Session 3
Probable Maximum Precipitation (PMP) Study for Texas

PMP Study

- Started August 2014
- Completion August 2016
- Contractor – Applied Weather Associates
- Peer Review Committee

PMP Study Peer Reviewers

- Dr. William Asquith, USGS and Texas Tech
- Dr. John Nielsen-Gammon, State Climatologist and Texas A&M
- George Bomar, Texas Department of Licensing and Regulation and author of *Texas Weather*

PMP Study Peer Reviewers

- Todd Marek, P. E., NRCS, Temple
- Simeon Benson, USCOE, Fort Worth
- Charles McWilliams, USCOE, Omaha, Neb.
- Debra Rankin, P. E., Retired TCEQ Dam Safety
- Warren Samuelson, P. E., TCEQ Dam Safety

Contractor Team

Applied Weather Associates, LLC

Project Manager and Chief Meteorologist

- Bill Kappel

Senior Hydrometeorologist

- Doug Hultstrand

Senior GIS Specialist/Staff Scientist

- Geoff Muhlestein

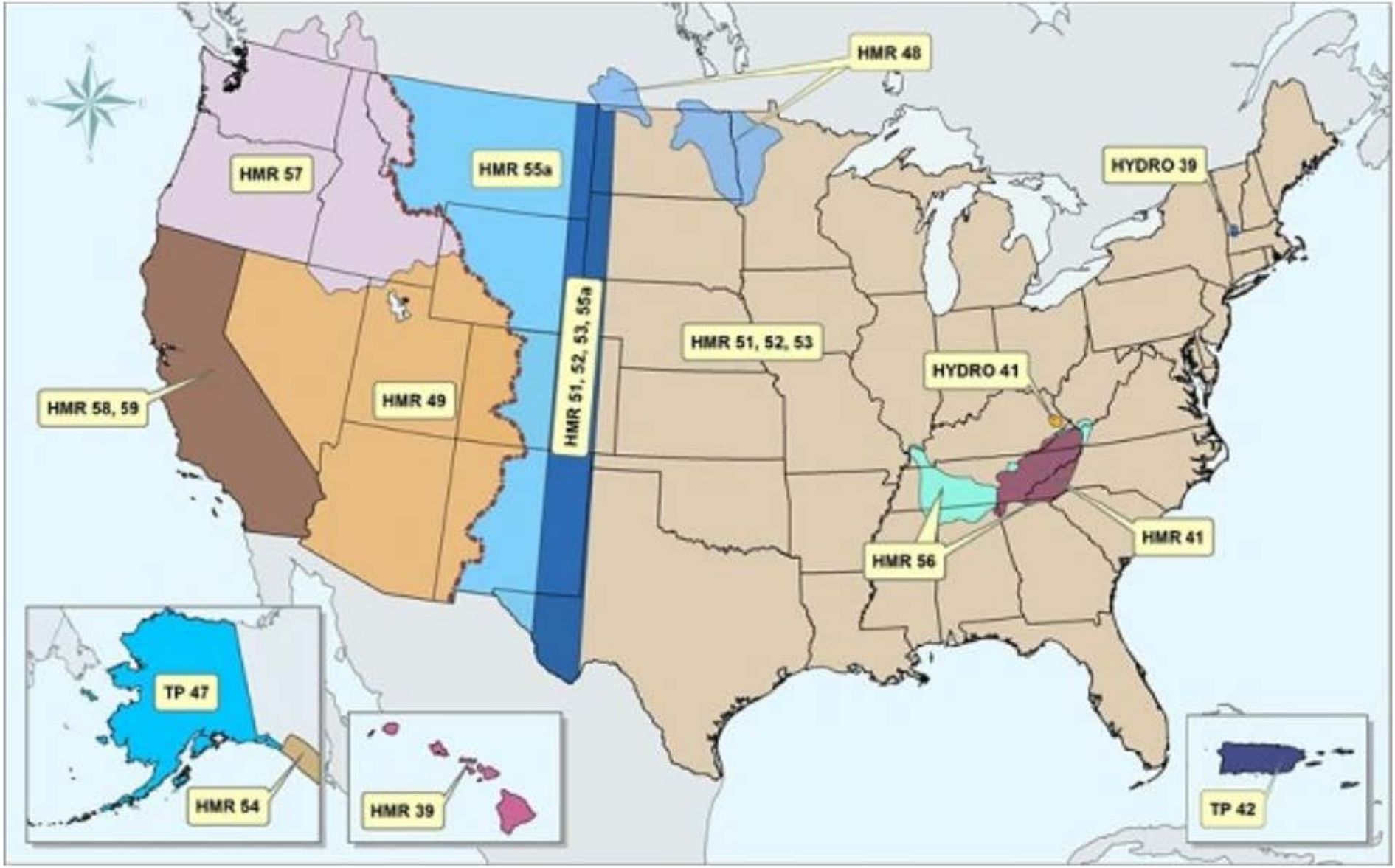
Staff Meteorologists

- Dana McGlone, Kristi Steinhilber, Bryon Lawrence, Steve Lovisone, Patrice Sutter

Probable Maximum Precipitation (PMP)

- **Definition:** The ***theoretically*** greatest depth of precipitation for a given duration that is ***physically possible*** over a given storm area at a particular ***geographic location*** at a certain time of year (HMR 59, 1999)
- **T**ypes of PMP studies:
  - Generalized (Hydrometeorological Reports)
    - Provides PMP values for a region
    - HMR 51 - East of the 105th Meridian from Canada to Mexico
  - Regional/Statewide
    - Provide PMP values over regions with varying topography
    - Individual basins are included in the regional/statewide results
  - Site-Specific
    - Provides PMP values for individual drainage basins
    - Considers unique meteorology and topography

Coverage of HMRs



How Do PMP Studies Provide Improved PMP Values?

- More storms considered
- New technologies used
- Problems/Unknowns in the HMRs corrected
- Topographic features addressed
- Updated climatologies used

Method for Computing PMP Values

- Observed extreme rainfall events are used
  - Storm based approach
- Identify extreme storms in Texas and regions that are considered transpositionable
  - Identify recent extreme storms since publication of the appropriate HMRs
  - Review older rainfall data records
- Identify extreme storm types
  - Local storms (thunderstorms/Mesoscale Convective Systems (MCS))
  - General storms (frontal systems)
  - Hurricanes/Tropical Systems

Method for Computing PMP Values

- Identify unique topography
  - Precipitation enhancement/decrease
    - Orographic effect
- Review HMR/Hydro/Tech Memo procedures
  - Identify inconsistent assumptions
  - Apply new technologies and data
  - Apply new/updated methods

Applied Weather Associates

PMP Study for Texas

Project Overview

- Comprehensive evaluations of extreme rainfall storm events
  - Extreme rainfall storm identification
  - Storm analyses
  - Storm maximization
  - Storm transpositioning
- Synoptic extreme rainfall (General Storms/ Tropical Storms)
- Thunderstorms and Mesoscale Convective System (MCS)

PMP Study for Texas

Background

- PMP values as provided in HMRs are overdue for updating
  - Storm data base grossly out of date (1970s)
  - Procedures used to analyze storms outdated
  - PMP values generally unreasonably conservatism
- Provide greater confidence, credibility, and more accurate/reliable values
- Apply updated meteorological understanding and techniques

PMP Study for Texas

Procedure

- Update the storm database
  - Produce Depth-Area-Duration (DAD) analyses for all major storm events
- Use updated dew point/sea surface temperatures to maximize storms
  - Storm representative & maximum dew points/SSTs
- Use of state-of-the-science procedures and tools
  - GIS & Geographic Transposition Factor
- Provide PMP values for all locations within Texas
  - All locations considered in this study
  - All durations and area sizes as required
- Utilize GIS to produce PMP on a gridded basis

PMP Study for Texas

Procedure

- Follow the basic procedures used in previous AWA studies
  - Nebraska, Arizona, Ohio, Wyoming statewide PMP studies
  - Numerous individual basin PMP studies (Tarrant Regional Water District)
  - Michigan and Wisconsin, Texas regional PMP
- Incorporated storms through May 2016
- Used GIS to provide efficient and effective distributions of PMP values across the Texas
- PMP to provide continuity of PMP values across the region in space and time while taking into considerations differences in topography and climate

Issues to Consider

- Storm Search Processes
  - Direct tropical system landfall limits
  - Seasonality of storm types
  - PMP storm type-General-Tropical-Local
- Orographic vs Non-orographic
  - Balcones Escarpment
  - Basin and Range of West Texas
- Large size and complexity
  - Subtle changes from east to west and north to south
- Transposition limits
  - Similarity of meteorology, topography
  - Different parameters depending on
    - Storm type, moisture source, intervening barriers
    - Proximity to the coast

PMP Study for Texas

Task 1

Review of previous studies for applicability

1. AWA PMP studies (e.g Nebraska, Ohio, Arizona, Wyoming, Tarrant, Arkansas Nuclear One, Quad Cities, etc)
2. HMRs 33, 51, 52, 53, etc
3. USACE and USGS storm and flood analyses

PMP Study for Texas

Task 2

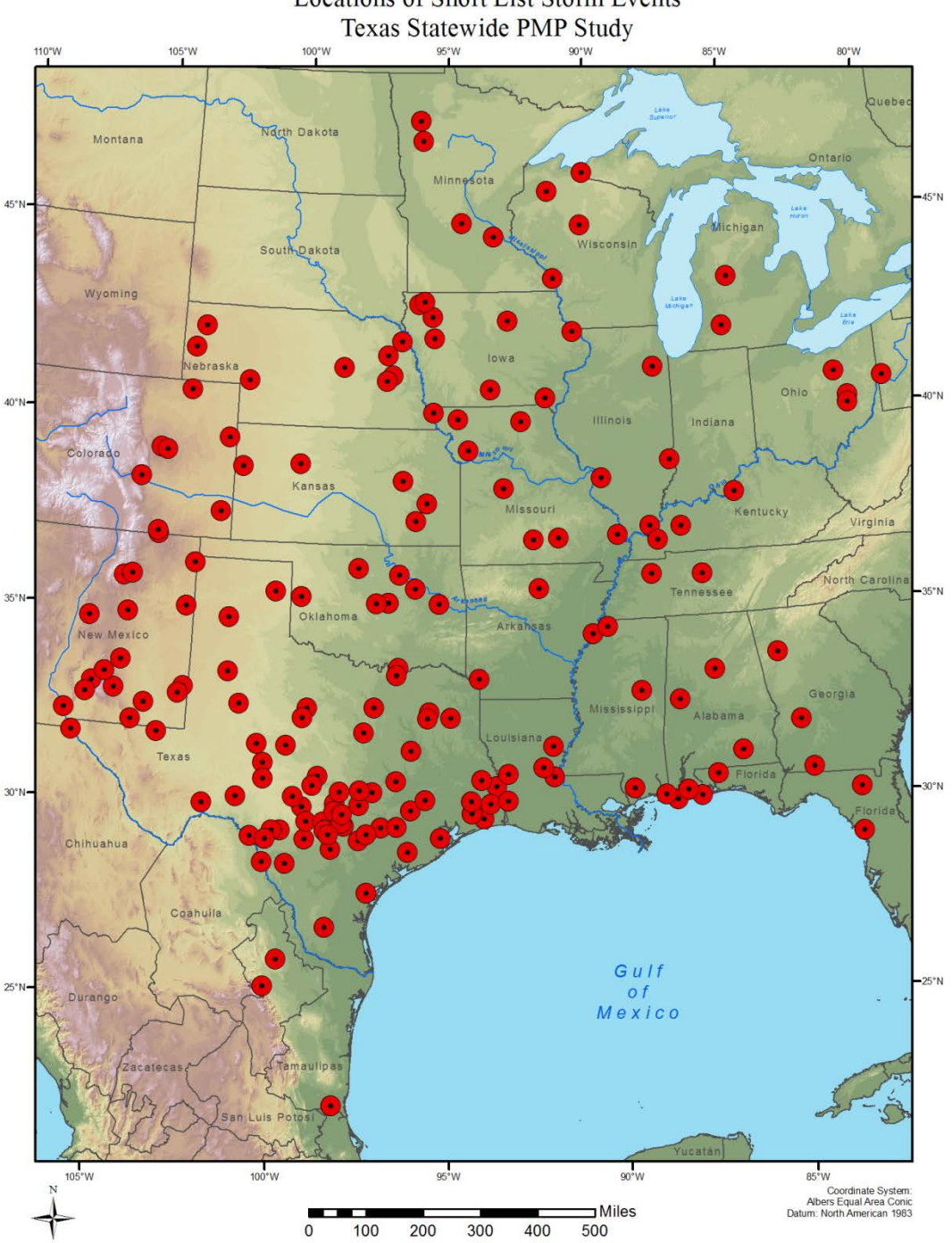
Storm Search and Short List Development

- Complete a storm search to identify the most significant storms that could have occurred over the region where storms are transpositionable to Texas
- Identify storms used in HMRs and other PMP studies
- Identify the most significant flood events that have occurred in region
- Identify extreme rainfall-producing storm types and seasons associated with those storms
- Use the Storm Precipitation Analyses System (SPAS) to analyze extreme rainfall events that have not previously been analyzed
- Use SPAS to reanalyze extreme rainfall events

Storm Search Domain
Texas PMP Study

Coordinate System: GCS WGS 1984
Datum: WGS 1984

Storms used for PMP Development



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Task 3

SPAS Storm Analysis

- All storms used for PMP develop analyzed with SPAS
- SPAS produces gridded rainfall analysis and required data sets
- USACE storms will need to be re-analyzed

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Task 4

Storm Maximizations/Transpositioning

- Utilize the updated maximum dew point climatology for use in storm maximization and transpositioning
- Maximum average dew point values
  - 6-hour
  - 12-hour
  - 24-hour
- Sea Surface Temperatures (SST) climatology for some events

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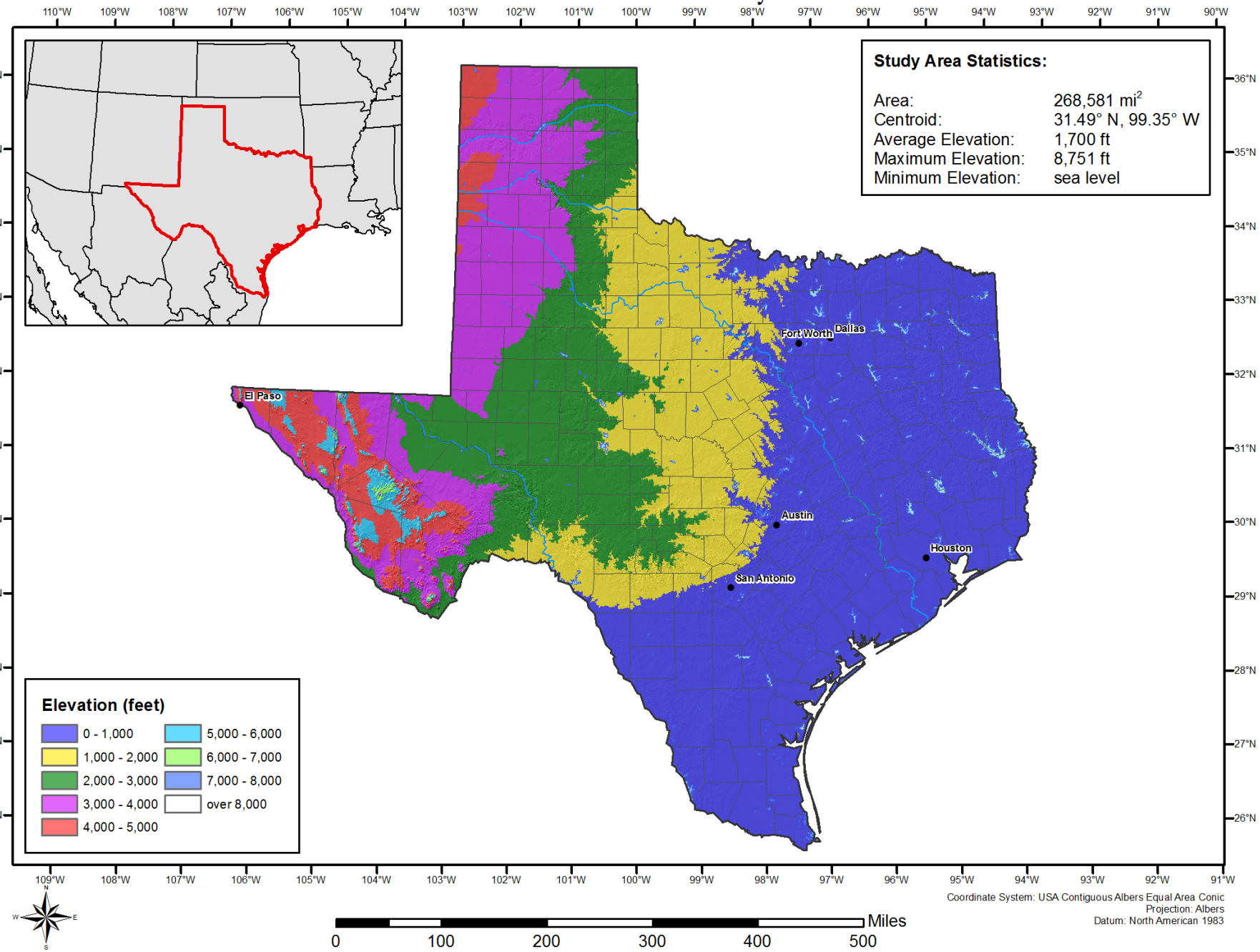
Task 5

Orographics and Grid Domain Analysis

- Develop total adjustment factors on a gridded basis
  - 2.5-square miles
  - Utilize storm Depth-Area-Duration data
  - Each storm explicitly transpositioned to each grid as appropriate
  - Allows for differences across state to be quantified
  - Each adjustment known and reproducible

Elevation Statistics
Texas Statewide PMP Study



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Task 6

Develop PMP

- Values will be provided on a gridded basis or other format
- Appropriate durations, 1-hr, 6-hr….as needed
  - Not confined to 72-hrs
  - ~2.5mi^2
- Analyze the orographic effects of elevated terrain
- Transposition limits for each storm will be determined
  - Use the procedures developed in previous PMP studies
  - Precip frequency data to calculate the Geographic Transposition Factor
    - Corrects stippled region in HMR 51/52

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Task 7

Storm Based Hydrology Application

- Work with users to provide PMP rainfall information as needed
- Updated temporal distributions
- Other rainfall characteristics

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Task 8

Quality Control and Sensitivity

- Compare results
    - HMR PMP values
    - Precip frequency data
    - Other PMP studies
- Discuss sensitivity of various parameters and assumptions on the final PMP values

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Task 9

Final Report

- A Draft final report will be submitted for review by the Peer Review Committee
- Review comments will be incorporated into a comprehensive final report as appropriate
- An appendix will be provided with all storm details and calculations used to determine the PMP values throughout Texas
- Maps of PMP values will be provided both in the report as well as in GIS format

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Task 10

Review Meetings

- Meetings will be held with the peer Review committee to present and review the approach and procedures to be used as well as work completed
- Four have been held to date
- Additional data has been provided by the committee members

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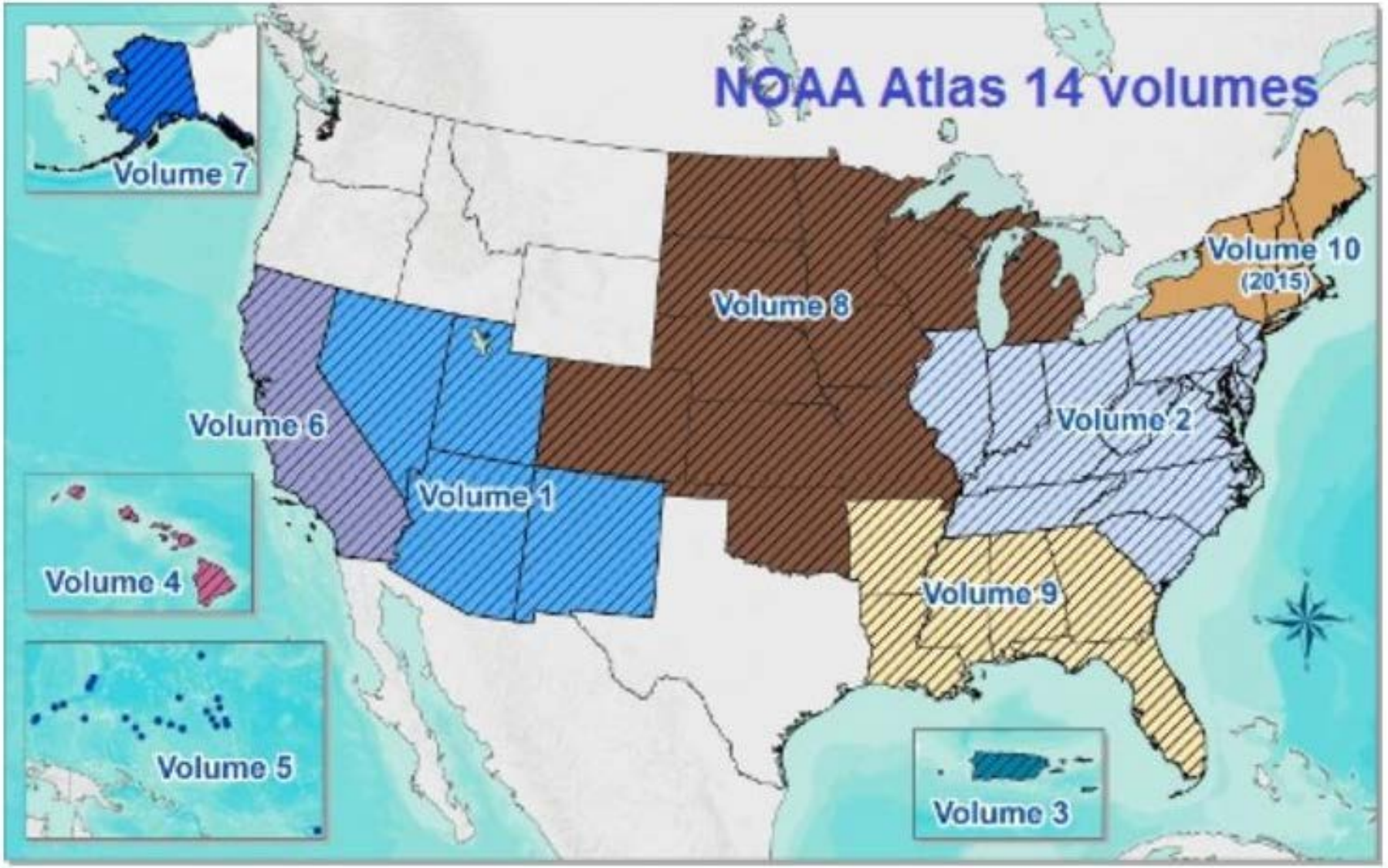
Task 11

Updated Precip Frequency

- Build from extensive previous work
  - Dr. William Asquith's publications
  - Southern Regional Climate Center
- Follow same methodology as NOAA Atlas 14
- 6hr and 24hr data used for PMP calculations

NOAA Atlas 14 Precip Frequency Coverage

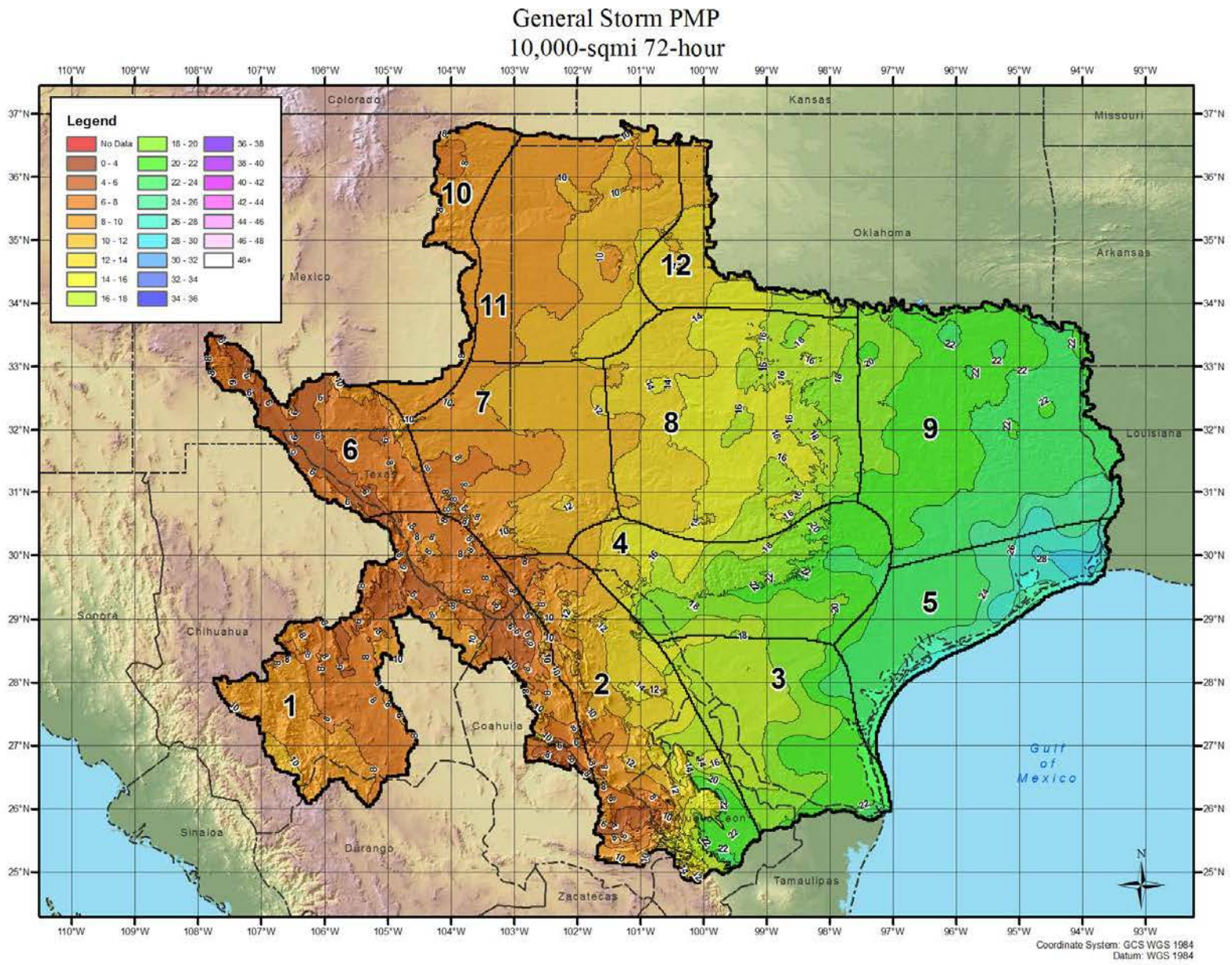


Probable Maximum Precipitation Study for Texas

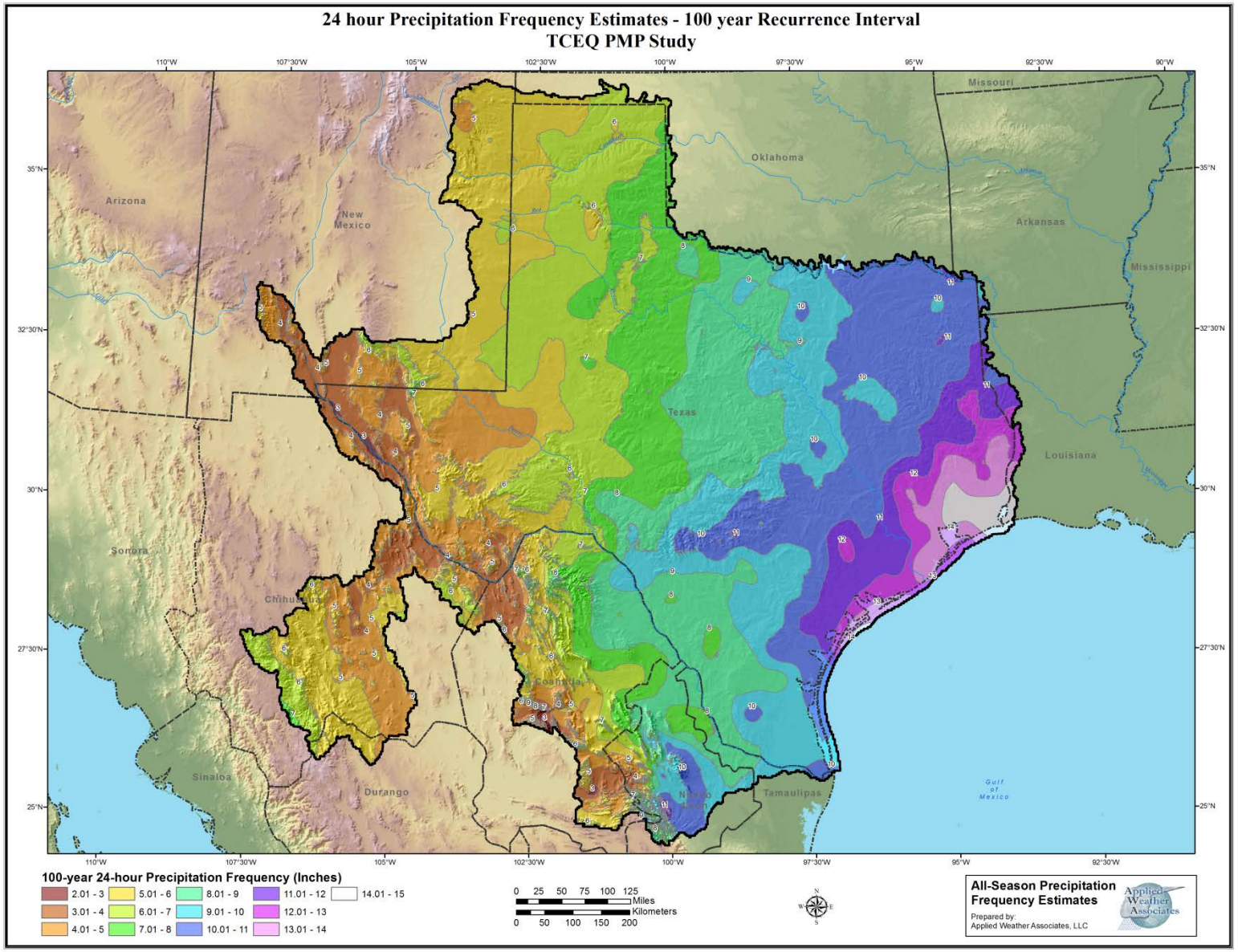
Results

- Updated PMP values for all locations
  - By storm type
    - Local, general, tropical
    - All area sizes and durations from 1-hr through 72-hours
  - Applied most current storm data and meteorological analyses
- Updated, gridded precipitation frequency climatology for entire region
  - 6- and 24-hour thru 1000-yr ARI

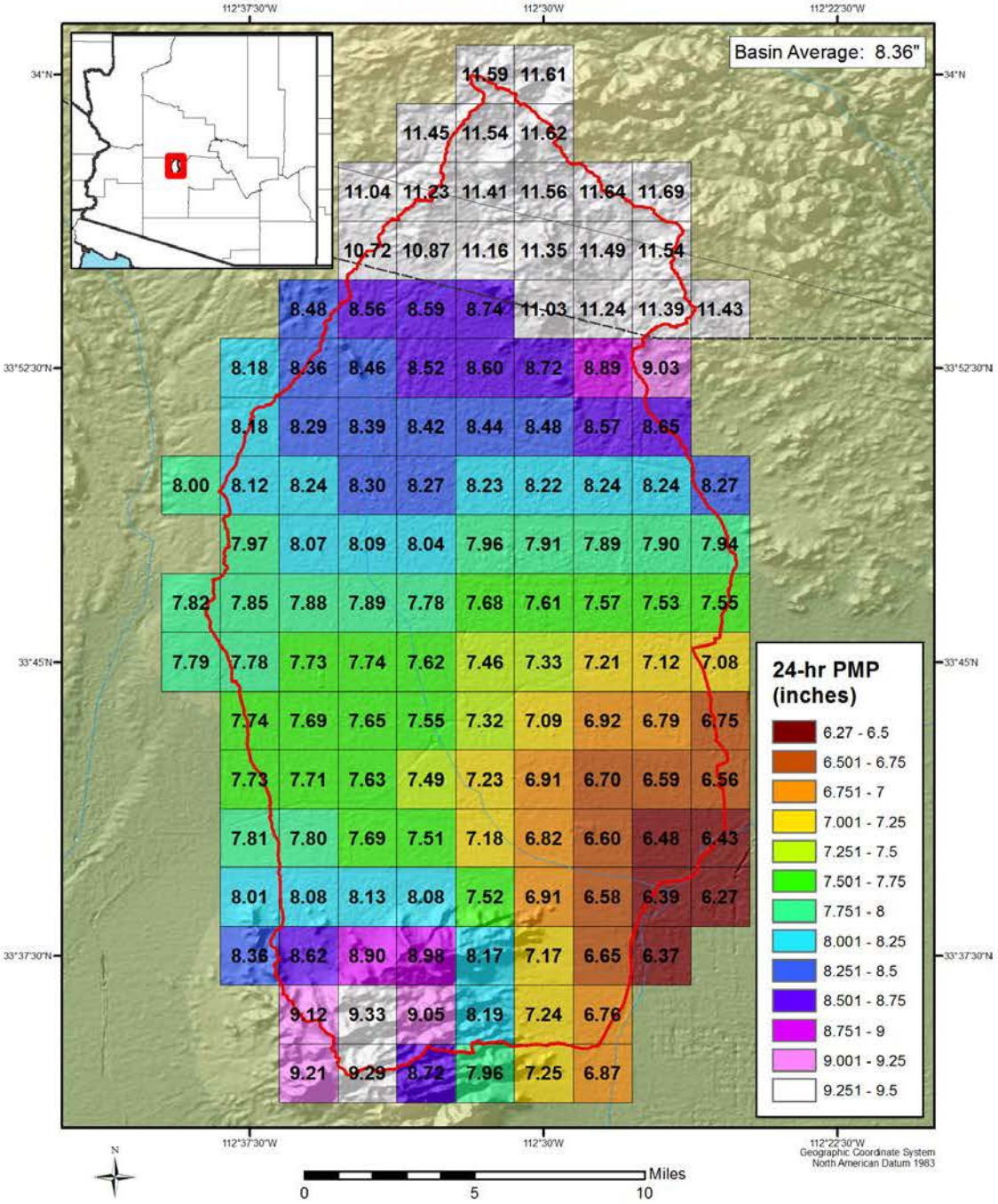
Example PMP Map-DRAFT



Precipitation Frequency Map



Tropical Storm 24-hour PMP (inches)
McMicken Dam Basin



What is next

- Prepare final report for per review team to review and provide final comments to TCEQ.
- TCEQ to develop method for making report and GIS grids available

When will it be available

- The report will be online first
- The maps will be available later
- TCEQ will maintain the data

Product

- You must have GIS capabilities
- Our initial plan is that you will submit a polygon of the drainage area
- We will provide the precipitation data for the drainage area.

Proposed date available

- We plan to have everything working by Jan. 1, sooner if possible.
- We will make it known when it is finally available and working

Grace Period

- We will allow at least 6 months from the date the system is working (July 1 if the date is Jan. 1) to use the new PMP
- We do not plan to change the temporal distribution at this time.

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Questions