APPENDIX E
DESIGN FORMS AND CHECKLISTS

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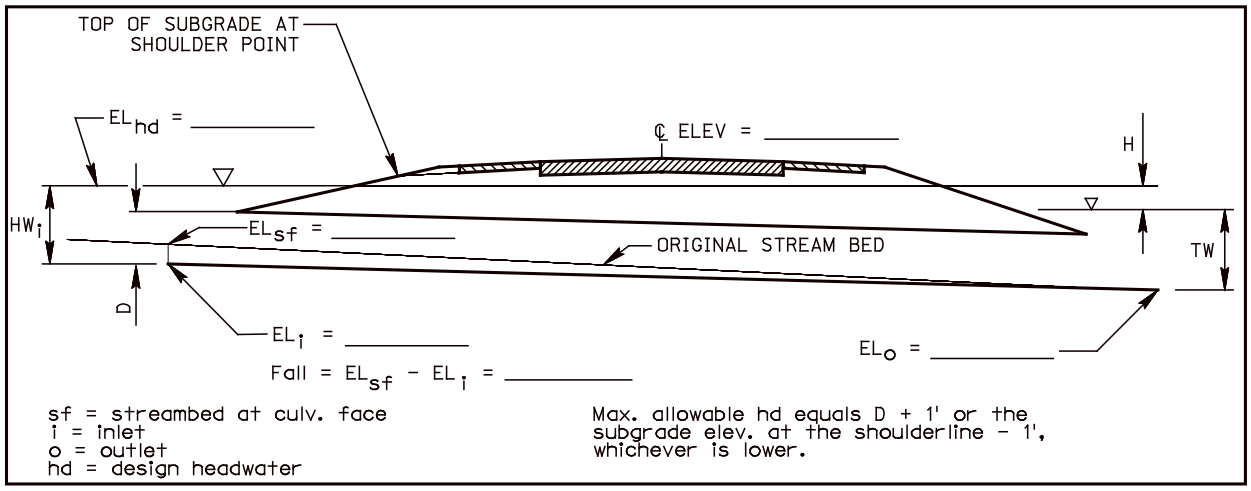


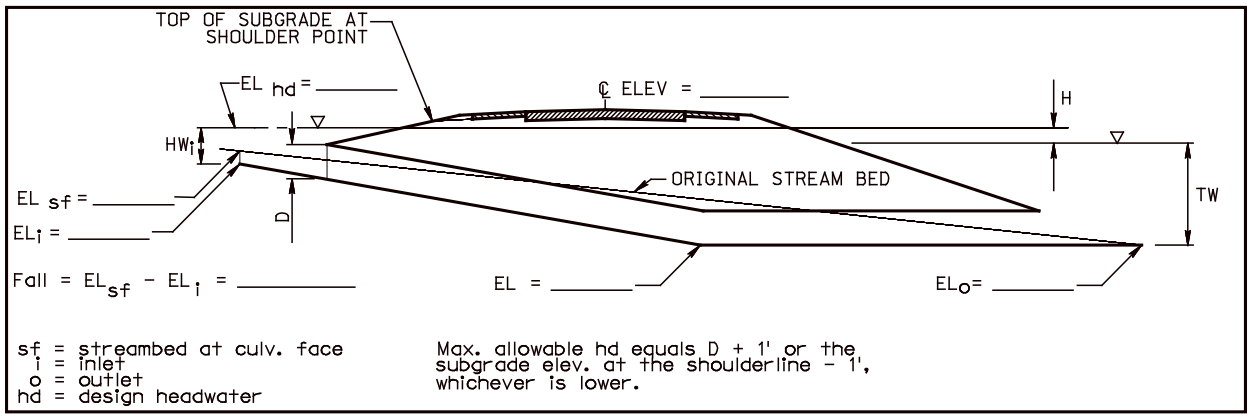
Project Location: _____

Project No: _____ Control No: _____ Designer: _____

Culvert Station: _____ Stream Name: _____

1- Roadway Design Standard _____
2- Average Daily Traffic (and date) _____
3- Design Frequency _____
   Comments _____
4- Design Discharge _____
5- Design Tailwater Level _____
6- Vertical Orientation (Broken Back, Breaks?) _____
7- Slope:
   Upstream: _____ Culvert: _____ Downstream: _____
8- Horizontal Orientation _____
9- Skew _____
10- Fill Height (See the "Pipe Material Policy"):
   Maximum _____ Minimum _____
11- Culvert Shape:
   Circular: _____ Box or Rectangular: _____ Arch: _____ Elliptical: _____
12- Culvert Type:
   Concrete: _____ Metal: _____ Plastic: _____
13- End Treatment, (FES, Headwall, etc.) _____
14- Design Headwater:
   Depth: _____ Elevation: _____
15- Elevations of Buildings / Upstream Considerations _____
   Comments _____
16- Outlet Velocity _____
17- Downstream Considerations _____
18- Velocity Protection Device _____
19- Velocity Control Device _____
20- Alternates Considered _____
21- Economic Comparison of Alternatives _____
22- Comments _____

Exhibit E.1 Culvert Design Checklist/Data



Project Location: _____

Project No: _____ Control No: _____ Designer: _____

Culvert Station: _____ Stream Name: _____

1- Roadway Design Standard _____
2- Average Daily Traffic (and date) _____
3- Design Frequency _____
   Comments _____
4- Design Discharge _____
5- Design Tailwater Level _____
6- Vertical Orientation (Broken Back, Breaks?) _____
7- Slope:
   Upstream: _____ Culvert: _____ Culvert: _____
   Culvert: _____ Downstream: _____
8- Horizontal Orientation _____
9- Skew _____
10- Fill Height (See the "Pipe Material Policy"):
   Maximum_____ Minimum_____
11- Culvert Shape:
   Circular: _____ Box or Rectangular: _____ Arch: _____ Elliptical: _____
12- Culvert Type:
   Concrete: _____ Metal: _____ Plastic: _____
13- End Treatment (FES, Headwall, etc.) _____
14- Design Headwater:
   Depth: _____ Elevation: _____
15- Elevations of Buildings / Upstream Considerations _____
   Comments _____
16- Outlet Velocity _____
17- Downstream Considerations _____
18- Velocity Protection Device _____
19- Velocity Control Device _____
20- Alternates Considered _____
21- Economic Comparison of Alternatives _____
22- Comments _____

Exhibit E.2 Culvert Design Checklist/Data

PROJECT: _____ STATION: _____ CULVERT DESIGN FORM

C.N. _____ SHEET _____ OF _____ DESIGNER/DATE: _____ / _____

REVIEWER/DATE: _____ / _____

HYDROLOGICAL DATA

☐ METHOD: _____

☐ DRAINAGE AREA: ____ ☐ STREAM SLOPE: ____

☐ CHANNEL SHAPE: _____

☐ ROUTING: _____ ☐ OTHER: _____

DESIGN FLOWS/TAILWATER

R.I. (YEARS) FLOW (cfs) TW (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)	Inlet Control HW_i	Inlet Control FALL (3)	Inlet Control EL_{hi} (4)	Outlet Control TW (5)	Outlet Control d_c	Outlet Control $\frac{d_c+D}{2}$	Outlet Control h_o (6)	Outlet Control k_e	Outlet Control H (7)	Outlet Control EL_{ho} (8)	CONTROL HEADWATER ELEVATIONS	OUTLET VELOCITY	COMMENTS

TECHNICAL FOOTNOTES:

(1) Use Q/NB for box culverts

(2) HW_i/D = HW/D or HW_i/D from design charts

(3) Fall = $EL_{sf} - EL_i$; fall is zero for culverts on grade

(4) $EL_{hi} = HW_i + EL_i$ (Invert of inlet control section)

(5) TW based on downstream control or flow depth in channel.

(6) h_o = TW or $(d_c+D/2)$ (Whichever is greater)

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

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

COMMENTS/DISCUSSION:

CULVERT BARREL SELECTED:

SIZE: _____

SHAPE: _____

MATERIAL: _____ n _____

ENTRANCE: _____

DEFINITIONS:

A. Cross-Sectional Area of the Barrel
a. Approximate
d_c. Critical Depth
D. Interior Height of Culv. Barrel
f. Culvert Face
g. Acceleration Due to Gravity (32.2 ft/s/s)
hd. Design Headwater
h_i. Headwater in Inlet Control
h_o. Headwater in Outlet Control
I. Inlet Control Section
k_e. Entrance Loss Coefficient
L. Length of Culvert Barrel
N. Number of Culvert Barrels
NB. Number of Boxes
o. Outlet
Q. Uniform Discharge, cfs
S. Slope of Culvert
sf. Streambed at Culvert Face
TW. Tailwater Depth Above the Outlet Invert
V. Average Velocity in Culv. Barrel (V=Q/A)

Exhibit E.3 Culvert Design Form

Drainage Computation Form

Location:	__________	Return Period:	__________	Computed By:	__________
Project Name:	__________	Zone:	__________	Date:	__________
Project No.:	__________	Drainage Area:	__________	Checked By:	__________
		Pipe Material:	__________	Date:	__________
		N Value:	__________	Page:	__________

HYDROLOGY												STORM SEWER HYDRAULICS					
							INCREMENTAL			CUMULATIVE							
STR. No.	Sta.	From / To	Inlet Time T_i (min)	Travel Time T_t (min)	Time of Conc. T_c (min)	Rainfall Intensity I (in/hr)	Area A (acres)	Runoff Coeff. C	C x A	C x A	Runoff Q (cfs)	Length (ft)	Slope (%)	Size (in)	Capacity Q_{full} (cfs)	Vel V_{full} (fps)	Remarks

Exhibit E.4 Drainage Computation Form

Hydraulic Grade Line Computation Form

Location: ______________________
Project Name: ______________________
Project No.: ______________________

Return Period: ______________________
Zone: ______________________

Computed By: ______________________
Date: ______________________
Checked By: ______________________
Date: ______________________
Page: ______________________

HYDRAULIC GRADE LINE CALCULATIONS

		PIPE DATA														ENERGY LOSSES							
STR. No.	Sta.	From / To	Pipe Size (in)	n	Pipe Length (ft)	Pipe Slope (%)	Area A (acres)	Runoff q (cfs)	V (q) (fps)	Capacity Q full (cfs)	q/Q full	d/D	Normal Depth (ft)	Critical Depth (ft)	Type of Flow	H_f (ft)	H_j2 (ft)	H_e (ft)	H_m (ft)	H_b (ft)	EGL Eleva.	Vel. Head (ft)	HGL Eleva.

Exhibit E.5 Hydraulic Grade Line Computation Form