

# The Development of a Flood Warning and Response System

Cameron Ackerman, P.E.  
Hydrologic Engineering Center, USACE



# Purpose

- ◆ Provide a Flood Warning and Response System to communities along river systems
  - Maximize response time (County Emergency Management Agency and Floodplain Residents)
  - Use stage/elevation-based flood inundation mapping
  - Damage estimates (expedite disaster assistance)
  - Evacuation & flood warning plan formulation tool
  - Educate the public on flood hazard



# Software Development Goals

- ◆ Use existing technologies as much as possible to develop the FWRS
- ◆ Develop new tools and interfaces only where necessary
- ◆ Maximize the use of geospatial displays
- ◆ Keep the interface simple and customizable
- ◆ Easily update data



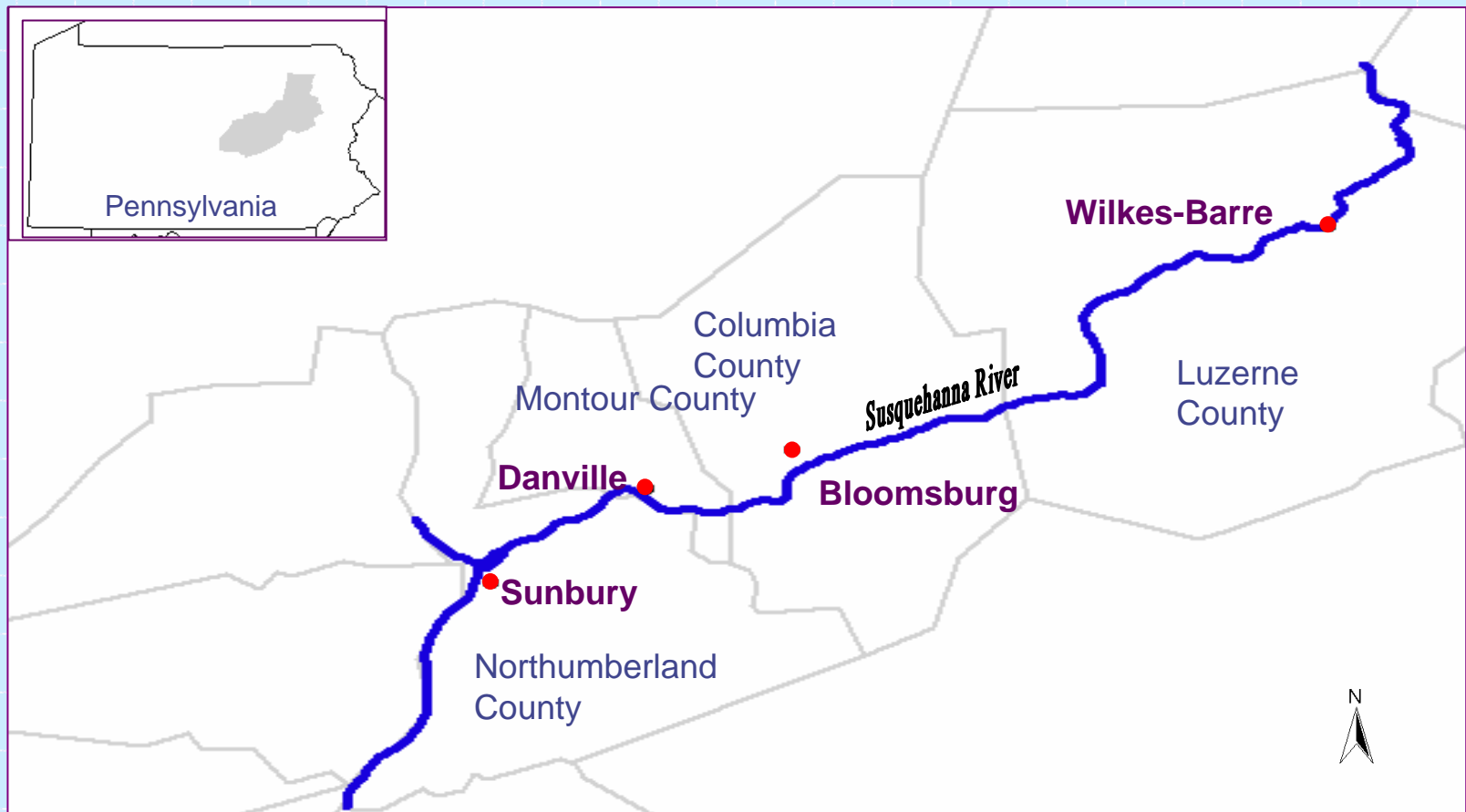
# Process Components

- ◆ Forecast Information
  - National Weather Service Forecasts
- ◆ River Hydraulics Model
  - River Analysis System (HEC-RAS), HEC-GeoRAS
- ◆ Data Visualization
  - ArcGIS – Customized Interface, Excel
- ◆ Flood Damage Computations
  - Structure Inventory
- ◆ Flood Impact Response Tables



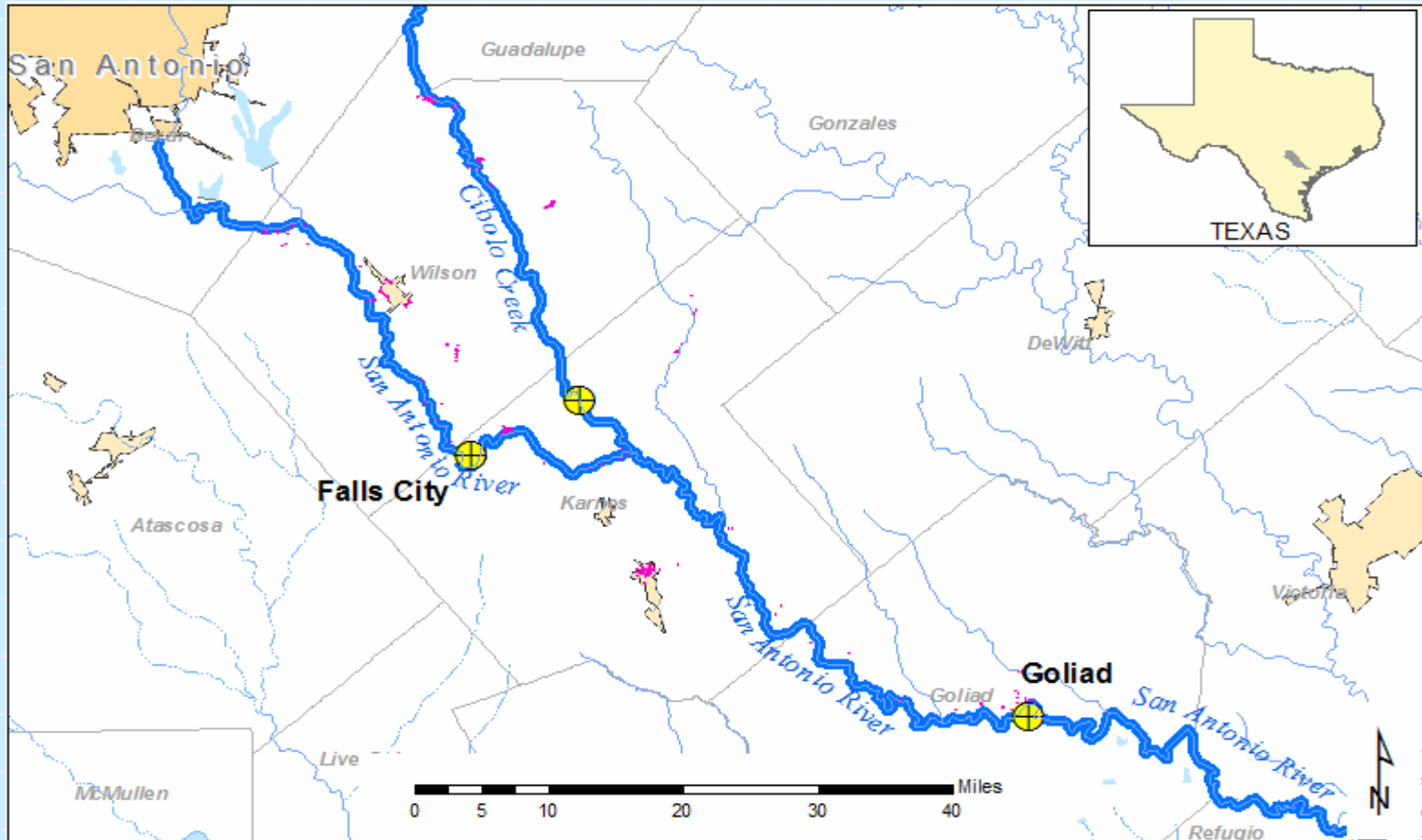
# Study Area – Susquehanna River

- ◆ 4 NWS Forecast Locations

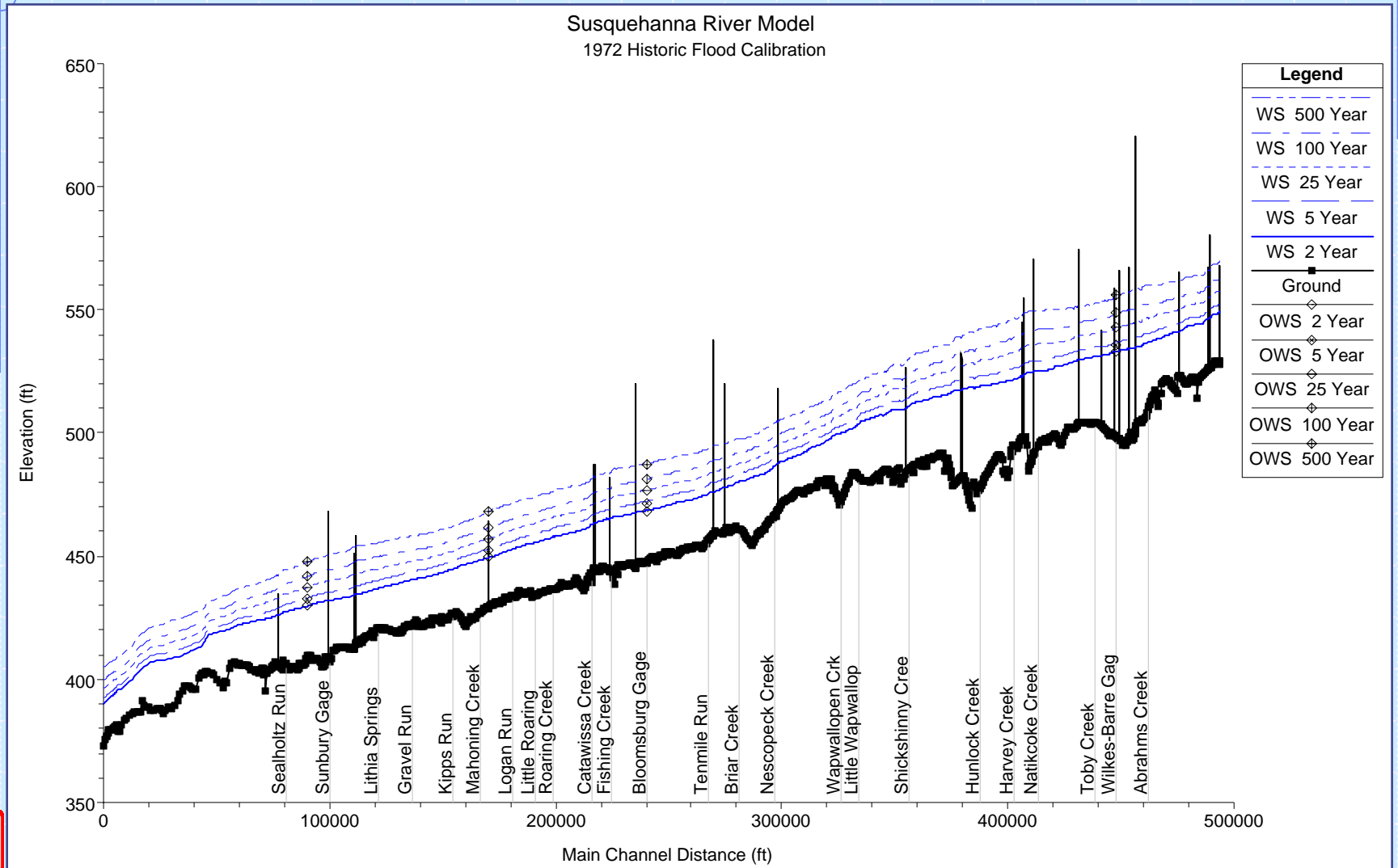


# Study Area - San Antonio River

- ◆ 3 NWS Forecast Locations

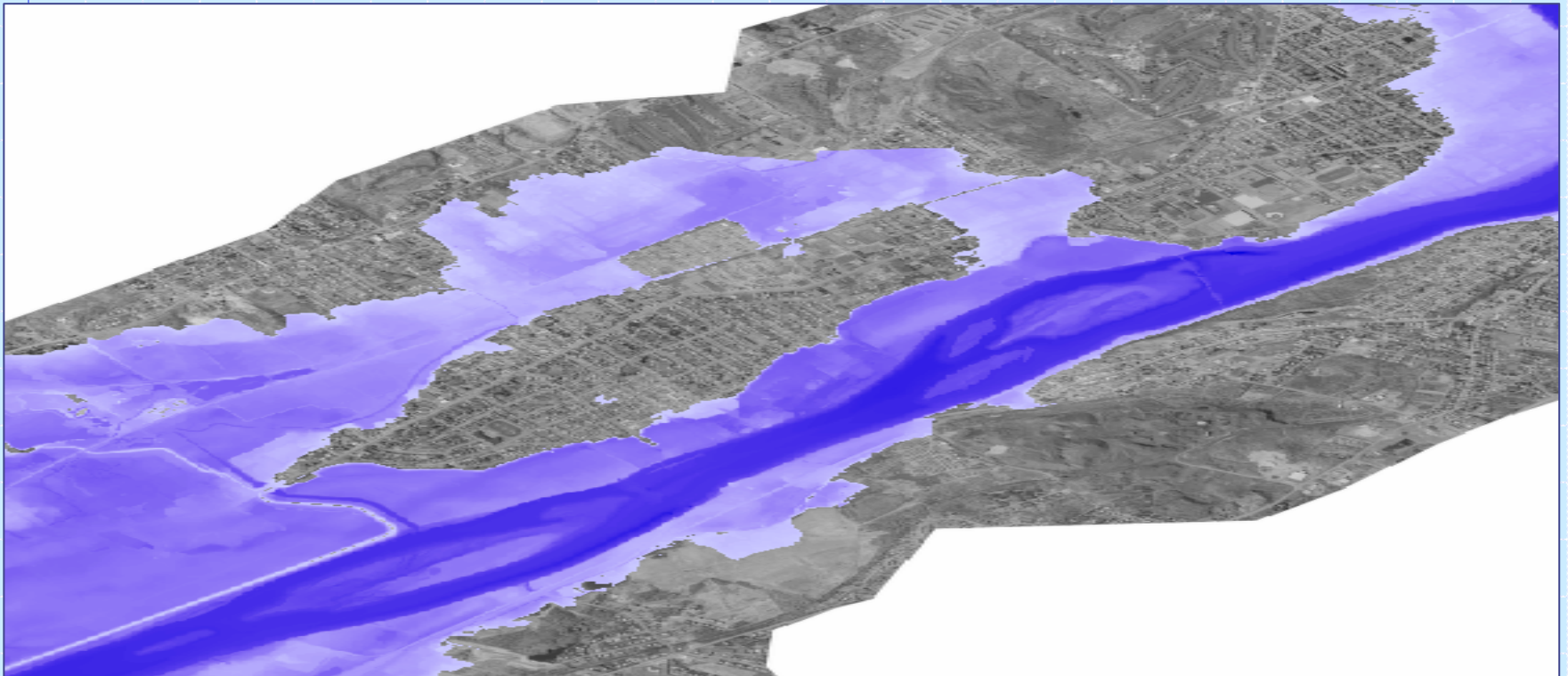


# HEC-RAS Model Creation and Calibration



# Inundation Mapping using HEC-GeoRAS

- ◆ Atlas of water surface profiles/inundation maps run to cover the range of expected events





# Flood Warning and Response System

- ◆ Customized interface to ArcGIS



- ◆ Entry of forecast information
- ◆ Query of inundation depths
- ◆ Access impact response tables
- ◆ Calculate structure damages



# Forecast Entry – Susquehanna River

- ◆ Predefined Locations for entry of Elevation or Stage

**Flood Warning Response System**

File Settings Tools Help

Forecast:

	Elevation	Stage
Wilkes-Barre	<input type="text" value="540.86"/>	<input type="text" value="30"/>
Bloomsburg	<input type="text"/>	<input type="text"/>
Danville	<input type="text"/>	<input type="text"/>
Sunbury	<input type="text"/>	<input type="text"/>

The map displays the Susquehanna River with four predefined locations marked by red dots and labeled: Sunbury, Danville, Bloomsburg, and Wilkes-Barre. Each location is enclosed in a pink rectangular box.



# Forecast Entry – San Antonio River

- ◆ Flexible “selection” of input locations

**Flood Warning and Response System**

File Forecast Tools Help

Forecast: Example Forecast

<u>Location</u>	<u>Elevation</u>
<b>San Antonio River</b>	
Near Falls City	310
At Goliad	136
<b>Cibolo Creek</b>	
Near Falls City	290

Close Map Forecast

- ◆ FWRS input form is built based on Excel sheet

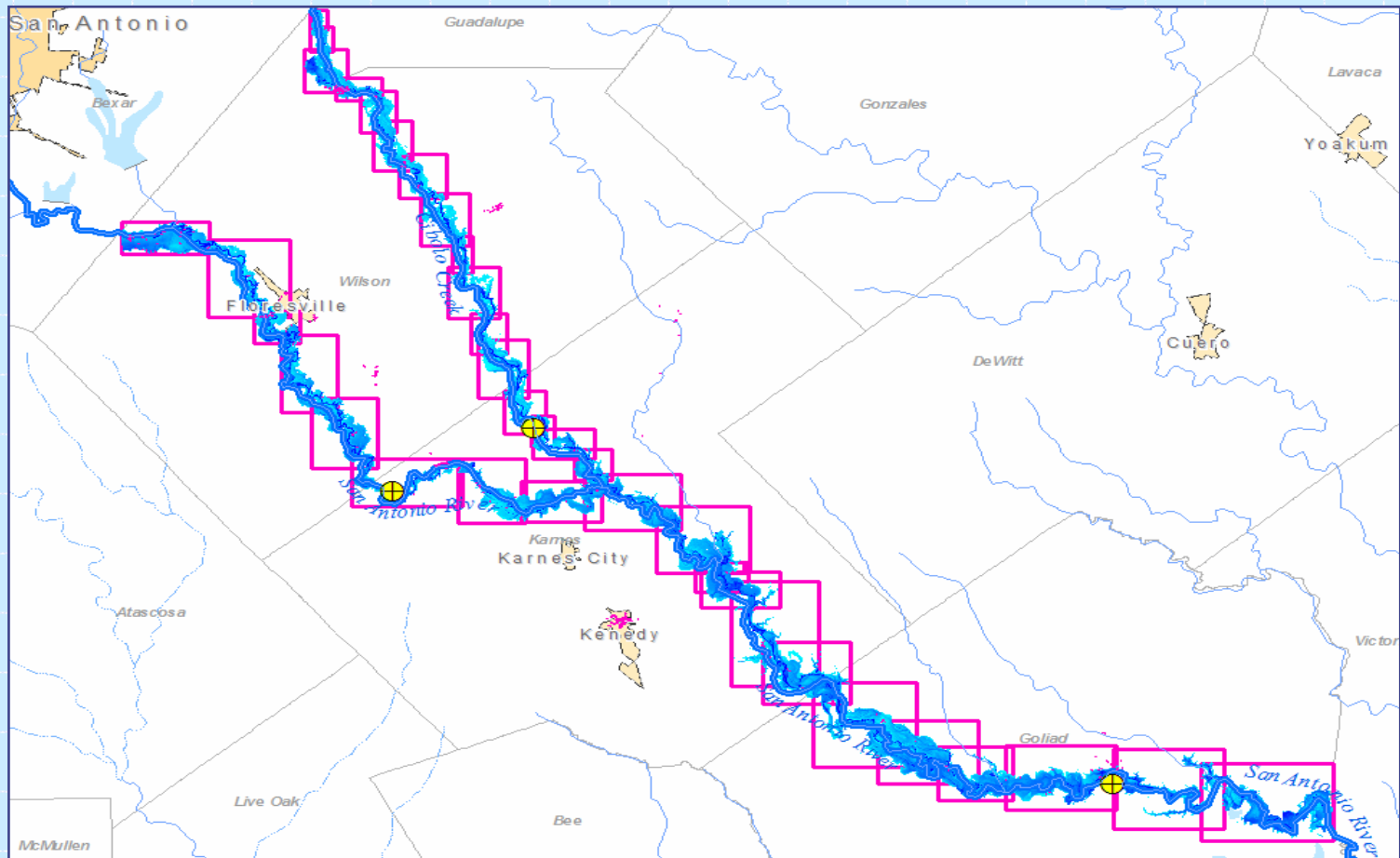
	A	B	C	D	E
1	River Name	River Station	Location Name	MinWSE	MaxWSE
2	San Antonio River	824797.2	Near Falls City	302.3	326
3	San Antonio River	368786.3	At Goliad	117.7	147.5
4	Cibolo Creek	56391	Near Falls City	286.4	300.2
5					

Gages/Rivers/San Antonio River/Cibolo



# Tiled Mapping

- ◆ 20 Tiles San Antonio River, 16 Tiles Cibolo Creek



# Tiled Mapping

- ◆ Interpolation by profile number
- ◆ Backwater by water surface elevation at confluences to handle tributaries
- ◆ Data stored by profile

Current Forecast Information

Current Forecast: Example Forecast

River	Location	RS	WSE
San Antonio River	Near Falls City	824797.2	310
San Antonio River	At Goliad	368786.3	136
Cibolo Creek	Near Falls City	56391	290

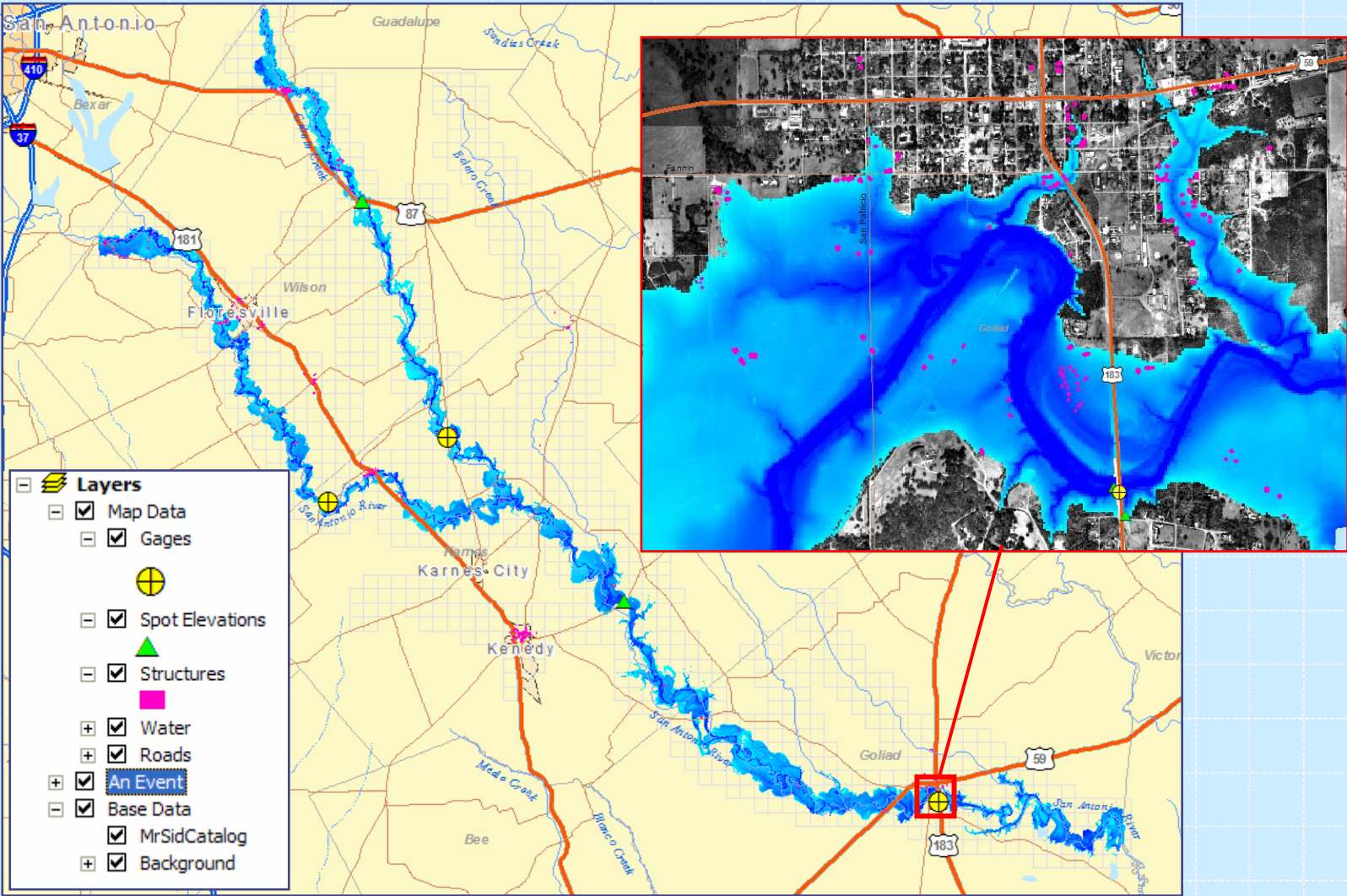
  

River	RS	Profile#	WSE
San Antonio River	1031432	11	399.4
San Antonio River	976688	11	374.1
San Antonio River	948696	11	364.5
San Antonio River	891006	11	338.5
San Antonio River	842867	11	319.5
San Antonio River	786329	11	287.0
San Antonio River	749746	12	271.5
San Antonio River	719556	12	258.4
San Antonio River	676304	13	242.3
San Antonio River	635889	13	224.9
San Antonio River	632094	14	223.6
San Antonio River	621620	14	221.6
San Antonio River	601515	14	217.6
San Antonio River	569404	14	205.0
San Antonio River	535276	15	191.4
San Antonio River	500441	15	169.0
San Antonio River	458834	16	156.5
San Antonio River	429696	16	146.7
San Antonio River	368786	17	136.2
San Antonio River	307626	17	112.9
San Antonio River	231398	17	79.6
Cibolo Creek	297191	7	497.2
Cibolo Creek	285194	7	482.7
Cibolo Creek	268357	7	461.2
Cibolo Creek	251730	7	445.1
Cibolo Creek	231899	7	428.8
Cibolo Creek	202724	7	406.7
Cibolo Creek	176677	7	386.4
Cibolo Creek	154718	7	369.2
Cibolo Creek	140951	7	359.6
Cibolo Creek	116276	7	335.9
Cibolo Creek	101713	7	326.1
Cibolo Creek	77177	7	308.9
Cibolo Creek	51177	7	286.8
Cibolo Creek	39009	7	276.7
Cibolo Creek	21456	7	267.4
Cibolo Creek	4215	14	259.5

Close



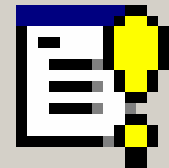
# Mapping Layers



# Flood Impact Response Tables

- ◆ Given a forecasted elevation:
  - What is the expected impact?
  - What response action should be taken?
- ◆ Developed by individual local Emergency Management Agencies
  - Excel spreadsheet
  - May be formatted (font, color, size)





# Flood Impact Response Tables

Flood Impact Response Table					
Print ...		Copy ...			
	Elevation	Stage	Impact	Response	
Wilkes-Barre City	528	19		W-B Market St. & Union St. Pumping Stations Activated	
	529	20	WARNING STAGE Inundation: Nesbitt Park	Vine St. Shickshinny, Farm Area Plainsville, EMA Control Center Activates.	
	530	21			
	531	22	FLOOD STAGE Inundation: Plymouth Flats, W. Nanticoke, Shickshinny		
	532	23	Farm Area Plains Inundated		
	533	24	Inundation: Lowlands, Pittston City, Canal St., Shickshinny		
	534	25	Inundation: W Pittston, Harding	Levee Patrol Begins, Lowlands of Plainsville.	
	535	26			
	536	27	Inundation: RT.11 W. Nanticoke & River Rd. Palinsville		
	537	28	Inundation: Canal St. W. Nanticoke	Close RT. 11 W. Nanticoke	
	538	29	Inundation: PP&L Riverlands, River Rd, Por Balanchard, Ws Pittston	Close RT. 11 Shickshinny	
	539	30	Inundation: RT.11 Avondale Flooding C.H. Subbasement, Main St. Shickshinny from sewers.	Activate W-B Brookside Flood Protection System	
	540	31	Duryea & W. Pittston affected	Hanover Twp. Installs Stop Logs Canadian Pacific RR Tracks Hollenback PK. W-B Mark Plaza EDW.	
	541	32	Main St. Shickshinny Inundated	County Installs Barrier Erie-Lackawanna RR Tracks, Swoyersville	
	542	33	Inundation: Mocanaqua	Kingston Installs Stop Logs, Pocono-NE RR Tracks. W-B Installs Barrier at rear of C.H.	
	543	34		Kingston Installs Sandbag Closure, RT. 11 Edwardsville. W-B Installs Enclosure at Market St Bridge	
	544	35	Inundation: RT.11 Edwardsville, Dundee Area, Hanover Twp.		
545	36	Inundation: Nescopeck B.	County Installs Sill, Lehigh Valley RR Tracks, Swoyersville.		
546	37	Levee topped - Inundation W-B	County Installs Sandbag Closure, Wilkern St. Exeter.		
547	38	Inundation: Hanover Twp. & West Side (Plymouth, Edwardsville, Kingston, Forty-Fort, Wyoming)			
548	39	Swoyersville, Luzerne begin Inundation.			





# Flood Damage Analysis

- ◆ Structure inventory
- ◆ Depth-%Damage curves
  - Damage Category (Susquehanna River)
    - ◆ Residential, commercial, ...
  - Occupancy type (San Antonio River)
    - ◆ Single Story Residential, 2 Story Residential, Mobile Home, Single Story Apartment, ...





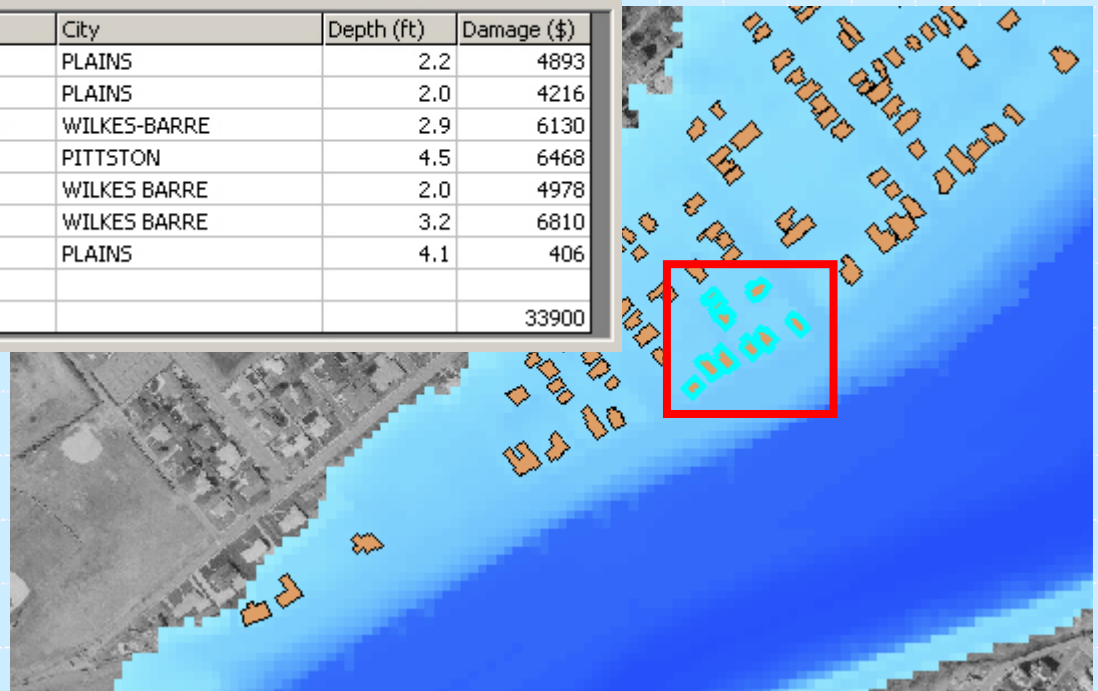
# Structure Damage

- ◆ Query inundation depth
- ◆ Compute individual structure damage

**Flood Damage by Structure**

Print ... Copy ...

Name	Address	City	Depth (ft)	Damage (\$)
OWENS WILLIAM & LORETTA	2 ROBERTS ST	PLAINS	2.2	4893
OWEN GEORGE R & SADIE J	10-12 ROBERT ST	PLAINS	2.0	4216
BELSKY DAVID & DIANE	163 COURTRIGHT ST	WILKES-BARRE	2.9	6130
POHODA JOHANNA THERESA	16 MITCHELL ST	PITTSTON	4.5	6468
LINSKI MARY H & BENJAMIN	15 MITCHELL ST	WILKES BARRE	2.0	4978
GRAY MARGARET A	6 MITCHELL ST	WILKES BARRE	3.2	6810
CHOPKA ANDREW & JEAN	2 MITCHELL ST	PLAINS	4.1	406
Total =				33900





# System-wide Damage

- ◆ Working estimate for FEMA disaster relief

	# Res.	Res. Damage(\$)	# Comm.	Comm. Damage(\$)	# Total	Total Damage(\$)	# Impacted
<b>Columbia County</b>							
Berwick Borough	1	11038	0		1	11038	18
Bloomsburg Town	127	2089524	26	1554798	153	3644320	589
Briar Creek Borough	0		0		0		18
Catawissa Borough	15	183563	3	55213	18	238776	90
Franklin Township	0		0		0		15
Mifflin Township	0		0		0		25
Montour Township	16	257353	0		16	257353	68
Scott Township	93	1504762	4	52773	97	1557536	357
South Centre Township	7	80559	10	6362070	17	6442628	70
Total	259	4126798	43	8024855	302	12151650	1250
<b>Lackawanna County</b>							
Ransom Township	0		0		0		14
Total	0		0		0		14
<b>Luzerne County</b>							
Conyngham Township	28	120324	0		28	120324	131
Duryea Borough	0		0		0		31
Edwardsville Borough	0		0		0		19
Exeter Borough	1	7697	0		1	7697	42



# Contact Information

- ◆ Cameron Ackerman, P.E.  
Hydrologic Engineering Center, USACE  
[cameron.t.ackerman@usace.army.mil](mailto:cameron.t.ackerman@usace.army.mil)

