

# FEMA Levee Analysis Guidelines



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**AECOM**

# Agenda

- All About Levees
- FEMA Procedures Memo #52
- Levee Accreditation
- Levee Analysis
- Mapping Procedures

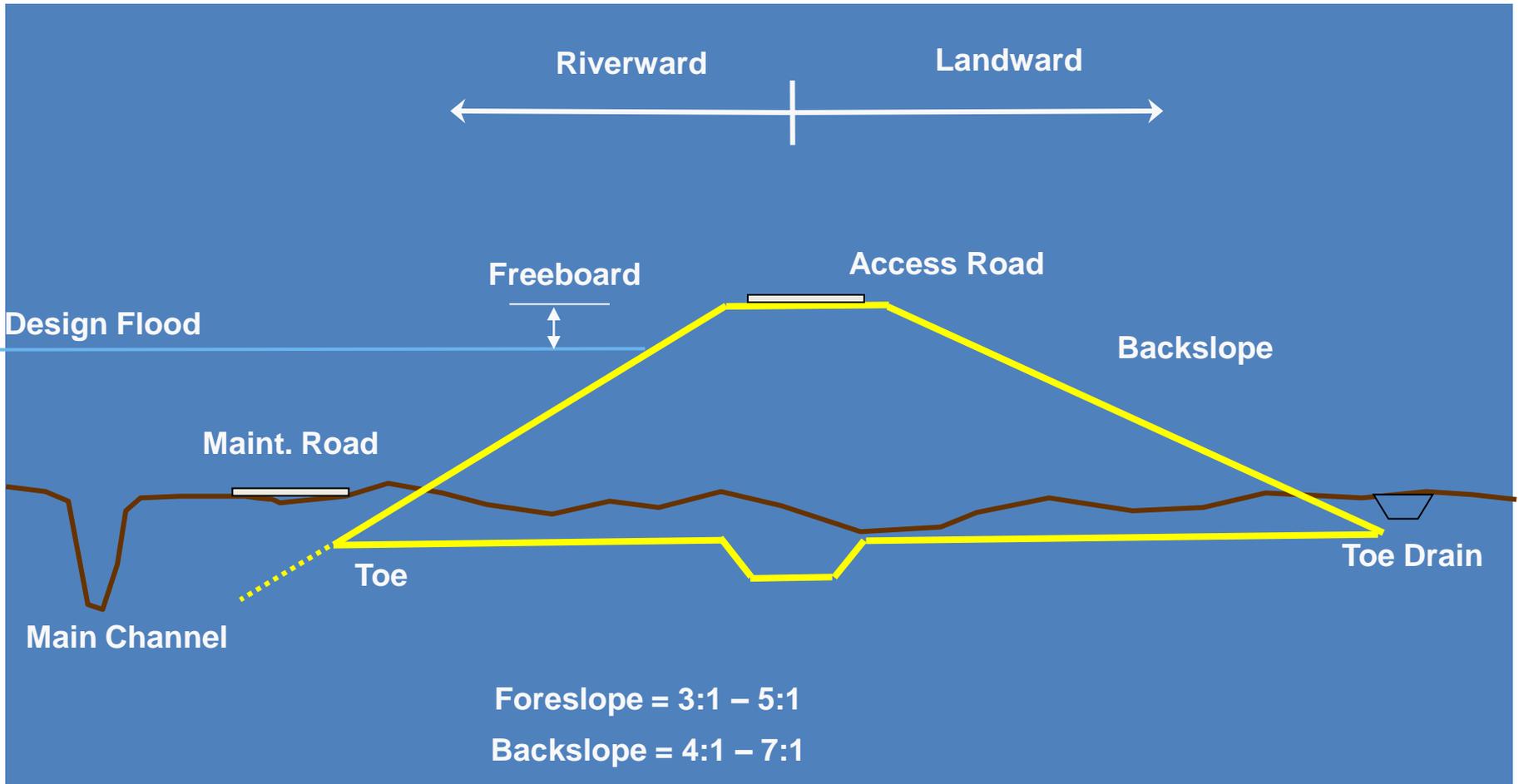
# Levee Basics



# What is a Levee?

- A levee is an earth embankment constructed along river or coastline to protect adjacent lands from flooding
- Floodwalls are concrete structures designed for urban areas that have insufficient room for levees
- Levees and floodwalls together are important components of the flood risk reduction systems for many flood prone communities
- Forty three percent of the nation's population live in counties with levees
- Ref: FEMA, The National Levee Challenge, 2006

# What is a Levee?





# Non-Levee Embankments

- Berms and embankments are structures that are not specifically built to retain flood waters, rather they support roads or railroads or serve other purposes.
- These structures can not be shown to provide flood protection on FEMA maps
- When scoping or mapping, check for floodplains terminating at roads, railroads or man-made structures

Main Channel

Foreslope = 3:1 – 5:1

Backslope = 4:1 – 7:1

# Procedure Memorandum #52



# Procedure Memorandum #52 (PM 52)

- Issued April 24, 2009
- “Effective immediately for all newly initiated studies and expiring PALs, optional for all other ongoing studies”
- All Risk MAP studies are subject to the guidelines of this Memo
- Clarifies many questions related to the technical study approach of levee systems that are not clear in Appendix H of FEMA’s *Guidelines & Specifications*
- Barring prior approval from FEMA, PM 52 essentially means that simply extending the riverward BFE out behind the levee and using that for mapping purposes is not acceptable

# Procedure Memorandum #52 (PM 52)

- Objective 1: establish consistent and comprehensive procedures for engineering analysis and mapping of flood hazards on the landward sides of levees
- Objective 2: establish consistent messaging, materials and process for levee de-accreditation among all regions and mapping partners.
- Guidelines will eventually be incorporated into Appendix H of the G&S
- Actions – produced two guidelines:
  - Guidelines For Mapping Landward Of Levee Systems*
  - Guidelines For the Notification Process for De-Accredited Levees*

# Levee Accreditation



# Levee Accreditation

- FEMA will recognize and accredit on its flood maps only those levee systems that have met and continue to meet the criteria of 44 CFR 65.10. If the community submits data and documentation showing compliance with the criteria, the levee or levee system will be **accredited**.
- If the submitted data and documentation does not comply with the criteria or if no such data is submitted, the levee or levee system is considered **non-accredited**.

# Levee Accreditation

- If the submitted data and documentation for a previously accredited and mapped levee does not comply with the criteria, the levee or levee system will be **de-accredited**.
- If the submitted data and documentation does not comply with the criteria, but there is a reasonable chance of achieving 1% flood protection, the levee owner can apply for provisional accreditation. If approved by FEMA, the levee owner has 24 months to submit documentation of compliance with 44 CFR 65.10. Such levees are denoted as **provisionally accredited levees** or PAL.

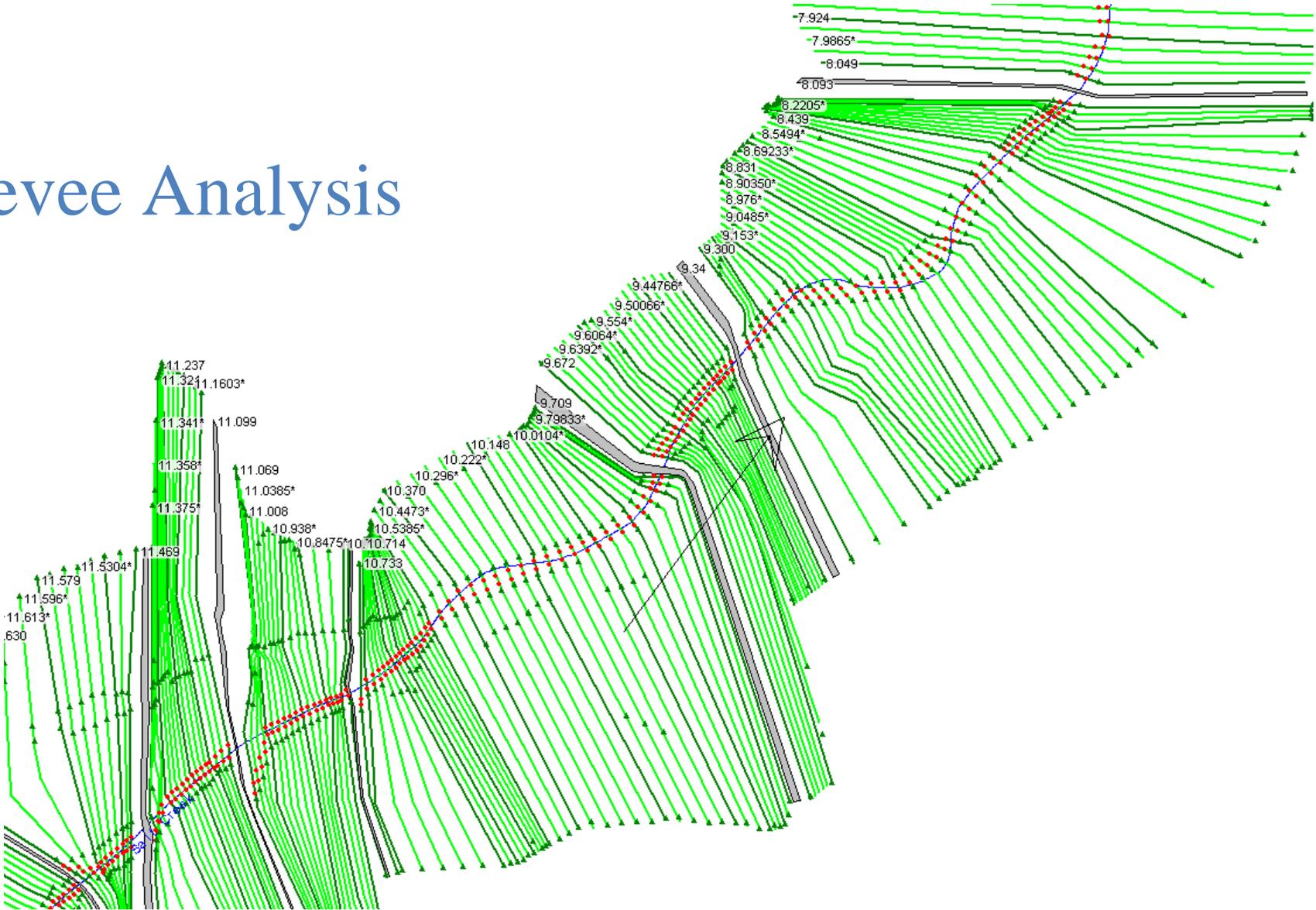
# Levee Accreditation – Accreditation Requirements

1. General Criteria
2. Design Criteria
  - Embankment Stability
  - Erosion Protection
  - Settlement Analysis
  - 100-year level of protection
  - Adequate Freeboard
  - Closure Structures
  - Interior Drainage
3. Operations Plan
4. Maintenance Plan
5. Certification

# Levee Accreditation - Summary

- Accredited Levees – Meet 44 CFR 65-10 Requirements
- Non-Accredited Levees – No Documentation or never applied
- De-accredited Levees – Ongoing documentation insufficient
- Provisionally Accredited Levees – Community is preparing documentation

# Levee Analysis



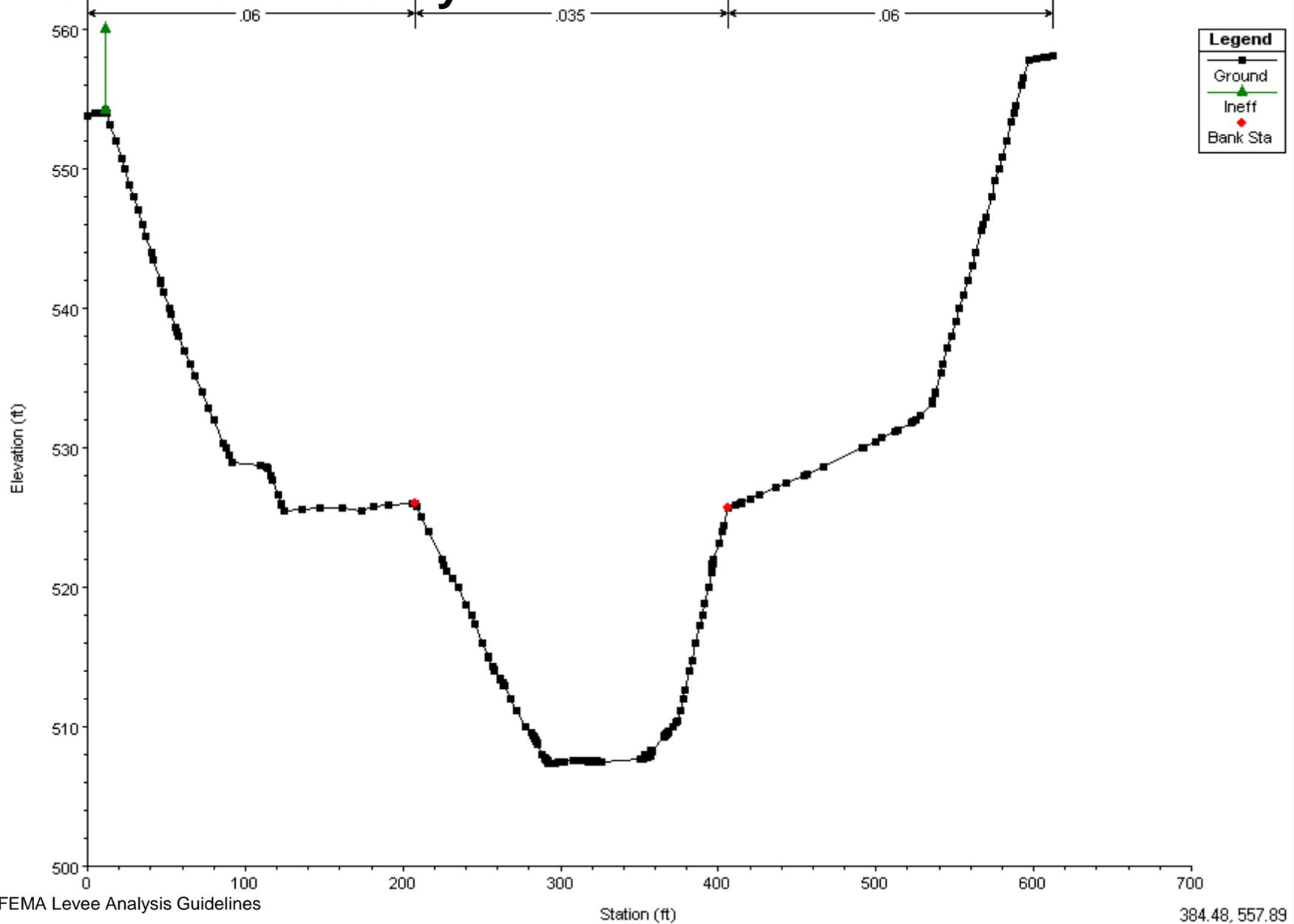
# Levee Representation in HEC-RAS

- Truncated Cross-section (X)
  - Levee Tool
  - Blocked Obstruction
- (X) Not acceptable under PM 52

# Truncated Geometry

Fort Worth Central City Plan: Revised Baseline Conditions - 2007

Effective flow in LOB set at North Main Levee.

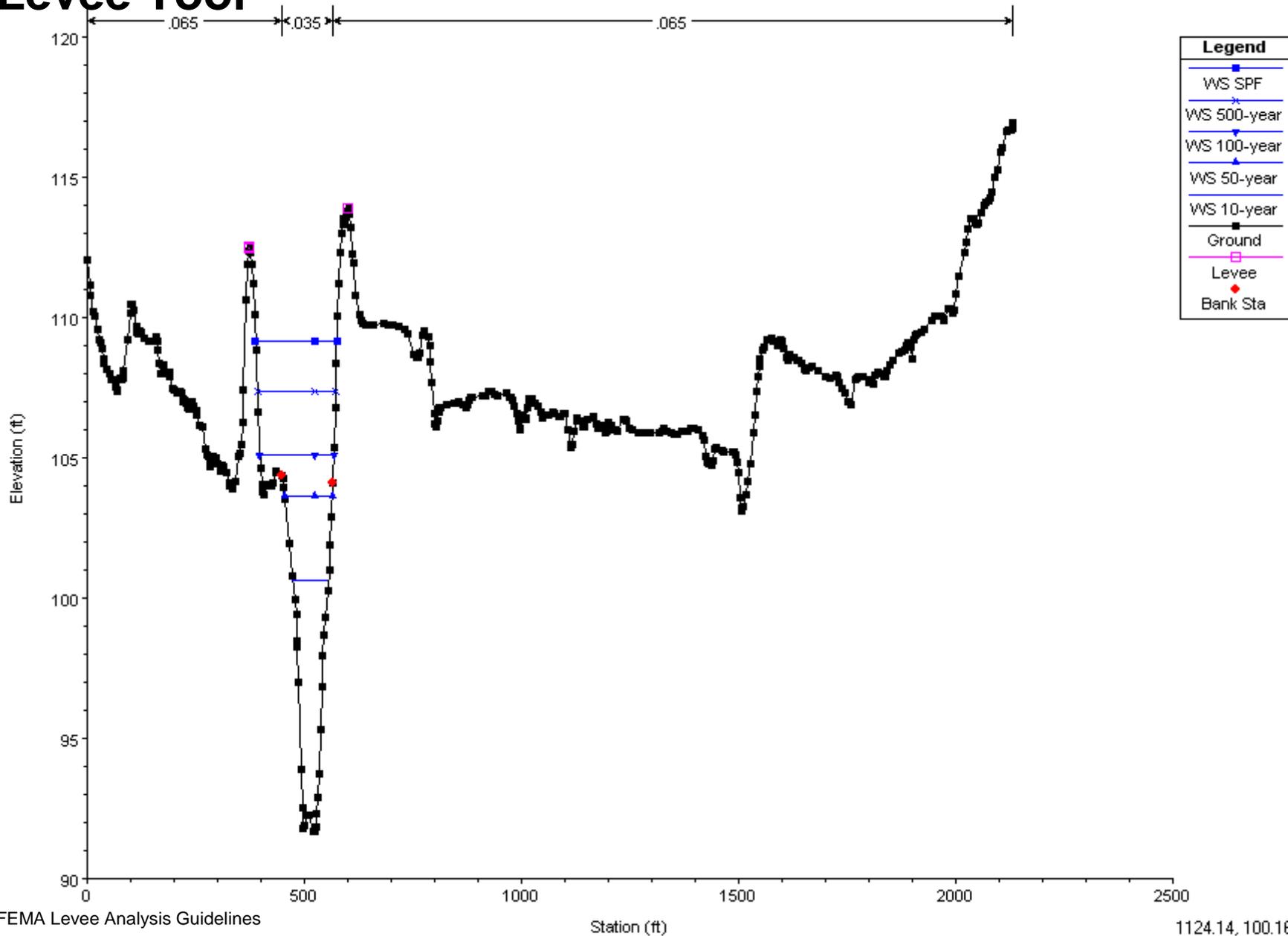


# Levee Tool

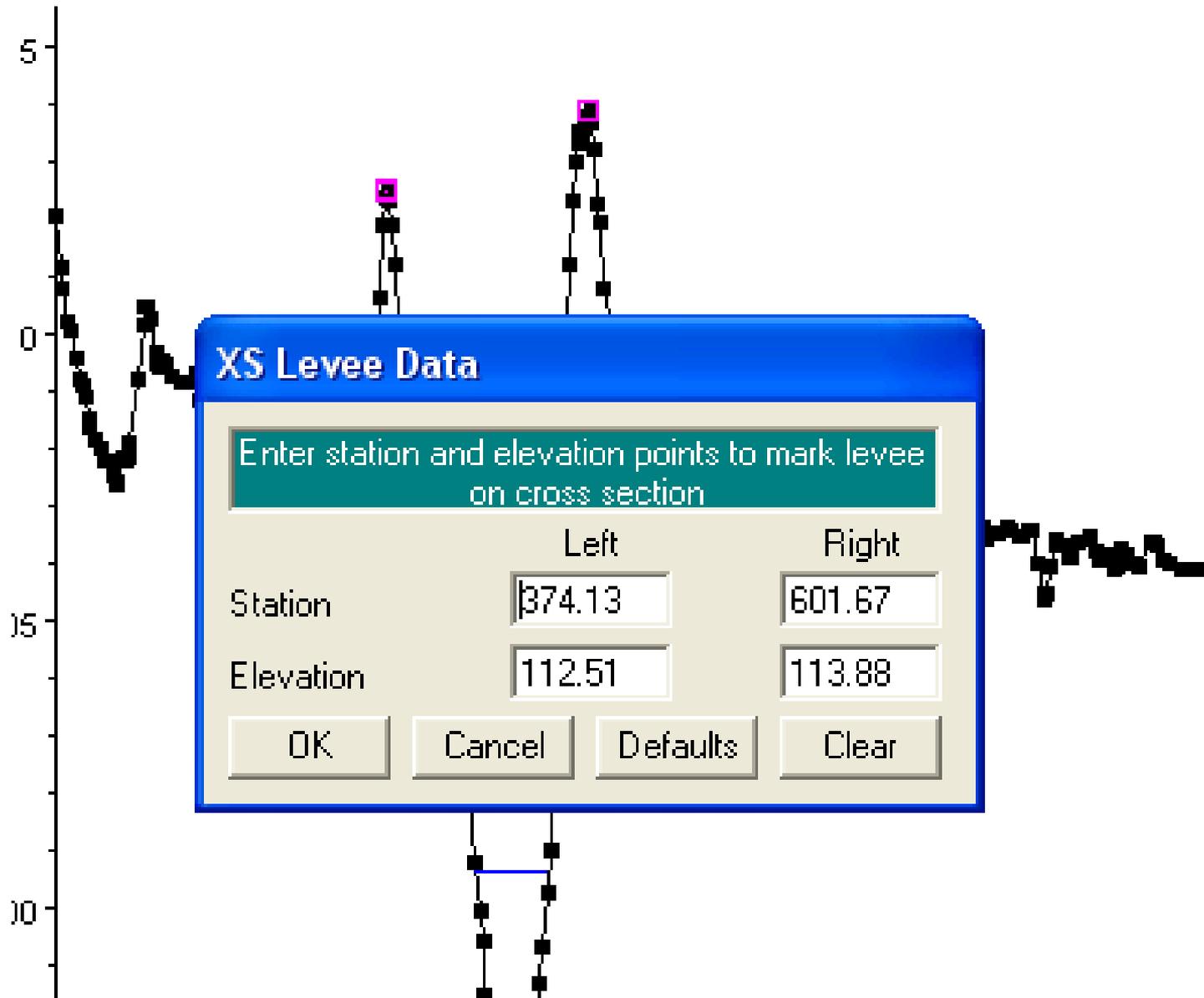
lao Stream - Maui County Floodplain

Plan: Without Bridge - Subcritical Flow

3/3/2010



# Levee Tool



# Levee Tool

**Edit Levees**

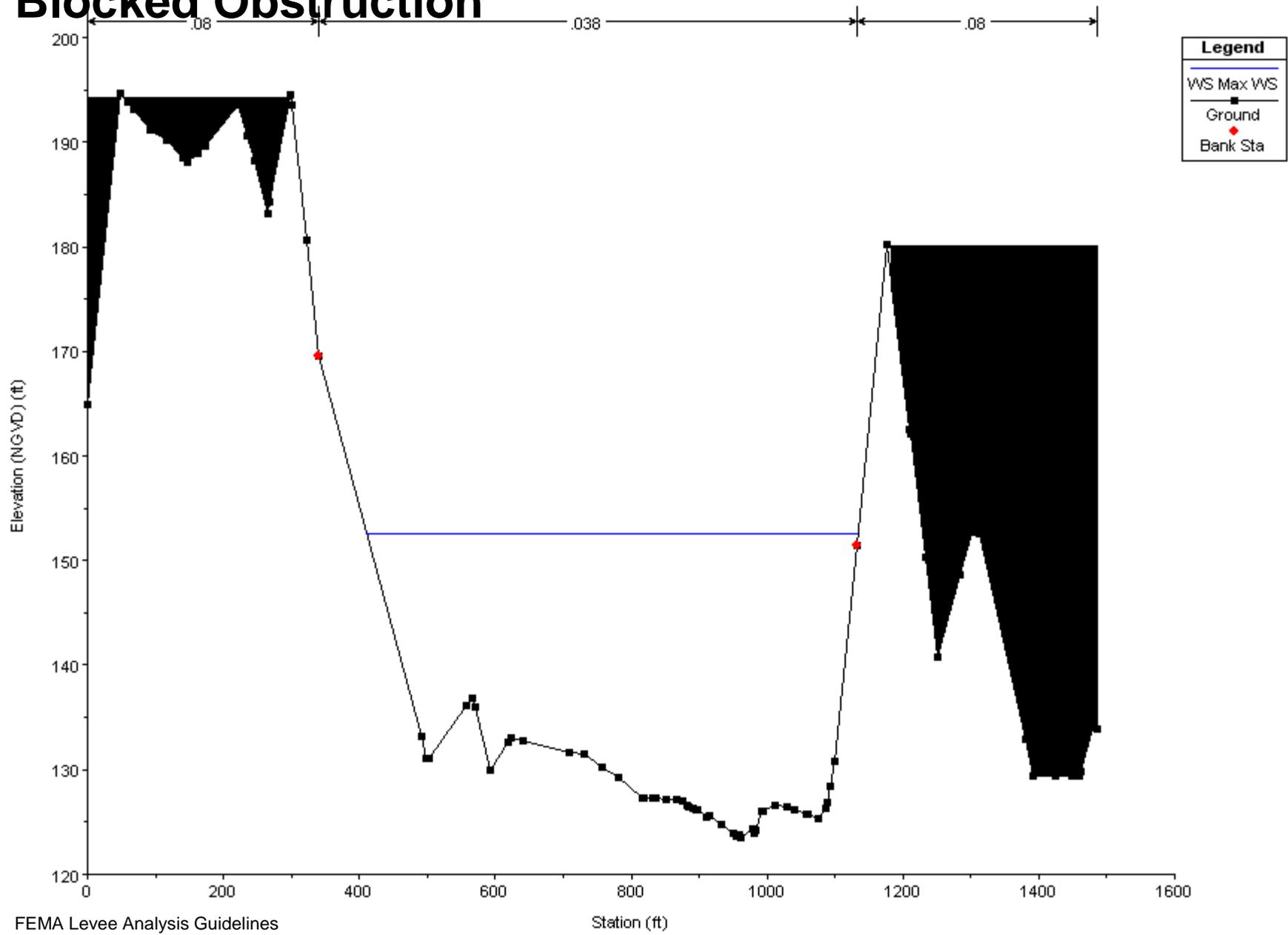
River: Feather River  Edit Interpolated XS's

Reach: Upper

Selected Area Edit Options

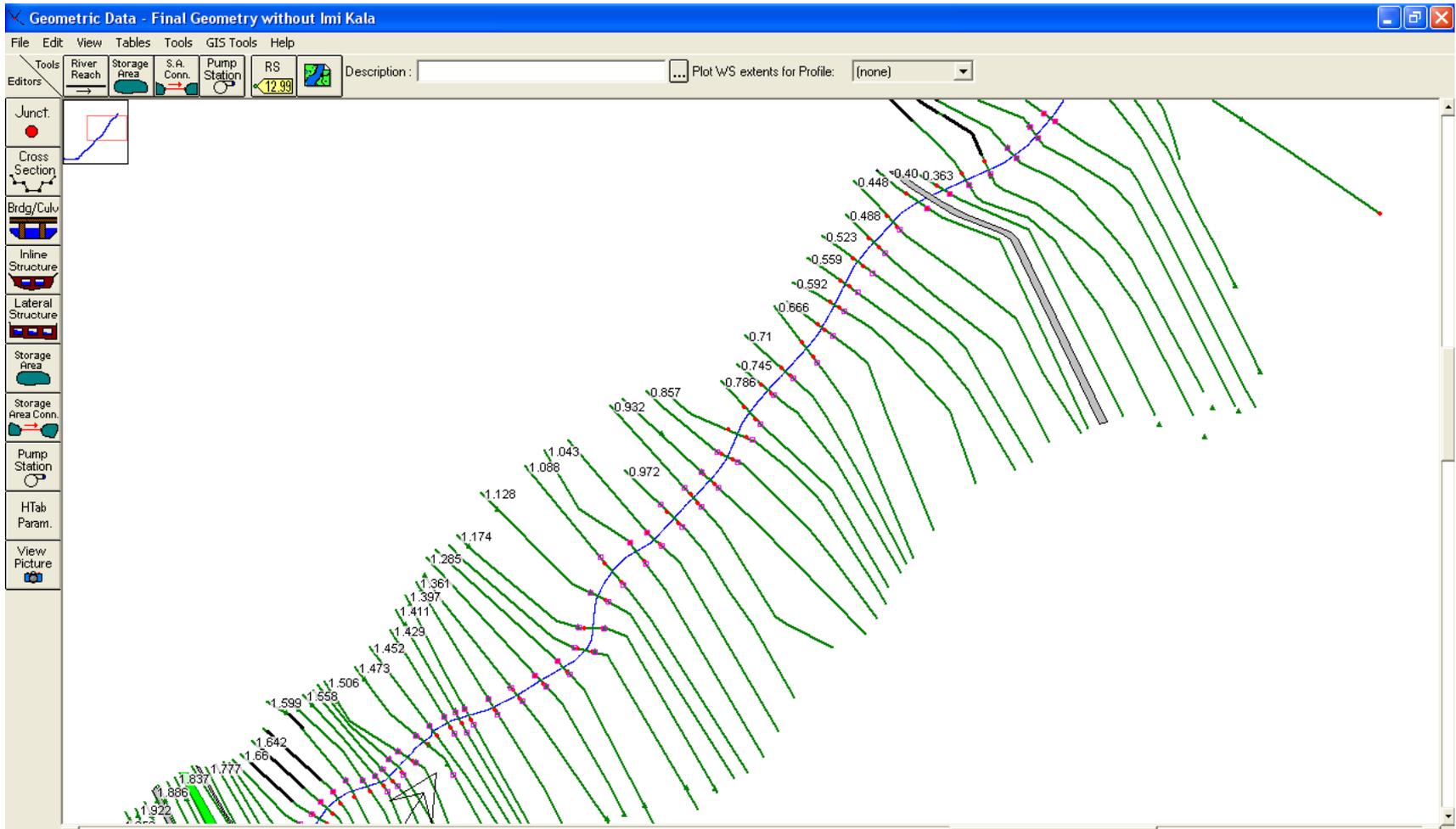
	River Station	Left Sta	Left Elev	Right Sta	Right Elev
113	52.21	569.9	105.64	8650.52	109.15
114	51.95	267.14	105.31	9573.24	109.28
115	51.35	309.88	104.17	11737.02	108.51
116	51.1777	785.4	104.03		
117	51.176	Lat Struct			
118	51.04	698.13	103.97	11818.34	103.65
119	50.84	844.17	103.4	11444.35	104.46
120	50.7	352.63	103.65	11343.83	104.88
121	50.59	127.95	103.04	10913.51	105.16
122	50.498	374	102.68	10941.97	108.54
123	50.496	470.17	102.6	10931.43	109.38
124	50.493	Bridge			
125	50.489	438.11	102.76	10918.26	108.33
126	50.487	427.43	102.76	10920.42	107.6
127	50.486	Lat Struct			
128	50.2	619.77	102.83	10333.59	103.68
129	50.17	Lat Struct			
130	50.06	737.31	103.57	10143.17	102.49
131	49.78	801.42	103.16	9895.92	101.76
132	49.58	6758.68	92.8	9412.48	100.78
133	49.38	6580.59	92.16	8573.81	100.35

# Blocked Obstruction



# Levee Analysis

- All new studies – Extend cross-sections across entire hazard area



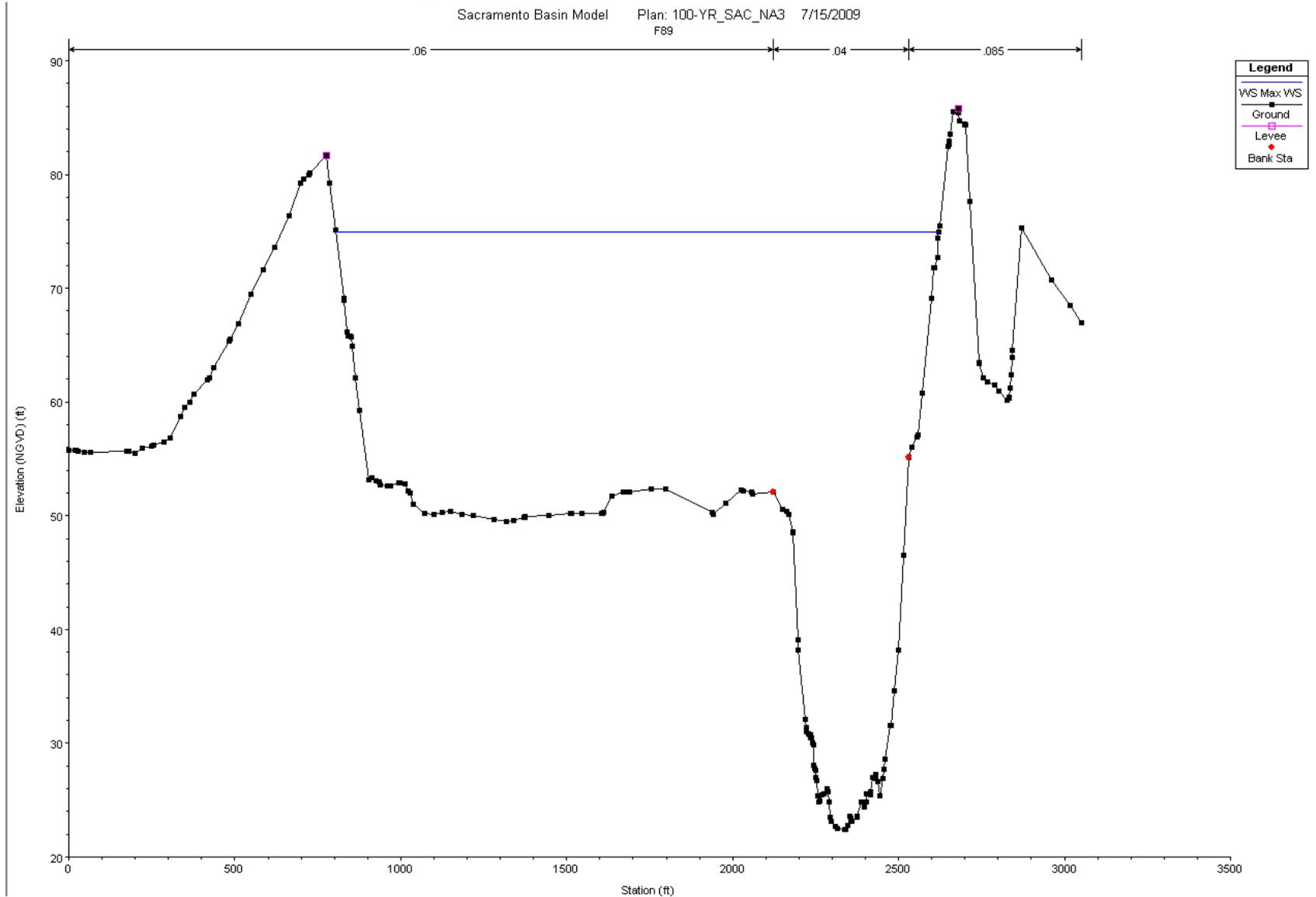
# Levee Analysis

- “With levee” and “without levee” hydraulic analysis
- Levee ground geometry used in both analyses
- Manning n reflects actual ground conditions
- Area landward of levee should not be treated as ineffective flow based solely on levee impediment in “without levee” scenario
- Split flow analysis is not permitted around de-accredited levees
- Breach analysis is never included in a FEMA analysis

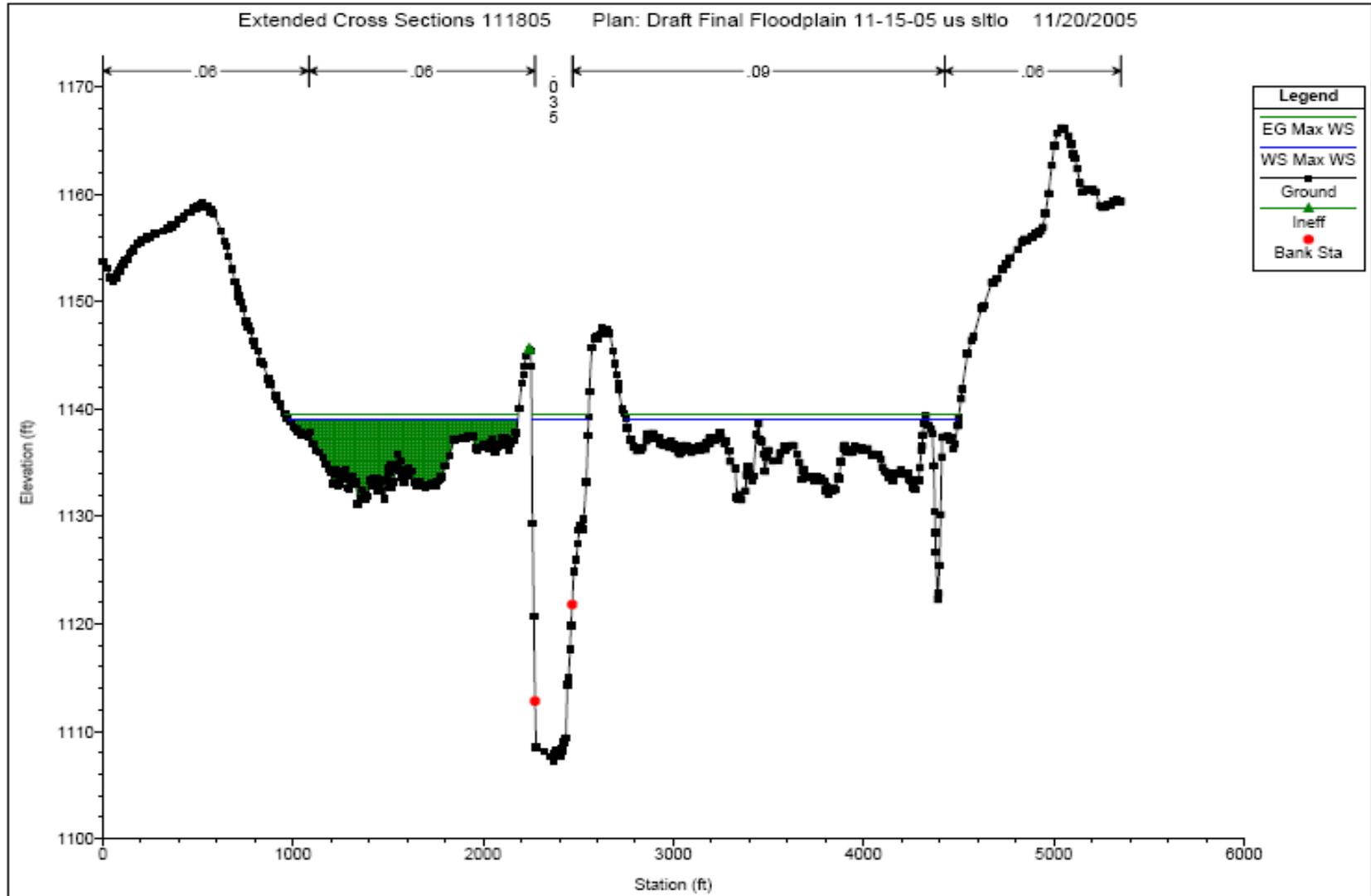
# Levee Analysis

- 10, 2 and 1 percent profiles based on “with levee” analysis
- 0.2 percent profile based on “without levee” analysis
- Additional profiles may be included as identified during scoping
- Unsteady analysis automatically accounts for change in storage
- Flows must be corrected for added storage in steady flow analysis

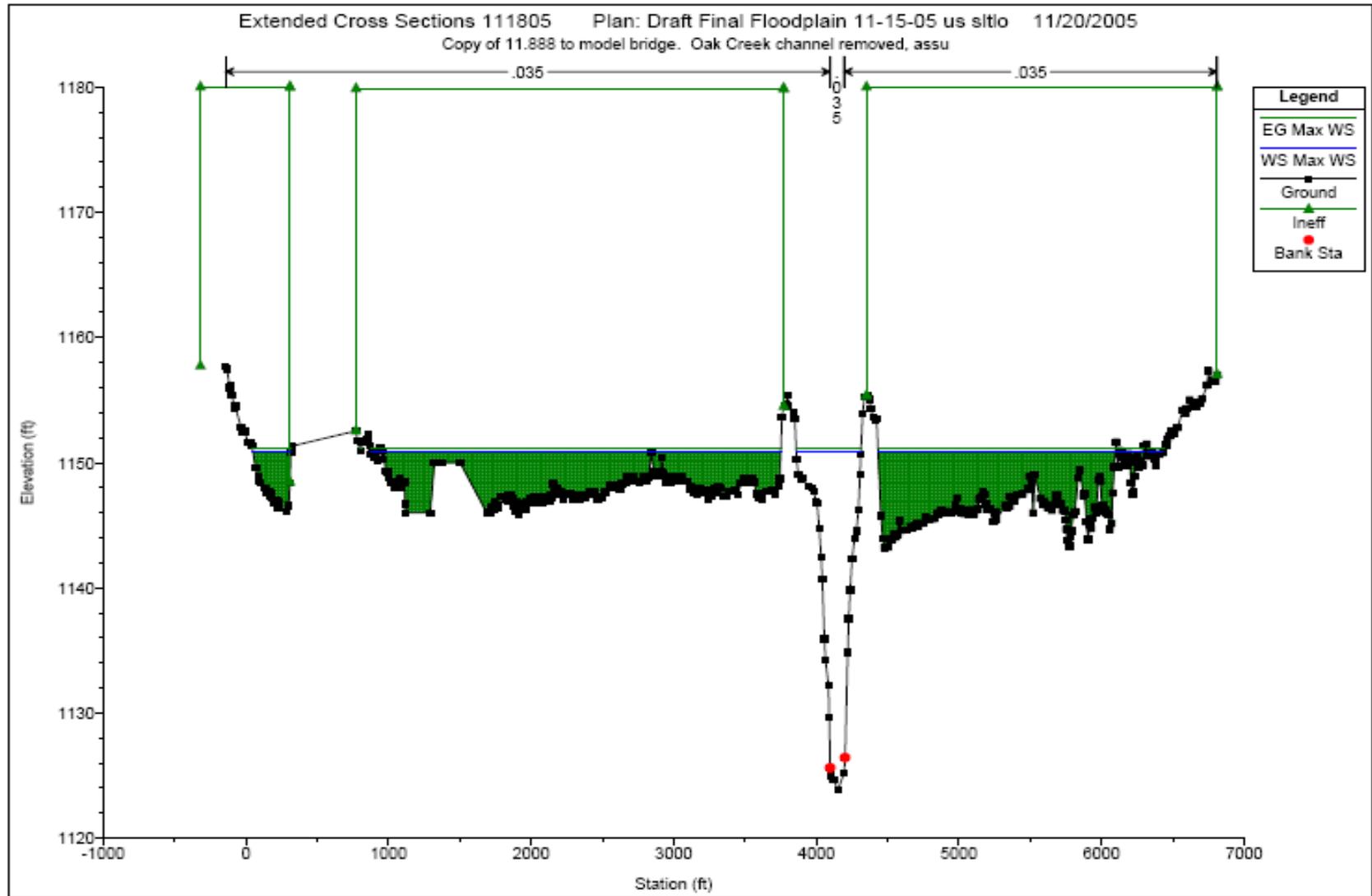
# “With Levee” Analysis



# “Without Levee” Analysis



# “Without Levee” Analysis



# Levee Analysis

- “With levee”

Flood is contained by levee(s)

Landward areas do not flood

HEC-RAS levee feature can be used to prevent conveyance behind levee

- “Without levee”

Levee remains in place in cross-section geometry

Landward areas can flood (HEC-RAS levee feature removed)

Levee does not impede conveyance (but other features may)

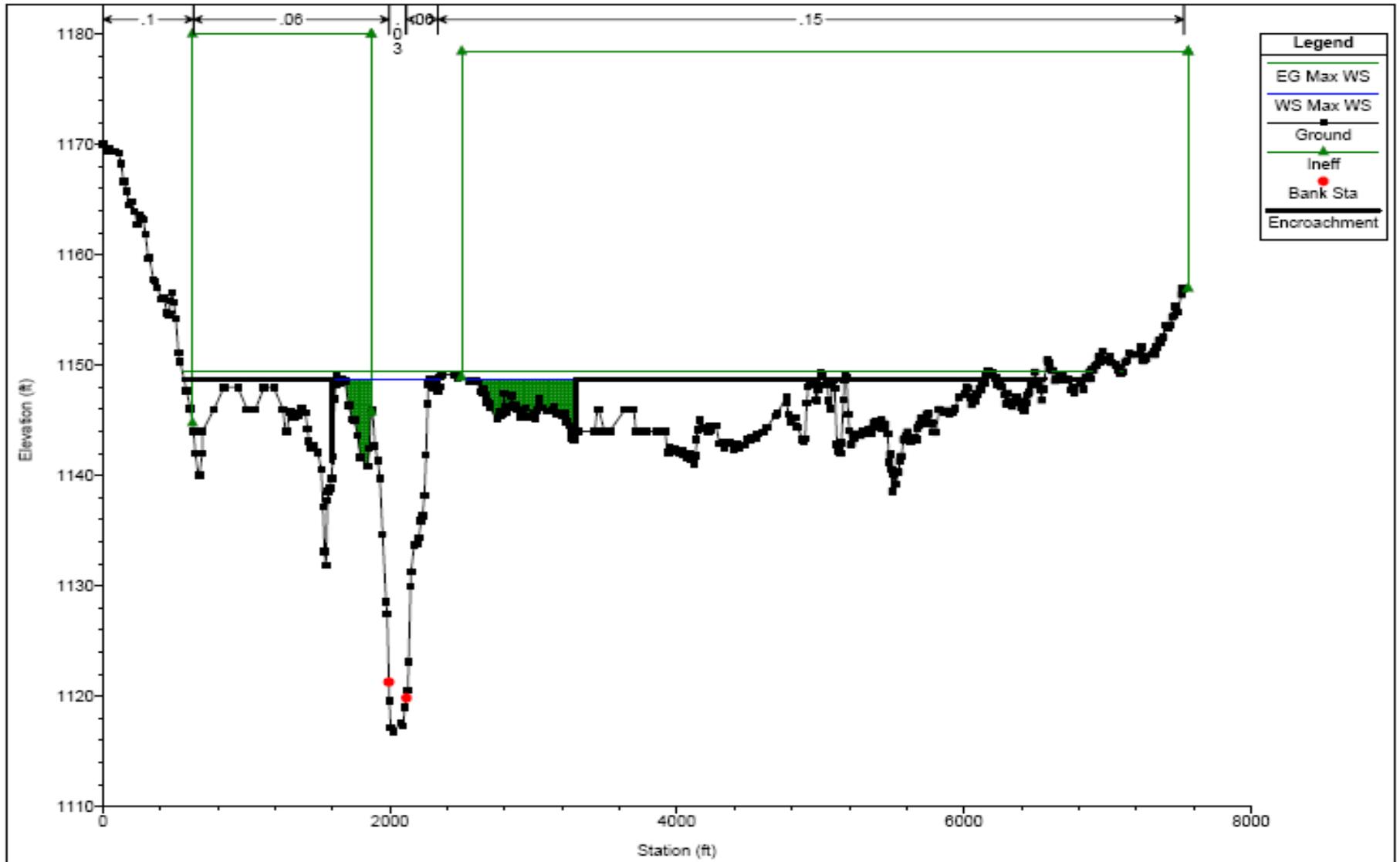
# Levee Analysis

- Levees on both sides of river – will require 4 analyses:
  1. With Both Levees in place (for BFEs riverward of both levees)
  2. With Right Levee in place, w/o Left Levee (for BFEs on Left)
  3. With Left Levee in place, w/o Right Levee (for BFEs on Right)
  4. Without Either Levee (for Floodway Analysis)
- Two Flooding Sources separated by a Levee – “the higher BFEs shall be used for mapping the flood hazards on the DFIRM” – Mississippi example

# Floodway Analysis (Detailed Studies Only)

- Floodway computed using the “without levee” analysis
- Compute a standard conveyance floodway
- If floodway limit computed in model is riverward of toe:
  - move mapped FW boundary to levee toe if requested by community or state with regulatory authority; otherwise, delineate at its computed location
- If floodway limit computed in model is between riverward and landward of toe:
  - move mapped FW boundary to landward toe of levee (try to keep modeled floodway limit at landward toe in model if computations support it)
- If floodway limit computed in model is landward of levee toe:
  - place FW boundary at computed location

# Floodway Analysis (Detailed Studies Only)





# Guidelines For Mapping Landward Of Levee Systems

- Conduct With Levee and Without Levee Analysis
- If “with levee” BFE is **below** top of levee:
  - “With levee” BFE is mapped riverward
  - “Without levee” BFEs are mapped landward
- If “with levee” BFE is **above** top of levee:
  - “With levee” BFE or top-of-levee is mapped riverward
  - “Without levee” BFEs are mapped landward

# Guidelines For Mapping Landward Of Levee Systems

## Detailed Procedure:

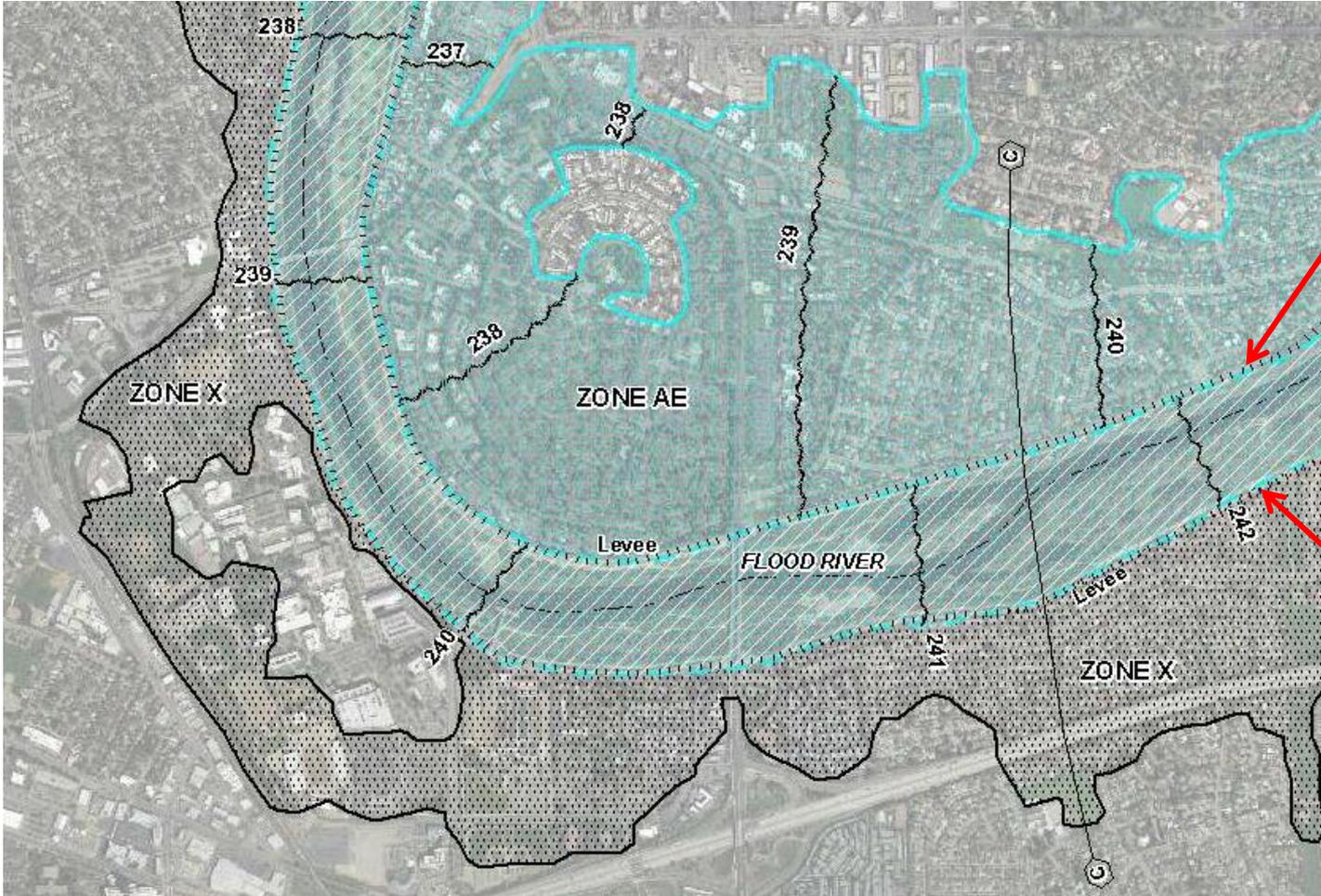
- If an effective model is used, it may have to be extended landward in order to best reflect current conditions in landward areas
- **Accredited levees** – use “without levee” analysis to map BFE on the topography as a shaded Zone X. Label with the appropriate protected area note per PM 45
- **Non accredited levees** - use “without levee” analysis to map BFE on the topography as a Zone AE.
- **Non accredited levees** - use “with levee” analysis to map BFE on the topography as a Zone AE in two special cases as follows:

# Guidelines For Mapping Landward Of Levee Systems

Special cases in which the “with levee” BFE would be used to map landward of the **non-accredited** levee

1. *Evidence is sufficient to show the area landward of the levee would have minimal conveyance regardless of the existence of the levee*
2. *A sensitivity analysis is performed which documents that the “without-levee” condition would be less than 0.5 feet different than the “with-levee” condition along the entire profile*

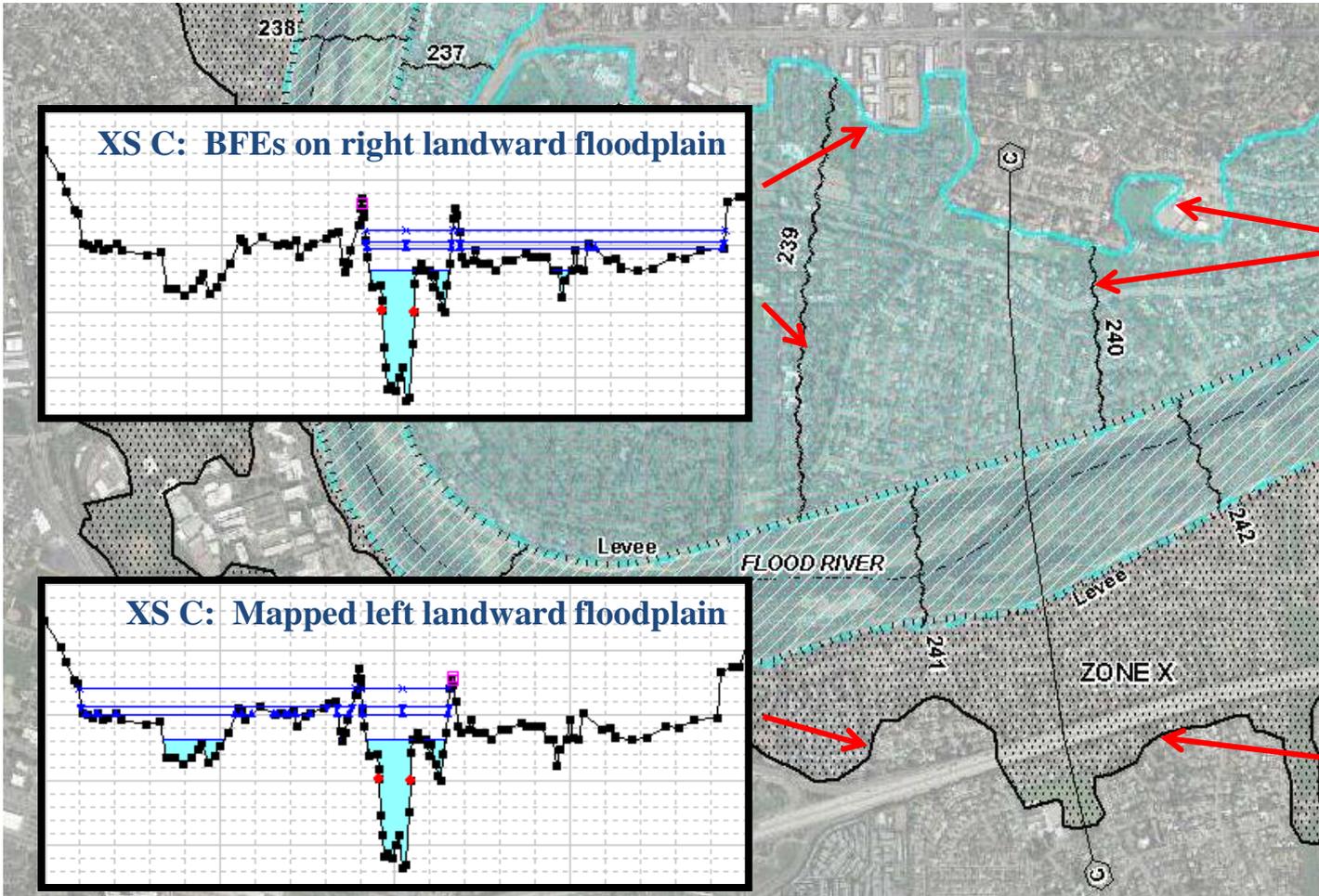
# Summary – DFIRM Example (Flood River)



Right Levee:  
Non- or De-  
Accredited

Left Levee:  
Accredited

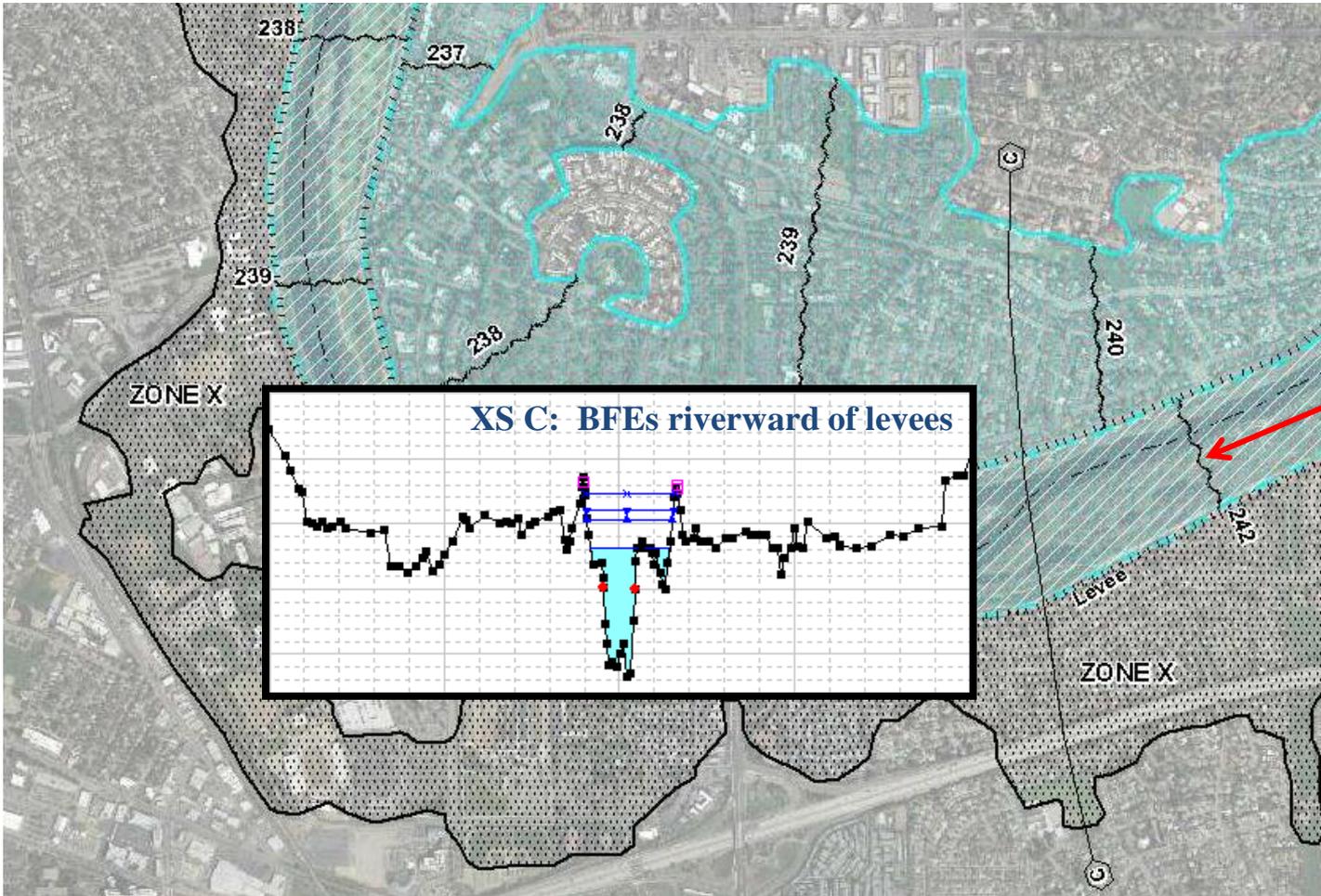
# Summary – DFIRM Example (Flood River)



BFEs based on  
100-year  
“Without Right  
Levee”

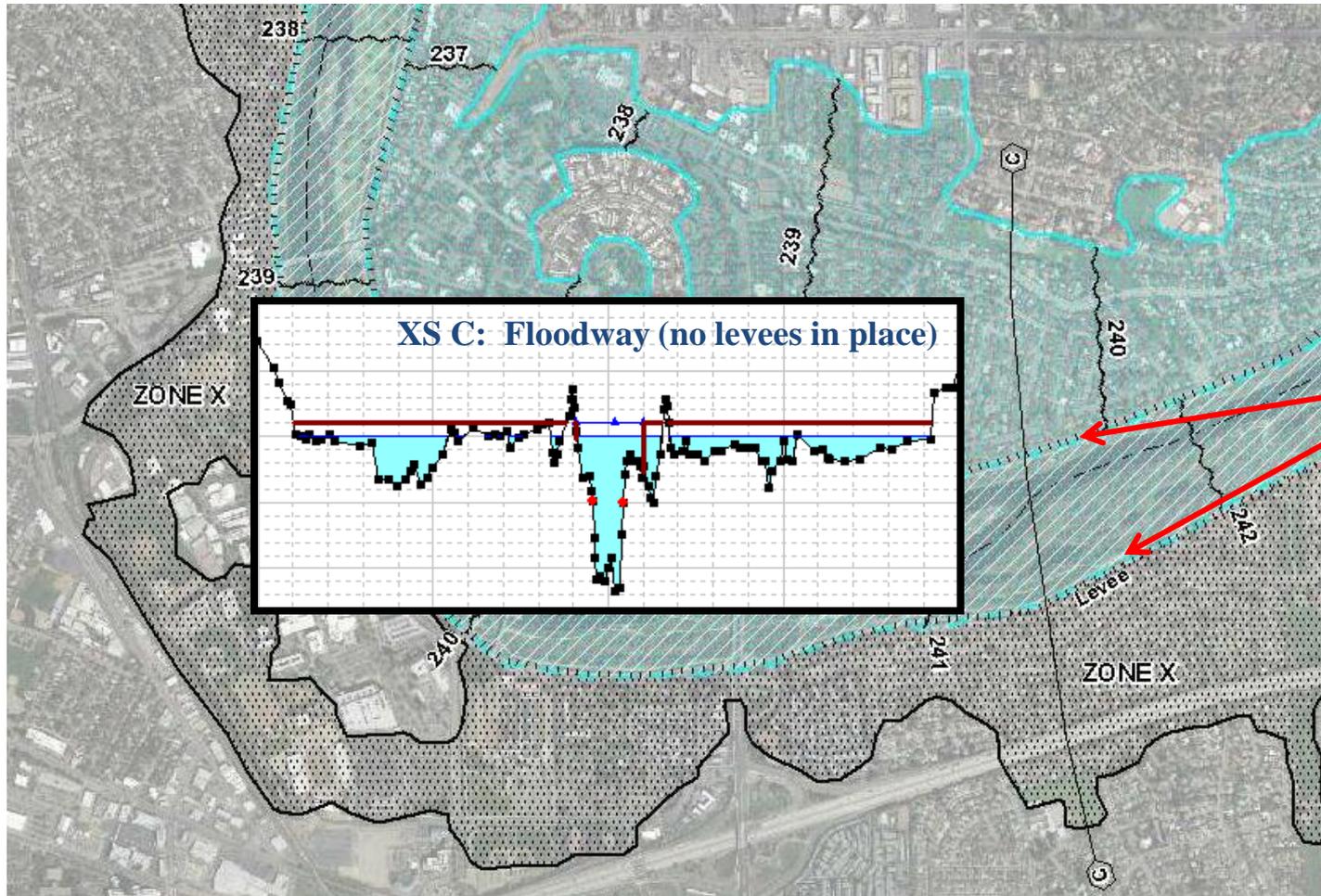
Shaded Zone  
X boundary  
based on 100-  
year “Without  
Left Levee”

# Summary – DFIRM Example (Flood River)



BFEs riverward of levee based on “With Levee” Analysis

# Summary – DFIRM Example (Flood River)



Floodway  
Analysis based  
on complete  
levee removal  
from model

# Guidelines For Mapping Landward Of Levee Systems

## Limited Detailed Procedure:

- Hydrologic Methods are similar to standard riverine limited detail studies
- Hydraulic model development follows usual limited detail engineering procedures
- **Accredited levees** – landward mapping is the same as detailed procedure
- **Non accredited levees** – FEMA, mapping partner, Community and State meet to decide whether BFE should be published on the maps (Zone A or AE).
  - If the decision is Zone AE, then landward mapping is the same as detailed procedure
  - otherwise the “without levee” results are mapped on the best available topography as an Approximate Zone A

# Guidelines For Mapping Landward Of Levee Systems

## Approximate Procedure:

- Hydrologic Methods are similar to standard riverine approximate studies
- Hydraulic Methods are similar to standard riverine approximate studies
- **Accredited levees** – landward mapping is the same as detailed procedure
- **Non accredited levees** – the “without levee” results are mapped on the best available topography as an Approximate Zone A

