**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)  □ Quarter 2 (April 1 – June 30)  X 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 | $653,728 | 36% |

***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** |
| $100,200 / 6% | $100,200 | 72% |

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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 completed the modernization of the station 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, and data quality checks for NCEI stations. In parallel, they will continue to evaluate the spatial covariates, and will start investigating the regionalization approach for this project area. |

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| **Significant Results:**  **Station metadata screening** - All NCEI datasets have been prescreened using the Python-based software that has been developed to modernize and automate our station metadata quality control process. Only stations that have failed two tests: elevation differences between the station metadata and DEM over 150 m and locations outside of the 1-minute precision box, were manually inspected for the metadata corrections. In this reporting period, NOAA continues to perform manual metadata inspection for datasets formatted and thus far completed the 95% of the metadata checks for all networks.  **Station Cleanup -** The station cleanup effort is performed to:   * screen for duplicate records * extend records at longer-duration stations using data from nearby stations * investigate large differences in annual maximum series (AMS) at collocated stations at critical * durations such as 1-hour and 1-day * implement data corrections to ensure data consistency across multiple gauges * determining if overall datasets are of good quality and should be used in the analysis   In this reporting period, NOAA investigated ways to automate station cleanup procedures to screen stations with a short period of record prior manual cleanup and quality control process. NOAA started testing on the Global Historical Climatology Network daily (GHCN-daily), specifically merging the CoCoRaHS stations into longer-record GHCN-daily stations, such as from the Cooperative Observer Network (COOP). Though the Community Collaborative Rain, Hail and Snow (CoCoRAHS) Network is relatively new, with shorter record lengths, they are very valuable for filling the gap of steadily decreasing station counts in the COOP network.  NOAA is investigating rules for auto-merging this information, such as:   * Auto-merging stations with no overlap within a small radius (eg. 3-5 km) * Auto-merging stations with overlapping records within a small radius, with a check on the correlation of the overlapping annual maximum series * Considering short-record CoCoRaHS that received a significant precipitation event in the context of nearby stations * Deleting duplicate, or near-duplicate data in data-dense areas   Stations failing correlation checks or having significantly different statistics will still be considered for merging in a manual round of cleanup. Rules for auto-merging stations will be finalized and applied in the next reporting period.  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) precipitation grids for this project area. By comparing skill metrics such as mean squared error and 𝑅𝑅², NOAA has identified the most critical covariates to include in stepwise multiple regressions to generate background MAM analyses. They have developed an ordinary kriging process to correct errors correlated over large spatial scales (typically 100-200 km) in that background, and demonstrated, via leave-one-out cross validation, that the combination of stepwise multiple regression and ordinary kriging produces error metrics that are similar, and at times slightly improved, relative to the PRISM based framework of previous Atlas 14 Volumes. NOAA has evolved the code so different configurations can be stored and executed repeatedly using YAML configuration files, and maintained this code in a GitHub repository to benefit collaboration.  For the next quarter, NOAA will generate configurations to produce MAM analyses for several durations (1 hour, 6 hours, 24 hours, and 10 days). They will also implement a third analysis (to follow the ordinary kriging step) which will adjust small-scale (50-100 km) residual errors in the analysis to better match station values. The MAM grids produced by that final step can then be used to interpolate at-station regional precipitation frequency estimates to 30 arc-sec grids, following the NOAA Atlas 14 interpolation process. NOAA will continue using cross-validation methods to optimize configurations and evaluate the results of our MAM analyses, and will continue managing the code produced for this effort (mostly Python) on GitHub.  **Extraction and quality control of annual maximum series outliers -** During this reporting period, the NCEP/EMC 4KM Gridded Data (GRIB) Stage IV Data was used to aid in discovery of “dry” hourly periods in the station precipitation data, in areas of sufficient radar coverage for approximately years 2005-present. This was tested on the COOP hourly dataset, in which 399 unflagged values >= 1.00”/hour were identified as likely invalid in the Volume 13 project area.  During the next reporting period, NOAA will confirm the validity of these values, possibly identify more events through additional criteria, and expand the analysis to other sub-daily datasets. |
| **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. |