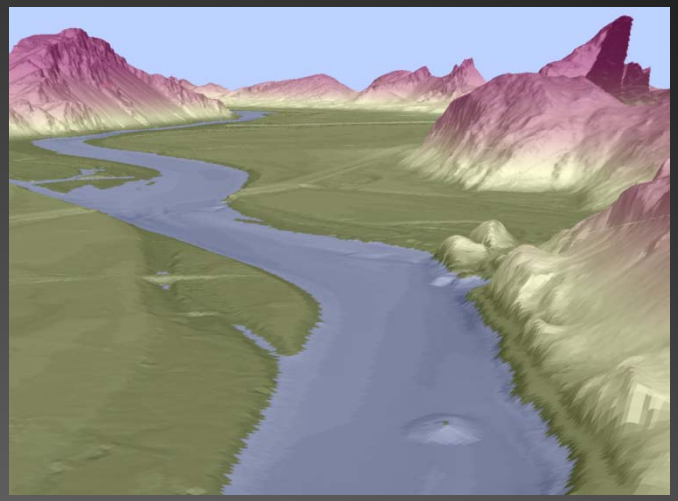
Floodway Encroachment "No-Rise Analysis"

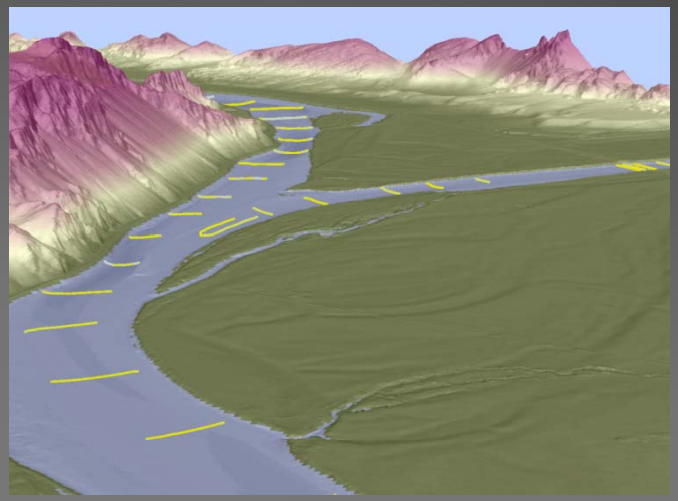
Steve Story, PE, CFM – State Floodplain Engineer

Floodway Encroachment No-Rise Analysis
DETAILED STUDY AREA

Presentation Overview:

- Detailed Study Type
- Floodway Concept
- Regulatory Requirements
- No-Rise Analysis Process





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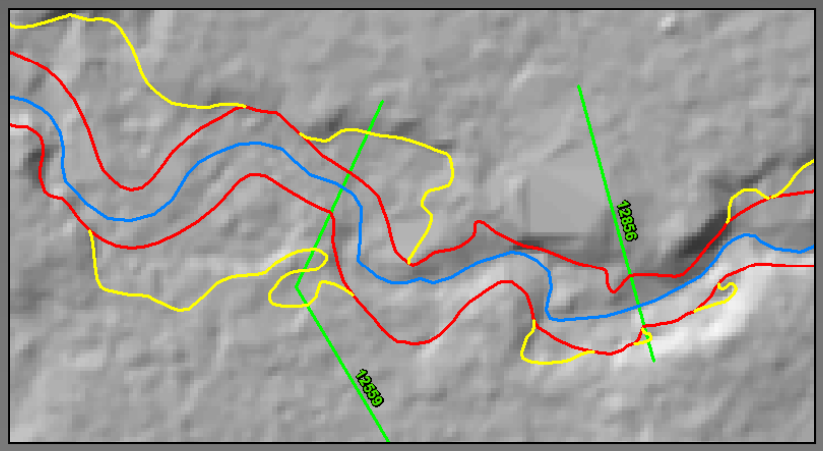
Review – FEMA Floodplain Study Types:

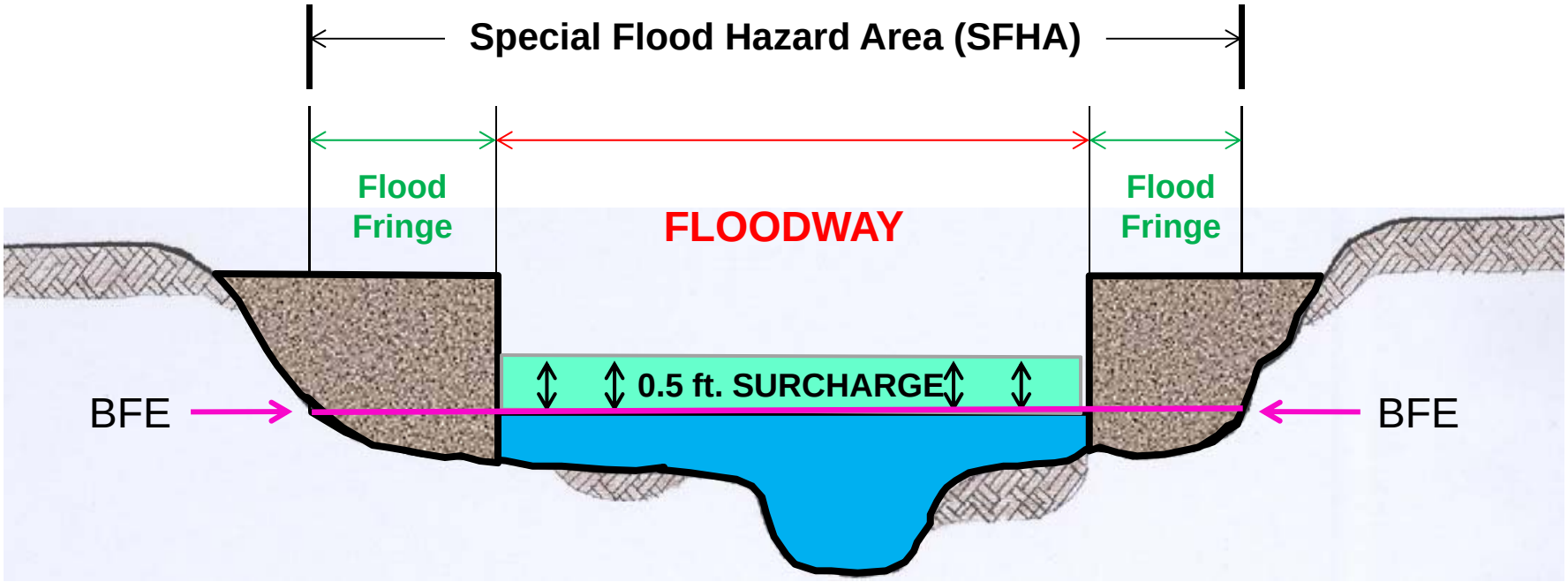
- Know your Floodplain Study Type:
  - Approximate
  - Limited Detail
  - Detailed (Floodway or Fringe)
- Because:
  - Regulations and Development Standards vary according to which study type the project is located.
  - Encroachment Review – approach, methods, and requirements are also variable.

Review – FEMA Floodplain Study Types:

- Detailed/Enhanced Level Study Reach (Zone AE):
  - FIRM/DFIRM: Boundaries include the SFHA (100-yr), 500-yr, and Floodway. BFEs and Cross Section locations shown.
  - FIS Report includes: Floodway Data Table (FWDT) with published BFEs and Profiles for the 10-, 2-, 1-, & 0.2 % annual-chance flood discharges. Hydrologic Data Summary Table.
  - Hydraulic Modeling: based on accurate topography and surveyed structure geometry. May be HEC-RAS, HEC-2, WSP-2, or other.



“Detailed” Study – Includes Delineated Floodway



FLOOD FRINGE - Encroachment Review not necessary

FLOODWAY – Proposed Encroachment activities requires No-Rise Analysis

Review – FEMA Floodplain Study Types:

- Limited Detail/Base Level Study Reach (Zone AE):
  - FIRM/DFIRM: Boundaries include the SFHA (100-yr). BFEs and Cross Section locations shown (sometimes).
  - FIS Report includes: Profiles for the 100-year (typically). Published BFEs (sometimes). Hydrologic Data Summary Table.
  - Hydraulic Modeling: based on accurate topography and Field measured (typically) structure geometry.
- Approximate Level Study Reach (Zone A):
  - FIRM/DFIRM: Boundaries include the SFHA (100-yr) Only.
  - FIS Report includes: Sometimes mentioned.
  - Hydraulic Modeling: None for old Approx. Studies.

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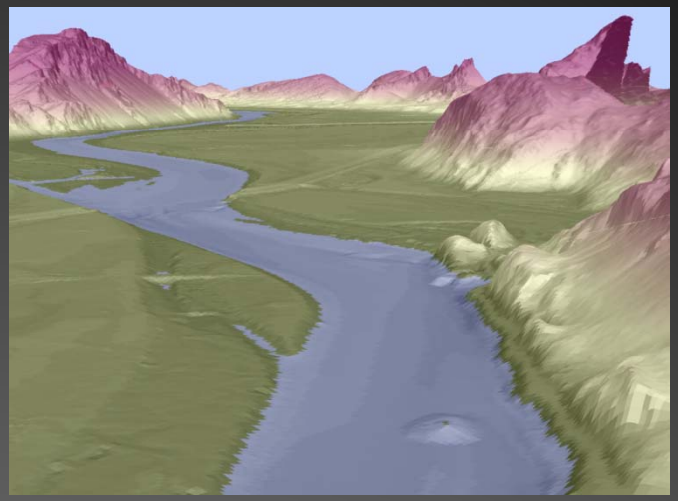

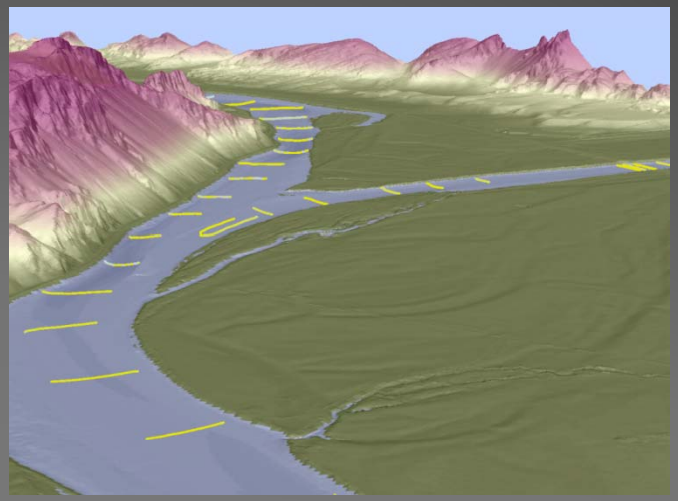

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Floodway Concept

What is a FLOODWAY?

Remember: The Floodway is a Regulatory Measure [not a physical feature] developed to assist communities with protecting the river corridor where flows are most sensitive to encroachment.

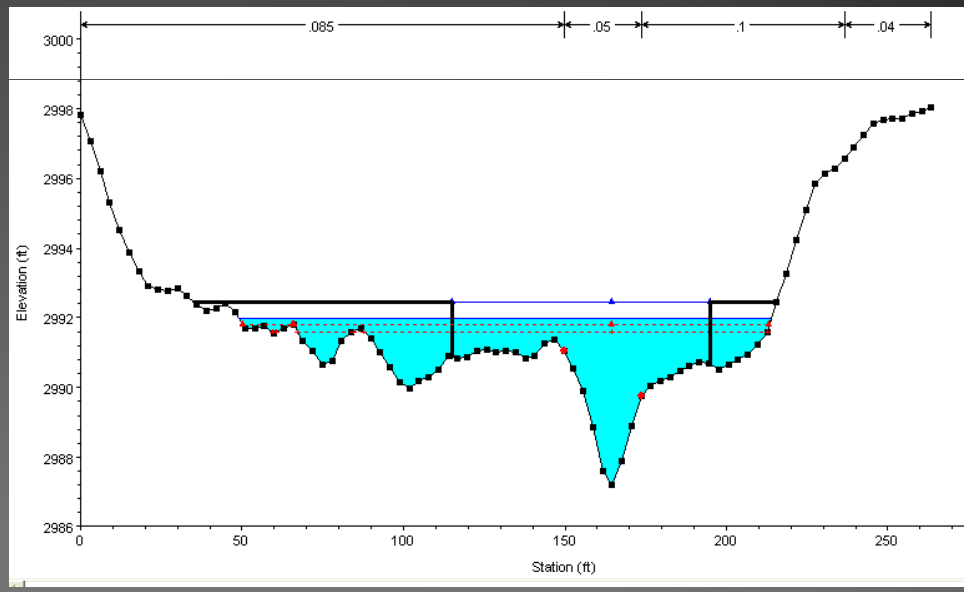
44 CFR 59.1 Definitions: "Regulatory Floodway" means the channel of a river or watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height (= 0.5 ft in MT).

Floodway Concept

How is a Floodway delineated and mapped?

Perform "Floodway/Encroachment Analysis"

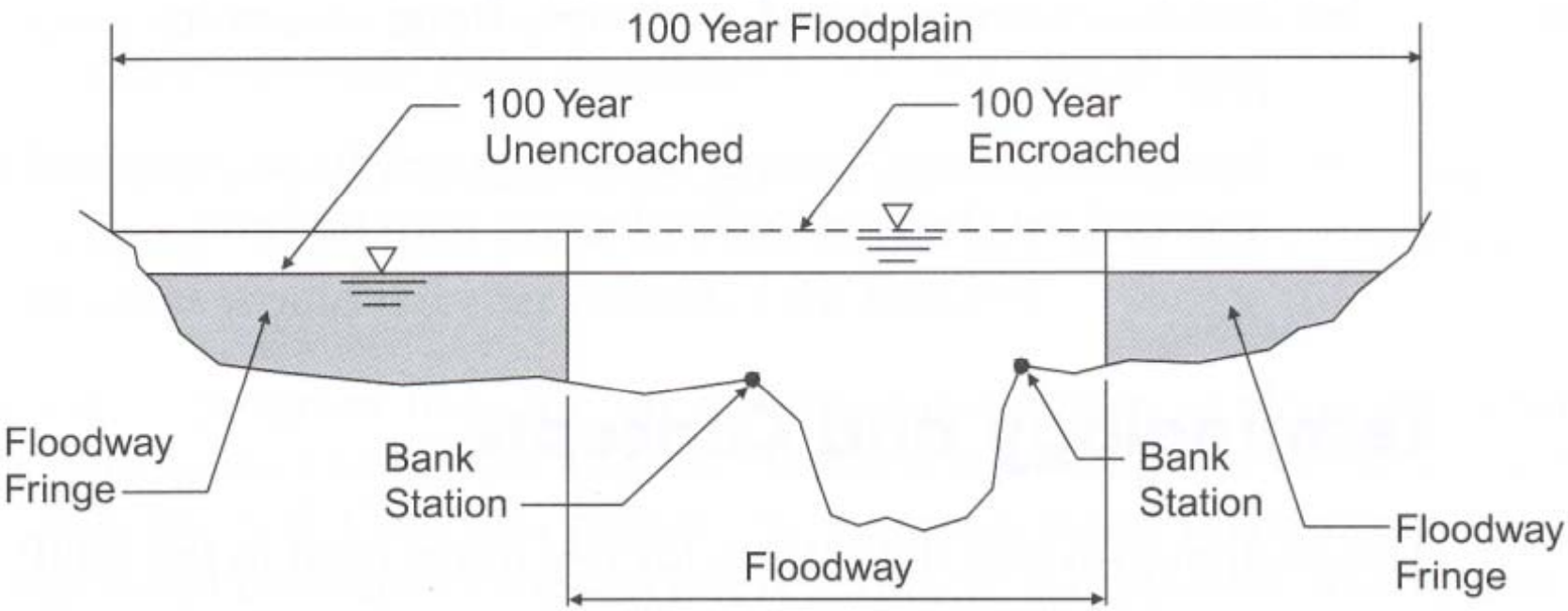
- Hydraulic Modeling Process
- Equal Conveyance Reduction
- Establish Encroachment Stations
- Max Surcharge: ≤ 0.5 ft in MT



- Results in FIS – Floodway Data Table (FWDT)

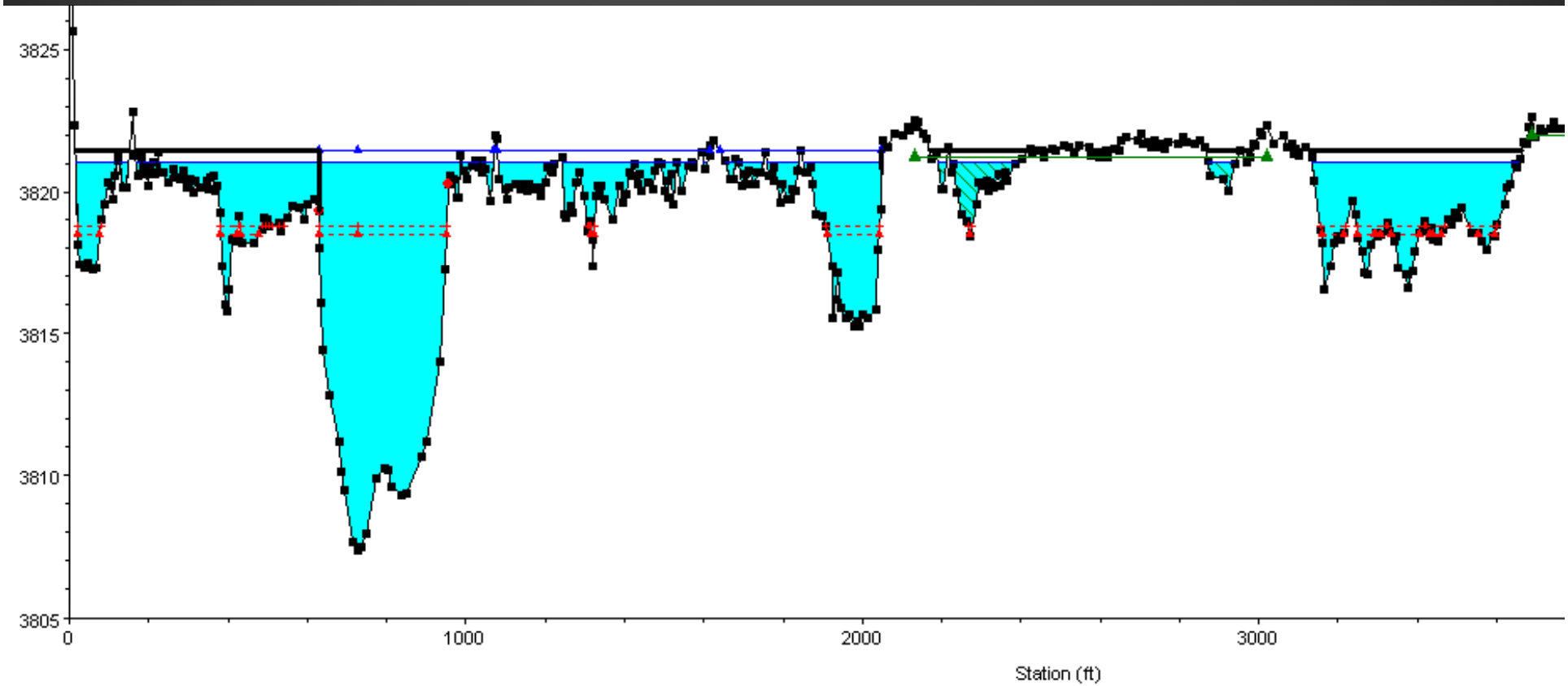
Floodway Concept

Floodway Encroachment Analysis – Typical Section



Floodway Encroachment Analysis

Example Cross Section – Missouri River near Townsend



Floodway Concept

Reality Check – IMPORTANT

The "No-Rise Encroachment Analysis" is NOT a Floodway Encroachment delineation – that has already been completed for a detailed study reach!

Remember: The Encroachment Review is a comparison of the Existing Conditions BFEs to the Proposed Conditions BFEs – which must demonstrate 0.00 increase or else a CLORM is required.

- Must simply know where the floodway is located to determine if you are proposing encroachment activities inside the floodway.

Floodway Concept

Reality Check – IMPORTANT

Floodway surcharge values (from FWDT) are meaningless for purposes of the No-Rise Encroachment Analysis because we are comparing the effect to BFEs (not the Floodway Surcharge or “With Floodway” Elevations)

Not using the Encroachment Tool in HEC-RAS for the No-Rise analysis.

Proposed Encroachment is represented by cross sectional differences between the Existing & Proposed Conditions Geometries.

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
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CC	174,500	1,377	12,545	6.6	2,972.7	2,972.7	2,973.2	0.5
CD	178,000	2,506	20,757	4.0	2,977.6	2,977.6	2,978.1	0.5
CE	180,700	2,416	17,097	4.9	2,980.9	2,980.9	2,981.4	0.5
CF	183,600	2,775	19,317	4.4	2,984.0	2,984.0	2,984.3	0.3
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CJ	200,070	1,181	12,310	7.7	3,004.1	3,004.1	3,004.3	0.2

[1]Feet above confluence with Flathead Lake

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

FLATHEAD RIVER

What Matters for a No-Rise Analysis? (Regulatory BFE)

Floodway Encroachment No-Rise Analysis
DETAILED STUDY AREA

Presentation Overview:

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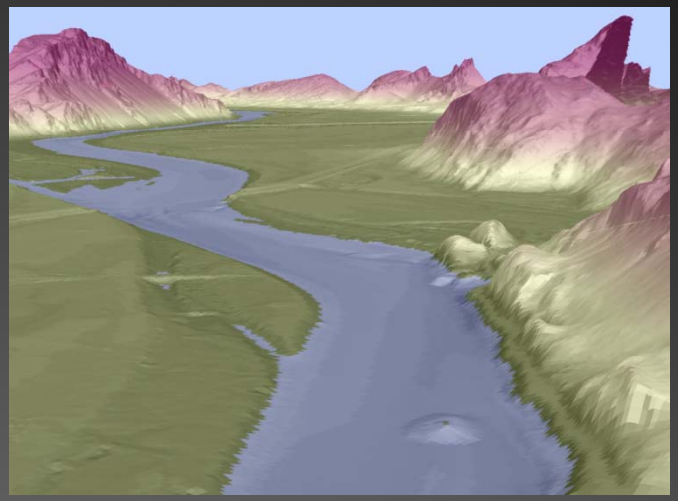

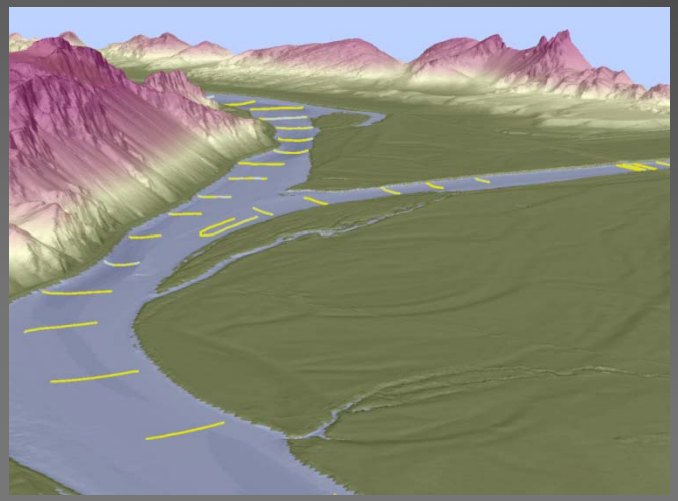

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Regulatory Requirements

Floodplain Regulations: Community Ordinances

- Must meet or exceed Federal requirements specified in 44 CFR 60.3.

- Must also meet or exceed State requirements of the Montana Administrative Rules.

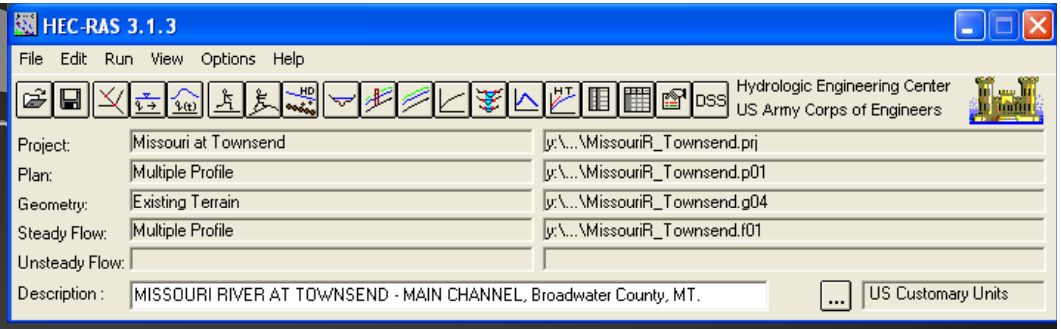
Regulatory Requirements – FEMA **No-Rise**

code of federal regulations

44 CFR 60.3(d)(3):

- [In the regulatory floodway, communities must] Prohibit encroachments, including fill, new construction, substantial improvements, and other development within the adopted regulatory FLOODWAY unless it has been demonstrated through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that the proposed encroachment would not result in any increase in flood levels within the community during the occurrence of the base flood discharge.
- This is the "**No-Rise**" requirement = Zero Increase (0.00)

Straight Talk..



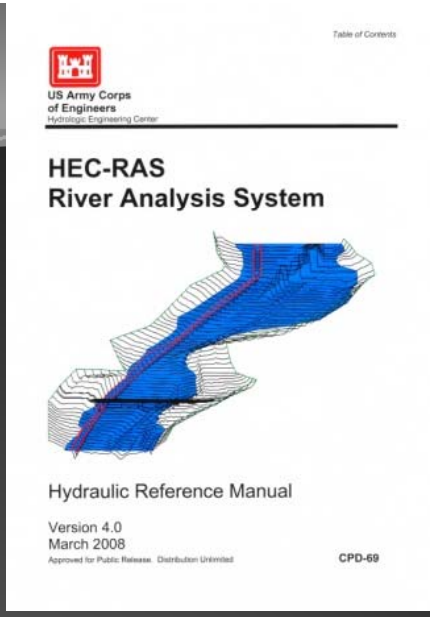
Just what does this mean?

- Communities shall not approve permits for Floodway Encroachment development activities without demonstrating Zero (0.00) increase in the <u>100-year water surface profile (i.e. the BFE).</u>
- Permit Applications must include an Encroachment review "<u>No-Rise Analysis</u>"
- The "No-Rise Analysis" is a Hydraulic Analysis that is:
  - Based on the Effective Hydraulic Model used for the study
  - Must be completed and certified/sealed by a MT P.E.

    (ARM 24.183.2203 – Must be competent in subject matter)

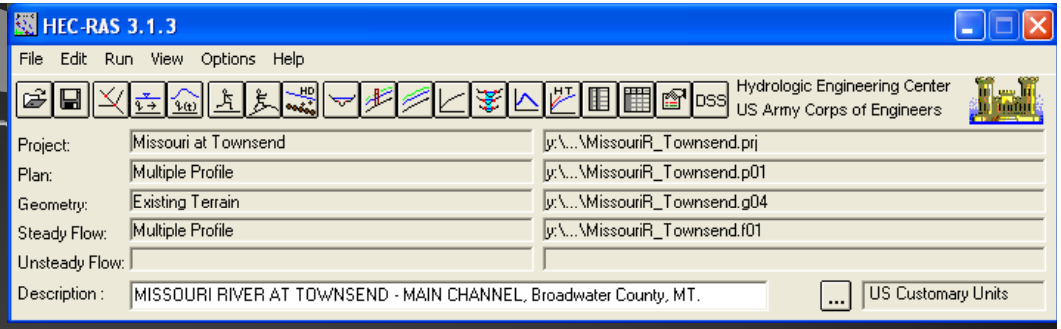
Straight Talk..

Just what does this mean to Applicants?



- Planning – Budget and Schedule accordingly
- Design may be iterative to avoid any BFE increase
- Community is required to review & approve these, but they have options:
  - Request DNRC Technical Assistance review
  - Require applicant complete CLOMR form and submit to FEMA for review
  - Perform in-house or hire a consultant to perform the review

Straight Talk..



Just what does this mean to Applicants?

- So you (the Applicant/Engineer) successfully demonstrate No-Rise and the analysis is approved by Community, now what?
  - Permit Approved & your work proceeds…
  - Note that a LOMR may still be necessary (more later) – if this is the case, FEMA will review your No-Rise when LOMR submitted.

    (Possible violation if the analysis is in error)
- But what if you (the Applicant/Engineer) <u>can't</u> demonstrate No-Rise? Is it all or nothing??

Regulatory Requirements – FEMA **CLOMR**

44 CFR 60.3(d)(4):

- Notwithstanding any other provisions of 60.3, a community may permit encroachments within the adopted regulatory floodway that would result in an increase in base flood elevations, provided that the community first applies for a conditional FIRM [CLOMR] and floodway revision, fulfills the requirements for such revisions as established under the provisions of 65.12 and receives the approval of the Administrator.
- This is the "**CLOMR**" requirement: Any proposed BFE increase (>0.00 ft) requires CLOMR submittal.

Straight Talk..

Just what does this mean to Applicants?

- If proposing BFE increase, then must prepare & submit CLOMR application to FEMA. Note that:
  - The Community must endorse and sign the CLOMR application
  - The Permit Application cannot be approved until the CLOMR is approved by FEMA. [i.e. the project work cannot proceed without the CLOMR approval].
  - Must satisfy the requirements of 44 CFR 65.12 which include:
    - CLOMR Application Fee ($4,400 for bridge/culvert/channel)
    - An Alternatives Evaluation; legal notice; no structures impacted; BFE & floodway revisions; follow-up LOMR (Fee $5,300).
    - FEMA to respond within 90 days of receiving application.

Regulatory Requirements – Montana
BFE Increase

ARM 36.15.604: Minimum Criteria for Permits [in Floodway]

In addition to the requirements of ARM 3615.602 and 36.15.603, a permit shall not be approved for new construction, substantial improvement, or alteration of an artificial obstruction under this rule if it will increase the upstream elevation of the base flood by 0.5 of a foot or as otherwise determined by the permit issuing authority or significantly increase flood velocities.

Straight Talk..

Just what does this mean to Applicants?

- State Standard: Intended to limit BFE increases [resulting from floodway encroachment] to maximum of 0.5 foot. Therefore, if proposing > 0.5', must get Variance.

- Must satisfy both FEMA and State Standards
  - FEMA: Satisfy No-Rise or else need CLOMR
  - State/DNRC: < 0.5 foot increase or else Variance

- Do these standards contradict each other?

  No, the State Standard is in addition to that of FEMA's requirements. [But we understand the confusion!]

In Summary..

Just what does this mean to Applicants?

EXAMPLES:

- Proposing increase of up to 2.3 feet in BFE:
  - Need CLOMR (per FEMA Standards)
  - Need Variance (per State Standards)
- Proposing increase of 0.4 foot in BFE:
  - Need CLOMR (per FEMA Standards)
- Demonstrate 0.00 increase in BFE:
  - Permit Issued (LOMR may still be needed after construction)

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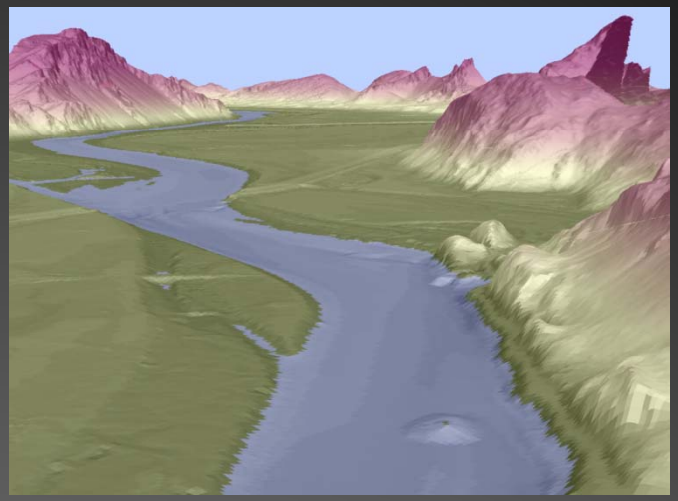

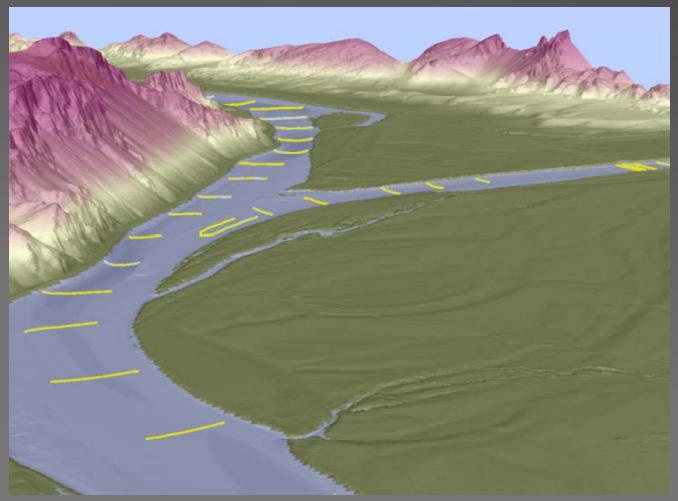

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No-Rise Analysis Process

Typical projects that usually require Encroachment Review & No-Rise analysis:

- Includes new construction, replacement or removal of existing structures:
  - Stream crossing structures: bridges, culverts
  - Flood control structures: dams, levees, flood walls, etc.
  - Roadway/RR embankments
- Fill
- Channel modifications – stream restoration & stabilization projects

No-Rise Analysis Process

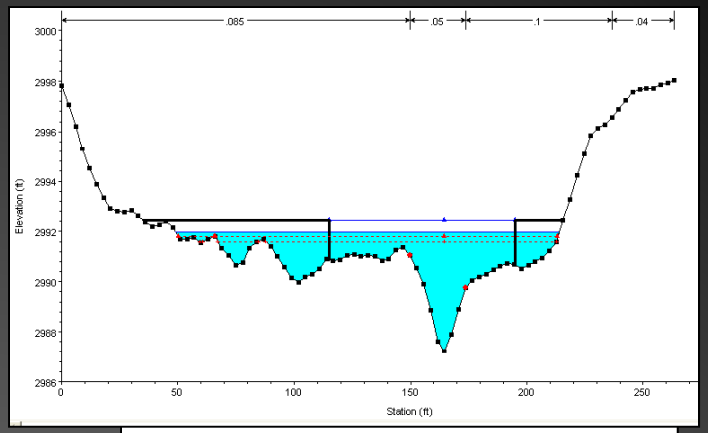
How to determine if your project encroaches on Floodway?

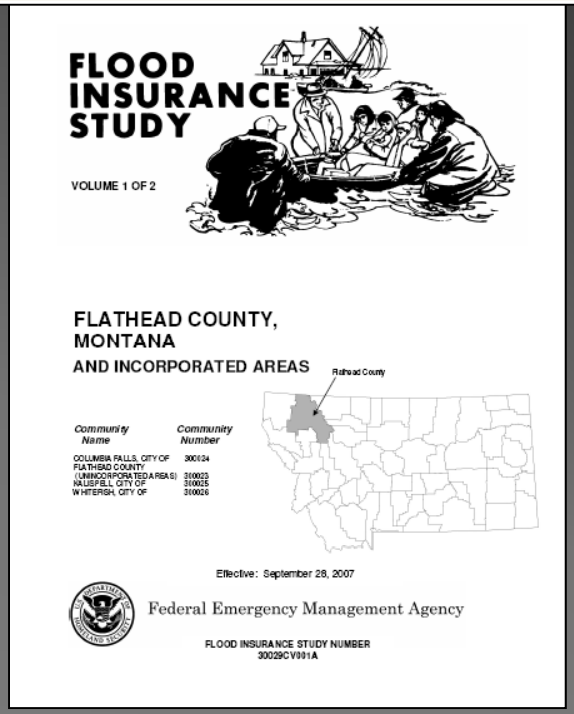
- Flood Insurance Rate Map (FIRM/DFIRM)

  GIS files for DFIRMs

- Flood Insurance Study (FIS) – Floodway Data Tables

- Effective Hydraulic Model at Cross Sections

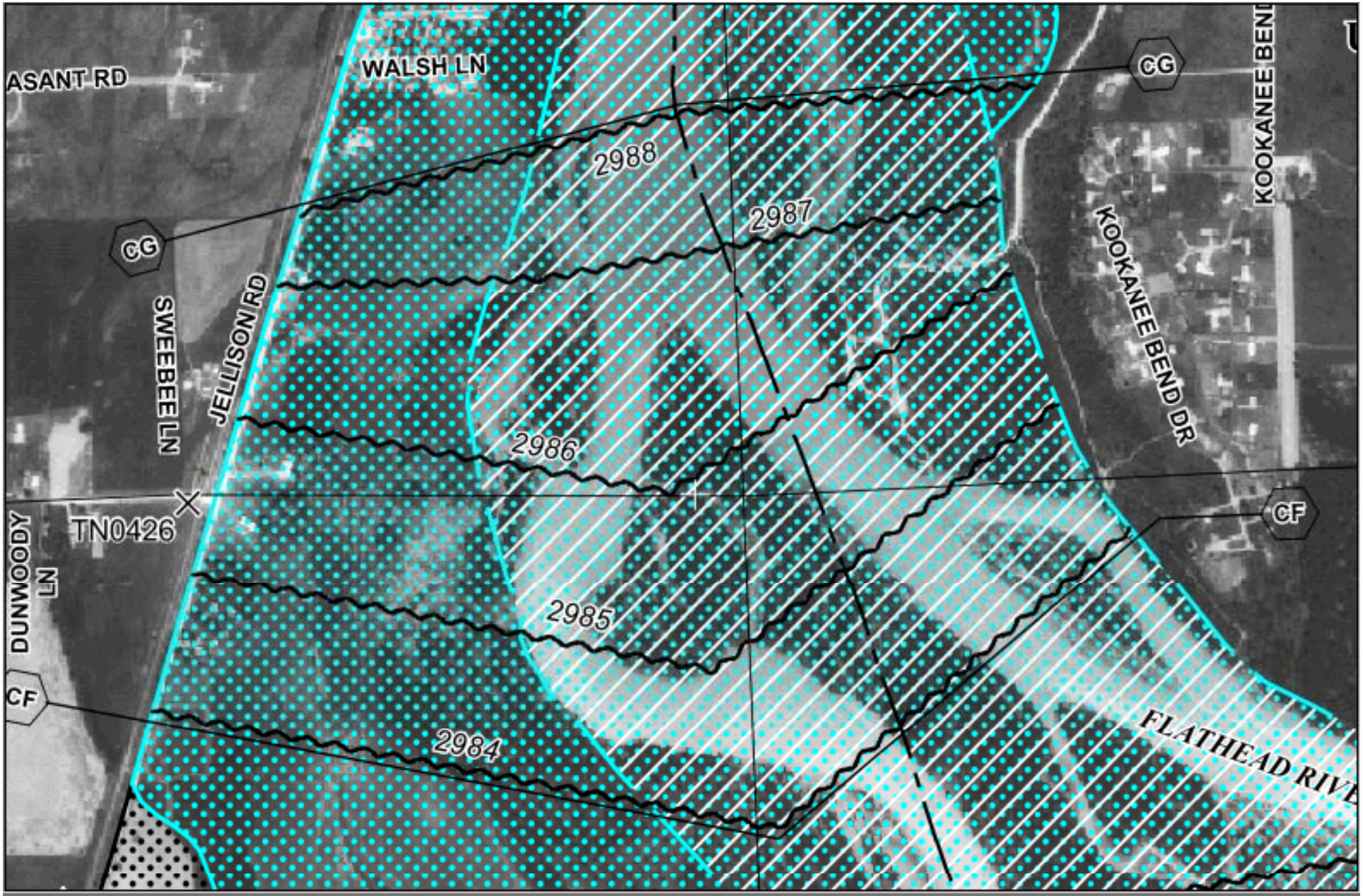




Use Effective FIS/FIRMs –

- Available at <u>FEMA Map Service Center</u>

  http://msc.fema.gov/webapp/wcs/stores/servlet/FemaWelcomeView?storeId=10001&catalogId=10001&langId=-1



Example – DFIRM

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TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

FLATHEAD RIVER

Example – Floodway Data Table

No-Rise Analysis Process

Encroachment Review required supplement with the Floodplain Development Permit Application

- Applicant must demonstrate that 44 CFR 60.3(d)(3) has been satisfied – i.e. complete a No-Rise Hydraulic Analysis OR provide explanation of why a hydraulic analysis is not necessary OR Submit CLOMR.

  (Possible exceptions - minor projects, conveyance shadow)

- Encroachment Analysis Certification: sealed/certified by MT PE

- The analysis must be supported by technical data, and be based on the Effective hydraulic model utilized to develop the Effective FIRM floodway and BFEs.
  - Must submit electronic model files with application (i.e. HEC-RAS, etc.)

No-Rise Analysis Process

Encroachment Review required supplement with the Floodplain Development Permit Application

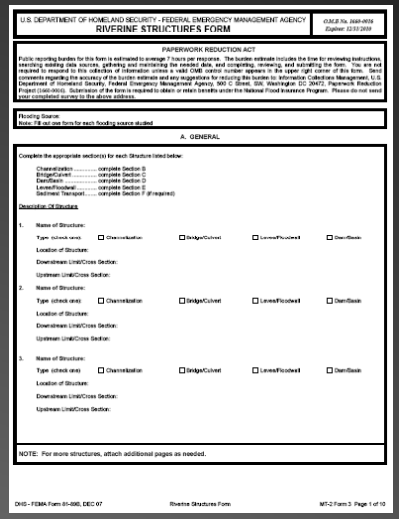
- Effective Model: The Hydraulic analysis for the Effective FIS
- Duplicate Effective Model: reproduction of the Effective model
- Corrected Effective Model: Corrects modeling errors in Effective (example: bridge not incorporated into Eff model)
- Existing/Pre-Project Conditions Model: reflects any modifications since the Effective model – i.e. the current existing conditions.
- Proposed/Post-Project Conditions Model: reflects changes of proposed project.

No-Rise Analysis Process

Guidelines & Specifications

- FEMA Instructions for completing MT-2 Forms (LOMR/CLOMR application forms)

  http://www.fema.gov/plan/prevent/fhm/dl_mt-2.shtm



U.S. DEPARTMENT OF HOMELAND SECURITY - FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE STRUCTURES FORM

O.M.B. No. 1660-0016
Expires: 12/31/2010

PAPERWORK REDUCTION ACT

Public reporting burden for this form is estimated to average 7 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number is displayed in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, U.S. Department of Homeland Security, Federal Emergency Management Agency, 500 C Street, SW, Washington, DC 20472. Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. Please do not send your completed survey to the above address.

Flooding Source:
Note: Fill out one form for each flooding source studied.

A. GENERAL

Complete the appropriate section(s) for each Structure listed below:

Channelization ..... complete Section B
Bridge/Culvert ..... complete Section C
Dam/Basin ..... complete Section D
Levee/Floodwall ..... complete Section E
Sediment Transport ..... complete Section F (if required)

Description Of Structure

1. Name of Structure:
   Type (check one): ☐ Channelization ☐ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam/Basin
   Location of Structure:
   Downstream Limit/Cross Section:
   Upstream Limit/Cross Section:
2. Name of Structure:
   Type (check one): ☐ Channelization ☐ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam/Basin
   Location of Structure:
   Downstream Limit/Cross Section:
   Upstream Limit/Cross Section:
3. Name of Structure:
   Type (check one): ☐ Channelization ☐ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam/Basin
   Location of Structure:
   Downstream Limit/Cross Section:
   Upstream Limit/Cross Section:

NOTE: For more structures, attach additional pages as needed.

DHS - FEMA Form 81-086, DEC 07 Riverine Structures Form MT-2 Form 3 Page 1 of 10

- Summary of MT-2 Forms:
  - Form 1 – Overview & Concurrence Form (Community must Sign)
  - Form 2 – Riverine Hydrology & Hydraulics Form **(REVIEW THESE INSTRUCTIONS)**
  - Form 3 – Riverine Structures Form
  - Form 4 & 5 – Coastal Analysis/Structures Forms
  - Form 6 – Alluvial Fan Flooding Form

No-Rise Analysis Process

Step 1 – Contact/Discuss Project with Floodplain Administrator, DNRC, and other permitting authorities.

- Site visit may be beneficial
- Determine if any new studies are in process that include the project area.
- Any LOMCs for the project area?
- The State, community, or others may have copies of effective hydraulic model for project site.

No-Rise Analysis Process

Step 2 – Acquire Effective Hydraulic Model

- This takes time – so plan accordingly!
- Request & obtain from FEMA Engineering Library:
  - Involves Fees ($150 +)
  - Takes 2-6 weeks to receive data
  - Receive microfiche copies of input/output hydraulic model files or the model files (if available).

http://www.fema.gov/plan/prevent/fhm/st_order.shtm

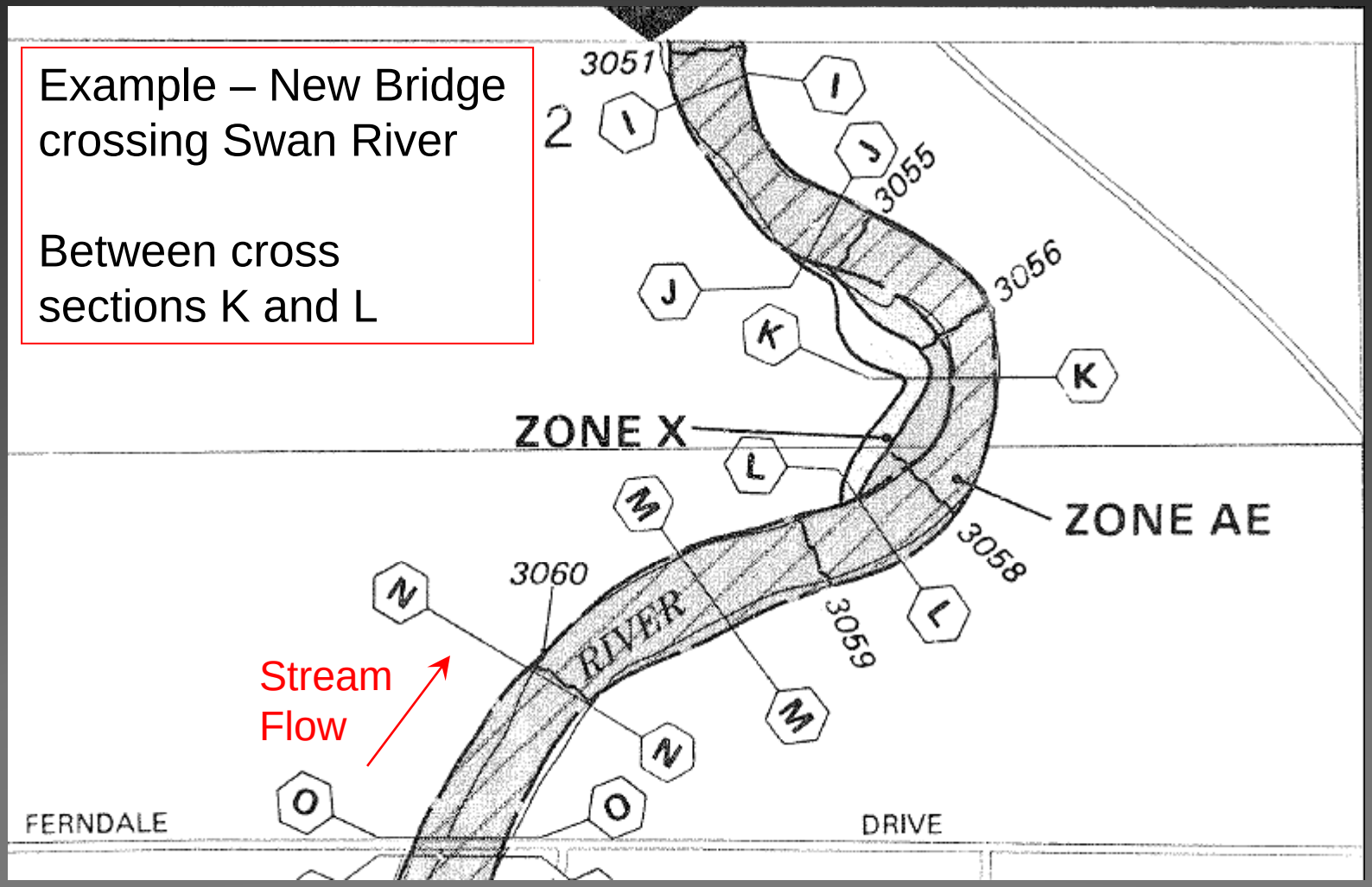
No-Rise Hydraulic Analysis Process

Step 3 – Develop Duplicate Effective Model

- This is a reproduction of the Effective model for the specific project area.
- Various scenarios based on date of the Effective model and the hydraulic software used (i.e. HEC-2, WSP-2, etc.)
- Duplicate the effective model results in the hydraulic model that you have selected (HEC-RAS most common)…
  - Must be FEAM approved model: http://www.fema.gov/plan/prevent/fhm/en_hydra.shtm

No-Rise Hydraulic Analysis Process

Step 3 – Develop Duplicate Effective Model



FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Lower Swan River								
A	64,410	173	1369	6.6	3033.8	3033.8	3033.9	0.1
B	65,025	180	1159	7.8	3034.8	3034.8	3034.9	0.1
C	65,630	255	1392	6.5	3036.3	3036.3	3036.4	0.1
D	66,230	150	718	12.5	3038.6	3038.6	3038.6	0.0
E	66,860	185	1067	8.4	3042.7	3042.7	3042.9	0.2
F	67,470	188	999	9.0	3044.7	3044.7	3044.8	0.1
G	68,050	210	1024	8.8	3047.0	3047.0	3047.1	0.1
H	68,665	265	1209	7.4	3049.6	3049.6	3049.6	0.0
I	69,245	250	935	9.6	3051.7	3051.7	3051.7	0.0
J	69,880	215	1226	7.3	3054.6	3054.6	3054.7	0.1
K	70,625	165	950	9.5	3056.3	3056.3	3056.5	0.2
L	71,295	255	1557	5.8	3058.6	3058.6	3058.8	0.2
M	71,915	300	1885	4.8	3059.5	3059.5	3059.6	0.1
N	72,520	260	1430	6.3	3060.1	3060.1	3060.2	0.1
O	73,120	280	1935	4.7	3061.4	3061.4	3061.4	0.0
P	73,165	280	1953	4.6	3061.4	3061.4	3061.4	0.0
Q	73,765	260	867	10.4	3063.1	3063.1	3063.1	0.0
R	74,370	260	1412	6.4	3066.3	3066.3	3066.3	0.0
S	74,960	275	1600	5.6	3067.3	3067.3	3067.4	0.1
T	75,570	185	1010	8.9	3067.9	3067.9	3068.1	0.2
U	76,185	285	1950	4.6	3069.7	3069.7	3069.9	0.2
V	76,795	265	1581	5.7	3070.1	3070.1	3070.3	0.2
W	77,395	260	1442	6.2	3070.9	3070.9	3071.2	0.3
X	77,925	210	1248	7.2	3071.8	3071.8	3072.0	0.2
Y	78,475	220	1362	6.6	3073.0	3073.0	3073.1	0.1

[1] Feet above mouth

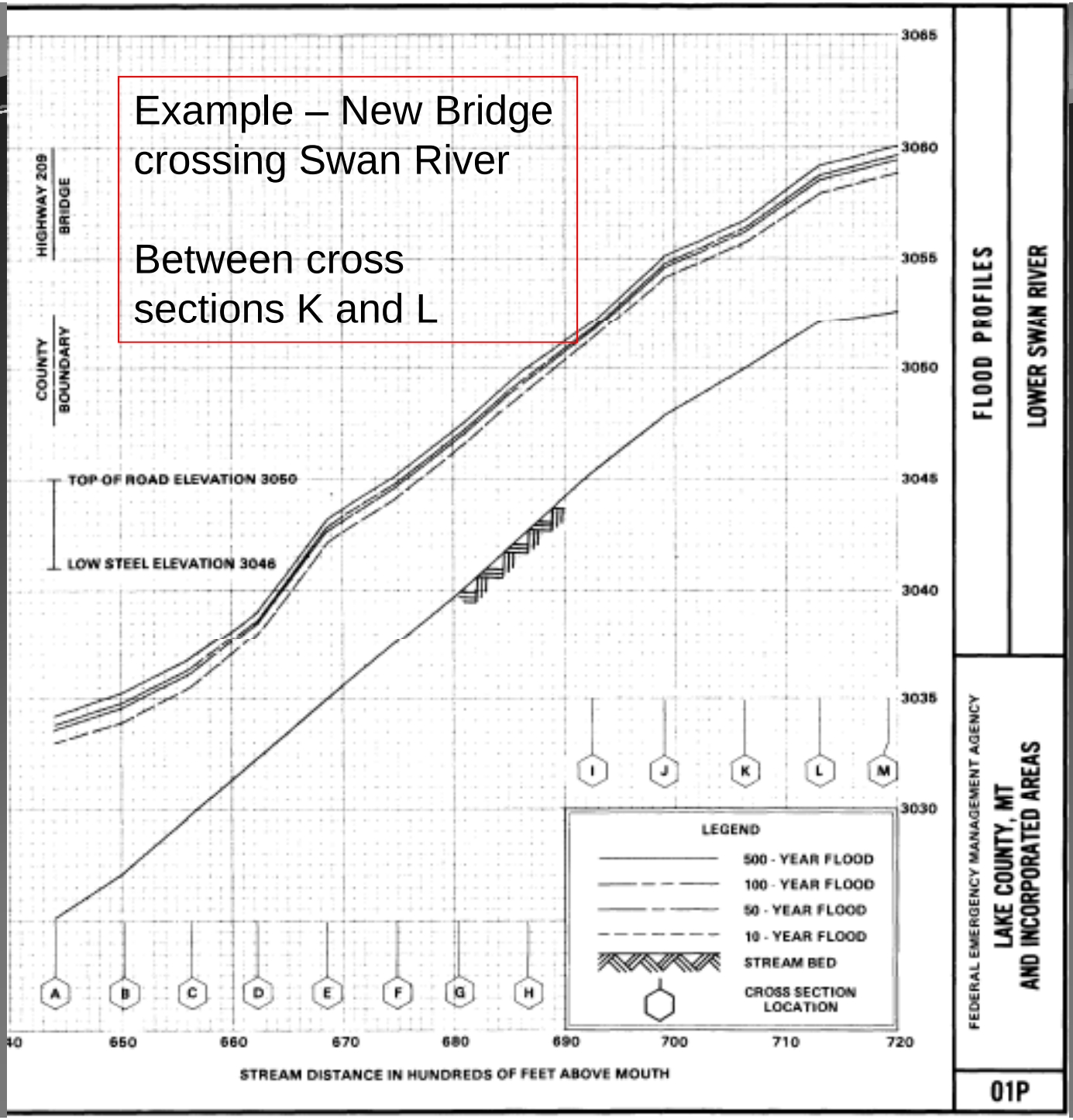
TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

LAKE COUNTY, MT
AND INCORPORATED AREAS

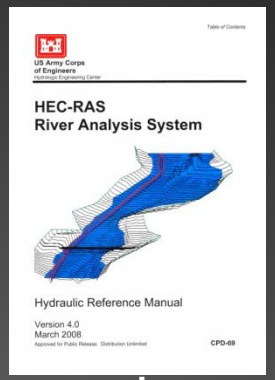
FLOODWAY DATA

LOWER SWAN RIVER


Example – New Bridge crossing Swan River
Between cross sections K and L
HIGHWAY 209 BRIDGE
COUNTY BOUNDARY
TOP OF ROAD ELEVATION 3050
LOW STEEL ELEVATION 3046
3065
3060
3055
3050
3045
3040
3035
3030
A
B
C
D
E
F
G
H
I
J
K
L
M
LEGEND
500 - YEAR FLOOD
100 - YEAR FLOOD
50 - YEAR FLOOD
10 - YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
640
650
660
670
680
690
700
710
720
STREAM DISTANCE IN HUNDREDS OF FEET ABOVE MOUTH
FLOOD PROFILES
LOWER SWAN RIVER
FEDERAL EMERGENCY MANAGEMENT AGENCY
LAKE COUNTY, MT
AND INCORPORATED AREAS
01P

No-Rise Hydraulic Analysis Process

Step 3 – Develop Duplicate Effective Model

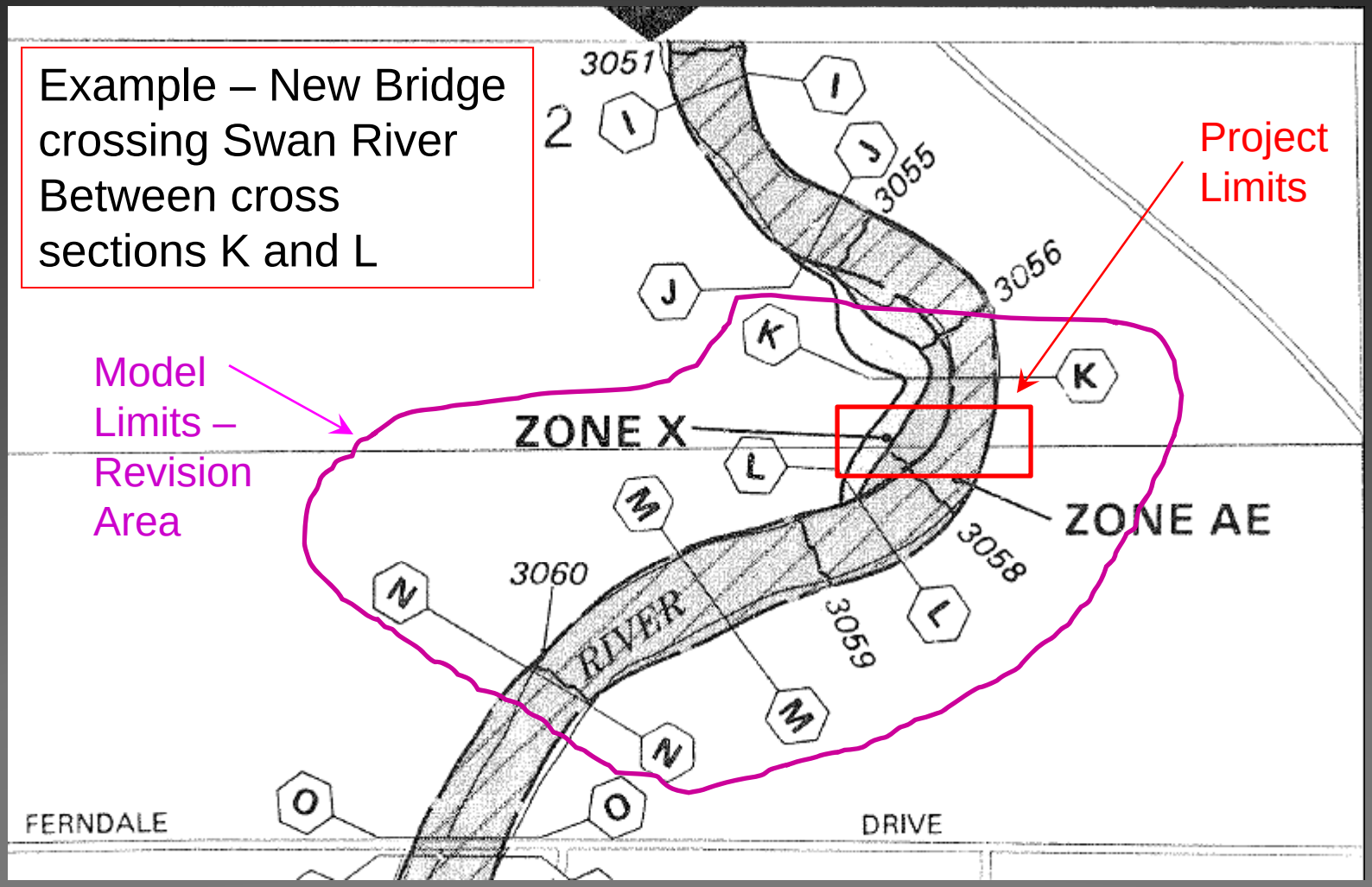


- Example – Using HEC-RAS hydraulic model
- Define Project Area
  - Go downstream from Project to first FIRM cross section and begin the model here (i.e. Cross Section K for example)
  - Upstream – recommend including 2-3 cross sections above project area (choose Cross Section N for example)

Duplicate Effective Model – has 4 cross sections (K, L, M, N) and any others not shown on FIRM maps but in eff model.

No-Rise Hydraulic Analysis Process

Step 3 – Develop Duplicate Effective Model



No-Rise Hydraulic Analysis Process

Step 3 – Develop Duplicate Effective Model

- Boundary Conditions – use Known Water Surface at downstream cross section (BFE @ K = 3056.3), not Normal Depth.
- Essentially creating a truncated version of the Effective hydraulic model for the project reach - using all the same data (geometry, friction values, channel & overbank reach lengths) from the Effective model to duplicate the results.
- Since Floodway – also have encroached/unencroached conditions with matching stations accordingly.

No-Rise Hydraulic Analysis Process

Step 3 – Develop Duplicate Effective Model

- Using same model program, i.e., HEC-2 to HEC-2: must duplicate FIS profiles and elevations in floodway data table to within 0.1 foot.
- Effective model not available: then new model must reproduce FIS profiles to within 0.5 foot.
- Using alternate model, i.e., HEC-2 to HEC-RAS: must reproduce FIS profiles to within 0.5 foot.

No-Rise Hydraulic Analysis Process

Step 4 – Develop Corrected Effective Model

- This is the Duplicate Effective model with the following modifications:
  - Corrections to any errors (technical error or construction in the floodplain that occurred prior to date of Eff. model).
  - Addition of cross sections (i.e. new cross section locations for new bridge) reflecting conditions at time of Eff. model. (Usually don't have this type of historical data)
- Must NOT reflect any man-made physical changes since the date of the effective model

No-Rise Hydraulic Analysis Process

Step 5 – Develop Pre-Project (Existing) Conditions Model

- Update with new/supplemental cross sections added to model to reflect current existing topographic conditions.
- Modifications apply to new cross sections as well as those in the original Effective model
- However – FIRM cross sections upstream (N) and downstream (K) of the revised reach (at effective tie-in) should be identical to those in the Effective model.

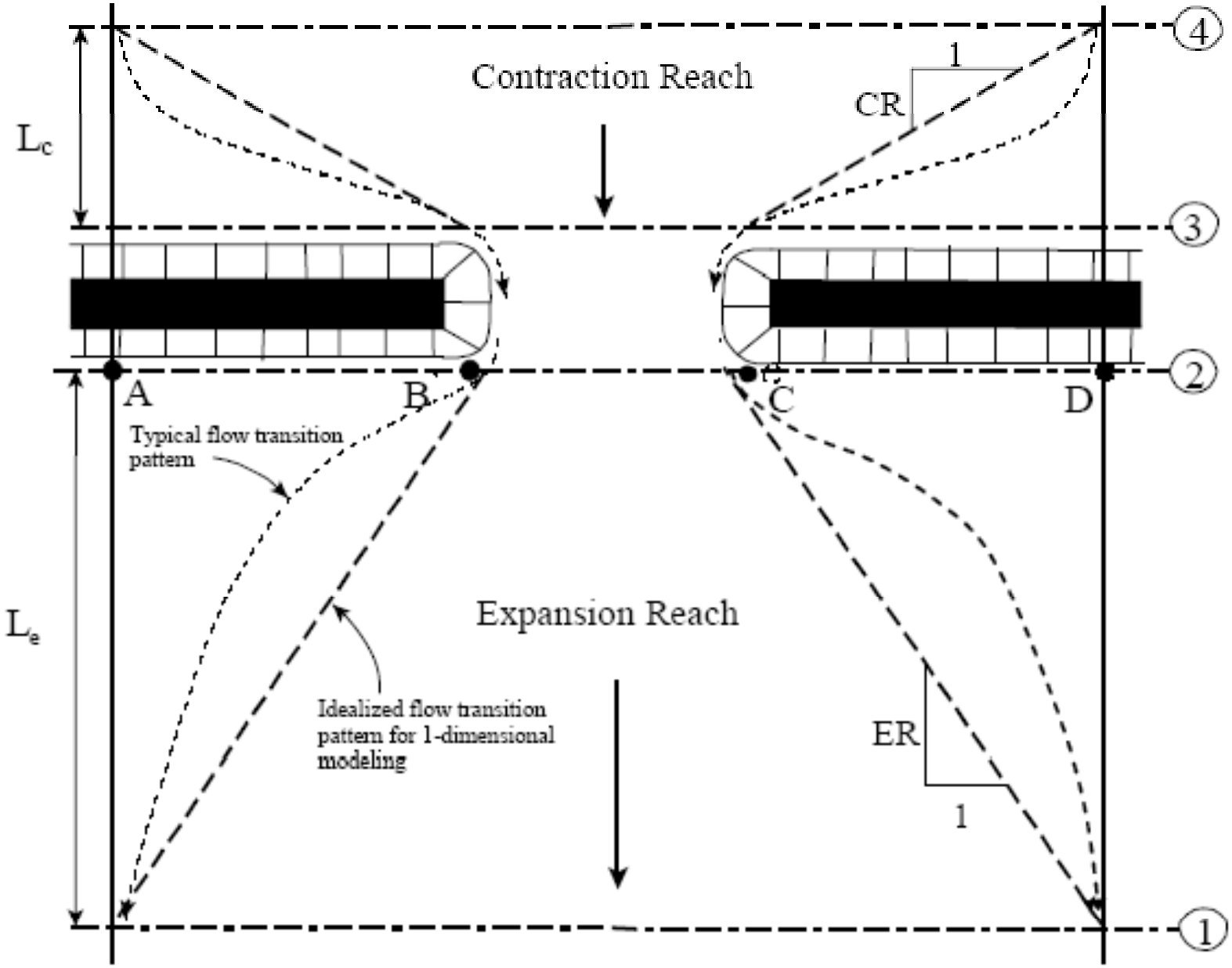


Figure 6-11 Cross Section Locations at a Bridge or Culvert

No-Rise Hydraulic Analysis Process

Step 6 – Develop Post-Project (Revised) Conditions Model

- Modify Existing Conditions Model to reflect the revised/proposed conditions – i.e. addition of the Bridge in this example.

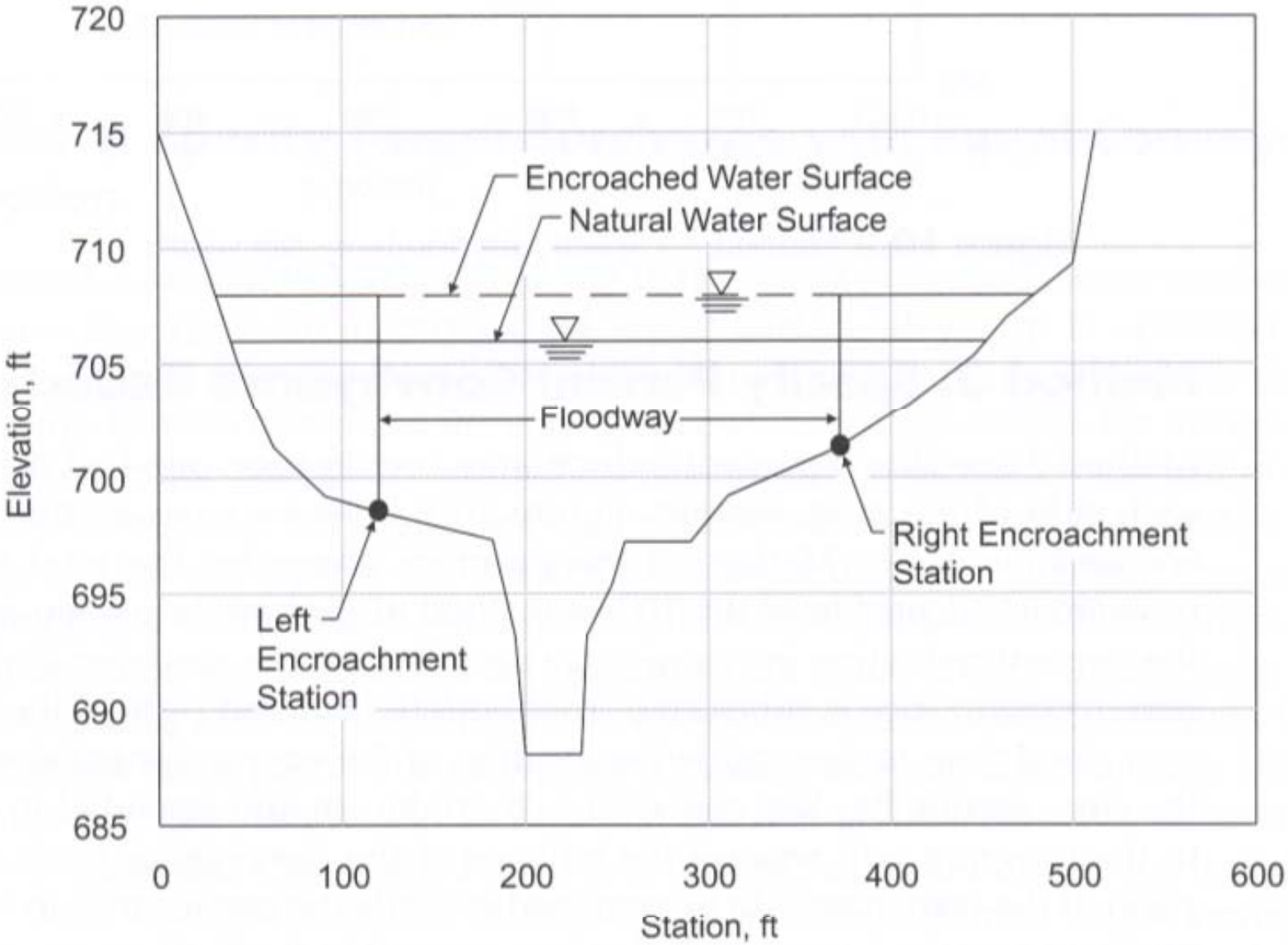
- This model incorporates any physical changes to the floodplain since the Effective model was produced.

No-Rise Hydraulic Analysis Process

Requirements

- The area of revision is defined by an effective tie-in at the upstream and downstream limits.
- Detailed Study – Effective tie-in obtained when revised base flood and floodway elevations are within 0.5 ft of the effective elevations,

  and the revised floodway encroachment stations match the effective floodway stations at both the upstream and downstream limits.


720
715
710
705
700
695
690
685
Elevation, ft
0
100
200
300
400
500
600
Station, ft
Encroached Water Surface
Natural Water Surface
Floodway
Left Encroachment Station
Right Encroachment Station

No-Rise Hydraulic Analysis Process

Requirements

- If the revised model does not tie-in to the Effective study at the project limits, the model must be extended upstream and downstream until it ties-in to the Effective study.

No-Rise Hydraulic Analysis Process

No-Rise Condition

- Comparison between pre-project (existing) conditions and post-project (proposed) conditions models.

- Some projects may still require a LOMR even thought they satisfied the No-Rise condition: Floodway widths revised per 44 CFR 65.7.

No-Rise Hydraulic Analysis Process

No-Rise Condition

- Applicant/Engineer should include a comparison table summarizing all the models and water surface elevations (BFEs) at each cross section within the model. This table must substantiate 0.00 increases at every cross section, otherwise a CLOMR will be required for the project.

	Water Surface Elevations, ft		
River Station	Effective	Existing	Proposed
2000	321.30	321.30	321.30
2200	–	321.80	321.75
2300	321.85	322.10	321.90
2400	–	322.25	322.50
2600	–	322.40	322.60
2700	–	322.50	322.65
2900	322.75	322.75	322.70
3000	322.80	322.80	322.80

Based on the table results, is a CLOMR required ?

LOMR/CLOMR Requirements

Key points:

- How do you know if your project is going to require a LOMR or CLOMR without a hydraulic analysis?

  Is professional judgment adequate?

- To avoid these requirements, must design project accordingly – may be an iterative process…
- Project Scoping is extremely important –
  - Scheduling – Hydraulic model acquisition; Floodplain permitting; CLOMR Review; etc.
  - Project Costs – LOMR/CLOMR fees; surveying; design iterations; permit & FEMA form preparation; etc.

Thank You

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Image Courtesy Watershed Sciences, Inc.