**TRANSPORTATION POOLED FUND PROGRAM**

**QUARTERLY PROGRESS REPORT**

Lead Agency (FHWA or State DOT): \_\_\_**FHWA**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**INSTRUCTIONS:**

*Project Managers and/or research project investigators should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.*

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| **Transportation Pooled Fund Program Project #**  TPF-5(475) | | **Transportation Pooled Fund Program - Report Period:**  □ Quarter 1 (January 1 – March 31)  X Quarter 2 (April 1 – June 30)  □ Quarter 3 (July 1 – September 30)  □ Quarter 4 (October 1 – December 31) | |
| **Project Title:**  Update Precipitation Frequency Estimates for Delaware, Maryland, North Carolina, Virginia, Pennsylvania, and South Carolina (NOAA Atlas 14, Vol. 13) | | | |
| **Name of Project Manager(s):**  Megan Frye | **Phone Number:**  (303) 396-9847 | | **E-Mail**  megan.frye@dot.gov |
| **Lead Agency Project ID:**  FHWA | **Other Project ID (i.e., contract #):** | | **Project Start Date:**  March 19, 2021 |
| **Original Project End Date:**  June 2024 | **Current Project End Date:**  December 2025 | | **Number of Extensions:** |

Project schedule status:

□ On schedule □ On revised schedule □ Ahead of schedule X Behind schedule

Overall Project Statistics:

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| **Total Project Budget** | **Total Cost to Date for Project** | **Percentage of Work**  **Completed to Date** |
| $1,802,000 | $553,528 | 31% |

***Quarterly*** Project Statistics:

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| **Total Project Expenses**  **and Percentage This Quarter** | **Total Amount of Funds**  **Expended This Quarter** | **Total Percentage of**  **Time Used to Date** |
| $59,829 / 3% | $59,829 | 66% |

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| **Project Description**:  The purpose of this project is to update precipitation frequency estimates for Delaware, Maryland, North Carolina, Virginia, Pennsylvania, and South Carolina published in NOAA Atlas 14 Volume 2. Like previous NOAA Atlas 14 volumes, the estimates and associated bounds of 90% confidence intervals will be provided at 30 arc-sec resolution for durations of 5-minute through 60-day at average recurrence intervals (ARIs) of 1-year through 1,000-year.  The study results will be published as NOAA Atlas 14 Volume 13, a wholly web-based publication available at Precipitation Frequency Data Server (PFDS). The publication will include the artifacts provided in previous NOAA Atlas 14 Volumes, including access through the PFDS, base grids in standard formats together with error estimates, electronic copies of maps, charts of seasonal distributions and probabilistic temporal distributions of heavy precipitation, and detailed documentation.  Updated areal reduction factors, which are needed to calculate analogous areal precipitation frequency estimates, will not be developed as a part of this project. |

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| **Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):**  NOAA continued to work on the cleanup software and initiated the manual station cleanup for the co-located NCEI networks. In addition, they continue quality controlling the station metadata and high outlier checks. Finally, NOAA continue investigating the development of the mean annual maxima grids for this project area.  Additional information on the status of the Atlas 14, Volume 13 work is available at:  https://www.weather.gov/owp/hdsc\_current\_projects |
| **Anticipated work next quarter**:  NOAA will continue with data collection, reformatting, cleanup, and data quality checks for NCEI stations. In parallel, NOAA will continue to evaluate the spatial covariates, and will start investigating the regionalization approach for this project area. |

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| **Significant Results:**  **Data collection and data screening -** NOAA continues to format and quality control the identified precipitation networks (see Table 2) that are considered for the development of the Atlas 14 Volume 13 estimates. As with all NOAA Atlas 14 Volumes, the primary source of data is the NOAA’s National Centers for Environmental Information Hydrometeorological Design Studies Center Progress Report, October 2024 10 (NCEI). The NCEI is the most reliable data source network in the United States. The NCEI’s precipitation data alone may not be sufficient to support the objectives of NOAA Atlas 14. Since the NOAA Atlas 14 estimates are based on the statistical analysis of the historical record of the observed precipitation data, denser spatial coverage may be needed to compute the robust and reliable precipitation frequency estimates. Therefore, for each project area, NOAA also collect digitized data measured at 1-day or shorter reporting intervals from other Federal, State and local agencies. During this reporting period, NCEI datasets were updated through water year 2024.  M**ean Annual Maxima (MAM) grids for base durations -** During this reporting period, NOAA continued to explore in-house development of mean annual maxima (MAM) grids for this project area. Using stepwise multiple regression, NOAA is attempting to determine the most critical covariates in this project area based on mean squared error and 𝑅𝑅² to derive the mean annual maxima grids that we can then use to interpolate at-station regional estimates to 30-arc-sec grids, following the NOAA Atlas 14 interpolation process.  For this analysis, NOAA has identified several different spatial covariates, belonging to three different categories: static variables, taken directly from source datasets (e.g., elevation, slope, aspect, latitude, longitude, and distance to coast); derived variables, based on journal publications (e.g., southness, eastness, height above local terrain, and nearby surface water proportion, a.k.a. "lake effect index"); and model/climatology based variables (e.g., PRISM mean annual precipitation, MAM derived from NCAR’s CONUS404). Initial analysis selects 7 of 11 covariates, including MAM grids derived from NCAR’S CONUS404. Using stepwise multiple regression with background error correction via ordinary kriging, this initial analysis produced a cross-validation 𝑅𝑅² ≈ 0.90. Error standard deviations are ±6-7% over the Volume 13 area for 1-day duration. In the next reporting period, NOAA will continue evaluating spatial covariates selected and will extend the analysis to other base durations needed for development of preliminary estimates.  **Extraction and quality control of annual maximum series outliers –** The precipitation frequency analysis approach used in this project is based on AMS analysis across a range of durations. AMS for each station whose data were formatted were obtained by extracting the highest precipitation amount for a particular duration in each successive calendar year. AMS at stations formatted during this period were extracted for all durations equal to or longer than Hydrometeorological Design Studies Center Progress Report, October 2024 12 the base duration (or reporting interval) up to 60 days. The criteria for extraction were designed to exclude maxima if there were too many missing or accumulated data during the year, especially during critical months when precipitation maxima were most likely to occur. All annual maxima that resulted from accumulated data were flagged and screened to ensure that the incomplete data did not result in erroneously low maxima. Since AMS data at both high and low extremities can considerably affect precipitation frequency estimates, they have to be carefully investigated and either corrected or removed from the AMS if due to measurement errors.  In this reporting period, NOAA started the daily AMS quality control task using different statistical tests to identify high and low outliers in the distribution of at-station precipitation AMS. All identified outliers and other questionable maxima at base durations (1-hour and 1-day) are now being verified. First, they are mapped with concurrent measurements at nearby stations. If the values cannot be confirmed from similar measurements at nearby stations, they are investigated further using information from monthly climatological data publications, cooperative observation forms, historical storm reports, surface weather observations and monthly storm data reports obtained primarily from NCEI’s Image and Publications Service/Common Access system and NERMS (NCEI Environmental Record Management System). Gridded precipitation products and other NEXRAD radar products are also used in some cases to verify and help disprove events for areas with good radar coverage. |
| **Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that**  **might affect the completion of the project within the time, scope and fiscal constraints set forth in the**  **agreement, along with recommended solutions to those problems).**  Delay in finalizing the IAA with NOAA. Estimated timeline to complete the work is late 2025 now.  Current schedule:   * Data collection, formatting, and initial quality control [Q1 2025; In Progress] * Extraction of annual maximum series (AMS); additional quality control and data reliability tests (e.g., outliers, independence, consistency across durations, duplicate stations, candidates for merging)] [Q1 2025; In Progress] * Regionalization and frequency analysis [Q1 2025; In Progress] * Initial spatial interpolation of precipitation frequency (PF) estimates and consistency checks across durations [Q2 2025; In Progress] * Peer review [Q2 2025; In Progress] * Revision of PF estimates [Q2 2025] * Remaining tasks (e.g., development of precipitation frequency estimates for partial duration series, seasonality, temporal distributions, documentation) [Q4 2025] * Web publication [Q4 2025] |

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| **Potential Implementation:**  All deliverables will be accessible through the Precipitation Frequency Data Server (PFDS). That includes:   * Interactive map of the United States. Via this map, IDF/DDF tables and curves will be available for any location in the project area. * Precipitation frequency grids in GIS compatible formats. * Metadata in Federal Geographic Data Transfer Standard format. * Cartographic maps of precipitation frequency estimates. * Charts of the seasonal distribution of annual maxima * Probabilistic temporal distributions for 6-hour, 12-hour, 24-hour, and 96-hour durations in both chart and digital form * Rainfall frequency estimates with corresponding upper and lower bounds of 90% confidence intervals will be available at 30-arc sec grid for durations of 1, 2, 3, 6, 12 and 24 hours. |