DRAINAGE GUIDANCE MANUAL

APPENDIX A

DRAINAGE FORMS

ENGINEERING "NO-RISE" CERTIFICATION

This is to certify that I am duly qualified engineer licensed to practice in the State of _____.

It is to further certify that the attached technical data supports the fact that proposed _____

_____ will not impact
(Name of Development)

the 100-year flood elevations, floodway elevations and floodway widths on _____
(Name of Stream)

at published sections in the Flood Insurance Study for

_____, dated
(Name of Community)

_____ and will not impact the 100-year flood elevations, floodway elevations, and floodway widths at unpublished cross-sections in the vicinity of the proposed development.

_____ _____
(Date) (Signature)

_____
(Title)

SEAL:

_____
(Address)

FEMA, NTHD
8/91

Federal Emergency Management Agency

Region IV
1371 Peachtree Street, NE, Suite 700
Atlanta, GA 30309

Data Request Checklist for A Conditional Letter of Map Revision

Requestor: _____ Date: _____

The information checked below in Column 1 is required to process the request for a conditional Letter of Map Revision. Information checked in Column 2 has been received and should not be resubmitted unless specifically requested.

(1) Req'd Data	(2) Rec'd Data			
_____	_____	1.	Initial fee for conditional Letter of Map Revision: (Checks made to UNITED STATES TREASURY.)	
_____	_____		a. New bridge or culvert (no channelization)	$350
_____	_____		b. Channel modifications only	$400
_____	_____		c. Channel modification and new bridge or culvert	$525
_____	_____		d. Levees, berms or other structural measures	$675
_____	_____	2.	A concise statement indicating the natural and extent of the proposed revision requested for the FIS/FIRM.	
_____	_____	3.	Letter from the community requesting a revision to the FIS/FIRM.	
_____	_____	4.	State approval of the proposed revision.	
_____	_____	5.	A brief statement describing the methodology used to determine hydrologic and/or hydraulic parameters (revised existing and/or proposed).	
_____	_____	6.	New/Revised hydrologic analyses (including a Summary of Discharges table) for existing conditions.	
_____	_____	7.	New/Revised hydrologic analyses (including a Summary of Discharges table) for proposed conditions.	
_____	_____	8.	Hydraulic analyses (computer models - input and output) which duplicate the hydraulic analyses used for the effective FIS (baseline model) for the following frequency floods: 10-, 50-, 100-, and 500-year floods and floodway.	

———	———	9.	New/Revised hydraulic analyses (computer models - input and output) for <u>existing</u> conditions for the following frequency floods: 10-, 50-, 100-, and 500-year floods and floodway.
———	———	10.	New/Revised hydraulic analyses (computer models - input and output) for <u>proposed</u> conditions for the following frequency floods: 10-, 50-, 100-, and 500-year floods and floodway.
———	———	11.	Certified topographic work map with existing and proposed topography showing revised existing and/or proposed 100- and 500 year flood boundaries, 100-year floodway, base flood elevations, cross sections, stream alignment, and road alignment.
———	———	12.	Annotated FIRM and/or Flood Boundary and Floodway Map (FBFM) showing revised existing and/or proposed 100- and 500-year flood boundaries, 100-year floodway, base flood alignment, and corporate limits.
———	———	13.	Annotated FIS flood profile(s) showing revised existing and/or proposed 10-, 50-, 100-, and 500-year flood profiles.
———	———	14.	Annotated FIS Floodway Data Table(s) showing revised existing and/or proposed floodway data.
———	———	15.	Certified construction plans for the proposed floodway modifications.
———	———	16.	Certification from a Federal agency or registered professional engineer indicating proposed structural flood protection measures are adequately designed and will be maintained to withstand a 100-year flood.
———	———	17.	A draft copy of an operation and maintenance plan for any proposed structural flood protection measures.
———	———	18.	Written statement from the community indicating they will accept ultimate responsibility for maintenance of a structural flood protection system.
———	———	19.	Study which addresses interior drainage for area to be protected by a proposed levee or dike system.

_____ _____ 20. Documentation supporting one of the following:

a. A public notice stating the community's intent to revise the floodway.

b. Evidence indicating the entire floodway revision is contained on the appellant's property.

_____ _____ 21. Other: _____

_____

_____

_____

** Please note the submittal of the items listed on the above list will initiate the review process. However, as the review progresses, you may be asked to submit additional information including, but not limited to, those data listed above.

Kentucky Transportation Cabinet Division of Design 7-93	DRAINAGE DESIGN SUMMARY TC 61-100	1 of 2

County :	Route :	Item No. :
UPN :	FPN :	Station :

EXISTING CONDITIONS							
Stream Name :		Drainage Area :				Slope :	
OHW Elev. :	Drift :		Bed Material :			D_{50} :	
Abrasion Level :	pH :		Restivity :			Date Taken :	
Return Interval (Years)	2	5	10	25	50	100	500
Discharge (cfs)							
Flow Depth or Tailwater (ft)							
Velocity (fps)							

PROPOSED STRUCTURE							
Type :		Length, Size, Spans, Skew :					
Lt. Abut. or Inlet Type :			Rt. Abut. or Outlet Type :				
Coating :	Cover Height :				Low Road Elev. :		
Net Opening :	Low Beam Elev. :				Grate Elev. :		
Slope :	Inlet Elev. :				Outlet Elev. :		
Alternates	1.		2.		3.		
WSEL w/Structure							
WSEL w/o Structure							
Velocity w/Structure (fps)							
Q over Road Lt / Rt (cfs)	/	/	/	/	/	/	/

EXISTING STRUCTURE							
Type :		Length, Size, Spans, Skew :					
Lt. Abut. or Inlet Type :			Rt. Abut. or Outlet Type :				
Condition :					Low Road Elev. :		
Net Opening :	Low Beam Elev. :				Grate Elev. :		
Slope :	Inlet Elev. :				Outlet Elev. :		
WSEL w/Structure							
WSEL w/o Structure							
Velocity w/Structure (fps)							
Q over Road Lt / Rt (cfs)	/	/	/	/	/	/	/

DRAINAGE DESIGN SUMMARY : TC 61-100 **(Rev. 6-93)** **2 of 2**

REMARKS and /or CONTROLS

RECORD HIGHWATER DATA

Source	1.	2.	3.
Elevation			
Date			
Location			

PROPOSED CHANNEL LINING

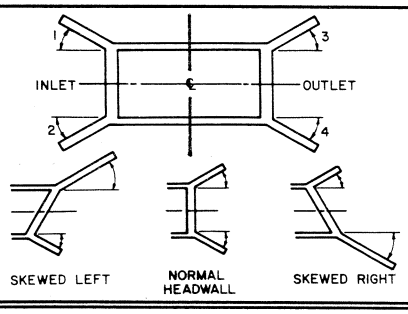
Location	Class	Thickness	Depth Protect	Length	Quantity (Tn)
Upstream					
Downstream					

PROPOSED DETOUR

Flooding	Return Interval	Discharge	Elevation
Design			
Overflow			

Recommended Size and Type of Opening(s)

PROPOSED BOX CULVERT OR SPECIAL WINGWALL ANGLES



	Normal End ?		Skewed End ?	
Location	1	2	3	4
30 Degree				
Skewed				
Special				

OTHER SITE SPECIFIC INFORMATION

KENTUCKY TRANSPORTATION CABINET
Division of Design

TC 61–102
Rev. 10/91

HYDRAULIC SITE DESCRIPTION

Date _____ Weather _____

Personnel _____

_____

1. County _____ 2. Road Name _____
3. UPN _____ 3a. Federal Number _____
4. Station _____ 5. _____

6. **CHANNEL DESCRIPTION**

Straight ☐ Twisting ☐ Banks Lined With Trees ☐ Islands ☐ Rock Bottom ☐

Suggested mannings "n" value *(See Drainage Manual)* _____ Channel appears Clear ☐ Restricted ☐

Remarks: _____

_____

_____

7. **SOIL DESCRIPTION**

Clay (*Hard and Non–Porous*) ☐ Loam (*Soft and Porous*) ☐ Rocky ☐

If rocky, what type (*limestone, sandstone, etc.*) _____ Apparent rock depth _____

8. **DRIFT**

Is drift present? Yes ☐ No ☐ If so, is it: Light ☐ Heavy ☐ Would multiple barrel structure pick up drift? Yes ☐ No ☐

Remarks: _____

_____

_____

9. **HIGH WATER**

Annual _____ Average _____ Extreme _____

Date _____ Name source of information _____

Pool stage _____ Is there backwater at the outlet? Yes ☐ No ☐

Explain: _____

_____

Elevation at which high water causes damage _____ Houses ☐ Buildings ☐ Other ☐

Explain: _____

_____

Elevation of ground at building _____ Elevation of basement floor _____

Elevation of ground floor _____ Other elevations _____

10. **EXISTING STRUCTURE**

Elevation inlet flood level _____ Elevation outlet flood level _____

Elevation inlet high water _____ Elevation outlet high water _____

Width or Span _____ Height _____ Length or Roadway Width (*Show sketch*) _____

Is existing structure Too small ☐ Too large ☐ Does water go over road? Yes ☐ No ☐

Description of existing structure (*Bridge, pipe, box, concrete, steel, stone, etc.*) _____

_____

Name of stream _____

Remarks: _____

_____

_____

Preliminary Drainage (Risk) Assessment
for
Floodplain Encroachments

County:	Route:	Station:
UPN:	FPN:	Item No:

LEVEL 1 - Qualitative assessment involving the application of hydrologic, hydraulic, and geomorphic factors to identify potential problems and alternative solutions.

Do Hydrology.

Do Field Survey (i.e. bridge opening, roadway profile, stream profile, hydraulic sections, etc.).

Review (check) available documentation: ☐ Bridge Maintenance File ☐ Bridge Plans
☐ County Soils Study ☐ Old Drainage Folder ☐ Flood Insurance Maps
☐ Flood Insurance Study ☐ Geologic Maps ☐ Roadway Plans
☐ USCOE Study ☐ USGS Study Other: _____

Identify Problems: _____
_____ Problems Solved? ☐ Yes ☐ No; if No, go to LEVEL 2.

If the proposed structure is a new crossing, go to LEVEL 2.

If the proposed crossing is >2 bridge widths up or downstream, > 1' grade change, > 50' (total bridge length) multispan, > 100' single span, or in a Regulatory Floodway; go to LEVEL 2.

Replace with hydrologic, hydraulic, and geomorphically Equivalent Crossing.

Document Design.

LEVEL 2 - Quantitative analysis combined with a more detailed qualitative assessment of the hydrologic, hydraulic, and geomorphic factors of the stream.

List Design Controls (i.e. hydraulic, roadway, structure, surrounding property, etc.): _____
_____

Do Stream Stability Analysis.

Do Hydraulic Analysis.

Do Scour Analysis.

Were the Design Controls met? ☐ Yes ☐ No; if No, explain; then go to LEVEL 3: _____
_____

If the deck area is > 125,000 square feet; go to LEVEL 3.

If the existing or proposed structure is a unique bridge, foundation, etc.; go to LEVEL 3.

Document Design.

LEVEL 3 - Complex quantitative analysis based on detailed mathematical modeling and possibly physical hydraulic modeling. This analysis is necessary only for high risk locations, extra-ordinarily complex problems, and after the fact analyses where losses and liability costs are high.

Check if used: ☐ FESWMS Analysis ☐ Floodway Modification* ☐ Overflow structure(s)
☐ Risk Analysis Other: _____

*IF EXISTING FLOODWAY WIDTH < PROPOSED, PURCHASE FLOODWAY INCREASE.
IF EXISTING FLOODWAY ELEVATION < PROPOSED, PURCHASE FLOODPLAIN INCREASE.

Document Design.

Kentucky Transportation Cabinet Division of Design 7-93	**INLET SPACING :** **CURB-OPENING, GRATED, & SLOTTED PIPE INLETS**	**TC 61-120** **Page of**
County :	Route :	Proj. No. :	Item No. :

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Sta. Loc.	CA	Q	Qc	Qa	Sx	Sw / Sx	So	T/W	T	d	V	W/T	Eo	Se	Lt	L/Lt	Rf	1-Eo	Rs	E	Qi	Qc

ALL INLETS : da = _____ Ta = _____ I = _____ n = _____ Wg = _____ Lg = _____ a = _____ Li = _____

SAG INLETS : Q_{SUM} = _____ Cw = _____ Co = _____ h = _____ do = _____ A/2 = _____ P/2 = _____

Kentucky Transportation Cabinet Division of Design 7-93	**BRIDGE AND CULVERT SUMMARY : TC 61-504** **Page of**

County :	Route :	Item No.
Road Name :		
UPN :	FPN :	Folder No. :
Type of Work :		Section :
Designer :	Reviewer :	
Termini :		

Bridges :	Box Culverts :	Pipe Culverts :
Arch Culverts :	Entrance Pipes :	Box Inlets :
Channel Changes :	Other :	

Station	Structure	Structure	Drawing No.	Remarks	Page

Kentucky Transportation Cabinet
Division of Design 7-93

STORM SEWER DESIGN : COMPUTATION TABLE

TC 61-505

Page of

County : | Route : | Proj. No. : | Item No. :

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Inlet or	Station	Δ Acre	"C"	Δ CA	Σ CA	Δ T	Σ T	I	Q	Pipe	Pipe	Pipe	Mean	Full	
No.		Acre		Acre	Acre	min	min	in /hr	cfs	LF	ft / ft	in	fps	cfs	

Kentucky Transportation Cabinet Division of Design 7-93	**CHANNEL ANALYSIS :**	**TC 61-507** **Page of**

County :	Item No. :
Project No. :	Route :

Location	Σ Acres	C	Tc	I	Q	Chan. Sect. ss _w_/ ss	n	So	dn	V	Remarks
						___/					
						___/					
						___/					
						___/					
						___/					
						___/					
						___/					
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Kentucky Transportation Cabinet
Division of Design 7-93

ENERGY GRADE LINE :
FOR STORM SEWERS

TC 61-508

Page of

County :	Route :	Proj. No. :	Item No. :

Station	Struct	Q	Inlet Elev.	Inlet								Pipe			HW	Comments
				H/D	H	dc	$\frac{dc+D}{2}$	V	VH	Coeff	H	L	Sf	Hf		

URBANIZATION TECHNIQUE :	(Rev. 6-93)	Page	of
County	Route	Item No.	
UPN	FPN	Station	

Equation --

$$UQ_{RI} = C \times A^{a} \times (13 - BDF)^{-b} \times RQ_{RI}{}^{c}$$

Where --

UQ = Runoff (cfs) for Urbanized Watershed
RI = Return Interval (yrs)
A = Drainage Area (mi^2)
BDF = Basin Development Factor (1 or 0 for each of 12 components in table below)
RQ = Runoff (cfs) from Regional Method Discharges
C, a, b, c = Constants for Equations below.

BASIN DEVELOPMENT FACTOR : BDF				
Portion of Drainage Area	Channel 1 - 2 Improvement	Channel Lining 1- 2	Storm Sewers 1 - 2	Curb & Gutter Streets 2
Upper Third				
Middle Third				
Lower Third				

BDF = _____

Σ above 1's and 0's

NOTES : 1. Assign a "1" to these components when Storm Sewers are ≥ 50% .
2. Assign a "1" to these components when Curb & Gutter Streets are ≥ 50%.

EQUATIONS

$UQ_2 = 13.20 \times \_\_\_\_^{0.21} \times \_\_\_\_^{-0.43} \times \_\_\_\_^{0.73} =$ _____ cfs

$UQ_5 = 10.60 \times \_\_\_\_^{0.17} \times \_\_\_\_^{-0.39} \times \_\_\_\_^{0.78} =$ _____ cfs

$UQ_{10} = 9.51 \times \_\_\_\_^{0.16} \times \_\_\_\_^{-0.36} \times \_\_\_\_^{0.79} =$ _____ cfs

$UQ_{25} = 8.68 \times \_\_\_\_^{0.15} \times \_\_\_\_^{-0.34} \times \_\_\_\_^{0.80} =$ _____ cfs

$UQ_{50} = 8.04 \times \_\_\_\_^{0.15} \times \_\_\_\_^{-0.32} \times \_\_\_\_^{0.81} =$ _____ cfs

$UQ_{100} = 7.70 \times \_\_\_\_^{0.15} \times \_\_\_\_^{-0.32} \times \_\_\_\_^{0.82} =$ _____ cfs

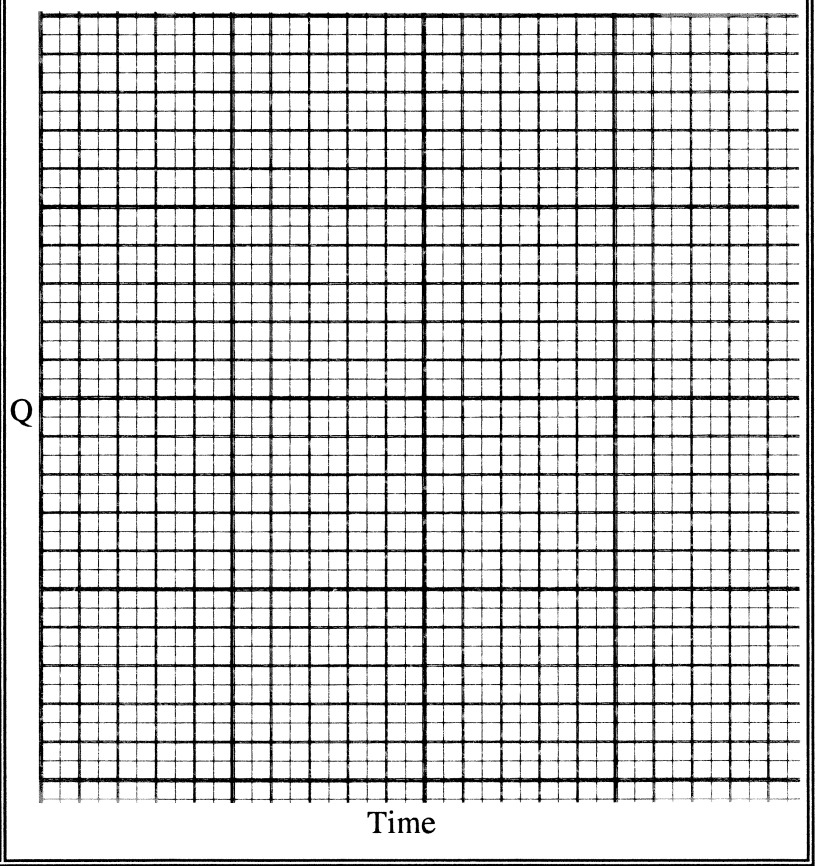
$UQ_{500} = 7.47 \times \_\_\_\_^{0.16} \times \_\_\_\_^{-0.30} \times \_\_\_\_^{0.82} =$ _____ cfs

UNIT HYDROGRAPH COMPUTATIONS : **(Rev. 6-93)** **1 of 4**

County :	Route :	Item No. :
UPN :	FPN :	Station :
Drainage Area (acres) :	C Present :	C Future :

Formulas	Present	Future
Q_____ = CIA		
Tc = Time of Concentration (min)		
Tr = Unit Duration (min) (≤ Tc)		
Tl = Lag Time (min) 0.7 Tc for C = 0.8		
1.0 Tc for C = 0.2		
Tp = Time to Peak (min) = Tc + (Tr / 2)		
Tb = Time of Base (min) 2.5 Tp for C = 0.8		
6.0 Tp for C = 0.2		
TΔ = Routing Interval (min) (≤ Tr)		
RO = Runoff = TΔ min.sec.ft. = 60.5 (A / TΔ)		
b = Unit Base = Tb / TΔ		
Qp = Peak Runoff (cfs) = RO (2 / b)		

Time	Present Q	Future Q



UNIT HYDROGRAPH COMPUTATIONS :		(Rev. 6-93) 2 of 4
County :	Route :	Item No. :
UPN :	FPN :	Station :

TRIAL STORAGE AND PIPE SIZE

Time	RO Future	RO Present	Δ
0	0	0	0

Σ =

Storage = $\frac{\quad}{\Sigma}$ x $\frac{\quad}{T\Delta}$ x 60 = _____ Ft^3

@ Allowable Headwater Elevation _____

Trial Pipe Size (AHW @ Qp for RO Present)

= _____

County :	Route :	Item No :
UPN :	FPN :	Station :

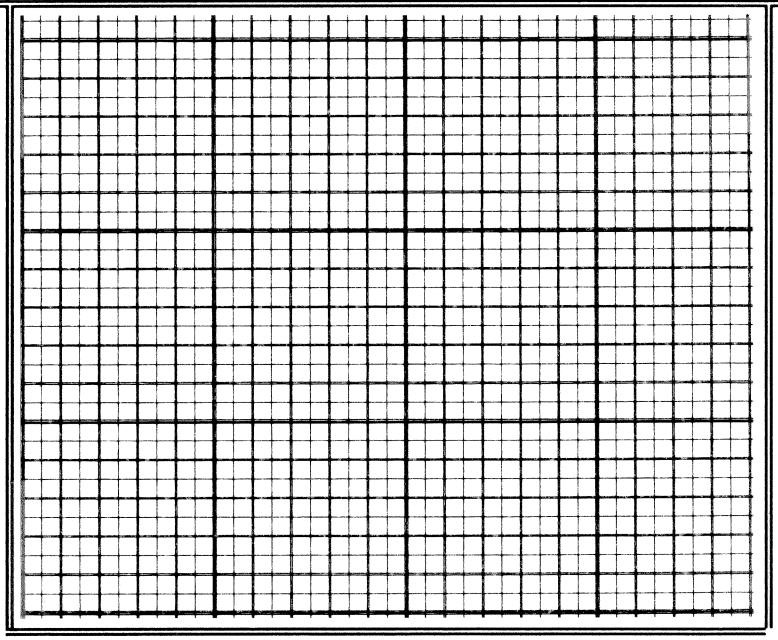
STORAGE OUTFALL

* _____ min.sec.ft. = Vol ft^3 / (_____ min x 60 sec)

Storage , S = Σ Vol

Water Surface		Q	O / 2	Surface Area	Δ Vol	* Δ Vol	S	S + O/2
Elev.	d	cfs		ft^2	ft^3	_____ min.sec. ft		

O (cfs)



S + (O / 2) cfs

UNIT HYDROGRAPH COMPUTATIONS : **(Rev. 6-93)**

County :	Route :	Item No. :
UPN :	FPN :	Station :

RETENTION DETERMINATION

Time	Inflow	Inflow	$S_1 + (O_1 / 2)$	O_1	$S_2 + (O_2 / 2)$	O_2	Remarks
min	cfs	Avg.					

SELECTION OF STREAM HEADWATER : DR-04.942 (Rev. 6-93) Page of

County :	Route :	Item No. :
UPN :	FPN :	Station :

The HEADWATER point on a stream is located at the site where the normal flow is 5 cubic feet per second (cfs).

Use the following equation ---

$$Q_a = 0.290\ A^{1.01}\ E^{0.25}\ I^{1.27}$$

Where :

Q_a = the mean annual discharge or the normal flow in cfs.

A = the drainage area in square miles

E = the mean elevation of the basin in thousands of feet. This is determined by laying a grid on the quad sheet and locating the elevation of five to ten uniformly spaced points. The average of these elevations divided by 1000 is E.

I = the maximum 24-hour 2-year rainfall

1. Determine A for site from USGS quadrangle sheets.
2. Determine E for the watershed.
3. Determine I from Exhibit DR-04.939.
4. Solve the above equation for Q_a.
5. If $Q_a \geq 5$ cfs, site is below the Headwaters for the stream.

A = _____ mi^2

E = _____ ft.

I = _____ in.

Q_a = _____ cfs