

Probable Maximum Precipitation Study for Pennsylvania

Flood Analysis of the July 1942 “Smethport” Extreme Rainfall Event

Aterra Solutions

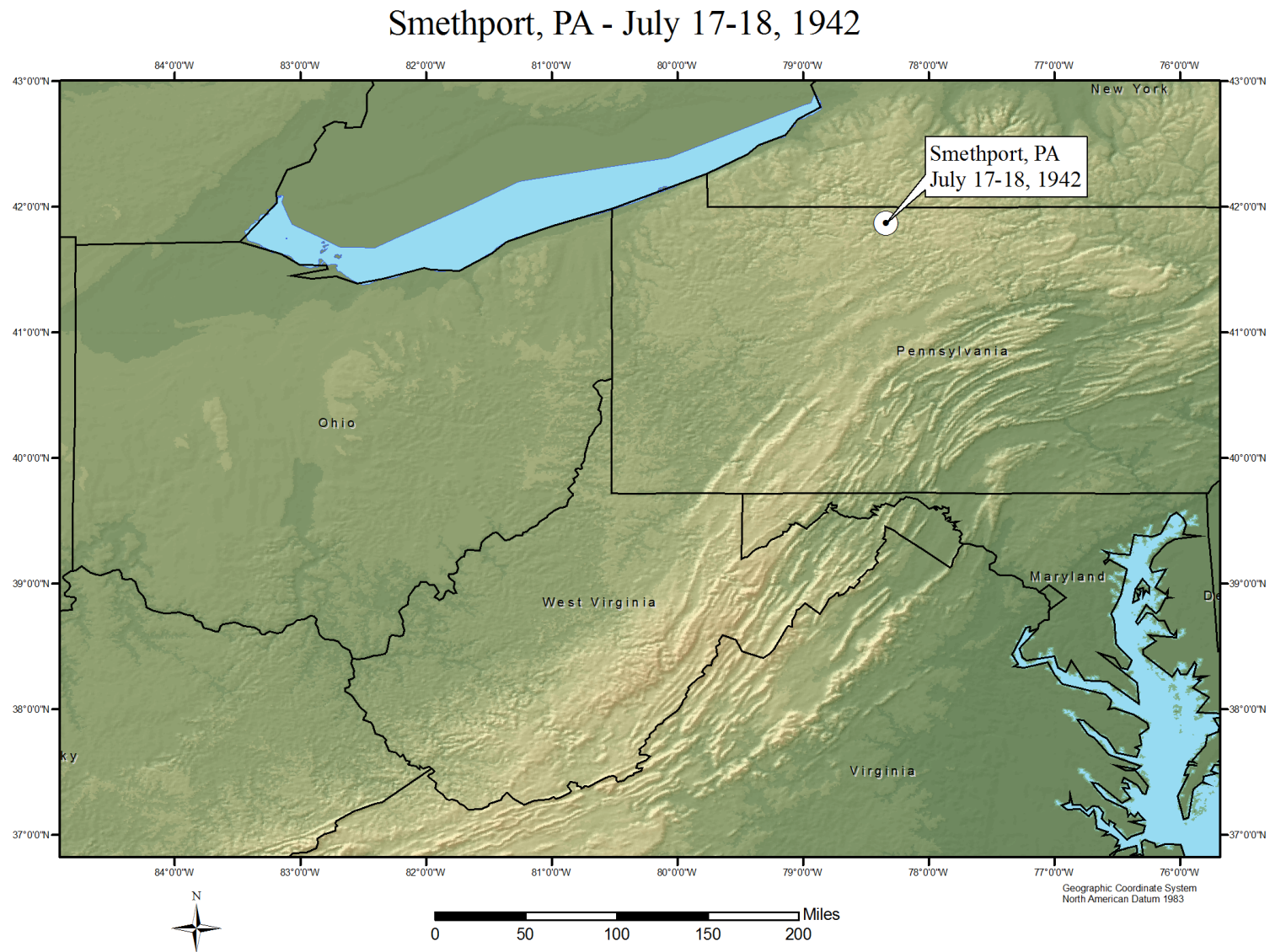
Joe Bellini, PE, PH, D.WRE, CFM

Applied Weather Associates

Bill Kappel, Chief Meteorologist

April 10, 2019

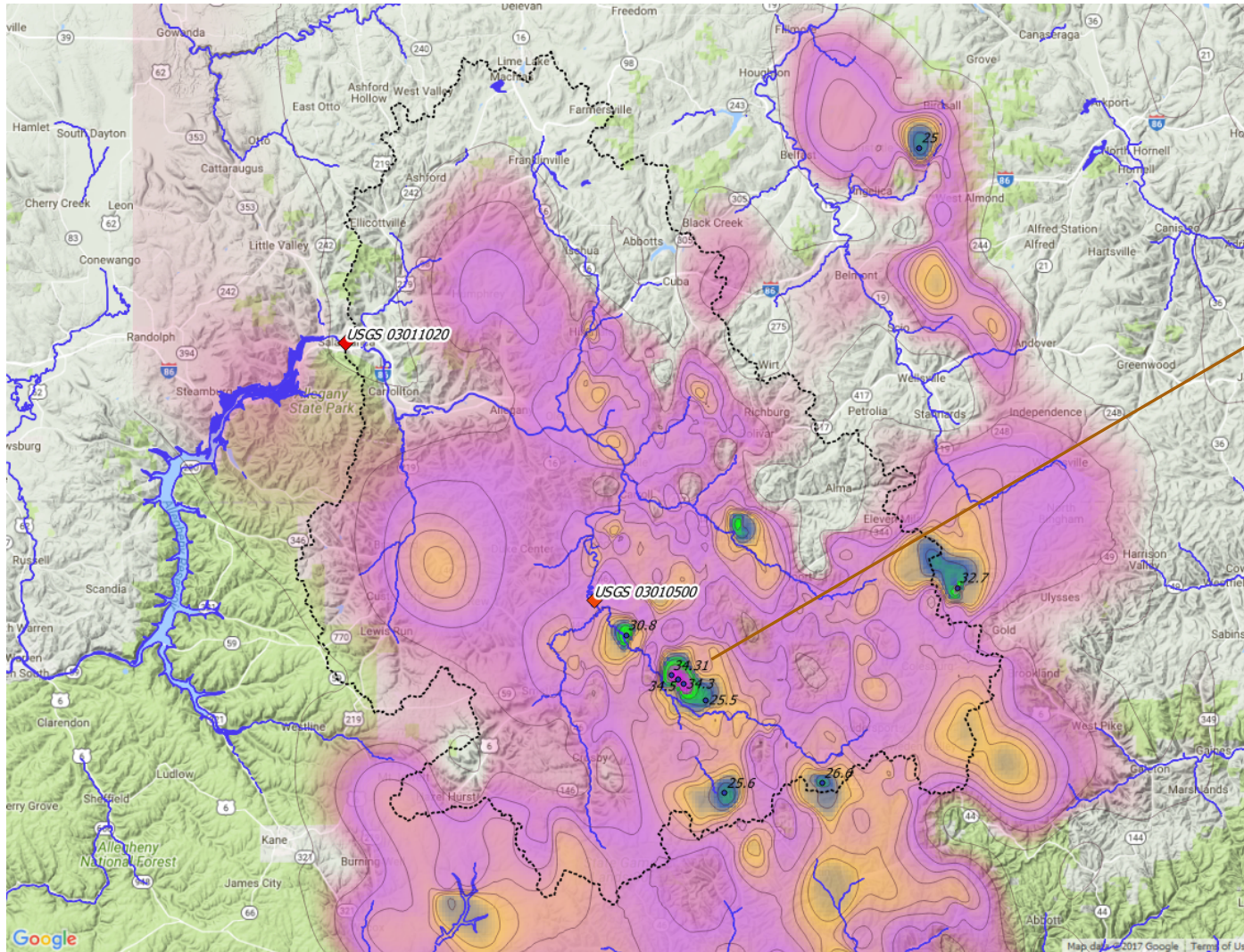
Location



Overview of the July 1942 Storm and Flood

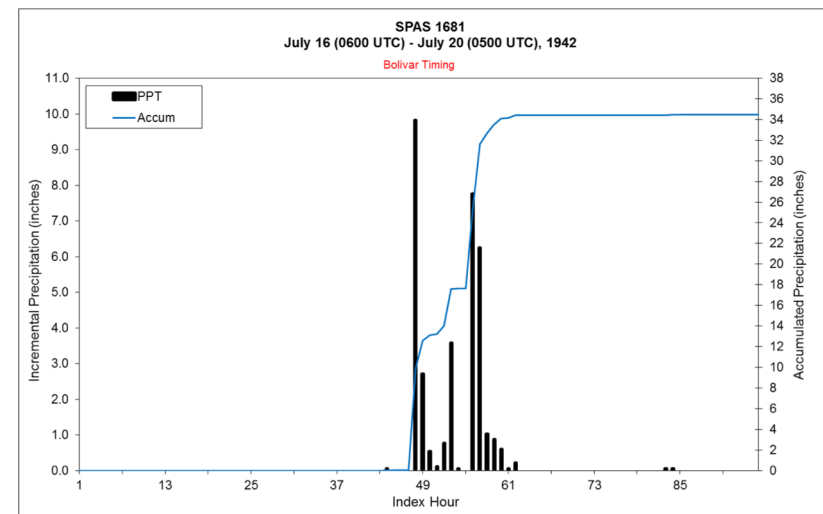
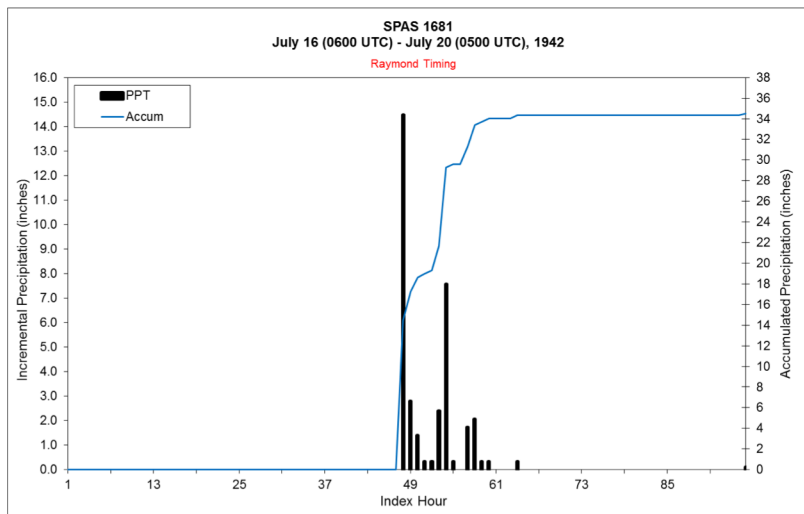
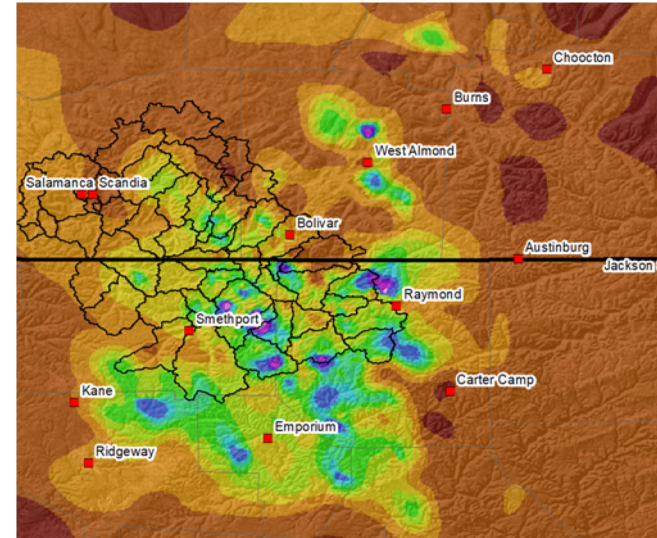
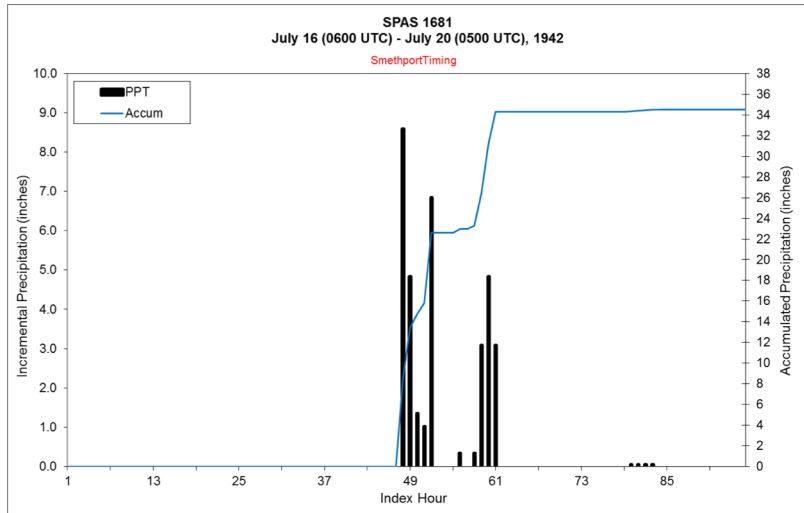
- World-record rainfall for the 3- and 4.5-hour durations at 28.5 and 30.8 inches, respectively.
- Controlling of PMP depths particularly for shorter durations and small area sizes.
- Flooding analysis/verification needed to ensure depths are as accurate as possible.

Overview of the July 1942 Storm and Flood



Port Allegany
 (location of
 most intense
 rainfall)

Overview of the July 1942 Storm and Flood



Overview of the July 1942 Storm and Flood

➤ The record-setting rainfall:



| | | | | | | | | | | |
|-----|----------------|-------|------|---------|-------|----|-------|---------|-------|---|
| 275 | G. Appolt..... | ----- | 7:45 | About 1 | *30.8 | 11 | ----- | About 1 | ----- | Heavy rain 7:45 a. m. to 12:30 p. m. 18. The heaviest rain was around noon. |
|-----|----------------|-------|------|---------|-------|----|-------|---------|-------|---|

Overview of the July 1942 Storm and Flood

This jar was set out about 7:45 a. m. [on July 18, 1942]; it filled with rain for a catch of 30.8 inches, and then overflowed. Considering the unmeasured rainfall prior to 7:45 a. m. and the unknown amount lost by overflow, it would appear that the rainfall at this point was at least 35 inches.

Overview of the July 1942 Storm and Flood

➤ The record-setting rainfall:

*The observer who recorded more than 30.8 inches of rain in 4.75 hours stated that it seemed to fall at a tremendous rate, but quite uniformly, for the greater part of the time... From her statement and the record of total rainfall at that point, it may be assumed that the rainfall **at no time exceeded a rate of about 10 inches per hour** and that there was no "streaming" for that rate and for that size of drop.*

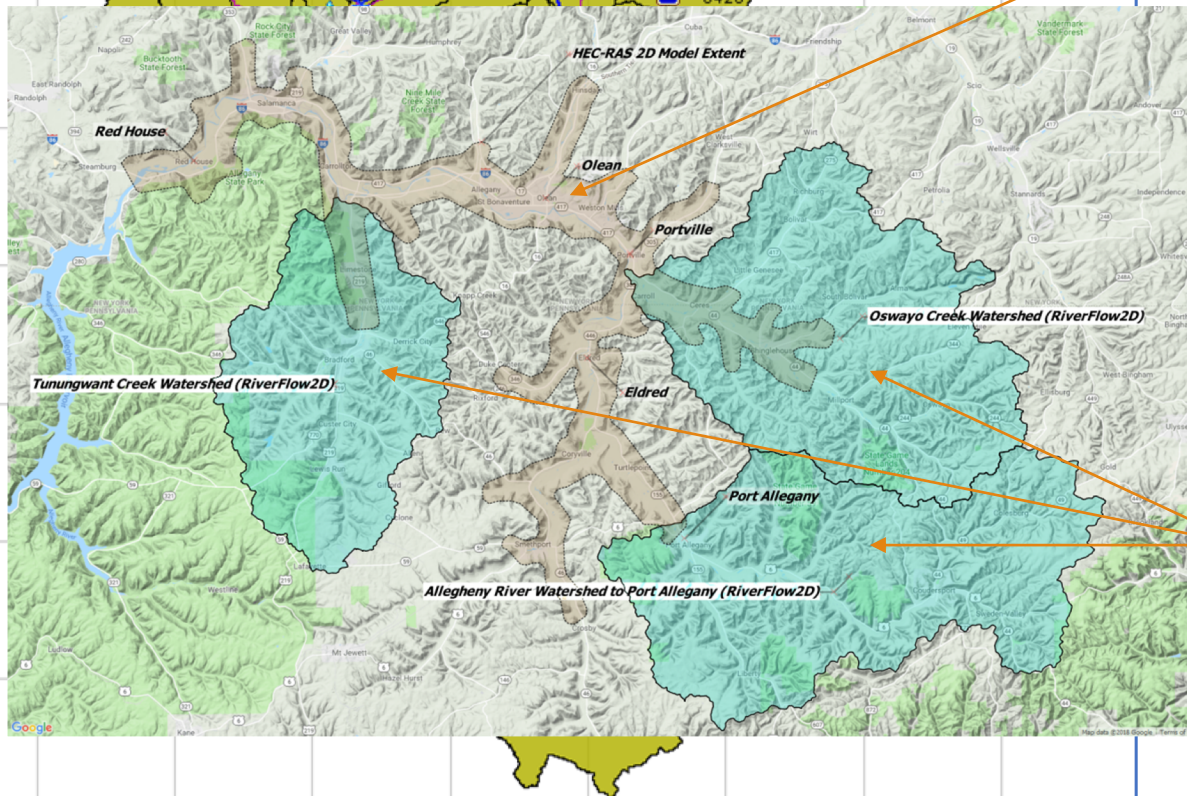
Overview of the July 1942 Storm & Flood - Port Allegany



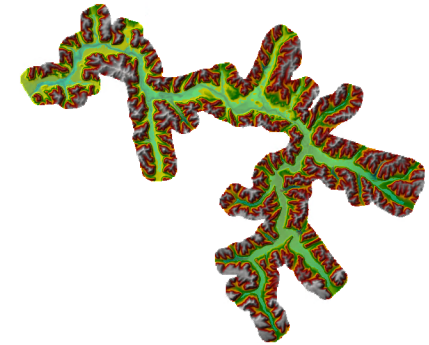
Flood Modeling Development

HEC-HMS (adjusted to match RiverFlow2D hydrology)

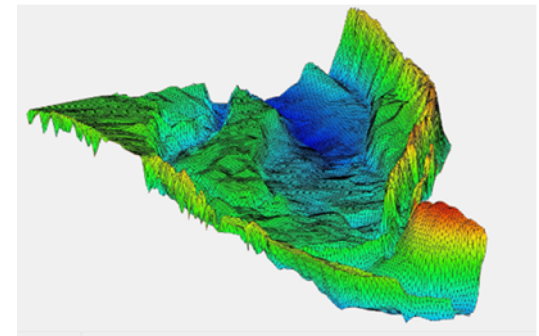
Model Domain (1,780 mi²)

HEC-RAS2D (main stem Allegheny hydraulics)



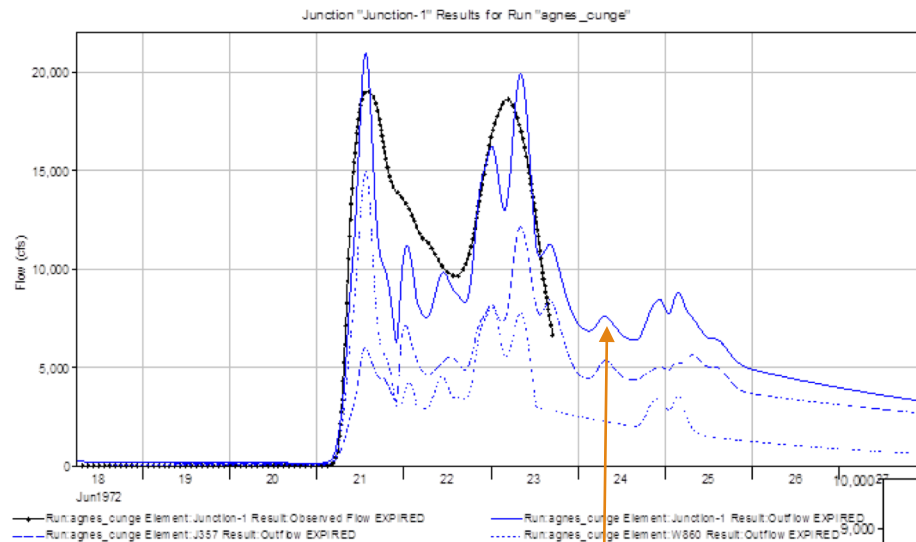
RiverFlow2D (hydrology & hydraulics)



Flood Model Development

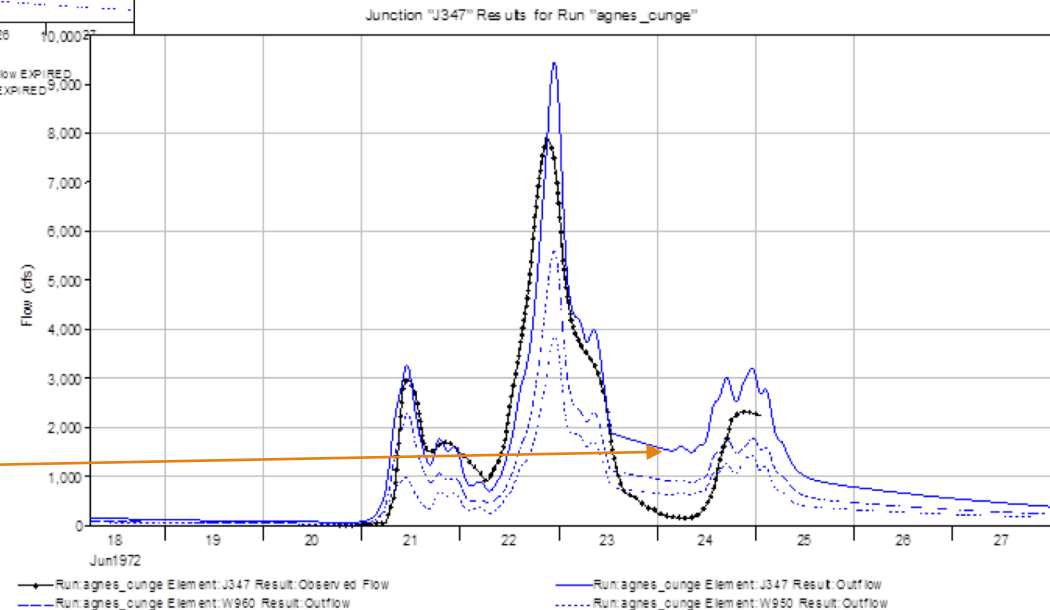
- HEC-HMS model adjusted to reconcile the RiverFlow2D model
- Non-linear UH adjustments in HEC-HMS – informed by RiverFlow2D
- The 1972 “Tropical Storm Agnes” flood was the primary calibration storm
- Two warm-season floods after 1996 (2004 and 2014) were used as verification storms.
- Post-1996 floods allowed the use of the NEXRAD data

Flood Modeling – Calibration



HEC-HMS UH and CN
 adjusted to reconcile with
 RiverFlow2D

HEC-HMS includes
 recession baseflow –
 RiverFlow2D only
 surface runoff



Review of Available July 1942 Flood Information

Read over the advertisements in this paper carefully. If it is on the market, you can get it in Port Allegany.

Port Allegany
PORT ALLEGANY, PA.

VOLUME LXVIII NO. 9.

FLOOD WATERS

Five Dead, Many Buildings Destroyed, Over Million in Damage

Two Hundred Rescued from Roof at Free Methodist Camp Meeting

Waters of Cloudburst up Lillibridge Creek Sweep Havoc and Destruction Throughout Community. Citizens Slowly Clearing up the Wreckage

The most disastrous flood in the history of Port Allegany struck this community about ten o'clock Saturday morning, July 18, 1942, causing the death of at least five persons, demolishing homes, garages, and business places besides doing an unaccountable amount of damage in all parts of the community.

An extremely severe cloudburst caused torrents of water to come raging down Lillibridge creek, doing a

THRILLING EXPERIENCES

Many Port Alleganians Had Exciting Experiences During Flood

Saturday morning's flood which rushed through Port Allegany produced many startling instances of almost superhuman courage. Many harrowing experiences have doubtless not been related and those given below are just examples of what happened to some of the local residents during the flood.

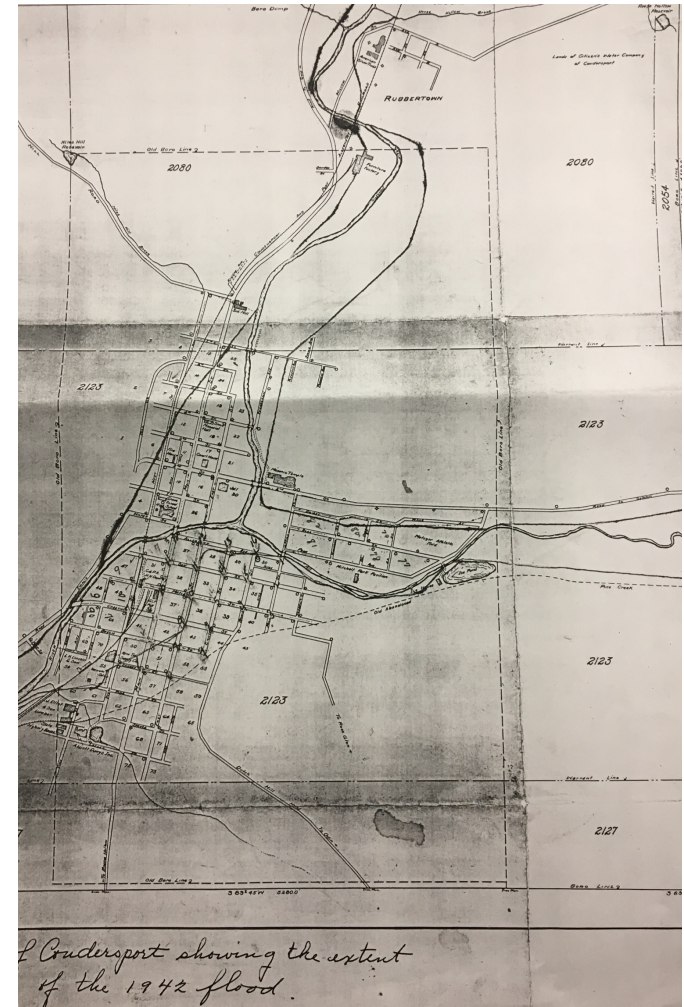
While the Harry Hardes house was being lifted from its foundation and carried down the stream, Mrs. Hardes managed to assist Mr. Hardes, who has been confined to his bed for over 10 years to a place of safety on the second floor of the building. He had been in bed on the first floor of the home. When they reached the second floor of the building they discovered

BRIDEGROOM DROWNS

Robert Henderson, Who Recently Wed Miss Bernice Robbins, Meets Death

Many local friends of Mrs. Bernice (Robbins) Henderson, a bride of three weeks, are extending to her their most sincere sympathy on the sudden and tragic death of her husband, Robert Henderson, Saturday evening, July 18. He drowned while trying to save his brother at Central Beach Park near Pittsburgh.

Reports of the accident indicate that Robert Eoyd Henderson, 21, apparently struck his head on the bottom of the boat when he dove into it in answer to a call for help from his brother, Samuel, 15. Mrs.





Review of Available July 1942 Flood Information

TABLE 6.—Flood-crest elevations—Continued

| Stream and location | Miles above month | Day and hour (July) | Elevation (feet) |
|--|-------------------|---------------------|------------------|
| SUSQUEHANNA RIVER DRAINAGE BASIN—Continued | | | |
| First Fork Sinnemahoning Creek: | | | |
| Costello, Pa., mouth of Freeman Run | 25.2 | 18, 1 p. m. | 1,195.4 |
| Nelson Run, 0.6 mile below mouth of | 21.4 | | 1,132.7 |
| Wharton, Pa., mouth of East Fork | 19.7 | 18, 2 p. m. | 1,094.5 |
| Bailey Run, mouth of | 17.2 | | 1,063.5 |
| First Fork, Pa. | 12.0 | 18, 3 p. m. | |
| Lushbaugh, Pa., 1.1 miles downstream at mouth of Short Bend Run | 8.1 | | 907.4 |
| Lick Island | 4.3 | 18, 4 p. m. | 844.7 |
| Mouth | 0 | 18, 5 p. m. | |
| Freeman Run: | | | |
| Austin, Pa., above, at dam that failed | 5.6 | 18, 11 a. m. | |
| Austin, Pa., Ford garage | 3.3 | 18, 11:30 a. m. | 1,353.5 |
| Highway bridge | .6 | | 1,223.4 |
| East Fork Sinnemahoning Creek: Highway bridge | 2.5 | | 1,172.8 |
| ALLEGHENY RIVER DRAINAGE BASIN | | | |
| Allegheny River: ¹ | | | |
| Seven Bridges, Pa., Dunn farm | 317.9 | 18, 7:30 a. m. | 1,930.9 |
| Coudersport, Pa., highway bridge | 308.6 | 18, 1:30 p. m. | 1,646.7 |
| Roulette, Pa., highway bridge | 298.3 | 18, 2 p. m. | 1,535.1 |
| Burtville, Pa., highway bridge | 295.1 | | 1,505.4 |
| Port Allegany, Pa., State Highway 155, bridge | 289.6 | | 1,482.1 |
| Port Allegany, Pa., U. S. Highway 6, old bridge | 288.9 | 18, 3:30 p. m. | 1,479.0 |
| Port Allegany, Pa., U. S. Highway 6, new bridge (destroyed by flood) | 288.0 | | 1,477.4 |
| Turtlepoint, Pa., highway bridge | 281.7 | | 1,453.7 |
| Larabee, Pa., highway bridge, USGS gage (discontinued) | 276.4 | 19, 1 a. m. | 1,447.4 |
| Eldred, Pa., highway bridge, USGS gage | 269.0 | 19, 9:30 a. m. | 1,443.8 |
| Mill Grove, N. Y., highway bridge | 262.9 | | 1,434.5 |
| Portville, N. Y., fire department building | 261.4 | 19, 3 p. m. | 1,434.5 |
| Olean, N. Y., highway bridge | 255.5 | 19, 6:30 p. m. | 1,423.3 |
| North Allegany, N. Y., highway bridge | 250.7 | | 1,413.9 |
| Vandalia, N. Y., highway bridge | 246.4 | 19, 11:30 p. m. | 1,404.7 |
| Riverside Junction, N. Y., Erie R. R. bridge | 242.1 | | 1,393.5 |
| South Carrollton, N. Y., railroad bridge | 240.4 | | 1,388.6 |
| Salamanca, N. Y., highway bridge | 233.7 | 20, 5 a. m. | 1,374.2 |
| Red House, N. Y., highway bridge, USGS gage | 226.0 | 20, 8:30 a. m. | 1,342.2 |
| Quaker Bridge, N. Y., highway bridge | 220.4 | | 1,320.2 |
| Onoville, N. Y., highway bridge | 214.0 | | 1,290.6 |
| Kinzua, Pa., railroad bridge, USGS gage | 200.0 | 20, 5 p. m. | 1,217.7 |
| Clarion River: | | | |
| Instantier | 109.4 | 18, 3:30 p. m. | |
| Johnsonburg, Pa., lower highway bridge | 94.0 | 18, 9 p. m. | 1,439.8 |
| Ridgway, Pa., West Penn power station | 88.4 | | 1,390.0 |
| Ridgway, Pa., Main Street bridge, USGS gage | 87.4 | 19, 1 a. m. | 1,378.0 |
| Carman, Pa., highway bridge | 80.1 | | 1,330.4 |
| Bell Town, Pa., highway bridge | 62.2 | | 1,225.2 |
| Cooksburg, Pa., dam site gage | 49.3 | | 1,170.6 |
| Cooksburg, Pa., highway bridge, USGS gage | 47.6 | 19, 9:30 a. m. | 1,161.4 |
| Clarion, Pa., Piney Dam, upper pool | 25.1 | | 1,093.1 |
| St. Petersburg, Pa., highway bridge, USGS gage | 4.5 | 19, 2 p. m. | 891.0 |

¹ Data other than for gaging stations furnished by Corps of Engineers.

ADDITIONAL FLOOD CREST ELEVATIONS

JULY 1942

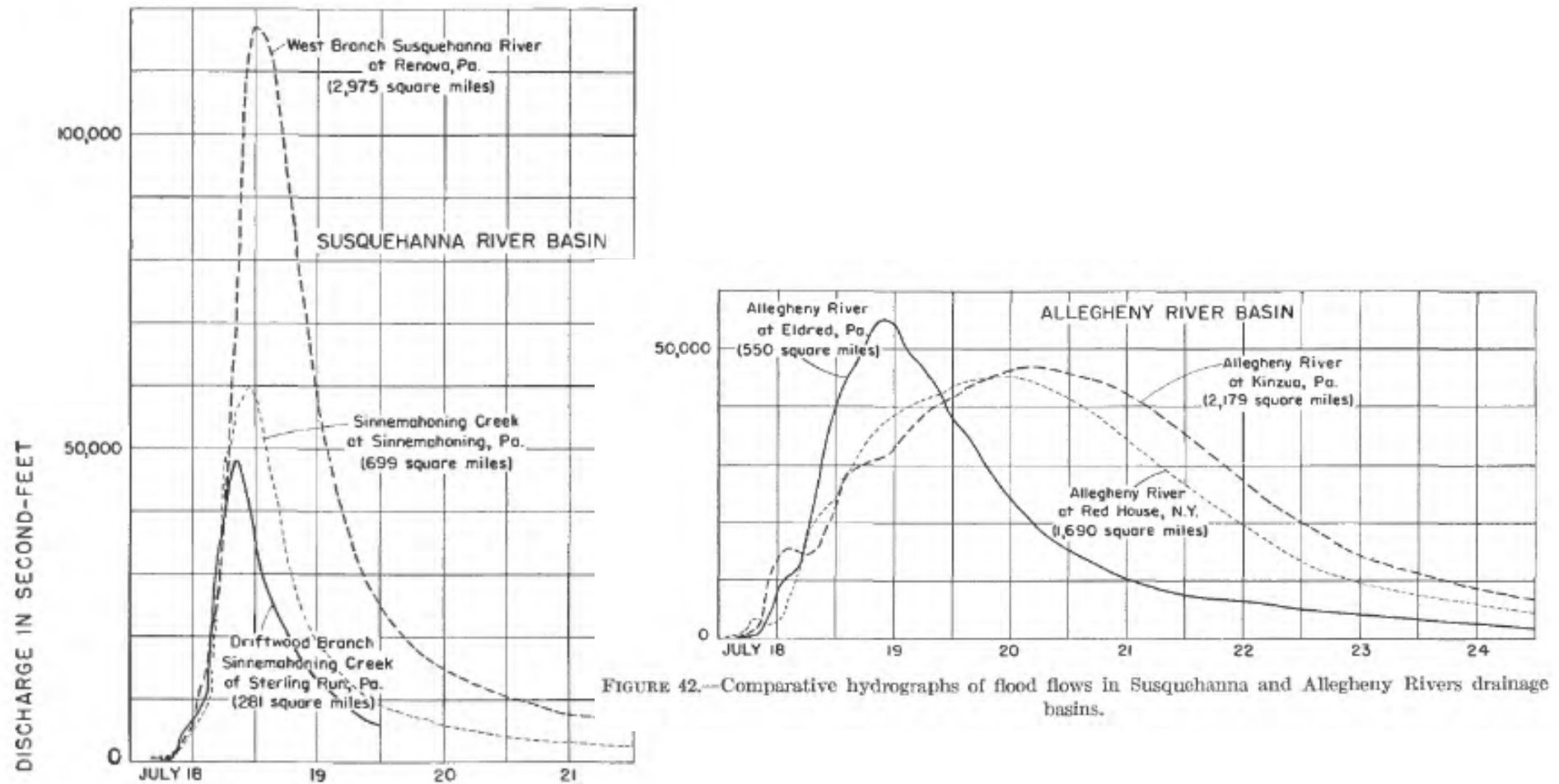
ALLEGHENY RIVER ABOVE KINZUA, PA.

| Miles above Mouth | Location | Elevation (feet) |
|-------------------|---|------------------|
| 200.0 | Kinzua, Pa.; R. R. bridge; gage | 1,217.7 |
| 214.0 | Onoville, N. Y.; highway bridge | 1,290.6 |
| 220.4 | Quaker Bridge, N. Y.; highway bridge | 1,320.2 |
| 226.0 | Red House, N. Y.; highway bridge; gage | 1,342.2 |
| 233.7 | Salamanca, N. Y.; highway bridge | 1,374.2 |
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| 255.5 | Olean, N. Y.; highway bridge | 1,423.3 |
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| 262.9 | Mill Grove, N. Y.; highway bridge | 1,434.5 |
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| 276.4 | Larabee, Pa.; highway bridge; gage | 1,447.4 |
| 281.7 | Turtlepoint, Pa.; highway bridge | 1,453.7 |
| 288.9 | Port Allegany, Pa.; highway bridge; Route No. 6 | 1,479.0 |
| 289.6 | Port Allegany, Pa.; highway bridge; Route 155 | 1,482.1 |
| 295.1 | Burtville, Pa.; highway bridge | 1,505.4 |
| 298.3 | Roulette, Pa.; highway bridge | 1,535.1 |
| 308.6 | Coudersport, Pa.; highway bridge | 1,646.7 |
| 317.9 | Seven Bridges, Pa.; Dunn Farm | 1,930.9 |

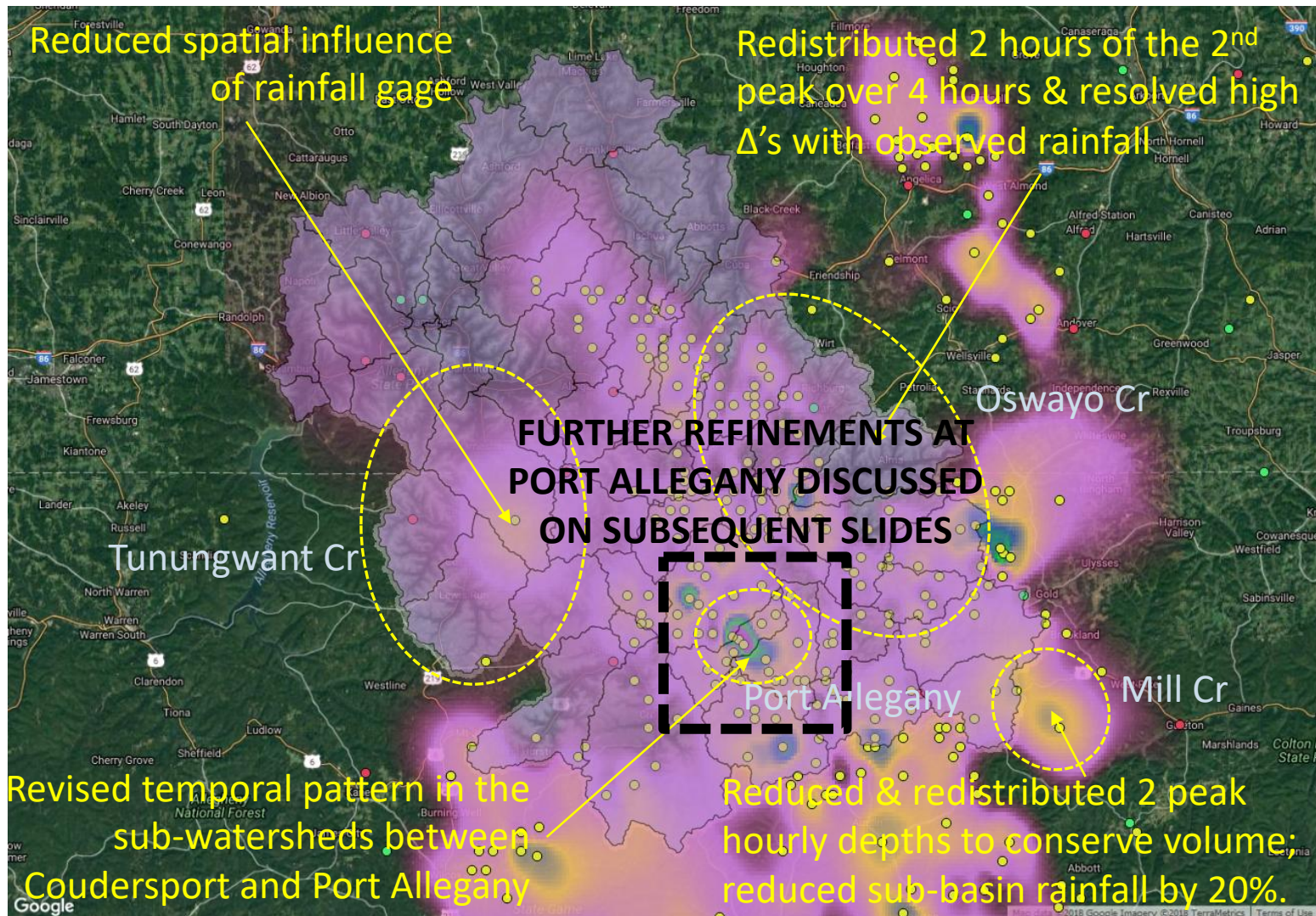
Notes.— Elevations, except at gaging stations, furnished by U. S. Engineer Office, Pittsburgh, Pa.

The July 1942 flood crest elevation at Mile 288.0, the location of the new bridge site for Route 6, is 1,477.4 feet.

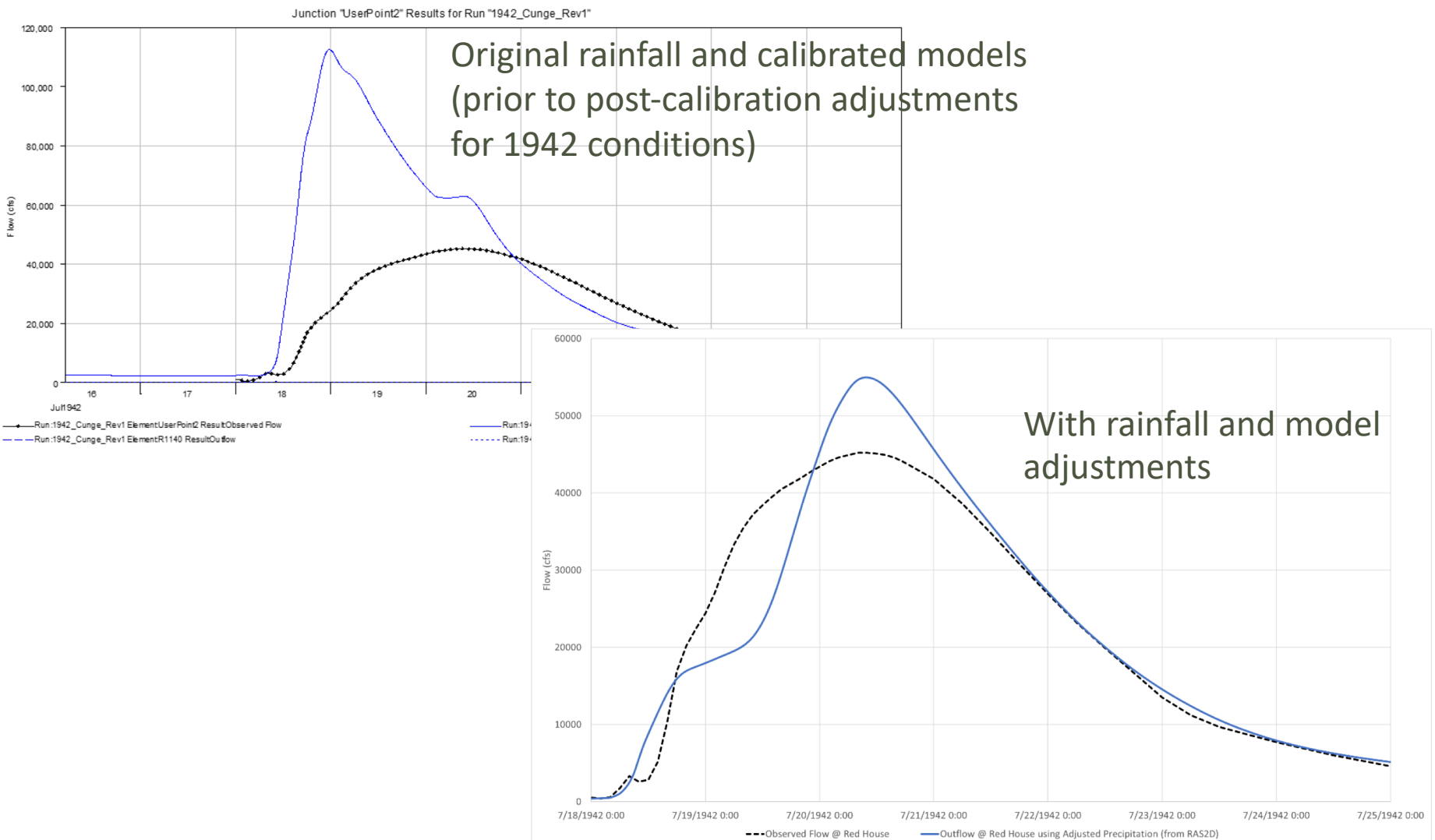
Review of Available July 1942 Flood Information



July 1942 Rainfall Adjustments and Lessons Learned

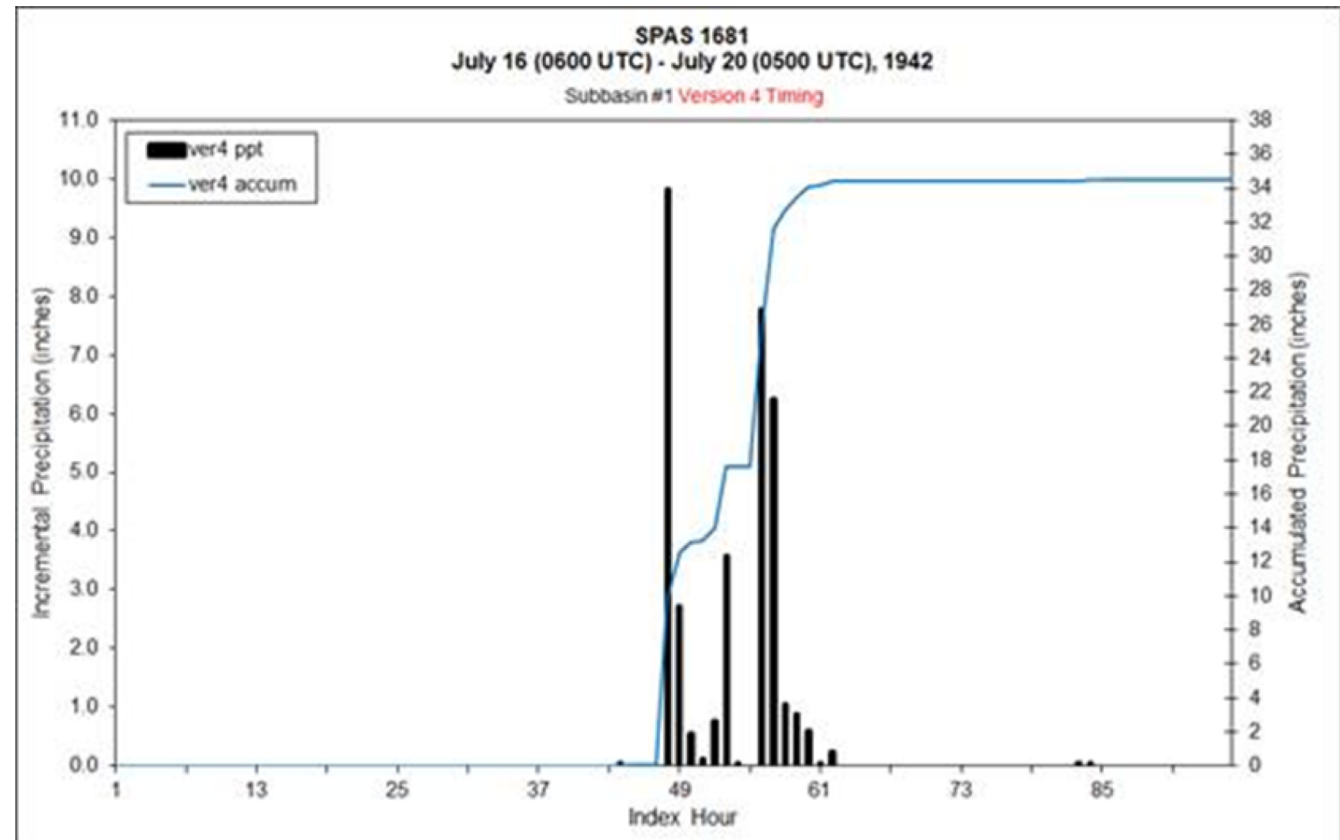
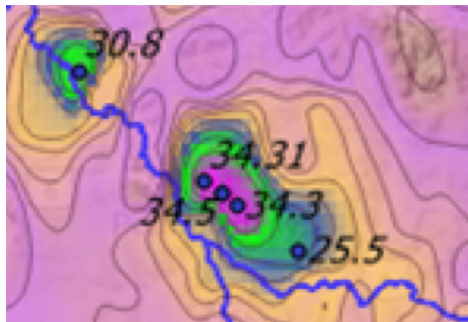


Downstream Results of 1942 Rainfall & Modeling Adjustments



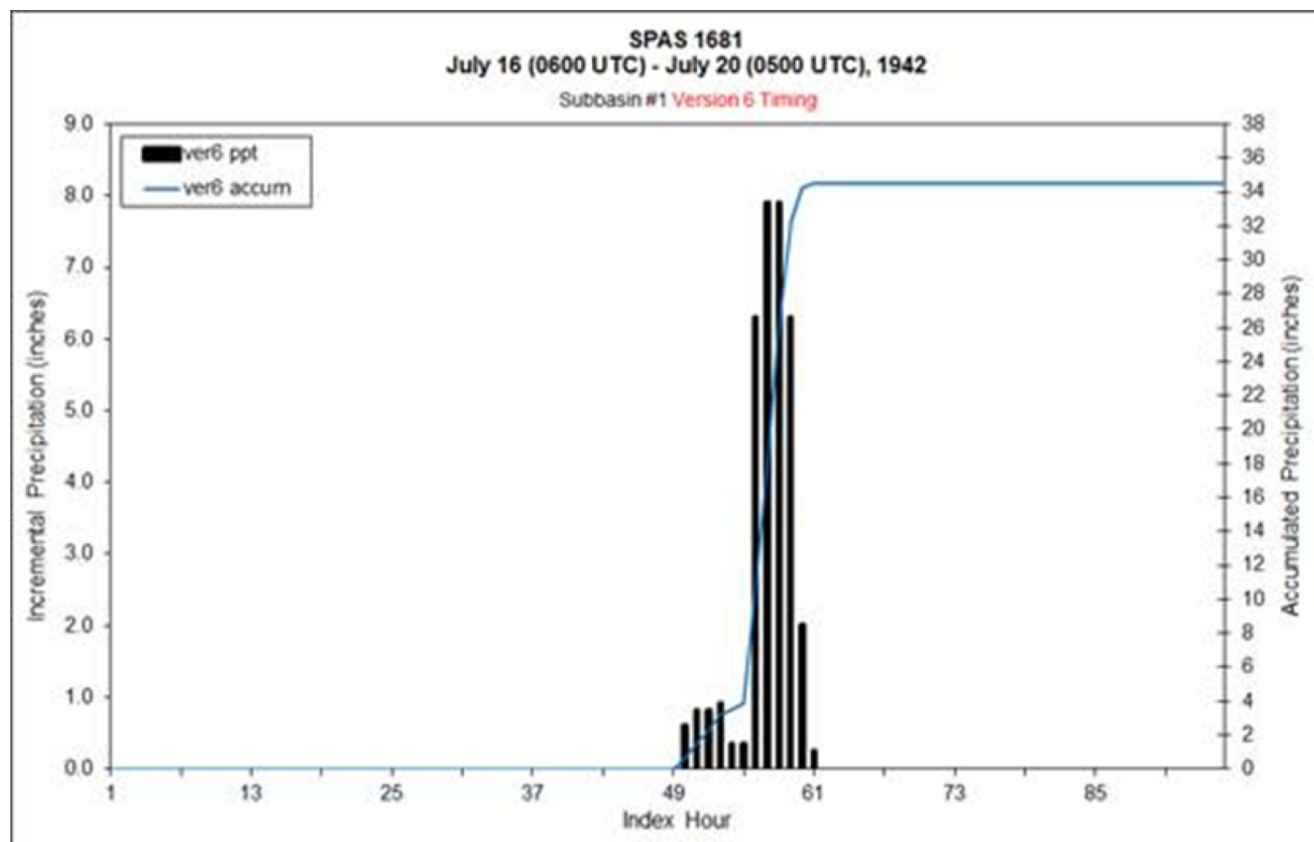
Does the Flood Modeling Support the July 1942 Record Rainfall Amount?

- The adjustments provide a good overall hydrologic fit but does not contain the record rainfall at Port Allegany (30.8 inches in 4.5 hours).



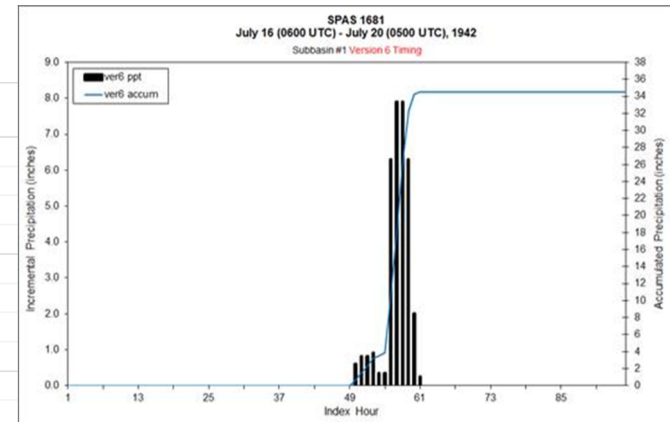
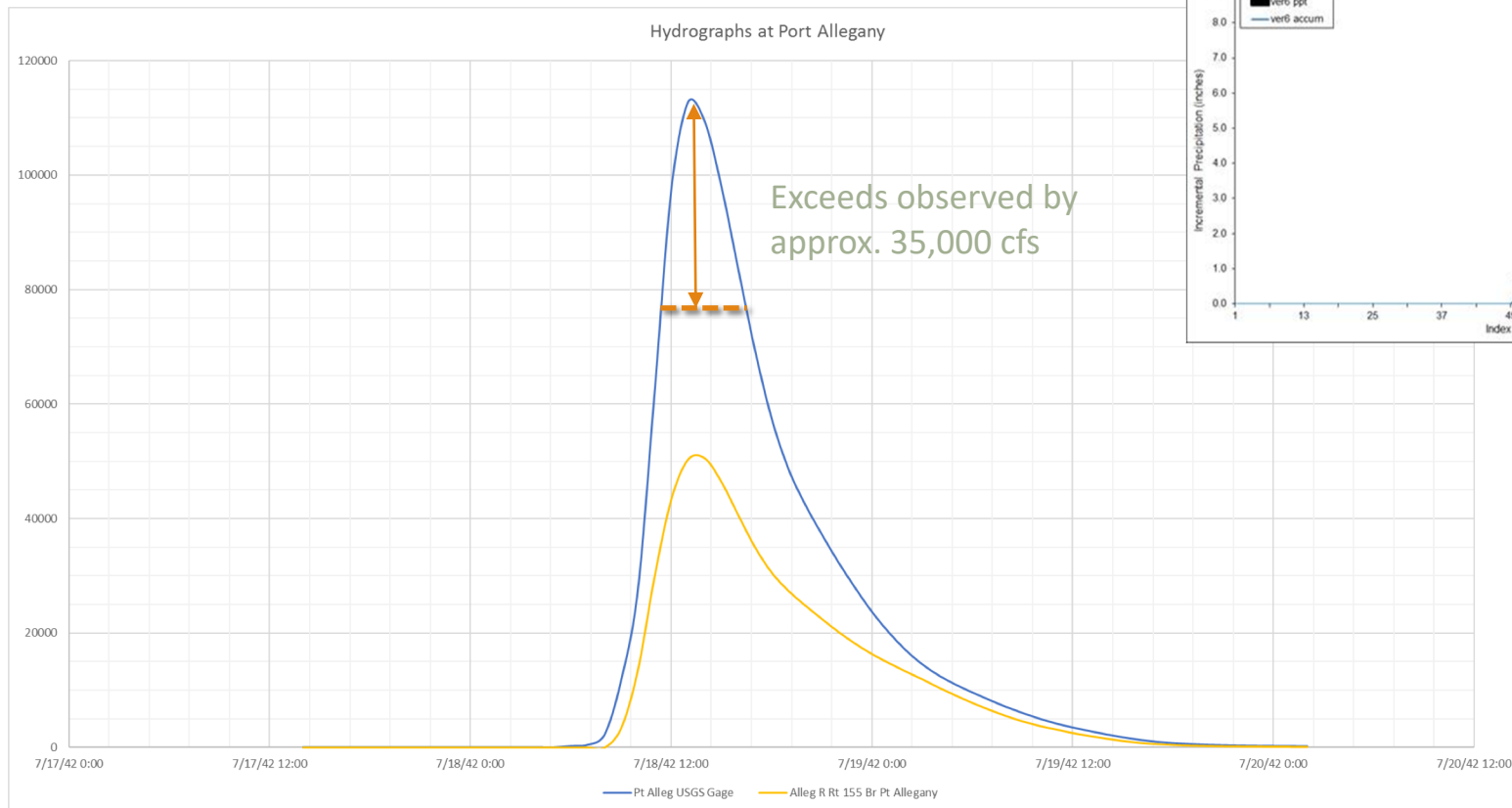
Does the Flood Modeling Support the July 1942 Record Rainfall Amount?

- An alternative temporal pattern was developed (below) that does contain the record 4.5-hour rainfall. This rainfall was applied at Port Allegany (at the storm center) and interpolated in SPAS to the surrounding hourly gages.



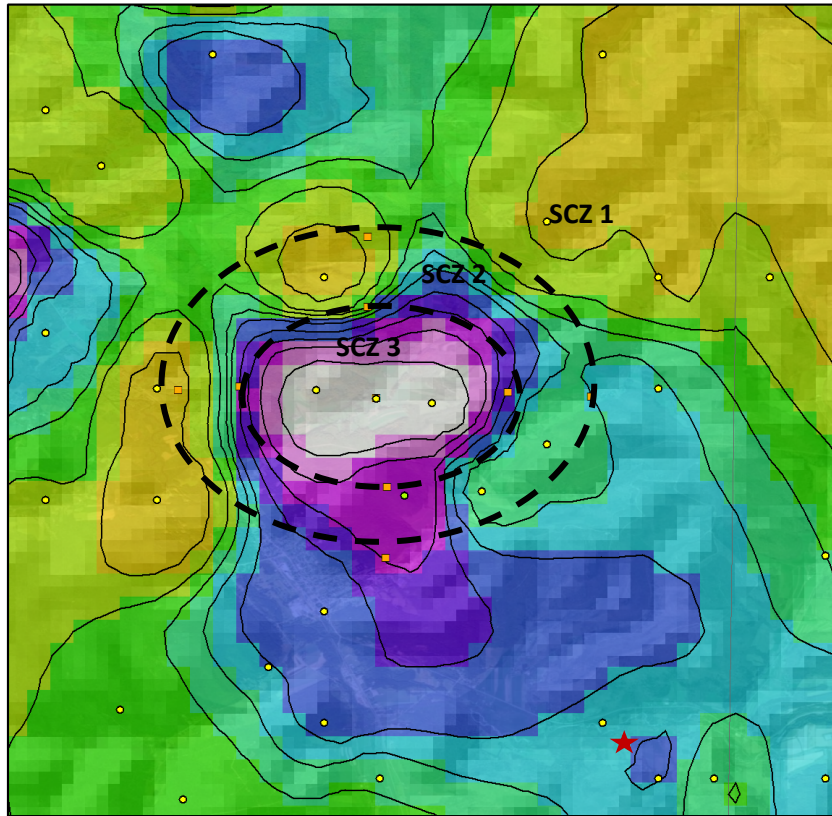
Does the Flood Modeling Support the July 1942 Record Rainfall Amount?

- The RiverFlow2D model shows that the alternative rainfall pattern, when permitted to have broad influence between hourly gages, does not produce a good hydrologic match.



Does the Flood Modeling Support the July 1942 Record Rainfall Amount?

- Does that mean the record rainfall didn't actually happen?
- Local hydrology supports the record rainfall but it had to be very localized
- Temporal pattern outside the localized cell patterned to hourly gages



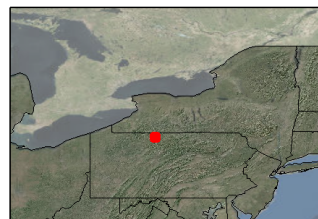
Total Storm (96-hr) Precipitation (inches)
07/16/1942 0600 UTC - 07/20/1942 0500 UTC
SPAS #1681 - Version 10

Gauges

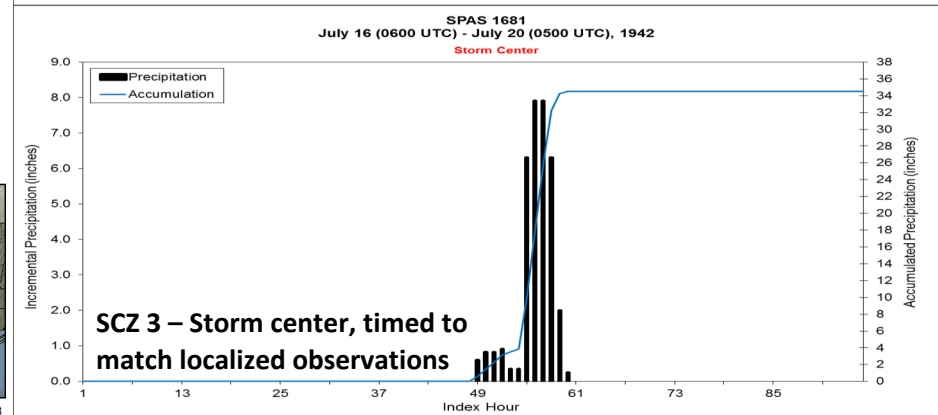
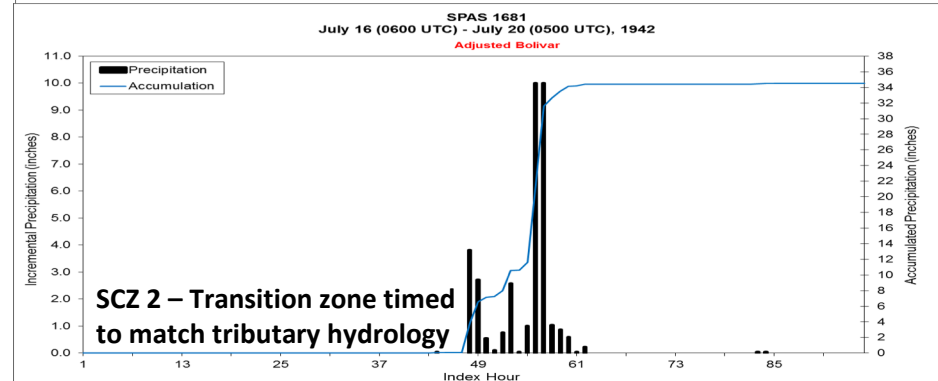
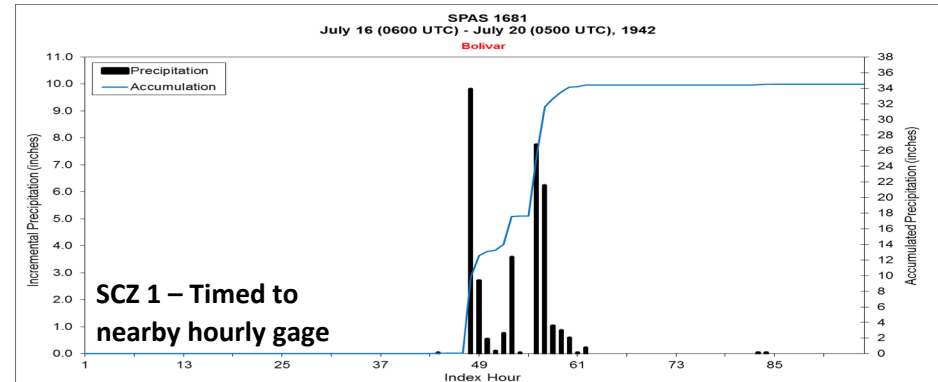
- Daily
- Hourly
- Hourly Pseudo
- Supplemental
- Supplemental Estimated

Precipitation (inches)

| | | | | |
|-------------|---------------|---------------|---------------|---------------|
| 0.00 - 2.00 | 6.01 - 8.00 | 12.01 - 14.00 | 20.01 - 24.00 | 32.01 - 36.00 |
| 2.01 - 4.00 | 8.01 - 10.00 | 14.01 - 16.00 | 24.01 - 28.00 | |
| 4.01 - 6.00 | 10.01 - 12.00 | 16.01 - 20.00 | 28.01 - 32.00 | |

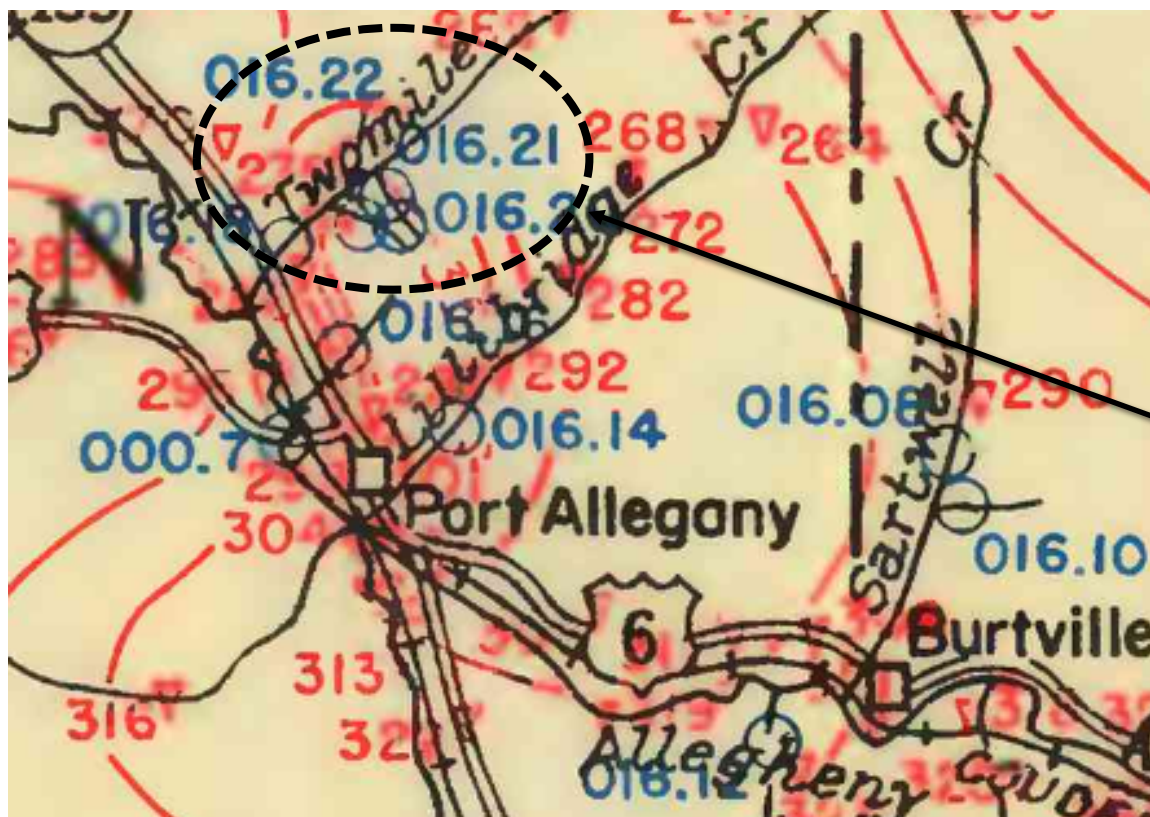


10/8/2018



Does the Flood Modeling Support the July 1942 Record Rainfall Amount?

- Additional insights into the record-setting observation.
- U.S. Department of the Interior, Geologic Survey Water Supply Paper 1134-B Report (1952)



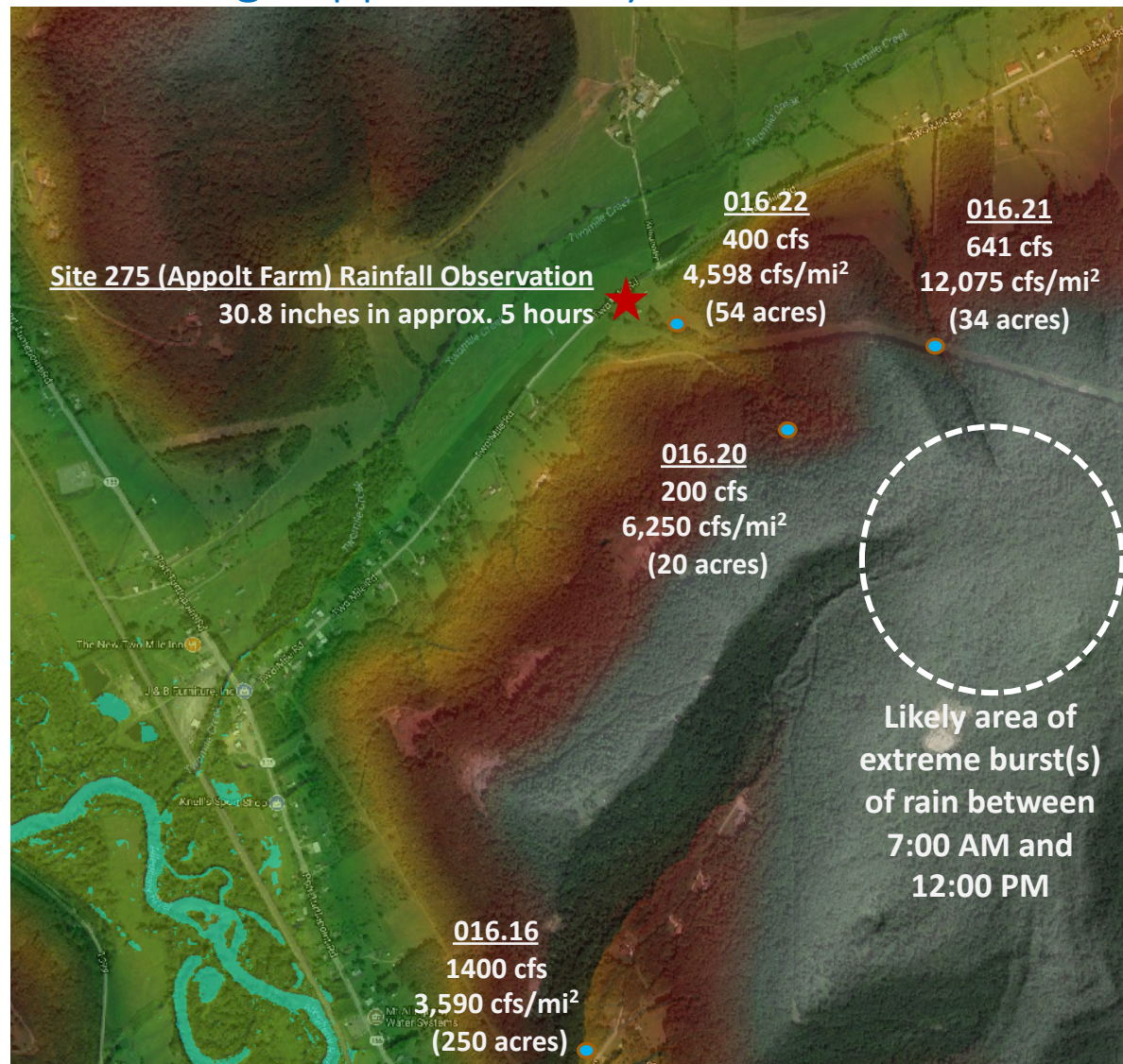
Location of record rainfall observation near flow measurements at points 016.20, 21, and 22.

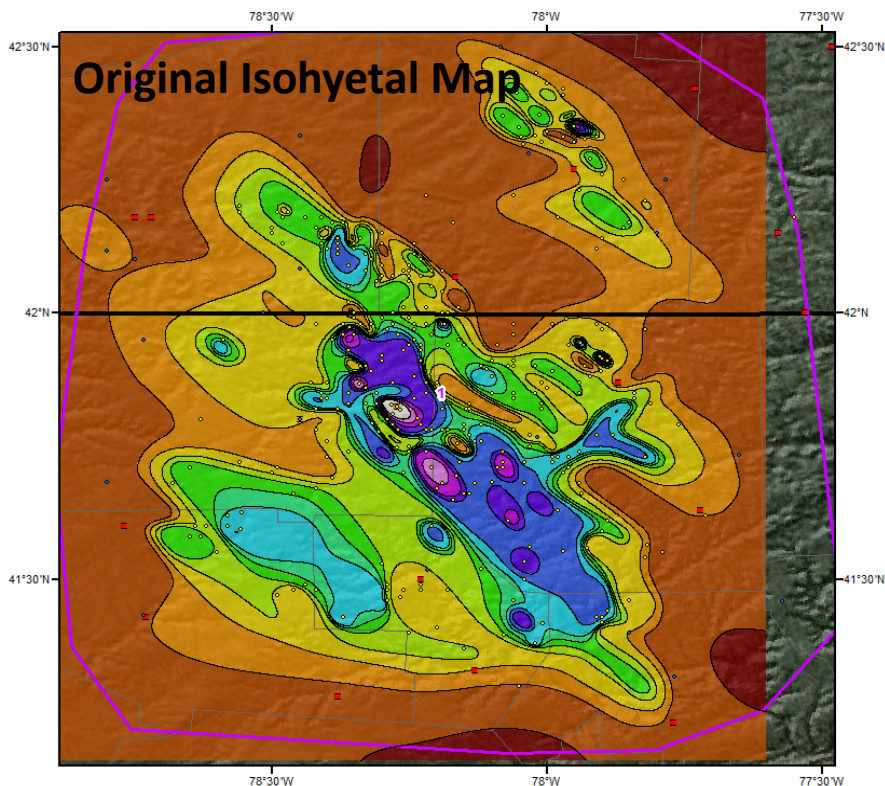
Does the Flood Modeling Support the July 1942 Record Rainfall Amount?

- Sub-hourly rainfall not available to use RiverFlow2D for very small catchments (with short T_c).
- Rational Equation applied to estimate rainfall intensity that would have produced observed flows.

| Watershed | Point # | Rational Runoff Coef (C) | Peak Intensity (in/hr) | Drainage Area (acres) | Peak Flow (cfs) | Flow per Sq Mile (cfs/mi ²) |
|----------------|---------|--------------------------------|------------------------------|-----------------------------|--------------------|---|
| Two Mile Run | 016.20 | 0.42 | 23.2 | 20 | 200 | 6,236 |
| Two Mile Run | 016.21 | 0.42 | 45.0 | 34 | 641 | 12,096 |
| Two Mile Run | 016.22 | 0.42 | 17.1 | 56 | 400 | 4,596 |
| Sartwell Creek | 016.10 | 0.32 | 16.1 | 60 | 310 | 3,297 |

Does the Flood Modeling Support the July 1942 Record Rainfall Amount?

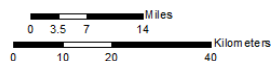




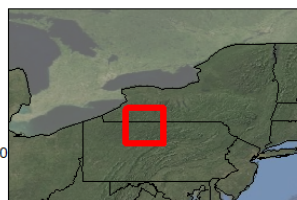
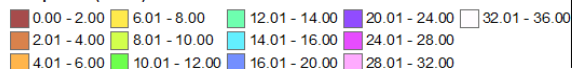
Total Storm Precipitation (inches)
Smethport, PA
USGS

Gauges

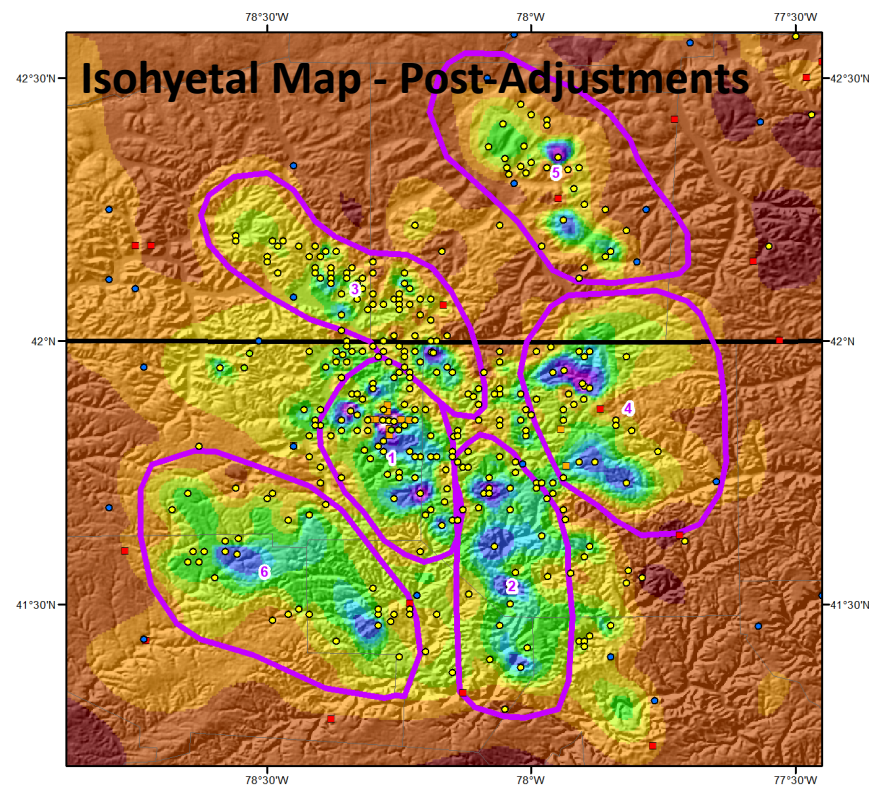
- Daily
- Hourly
- Hourly Pseudo
- Supplemental



Precipitation (inches)



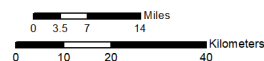
9/12/2014



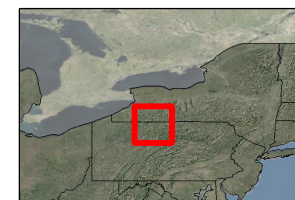
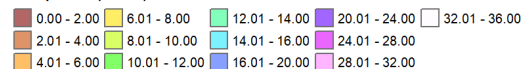
Total Storm (96-hr) Precipitation (inches)
07/16/1942 0600 UTC - 07/20/1942 0500 UTC
SPAS #1681 - Version 10

Gauges

- D
- H
- HP
- S
- SE



Precipitation (inches)



10/8/2018

Questions

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