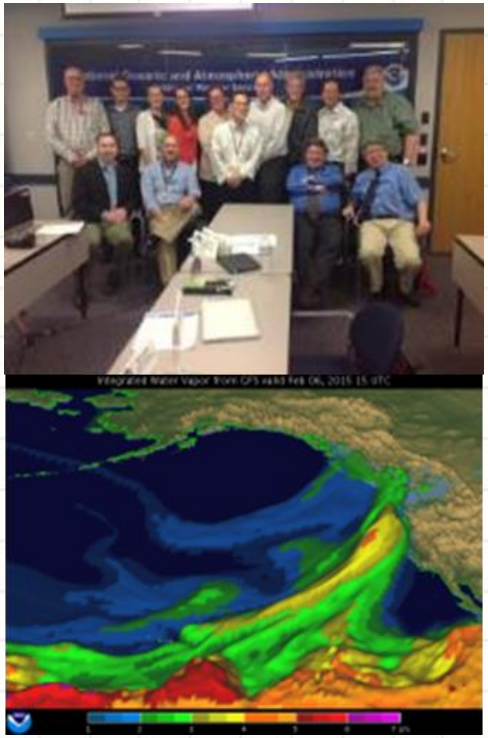
# SOH Extreme Storm Events Work Group (ESEWG)

- **Thomas Nicholson, ESEWG Chair,** U.S. Nuclear Regulatory Commission
- **William Otero, ESEWG Vice-Chair,** U.S. Army Corps of Engineers

## Meeting Objectives:

- ❑ Brief the SOH members and public in detail on the ***Extreme Rainfall Product Needs Proposal***
- ❑ Discuss proposal needs and recommendations to meet those needs
- ❑ Outline resources needed to accomplish the recommendations

## Workshop to Define Needed Extreme Precipitation Products held at NOAA, Silver Spring, MD



Workshop Synthesis Report (with Appendices)

Appendix A - Federal Agency Questionnaire for Needs in Extreme Precipitation
Appendix B - Summary of Questionnaire Responses by Federal Agencies
Appendix C - State Dam Safety Agency Questionnaire
Appendix D - Summary of Questionnaire Responses by State Dam Safety Agencies
Appendix E - Program and Agenda
Appendix F - Attendees
Appendix G - Presentations from the Federal and State Agencies

*See proceedings: https://acwi.gov/hydrology/extreme-storm/minutes/index.html*

Map of the regions covered by various National Weather Service Probable Maximum Precipitation products (National Weather Service, 2017b)

- ✓ Following the workshop, a Proposal Writing Team (PWT) was formed to review the workshop presentations, and responses to the Federal and State agency surveys.
- ✓ PWT meet on numerous occasions to discuss the proposal's outline, needs and recommendations.
- ✓ On May 16, 2018, ESEWG met to review the Proposal and voted unanimously to approve its submission to SOH for their review and approval.

# Proposal Chapters and their Presenters

- *Chapter 2 – NOAA Atlas 1 Updates and Upgrades …….*
  *Sanja Perica, Chief, Hydrometeorological Design Studies Center, National Weather Service, NOAA*

- *Chapter 3 – U.S. Precipitation Database …….*
  *George Hayes, USACE and Marian Baker, NOAA/NWS*

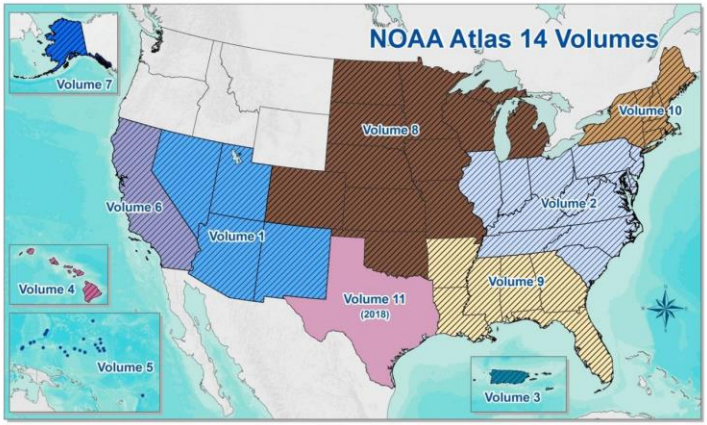
- *Chapter 4 – Updated Probable Maximum Precipitation (PMP) for HMRs and National Guidance Document to Review Site-Specific PMPs ……. John Onderdonk and Ken Fearon, FERC & Mark Perry, State of Colorado*

# 2. NOAA ATLAS 14 UPDATES AND UPGRADES

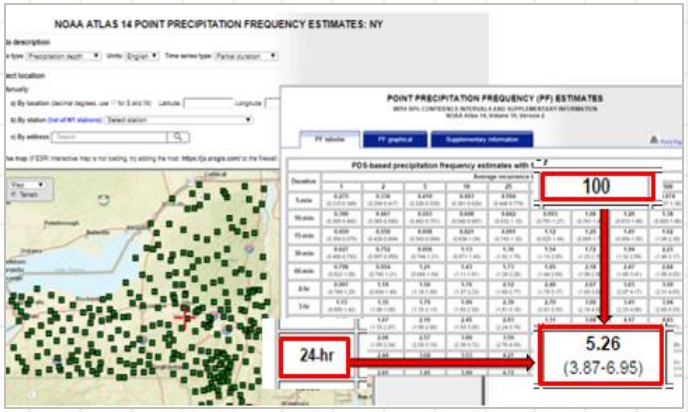
## 2.1. Product Background

- "NOAA Atlas 14: Precipitation-Frequency Atlas of the United States" developed by Hydrometeorological Design Studies Center/OWP/NWS/NOAA
- Since 2004, updated precipitation frequency estimates with supplementary information published online as Volumes of NOAA Atlas 14: hdsc.nws.noaa.gov/hdsc/pfds/index.htm

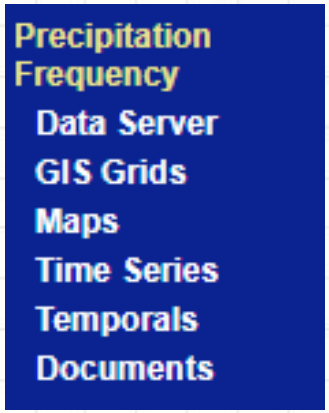
**NA14 VOLUMES:**




**PRODUCTS:**




*at a given location*




*for whole project area*

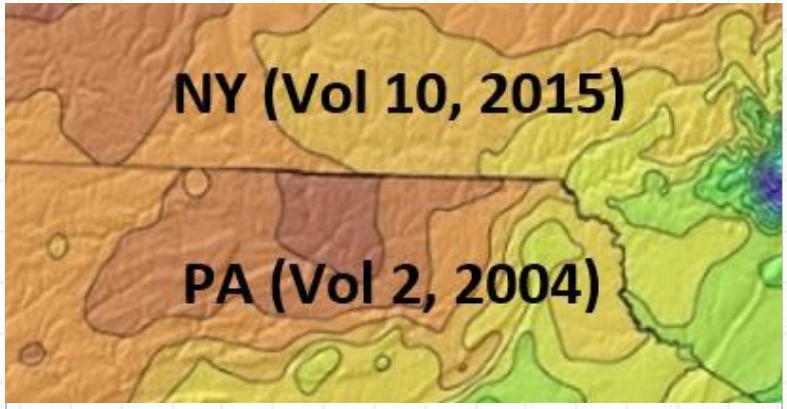
# 2. NOAA ATLAS 14 UPDATES AND UPGRADES

## 2.2. Proposed Updates and Upgrades

### 2.2.1. Funding Approach

**Current:**

- Ad-hoc funding from external sources dictates that updates are done based on state boundaries
- Concerns:
  - Currency of information
  - Consistency of estimates
  - Efficiency of volume development
  - Retention of knowledge base




*Discrepancies in 100-year 24-hour estimates at boundary of Volumes 2 &10*

**Proposed:**

- Changing funding approach from an ad-hoc to a defined, consistent, reliable approach.

# 2. NOAA ATLAS 14 UPDATES AND UPGRADES

## 2.2. Proposed Updates and Upgrades

### 2.2.2. Methodology Improvements

**Current:**

- Region-of-influence regional frequency analysis approach based on Generalized Extreme Value distribution with parameters calculated based on L-moment statistics from annual maximum series – AMS (AMS assumed stationary)

**Proposed:**

- Use of data and methods appropriate for non-stationary climate
  - Partial Duration Series (PDS) replacing AMS
  - Testing the feasibility of incorporating climate projections into analysis
  - Maximum Likelihood distribution parameterization replacing L-moments
  - Time dependency (linear, non-linear) introduced in calculation of distribution parameters

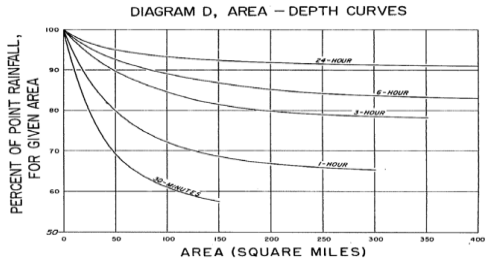
# 2. NOAA ATLAS 14 UPDATES AND UPGRADES

## 2.2. Proposed Updates and Upgrades

### 2.2.3. Products Improvements

#### NA14 areal reduction factors

**Current:**

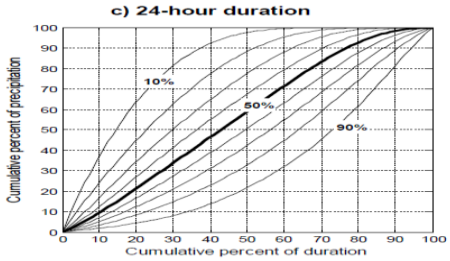



**Proposed:**

- NA14 regional ARFs (fn of A, ARI, D)
- Web tool for watershed delineation
- Areal estimates on the fly

#### NA14 design storm

**Current:**

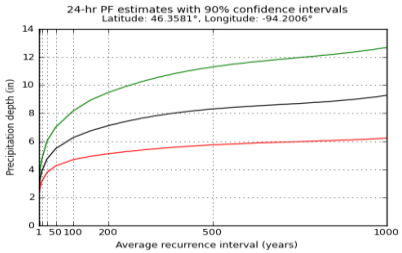



**Proposed:**

- Design storm product for engineering design with guidance on how to use it

#### Confidence intervals

**Current:**




**Proposed:**

- Conf. intervals of varied width
- Improved method to address more sources of uncertainty

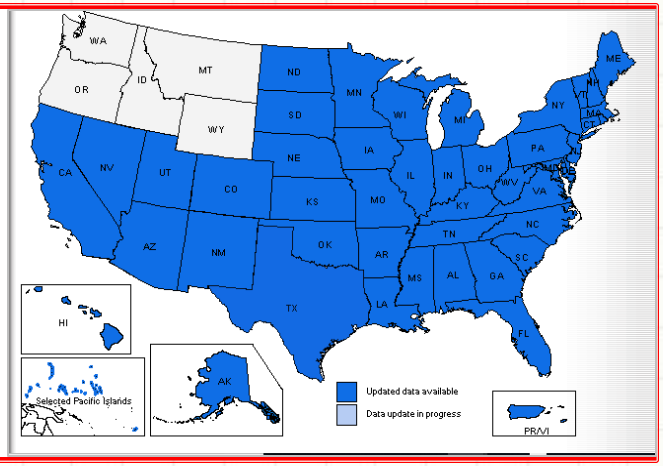
# 2. NOAA ATLAS 14 UPDATES AND UPGRADES

## 2.3. Implementation

**RECOMMENDATION:**

**At minimum**, extension of NOAA Atlas 14 coverage to the remaining five Northwestern States (ID, MT, OR,WA,WY)

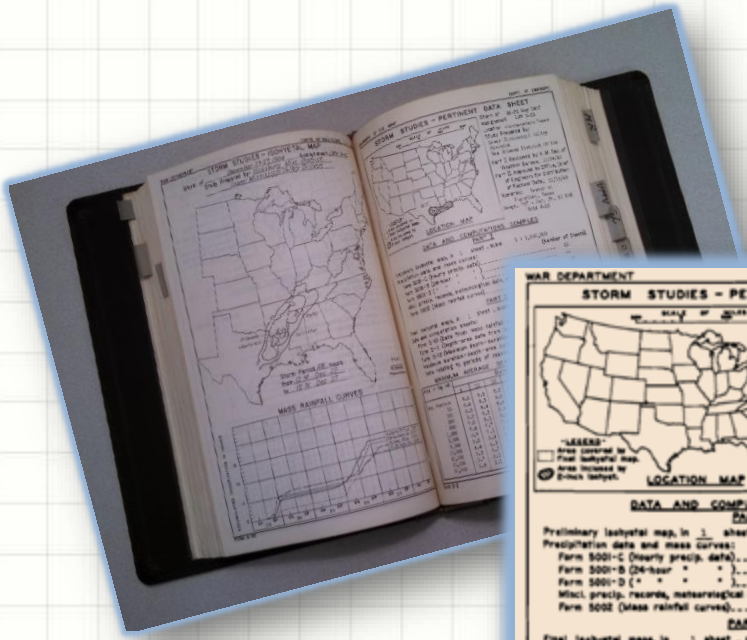
Development of an enhanced suite of products in 10- yr cycles for the whole country simultaneously using improved process capable of accounting for the non-stationary climate, etc.

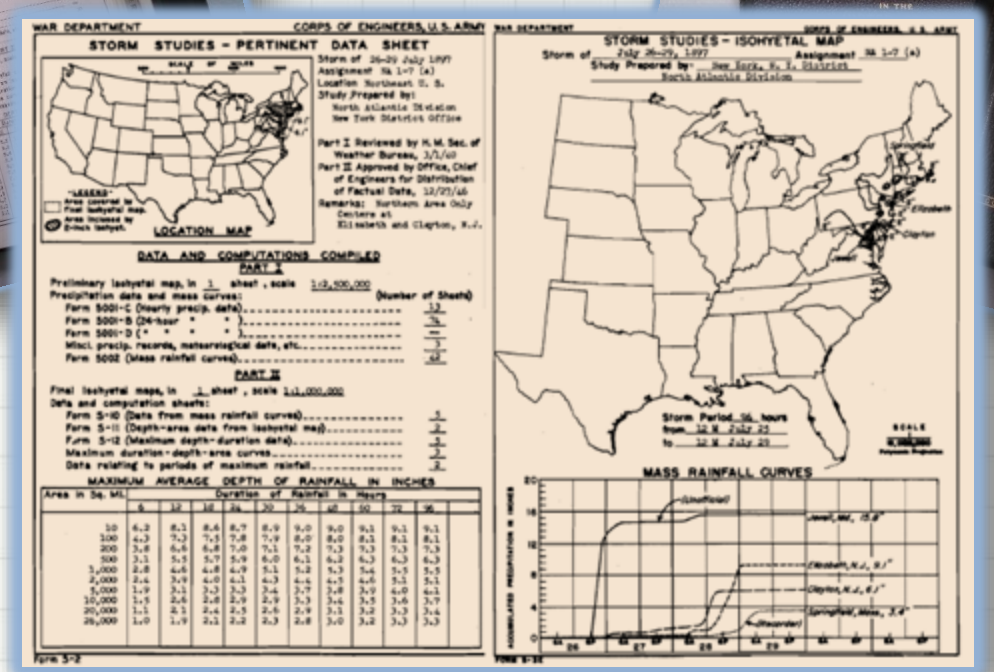


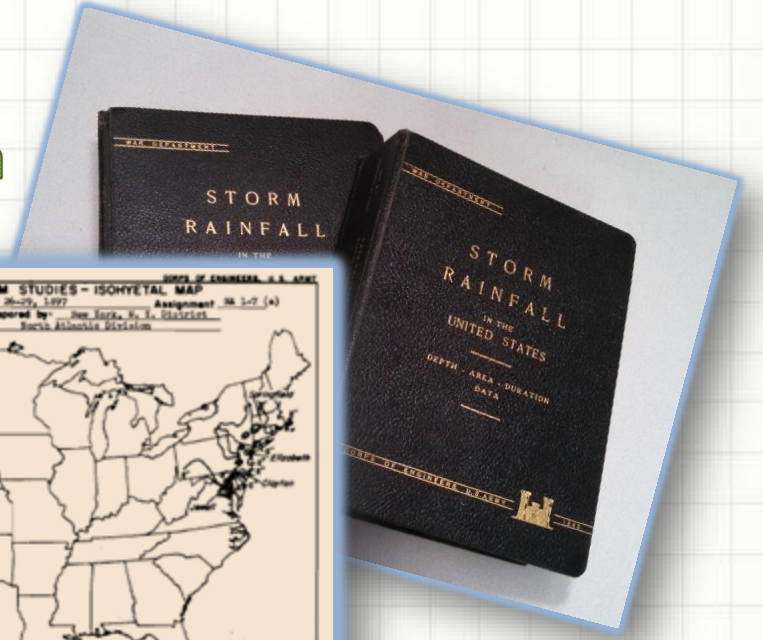

| Task | Resources/Timeframe |
|---|---|
| Complete NOAA Atlas 14 for the Northwestern USA | 5 scientists/3 years |
| Update whole country at once using improved methods | 10 scientists/4 years |
| Enhance products' suite | 3 scientists/2 year |
| **Responsible Agency:** NOAA<br>**Funding Source:** Various federal and state agencies | |

# War Department "Storm Rainfall in the United States"

## Depth Area Duration Data

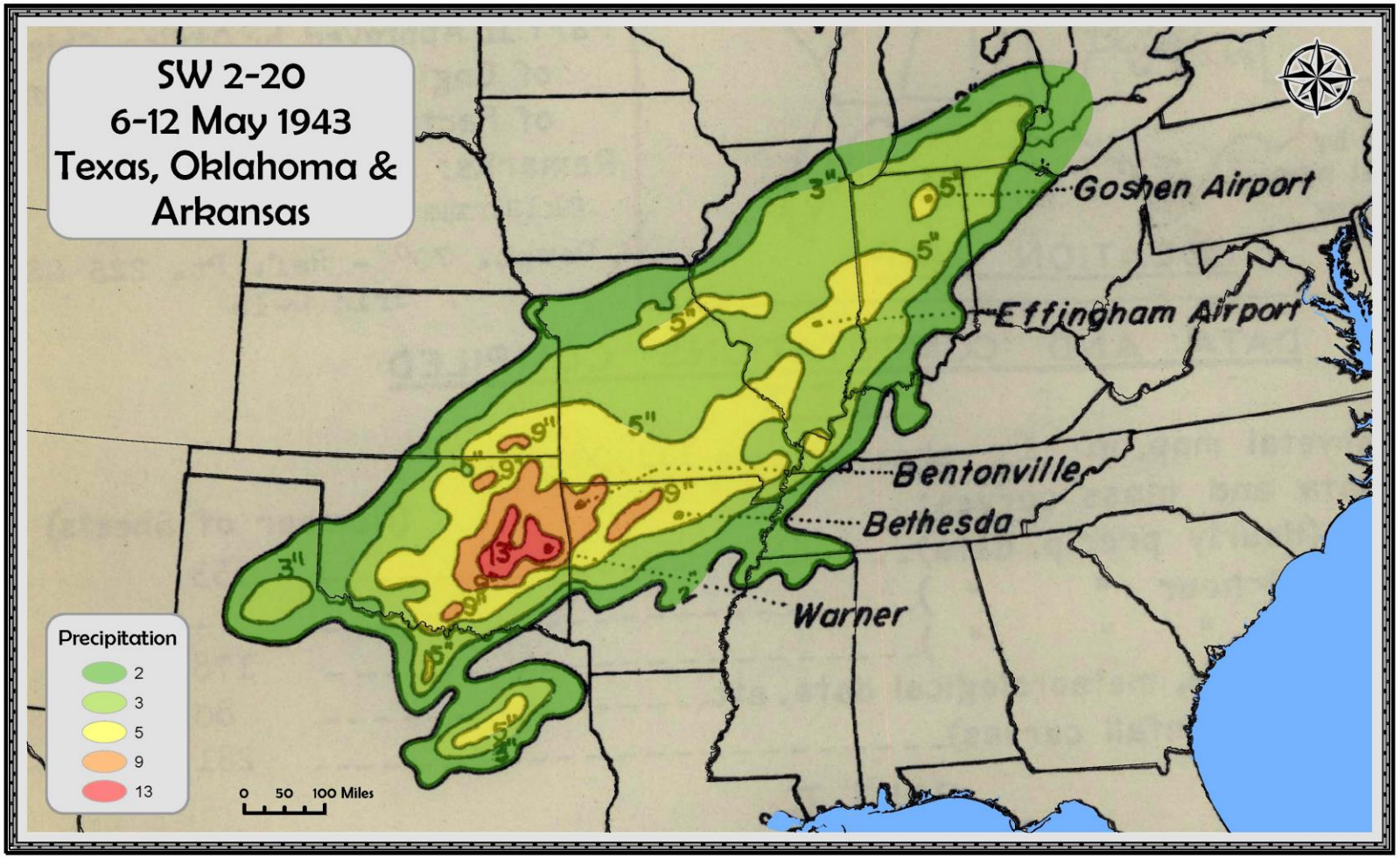


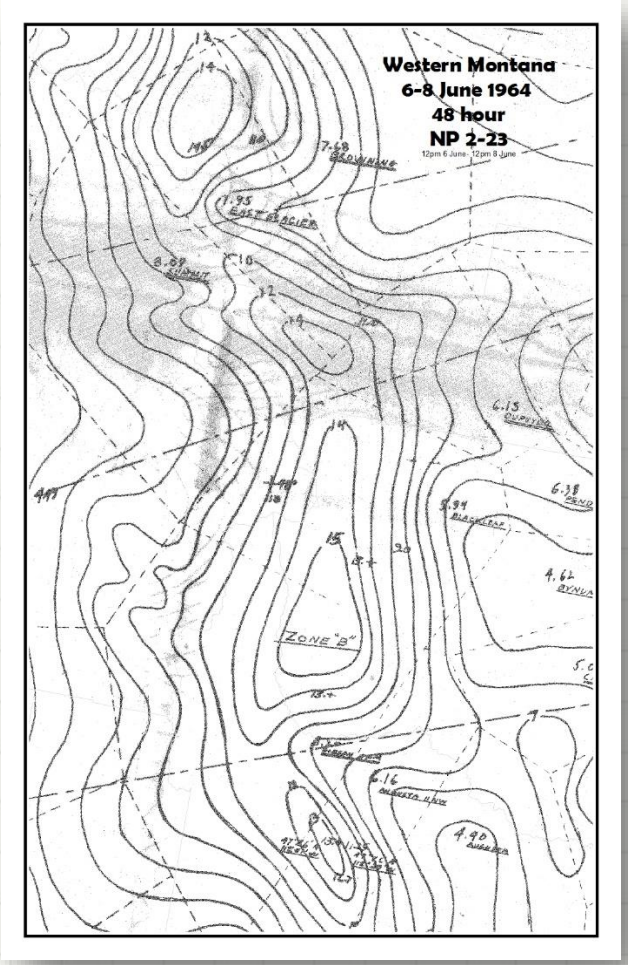


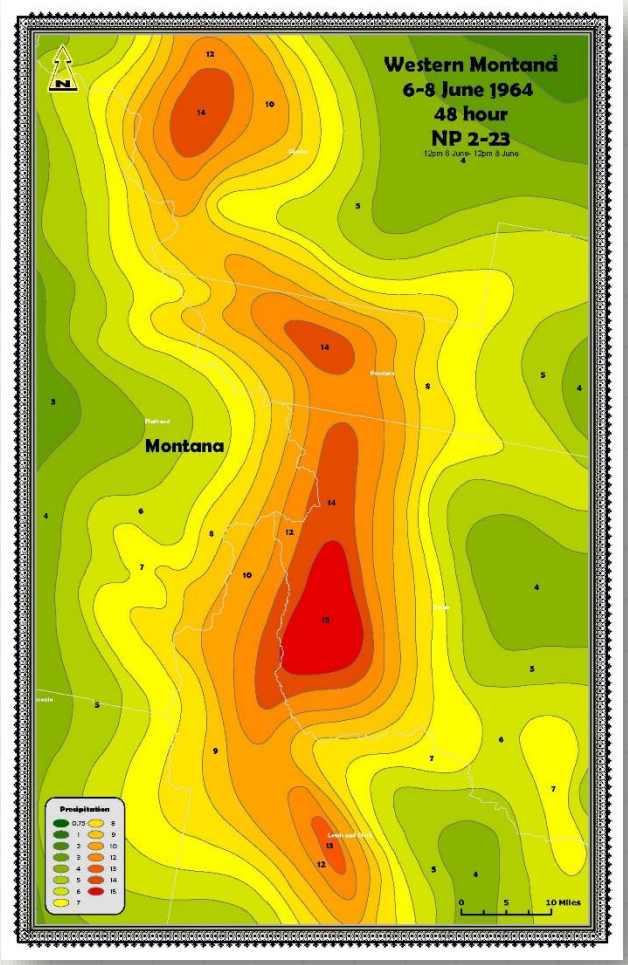




aka "Black Books"

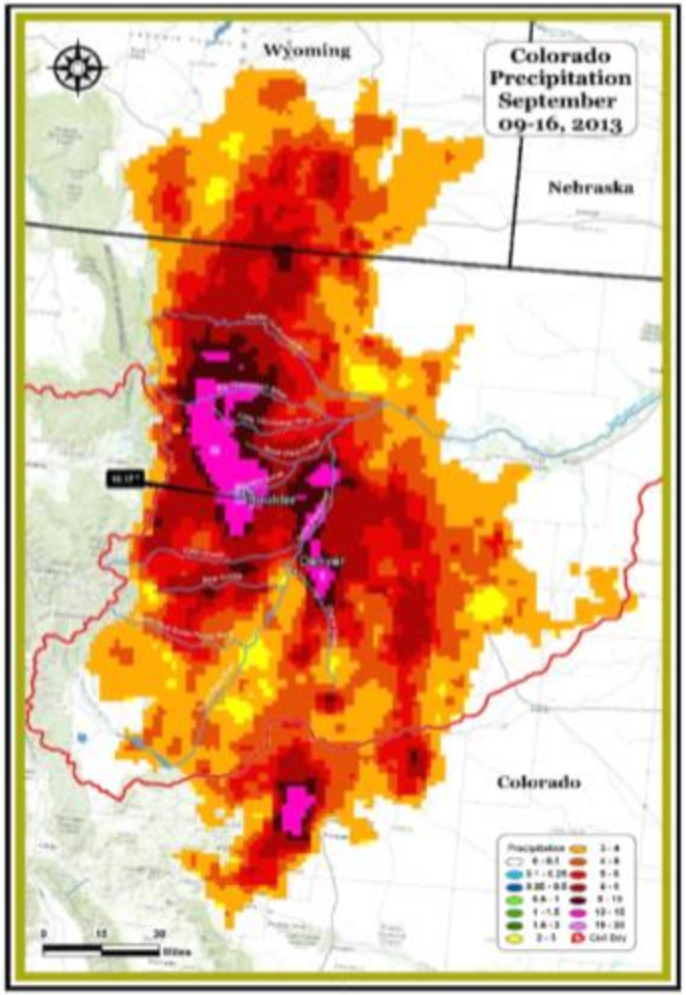
| Id | Assignment Number | Approximate Location of Storm Center | State Name | Division | District | Date Start | Date End | Total Rainfall (in) | Storm Duration (hr) | Storm Area (mi²) | Max Average Depth of Rainfall (in) | 24-hr, 100 mi² Rainfall (in) | Storm Dewpoint | Max Dewpoint | In-Place Moisture Adjustment | Ref Location | Elevation | Storm Source | Storm Classification | Transposition Polygon Exists |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | GM 3-13 | Elk, NM | NEW MEXICO | South Pacific | Albuquerque | 21-Jul-1905 | 25-Jul-1905 | 13.3 | 108 | 44000 | 3.8 | 5.1 | 74 | - | - | 470 SE | 5720 | - | - | No |
| 2 | GM 3-14 | Knickerbocker, TX | TEXAS | Southw estern | Fort Worth | 04-Aug-1906 | 06-Aug-1906 | 9 | 48 | 24600 | 4.9 | 8.6 | 74 | - | 1.21 | 250 SE | 2160 | - | - | No |
| 3 | GM 4-21 | Eagle Pass, TX | TEXAS | Southw estern | Fort Worth | 27-May-1925 | 29-May-1925 | 11.2 | 60 | 47100 | 4.4 | 8.5 | 69 | - | - | 315 SE | 800 | - | - | No |
| 4 | GM 5-1 | Mountain Home, TX | - | Southw estern | Fort Worth | 30-Jun-1932 | 02-Jul-1932 | 35.6 | 42 | 30000 | 5.9 | 25.8 | 75 | - | 1.16 | 175 S | 2000 | - | - | No |
| 5 | GM 5-10 | Eldorado, TX | - | Southw estern | Fort Worth | 19-Jul-1938 | 25-Jul-1938 | 30 | 144 | 68000 | 6.1 | 12.5 | 75 | - | - | 240 SSE | 5700 | - | - | No |
| 6 | GM 5-15B | Meek, NM | - | South Pacific | Albuquerque | 15-Sep-1919 | 17-Sep-1919 | 9.8 | 54 | 75000 | 4.4 | 6.4 | 72 | 79 | 1.4 | 400 ESE | 6700 | - | - | No |
| 7 | GM 5-16B | Abilene, TX | - | Southw estern | Fort Worth | 05-Sep-1932 | 07-Sep-1932 | 6.1 | 60 | 20400 | 3.3 | 4.8 | 75 | - | - | 400 SE | 1760 | - | - | No |
| 8 | GM 5-17 | Ragland, NM | - | South Pacific | Albuquerque | 26-May-1937 | 30-May-1937 | 7.8 | 84 | 37000 | 3.2 | 4.1 | 66 | - | - | 220 SE | 4900 | - | - | No |
| 9 | GM 5-18 | Prairieview , NM | - | South Pacific | Albuquerque | 20-May-1941 | 25-May-1941 | 10 | 108 | 44000 | 5.2 | 6.3 | 73 | 78 | 1.28 | 370 SE | 4000 | - | - | No |
| 10 | GM 5-19 | McColleum Ranch, NM | - | South Pacific | Albuquerque | 20-Sep-1941 | 23-Sep-1941 | 21.2 | 78 | 38000 | 5.5 | 9 | 72 | 79 | 1.4 | 300 SE | 5800 | - | - | No |

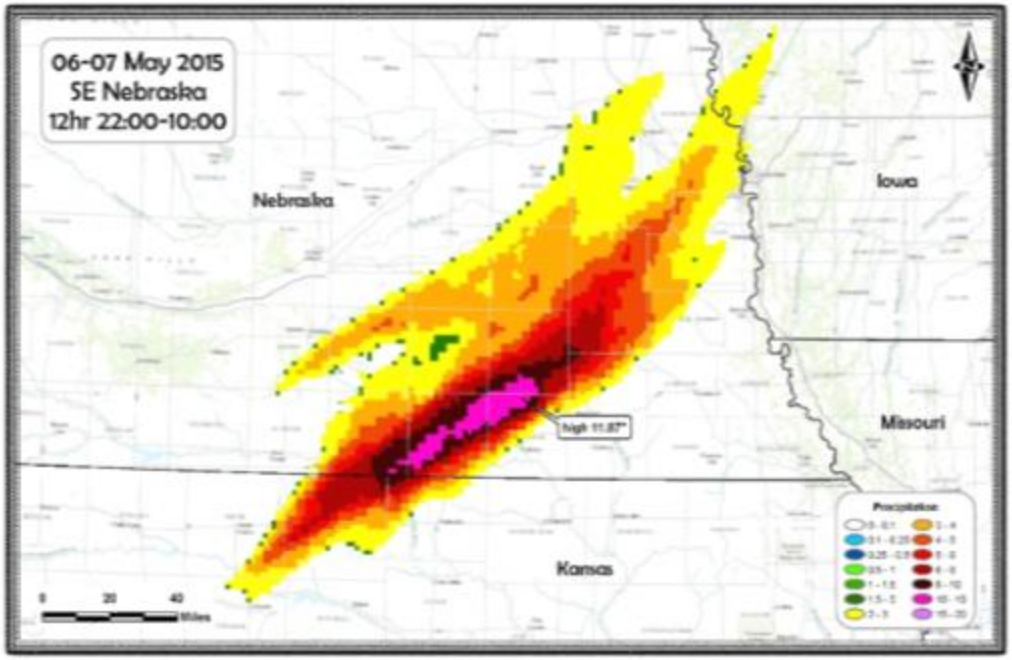

SW 2-20
6-12 May 1943
Texas, Oklahoma & Arkansas
Goshen Airport
Effingham Airport
Bentonville
Bethesda
Warner
Precipitation
2
3
5
9
13
0 50 100 Miles




Historic Isohyetals → GIS shapefiles




**Recent storm events that are considered mission critical for USACE operations are being included in the database.**

US Army Corps of Engineers ®
Omaha District

# Extreme Storms Database

UPLOAD DOWNLOAD

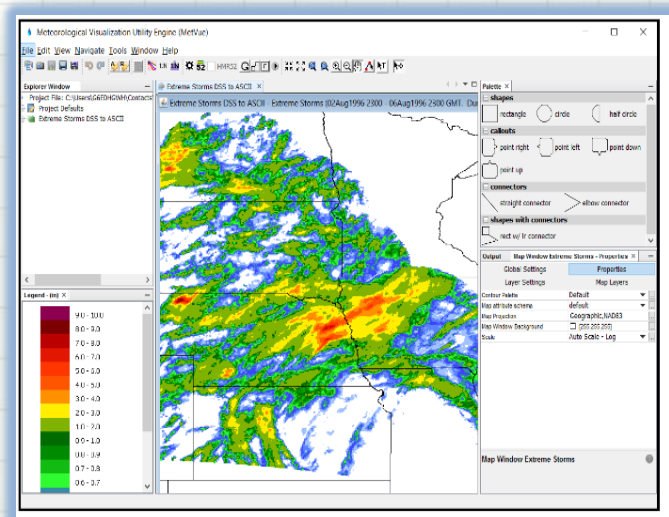
## Extreme Storms Database Downloader

### Grid Set

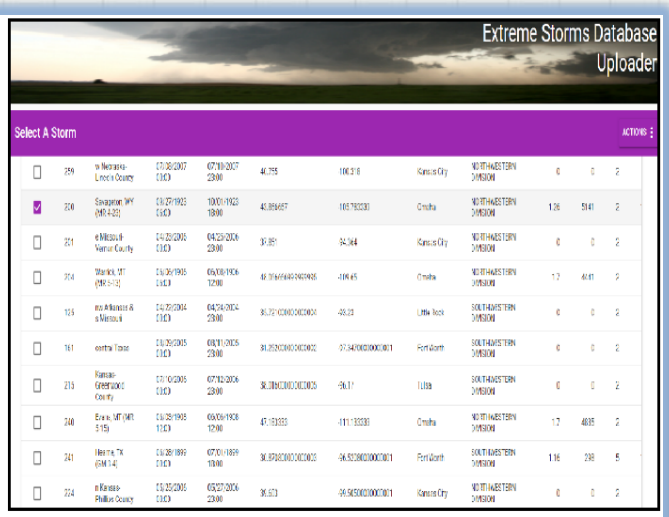
| ID | Type | Start Date Time | End Date Time | Total Grids | Load Date |
|---|---|---|---|---|---|
| 17 | Raw Radar | 06/26/2007 00:00 | 07/01/2007 23:00 | 144 | 08/15/2017 14:19 |
| 545 | Multi-Sensor Precipitation | 06/28/2007 00:00 | 07/01/2007 23:00 | 95 | 06/21/2018 12:40 |
| 546 | Multi-Sensor Precipitation | 06/28/2007 00:00 | 07/01/2007 23:00 | 1 | 06/21/2018 12:57 |

### Media

| ID | Name | File Extension | File Type | Description | Load Date |
|---|---|---|---|---|---|
| 1 | Mass Rainfall Curve | .png | IMAGE | Mass Rainfall Curve for storm duration | 12/22/2017 19:02 |
| 2 | Weather Charts | .pdf | IMAGE | Weather Charts 27June-2July 2007 | 12/22/2017 19:02 |
| 3 | Storm Dew Point Analysis | .xlsx | IMAGE | Spreadsheet with Dew Point Calculations | 12/22/2017 19:02 |
| 4 | Dew Point HYSPLIT Analysis | .docx | IMAGE | Word document with HYSPLIT, surface chart maps | 12/22/2017 19:02 |
| 15 | Map Compilation | .docx | IMAGE | Moisture Inflow map compilation | 12/26/2017 20:23 |




HEC-MetVue



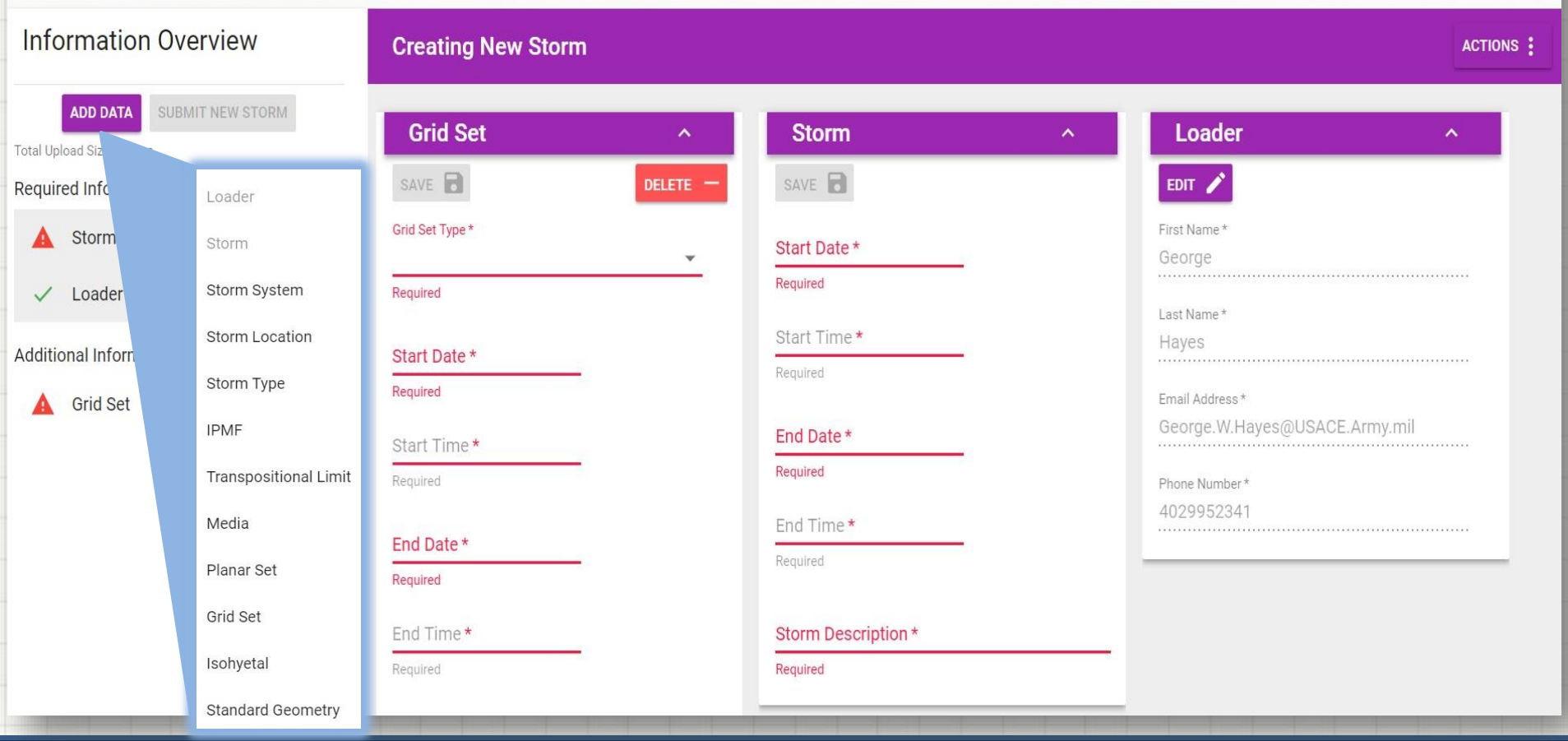

Extreme Storms Database

## Extreme Storm Database

SMITH, Jane

| Assignment Number | County | State | Latitude / Longitude | Start Date | Total Rainfall | Storm Duration | Isohyetal | Detailed Isohyetal | Storm Animation | Radar Data | Precep Data | Map Information | Location | Depth Area Duration Table / Curve |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GM 3-14 | Tom Green | Texas | 31.26 100.53 | 04-Aug-1906 | 9 in | 48 hours | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ |
| GM 3-15 | Tom Green | Texas | 31.26 100.53 | 04-Aug-1906 | 9 in | 48 hours | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ |
| GM 3-16 | Tom Green | Texas | 31.26 100.53 | 04-Aug-1906 | 9 in | 48 hours | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ |
| GM 3-17 | Tom Green | Texas | 31.26 100.53 | 04-Aug-1906 | 9 in | 48 hours | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ |
| GM 3-18 | Tom Green | Texas | 31.26 100.53 | 04-Aug-1906 | 9 in | 48 hours | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ |
| GM 3-19 | Tom Green | Texas | 31.26 100.53 | 04-Aug-1906 | 9 in | 48 hours | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ |
| GM 3-20 | Tom Green | Texas | 31.26 100.53 | 04-Aug-1906 | 9 in | 48 hours | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ |

# Extreme Storms Database Uploader



# Future Database Plans

- Full Storm Analysis Data to be ingested into an archive.
- Archive is currently hosted by the COE internally
- Future plans to have the database hosted at NCEI

# Future Database

- An NCEI database would offer several features:
- Consistent Digital Storm Data Delivery
- Archival Digital Storm Histories
- Available MetVue Analysis and data
- Fully available to the Public

# Chapter 4 - Updated Probable Maximum Precipitation Estimates

**Product Background**

- Group tasked with developing a plan of study and funding requirements to update the NOAA/NWS Hydrometeorological Reports for estimating PMP.
- PMP is the greatest depth of precipitation for a given duration meteorologically possible for a design watershed or a given storm area at a particular location at a particular time of year.
- Used by Federal and State agencies for designing and regulating critical infrastructure such as dams and nuclear facilities.
- Engineers use PMPs to derive Probable Maximum Floods (PMFs) as part of spillway designs for High and Significant Hazard dams.
- Inflow design Flood (IDF) upper limit is based on PMF, and is the used as the basis of spillway sizing for many of the nation's largest and highest hazard dams.

**Product Background Cont.**

- Between the 1970's and 1990's NOAA developed and published various HMR atlases of PMP estimates for the United States, state-of-art when originally published; but have not been consistently updated for many years.
- Presently NOAA does not have the funding or resources to update the HMRs or PMP estimates.
- The need for PMP estimates from the HMRs still exists as engineers and hydrologists continue to design critical national infrastructure.
- Part of FERC's mission is safety and adequacy of 2,523 non-federal, jurisdictional hydropower facilities
- Coordinating the effort to review extreme storm data and update HMRs for use in development of extreme storm precipitation estimates is a responsibility of FERC.
- The majority of the country is covered by HMRs that are approximately 40 years old. The most recent HMRs cover the U.S. west coast areas are the most recently published ( 18-23 years old).

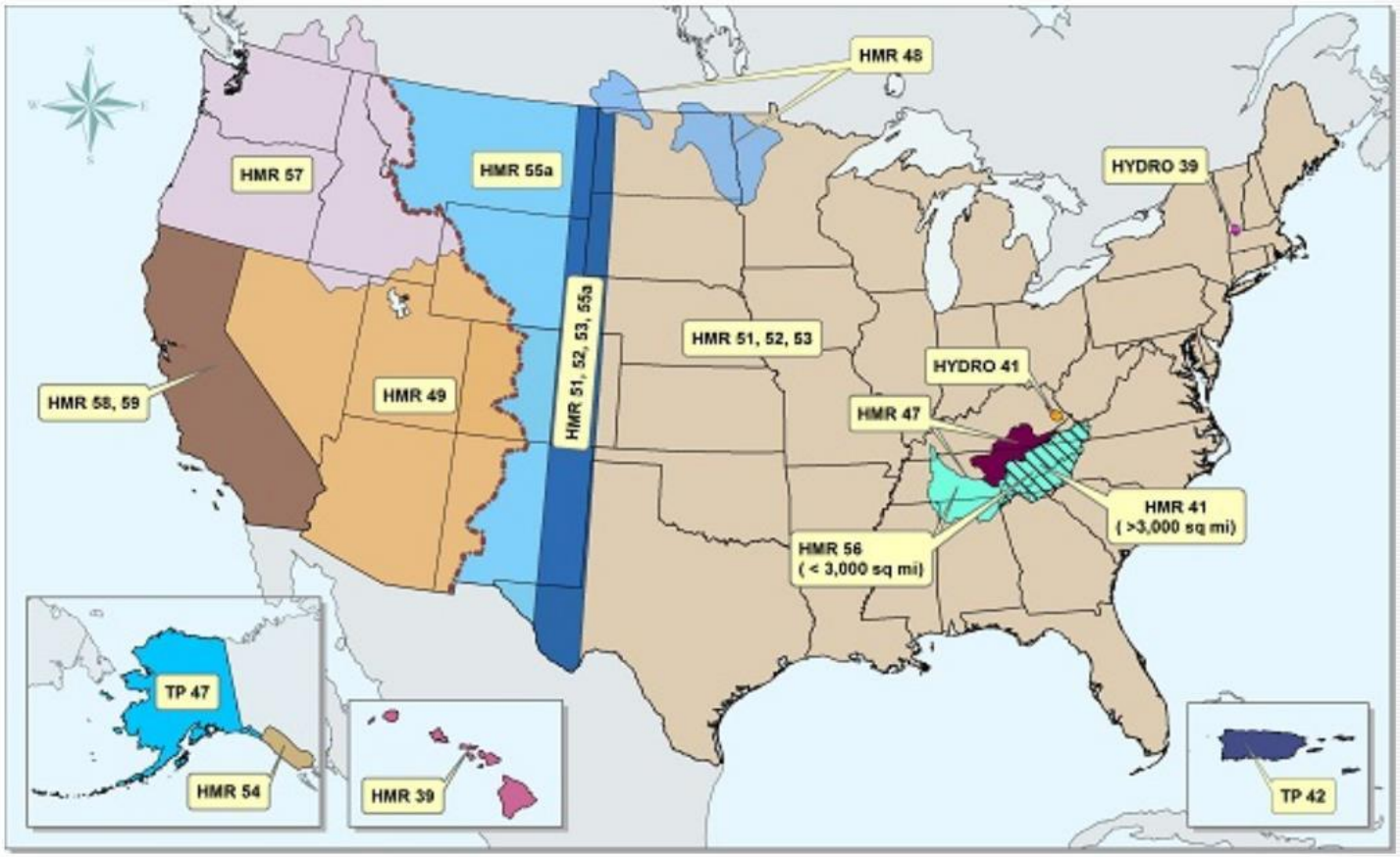



**Figure 4-1.** HMR publications covering the United States **(National Weather Service, 2017)**

| Document Link | Title | Year |
|---|---|---|
| Hydrometeorological Report No. 39 | Probable Maximum Precipitation in the Hawaiian Islands | 1963 |
| Hydrometeorological Report No. 41 | Probable Maximum and TVA Precipitation over the Tennessee River Basin above Chattanooga | 1965 |
| Hydrometeorological Report No. 46 | Probable Maximum Precipitation, Mekong River Basin | 1970 |
| Hydrometeorological Report No. 47 | Meteorological Criteria for Extreme Floods for Four Basins in the Tennessee and Cumberland River Watersheds | 1973 |
| Hydrometeorological Report No. 48 | Probable Maximum Precipitation and Snowmelt Criteria For Red River of the North Above Pembina, and Souris River Above Minot, North Dakota | 1973 |
| Hydrometeorological Report No. 49 | Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages | 1977 |
| Hydrometeorological Report No. 51 (Digitized maps) | Probable Maximum Precipitation Estimates, United States East of the 105th Meridian | 1978 |
| Hydrometeorological Report No. 52 | Application of Probable Maximum Precipitation Estimates - United States East of the 105th Meridian | 1982 |
| Hydrometeorological Report No. 53 | Seasonal Variation of 10-Square-Mile Probable Maximum Precipitation Estimates, United States East of the 105th Meridian | 1980 |
| Hydrometeorological Report No. 54 | Probable Maximum Precipitation and Snowmelt Criteria for Southeast Alaska | 1983 |
| Hydrometeorological Report No. 55A | Probable Maximum Precipitation Estimates - United States Between the Continental Divide and the 103rd Meridian | 1988 |
| Hydrometeorological Report No. 56 | Probable Maximum and TVA Precipitation Estimates With Areal Distribution for Tennessee River Drainages Less Than 3,000 $Mi^2$ in Area | 1986 |
| Hydrometeorological Report No. 57 | Probable Maximum Precipitation - Pacific Northwest States. Columbia River (including portions of Canada), Snake River and Pacific Coastal Drainages | 1994 |
| Hydrometeorological Report No. 58 | Probable Maximum Precipitation for California - Calculation Procedures | 1998 |
| Hydrometeorological Report No. 59 (HMR58 and HMR59 shapefiles) | Probable Maximum Precipitation for California | 1999 |

**Table 4-1.** Summary of HMRs with publication date **(National Weather Service, 2017b)**

## Product Background Cont.

- The Extreme Storm Events Work Group (ESEWG) conducted a survey in 2014 to assess extreme precipitation products needs of Federal and State agencies.

**States articulated the following needs:**

1) PMP estimates are very important to States; State regulations for determining spillway capacities are typically based upon PMFs using HMR PMPs.

2) Extreme precipitation products should consider heavy workloads of state dam safety agencies which are typically hundreds of dams per staff member.

3) States would benefit from using PMP estimates that are technically and politically defensible to private dam owners and state legislators.

4) National extreme precipitation products and guidelines would be good for the dam safety industry, and are needed to provide water resources developers with the confidence needed to invest in multi-million dollar infrastructure projects.

6) The importance of updated PMP estimates is urgent.

## Product Background Cont.

- Absence of updated HMRs have led to water development projects to move forward with "site-specific PMP" (SSPMP) studies adding to workload
- SSPMP studies have placed a burden on regulatory agencies due to a lack of expertise or resources to review hydrometeorological studies adding to workload.
- ESEWG has identified **three key products** in **support of updated PMP estimates**:

  1) updated HMRs

  2) a national guidelines document to define best practices for State-wide/regional and Site-Specific PMP studies

  3) Maintenance, Research, and Development of PMP estimates.

# Updated HydroMeteorological Reports of Generalized Probable Maximum Precipitation Estimates

## Product Description

- Updated HMRs would take into consideration new technology that has evolved since the original HMRs were authored.
- New PMP studies can benefit from a wide range of data sources, updated observations, and radar data.
- These new data and methods should be fully reviewed and investigated to document the impacts on PMP estimates.
- Updated HMRs should provide modern, defensible PMP estimates for the United States.
- Technology and methods have continued to advance through State-wide and site-specific PMP studies.

## Necessary HMR advancements (where standard-of-practice has been moved forward by private meteorology firms):

1) PMP estimates available via web-based server to provide PMP estimates for a basin of interest, similar to the NOAA Atlas 14 Precipitation Frequency Data Server.

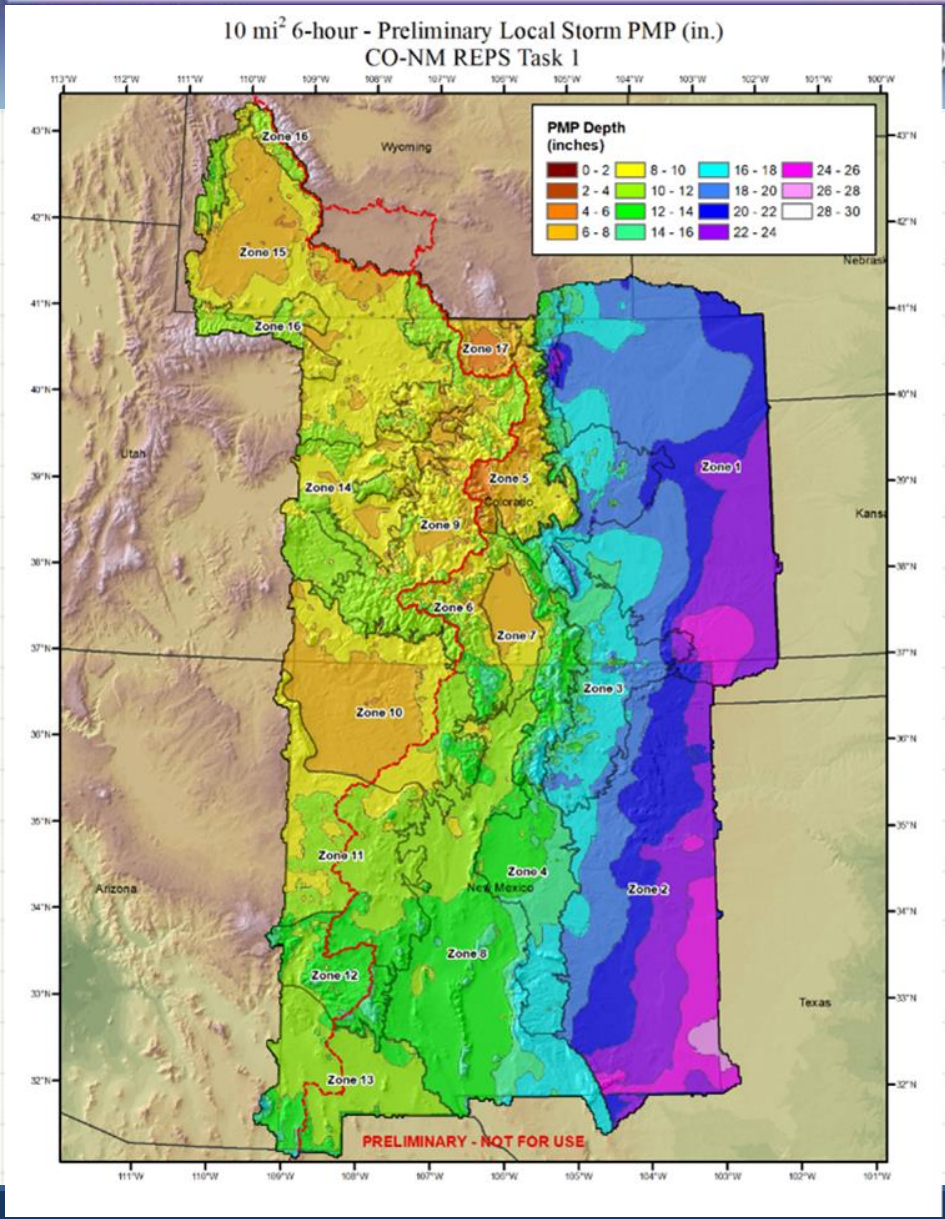
2) Gridded PMP estimates in GIS format to support distributed hydrological modeling.

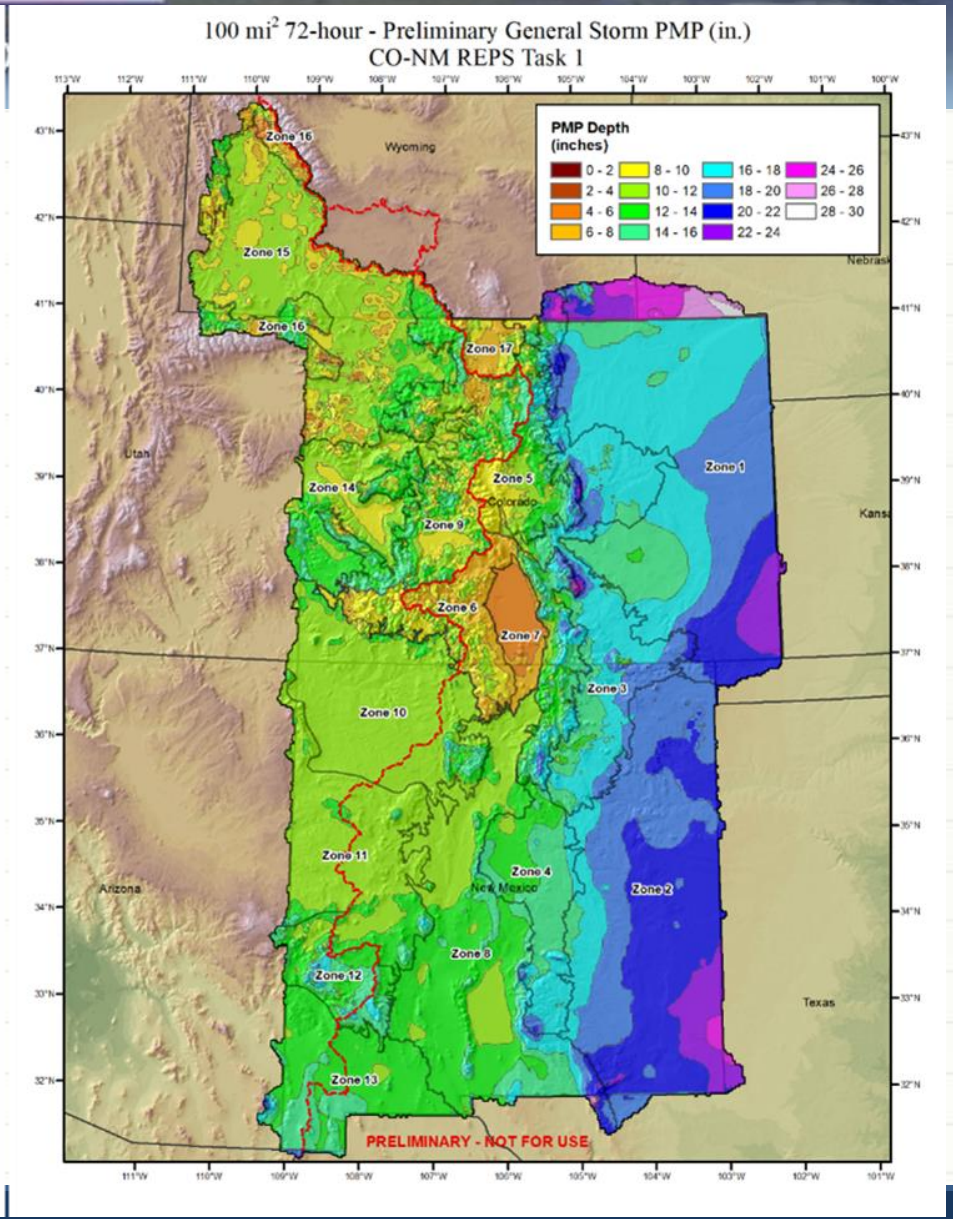
3) Updated storm catalog to include analysis of recent extreme events.

4) Use of Next Generation Weather Radar (NEXRAD) for storms that occurred after 1995.

5) Physically-based methods to account for orographic effects on extreme precipitation during storm transportation process, possibly supported by dynamical modeling.

6) PMP estimates should be extended beyond the historically-provided duration of 72-hours, which is a lesson learned from numerous long-duration high volume rain events.


10 mi² 6-hour - Preliminary Local Storm PMP (in.)
CO-NM REPS Task 1
PMP Depth (inches)
0 - 2
2 - 4
4 - 6
6 - 8
8 - 10
10 - 12
12 - 14
14 - 16
16 - 18
18 - 20
20 - 22
22 - 24
24 - 26
26 - 28
28 - 30
Wyoming
Utah
Colorado
Arizona
New Mexico
Texas
Zone 1
Zone 2
Zone 3
Zone 4
Zone 5
Zone 6
Zone 7
Zone 8
Zone 9
Zone 10
Zone 11
Zone 12
Zone 13
Zone 14
Zone 15
Zone 16
Zone 17
PRELIMINARY - NOT FOR USE


100 mi² 72-hour - Preliminary General Storm PMP (in.)
CO-NM REPS Task 1
PMP Depth (inches)
0 - 2
2 - 4
4 - 6
6 - 8
8 - 10
10 - 12
12 - 14
14 - 16
16 - 18
18 - 20
20 - 22
22 - 24
24 - 26
26 - 28
28 - 30
Wyoming
Utah
Colorado
Arizona
New Mexico
Texas
Zone 1
Zone 2
Zone 3
Zone 4
Zone 5
Zone 6
Zone 7
Zone 8
Zone 9
Zone 10
Zone 11
Zone 12
Zone 13
Zone 14
Zone 15
Zone 16
Zone 17
PRELIMINARY - NOT FOR USE

# Product Implementation

- Updating HMRs will require rebuilding a workgroup within an existing Federal agency with experience in meteorology, hydrology, and extreme precipitation studies. **This will be a challenge**.
- Currently no single agency possesses personnel of the size needed to update the HMRs.
- NOAA, USACE, and USBR have groups that could provide the building blocks.
- HMR updates should be performed regionally based upon major drainage basin or meteorologically similar climate region.
- **Updates should be prioritized**, HMR 51/52 (largest are and population coverage), HMR 49 (age), MHR 55A and so on.
- Consideration should be given to removal of existing HMRs from the NOAA Hydrometeorological Design Studies Center website, since they are no longer supported by NOAA.

**Table 4-2.** Tasks to be completed for HMR PMP updates and resources needed

| Task | Timeframe | Responsible Agency | Funding Source | Resources Needed |
|---|---|---|---|---|
| Update HMR PMP for HMR 51/52 study area (including HMRs 41, 47, 48, and 56, which lie within the larger 51/52 boundaries) | 2 years | NOAA, USACE or USBR (lead agency to be determined) | USACE, USBR, NRCS, NRC and state dam safety agencies (by FEMA National Dam Safety Program grants) | Dedicated agency work group staffed with 5 meteorologists, 2 hydrologists, 3 GIS technicians, and 2 web application developers |
| Update HMR 49 study area | Same as above | | | |
| Update HMR 55A study area | Same as above | | | |
| Update HMR 39 (Hawaii) and HMR 54/TP47 (Alaska) study area | Same as above | | | |
| Update HMR 57-59 study area | Same as above | | | |

# HMR update studies should include:

1. Identify historic extreme storms relevant to the region of study.
2. Grouping of storms by independent storm type (i.e., separating those that would not occur simultaneously).
3. Construct depth-area-duration data for historic extreme storms.
4. Determine representative and maximum theoretical measures of efficiency for historic extreme storms.
5. Transposition storms over the study region according to agreed-upon limits and adjustment procedures, including physically-based procedures to account for orographic influence.
6. Spatially map PMP estimates for each independent storm type over the study area.

# HMR update studies should include: Cont.

7. Spatially and temporally envelope PMP estimates to account for sample variation due to limited sample size of extreme storms.

8. Provide guidance on spatial and temporal patterns of PMP design storms for hydrological modeling.

9. **Address climate change impacts if warranted by non-stationarity analysis.**

**10. Estimate annual exceedance probability for PMP estimates based on regional extreme precipitation frequency analysis as an independent check**

Colorado-New Mexico Regional Extreme Precipitation Study

VOLUME VI

# Considering Climate Change in the Estimation of Extreme Precipitation for Dam Safety

*FINAL DRAFT*

*June 28, 2018*

*Prepared by:*

*Kelly Mahoney, NOAA Earth Systems Research Laboratory, Physical Sciences Division, Boulder, CO*

*Jeff Lukas, Western Water Assessment, CIRES, University of Colorado Boulder*

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***2 Overview of anthropogenic climate change***

***3 Observed climate trends: Global and regional***

***4 About global climate models (GCMs)***

***5 GCM projections of future regional climate***

***6 Mechanisms by which climate change may impact extreme precipitation events/PMP***

***7 The current state and direction of PMP/PFA practice with respect to climate change***

***8 Review of approaches for incorporating climate change into PMP and PFA***

***9 Conclusions and Recommendations***

***Appendix A - Summary of results of stakeholder survey***

| Point PF Interface | | Watershed PF Interface | | Spatial/Temporal/Temperature Analyses |

# METPORTAL

Precipitation Frequency CO-NM REPS

METSTAT

Download User Guide | Download Data For Selected Inputs

Download PF grids for Selected Duration

Storm Type/Duration

MBC 6hr

Annual Exceedance Probability for Precip Plotting

AEP=10^-4

Select Watershed on Map or Upload Watershed Shapefile (dbf,shp,shx,prj or zip containing these) in WGS84 geographic coordinate system

Browse... 8 files

Upload complete

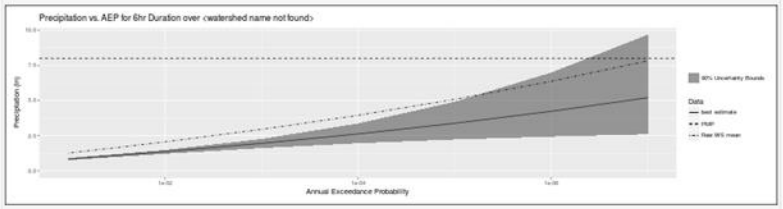
Probable Maximum Precipitation (inches) -- enter a value to override gridded PMP

8

Show Uncertainty Bounds?

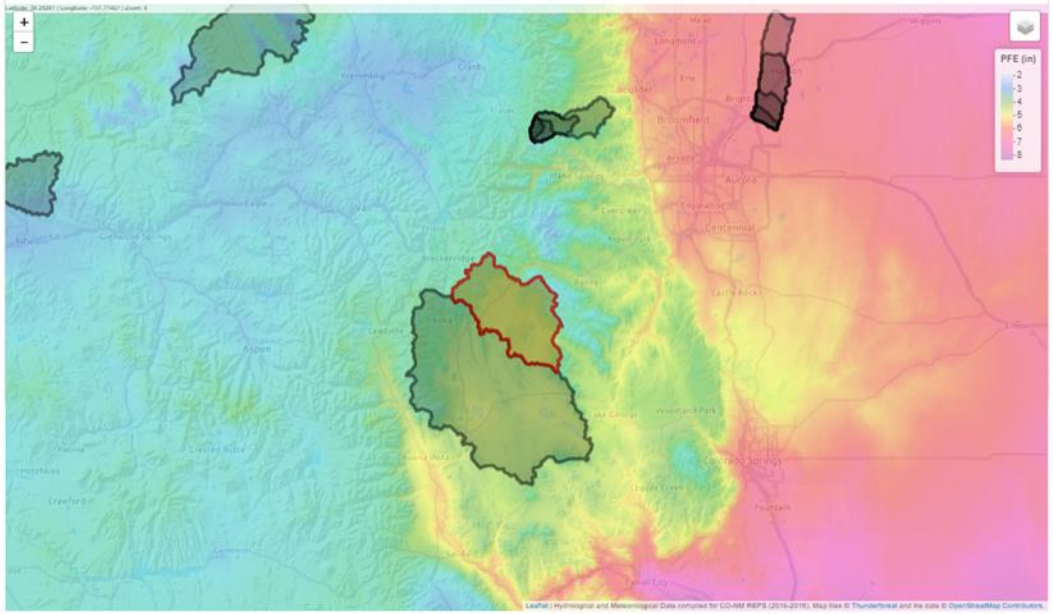
**ARF and PF data over <watershed name not found> for 6hr Duration and Given AEP**

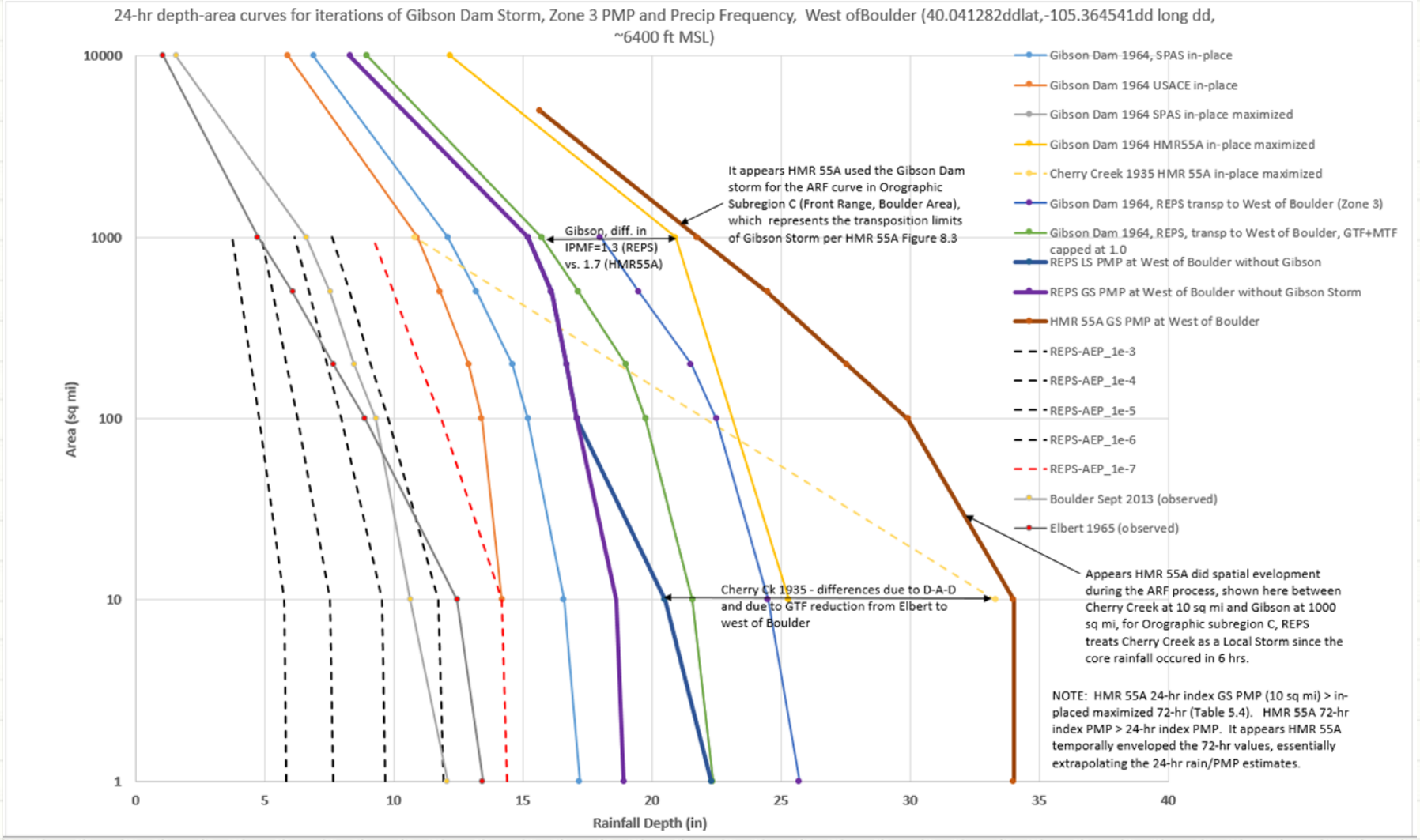
| | Lower Bound (in) | Best Estimate (ARF reduced WS mean; inches) | Upper Bound (in) | WS Mean Precip (in) | ARF |
|---|---|---|---|---|---|
| AEP=10^-1 | 0.77 | 0.83 | 0.90 | 1.25 | 0.66 |
| AEP=10^-2 | 1.21 | 1.36 | 1.48 | 2.05 | 0.66 |
| AEP=10^-3 | 1.62 | 1.96 | 2.26 | 2.94 | 0.66 |
| AEP=10^-4 | 1.96 | 2.62 | 3.37 | 3.95 | 0.66 |
| AEP=10^-5 | 2.23 | 3.38 | 4.51 | 5.08 | 0.66 |
| AEP=10^-6 | 2.43 | 4.23 | 6.39 | 6.36 | 0.66 |
| AEP=10^-7 | 2.60 | 5.20 | 9.68 | 7.82 | 0.66 |




MetPortal CO-NM Precipitation Frequency GUI v0.9.19
Email Bug Reports, Questions, and Suggestions to: ballen@metstat.com
Please Use 'CO-NM PF GUI Feedback' as Your Subject Line

Date and Time of Analysis: 2018-08-16 18:49:44
Watershed: <watershed name not found in shapefile ID attribute>
WS Centroid: 39.31N 105.77W
Region: East
Storm Type: 6hr
AEP Selected: 10^-4
Analysis Type: WS Average Precipitation Frequency




24-hr depth-area curves for iterations of Gibson Dam Storm, Zone 3 PMP and Precip Frequency, West ofBoulder (40.041282ddlat,-105.364541dd long dd, ~6400 ft MSL)
Area (sq mi)
Rainfall Depth (in)
10000
1000
100
10
1
0
5
10
15
20
25
30
35
40
Gibson Dam 1964, SPAS in-place
Gibson Dam 1964 USACE in-place
Gibson Dam 1964 SPAS in-place maximized
Gibson Dam 1964 HMR55A in-place maximized
Cherry Creek 1935 HMR 55A in-place maximized
Gibson Dam 1964, REPS transp to West of Boulder (Zone 3)
Gibson Dam 1964, REPS, transp to West of Boulder, GTF+MTF capped at 1.0
REPS LS PMP at West of Boulder without Gibson
REPS GS PMP at West of Boulder without Gibson Storm
HMR 55A GS PMP at West of Boulder
REPS-AEP_1e-3
REPS-AEP_1e-4
REPS-AEP_1e-5
REPS-AEP_1e-6
REPS-AEP_1e-7
Boulder Sept 2013 (observed)
Elbert 1965 (observed)
It appears HMR 55A used the Gibson Dam storm for the ARF curve in Orographic Subregion C (Front Range, Boulder Area), which represents the transposition limits of Gibson Storm per HMR 55A Figure 8.3
Gibson, diff. in IPMF=1.3 (REPS) vs. 1.7 (HMR55A)
Cherry Ck 1935 - differences due to D-A-D and due to GTF reduction from Elbert to west of Boulder
Appears HMR 55A did spatial evelopment during the ARF process, shown here between Cherry Creek at 10 sq mi and Gibson at 1000 sq mi, for Orographic subregion C, REPS treats Cherry Creek as a Local Storm since the core rainfall occured in 6 hrs.
NOTE: HMR 55A 24-hr index GS PMP (10 sq mi) > in-placed maximized 72-hr (Table 5.4). HMR 55A 72-hr index PMP > 24-hr index PMP. It appears HMR 55A temporally enveloped the 72-hr values, essentially extrapolating the 24-hr rain/PMP estimates.

# PMP program management:

- Responsible federal science agency assumes primary responsibility for updating the HMR PMP estimates.
- A multi-agency review board should be formed to peer review each new HMR study.
- Private meteorology consulting firms have developed expertise in PMP and extreme precipitation analysis and could support federal efforts

# National Guidance Document for Statewide/Regional and Site-Specific PMP Studies

- **Product Description**
- Until the HMRs are completely updated, a need will continue for some States to move forward with their own Statewide/regional PMP studies
- A national guidance document for State-wide/regional and site specific PMP studies is recommended to provide best practices that can be followed by Federal and State regulatory agencies and private meteorological consultants in performing such studies.

**Guideline document objectives;**

1) ensure consistency between PMP studies and study regions
2) Facilitate review of PMP studies by regulatory agencies.
3) Provide confidence in regional and site-specific PMP estimates.

## Product description continued;

- Colorado and New Mexico currently completing multi-year, state-of-the-practice Regional Extreme Precipitation Study (CO-NM REPS).
- ESEWG recommends guidance document be published by FEMA as a part of their "guidelines for dam safety" series of reports (National Dam Safety Program).
- Guideline Documents should address;
- Data needs and sources
- Best practices in PMP estimation methods
- Quality control/assurance practices
- Oversight and review
- Study documentation and Identification of items for future research.

## Product Description Cont.

**FERC Requirements for site-specific PMP studies.**

1) The studies must be performed by qualified hydrometeorologist.

2) Must be reviewed by a Board of Independent Consultants (BOC). Consisting of three of more professionals that usually include meteorologist, hydrologist, and engineer.

The BOC should be approved by the FERC (or responsible regulatory agency)

FERC (or responsible regulatory agency) representatives must be involved throughout the study and BOC review process.

# Product Implementation

**ESEWG Recommends;**

*1) FEMA as the lead agency for the National Dam Safety Program, sponsor the development of the national guidelines document, and assemble an expert committee to edit it.*

*2) National Dam Safety Review Board (NDSRB) help guide the direction of the document.*

*3) Using the CO-NM-REPS standard-of-Practice report as a starting point to ease the burden of developing a national guidelines document. With FEMA led expert committee reviewing and editing the CO-NM-REPS report to meet the needs of a national audience.*

## Colorado – New Mexico Regional Extreme Precipitation Study

### Summary Report

### VOLUME V
### Draft Standard of Practice

*DRAFT*

Prepared by:
Project Sponsors

July 10, 2018

*For internal discussion purposes only. Not for distribution.*

COLORADO
Colorado Water Conservation Board

## Outline

**Preface**
- Generally follows FEMA 65 - Earthquake Analysis and Design of Dams
- Acknowledgements

**Introduction**
**Purpose**
**Scope**
**References and Glossary**
**Project Development**
- Project Design and Scope Development
  - Key decision points
    - Statewide or Regional Study
    - Methods to Include
      - Deterministic PMP
      - PF
      - Numerical Modeling Analysis
    - Recommended methods to Include
  - Scope Development
      - Study area boundary
      - Sequencing and Scheduling
    - Team Composition
      - Technical Consultant(s)
      - Review Board
      - Project Management
    - Project Contracting and Funding
      - MOA's
      - Cost sharing between states
    - Product/Results
      - Reports
      - Tools
      - Project Documentation
    - Project management
      - In house vs. contracted

**Table 4-3.** *Tasks to be completed for publication of the national-guidelines document for State-wide/regional and Site-Specific PMP studies and resources needed*

| Task | Timeframe | Responsible Agency | Funding Source | Resources Needed |
|---|---|---|---|---|
| FEMA-led expert committee to review and edit the CO-NM REPS standard-of-practice report in order to meet needs of a national audience | 6 months | FEMA, USACE, USBR, NRC, NOAA, FERC and representatives from state dam safety agencies and ASDSO | FEMA National Dam Safety Program | 7 hydro-meteorological and dam safety experts from responsible agencies (estimated 260 hours total over 6 months at 10 hours/week for each worker) |
| Review by National Dam Safety Review Board | 2 months | NDSRB participants | NDSRB participants | NDSRB participants |
| Publication of guidance document | 3 months | FEMA | FEMA | Technical writing staff, report publication staff |

# PMP Maintenance, Research and Development, and Updates

- ESEWG recommends that long-term maintenance, research and development, and update tasks need to be performed.

**The follow-on tasks are needed:**

1. Coordination of HMR update methods and State/regional and site-specific PMP guidelines to ensure that the two approaches maintain consistency.
2. Compile, host, and maintain the various HMRs, State/regional, and site-specific PMP studies, which are performed in accordance with the national guidelines document.
3. Perform, fund, and promote continued research in the fields of PMP estimation and extreme precipitation estimation, relying on issues raised during HMR update studies and State/regional and site-specific PMP studies.
4. Determine criteria and frequency for review and update of PMP estimates such that PMP estimates are kept current based on occurrence of new storms, new methodologies, etc. Perform such updates as are deemed necessary.

- Conclusion
- Questions?