres}$$

$$\text{Runoff Coef.} = C_W = \frac{(0.9)(28)+(0.5)(30)}{58} = 0.69$$

$$i = i_p \frac{P_{10}^6}{2.07} = i_p\left(\frac{2.0}{2.07}\right) = 0.97\, i_p$$

Try $T_c = 10$ min $\Rightarrow i_{p(10\,year)} = 4.5$ in/hr $\Rightarrow i = (0.97)(4.5) = 4.37$ in/hr

$$\therefore T_c = 11.4\, L^{0.5} K_b^{0.52} S^{-0.31} i^{-0.38}$$

$L = 1289/5280 = 0.244$ mile

$K_b = m \log A + b = -0.00625 \log 10.2 + 0.04 = 0.034$

$S = (43.44 - 34.74)/(0.244) = 35.66$ ft/mile

$$\Rightarrow T_c = (11.4)(0.244)^{0.5}(0.034)^{0.52}(35.66)^{-0.31}(i)^{-0.38} = 0.32\, i^{-0.38}$$

$i = 4.37$ in/hr $\Rightarrow T_c = 0.18$ hr $= 11$ min. O.K.

$$\Rightarrow Q_{10} = CIA = (0.69)(4.37)(1.72) = 5.2 \text{ cfs}$$

Install 18" CMP w/ End Sections ✓

See Culvert Design Form for Calc's

PRODUCT 204-1 NEBS Inc. Groton, Mass. 01471

PROJECT: Dysart Road (68644)
D.A #1 & #12

STATION: 192+48 Rt.

SHEET ____ OF ____

CULVERT DESIGN FORM

DESIGNER / DATE: SHM / 7/92

REVIEWER / DATE: ____ / ____

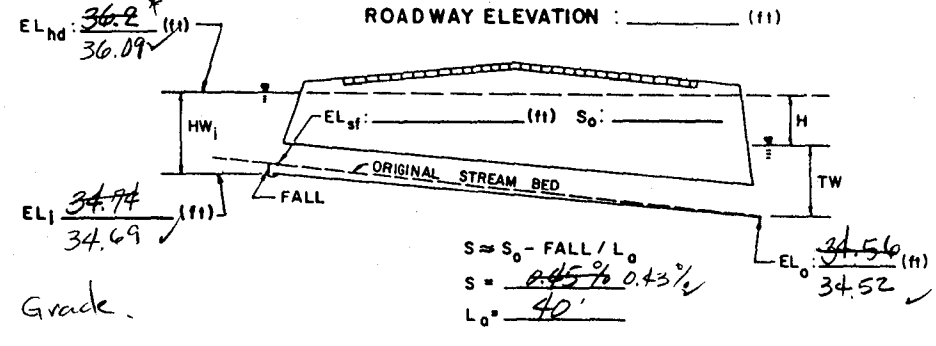
HYDROLOGICAL DATA

SEE ADD'L. SHTS.

- ☐ METHOD: Rational
- ☐ DRAINAGE AREA: 1.72 Ac ☐ STREAM SLOPE: 0.44 %
- ☐ CHANNEL SHAPE: Triangular
- ☐ ROUTING: ____ ☐ OTHER: ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	5.2	0.6



* E/P Grade.

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE

CULVERT DESCRIPTION	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HW i/D (2)	HW i	FALL (3)	EL hi (4)	TW (5)	d c	(d c + D)/2	h o (6)	k e	H (7)	EL ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
			INLET CONTROL				OUTLET CONTROL									
Cmp, Circ., 18", End Section	5.2	—	0.87	1.31	—	~~36.15~~	0.6	0.8	1.15	1.15	0.5	0.3	~~36.0~~	~~36.05~~	4.3	ok.
						36.00							35.97	36.00		

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_1/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) $H = \left[1 + k_e + (29 n^2 L)/R^{1.33}\right] V^2/2g$

(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:

HELICAL CORRUGATION ONLY

CULVERT BARREL SELECTED:

SIZE: 18" cmp
SHAPE: Circular
MATERIAL: Cmp n 0.013
ENTRANCE: End Section

240

P.4

Z & H ENGINEERING, INC.
717 West Dunlap Avenue
PHOENIX, ARIZONA 85021
(602) 997-7536

JOB DYSART RD (68644)
SHEET NO. _____ OF _____
CALCULATED BY SHM DATE 7/92
CHECKED BY _____ DATE _____
SCALE _____

DRAINAGE AREA No. 2. (Sta. 179+38 to Sta 205+57 Rt.)

Area $= [(80-22)(2619)](1/43560) = 3.49$ Acres

Runoff Coef., $C_N = 0.69$ (Same as D.A No. 1.)

Rainfall intensity, $i = 0.97\, i_p$

$$T_c = 11.4\, L^{0.5}\, K_b^{0.52}\, S^{-0.31}\, i^{-0.38}$$

$L = 2619/5280 = 0.496$ mile
$K_b = 0.034$
$S = (43.44 - 28.97)/(0.496) = 29.17$ ft/mile

$$\therefore T_c = 11.4\,(0.496)^{0.5}(0.034)^{0.52}(29.17)^{-0.31}\, i^{-0.38} = 0.486\, i^{-0.38}$$

Try $T_c = 20$ min $\Rightarrow i_p = 3.25 \Rightarrow i = 3.15$ in/hr

$\therefore T_c = 0.486(3.15)^{-0.38} = 0.314$ hr $= 18.8$ min. < 20 min

Try $T_c = 19$ min $\Rightarrow i_p = 3.30 \Rightarrow i = 3.20$ in/hr

$\therefore T_c = 0.486(3.20)^{-0.38} = 0.312$ hr $= 18.7$ min OK.

$\Rightarrow Q_{10} = CIA = (0.69)(3.20)(3.49) = 7.7$ cfs

Install ~~18"~~ 24" x 18" ✓ CMPA w/ End sections

See Culvert Design form for Calc's

PRODUCT 204-1 NEBS Inc. Groton, Mass. 01471

PROJECT: DESERT RD (68644)
D.A. #2

STATION: 177+18 Rt.

SHEET ____ OF ____

CULVERT DESIGN FORM

DESIGNER / DATE: SHM / 7/92

REVIEWER / DATE: ____ / ____

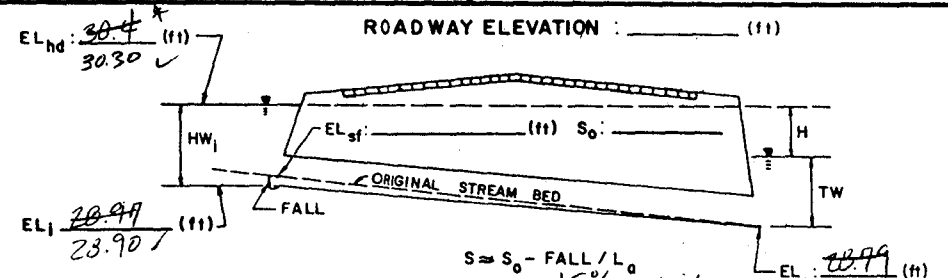
HYDROLOGICAL DATA

SEE ADD'L. SHTS.

- ☐ METHOD: Rational
- ☐ DRAINAGE AREA: 3.49 ☐ STREAM SLOPE: 0.44%
- ☐ CHANNEL SHAPE: Triangular
- ☐ ROUTING: ____ ☐ OTHER: ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	7.7	0.70'



* E/P Grade

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
CMP - Circ. - 18" - Endsection	7.7	-	1.15	1.72	-	~~30.90~~ 30.62	0.7	1.1	1.3	1.3	0.5	0.65	~~30.94~~ 30.68	~~31.94~~ 30.68	4.0	Try 24x18" CMPA
CMPA - Arch - 24"x18" - Endsection	7.7	-	1.00	1.5	-	30.40	0.7	0.78	1.14	1.14	0.5	0.50	30.37	30.40	4.0	OK

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

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

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

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

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

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

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

(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:

HELICAL CORRUGATION ONLY.

Some Driveway overtopping @ low pt.

CULVERT BARREL SELECTED:

SIZE: 24" x 18"
SHAPE: Arch Pipe
MATERIAL: CMPA n 0.013
ENTRANCE: End Section

240

P.6

Z & H ENGINEERING, INC.
717 West Dunlap Avenue
PHOENIX, ARIZONA 85021
(602) 997-7536

JOB Dysart Rd. (68644)
SHEET NO. ____ OF ____
CALCULATED BY SHM DATE 7/92
CHECKED BY ____ DATE ____
SCALE ____

DRAINAGE AREA NO. 3 (Sta. 108+79 to 205+57 Rt.)

Area = [(80 − 22)(3678)](1/43560) = 4.90 Acre

Runoff Coef., C_N = 0.69

Rainfall Intensity, i = 0.97 i_p

$$T_c = 11.4\, L^{0.5}\, K_b^{0.52}\, S^{-0.31}\, i^{-0.38}$$

L = 3678/5280 = 0.700 mile
K_b = 0.034
S = (43.44 − 24.33)/0.700 = 27.3 ft/mile

$$\therefore\ T_c = 11.4\,(0.700)^{0.5}(0.034)^{0.52}(27.3)^{-0.3}\, i^{-0.38} = 0.610\, i^{-0.38}$$

Try T_c = 25 min ⇒ i_p = 2.8 in/hr ⇒ i = 2.72 in/hr

$$\therefore\ T_c = 0.610\,(2.72)^{-0.38} = 0.42 \text{ hr} = 25.2 \text{ min} \quad \text{Ok}$$

$$\Rightarrow Q = CIA = (0.69)(2.72)(4.90) = 9.2 \text{ cfs}$$

Install 28" x 20" ✓ cmpA w/ End Sections

See Culvert Design Form for Calcs

P.7

PROJECT: DYSART RD (68644)
D.A. #3

STATION: 168+59 Rt.

SHEET ____ OF ____

CULVERT DESIGN FORM

DESIGNER / DATE: SHM / 9/92

REVIEWER / DATE: ____ / ____

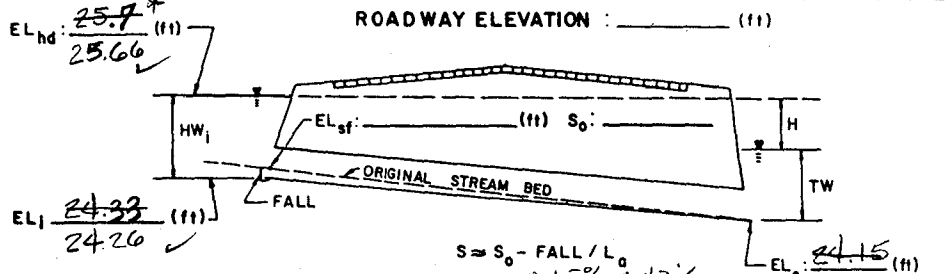
HYDROLOGICAL DATA

SEE ADD'L. SHTS.

- ☐ METHOD: Rational
- ☐ DRAINAGE AREA: 4.9 ☐ STREAM SLOPE: 0.44
- ☐ CHANNEL SHAPE: Triangular
- ☐ ROUTING: ____ ☐ OTHER: ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	9.2	



* E/P Grade

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
Cmp - Arch - 28"x20" - End Section	9.2	-	0.88	1.47	-	~~25.8~~	0.75	0.8	1.23	1.23	0.5	0.4	~~25.48~~	~~25.8~~	4.2	OK
						25.73							25.92	25.73		

Q_{full} = 10.8

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

(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:

HELICAL CORRUGATION ONLY

Some Driveway Overtopping at low pt.

CULVERT BARREL SELECTED:

SIZE: 28"x20"

SHAPE: Arch

MATERIAL: Cmp n 0.016

ENTRANCE: End Section

240

P.B

Z & H ENGINEERING, INC.
717 West Dunlap Avenue
PHOENIX, ARIZONA 85021
(602) 997-7536

JOB DYSART RD (68644)
SHEET NO. ____ OF ____
CALCULATED BY SHM DATE 7/92
CHECKED BY ____ DATE ____
SCALE ____

DRAINAGE AREA NO. 4 (Sta 152+80 to Sta 205+57 Rt.)

$$\text{Area} = [(80-22)(5277) + (55)(2500)](1/43560) = 10.2 \text{ Acres}$$

$$\text{Runoff Coef.} = C_W = \frac{(C_{W1})(A_1) + (C_{W2})(A_2)}{A_1 + A_2}$$

$A_1 = (58)(5277)(1/43560) = 7.03$ Ac
$A_2 = (55)(2500)(1/43560) = 3.16$ Ac

$C_{W1} = 0.69$

$$C_{W2} = \frac{(0.9)(24) + (1.5)(31)}{55} = 0.67 \Rightarrow C_W = \frac{(0.69)(7.03) + (0.67)(3.16)}{10.2} = 0.68$$

$i = 0.97\, i_p$

$$T_c = 11.4\, L^{0.5}\, K_b^{0.52}\, S^{-0.31}\, i^{-0.38}$$

$L = 5277/5280 = 1.0$ mile
$K_b = 0.034$
$S = (43.44 - 20.30)/(1.0) = 23.14$ ft/mile

$$\therefore T_c = 11.4(1.0)^{0.5}(0.034)^{0.52}(23.14)^{-0.31}(i)^{-0.38} = 0.742\, i^{-0.38}$$

Try $T_c = 30$ min $\Rightarrow i_p = 2.5$ in/hr $\Rightarrow i = 2.43$ in/hr

$$\therefore T_c = (0.742)(2.43)^{-0.38} = 0.53 \text{ hr} = 31.8 \text{ min}$$

Try $T_c = 33$ min $\Rightarrow i_p = 2.3$ in/hr $\Rightarrow i = 2.22$ in/hr

$$\therefore T_c = (0.742)(2.22)^{-0.38} = 0.55 \text{ hr} = 33 \text{ min} \quad \text{Ok.}$$

$$\Rightarrow Q = CIA = (0.68)(2.22)(10.2) = 15.4 \text{ cfs}$$

Use ~~38" x 24" HERCP~~ 24" RGRCP ✓ w/ Catch Basins at inlet & outlet
See Culvert Design Form for Calcs

PRODUCT 204-1 NEBS Inc. Groton Mass. 01471

PROJECT: DYSART RD (68644)
D.A. #4

STATION: 152+80 Rt.
Sta 11+12 I.S. Rd.
SHEET ____ OF ____

CULVERT DESIGN FORM

DESIGNER / DATE: SHM / 7/92
REVIEWER / DATE: ____ / ____

HYDROLOGICAL DATA

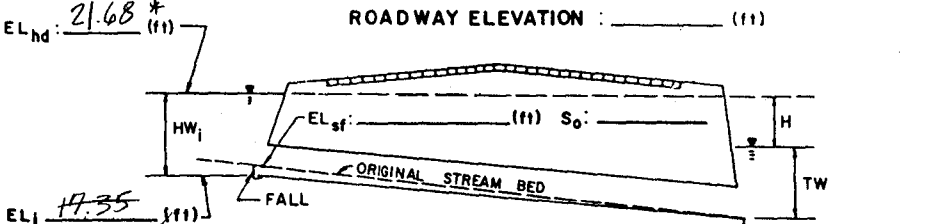
SEE ADD'L. SHTS.

- ☐ METHOD: RATIONAL
- ☐ DRAINAGE AREA: 10.2 ☐ STREAM SLOPE: –
- ☐ CHANNEL SHAPE: ____
- ☐ ROUTING: ____ ☐ OTHER: ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	15.4	2.00 **

** Full Flow Condition



$S \approx S_o$ - FALL / L_o
S = 0.005'/ft
L_o = 87.5'

* E/p Grade @ I.S. Rd. (B.C.R.)

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
Conc. - Circ. - 24" - HWL w/ Groove End	15.4	-	1.08	2.16	–	19.51	2.00	1.5	1.75	2.00	0.2	0.82	19.73	19.73	4.9	OK

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

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

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

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

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

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

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

(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
st. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION:

outlet velocity computed for full flow condition

CULVERT BARREL SELECTED:

SIZE: 24"
SHAPE: Circular
MATERIAL: Conc. n 0.012
ENTRANCE: HWL W/Groove End

240

P.10

Z & H ENGINEERING, INC.
717 West Dunlap Avenue
PHOENIX, ARIZONA 85021
(602) 997-7536

JOB
SHEET NO. OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

DRAINAGE AREA No. 5 (Sta. 152+35 to 205+57 Rt.)

This Area is the Same as D.A. No. 4 Except the Area which includes the South half of the Indian School Rd.

The T_c, intensity & Runoff Coef. are the Same as D.A. No. 4.

Area = 10.2 + (55)(2500)(1/43560) = 13.4 Acres

Q_{10} = CIA = (0.68)(2.22)(13.4) = 20.2 cfs

Use 30" RCRCP w/ catch basin @ inlet & MH at outlet (See Culvert Design form for Calc's)

DRAINAGE AREA No. 5A

(South 55' R/W of the Indian school Rd draining west to New C.B.)

Area = (55)(2500)(1/43560) = 3.16 AC.

C_W = 0.67 (See D.A. No. 4)

$i = 0.97\, i_p$

$T_c = 11.4\, L^{0.5} K_b^{0.52} S^{-0.31} i^{-0.38}$

L = 2500/5280 = 0.47 mile

K_b = 0.034

S = (27.0 − 20.60)/(0.47) = 13.62 ft/mile

$\therefore T_c = 11.4(0.47)^{0.5}(0.034)^{0.52}(13.62)^{-0.31} i^{-0.38} = 0.60\, i^{-0.38}$

Try T_c = 25 min ⇒ i_p = 2.8 in/hr ⇒ i = 2.72 in/hr

$\therefore T_c = 0.60(2.72)^{-0.38} = 0.41$ hr = 24.6 min OK

Q_{10} = CIA = (0.67)(2.72)(3.16) = 5.8 cfs

PRODUCT 204-1 NEBS Inc. Groton, Mass. 01471

PROJECT: DYSART RD (68644)
D.A. #5

STATION: 152+15

SHEET ____ OF ____

CULVERT DESIGN FORM

DESIGNER / DATE: SHM / 7/92

REVIEWER / DATE: ____ / ____

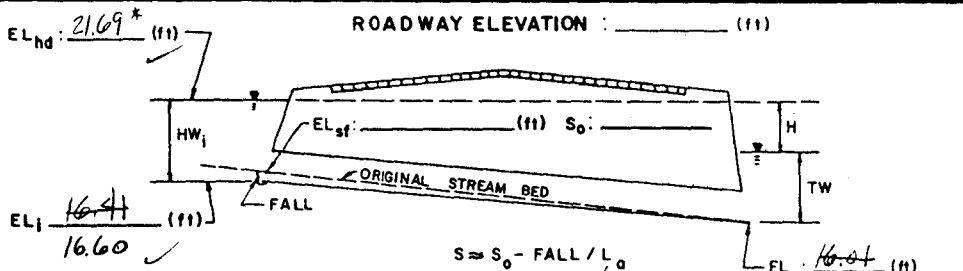
HYDROLOGICAL DATA

SEE ADD'L. SHTS.

- ☐ METHOD: RATIONAL
- ☐ DRAINAGE AREA: 13.4 ☐ STREAM SLOPE: ____
- ☐ CHANNEL SHAPE: ____
- ☐ ROUTING: ____ ☐ OTHER: ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	20.2	2.5' **
		** Full Flow Condition



$S \approx S_o - FALL / L_a$

$S = 0.0025'/ft$

$L_a = 160.4$

Flp Grade @ I.S. Rd (E.C.R.)

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
Conc. - Circ - 30" - HWL W/ Groove end	20.2	—	0.88	2.20	—	18.61	2.5	1.6	2.0	2.5	0.2	0.68	19.19	19.19	4.1	Ok.

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

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

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

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

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

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

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

(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:

outlet velocity computed for full flow condition

CULVERT BARREL SELECTED:

SIZE: 30"
SHAPE: Circular
MATERIAL: Conc n 0.012
ENTRANCE: HWL W/ Groove end

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(602) 997-7536

JOB DYSART RD (68604)
SHEET NO. _____ OF _____
CALCULATED BY SHM DATE 7/92
CHECKED BY _____ DATE _____
SCALE _____

DRAINAGE AREA NO. 6 (Sta. 194+23 to 205+57 Lt.)

$$\text{Area} = [(55+22)(1134)](1/43560) = 2.0 \text{ Acres}$$

$$\text{Runoff Coef.} = C_N = \frac{(0.9)(28)+(0.5)(49)}{77} = 0.65$$

$$i = 0.97\, i_p$$

$$T_c = 11.4\, L^{0.5}\, K_b^{0.52}\, S^{-0.31}\, i^{-0.38}$$

$L = 1134/5280 = 0.215$ mile
$K_b = 0.034$
$S = (43.44 - 33.92)(0.215) = 44.3$ ft/mile

$$\therefore T_c = 11.4(0.215)^{0.5}(0.034)^{0.52}(44.3)^{-0.31}(i)^{-0.38} = 0.281\,(i)^{-0.38}$$

Try $T_c = 10$ min $\Rightarrow i_p = 4.5$ in/hr $\Rightarrow i = (0.97)(4.5) = 4.37$ in/hr

$$\therefore T_c = (0.281)(4.37)^{-0.38} = 0.16 \text{ hr} = 9.6 \text{ min} \quad \text{OK}$$

$$Q = C_N I A = (0.65)(4.37)(2.00) = 5.7 \text{ cfs}$$

USE 18" ✓ Cmp w/ End Sections

See Culvert Design Form for Calc's

PRODUCT 204-1 NEBS Inc., Groton, Mass. 01471.

PROJECT: DYSART RD. (68644)
D.A. #6

STATION: 193+70 Lt.
SHEET ____ OF ____

CULVERT DESIGN FORM
DESIGNER / DATE: SHM / 7/92
REVIEWER / DATE: ____ / ____

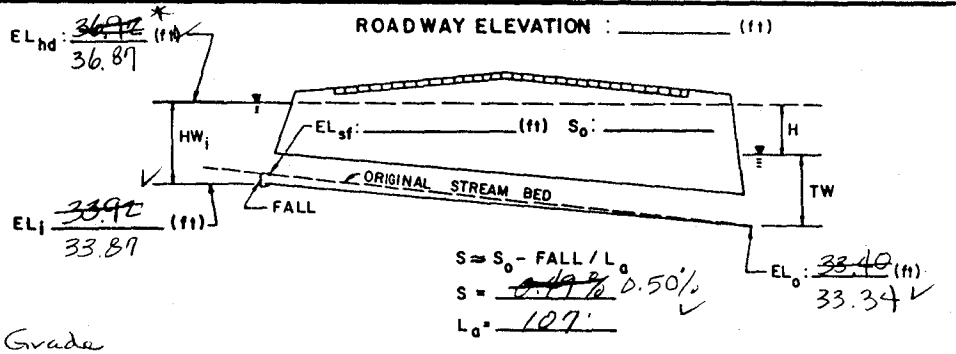
HYDROLOGICAL DATA

SEE ADD'L. SHTS.

- ☐ METHOD: RATIONAL
- ☐ DRAINAGE AREA: 2.0 Ac ☐ STREAM SLOPE: 0.44%
- ☐ CHANNEL SHAPE: Triangular
- ☐ ROUTING: ____ ☐ OTHER: ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	5.7	0.87'



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
Cmp - Circ - 18" - End Section	5.7	-	0.92	1.38	-	~~35.3~~ 35.25	0.87	1.0	1.25	1.25	0.5	0.10	~~35.25~~ 35.19	~~35.3~~ 35.25	4.6	ok.

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_f/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) $H = \left[1 + k_e + (29 n^2 L)/R^{1.33}\right] V^2/2g$

(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:

HELICAL CORRUGATION ONLY

CULVERT BARREL SELECTED:

SIZE: 18"
SHAPE: Circular
MATERIAL: Cmp n 0.013
ENTRANCE: End Section

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PHOENIX, ARIZONA 85021
(602) 997-7536

JOB DYSART RD (68644)
SHEET NO. ____ OF ____
CALCULATED BY SHM DATE 7/92
CHECKED BY ____ DATE ____
SCALE ____

DRAINAGE AREA NO. 7 (Sta. 167+26 to 205+57 Lt.)

$Area = [(55+22)(3831)](1/43560) = 6.8$ AC

Runoff coef. $= C_w = 0.65$

$i = 0.97\, i_p$

$T_c = 11.4\, L^{0.5}\, K_b^{0.52}\, S^{-0.31}\, i^{-0.38}$

$L = 3831/5280 = 0.726$ mile
$K_b = 0.034$
$S = (43.44 - 22.06)/0.726 = 29.4$ ft/mile

$\therefore T_c = 11.4(0.726)^{0.5}(0.034)^{0.52}(29.4)^{-0.31}\, i^{-0.38} = 0.587\, i^{-0.38}$

Try $T_c = 20$ min $\Rightarrow i_p = 3.25$ in/hr $\Rightarrow i = 3.15$ in/hr

$\therefore T_c = (0.587)(3.15)^{-0.38} = 0.380$ hr $= 22.80 > 20$ min

Try $T_c = 23$ min $\Rightarrow i_p = 3.00$ in/hr $\Rightarrow i = 2.91$ in/hr

$\therefore T_c = (0.587)(2.91)^{-0.38} = 0.39$ hr $= 23.4$ min Ok.

$\therefore Q_{10} = C_w i A = (0.65)(2.91)(6.8) = 12.9$ cfs

USE 28' x 20' ✓ CMPA w/ End Sections

See Culvert Design Form for Calcs

PRODUCT 204-1 NEBS Inc. Groton, Mass. 01471.

PROJECT: DYSART RD (68644)
D.A. #7

STATION: 166+68 Lt.
SHEET ____ OF ____

CULVERT DESIGN FORM
DESIGNER / DATE: SHM / 7/92
REVIEWER / DATE: ____ / ____

HYDROLOGICAL DATA

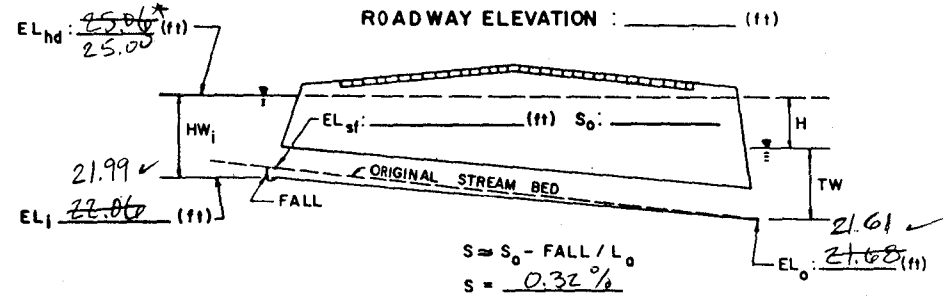
SEE ADD'L. SHTS.

- ☐ METHOD: RATIONAL
- ☐ DRAINAGE AREA: 6.8 Ac ☐ STREAM SLOPE: 0.21%
- ☐ CHANNEL SHAPE: Triangular
- ☐ ROUTING: ____ ☐ OTHER: ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	12.9	1.36'

ROADWAY ELEVATION: ____ (ft)



$S = S_o - FALL / L_a$
$S = 0.32\%$
$L_a = 117'$

* E/P Grade

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
Cmp-Arch-28"x20"-End Sect	12.9	—	1.21	2.02	—	24.08	1.36	0.98	1.33	1.33	0.5	1.22	24.23	24.23	5.1	ok

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

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

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

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

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

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

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

(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:

HELICAL CORRUGATION ONLY ✓

CULVERT BARREL SELECTED:

SIZE: 28" x 20" ✓
SHAPE: Arch
MATERIAL: CMP n 0.016
ENTRANCE: End section

240

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(602) 997-7536

JOB DYSART RD (68644)
SHEET NO. ____ OF ____
CALCULATED BY SHM DATE 7/92
CHECKED BY ____ DATE ____
SCALE ____

DRAINAGE AREA NO. 8 (Sta. 153+55 to 205+57 Lt.)

Area = [(55+22)(5202)](1/43560) = 9.2 Acre

Runoff Coef. = C_N = 0.65

$i = 0.97\, i_p$

$T_c = 11.4\, L^{0.5}\, K_b^{0.52}\, S^{-0.31}\, i^{-0.38}$

L = 5202/5280 = 0.99 mile
K_b = 0.034
S = (43.44 − 18.96)/0.99 = 24.7 ft/mile

$\therefore T_c = 11.4(0.99)^{0.5}(0.034)^{0.52}(24.7)^{-0.31}(i)^{-0.38} = 0.723\,(i)^{-0.38}$

Try T_c = 30 min ⇒ i_p = 2.5 in/hr ⇒ i = 2.43 in/hr

$\therefore T_c = 0.723\,(2.43)^{-0.38} = 0.52$ hr = 31.20 min

Try T_c = 32 min ⇒ i_p = 2.4 in/hr ⇒ i = 2.33 in/hr

$\therefore T_c = 0.723\,(2.33)^{-0.38} = 0.53$ hr = 31.8 min ok

⇒ $Q = C_N\, i\, A = (0.65)(2.33)(9.2) = 13.9$ cfs

USE ~~30" x 19" HERCP~~ 24" RGRCP ✓ w/ HWL @ inlet & MH @ outlet

See Culvert Design Form for Calcs

PRODUCT 204-1 NEBS Inc. Groton, Mass 01471

PROJECT: DYSART RD (68644) D.A. #8	STATION: 152+80 Lt. SHEET ____ OF ____	CULVERT DESIGN FORM DESIGNER/DATE: SHM / 7/92 REVIEWER/DATE: ____ / ____

HYDROLOGICAL DATA

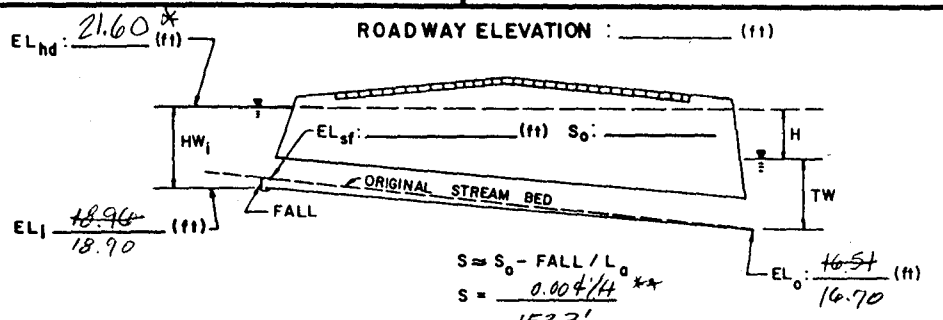
SEE ADD'L. SHTS.

- ☐ METHOD: RATIONAL
- ☐ DRAINAGE AREA: 9.2 ☐ STREAM SLOPE: ____
- ☐ CHANNEL SHAPE: Triangular
- ☐ ROUTING: ____ ☐ OTHER: ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	13.9	2.0***

*** Full flow Condition



$S \approx S_o - FALL / L_a$

$S = 0.004'/ft$ **

$L_a = 153.3'$

* E/P Grade @ I.S. Rd.

** Lower Segment of pipe

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
RGRCP - Circ - 18" - HWL W/ GROOVE END	13.9	–	2.0	3.00	–	21.96	> 21.60								→	Try 24" conc.
RGRCP - Circ - 24" - HWL W/ GROOVE END	13.9	–	1.0	2.00	–	20.96	2.0	1.3	1.65	2.0	0.2	0.86	19.37	20.96	5.6	ok.

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_f/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) $H = \left[1 + k_e + (29 n^2 L)/R^{1.33}\right] V^2/2g$

(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: 24"
SHAPE: Circular
MATERIAL: Conc. n 0.012
ENTRANCE: HWL W/ GROOVE END

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JOB DYSART RD (68644)
SHEET NO. ____ OF ____
CALCULATED BY SHM DATE 7/92
CHECKED BY ____ DATE ____
SCALE ____

DRAINAGE AREA No. 9 (D.A. #5 + D.A. #8)

The Confluence pt is the New Manhole at Sta. 152+00, 170' Lt.

Area = 13.4 + 9.2 = 22.6 Acres

$$C_W = \frac{(0.68)(13.4) + (0.65)(9.2)}{22.6} = 0.67$$

$i = 0.97\, i_p$

$T_c = T_{c(D.A.\#5)} + 1$ min (pipe flow time) $= 33 + 1 = 34$ min

$\Rightarrow i_p = 2.3$ in/hr $\Rightarrow i = (0.97)(2.3) = 2.23$ in/hr

$Q_{10} = C_W\, I\, A = (0.67)(2.23)(22.6) = 33.8$ cfs

✓

Use 42" x 29" CMPA (100% paved, n = 0.012) w/MH @ inlet & Dysart channel @ outlet

$$Q_{full} = \frac{1.486}{0.012}(0.0035)^{1/2}(0.69)^{2/3}(6.5) = 37.2 \text{ cfs} > 33.8$$

Ok.

100 YEAR STORM

Area = 22.6 Acres
$C_W = 0.67$
$T_c = 0.742\, i^{-0.38} \Rightarrow T_c = 25$ min $\Rightarrow i_p\ 4.5 \Rightarrow i = 4.36 \Rightarrow T_c = 25.4$ min ok.

$\Rightarrow Q_{100} = CIA = (0.67)(4.36)(22.6) = 66$ cfs use 75% $\Rightarrow Q_{100} = 50$ cfs

Dysart Channel from South of I.S. Rd. to RID to be designed for $Q_{100} = 188 + 50 = 238$ cfs

P.19

PROJECT: DYSART ROAD (68644)
D.A. #9

STATION: 146+51

SHEET 1 OF 1

CULVERT DESIGN FORM

DESIGNER / DATE: SHM / 12/8/92

REVIEWER / DATE: ____ / ____

HYDROLOGICAL DATA

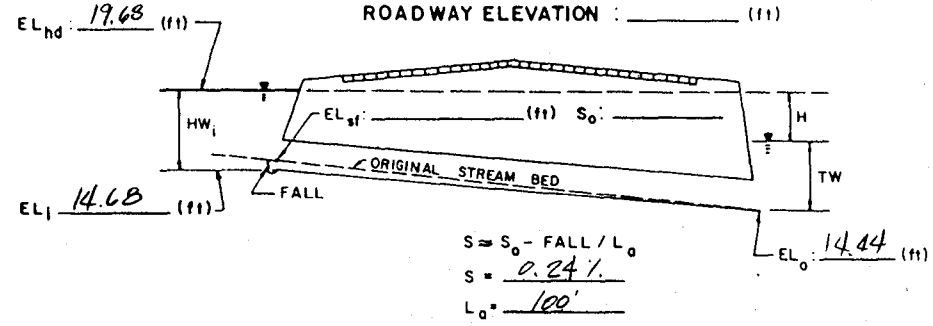
SEE ADD'L. SHTS.

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

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
100	238	2.11

ROADWAY ELEVATION: ____ (ft)



$S = S_o - FALL / L_a$

$S = 0.24\%$

$L_a = 100'$

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
Conc, Circular, 3-42" HWL w/ Groove END	238	79.3	1.32	4.62	–	19.30	2.11	2.8	3.15	3.15	0.5	2.15	19.74*	19.74	9.5**	ok use it

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) HW_i/D = HW /D OR HW_1/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) $H = \left[1 + k_e + (29 n^2 L) / R^{1.33}\right] V^2/2g$

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

* Some over To

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:

* Some over Topping will occur
** outlet protect — required
*** use the Same @ Sta 126+40.73

CULVERT BARREL SELECTED:

SIZE: 3-42"
SHAPE: Circular
MATERIAL: Conc. n 0.012
ENTRANCE: HWL w/ Groove ends

$\frac{d_c}{D} = \frac{2.8}{3.5} = 0.8 \Rightarrow \frac{V}{V_{full}} = 1.15$, $V_{full} = \frac{79.3}{9.621} = 8.24 \Rightarrow V = 9.5$ f/s

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JOB DYSART ROAD (68644)
SHEET NO. ____ OF ____
CALCULATED BY SHM DATE ____
CHECKED BY ____ DATE ____
SCALE ____

DRAINAGE AREA NO. 10 (Sta 122+00 to 152+80, Rt.)

Low point @ Sta 128+37.19, 53' Rt.

$$\text{Area} = \left\{\left[(130+26.59)-(122+00)\right](65) + \left[(149+80.45)-(130+26.59)\right]\left(\frac{80+58}{2}\right) - \left[(138+00)-(130+26.59)\right](15) + \left[(152+80)-(149+80.45)(58)\right]\right\}(1/43560) =$$

$$= 4.46 \text{ Acres}$$

Runoff Coef $= 0.65$

$i = 0.97\ i_p$

$T_c = 11.4\, L^{0.5} K_b^{0.52} S^{-0.31} i^{-0.38}$

L $\quad L = 2443/5280 = 0.463$ mile

$K_b = 0.034$

$S = (22.40 - 14.13)/0.463 = 17.86$ '/mile

$\therefore\ T_c = 11.4(0.463)^{0.5}(0.034)^{0.52}(17.86)^{-0.31} i^{-0.38} = 0.547\, i^{-0.38}$

Try $T_c = 20$ min $\Rightarrow i_p = 3.25$ in/hr $\Rightarrow i = 3.15$ in/hr

$\therefore\ T_c = 0.547(3.15)^{-0.38} = 0.35$ hr $= 21.2$ min

Try $T_c = 22$ min $\Rightarrow i_p = 3.10$ in/hr $\Rightarrow i = 3.01$ in/hr

$\therefore\ T_c = 0.547(3.01)^{-0.38} = 0.36$ hr $= 21.6$ min OK

$\therefore\ Q_{10} = C_w I A = (0.65)(3.01)(4.46) = 8.73$ cfs

Use 24" RGRCP @ 0.003 '/ft

(See Culvert design form for Calcs)

PRODUCT 204-1 NEBS Inc. Groton, Mass. 01471

PROJECT: DYSART ROAD (68644)
D.A. # 10

STATION: 128+37.19, Rt

SHEET 1 OF 1

CULVERT DESIGN FORM

DESIGNER / DATE: SHM / 4/8/93

REVIEWER / DATE: ____ / ____

HYDROLOGICAL DATA

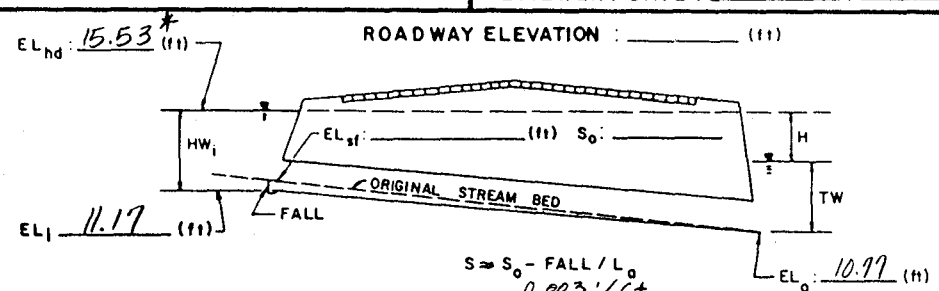
SEE ADD'L. SHTS.

- METHOD: RATIONAL
- DRAINAGE AREA: 4.46 ☐ STREAM SLOPE ____
- CHANNEL SHAPE: Triangular
- ROUTING: ____ ☐ OTHER ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	8.73	1.0'
100	19	2.19

ROADWAY ELEVATION: ____ (ft)



$S = S_o - FALL / L_a$

$S = 0.003'/ft$

$L_a = 136.4'$

E/P Grade

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
RGRCP - Circ - 24" - HWL Groove End	19	–	1.25	2.5	–	13.67	2.19	1.60	1.80	2.19	0.5	1.65	14.61	14.6'	6.1	

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

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

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

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

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

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

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

(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:

Low point on the Roadway, use 100 year Storm

CULVERT BARREL SELECTED:

SIZE: 24"

SHAPE: Circular

MATERIAL: Conc. n 0.012

ENTRANCE: HWL/Groove End

240

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Z & H ENGINEERING, INC.
717 West Dunlap Avenue
PHOENIX, ARIZONA 85021
(602) 997-7536

JOB DYSART ROAD (68644)
SHEET NO. _____ OF _____
CALCULATED BY SHM DATE 4/7/93
CHECKED BY _____ DATE _____
SCALE _____

DRAINAGE AREA NO. 11 (Sta. 205+57 to Sta. 219+00 Rt.)

Colter St.

$$Area = \left[(300)(85-22) + (550)\left(\frac{63+66}{2}\right) + (492)\left(\frac{51+62}{2}\right) + (1050)(20)\right](1/43560) =$$

$$= 2.4 \text{ Acres}$$

$C_N = 0.66$

$i = 0.97 i_p$

$T_c = 11.4\, L^{0.5}\, K_b^{0.52}\, S^{-0.31}\, i^{-0.38}$

$L = 2392/5280 = 0.453$ mile
$K_b = 0.034$
$S = (51.7 - 41.50)/(0.453) = 22.52$ ft/mile

$$\therefore T_c = 11.4(0.453)^{0.5}(0.034)^{0.52}(22.52)^{-0.3}(i)^{-0.38} = 0.520(i)^{-0.38}$$

Try $T_c = 20$ min $\Rightarrow i_p = 3.25$ in/hr $\Rightarrow i = (0.97)(3.25) = 3.15$ in/hr

$\therefore T_c = (0.520)(3.15)^{-0.38} = 0.336$ hr $= 20.17$ min OK.

$\Rightarrow Q_{10} = C_N i A = (0.66)(3.15)(2.4) = 5.0$ cfs

18" CMP OK by comparison but
use <u>24" CMP</u> w/ Catch Basin @ inlet.

(slightly oversized due to Location being @ intersection)

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(602) 997-7536

JOB DYSART RD (68644)
SHEET NO. _____ OF _____
CALCULATED BY SHM DATE 4/8/93
CHECKED BY _____ DATE _____
SCALE _____

DRAINAGE AREA NO. 12 (Sta 209+12 to 220+50 Lt.)

$$Area = \left(\frac{55+77}{2}\right)(1138)\left(1/43560\right) = 1.72 \text{ Acres}$$

$$C_W = \frac{(0.9)(24)+(0.5)(42)}{66} = 0.65$$

$$i = i_p \frac{P_{10}^{6}}{209} = i_p\left(\frac{2.0}{2.07}\right) = 0.97\, i_p$$

$$T_c = 11.4\, L^{0.5}\, K_b^{0.52}\, S^{-0.31}\, i^{-0.38}$$

$L = 1138/5280 = 0.216$ mile

$K_b = 0.034$

$S = (51.92 - 43.57)/0.216 = 38.66$ ft/mile

$$\therefore T_c = 11.4(0.216)^{0.5}(0.034)^{0.52}(38.66)^{-0.31}(i)^{-0.38} = 0.294\, i^{-0.38}$$

Try $T_c = 10$ min $\Rightarrow i_p = 4.5$ in/hr $\Rightarrow i = (0.97)(4.5) = 4.37$ in/hr

$$\Rightarrow T_c = (0.294)(4.37)^{-0.38} = 0.168 \text{ hr} = 10.07 \text{ min} \quad \text{ok.}$$

$$\Rightarrow Q_{10} = C_W\, i\, A = (0.65)(4.37)(1.72) = 4.9 \text{ cfs}$$

Similar to D.A. No. 1 therefore use 18" CMP w/ end Section. (See Culvert design form of D.A. No. 1)

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(602) 997-7536

JOB _____
SHEET NO. _____ OF _____
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____
SCALE _____

Catch Basin Grate Interception Capacity:

USE ADOT S.D. C-15.30 (w/o Curb & Gutter Depression) with EF-1 Type Grate.

$Q_{10} = 15.4$ cfs (See DRNG. AREA No. 4 for Calc's) (@ NE Corner of Dysart Rd. & I.S. Rd. Intersect.)

Ponding Depth over C.B. Grate, $d = 1021.68 - 1020.30 = 1.38'$

Assume weir flow applies.

$$Q = 3pd^{1.5}$$

p, clear Grate perimeter $= 2\left(20\tfrac{3}{4}'' + 32\tfrac{3}{4}''\right)/12 = 8.92$ ft

$P_{eff.} = 8.92/2 = 4.46'$ (clogging factor = 2)

$$\therefore Q = 3(4.46)(1.38)^{1.5} = 21.69 \text{ cfs} > 15.4 \text{ cfs}$$

ok.

USE Single Grate Catch Basin per ADOT S.D. C-15.30 w/ EF-1 Type Grate per ADOT S.D. C-15.50 and 2" A.C. Apron per ADOT S.D. C-15.70

USE THE SAME AT SE CORNER OF DYSART RD & Indian School Rd. Intersection. Note the orientation of this Catch Basin (Longer Side to be East & West walls so the 30"Ø outlet Pipe can fit the C.B. Side wall)

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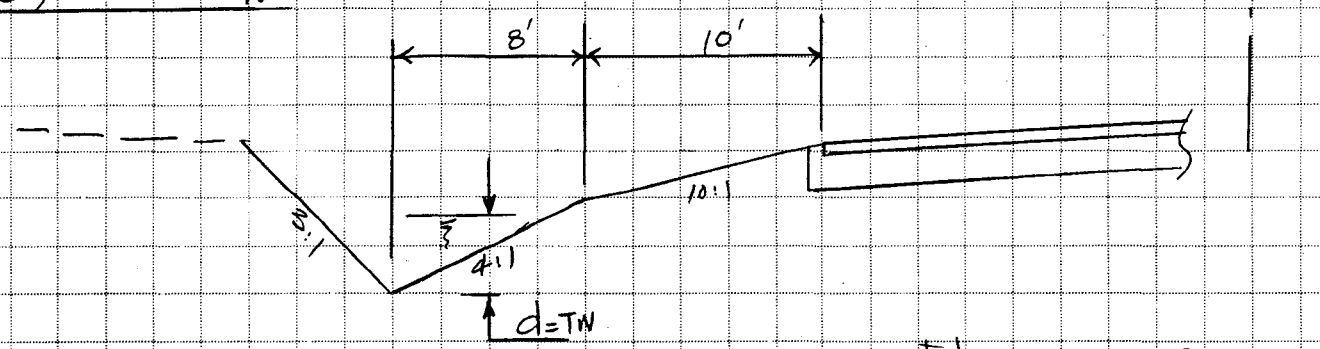
JOB DYSART RD (68644)
SHEET NO. ____ OF ____
CALCULATED BY SHM DATE 7/92
CHECKED BY ____ DATE ____
SCALE ____

CONVEYANCE CAPACITY OF ROADSIDE DITCHES (Cont.)

(Tailwater Depth @ New Culverts)

B) West Side



Ditch Cross Section

$$A = [(4+3)d](d/2) = 3.5\,d^2$$

$$W_p = \sqrt{17d^2} + \sqrt{10d^2} = 7.3\,d$$

$$R_H = 3.5d^2/7.3\,d = 0.48\,d$$

$$\therefore Q = \frac{1.486}{n} S_o^{1/2} R_H^{2/3} A = \frac{1.486}{0.020}(0.48\,d)^{2/3}(3.5\,d^2)\,S_o^{1/2}$$

$$\therefore Q = 124.82\,d^{8/3}\,S_o^{1/2}$$

OUTLET STA.	Q (cfs)	S. H/H	d(ft) = TW
193+16	5.7	0.0044	0.87'
166+09	12.9	0.0021	1.36'

PRODUCT 204-1 NEBS Inc. Groton, Mass. 01471.

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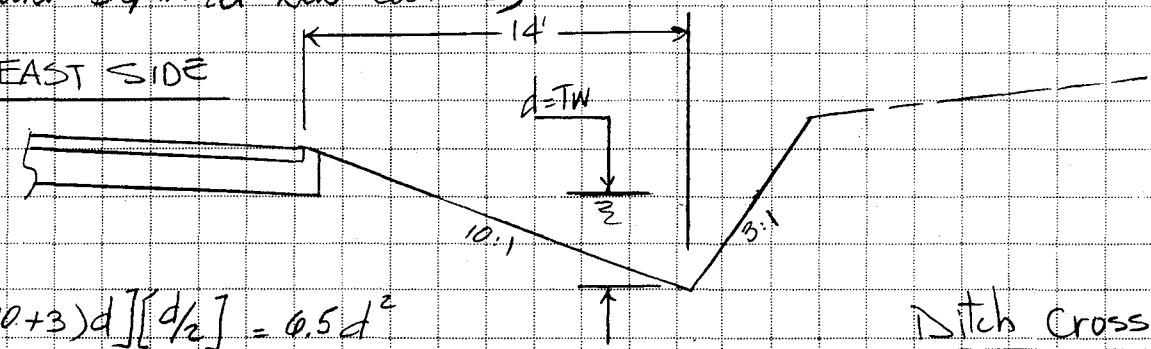
JOB Dysart Rd. (68644)
SHEET NO. ____ OF ____
CALCULATED BY SHM DATE 7/92
CHECKED BY ____ DATE ____
SCALE ____

Conveyance Capacity of Roadside Ditches
(Tailwater Depth at New Culverts)

A) EAST SIDE



Ditch Cross SECTION

$$A = [(10+3)d][d/2] = 6.5d^2$$

$$W_P = \sqrt{101d^2} + \sqrt{10d^2} = 13.2\,d$$

$$R_H = 6.5d^2/13.2d = 0.49\,d$$

$$\therefore Q = \frac{1.486}{n} S_o^{1/2} R_H^{2/3} A = \frac{1.486}{0.020}(0.49d)^{2/3}(6.5d^2)\,S_o^{1/2}$$

$$\therefore Q = 300.17\,d^{8/3} S_o^{1/2}$$

Outlet Sta.	Q (cfs)	S (ft/ft)	d (ft) = TW
192+28	5.2	0.0044	0.60'
179+18	7.7	0.0044	0.70'
168+39	9.2	0.0044	0.75'

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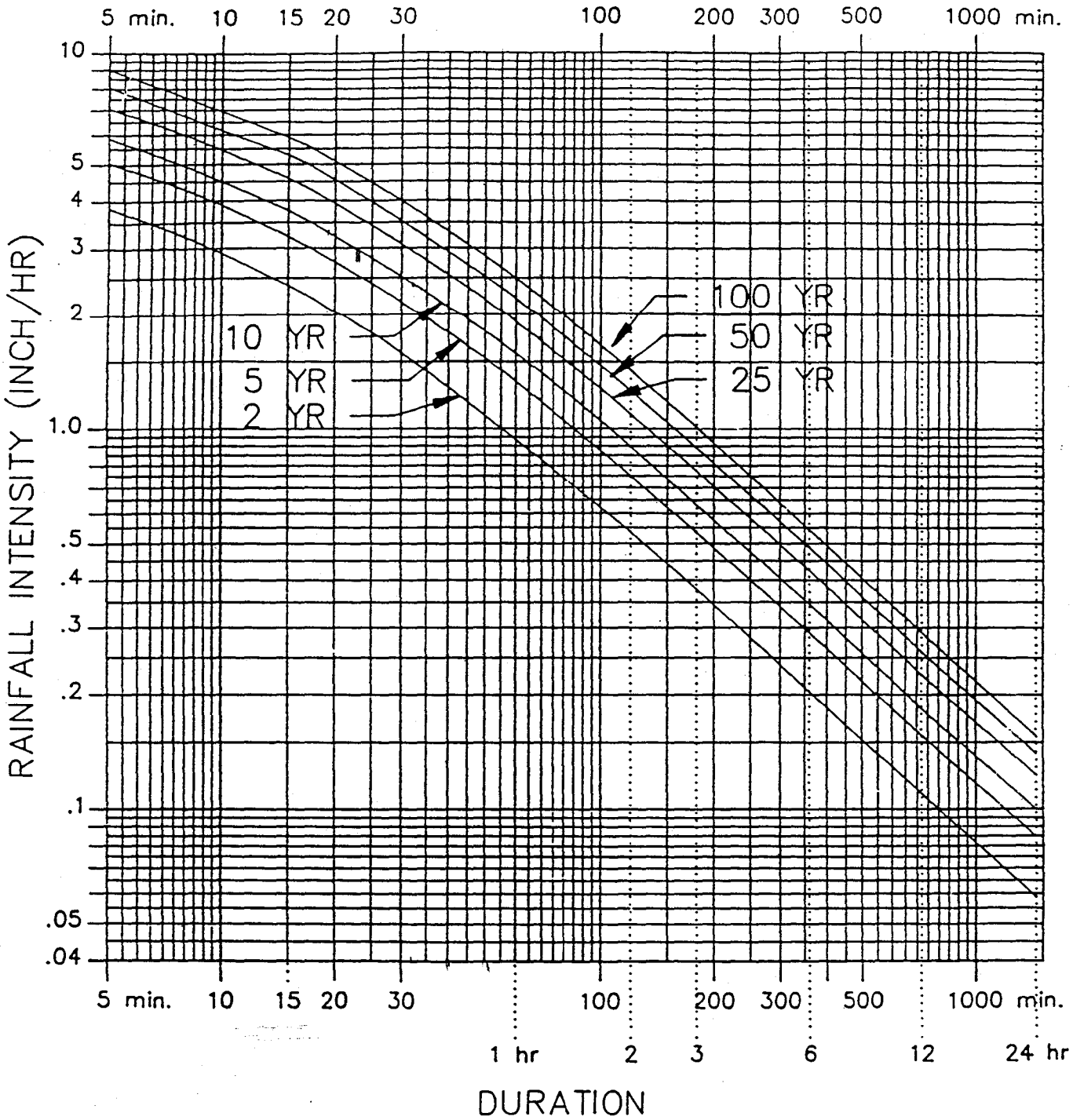

Figure 3.2
Rainfall Intensity-Duration-Frequency Relation
(Phoenix Metro Area)

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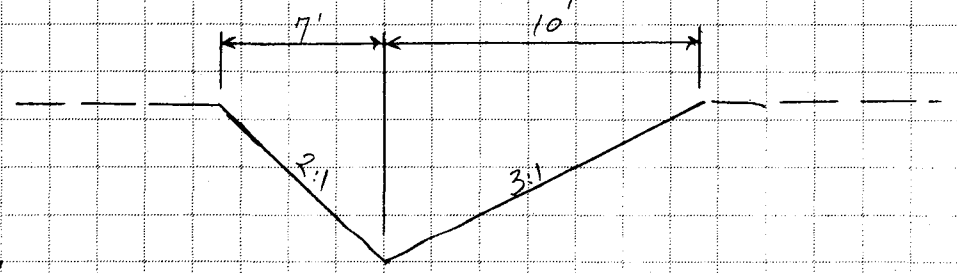
717 West Dunlap Avenue
PHOENIX, ARIZONA 85021
(602) 997-7536

JOB: DYSART RD (68644)
SHEET NO. 1 OF 1
CALCULATED BY: SHM DATE: 12/8/92
CHECKED BY: DATE:
SCALE:

CAPACITY CALC'S FOR Irrigation Waste Water Ditch (Unlined)

Sta 122+00 to 138+00



$d_{max} = 3.0'$

$S_o = 0.0015$ '/ft

$n = 0.035$

$$A = [(3)(2)+(3)(3)](3)(1/2) = 22.5 \text{ SF}$$

$$W_p = [(6)^2+(3)^2]^{1/2} + [(9)^2+(3)^2]^{1/2} = 16.2 \text{ ft}$$

$$R = \frac{A}{W_p} = \frac{22.5}{16.2} = 1.39'$$

$$Q_{max} = \frac{1.486}{n}(S)^{1/2}(R)^{2/3}A$$

$$= \frac{1.486}{0.035}(0.0015)^{1/2}(1.39)^{2/3}(22.5)$$

$$= 46.1 \text{ cfs}$$

$$V = \frac{Q}{A} = \frac{46.1}{22.5} = 2.05 \text{ fps}$$

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OFF-SITE DRAINAGE

100 YR STORM

See CP 5 for
100 yr - 6 hr peak
discharge

```
1****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*            SEPTEMBER 1990            *
*             VERSION 4.0              *
*                                      *
* RUN DATE  10/23/1991  TIME  15:40:14 *
*                                      *
****************************************
```

```
****************************************
*                                      *
*   U.S. ARMY CORPS OF ENGINEERS       *
*   HYDROLOGIC ENGINEERING CENTER      *
*         609 SECOND STREET            *
*      DAVIS, CALIFORNIA 95616         *
*          (916) 756-1104              *
*                                      *
****************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X       XXXXX  X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID
  2           ID  ******************************************************************************
  3           ID
  4           ID  ZZZZZ   A   H   H   EEEEE N   N GGGGG I N   N EEEEE EEEEE RRRRR I N   N GGGGG
  5           ID     Z       H   H   E     NN  N G     I NN  N E     E     R   R I NN  N G
  6           ID    Z    N   HHHHH   EEE   N N N G GGG I N N N EEE   EEE   RRR   I N N N G GGG
  7           ID   Z         H   H   E     N  NN G   G I N  NN E     E     R  R  I N  NN G   G
  8           ID  ZZZZZ   D   H   H   EEEEE N   N GGGGG I N   N EEEEE EEEEE R   R I N   N GGGGG
  9           ID
 10           ID  ******************************************************************************
 11           ID          ***************************************************
 12           ID          * DYSART ROAD - MARICOPA COUNTY, ARIZONA          *
 13           ID          * POST-DEVELOPMENT CONDITIONS                     *
 14           ID          ***************************************************
 15           ID          * DISTRIBUTION ..................... 6 HOUR, MCFC *
 16           ID          * RETURN PERIOD ........................ 100 YEAR *
```

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```
17          ID            * PATTERN NO. ............................ 1.37 *
18          ID            * UNIT HYDROGRAPH ........................ CLARK *
19          ID            * LOSSES ....................... GREEN AND AMPT *
20          ID            * TIME-AREA CURVE ....................... URBAN *
21          ID            * FILE NAME ........................... DYSRT100 *
22          ID            * DATE ....................... OCTOBER 21, 1991 *
23          ID            ************************************************
            *DIAGRAM
24          IT      5       0       0     120
25          IO      5

26          KK   SUB 1
27          KM   RUNOFF FROM SUBBASIN 1
28          BA   .0038
29          IN     15
30          PB   3.10
31          PC   .000    .008    .016    .025    .033    .041    .050    .058    .066    .075
32          PC   .087    .099    .119    .147    .229    .404    .782    .884    .920    .946
33          PC   .958    .969    .980    .990   1.000
34          LG    .15     .35     3.5     .25      36
35          UC   .267    .674
36          UA      0       5      16      30      65      77      84      90      94      97
37          UA    100

38          KK   SUB 2
39          KM   RUNOFF FROM SUBBASIN 2
40          BA   .0463
41          LG    .35     .31     5.5     .21       0
42          UC   .700    .744
43          UA      0       5      16      30      65      77      84      90      94      97
44          UA    100

45          KK    CP 1
46          KM   COMBINE HYDROGRAPHS FROM SUB 1 AND SUB 2
47          HC      2
```



```
LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

48          KK    1.2
49          KM   ROUTE CP 1 TO CP 2
50          RK   4000    .003    .020            TRAP       0       4

51          KK   SUB 3
52          KM   RUNOFF FROM SUBBASIN 3
53          BA   .0115
54          LG    .15     .28     6.6     .11      36
55          UC   .533   1.865
56          UA      0       5      16      30      65      77      84      90      94      97
57          UA    100

58          KK   SUB 4
59          KM   RUNOFF FROM SUBBASIN 4
```

```
 60          BA   .3868
 61          LG     .40     .20     5.7     .19       0
 62          UC   1.000    .656
 63          UA       0       5      16      30      65      77      84      90      94      97
 64          UA     100

 65          KK    CP 2
 66          KM   COMBINE HYDROGRAPHS FROM 1.2, SUB 3 AND SUB 4
 67          HC       3

 68          KK     2.3
 69          KM   ROUTE CP 2 TO CP 3
 70          RK     100    .005    .024            CIRC       3

 71          KK   SUB 5
 72          KM   RUNOFF FROM SUBBASIN 5
 73          BA   .0105
 74          LG     .12     .30     5.9     .15      52
 75          UC    .650   3.079
 76          UA       0       5      16      30      65      77      84      90      94      97
 77          UA     100

 78          KK    CP 3
 79          KM   COMBINE HYDROGRAPHS FROM 2.3 AND SUB 5
 80          HC       2

 81          KK     3.6
 82          KM   ROUTE CP 3 TO CP 6
 83          RK     250    .005    .024            CIRC       3

 84          KK   SUB 6
 85          KM   RUNOFF FROM SUBBASIN 6
 86          BA   .1031
 87          LG     .17     .20     6.0     .16      20
 88          UC    .633    .973
 89          UA       0       5      16      30      65      77      84      90      94      97
 90          UA     100
```



```
LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 91          KK   SUB 7
 92          KM   RUNOFF FROM SUBBASIN 7
 93          BA   .2401
 94          LG     .19     .19     6.8     .20       3
 95          UC    .667    .696
 96          UA       0       5      16      30      65      77      84      90      94      97
 97          UA     100

 98          KK    CP 4
 99          KM   DIVERTED FLOW TO EXIT THIS WATERSHED
100          DT    OUT
101          DI       0       5      10      20      30      50      75     100     250
```

↓ ↓ (cont.)

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↑ ↑ (Cont.)

```
102        DQ      0      0      5     10     15     25   37.5     50    125

103        KK    CP 5
104        KM   COMBINE HYDROGRAPHS FROM SUB 6 AND CP 4
105        HC       2

106        KK     5.6
107        KM   ROUTE CP 5 TO CP6
108        RK     120    .005    .024           CIRC      4

109        KK    CP 6
110        KM   COMBINE HYDROGRAPHS FROM 3.6 AND 5.6
111        HC       2

112        KK    6.10
113        KM   ROUTE CP 6 TO CP 10
114        RK    3168    .003    .020           TRAP     10      4

115        KK   SUB 8
116        KM   RUNOFF FROM SUBBASIN 8
117        BA   .0055
118        LG     .07     .25     8.2     .04      90
119        UC    .183    .214
120        UA       0       5      16      30      65      77      84      90      94      97
121        UA     100

122        KK   SUB 9
123        KM   RUNOFF FROM SUBBASIN 9
124        BA   .0051
125        LG     .13     .27     7.1     .09      48
126        UC    .383   1.317
127        UA       0       5      16      30      65      77      84      90      94      97
128        UA     100

129        KK    CP 7
130        KM   COMBINE HYDROGRAPHS FROM SUB 8 AND SUB 9
131        HC       2
```



```
LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

132        KK     7.8
133        KM   ROUTE CP 7 TO CP 8
134        RK     895    .003    .020           TRAP      0      4

135        KK  SUB 10
136        KM   RUNOFF FROM SUBBASIN 10
137        BA   .0580
138        LG     .40     .19     6.2     .15       0
139        UC    .600    .571
140        UA       0       5      16      30      65      77      84      90      94      97
141        UA     100
```

```
142          KK  SUB 11
143          KM   RUNOFF FROM SUBBASIN 11
144          BA   .0026
145          LG     .15     .25     8.2     .04      36
146          UC    .217    .488
147          UA       0       5      16      30      65      77      84      90      94      97
148          UA     100

149          KK    CP 8
150          KM   COMBINE HYDROGRAPHS FROM 7.8, SUB 10 AND SUB 11
151          HC       3

152          KK     8.9
153          KM   ROUTE CP 8 TO CP 9
154          RK    1833    .003    .020            TRAP       0       4

155          KK  SUB 12
156          KM   RUNOFF FROM SUBBASIN 12
157          BA   .0615
158          LG     .40     .24     3.8     .27       0
159          UC    .517    .350
160          UA       0       5      16      30      65      77      84      90      94      97
161          UA     100

162          KK  SUB 13
163          KM   RUNOFF FROM SUBBASIN 13
164          BA   .0043
165          LG     .13     .32     4.8     .19      44
166          UC    .367   1.277
167          UA       0       5      16      30      65      77      84      90      94      97
168          UA     100

169          KK    CP 9
170          KM   COMBINE HYDROGRAPHS FROM 8.9, SUB 12 AND SUB 13
171          HC       3

172          KK    9.10
173          KM   ROUTE CP 9 TO CP 10
174          RK     100    .005    .024            CIRC       3
```



```
LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

175          KK  SUB 14
176          KM   RUNOFF FROM SUBBASIN 14
177          BA   .0074
178          LG     .13     .29     6.2     .13      44
179          UC    .467   1.729
180          UA       0       5      16      30      65      77      84      90      94      97
181          UA     100

182          KK   CP 10
183          KM   COMBINE HYDROGRAPHS FROM 6.10, 9.10 AND SUB 14
```

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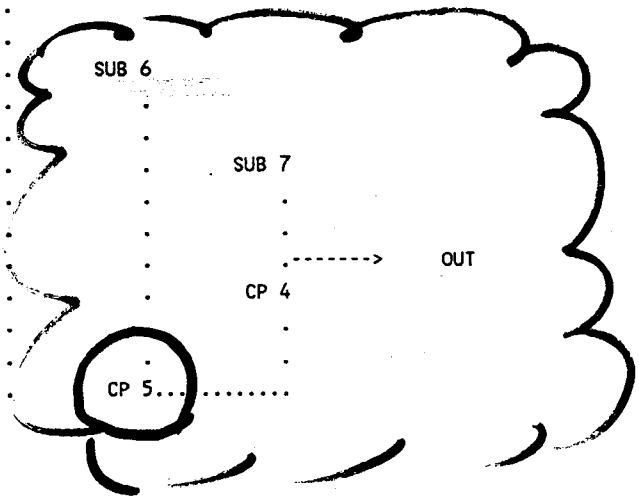
```
        184          KO       2
        185          HC       3
        186          ZZ
1
                SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
 LINE     (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.     (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   26      SUB 1
              .
              .
   38         .       SUB 2
              .           .
              .           .
   45      CP 1............
              V
              V
   48       1.2
              .
              .
   51         .       SUB 3
              .           .
              .           .
   58         .           .       SUB 4
              .           .           .
              .           .           .
   65      CP 2.......................
              V
              V
   68       2.3
              .
              .
   71         .       SUB 5
              .           .
              .           .
   78      CP 3............
              V
              V
   81       3.6
              .
              .
   84         .       SUB 6
              .           .
              .           .
   91         .           .       SUB 7
              .           .           .
              .           .           .
  100         .           .           .-------->     OUT
   98         .           .       CP 4
              .           .           .
              .           .           .
  103         .       CP 5............
```



P.37

```
                .          V
                .          V
106             .        5.6
                .          .
                .          .
109          CP 6............
                V
                V
112          6.10
                .
                .
115             .      SUB 8
                .          .
                .          .
122             .          .      SUB 9
                .          .          .
                .          .          .
129             .       CP 7............
                .          V
                .          V
132             .        7.8
                .          .
                .          .
135             .          .     SUB 10
                .          .          .
                .          .          .
142             .          .          .     SUB 11
                .          .          .          .
                .          .          .          .
149             .       CP 8........................
                .          V
                .          V
152             .        8.9
                .          .
                .          .
155             .          .     SUB 12
                .          .          .
                .          .          .
162             .          .          .     SUB 13
                .          .          .          .
                .          .          .          .
169             .       CP 9........................
                .          V
                .          V
172             .       9.10
                .          .
                .          .
175             .          .     SUB 14
                .          .          .
                .          .          .
182          CP 10........................
```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

1**********

P.38

****

```
*                                    *                                                    *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                                    *   U.S. ARMY CORPS OF ENGINEERS
*            SEPTEMBER 1990            *                                                    *   HYDROLOGIC ENGINEERING CENTER
*             VERSION 4.0              *                                                    *        609 SECOND STREET
*                                      *                                                    *      DAVIS, CALIFORNIA 95616
*  RUN DATE  10/23/1991  TIME  15:40:14 *                                                    *         (916) 756-1104
*                                      *                                                    *
****************************************                                                    ****************************************
```

```
                    ******************************************************************************

                    ZZZZZ   A   H   H   EEEEE N   N GGGGG I N   N EEEEE EEEEE RRRRR I N   N GGGGG
                       Z        H   H   E     NN  N G     I NN  N E     E     R   R I NN  N G
                      Z     N   HHHHH   EEE   N N N G GGG I N N N EEE   EEE   RRR   I N N N G GGG
                     Z          H   H   E     N  NN G   G I N  NN E     E     R  R  I N  NN G   G
                    ZZZZZ   D   H   H   EEEEE N   N GGGGG I N   N EEEEE EEEEE R   R I N   N GGGGG

                    ******************************************************************************
                              ************************************************
                              * DYSART ROAD - MARICOPA COUNTY, ARIZONA        *
                              * POST-DEVELOPMENT CONDITIONS                   *
                              ************************************************
                              * DISTRIBUTION ..................... 6 HOUR, MCFC *
                              * RETURN PERIOD ........................ 100 YEAR *
                              * PATTERN NO. ............................ 1.37 *
                              * UNIT HYDROGRAPH ........................ CLARK *
                              * LOSSES ........................ GREEN AND AMPT *
                              * TIME-AREA CURVE ........................ URBAN *
                              * FILE NAME ........................... DYSRT100 *
                              * DATE ........................ OCTOBER 21, 1991 *
                              ************************************************

 25 IO          OUTPUT CONTROL VARIABLES
                      IPRNT           5  PRINT CONTROL
                      IPLOT           0  PLOT CONTROL
                      QSCAL          0.  HYDROGRAPH PLOT SCALE

    IT          HYDROGRAPH TIME DATA
                       NMIN           5  MINUTES IN COMPUTATION INTERVAL
                      IDATE      1    0  STARTING DATE
                      ITIME        0000  STARTING TIME
                         NQ         120  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      1    0  ENDING DATE
                     NDTIME        0955  ENDING TIME
                      ICENT          19  CENTURY MARK

                 COMPUTATION INTERVAL     .08 HOURS
                      TOTAL TIME BASE    9.92 HOURS
```

```
ENGLISH UNITS
    DRAINAGE AREA          SQUARE MILES
    PRECIPITATION DEPTH    INCHES
    LENGTH, ELEVATION      FEET
    FLOW                   CUBIC FEET PER SECOND
    STORAGE VOLUME         ACRE-FEET
    SURFACE AREA           ACRES
    TEMPERATURE            DEGREES FAHRENHEIT
```

*** **

```
          **************
          *            *
182 KK    *     CP 10  *
          *            *
          **************

184 KO         OUTPUT CONTROL VARIABLES
                    IPRNT          2  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

185 HC         HYDROGRAPH COMBINATION
                    ICOMP          3  NUMBER OF HYDROGRAPHS TO COMBINE
```

***

****

HYDROGRAPH AT STATION CP 10
SUM OF 3 HYDROGRAPHS

****

DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW
1		0000	1	0.	1		0230	31	3.	1		0500	61	431.	1		0730	91	22.
1		0005	2	0.	1		0235	32	3.	1		0505	62	388.	1		0735	92	20.
1		0010	3	0.	1		0240	33	3.	1		0510	63	347.	1		0740	93	18.
1		0015	4	0.	1		0245	34	3.	1		0515	64	311.	1		0745	94	16.
1		0020	5	0.	1		0250	35	3.	1		0520	65	278.	1		0750	95	15.
1		0025	6	0.	1		0255	36	3.	1		0525	66	248.	1		0755	96	13.
1		0030	7	0.	1		0300	37	3.	1		0530	67	222.	1		0800	97	11.
1		0035	8	0.	1		0305	38	4.	1		0535	68	199.	1		0805	98	10.
1		0040	9	0.	1		0310	39	4.	1		0540	69	179.	1		0810	99	9.
1		0045	10	0.	1		0315	40	4.	1		0545	70	160.	1		0815	100	8.
1		0050	11	1.	1		0320	41	4.	1		0550	71	144.	1		0820	101	7.
1		0055	12	1.	1		0325	42	5.	1		0555	72	129.	1		0825	102	6.
1		0100	13	1.	1		0330	43	6.	1		0600	73	116.	1		0830	103	6.
1		0105	14	1.	1		0335	44	8.	1		0605	74	105.	1		0835	104	6.
1		0110	15	1.	1		0340	45	13.	1		0610	75	95.	1		0840	105	5.

1	0115	16	2.	*	1	0345	46	26.	*	1	0615	76	86.	*	1	0845	106	5.
1	0120	17	2.	*	1	0350	47	51.	*	1	0620	77	77.	*	1	0850	107	5.
1	0125	18	2.	*	1	0355	48	101.	*	1	0625	78	70.	*	1	0855	108	4.
1	0130	19	2.	*	1	0400	49	183.	*	1	0630	79	63.	*	1	0900	109	4.
1	0135	20	2.	*	1	0405	50	299.	*	1	0635	80	57.	*	1	0905	110	4.
1	0140	21	2.	*	1	0410	51	426.	*	1	0640	81	52.	*	1	0910	111	4.
1	0145	22	2.	*	1	0415	52	536.	*	1	0645	82	47.	*	1	0915	112	3.
1	0150	23	2.	*	1	0420	53	620.	*	1	0650	83	43.	*	1	0920	113	3.
1	0155	24	2.	*	1	0425	54	662.	*	1	0655	84	39.	*	1	0925	114	3.
1	0200	25	3.	*	1	0430	55	668.	*	1	0700	85	36.	*	1	0930	115	3.
1	0205	26	3.	*	1	0435	56	647.	*	1	0705	86	34.	*	1	0935	116	3.
1	0210	27	3.	*	1	0440	57	613.	*	1	0710	87	31.	*	1	0940	117	2.
1	0215	28	3.	*	1	0445	58	570.	*	1	0715	88	29.	*	1	0945	118	2.
1	0220	29	3.	*	1	0450	59	523.	*	1	0720	89	26.	*	1	0950	119	2.
1	0225	30	3.	*	1	0455	60	477.	*	1	0725	90	24.	*	1	0955	120	2.
				*					*					*				

****

PEAK FLOW (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	9.92-HR
		(CFS)				
668.	4.50		149.	91.	91.	91.
		(INCHES)	1.460	1.473	1.473	1.473
		(AC-FT)	74.	74.	74.	74.

CUMULATIVE AREA = .95 SQ MI

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	SUB 1	4.	4.17	1.	1.	1.	.00		
HYDROGRAPH AT	SUB 2	34.	4.42	7.	4.	4.	.05		
2 COMBINED AT	CP 1	38.	4.33	8.	5.	5.	.05		
ROUTED TO	1.2	38.	4.50	8.	5.	5.	.05		
HYDROGRAPH AT	SUB 3	6.	4.42	3.	2.	2.	.01		
HYDROGRAPH AT	SUB 4	310.	4.50	65.	40.	40.	.39		

	3 COMBINED AT						
+	CP 2	354.	4.50	76.	46.	46.	.45
	ROUTED TO						
+	2.3	354.	4.50	76.	46.	46.	.45
	HYDROGRAPH AT						
+	SUB 5	4.	4.58	2.	1.	1.	.01
	2 COMBINED AT						
+	CP 3	358.	4.50	78.	48.	48.	.46
	ROUTED TO						
+	3.6	358.	4.50	78.	48.	48.	.46
	HYDROGRAPH AT						
+	SUB 6	83.	4.42	22.	14.	14.	.10
	HYDROGRAPH AT						
+	SUB 7	211.	4.33	43.	26.	26.	.24
	DIVERSION TO						
+	OUT	106.	4.33	21.	13.	13.	.24
	HYDROGRAPH AT						
+	CP 4	106.	4.33	22.	13.	13.	.24
	2 COMBINED AT						
+	CP 5	188.	4.33	44.	27.	27.	.34
	ROUTED TO						
+	5.6	187.	4.33	44.	27.	27.	.34
	2 COMBINED AT						
+	CP 6	540.	4.42	122.	75.	75.	.80
	ROUTED TO						
+	6.10	540.	4.50	122.	74.	74.	.80
	HYDROGRAPH AT						
+	SUB 8	12.	4.08	2.	1.	1.	.01
	HYDROGRAPH AT						
+	SUB 9	4.	4.33	1.	1.	1.	.01
	2 COMBINED AT						
+	CP 7	15.	4.08	3.	2.	2.	.01
	ROUTED TO						
+	7.8	15.	4.08	3.	2.	2.	.01
	HYDROGRAPH AT						
+	SUB 10	59.	4.33	10.	6.	6.	.06

100

```
        HYDROGRAPH AT
+                    SUB 11      4.    4.08        1.        0.        0.      .00

        3 COMBINED AT
+                     CP 8      75.    4.25       14.        9.        9.      .07

        ROUTED TO
+                      8.9      75.    4.33       14.        9.        9.      .07

        HYDROGRAPH AT
+                    SUB 12     77.    4.25       10.        6.        6.      .06

        HYDROGRAPH AT
+                    SUB 13      3.    4.33        1.        1.        1.      .00

        3 COMBINED AT
+                     CP 9     152.    4.25       25.       15.       15.      .14

        ROUTED TO
+                     9.10     152.    4.25       25.       15.       15.      .14

        HYDROGRAPH AT
+                    SUB 14      4.    4.42        2.        1.        1.      .01

        3 COMBINED AT
+                    CP 10     668.    4.50      149.       91.       91.      .95
1
                                SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
                                   (FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)
                                                                  INTERPOLATED TO
                                                                COMPUTATION INTERVAL
   ISTAQ    ELEMENT      DT       PEAK    TIME TO    VOLUME      DT      PEAK   TIME TO    VOLUME
                                          PEAK                                   PEAK

                       (MIN)     (CFS)     (MIN)     (IN)    (MIN)     (CFS)    (MIN)      (IN)

      1.2  MANE         4.90     38.00    271.17     1.50     5.00     37.76   270.00      1.50

CONTINUITY SUMMARY (AC-FT) - INFLOW= .3994E+01 EXCESS= .0000E+00 OUTFLOW= .3997E+01 BASIN STORAGE= .7322E-03 PERCENT ERROR=   -.1

      2.3  MANE          .22    354.18    270.03     1.58     5.00    354.16   270.00      1.58

CONTINUITY SUMMARY (AC-FT) - INFLOW= .3779E+02 EXCESS= .0000E+00 OUTFLOW= .3778E+02 BASIN STORAGE= .2760E-03 PERCENT ERROR=    .0

      3.6  MANE          .17    358.04    270.35     1.59     5.00    357.90   270.00      1.59

CONTINUITY SUMMARY (AC-FT) - INFLOW= .3895E+02 EXCESS= .0000E+00 OUTFLOW= .3894E+02 BASIN STORAGE= .1643E-02 PERCENT ERROR=    .0
```

```
          5.6  MANE        .16    187.50    260.35      1.21      5.00    187.29    260.00        1.21

CONTINUITY SUMMARY (AC-FT) - INFLOW= .2211E+02 EXCESS= .0000E+00 OUTFLOW= .2211E+02 BASIN STORAGE= .4585E-04 PERCENT ERROR=    .0

         6.10  MANE       2.06    539.92    269.56      1.43      5.00    539.82    270.00        1.43

CONTINUITY SUMMARY (AC-FT) - INFLOW= .6106E+02 EXCESS= .0000E+00 OUTFLOW= .6101E+02 BASIN STORAGE= .5054E-01 PERCENT ERROR=    .0

          7.8  MANE       1.39     15.22    248.04      2.73      5.00     14.94    245.00        2.73

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1546E+01 EXCESS= .0000E+00 OUTFLOW= .1546E+01 BASIN STORAGE= .1232E-02 PERCENT ERROR=    .0

          8.9  MANE       1.89     74.89    258.87      1.85      5.00     74.50    260.00        1.85

CONTINUITY SUMMARY (AC-FT) - INFLOW= .7038E+01 EXCESS= .0000E+00 OUTFLOW= .7036E+01 BASIN STORAGE= .3004E-02 PERCENT ERROR=    .0

         9.10  MANE        .14    152.19    255.27      1.70      5.00    152.00    255.00        1.70

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1244E+02 EXCESS= .0000E+00 OUTFLOW= .1244E+02 BASIN STORAGE= .1241E-03 PERCENT ERROR=    .0


*** NORMAL END OF HEC-1 ***
```

PROJECT: DYSART ROAD (68644)	STATION: 8+36 Indian School Road Skew ∡ = 19° Lt.	CULVERT DESIGN FORM DESIGNER / DATE: SHM / 8/3/92 REVIEWER / DATE: / / 2

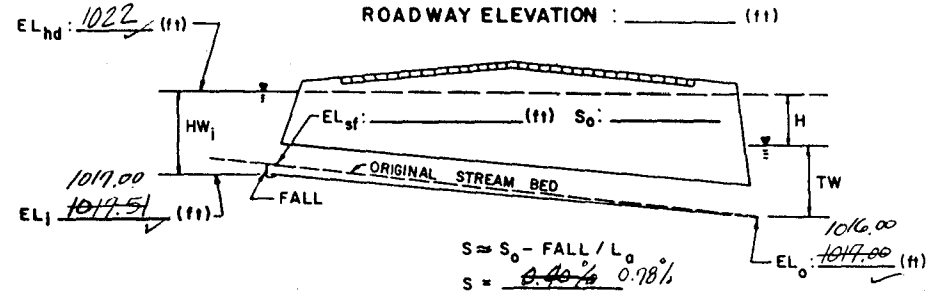
HYDROLOGICAL DATA

SEE ADD'L. SHTS.

- ☐ METHOD: HEC-1
- ☐ DRAINAGE AREA: _____ ☐ STREAM SLOPE: _____
- ☐ CHANNEL SHAPE: _____
- ☐ ROUTING: _____ ☐ OTHER: _____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
100	188	1.86



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
Conc., Circular, 3-42", HWL w/ Groove End	188	62.7	1.08	3.78	–	20.78	1.86	2.5	3	3	0.2	1.21	20.21	20.78	–	OK. TRY 3-36"
Conc, Circular, 3-36", "	188	62.7	1.5	4.5	–	21.50	1.86	2.55	2.78	2.78	0.2	2.42	21.20	21.50	9.4	O.K. TRY 2-42"
Conc, Circular, 2-42" "	188	94	1.56	5.46	–	22.46	>22.00									NG.

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) HW_i/D = HW/D OR HW_t/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) $H = \left[1 + k_e + (29 n^2 L)/R^{1.33}\right] V^2/2g$

(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:

outlet protection required

CULVERT BARREL SELECTED:

SIZE: 3-36" ✓
SHAPE: Circular
MATERIAL: Galv. n 0.012
ENTRANCE: HWL w/ Groove End

240

P.45

42" Φ

$V_{full} = Q/A = 62.7/9.621 = 6.52$ fps $\Rightarrow V^2/2g = 0.66$

$R = 0.875$, $n = 0.012$, $K_e = 0.2$, $L = 128'$ $\Rightarrow$ $H = 1.21'$

$Q/Q_{full} = 62.7/68.94 = 0.9 \Rightarrow V/V_{full} = 1.135 \Rightarrow V = 8.13$ '/sec

36" Φ

$V_{full} = Q/A = 62.7/7.069 = 8.87$ fps $\Rightarrow V^2/2g = 1.22$

$R = 0.75$, $n = 0.012$, $L = 128'$, $K_e = 0.2$

$\Rightarrow H = 2.42'$

$Q/Q_{full} = 62.7/96.27 = 0.65 \Rightarrow V/V_{full} = 1.06 \Rightarrow V = 9.4$ '/sec

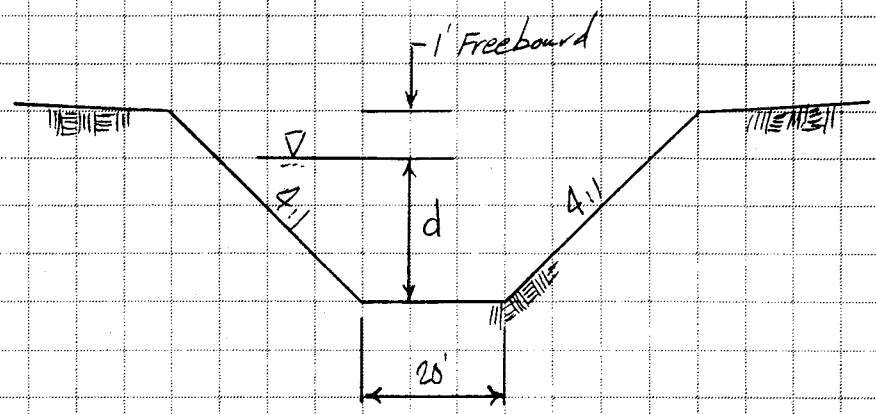
Z & H ENGINEERING, INC.
717 West Dunlap Avenue
PHOENIX, ARIZONA 85021
(602) 997-7536

JOB Dysart RD (68644
SHEET NO. 2 OF 2
CALCULATED BY JHM DATE 8/3/92
CHECKED BY DATE
SCALE

Culverts across I.S. Rd. (sta 8+36)

Outlet Channel

Trapezoidal shape
Side slope = 4:1
Bottom width = 20'
$n = 0.025$
$S_o = 0.2372$ %



Find d:

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

$$188 = \frac{1.486}{0.025} (0.002372)^{1/2} (R)^{2/3} A$$

By Trial & Error

$d = 1.86'$, $Q = 188.8 \simeq 138$ ok.

DYSART CHANNEL (See Cross Sect. above)

$Q = 188 + 50 = 238$ cfs See D.A. #9
$n = 0.025$
$B = 20'$
SS = 4:1

Channel sta to sta	Slope (%)	Depth (ft)	Velocity (fps)
147+01 to 151+85.31	0.2372	2.11	3.97
144+31.70 to 146+01	0.2363	2.11	3.96
126+91 to 144+31.70	0.2051	2.19	3.77
122+00 to 125+91	0.2061	2.19	3.78

USE 4.0 fps (see const plans)

P.46

PRODUCT 204-1 (Single Sheets) 205-1 (Padded) NEBS Inc., Groton, Mass. 01471. To Order PHONE TOLL FREE 1-800-225-6380

PROJECT: DYSART RD (68644)	STATION: 122+15	CULVERT DESIGN FORM
	SHEET ____ OF ____	DESIGNER / DATE: SHM / 9/30/92
		REVIEWER / DATE: ____ / ____

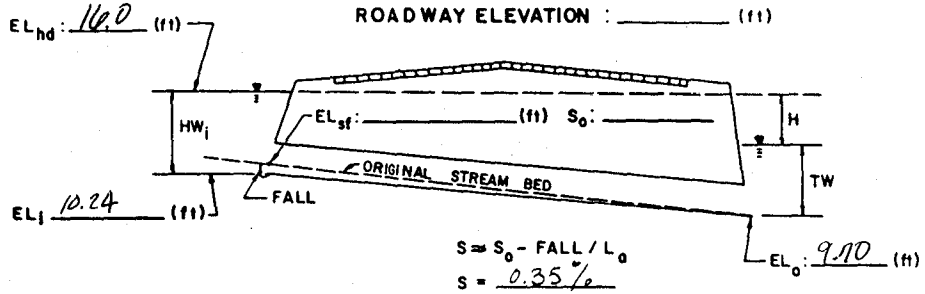
HYDROLOGICAL DATA

SEE ADD'L. SHTS.

- ☐ METHOD: Provided By County (CVL's Report)
- ☐ DRAINAGE AREA: ____ ☐ STREAM SLOPE: ____
- ☐ CHANNEL SHAPE: ____
- ☐ ROUTING: ____ ☐ OTHER: ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
100	265	2.61'



$S \approx S_o - FALL / L_o$

$S = 0.35\%$

$L_o = 155$

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
Conc., Circular, 3-42", HWL w/ Groove end	265	88.3	1.25	5.08	–	15.32	2.61	2.9	3.2	3.2	0.2	2.7	15.60	15.60	10.6	ok.

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

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

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

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

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

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

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

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

SUBSCRIPT DEFINITIONS:

- o. 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:

Outlet protection Required

CULVERT BARREL SELECTED:

SIZE: 3-42"

SHAPE: Circular

MATERIAL: Conc. n 0.012

ENTRANCE: HWL W/ Groove End

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Z & H ENGINEERING, INC.
717 West Dunlap Avenue
PHOENIX, ARIZONA 85021
(602) 997-7536

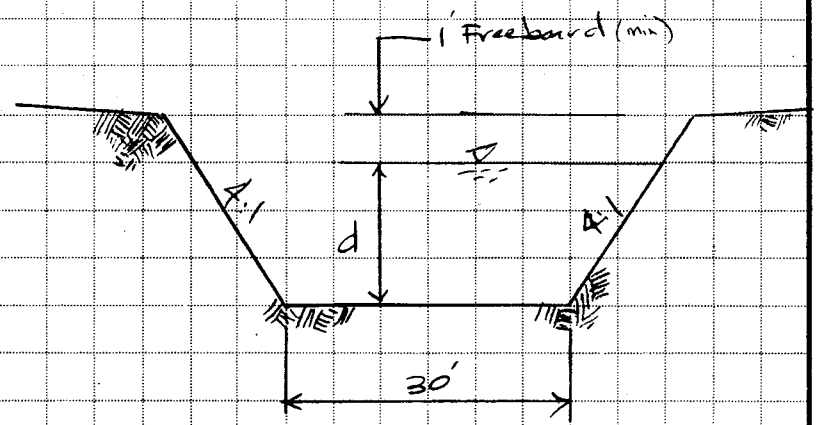
JOB _____
SHEET NO. _____ OF _____
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____
SCALE _____

CHANNEL ALONG RID CANAL

The following Cross Section has been Assummed in order to Select the Culverts under crossing Dysart Road. The final design of this channel to be performed by Erickson & Salmon as part of project No. 68204.

CHANNEL DATA:

Trapezoidal shape
Bottom width = 20'
S_o = 0.2000 %
Side slopes = 4:1
n = 0.025



$Q_{100} = 188 + 265 = 435$ (a conservative figure)

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

By Trial & Error $\Rightarrow$ $d = 2.61'$ for $Q = 452.6 \simeq 453$ cfs ok

PRODUCT 204-1 NEBS Inc. Groton, Mass. 01471

APPENDIX

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Z & H ENGINEERING Date: 4/7/93

LOCATION DATA

Location: STA. 192+68 RT.

Project Name: DYSART ROAD Subarea id: 1

Drainage Area Cover: ROAD R/W

DESIGN DATA

Drainage Area	1.72	acres
Watercourse Length	1289.0	feet
Top Elevation	43.4	feet
Bottom Elevation	34.7	feet
Slope	.00675	feet/feet
Roughness Coefficient (Kb)	.03400	
10-Year, 6-Hour Rainfall	2.00	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	3	4	5	7	9	10
C	0.690	0.690	0.690	0.759	0.828	0.863
Tc (min)	13.6	12.0	11.4	10.2	9.7	9.2
i (in/hr)	2.5	3.4	3.9	5.3	6.0	7.0

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Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Z & H ENGINEERING Date: 4/7/93

LOCATION DATA

Location: STA. 179+38 RT.

Project Name: DYSART ROAD Subarea id: 2

Drainage Area Cover: ROAD R/W

DESIGN DATA

Drainage Area	3.49	acres
Watercourse Length	2619.0	feet
Top Elevation	43.4	feet
Bottom Elevation	29.0	feet
Slope	.00553	feet/feet
Roughness Coefficient (Kb)	.03400	
10-Year, 6-Hour Rainfall	2.00	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	5	6	8	11	14	17
C	0.690	0.690	0.690	0.759	0.828	0.863
Tc (min)	23.0	20.2	18.7	17.0	16.0	15.1
i (in/hr)	1.9	2.6	3.2	4.1	4.9	5.7

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Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Z & H ENGINEERING Date: 4/7/93

LOCATION DATA

Location: STA. 168+79 RT.

Project Name: DYSART ROAD Subarea id: 3

Drainage Area Cover: ROAD R/W

DESIGN DATA

Drainage Area	4.90	acres
Watercourse Length	3678.0	feet
Top Elevation	43.4	feet
Bottom Elevation	24.3	feet
Slope	.00520	feet/feet
Roughness Coefficient (Kb)	.03400	
10-Year, 6-Hour Rainfall	2.00	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	5	8	10	14	18	21
C	0.690	0.690	0.690	0.759	0.828	0.863
Tc (min)	29.8	25.9	23.5	21.4	20.2	19.0
i (in/hr)	1.6	2.2	2.9	3.7	4.3	5.1

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Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Z & H ENGINEERING Date: 4/7/93

LOCATION DATA

Location: STA. 153+25 RT.

Project Name: DYSART ROAD Subarea id: 4

Drainage Area Cover: ROAD R/W

DESIGN DATA

Drainage Area	10.20	acres
Watercourse Length	5277.0	feet
Top Elevation	43.4	feet
Bottom Elevation	20.3	feet
Slope	.00439	feet/feet
Roughness Coefficient (Kb)	.03400	
10-Year, 6-Hour Rainfall	2.00	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	8	12	17	24	31	37
C	0.680	0.680	0.680	0.748	0.816	0.850
Tc (min)	42.2	35.8	32.0	28.8	27.1	25.6
i (in/hr)	1.2	1.8	2.4	3.2	3.7	4.3

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Z & H ENGINEERING Date: 4/7/93

LOCATION DATA

Location: STA. 152+35 RT.

Project Name: DYSART ROAD Subarea id: 5

Drainage Area Cover: ROAD R/W

DESIGN DATA

Drainage Area	13.40	acres
Watercourse Length	5277.0	feet
Top Elevation	43.4	feet
Bottom Elevation	20.3	feet
Slope	.00439	feet/feet
Roughness Coefficient (Kb)	.03400	
10-Year, 6-Hour Rainfall	2.00	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	10	16	22	32	40	49
C	0.680	0.680	0.680	0.748	0.816	0.850
Tc (min)	42.2	35.8	32.0	28.8	27.1	25.6
i (in/hr)	1.2	1.8	2.4	3.2	3.7	4.3

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Z & H ENGINEERING Date: 4/7/93

LOCATION DATA

Location: STA. 152+35 RT.

Project Name: DYSART ROAD Subarea id: 5A

Drainage Area Cover: ROAD R/W

DESIGN DATA

Drainage Area	3.16	acres
Watercourse Length	2500.0	feet
Top Elevation	27.0	feet
Bottom Elevation	20.6	feet
Slope	.00256	feet/feet
Roughness Coefficient (Kb)	.03400	
10-Year, 6-Hour Rainfall	2.00	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	3	5	6	9	11	13
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	31.0	26.9	24.3	22.1	20.8	19.7
i (in/hr)	1.5	2.2	2.8	3.7	4.3	5.0

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Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Z & H ENGINEERING Date: 4/7/93

LOCATION DATA

Location: STA. 194+23 LT.

Project Name: DYSART ROAD Subarea id: 6

Drainage Area Cover: ROAD R/W

DESIGN DATA

Drainage Area	2.00	acres
Watercourse Length	1134.0	feet
Top Elevation	43.4	feet
Bottom Elevation	33.9	feet
Slope	.00840	feet/feet
Roughness Coefficient (Kb)	.03400	
10-Year, 6-Hour Rainfall	2.00	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	3	5	5	8	10	12
C	0.650	0.650	0.650	0.715	0.780	0.813
Tc (min)	11.6	10.3	9.8	8.8	8.3	7.9
i (in/hr)	2.7	3.7	4.2	5.6	6.4	7.4

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Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Z & H ENGINEERING Date: 4/7/93

LOCATION DATA

Location: STA. 167+26 LT.

Project Name: DYSART ROAD Subarea id: 7

Drainage Area Cover: ROAD R/W

DESIGN DATA

Drainage Area	6.80	acres
Watercourse Length	3831.0	feet
Top Elevation	43.4	feet
Bottom Elevation	22.1	feet
Slope	.00558	feet/feet
Roughness Coefficient (Kb)	.03400	
10-Year, 6-Hour Rainfall	2.00	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	7	10	13	18	23	28
C	0.650	0.650	0.650	0.715	0.780	0.813
Tc (min)	29.7	25.9	23.5	21.3	20.1	19.0
i (in/hr)	1.6	2.2	2.9	3.7	4.3	5.1

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Z & H ENGINEERING Date: 4/7/93

LOCATION DATA

Location: STA. 153+55 LT

Project Name: DYSART ROAD Subarea id: 8

Drainage Area Cover: ROAD R/W

DESIGN DATA

Drainage Area	9.20	acres
Watercourse Length	5202.0	feet
Top Elevation	43.4	feet
Bottom Elevation	19.0	feet
Slope	.00471	feet/feet
Roughness Coefficient (Kb)	.03400	
10-Year, 6-Hour Rainfall	2.00	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	7	11	15	21	27	33
C	0.650	0.650	0.650	0.715	0.780	0.813
Tc (min)	40.3	34.4	30.8	27.7	26.1	24.7
i (in/hr)	1.2	1.8	2.4	3.2	3.8	4.4

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Z & H ENGINEERING Date: 4/7/93

LOCATION DATA

Location: STA. 152+00 LT.

Project Name: DYSART ROAD Subarea id: 9

Drainage Area Cover: ROAD R/W

DESIGN DATA

Drainage Area	22.60 acres
Watercourse Length	5527.0 feet
Top Elevation	43.4 feet
Bottom Elevation	19.5 feet
Slope	.00433 feet/feet
Roughness Coefficient (Kb)	.03400
10-Year, 6-Hour Rainfall	2.00 inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	17	26	35	51	66	79
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	44.0	37.2	33.2	29.8	28.0	26.5
i (in/hr)	1.1	1.7	2.3	3.1	3.6	4.2

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Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Z & H ENGINEERING Date: 4/7/93

LOCATION DATA

Location: STA. 128+37 RT.

Project Name: DYSART ROAD Subarea id: 10

Drainage Area Cover: ROAD R/W

DESIGN DATA

Drainage Area	4.46 acres
Watercourse Length	2443.0 feet
Top Elevation	22.4 feet
Bottom Elevation	14.1 feet
Slope	.00339 feet/feet
Roughness Coefficient (Kb)	.03400
10-Year, 6-Hour Rainfall	2.00 inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	5	7	9	12	16	19
C	0.650	0.650	0.650	0.715	0.780	0.813
Tc (min)	26.9	23.5	21.5	19.7	18.5	17.4
i (in/hr)	1.7	2.4	3.1	3.8	4.5	5.3

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Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Z & H ENGINEERING Date: 4/8/93

LOCATION DATA

Location: STA. 206+35 RT.

Project Name: DYSART ROAD Subarea id: 11

Drainage Area Cover: ROAD R/W

DESIGN DATA

Drainage Area	2.40	acres
Watercourse Length	2392.0	feet
Top Elevation	51.7	feet
Bottom Elevation	41.5	feet
Slope	.00426	feet/feet
Roughness Coefficient (Kb)	.03400	
10-Year, 6-Hour Rainfall	2.00	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	3	4	5	7	9	11
C	0.660	0.660	0.660	0.726	0.792	0.825
Tc (min)	24.1	21.1	19.5	17.8	16.7	15.8
i (in/hr)	1.8	2.6	3.2	4.1	4.8	5.5

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Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Z & H ENGINEERING Date: 4/8/93

LOCATION DATA

Location: STA. 209+12 LT.

Project Name: DYSART ROAD Subarea id: 12

Drainage Area Cover: ROAD R/W

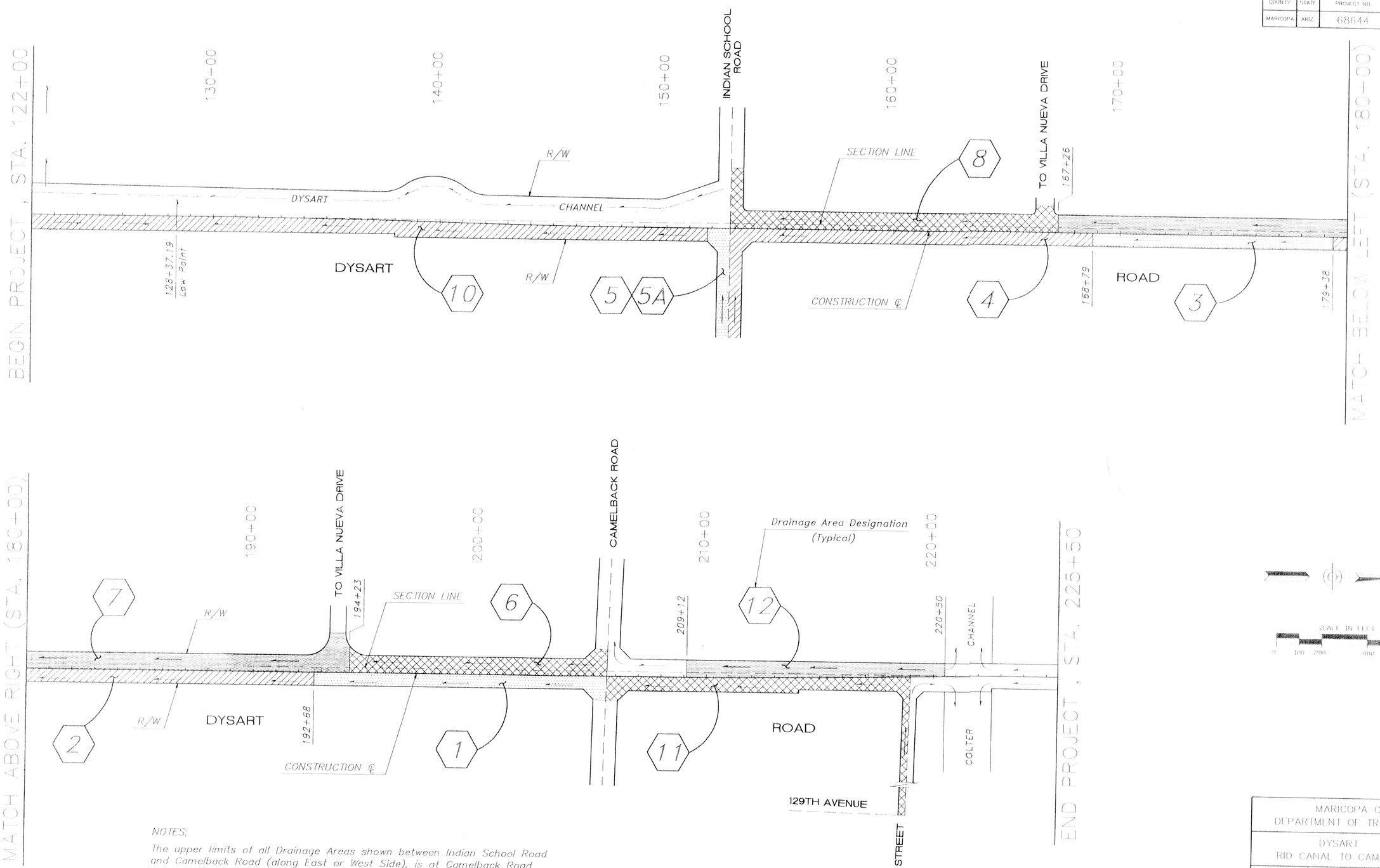
DESIGN DATA

Drainage Area	1.72	acres
Watercourse Length	1138.0	feet
Top Elevation	51.9	feet
Bottom Elevation	43.6	feet
Slope	.00734	feet/feet
Roughness Coefficient (Kb)	.03400	
10-Year, 6-Hour Rainfall	2.00	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	3	4	5	7	8	10
C	0.650	0.650	0.650	0.715	0.780	0.813
Tc (min)	12.2	10.8	10.3	9.2	8.8	8.3
i (in/hr)	2.6	3.6	4.1	5.5	6.3	7.3

COUNTY	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
MARICOPA	ARIZ	68644			



NOTES:

The upper limits of all Drainage Areas shown between Indian School Road and Camelback Road (along East or West Side), is at Camelback Road Monument Line.

For example: 1) Area designated as Drainage Area # 4 includes Drainage Areas # 4, 3, 2, and 1.
2) Area designated as Drainage Area # 8 includes Drainage Areas # 8, 7 and 6.

MARICOPA COUNTY
DEPARTMENT OF TRANSPORTATION

DYSART ROAD
RID CANAL TO CAMELBACK ROAD

	NAME	DATE
DESIGN	SHM	4/93
DRAWN	KJH	4/93
CHECKED		

Z & H Engineering, Inc.
717 WEST DUNLAP AVENUE
PHOENIX, ARIZONA 85021
PHONE (602) 997-7536

ON-SITE DRAINAGE MAP

SHEET 1 OF 1

Plot Date 04-14-93