SEMIARID PRECIPITATION FREQUENCY PROJECT

Update of *Technical Paper No. 49* and *NOAA Atlas 2*

Twenty-ninth Progress Report
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Hydrometeorological Design Studies Center
Hydrology Laboratory

Office of Hydrologic Development
U.S. National Weather Service
National Oceanic and Atmospheric Administration
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The data and information presented in this report are provided only to demonstrate current progress on the various technical tasks associated with this project. Values presented herein are NOT intended for any other use beyond the scope of this progress report. Anyone using any data or information presented in this report for any purpose other than for what it was intended does so at their own risk.

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1. Introduction

The Hydrometeorological Design Studies Center (HDSC), Hydrology Laboratory, Office of Hydrologic Development, U.S. National Weather Service has updated its precipitation frequency estimates for the Semiarid Southwestern United States. Updated precipitation frequency estimates contained in NOAA Atlas 14 Volume 1 "Precipitation Frequency Atlas of the United States" replace those found in *Technical Paper No. 49* "Two- to ten-day precipitation for return periods of 2 to 100 years in the contiguous United States" (Miller et al 1964), *NOAA Atlas 2* "Precipitation-Frequency Atlas of the Western United States" (Miller et al 1973), "Short Duration Rainfall Frequency Relations for California" (Frederick and Miller, 1979) and "Short Duration Rainfall Relations for the Western United States" (Arkell and Richards, 1986) for the Semiarid region. The project included data collection and quality control, dataset formatting, regional frequency analyses, frequency distribution selection and fitting techniques, and spatial interpolation with reports and other documentation to follow.

The project determined annual all-season precipitation frequencies for durations from 5 minutes to 60 days, for average recurrence intervals from 2 to 1,000 years. For the project, HDSC reviewed and processed all available rainfall data for the Semiarid project area and used accepted statistical methods. In particular, the Semiarid Project was the pilot project in which decisions regarding the methods and format were made that affect subsequent projects. The project results are published as Volumes of *NOAA Atlas 14* on the internet (http://www.nws.noaa.gov/ohd/hdsc) with the additional ability to download digital files.

The Semiarid Project includes estimates for 4 states completely, Arizona, Nevada, New Mexico, and Utah, and southeastern California. Additional data from 7 bordering states and Mexico (Figure 1) were included for continuity across state borders. The core and border areas and regional groups used for long duration (24-hour through 60-day) analyses are shown in Figure 1. Regional groups used for short duration (60-minute through 12-hour) analyses are shown in Figure 2.

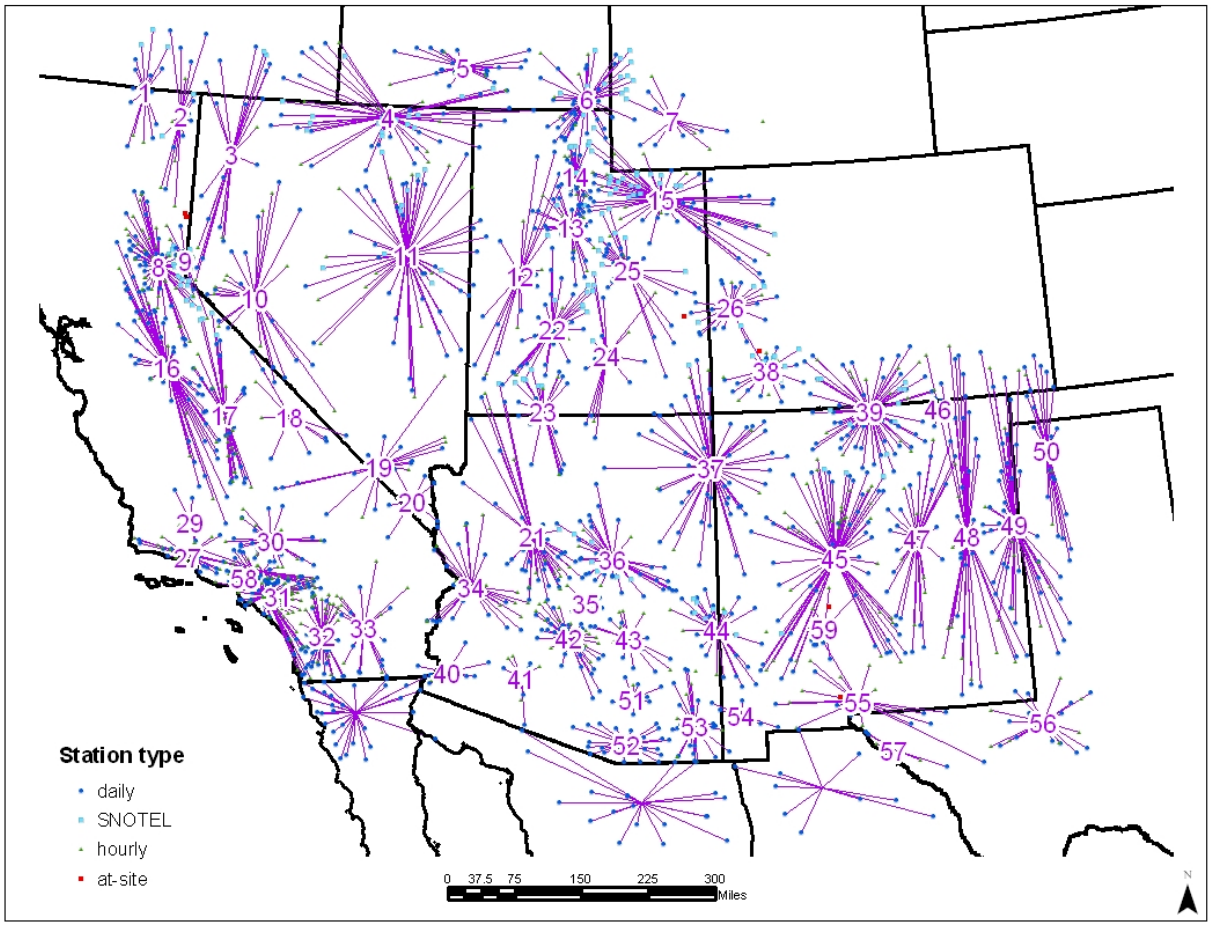


Figure 1. Semiarid Precipitation Frequency project area and 59 regional groups for 24-hour and longer duration values.

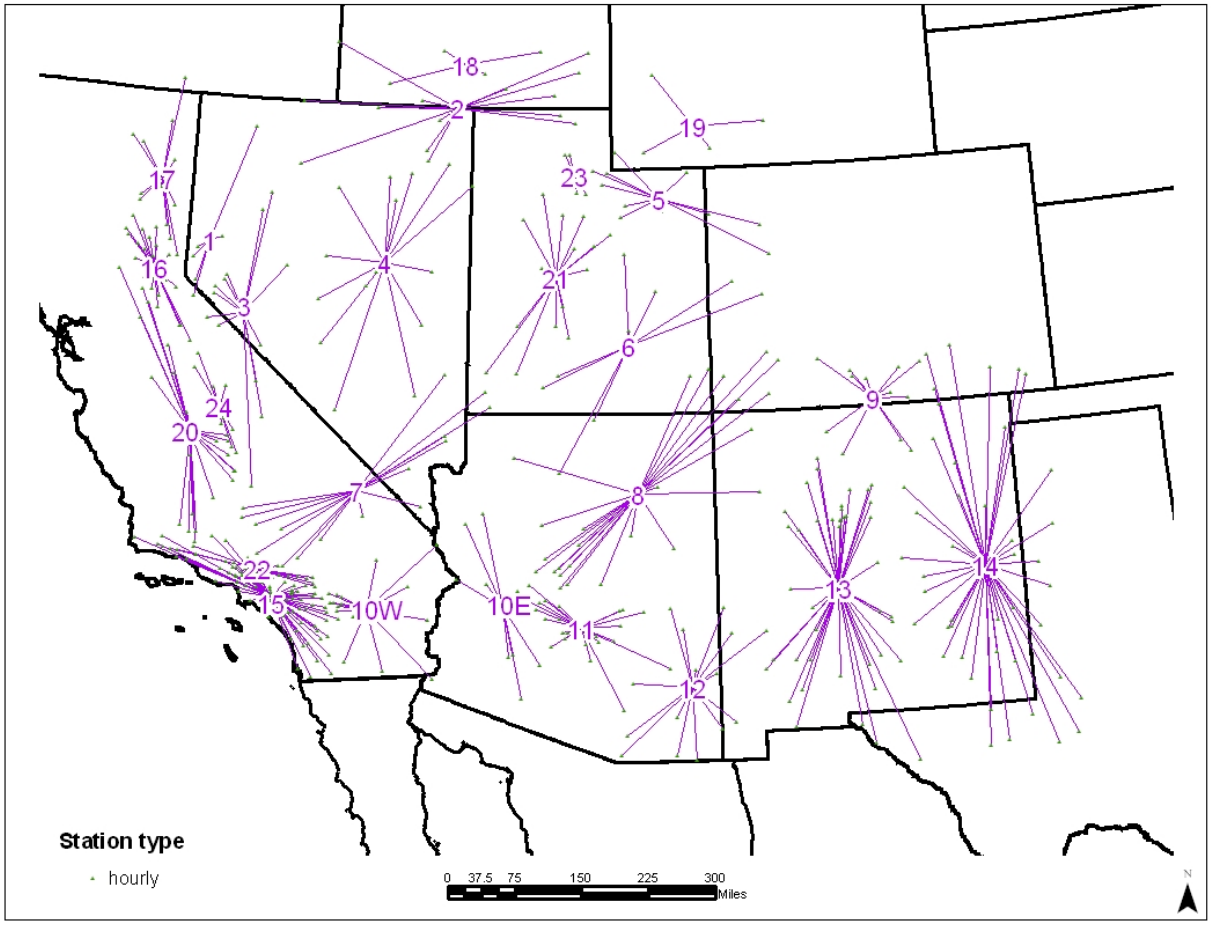


Figure 2. Semiarid Precipitation Frequency 25 regional groups for 12-hour and shorter duration values.

2. Highlights

Validation of the annual maximum series to partial duration series conversion factors was achieved this past quarter. Additional information is provided in Section 3.1, AMS-PDS Conversion Factors.

NOAA Atlas 14 Volume 1 precipitation frequency estimates for the Semiarid Southwestern United States are available via the Precipitation Frequency Data Server at http://hdsc.nws.noaa.gov/hdsc/pfds in various forms and with associated information. Sections of the text for the final documentation of NOAA Atlas 14 have been written and some data has been compiled for final publication. Additional information is provided in Section 3.2, Final Documentation.

The Precipitation Frequency Data Server (PFDS) under went several important changes. Additional information is provided in Section 3.3, Precipitation Frequency Data Server.

All study areas for the areal reduction factor (ARF) development have been selected have been quality controlled. A new site, Clark County, NV, has been identified and will be shortly added to the current list of sites to be used in the A-R-F curve development. There are currently 14 sites located throughout the conterminous US, Hawaii, and Puerto Rico that have been quality controlled, processed and ready for ARF analysis. Software development to process the data and ultimately generate the ARF curves is still underway. Additional information is provided in Section 3.4, Areal Reduction Factors.

3. Progress in this Reporting Period

3.1 AMS-PDS Conversion Factors

A review and validation of the conversion factors used to convert annual maximum series (AMS) results to partial duration series (PDS) results in the Semiarid project area is complete. Ratios for durations of 60-minute, 6-hour, 1-day, and 7-day were calculated, averaged and compared. The best-fitting distributions based on each individual duration in each region were used for both the AMS and PDS data. These were not necessarily the distributions selected for each region based on the 24-hour analysis. The ratios were not significantly different from each other regardless of the duration and were also very close to theoretical estimates. This also implies that the ratio is a "duration-free" conversion factor.

Figure 3 and Table 1 show the calculated ratios for each tested duration. The decision was made to retain the 24-hour ratios (Table 2) as representative of all durations for several reasons including: (1) 24-hour is the most reliable duration, (2) all ratios are within one standard deviation and mostly within the standard error of each duration's results, (3) there were only small differences between the studied durations.

Figure 3: AMS to PDS ratios for 24-hour, 7-day, 6-hour and 1-hour data in the Semiarid Project.

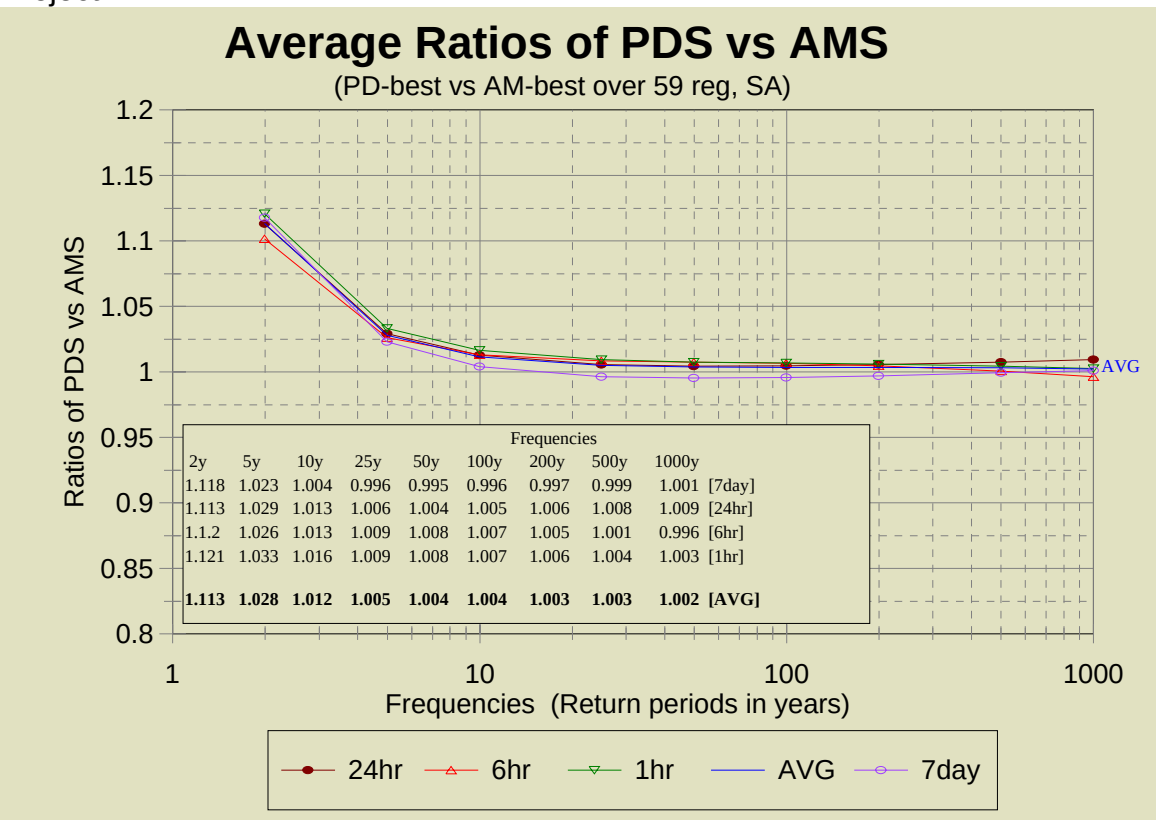


Table 1: Average ratios of PDS vs. AMS ratios for Semiarid Project area.

	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	200-yr	500-yr	1000-yr
7-day	1.118	1.023	1.004	0.996	0.995	0.996	0.997	0.999	1.001
24-hour	1.113	1.029	1.013	1.006	1.004	1.005	1.006	1.008	1.009
6-hour	1.102	1.026	1.013	1.009	1.008	1.007	1.005	1.001	0.996
1-hour	1.121	1.033	1.016	1.009	1.008	1.007	1.006	1.004	1.003
Average	1.113	1.028	1.012	1.005	1.004	1.004	1.003	1.003	1.002

Table 2: Final AMS to PDS ratios for Semiarid data.

2yr	5yr	10yr	25yr	50yr	100yr	200yr	500yr	1000yr
1.113	1.029	1.013	1.006	1.004	1.004	1.004	1.004	1.004

3.2 Final Documentation

NOAA Atlas 14 Volume 1 precipitation frequency estimates for the Semiarid Southwestern United States are available via the Precipitation Frequency Data Server at http://hdsc.nws.noaa.gov/hdsc/pfds. The types of results that are found there include:

1. point estimates (via the point-and-click interface)
2. ArcInfo ASCII grids
3. GIS shapefiles
4. cartographic maps: all possible combinations of frequencies (2-year to 1,000-year) and durations (5-minute to 60-day) for each state
5. associated metadata
6. time series used in the analyses: annual maximum series and partial duration series
7. temporal distributions of extreme rainfall (6-hour, 12-hour, 24-hour and 96-hour)
8. seasonal graphs: counts of events that exceed the 2-year, 10-year, 25-year, 100-year return intervals for the 60-minute, 24-hour, 48-hour, and 10-day durations.

The following matrix (Table 2) illustrates the cartographic maps that are available for each state (Arizona, Southeastern California, Nevada, New Mexico and Utah) in the Semiarid Project.

Table 2: Matrix of cartographic maps available on the PFDS for the Semiarid Project.

Duration \ Return Interval	2-year	5-year	10-year	25-year	50-year	100-year	200-year	500-year	1,000-year
5-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓
10-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓
15-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓
30-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓
60-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓
120-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓
3-hour	✓	✓	✓	✓	✓	✓	✓	✓	✓
6-hour	✓	✓	✓	✓	✓	✓	✓	✓	✓
12-hour	✓	✓	✓	✓	✓	✓	✓	✓	✓
24-hour	✓	✓	✓	✓	✓	✓	✓	✓	✓
48-hour	✓	✓	✓	✓	✓	✓	✓	✓	✓
4-day	✓	✓	✓	✓	✓	✓	✓	✓	✓
7-day	✓	✓	✓	✓	✓	✓	✓	✓	✓
10-day	✓	✓	✓	✓	✓	✓	✓	✓	✓
20-day	✓	✓	✓	✓	✓	✓	✓	✓	✓
30-day	✓	✓	✓	✓	✓	✓	✓	✓	✓
45-day	✓	✓	✓	✓	✓	✓	✓	✓	✓
60-day	✓	✓	✓	✓	✓	✓	✓	✓	✓

Sections of the text, specifically the Preface, Introduction, and Methodology sections have been written and revised. Other sections are currently being written (Spatial Interpolation, Interpretation of Results) for final publication.

3.3 Precipitation Frequency Data Server

The Precipitation Frequency Data Server (PFDS) under went several subtle, but important changes. They include:

1. In order to be consistent and clear, we have adopted the standard terminology proposed by The Institution of Engineers, Australia in the 1987 edition of Australian Rainfall and Runoff for describing precipitation frequency estimates. Therefore, the PFDS output pages now indicate the frequency when using a partial duration series as Average Recurrence Interval (ARI) in units of years. Likewise, the output indicates frequency when using an annual maximum series as Annual Exceedance Probability (AEP) in units of 1 in Y, where Y is dimensionless; for instance, a 100-year frequency is indicated as “1 in 100,” in other words there is a 1 in 100 chance of it being exceeded in any particular year.

2. The text describing the seasonality graphs was changed to be consistent with the new terminology and the 1 in 10 Annual Exceedence Probability (i.e., 10-year) curve was added.
3. The map of the United States on the opening screen of the PFDS, was changed to reflect the areas that have updated precipitation frequency estimates available.
4. The final quality controlled partial duration series data for all stations used in the analysis were added.

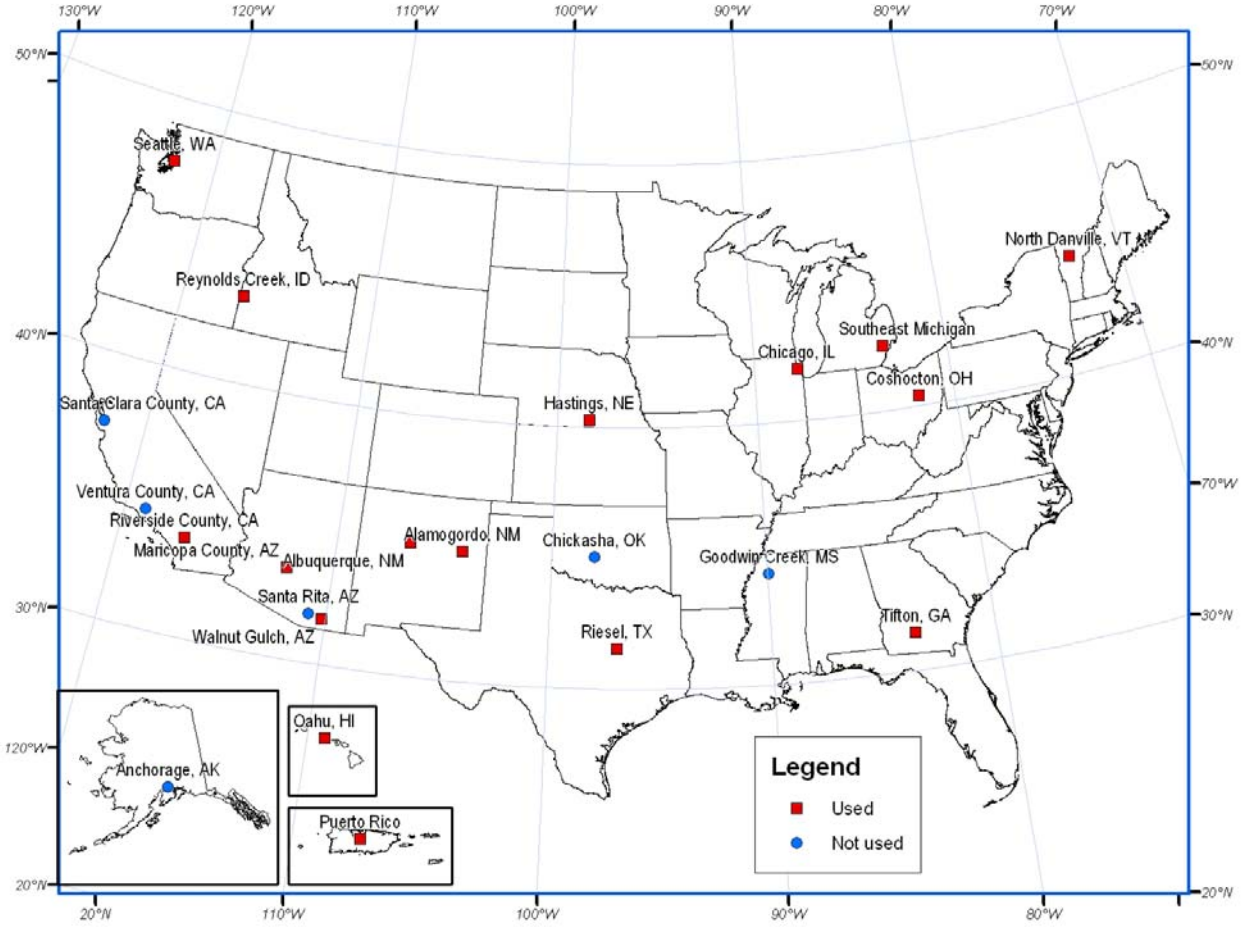
3.4 Areal Reduction Factors Factors

Progress continues in the development of geographically-fixed Areal-Reduction-Factor (ARF) curves for area sizes of 10 to 400 square miles. Development and testing of software from the procedure described in NOAA Technical Report NWS 24 (TR-24) is still underway. A preliminary set of ARF curves for the 2-year return period for the Chicago, IL area study site are consistent with results published in TR-24.

A total of 15 study areas throughout the United States will be used in the study (see Figure 4). The “not used” study areas indicated in Figure 4 were considered but judged inadequate for the study due to poor data, limited or no metadata, or other problems. The set of ARF curves developed for each study area used will be tested for differences to determine if a single set of ARF curves can be used for the entire U.S. as is the case today or whether separate curves for different regions of the country are more appropriate.

Quality control has been performed and completed on the precipitation data from the sites in the southeast Michigan, Albuquerque, and Seattle study areas. A new site, Clark County, NV, has been identified and will be shortly added to the current list of sites to be used in the A-R-F curve development. There are currently 14 sites located throughout the conterminous US, Hawaii, and Puerto Rico that have been quality controlled, processed and ready for ARF analysis.

Figure 4: Map of ARF study areas



4. Issues

4.1 Recent and Upcoming Presentations

Past and future presentations by HDSC, include the following:

- "Statistics of Recent Updates to NOAA/NWS Rainfall Frequency Atlases" at the American Society of Civil Engineers World Water and Environmental Resources Congress on June 29, 2004
- "Recent Updates to NOAA/NWS Rainfall Frequency Atlases" at the California Extreme Precipitation Symposium in Davis, CA on July 1, 2004
- An update of the Ohio River Basin and Surrounding States Precipitation Frequency Project progress at the 84th Meeting of the Ohio River Basin Commission on July 14, 2004
- "Regional Frequency Studies of Annual Extreme Precipitation in the United States Using Regional L-moments Analysis" at the International Ocean-Atmosphere Conference held by the Chinese-American Oceanic and Atmospheric Association (COAA) in Beijing, China on June 27-30, 2004

5. Projected Schedule and Remaining Tasks

The following list provides a tentative schedule with completion dates. Brief descriptions of tasks being worked on next quarter are also included in this section.

Final Report [August 2004]
Areal Reduction Factors [August 2004]

5.1 Documentation

Final documentation will be completed during the next quarter and published on-line through the Precipitation Frequency Data Server.

5.2 Areal Reduction Factors (ARF)

Computations for the ARF curves will be completed in the next quarter for 15 areas. The resulting curves will be tested for differences to determine if a single set of ARF curves is applicable to the entire U.S. or whether curves vary by region.

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